ENGINEERING TOMORROW

Service Guide
Enclosures B1–B4 and C1–C4

VLT® HVAC Drive FC 102 • VLT® Refrigeration Drive FC 103 • VLT® AQUA Drive FC 202 • VLT® AutomationDrive FC 300

vlt-drives.danfoss.com

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1 Introduction

1.1 Purpose

This guide provides service information for drives in B1–B4 and C1–C4 enclosures. It is intended to be used by qualified technicians to identify faults and perform repairs.

The guide includes the following information:

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

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1.2 Additional Resources

Additional resources are available to understand advanced drive functions and programming.

- The programming guide provides greater detail on working with parameters and shows many application examples.
- The design guide provides detailed information about capabilities and functionality to design motor control systems.
- The operating guide provides information required to install and commission the drive.
- The *Safe Torque Off Operating Guide* provides detailed specifications, requirements, and installation instructions for the Safe Torque Off function.
- Supplementary publications and manuals are available from Danfoss. See *www.danfoss.com/en/search/?filter=type%3Adocumentation* for listings.

1.3 Abbreviations and Acronyms

°C	Degrees Celsius
°F	Degrees Fahrenheit
Ω	Ohm
AC	Alternating current
ACP	Application control processor
AWG	American wire gauge
AMA	Automatic motor adaptation
CPU	Central processing unit
CSIV	Customer-specific initialization values
CT	Current transformer
DC	Direct current
DVM	Digital voltmeter
EEPROM	Electrically erasable programmable read-only memory
EMC	Electromagnetic compatibility
EMI	Electromagnetic interference
ESD	Electrostatic discharge
ETR	Electronic thermal relay
$f_{M,N}$	Nominal motor frequency
FC	Frequency converter
FPC	Fan power card
HF	High frequency
HVAC	Heating, ventilation, and air conditioning
Hz	Hertz
I_{LIM}	Current limit
I_{INV}	Rated inverter output current
$I_{M,N}$	Nominal motor current
$I_{VLT,MAX}$	Maximum output current
$I_{VLT,N}$	Rated output current supplied by the drive
IEC	International electrotechnical commission
IGBT	Insulated-gate bipolar transistor
I/O	Input/output
IP	Ingress protection
kHz	Kilohertz
kW	Kilowatt
L_d	Motor d-axis inductance
L_q	Motor q-axis inductance
LC	Inductor-capacitor
LCP	Local control panel
LED	Light-emitting diode
LOP	Local operation pad
mA	Milliamp
MCB	Miniature circuit breakers
MCO	Motion control option
MCP	Motor control processor
MCT	Motion control tool
MDCIC	Multi-drive control interface card
mV	Millivolts

NEMA	National Electrical Manufacturers Association
NTC	Negative temperature coefficient
$P_{M,N}$	Nominal motor power
PCB	Printed circuit board
PE	Protective earth
PELV	Protective extra low voltage
PID	Proportional integral derivative
PLC	Programmable logic controller
P/N	Part number
PROM	Programmable read-only memory
PS	Power section
PTC	Positive temperature coefficient
PWM	Pulse width modulation
R_s	Stator resistance
RAM	Random-access memory
RCD	Residual current device
Regen	Regenerative terminals
RFI	Radio frequency interference
RMS	Root means square (cyclically alternating electric current)
RPM	Revolutions per minute
SCR	Silicon controlled rectifier
SMPS	Switch mode power supply
S/N	Serial number
STO	Safe Torque Off
T_{LIM}	Torque limit
$U_{M,N}$	Nominal motor voltage
V	Volt
VVC	Voltage vector control
X_h	Motor main reactance

Table 1.1 Abbreviations, Acronyms, and Symbols

1.4 Conventions

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

1.5 Document and Software Version

This guide is regularly reviewed and updated. All suggestions for improvement are welcome. *Table 1.2* shows the document and software versions.

Edition	Remarks
MG94E1xx	Initial release.

Table 1.2 Document Version

Product name and series	Software version
VLT® HVAC Drive FC 102	4.44
VLT® Refrigeration Drive FC 103	1.51
VLT® AQUA Drive FC 202	2.70
VLT® AutomationDrive FC 302	7.60

Table 1.3 Software Version

1.6 Approvals and Certifications

The following list is a selection of possible type approvals and certifications for Danfoss drives:

CE	ErP READY	
TÜVRheinland CERTIFIED Functional Safety Type Approved www.tuv.com ID 0600000000	TÜV SÜD	
c UL us	EAC	089
OSHPD	DNV·GL	ABS FOUNDED 1862
BUREAU VERITAS 1828	ClassNK	LR
		RINA 1861

NOTICE

The specific approvals and certification for the drive can be found on the nameplate. For more information, contact the local Danfoss office or partner.

For more information on UL 508C thermal memory retention requirements, refer to the *Motor Thermal Protection* section in the design guide. For more information on compliance with the European Agreement concerning International Carriage of Dangerous Goods by Inland Waterways (ADN), refer to the *ADN-compliant Installation* section in the design guide.

1.7 Disposal

	Do not dispose of equipment containing electrical components together with domestic waste. Collect it separately in accordance with local and currently valid legislation.

2 Safety

2.1 Introduction

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

2.2 Safety Symbols

The following symbols are used in this guide:

⚠WARNING

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

⚠CAUTION

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

NOTICE

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

2.3 Qualified Personnel

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

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

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

2.4 Safety Precautions

⚠WARNING

HIGH VOLTAGE

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

- **Only qualified personnel must install, start up, and maintain the drive.**

⚠WARNING

UNINTENDED START

When the drive is connected to the AC mains, DC supply, or load sharing, the motor can start at any time. Unintended start during programming, service, or repair work can result in death, serious injury, or property damage. The motor can start with an external switch, a fieldbus command, an input reference signal from the LCP or LOP, via remote operation using MCT 10 Set-up Software, or after a cleared fault condition.

To prevent unintended motor start:

- **Press [Off/Reset] on the LCP before programming parameters.**
- **Disconnect the drive from the mains.**
- **Completely wire and assemble the drive, motor, and any driven equipment before connecting the drive to the AC mains, DC supply, or load sharing.**

⚠WARNING

DISCHARGE TIME

The drive contains DC-link capacitors, which can remain charged even when the drive is not powered. High voltage can be present even when the warning LED indicator lights are off. Failure to wait for 15 minutes after power has been removed before performing service or repair work can result in death or serious injury.

- **Stop the motor.**
- **Disconnect AC mains and remote DC-link power supplies, including battery back-ups, UPS, and DC-link connections to other drives.**
- **Disconnect or lock PM motor.**
- **Wait 15 minutes for the capacitors to discharge fully. The minimum wait time (15 minutes) is also visible on the product label on top of the drive.**
- **Before performing any service or repair work, use an appropriate voltage measuring device to make sure that the capacitors are fully discharged.**

⚠WARNING

LEAKAGE CURRENT HAZARD

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

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

⚠WARNING

LOAD SHARE DISCONNECT

Load share is a connection between DC circuits of several drives, creating a multiple-drive system to run a single mechanical load. When servicing a drive that is part of a load share application:

- **Turn off all drives in the system via a disconnect.**
- **Wait for the drives to discharge fully, using the longest waiting period required of the drives in the multi-drive system. Refer to the discharge time warning in this section.**

⚠WARNING

EQUIPMENT HAZARD

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

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

⚠WARNING

UNINTENDED MOTOR ROTATION WINDMILLING

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

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

⚠WARNING

SHOCK HAZARD AND RISK OF INJURY

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

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

⚠WARNING

INTERNAL FAILURE HAZARD

Under certain circumstances, an internal failure can cause a component to explode. Failure to keep the enclosure closed and properly secured can cause death or serious injury.

- **Do not operate the drive with the door open or panels off.**
- **Ensure that the enclosure is properly closed and secured during operation.**

WARNING

SHOCK HAZARD

The drive can cause a DC current in the protective earth/ground (PE) conductor and thus result in death or serious injury.

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

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

CAUTION

RISK OF INJURY OR PROPERTY DAMAGE

Do not assume that a motor is wired properly after completed service of the drive. Failure to perform these checks can result in personal injury, property damage, or less than optimal performance.

Check for:

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

CAUTION

HOT SURFACES

The drive contains metal components that are still hot even after the drive has been powered off. Failure to observe the high temperature symbol (yellow triangle) on the drive can result in serious burns.

- **Be aware that internal components, such as busbars, can be extremely hot even after the drive has been powered off.**
- **Exterior areas marked by the high-temperature symbol (yellow triangle) are hot while the drive is in use and immediately after being powered off.**

NOTICE

LIFTING - EQUIPMENT DAMAGE RISK

Incorrect lifting can result in equipment damage.

- **Use lifting lugs where provided.**
- **Prevent uncontrolled rotation.**

2.5 Electrostatic Discharge

NOTICE

STATIC DISCHARGE

When performing service, use proper Electrostatic Discharge (ESD) procedures to prevent damage to sensitive components.

NOTICE

AVOID TOUCH

Do not touch components on the circuit boards. Hold circuit boards by the corners and edges only.

Many electronic components within the drive 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.

3 Product Overview

3.1 Introduction

The VLT® HVAC Drive series is designed for the HVAC market. These drives operate in variable torque mode or constant torque down to 15 Hz and include special features and options designed for fan and pump applications.

The VLT® Refrigeration Drive series is designed for use with refrigeration systems. These drives offer continuous variable speed control and provide energy savings in a range of applications including pumps, fans, compressors, condensers, and evaporators.

The VLT® AQUA Drive series is designed for water and waste water markets. These drives operate in either constant torque or variable torque with limited overload capabilities. Their features and options make them suitable for various water pumping and processing applications.

The VLT® AutomationDrive series is fully programmable for either constant torque or variable torque industrial applications. These drives incorporate a wide range of control and communication options.

These models are available in IP20 (protected chassis), IP21 (Type 1), IP55 (Type XX), and IP66 (Type XX) enclosures.

3.2 Tools Required

Item	Description
ESD protection kit	Wrist strap and mat
Metric socket set	7–19 mm
Socket extensions	100–150 mm (4 in and 6 in)
Magnetic sockets	–
Ratchet wrench	–
Torque wrench	Torque range 0.5–19 Nm (6–170 in-lb)
Torx driver set	T10–T50
Needle nose pliers	–
Screwdrivers	Standard and Phillips

Table 3.1 Tools Required for Disassembling and Assembling Drives

Item	Description
Digital volt-ohm meter (PWM-compatible)	• Rated for true RMS. • Rated for the mains AC voltage and DC-link voltage of the drive. (DC-link voltage = 1.414 x mains voltage). • Supports the diode mode.
Analog voltmeter with safety probe tip extenders	–
Oscilloscope	–
Clamp-on ammeter	Rated for true RMS

Table 3.2 Instruments Recommended for Testing Drives

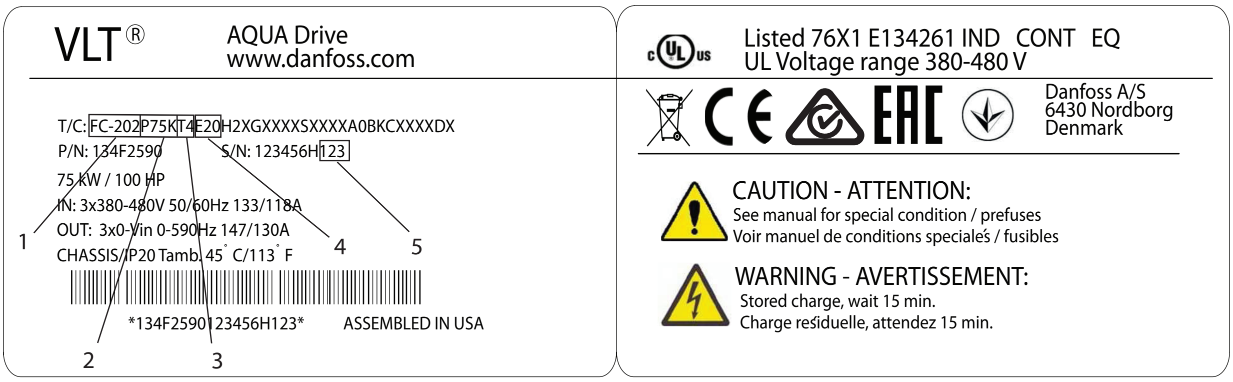
3.3 Service Report

Report the serial number (S/N) of the drive when requesting support or preparing the service report. The serial number is listed on the nameplate. Refer to *Illustration 3.1* for details.

3.4 Enclosure Size Identification

Enclosure size is used in this guide whenever procedures or components differ between drives based on physical size. Find the enclosure size using these steps:

1. Locate the nameplate label. Typically found on either the top of the drive or inside on the bottom shelf.
2. Obtain the following information from the nameplate. See *Illustration 3.1*.
   - 2a Product group and drive series (characters 1–6).
   - 2b Model (characters 7–10).
   - 2c Voltage rating (phases and mains) (characters 11–12).
   - 2d Protection rating of the enclosure (characters 13–15).
   - 2e Date that the drive module was built.
3. Using the data from the nameplate label, find the product group and drive series table.
4. In the 1st column, find the appropriate voltage rating for the drive.
5. In the 2nd column, find the model.
6. In the 3rd column, select the enclosure protection rating. This step identifies the enclosure size.



1	Product group and drive series	4	Protection rating
2	Model	5	Build date (wwy, where ww = the week and y = last digit of the year). For example, 345 = week 34 of 2015.
3	Voltage rating (phases and mains)		

Illustration 3.1 Reading the Type Code from the Nameplate

Product group and drive series: FC 102

Voltage	Model	Protection rating type code	Enclosure size
T2	P5.5K	E21/E55/E66/P21/P55	B1
T2	P7.5K	E21/E55/E66/P21/P55	B1
T2	P11K	E21/E55/E66/P21/P55	B1
T2	P15K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T2	P18K	E20/P20	B4
		E21/E55/E66/P21/P55	C1
T2	P22K	E21/E55/E66/P21/P55	C1
		E20/P20	C3
T2	P30K	E21/E55/E66/P21/P55	C1
		E20/P20	C3
T2	P37K	E21/E55/E66/P21/P55	C2
		E20/P20	C4
T2	P45K	E21/E55/E66/P21/P55	C2
		E20/P20	C4
T4	P11K	E21/E55/E66/P21/P55	B1
		E20/P20	B3
T4	P15K	E21/E55/E66/P21/P55	B1
		E20/P20	B3
T4	P18K	E21/E55/E66/P21/P55	B1
		E20/P20	B3
T4	P22K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T4	P30K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T4	P37K	E20/P20	B4
		E21/E55/E66/P21/P55	C1
T4	P45K	E21/E55/E66/P21/P55	C1
		E20/P20	C3
T4	P55K	E21/E55/E66/P21/P55	C1
		E20/P20	C3
T4	P75K	E21/E55/E66/P21/P55	C2
		E20/P20	C4
T4	P90K	E21/E55/E66/P21/P55	C2
		E20/P20	C4
T6	P11K	E21/E55/E66/P21/P55	B1
		E20/P20	B3
T6	P15K	E21/E55/E66/P21/P55	B1
		E20/P20	B3
T6	P18K	E21/E55/E66/P21/P55	B1
		E20/P20	B3
T6	P22K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T6	P30K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T6	P37K	E20/P20	B4
		E21/E55/E66/P21/P55	C1
T6	P45K	E21/E55/E66/P21/P55	C1
		E20/P20	C3
T6	P55K	E21/E55/E66/P21/P55	C1
		E20/P20	C3

Voltage	Model	Protection rating type code	Enclosure size
T6	P75K	E21/E55/E66/P21/P55	C2
		E20/P20	C4
T6	P90K	E21/E55/E66/P21/P55	C2
		E20/P20	C4
T7	P11K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T7	P15K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T7	P18K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T7	P22K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T7	P30K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T7	P37K	E20/P20	B4
		E21/E55/E66/P21/P55	C2
T7	P45K	E21/E55/E66/P21/P55	C2
		E20/P20	C3
T7	P55K	E21/E55/E66/P21/P55	C2
		E20/P20	C3
T7	P75K	E21/E55/E66/P21/P55	C2
T7	P90K	E21/E55/E66/P21/P55	C2

Table 3.3 Identifying VLT® HVAC Drive FC 102 Enclosures

Product group and drive series: FC 103

Voltage	Model	Protection rating type code	Enclosure size
T2	P5.5K	E21/E55/E66/P21/P55	B1
T2	P7.5K	E21/E55/E66/P21/P55	B1
T2	P11K	E21/E55/E66/P21/P55	B1
T2	P15K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T2	P18K	E20/P20	B4
		E21/E55/E66/P21/P55	C1
T2	P22K	E21/E55/E66/P21/P55	C1
		E20/P20	C3
T2	P30K	E21/E55/E66/P21/P55	C1
		E20/P20	C3
T2	P37K	E21/E55/E66/P21/P55	C2
		E20/P20	C4
T2	P45K	E21/E55/E66/P21/P55	C2
		E20/P20	C4
T4	P11K	E21/E55/E66/P21/P55	B1
		E20/P20	B3
T4	P15K	E21/E55/E66/P21/P55	B1
		E20/P20	B3
T4	P18K	E21/E55/E66/P21/P55	B1
		E20/P20	B3
T4	P22K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T4	P30K	E21/E55/E66/P21/P55	B2
		E20/P20	B4

Voltage	Model	Protection rating type code	Enclosure size
T4	P37K	E20/P20	B4
		E21/E55/E66/P21/P55	C1
T4	P45K	E21/E55/E66/P21/P55	C1
		E20/P20	C3
T4	P55K	E21/E55/E66/P21/P55	C1
		E20/P20	C3
T4	P75K	E21/E55/E66/P21/P55	C2
		E20/P20	C4
T4	P90K	E21/E55/E66/P21/P55	C2
		E20/P20	C4
T6	P11K	E21/E55/E66/P21/P55	B1
		E20/P20	B3
T6	P15K	E21/E55/E66/P21/P55	B1
		E20/P20	B3
T6	P18K	E21/E55/E66/P21/P55	B1
		E20/P20	B3
T6	P22K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T6	P30K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T6	P37K	E20/P20	B4
		E21/E55/E66/P21/P55	C1
T6	P45K	E21/E55/E66/P21/P55	C1
		E20/P20	C3
T6	P55K	E21/E55/E66/P21/P55	C1
		E20/P20	C3
T6	P75K	E21/E55/E66/P21/P55	C2
		E20/P20	C4
T6	P90K	E21/E55/E66/P21/P55	C2
		E20/P20	C4
T7	P11K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T7	P15K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T7	P18K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T7	P22K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T7	P30K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T7	P37K	E20/P20	B4
		E21/E55/E66/P21/P55	C2
T7	P45K	E21/E55/E66/P21/P55	C2
		E20/P20	C3
T7	P55K	E21/E55/E66/P21/P55	C2
		E20/P20	C3
T7	P75K	E21/E55/E66/P21/P55	C2
T7	P90K	E21/E55/E66/P21/P55	C2

Table 3.4 Identifying VLT® Refrigeration Drive FC 103 Enclosures

Product group and drive series: FC 202

Voltage	Model	Protection rating type code	Enclosure size
T2	P5.5K	E21/E55/E66/P21/P55	B1
T2	P7.5K	E21/E55/E66/P21/P55	B1
T2	P11K	E21/E55/E66/P21/P55	B1
T2	P15K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T2	P18K	E20/P20	B4
		E21/E55/E66/P21/P55	C1
T2	P22K	E21/E55/E66/P21/P55	C1
		E20/P20	C3
T2	P30K	E21/E55/E66/P21/P55	C1
		E20/P20	C3
T2	P37K	E21/E55/E66/P21/P55	C2
		E20/P20	C4
T2	P45K	E21/E55/E66/P21/P55	C2
		E20/P20	C4
T4	P11K	E21/E55/E66/P21/P55	B1
		E20/P20	B3
T4	P15K	E21/E55/E66/P21/P55	B1
		E20/P20	B3
T4	P18K	E21/E55/E66/P21/P55	B1
		E20/P20	B3
T4	P22K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T4	P30K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T4	P37K	E20/P20	B4
		E21/E55/E66/P21/P55	C1
T4	P45K	E21/E55/E66/P21/P55	C1
		E20/P20	C3
T4	P55K	E21/E55/E66/P21/P55	C1
		E20/P20	C3
T4	P75K	E21/E55/E66/P21/P55	C2
		E20/P20	C4
T4	P90K	E21/E55/E66/P21/P55	C2
		E20/P20	C4
T6	P11K	E21/E55/E66/P21/P55	B1
		E20/P20	B3
T6	P15K	E21/E55/E66/P21/P55	B1
		E20/P20	B3
T6	P18K	E21/E55/E66/P21/P55	B1
		E20/P20	B3
T6	P22K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T6	P30K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T6	P37K	E20/P20	B4
		E21/E55/E66/P21/P55	C1
T6	P45K	E21/E55/E66/P21/P55	C1
		E20/P20	C3
T6	P55K	E21/E55/E66/P21/P55	C1
		E20/P20	C3

Voltage	Model	Protection rating type code	Enclosure size
T6	P75K	E21/E55/E66/P21/P55	C2
		E20/P20	C4
T6	P90K	E21/E55/E66/P21/P55	C2
		E20/P20	C4
T7	P11K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T7	P15K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T7	P18K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T7	P22K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T7	P30K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T7	P37K	E20/P20	B4
		E21/E55/E66/P21/P55	C2
T7	P45K	E21/E55/E66/P21/P55	C2
		E20/P20	C3
T7	P55K	E21/E55/E66/P21/P55	C2
		E20/P20	C3
T7	P75K	E21/E55/E66/P21/P55	C2
T7	P90K	E21/E55/E66/P21/P55	C2

Table 3.5 Identifying VLT® AQUA Drive FC 202 Enclosures

Product group and drive series: FC 301 and FC 302

Voltage	Model	Protection rating type code	Enclosure size
T2	P5.5K	E21/E55/E66/P21/P55	B1
T2	P7.5K	E21/E55/E66/P21/P55	B1
T2	P11K	E21/E55/E66/P21/P55	B2
T2	P15K	E20/P20	B4
		E21/E55/E66/P21/P55	C1
T2	P18K	E21/E55/E66/P21/P55	C1
		E20/P20	C3
T2	P22K	E21/E55/E66/P21/P55	C1
		E20/P20	C3
T2	P30K	E21/E55/E66/P21/P55	C2
		E20/P20	C4
T2	P37K	E21/E55/E66/P21/P55	C2
		E20/P20	C4
T5	P11K	E21/E55/E66/P21/P55	B1
		E20/P20	B3
T5	P15K	E21/E55/E66/P21/P55	B1
		E20/P20	B3
T5	P18K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T5	P22K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T5	P30K	E20/P20	B4
		E21/E55/E66/P21/P55	C1
T5	P37K	E21/E55/E66/P21/P55	C1
		E20/P20	C3

Voltage	Model	Protection rating type code	Enclosure size
T5	P45K	E21/E55/E66/P21/P55	C1
		E20/P20	C3
T5	P55K	E21/E55/E66/P21/P55	C1
		E20/P20	C3
T5	P75K	E21/E55/E66/P21/P55	C1
		E20/P20	C3
T6	P11K	E21/E55/E66/P21/P55	B1
		E20/P20	B3
T6	P15K	E21/E55/E66/P21/P55	B1
		E20/P20	B3
T6	P18K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T6	P22K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T6	P30K	E20/P20	B4
		E21/E55/E66/P21/P55	C1
T6	P37K	E21/E55/E66/P21/P55	C1
		E20/P20	C3
T6	P45K	E21/E55/E66/P21/P55	C1
		E20/P20	C3
T6	P55K	E21/E55/E66/P21/P55	C2
		E20/P20	C4
T6	P75K	E21/E55/E66/P21/P55	C2
		E20/P20	C4
T7	P11K	E21/E55/E66/P21/P55	B1
		E20/P20	B3
T7	P15K	E21/E55/E66/P21/P55	B1
		E20/P20	B3
T7	P18K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T7	P22K	E21/E55/E66/P21/P55	B2
		E20/P20	B4
T7	P30K	E20/P20	B4
		E21/E55/E66/P21/P55	C1
T7	P37K	E21/E55/E66/P21/P55	C1
		E20/P20	C3
T7	P45K	E21/E55/E66/P21/P55	C1
		E20/P20	C3
T7	P55K	E21/E55/E66/P21/P55	C2
		E20/P20	C4
T7	P75K	E21/E55/E66/P21/P55	C2
		E20/P20	C4

Table 3.6 Identifying VLT® AutomationDrive FC 300 Enclosures

4

4 Operator Interface and Drive Control

4.1 Introduction

Drives are designed with self-diagnostic circuitry to isolate fault conditions and show messages that simplify trouble-shooting and service. The operating status of the drive is shown in real time. Virtually every command given to the drive results in some indication on the local control panel (LCP) display. Fault logs are maintained within the drive for fault history.

The drive monitors supply and output voltages along with the operational condition of the motor and load. When the drive issues a warning or alarm, the fault is not always within the drive itself. In fact, for most service calls, the fault condition exists outside of the drive. Most of the warnings and alarms that the drive shows are in response to faults outside of the drive. This service guide provides techniques and test procedures to help isolate a fault condition whether in the drive or elsewhere.

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

4.2 User Interface

The local control panel (LCP) is the combined display and keypad on the front of the unit. See *Illustration 4.1*.

The LCP has several user functions:

- Starts, stops, and controls speed when in local control.
- Shows operational data, status, warnings, and alarms.
- Programs drive functions.
- Manually resets the drive after a fault when auto reset is inactive.

4.2.1 Layout

The LCP is activated when the drive receives power from 1 of the following:

- Mains voltage.
- DC bus terminal.
- 24 V DC external supply.

The LCP is divided into the following functional groups:

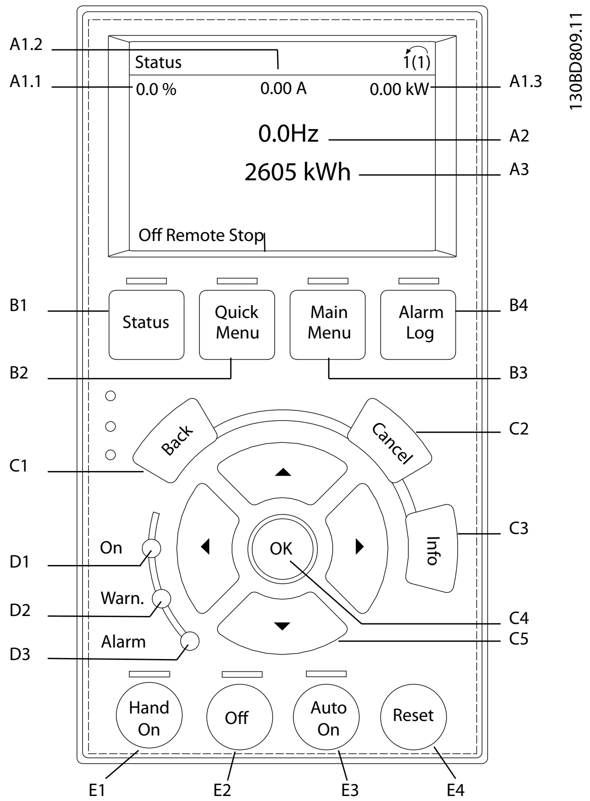


Illustration 4.1 Local Control Panel (LCP)

A. Display area

Each display readout has a parameter associated with it. Refer to *Illustration 4.1*. The information shown on the LCP can be customized for user application by selecting options in the Quick Menus *Q1 My Personal Menu*.

Callout	Parameter number	Default setting
A1.1	0-20	Refer to *Table 4.6 – Table 4.8*
A1.2	0-21	
A1.3	0-22	
A2	0-23	
A3	0-24	

Table 4.1 LCP Display Area

B. Menu keys

Menu keys are used to access the menu for setting up parameters, toggling through status display modes during normal operation, and viewing fault log data.

Callout	Key	Function
B1	Status	Shows operational information.
B2	Quick Menu	Allows access to parameters for initial set-up instructions. Also provides detailed application steps. Refer to *chapter 4.2.2.1 Quick Menu Mode*.
B3	Main Menu	Allows access to all parameters. Refer to *chapter 4.2.2.6 Main Menu Mode*.
B4	Alarm Log	Shows a list of current warnings and the last 10 alarms.

Table 4.2 LCP Menu Keys

C. Navigation keys

Navigation keys are used for programming functions and moving the display cursor. The navigation keys also provide speed control in local (hand) operation. Adjust display brightness by pressing [Status] and [▲]/[▼] keys.

Callout	Key	Function
C1	Back	Reverts to the previous step or list in the menu structure.
C2	Cancel	Cancels the last change or command as long as the display mode has not changed.
C3	Info	Shows a definition of the function being shown.
C4	OK	Accesses parameter groups or enables an option.
C5	▲ ▼ ◄ ►	Moves between items in the menu.

Table 4.3 LCP Navigation Keys

D. Indicator lights

Indicator lights are used to identify the drive status and to provide a visual notification of warning or fault conditions.

Callout	Indicator	Indicator light	Function
D1	On	Green	Activates when the drive receives power from the mains voltage or a 24 V external supply.
D2	Warn.	Yellow	Activates when warning conditions are active. Text appears in the display area identifying the problem.
D3	Alarm	Red	Activates during a fault condition. Text appears in the display area identifying the problem.

Table 4.4 LCP Indicator Lights

E. Operation keys and reset

The operation keys are found toward the bottom of the local control panel.

Callout	Key	Function
E1	[Hand On]	Starts the drive in local control. An external stop signal by control input or serial communication overrides the local hand on.
E2	Off	Stops the motor but does not remove power to the drive.
E3	Auto On	Puts the system in remote operational mode so it can respond to an external start command by control terminals or serial communication.
E4	Reset	Resets the drive manually after a fault has been cleared.

Table 4.5 LCP Operation Keys and Reset

4.2.2 Menus

4.2.2.1 Quick Menu Mode

The LCP provides access to parameters via the Quick Menus. To list the quick menu options, press [Quick Menus].

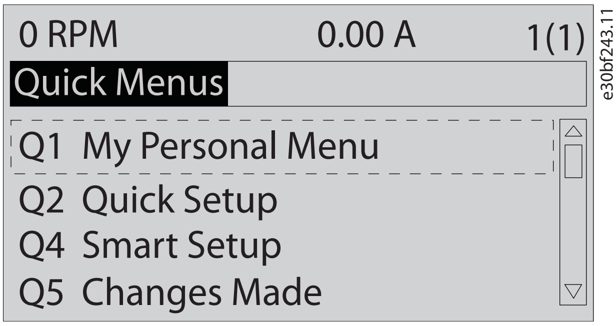


Illustration 4.2 Quick Menu View

4.2.2.2 Q1 My Personal Menu

My Personal Menu is used to define the LCP display (refer to *chapter 4.2.1 Layout*) and store pre-selected parameters. Store important set-up values by using up to 20 pre-programmed parameters. These parameters are selected in *parameter 0-25 My Personal Menu*.

Parameter	Default setting
Parameter 0-01 Language	English
Parameter 0-20 Display Line 1.1 Small	Reference %
Parameter 0-21 Display Line 1.2 Small	Motor current
Parameter 0-22 Display Line 1.3 Small	Power [kW]
Parameter 0-23 Display Line 2 Large	Frequency
Parameter 0-24 Display Line 3 Large	kWh counter
Parameter 15-51 Frequency Converter Serial Number	

Table 4.6 Q1 My Personal Menu Settings for VLT® HVAC Drive FC 102

Parameter	Default setting
Parameter 0-01 Language	English
Parameter 0-20 Display Line 1.1 Small	Reference [Unit]
Parameter 0-21 Display Line 1.2 Small	Analog input 53
Parameter 0-22 Display Line 1.3 Small	Motor current
Parameter 0-23 Display Line 2 Large	Frequency
Parameter 0-24 Display Line 3 Large	Feedback [Unit]
Parameter 15-51 Frequency Converter Serial Number	

Table 4.7 Q1 My Personal Menu Settings for VLT® AQUA Drive FC 202

Parameter	Default setting
Parameter 0-01 Language	English
Parameter 0-20 Display Line 1.1 Small	Speed [RPM]
Parameter 0-21 Display Line 1.2 Small	Motor current
Parameter 0-22 Display Line 1.3 Small	Power [kW]
Parameter 0-23 Display Line 2 Large	Frequency
Parameter 0-24 Display Line 3 Large	Reference %
Parameter 15-51 Frequency Converter Serial Number	

Table 4.8 Q1 My Personal Menu Settings for VLT® AutomationDrive FC 302

4.2.2.3 Q2 Quick Set-up

The parameters in *Q2 Quick Set-up* are the basic parameters that are always necessary for set-up. This menu provides the most efficient set-up for most applications. Perform the unit set-up in the order listed. Refer to the *programming guide* for the set-up steps.

4.2.2.4 Q5 Changes Made

Select *Q5 Changes Made* for information about:

- The 10 most recent changes.
- Changes made from default setting.

4.2.2.5 Q6 Loggings

Use *Q6 Loggings* for fault finding. To get information about the display line readout, select *Loggings*. The information is shown as graphs. Only parameters selected in *parameter 0-20 Display Line 1.1 Small* to *parameter 0-24 Display Line 3 Large* can be viewed. It is possible to store up to 120 samples in the memory for later reference.

Q6 Loggings	
Parameter 0-20 Display Line 1.1 Small	Speed [RPM]
Parameter 0-21 Display Line 1.2 Small	Motor Current
Parameter 0-22 Display Line 1.3 Small	Power [kW]
Parameter 0-23 Display Line 2 Large	Frequency
Parameter 0-24 Display Line 3 Large	Reference %

Table 4.9 Loggings Parameter Examples

4.2.2.6 Main Menu Mode

The LCP provides access to the *Main Menu* mode. Select the *Main Menu* mode by pressing the [Main Menu] key. The resulting readout appears on the LCP display.

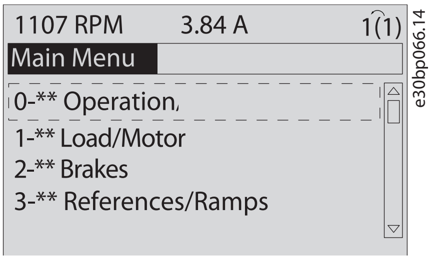


Illustration 4.3 Main Menu View

Lines 2 through 5 on the display show a list of parameter groups that can be selected via the [▲] and [▼] keys.

All parameters can be changed in the main menu. Option cards added to the unit enable extra parameters associated with the option device.

4.2.3 Parameter Settings

Establishing the correct programming for applications requires setting several parameter functions. Details for parameters are provided in the *programming guide*.

Parameter settings are stored internally in the drive, allowing the following advantages:

- Parameter settings can be uploaded into the LCP memory and stored as a back-up.
- Multiple units can be programmed quickly by connecting the LCP to the unit and downloading the stored parameter settings.
- Settings that are stored in the LCP are not changed when restoring factory default settings.

4.2.4 Uploading and Downloading Parameter Settings

The drive operates using parameters stored on the control card, which is located within the drive. The upload and download functions move the parameters between the control card and the LCP.

1. Press [Off].
2. Go to *parameter 0-50 LCP Copy* and press [OK].
3. Select 1 of the following:
   - 3a To upload data from the control card to the LCP, select *[1] All to LCP*.
   - 3b To download data from the LCP to the control card, select *[2] All from LCP*.
4. Press [OK]. A progress bar shows the uploading or downloading process.
5. Press [Hand On] or [Auto On].

4.2.5 Restoring Factory Default Settings

NOTICE

LOSS OF DATA

Loss of programming, motor data, localization, and monitoring records occurs when restoring default settings. To create a back-up, upload data to the LCP before initialization. Refer to *chapter 4.2.4 Uploading and Downloading Parameter Settings*.

Restore the default parameter settings by initializing the unit. Initialization is carried out through *parameter 14-22 Operation Mode* or manually.

Parameter 14-22 Operation Mode does not reset settings such as the following:

- Running hours.
- Serial communication options.
- Personal menu settings.
- Fault log, alarm log, and other monitoring functions.

Recommended initialization

1. Press [Main Menu] twice to access parameters.
2. Go to *parameter 14-22 Operation Mode* and press [OK].
3. Scroll to *Initialization* and press [OK].
4. Remove power to the unit and wait for the display to turn off.
5. Apply power to the unit. Default parameter settings are restored during start-up. Start-up takes slightly longer than normal.
6. After *alarm 80, Drive initialized to default value* appears, press [Reset].

Manual initialization

Manual initialization resets all factory settings except for the following:

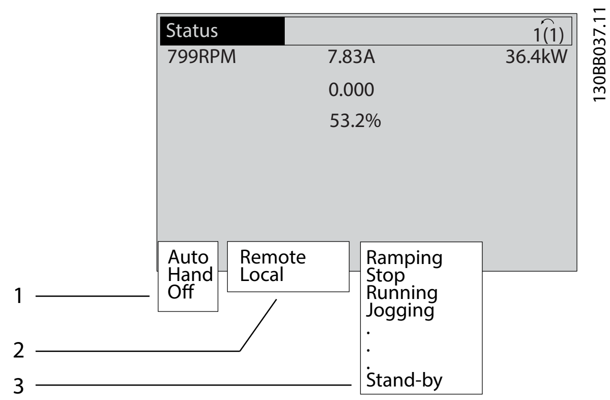
- *Parameter 15-00 Operating hours*.
- *Parameter 15-03 Power Up's*.
- *Parameter 15-04 Over Temp's*.
- *Parameter 15-05 Over Volt's*.

To perform manual initialization:

1. Remove power to the unit and wait for the display to turn off.
2. Press and hold [Status], [Main Menu], and [OK] simultaneously while applying power (approximately 5 s or until a click sounds and the fan starts). Start-up takes slightly longer than normal.

4.3 Status Messages

When the drive is in status mode, status messages automatically appear in the bottom line of the LCP display (refer to *Illustration 4.4*.) Status messages are defined in *Table 4.10 – Table 4.12*.



1	The 1st part of the status line indicates where the stop/start command originates. Refer to *Table 4.10*.
2	The 2nd part of the status line indicates where the speed control originates. Refer to *Table 4.11*.
3	The last part of the status line gives the present drive status. The status shows the operational mode that the drive is in. Refer to *Table 4.12*.

Illustration 4.4 Status Display

NOTICE

AUTO/REMOTE MODE

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

4.4 Status Message Definitions

Table 4.10 – *Table 4.12* define the listed status messages.

Off	The drive does not react to any control signal until [Auto On] or [Hand On] is pressed.
Auto	Start/stop commands are sent via the control terminals and/or serial communication.
Hand	The navigation keys on the LCP can be used to control the drive. Stop commands, reset, reversing, DC brake, and other signals applied to the control terminals can override local control.

Table 4.10 Operating Mode

Remote	The speed reference is given from • External signals. • Serial communication. • Internal preset references.
Local	The drive uses reference values from the LCP.

Table 4.11 Reference Site

AC braking	AC braking was selected in *parameter 2-10 Brake Function*. The AC braking overmagnetizes the motor to achieve a controlled slow down.
AMA finish OK	Automatic motor adaptation (AMA) was carried out successfully.
AMA ready	AMA is ready to start. Press [Hand On].
AMA running	AMA process is in progress.
Braking	The brake chopper is in operation. The brake resistor absorbs the generative energy.
Braking max.	The brake chopper is in operation. The power limit for the brake resistor defined in *parameter 2-12 Brake Power Limit (kW)* has been reached.
Bus jog 1	PROFIdrive profile was selected in *parameter 8-10 Control Profile*. The Jog 1 function is activated via serial communication. The motor is running with *parameter 8-90 Bus Jog 1 Speed*.
Bus jog 2	PROFIdrive profile was selected in *parameter 8-10 Control Profile*. The Jog 2 function is activated via serial communication. The motor is running with *parameter 8-91 Bus Jog 2 Speed*.
Catch up	The value set in *parameter 3-12 Catch up/slow Down Value* corrects the output frequency. • Catch up is selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal is active. • Catch up was activated via serial communication.
Coast	• Coast inverse was selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal is not connected. • Coast activated by serial communication.
Control ready	PROFIdrive profile was selected in *parameter 8-10 Control Profile*. The drive needs the 1st part (for example, 0x047E) of the 2-part start command via serial communication to allow starting. Using a terminal is not possible.
Ctrl. ramp-down	*[1] Ctrl. ramp-down* was selected in *parameter 14-10 Mains Failure*. • The mains voltage is below the value set in *parameter 14-11 Mains Voltage at Mains Fault* at mains fault. • The drive ramps down the motor using a controlled ramp down.
Current high	The drive output current is above the limit set in *parameter 4-51 Warning Current High*.
Current low	The drive output current is below the limit set in *parameter 4-50 Warning Current Low*.
DC hold	*[1] DC hold* is selected in *parameter 1-80 Function at Stop* and a stop command is active. The motor is held by a DC current set in *parameter 2-00 DC Hold/Preheat Current*.
DC stop	The motor is held with a DC current (*parameter 2-01 DC Brake Current*) for a specified time (*parameter 2-02 DC Braking Time*). • DC brake is activated in *parameter 2-03 DC Brake Cut In Speed [RPM]* and a stop command is active. • DC brake (inverse) is selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal is not active. • The DC brake is activated via serial communication.

DC voltage U0	In *parameter 1-01 Motor Control Principle* and in *parameter 1-80 Function at Stop*, *[4] DC Voltage U0* is selected. When a stop command (for example, Stop (inverse)) is activated, the voltage selected according to the *parameter 1-55 U/f Characteristic - U* is applied to the motor.
Feedback high	The sum of all active feedbacks is above the feedback limit set in *parameter 4-57 Warning Feedback High*.
Feedback low	The sum of all active feedbacks is below the feedback limit set in *parameter 4-56 Warning Feedback Low*.
Flying start	The drive is testing if the connected motor is running with a speed that is in the adjusted speed range. The process was started by connecting a digital input (*parameter group 5-1* Digital Inputs*) programmed as coast inverse or by connecting to the mains.
Freeze output	The remote reference is active, which holds the present speed. • Freeze output was selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal is active. Speed control is possible only via the terminal functions speed up and speed down. • Hold ramp is activated via serial communication.
Freeze output request	A freeze output command has been given, but the motor remains stopped until a run permissive signal is received.
Freeze ref.	Freeze reference was selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal is active. The drive saves the actual reference. Changing the reference is now only possible via terminal functions speed up and speed down.
Jog request	A jog command has been given, but the motor is stopped until a run permissive signal is received via a digital input.
Jogging	The motor runs as programmed in *parameter 3-19 Jog Speed [RPM]*. • *Jog* was selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal (for example, terminal 29) is active. • The jog function is activated via the serial communication. • The jog function was selected as a reaction for a monitoring function (for example, No signal). The monitoring function is active.

Kinetic back-up	In *parameter 14-10 Mains Failure*, a function was set as *[4] kinetic back-up*. The mains voltage is below the value set in *parameter 14-11 Mains Voltage at Mains Fault*. The drive is running the motor momentarily with kinetic energy from the inertia of the load.
Motor check	In *parameter 1-80 Function at Stop*, *[2] Motor Check* was selected. A stop command is active. To ensure that a motor is connected to the drive, a permanent test current is applied to the motor. Only available in VLT® HVAC Drive FC 102 and VLT® AQUA Drive FC 202.
Off1	*[1] PROFIdrive profile* was selected in *parameter 8-10 Control Profile*. The Off1 function is activated via serial communication. The motor is stopped via the ramp.
Off2	*[1] PROFIdrive profile* was selected in *parameter 8-10 Control Profile*. The Off2 function is activated via serial communication. The output of the drive is disabled immediately and the motor coasts.
Off3	*[1] PROFIdrive profile* was selected in *parameter 8-10 Control Profile*. The Off3 function is activated via serial communication. The motor is stopped via the ramp.
OVC control	*[2] Enabled* was activated in *parameter 2-17 Over-voltage Control*. The connected motor supplies the drive with generative energy. The overvoltage control adjusts the V/Hz ratio to run the motor in controlled mode, and to prevent the drive from tripping.
Power unit off	(For drives with a 24 V external supply installed only.) Mains supply to the drive is removed, but the control card is supplied by the external 24 V.
Pre-magnetize	Premagnetization is selected in *parameter 1-80 Function at Stop*. A stop command (for example, stop inverse) is activated. A suitable constant magnetizing current is applied to the motor.
Protection md	Protection mode is active. The unit has detected a critical status (an overcurrent or overvoltage). • To avoid tripping, the switching frequency is reduced to 1500 kHz if *parameter 14-55 Output Filter* is set to *[2] Sine-Wave Filter Fixed*. Otherwise, the switching frequency is reduced to 1000 Hz. • If possible, protection mode ends after approximately 10 s. • Protection mode can be restricted in *parameter 14-26 Trip Delay at Inverter Fault*.

QStop	The motor decelerates using *parameter 3-81 Quick Stop Ramp Time*. • *[4] Quick stop inverse* was selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal is not active. • The quick stop function was activated via serial communication.
Ramping	The motor accelerates/decelerates using the active ramp up/down. The reference, a limit value, or a standstill is not yet reached.
Ref. high	The sum of all active references is above the reference limit set in *parameter 4-55 Warning Reference High*.
Ref. low	The sum of all active references is below the reference limit set in *parameter 4-54 Warning Reference Low*.
Run on ref.	The drive is running in the reference range. The feedback value matches the setpoint value.
Run request	A start command has been given, but the motor is stopped until a run permissive signal is received via digital input. Only available in VLT® HVAC Drive FC 102 and VLT® AQUA Drive FC 202.
Running	The drive propels the motor, the ramping phase is done, and the motor revolutions are outside the on-reference range. Occurs when 1 of the motor speed limits (*parameters 4-11* to *4-14*) is set, but the maximum reference is outside this range.
Sleep boost	The boost function in *parameter 22-45 Setpoint Boost* is enabled. This function is only possible in closed-loop operation. Only available in VLT® HVAC Drive FC 102 and VLT® AQUA Drive FC 202.
Sleep mode	The energy saving function is enabled, which means the motor has now stopped, but restarts automatically when required. Only available in VLT® HVAC Drive FC 102 and VLT® AQUA Drive FC 202.
Speed down	The value set in *parameter 3-12 Catch up/slow Down Value* is used to correct the output frequency. • Speed down was selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal is active. • Speed down was activated via serial communication.
Speed high	Motor speed is above the value set in *parameter 4-53 Warning Speed High*.
Speed low	Motor speed is below the value set in *parameter 4-52 Warning Speed Low*.
Standby	In auto-on mode, the drive starts the motor with a start signal from a digital input or serial communication.
Start delay	In *parameter 1-71 Start Delay*, a delay starting time was set. A start command is activated and the motor starts after the start delay time expires.
Start fwd/rev	*[8] Start* and *11 [Start reversing]* were selected as functions for 2 different digital inputs (*parameter group 5-1* Digital Inputs*). The motor starts in forward or reverse depending on which corresponding terminal is activated.
Start inhibit	PROFIdrive profile was selected in *parameter 8-10 Control Profile*. The start inhibition is active. The drive needs the first part (for example, 0x047E) of the 2-part start command via serial communication to allow starting. Refer to the *Control ready* function in this table.
Stop	The drive receives a stop command from 1 of the following: • LCP. • Digital input. • Serial communication.
Trip	An alarm occurs and the motor stops. Once the cause of the alarm is cleared, reset the drive manually by • Pressing [Reset] on the LCP. • Resetting remotely via control terminals. • Reseting via serial communication.
Trip lock	An alarm occurs and the motor stops. Once the cause of the alarm is cleared, cycle power to the drive. Reset the drive manually by • Pressing [Reset] on the LCP. • Resetting remotely via control terminals. • Reseting via serial communication.
Unit/drive not ready	*[1] PROFIdrive profile* was selected in *parameter 8-10 Control Profile*. A control word is sent to the drive via serial communication with Off 1, Off 2, and Off 3 active. Start inhibit is active. To enable start, refer to *Start inhibit* function in this table.

Table 4.12 Operation Status

NOTICE

AUTO/REMOTE MODE

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

4.5 Service Functions

Service information for the drive is listed on display lines 3 and 4. Service information includes:

- Operating hours.
- Power ups.
- Trips.
- Fault logs of status values during the 20 most recent events that stopped the drive.
- Drive nameplate data.

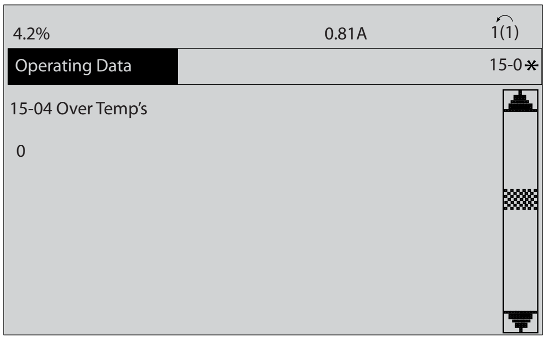


Illustration 4.5 Example of Service Information

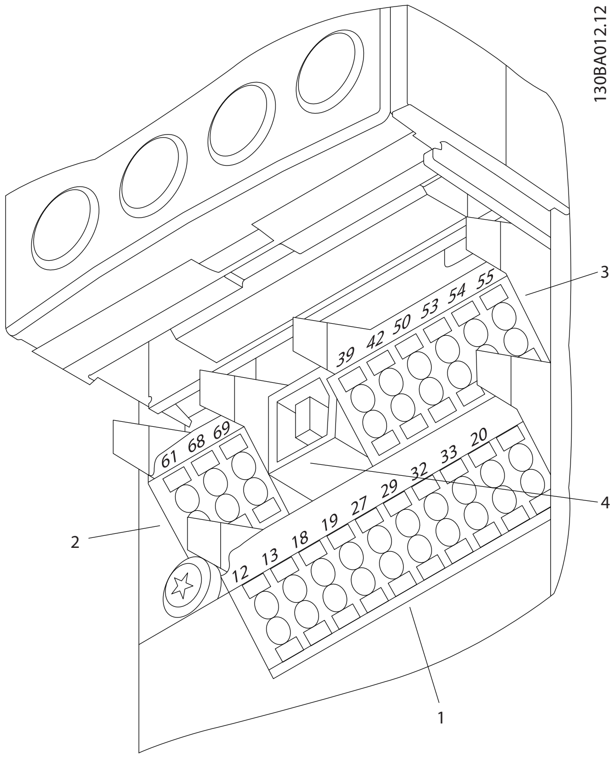
See the *programming guide* for information on accessing and viewing parameters, and for service information available in *parameter group 15-** Drive Information*.

4.6 Drive Inputs and Outputs

The drive operates by receiving control input signals. The drive can also output status data or control auxiliary devices. Control input is connected to the drive in 3 possible ways. One way to control the drive is through the LCP on the front of the drive when operating in hand-on mode. These inputs include start, stop, reset, and speed reference.

Another control source is through serial communication from a fieldbus. A serial communication protocol supplies commands and references to the drive, can program the drive, and reads status data from the drive. The fieldbus connects to the drive through the RS485 serial port or through a communication option card.

The 3rd way is through signal wiring connected to the drive control terminals. Refer to *Illustration 4.6*. The drive control terminals are located below the drive LCP. Improperly connected control wiring can be the cause of a motor not operating or the drive not responding to a remote input.



1	Digital I/O terminals
2	RS485 (EIA-485) terminal
3	Analog I/O terminals
4	USB connector

Illustration 4.6 Control Terminals

4.6.1 Input Signals

The drive can receive 2 types of remote input signals: digital or analog. Digital inputs are wired to terminals 18, 19, 20 (common), 27, 29, 32, and 33. Analog inputs are wired to terminals 53 or 54 and 55 (common). Underneath the LCP is a switch used for setting the analog terminal functions. Some options include more terminals for input signals.

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

Digital signals are a simple binary 0 or 1 that act 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 (open). A voltage higher than 10 V DC is a logic 1 (closed). Digital inputs to the drive are switched commands such as start, stop, reverse, coast, reset.

NOTICE

SERIAL COMMUNICATION FORMAT

Do not confuse these digital inputs with serial communication formats where digital bytes are grouped into communication words and protocols.

The RS485 serial communication connector is wired to terminals (+) 68 and (-) 69. Terminal 61 is common and is sometimes used for terminating shields when the control cable is run between multiple drives, not other devices. Refer to *chapter 4.9 Grounded Shielded Cables* for correct methods for terminating a shielded control cable.

4.6.2 Output Signals

The drive also produces output signals that are carried through either the RS485 fieldbus 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 drive frequency, current, torque, and so on, to an external controller or system. Digital outputs can be control signals used to open or close a damper, for example, or to send a start or stop command to auxiliary equipment. Some options include more terminals for output signals.

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

4.6.3 Control Supply

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

4.7 Control Terminals

Control terminals must be programmed. Each terminal has specific functions it performs and a numbered parameter associated with it. Refer to *Table 4.13*. 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.

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. To select digital input for display, press the [Status] key as discussed previously, or use a voltmeter to check for voltage at the control terminal. Refer to *chapter 8.5.12 Input Terminal Signal Tests*.

For proper operation of the drive, the drive input control terminals must be:

- Wired properly.
- Powered.
- Programmed correctly for the intended function.
- Receiving a signal.

4.8 Control Terminal Functions

Table 4.13 describes the functions of the control terminals. Many of these terminals have multiple functions determined by parameter settings. Some options provide more terminals.

Terminal	Function
01, 02, 03 and 04, 05, 06	Two Form C output relays. Maximum 240 V AC, 2 A. Minimum 24 V DC, 10 mA, or 24 V AC, 100 mA. Can be used for indicating status and warnings. Found on the power card.
12, 13	24 V DC supply to digital inputs and external transducers. The maximum output current is 200 mA.
18, 19, 27, 29, 32, 33	Digital inputs for controlling the drive. R = 2 kΩ. Less than 5 V = logic 0 (open). Greater than 10 V = logic 1 (closed). Terminals 27 and 29 are programmable as digital/pulse outputs.
20	Common for digital inputs.
37	0–24 V DC input for Safe Torque Off (some units).
39	Common for analog and digital outputs.
42	Analog and digital outputs for indicating values such as frequency, reference, current, and torque. The analog signal is 0/4 to 20 mA at a maximum of 500 Ω. The digital signal is 24 V DC at a minimum of 500 Ω.
50	10 V DC, 15 mA maximum analog supply voltage for potentiometer or thermistor.
53, 54	Selectable for 0–10 V DC voltage input, R = 10 kΩ, or analog signals 0/4 to 20 mA at a maximum of 200 Ω. Used for reference or feedback signals. A thermistor can be connected here.
55	Common for terminals 53 and 54.
61	RS485 common.
68, 69	RS485 interface and serial communication.

Table 4.13 Control Terminals and Functions

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

Table 4.14 Control Terminals and Associated Parameters

4.9 Grounded Shielded Cables

Connect the shielded control cables with cable clamps at both ends to the metal cabinet of the drive. *Table 4.15* shows ground cabling for optimal results.

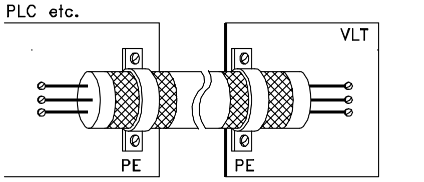
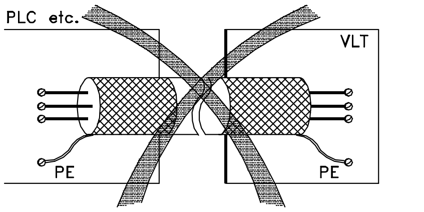
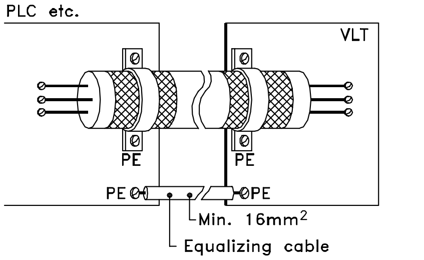
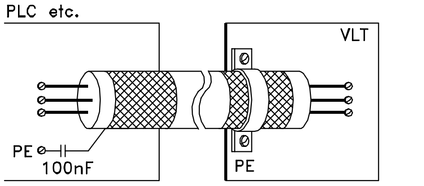
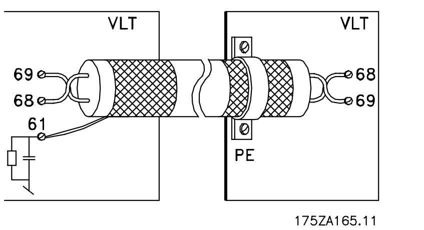
	**Correct grounding** Fit control cables and cables for serial communication with cable clamps at both ends to ensure the best possible electrical connection.
	**Incorrect grounding** Do not use twisted cable ends (pigtails) since it increases shield impedance at high frequencies.
	**Ground potential protection** When the ground potential between the drive and the PLC or other interface device is different, electrical noise occurs that can disturb the entire system. Fitting an equalizing cable next to the control cable resolves this issue. Minimum cable cross-section is 8.36 mm^2 (8 AWG).
	**50/60 Hz ground loops** When using long control cables, 50/60 Hz ground loops can occur, disturbing the entire system. Connecting 1 end of the shield with a 100 nF capacitor and keeping the lead short resolves this issue.
	**Serial communication control cables** Low-frequency noise currents between drives can be eliminated by connecting 1 end of the shielded cable to drive terminal 61. This terminal connects to ground through an internal RC link. Reduce the differential mode interference between conductors by using twisted-pair cables.

Table 4.15 Shielded Cable Grounding

5 Internal Drive Operation

5.1 Introduction

This section is intended to provide an operational overview of the main assemblies and circuitry of a drive. With this information, a repair technician can better understand the operation of the drive and the troubleshooting process.

5.2 Description of Operation

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

In its basic form, the drive can be divided into the following 4 main areas:

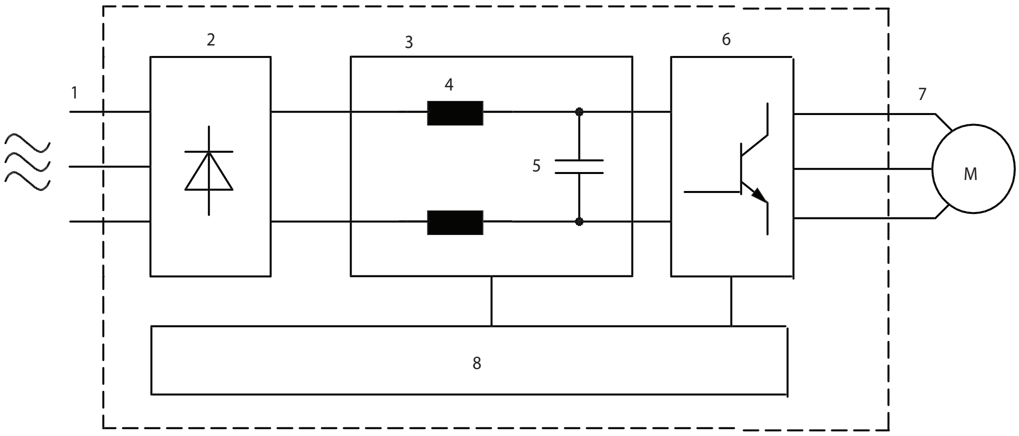
- Rectifier.
- DC link (DC bus).
- Inverter.
- Control.

See *Illustration 5.1* for details.

Within those areas, components are grouped into 3 sections:

- Control logic section.
- Logic-to-power interface.
- Power section.

These areas and components are covered in greater detail in *chapter 5.3 Sequence of Operation*.



Area	Title	Functions
1	Mains input	Provides AC mains power input to the drive module.
2	Input rectifier section	Converts mains input AC voltage into DC voltage.
3	Intermediate DC bus section	Acts as a filter and stores energy in the form of DC voltage.
4	DC reactors	• Filter the DC-link voltage. • Reduce RMS current. • Raise the power factor reflected back to the line. • Reduce harmonics on the AC input.
5	Capacitor bank	Stores the DC power and provides ride-through protection for short power losses.
6	Inverter section	Converts the DC voltage into a variable, controlled PWM AC output voltage to the motor.
7	Motor output	Sends output to the motor being controlled.
8	Control	• Monitors input and motor current to provide efficient operation and control. • Monitors the user interface and performs external commands. • Can provide status output and control. • Includes the power card and inrush card.

Illustration 5.1 Drive Module Basic Block Diagram

5.2.1 Logic Section

Microprocessor
The control card contains most of the logic section (see *Illustration 5.2*). The primary logic element of the control card is a microprocessor, which supervises and controls all functions of operation of the drive. In addition, separate PROMs contain the parameters to provide programmable options. These parameters are programmed to enable the drive to meet specific application requirements. This data is then stored in an EEPROM which provides security during power-down and allows for changing the operational characteristics of the drive.

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

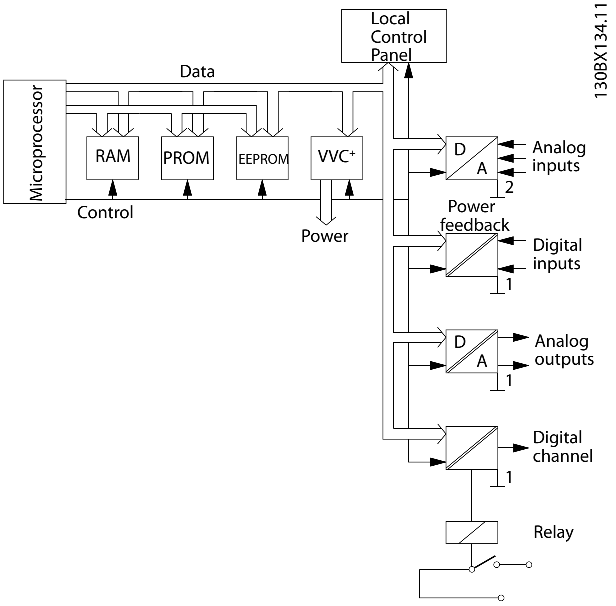


Illustration 5.2 Logic Section

The PWM waveform is created using an improved control scheme called VVC+, a further development of the earlier VVC (voltage vector control) system. VVC+ provides a variable frequency and voltage to the motor, which matches the motor requirements.

Local control panel (LCP)
Another part of the logic section is the local control panel (LCP). The LCP is a removable keypad/display mounted on the front of the drive. The LCP provides the interface between the internal digital logic and the operator.

All the programmable parameter settings can be uploaded into the EEPROM of the LCP. This function is useful for maintaining a back-up drive profile and parameter set. It can also be used, through its download function, in programming other drives or to restore a program to a repaired unit. The LCP is removable during operation to prevent undesired program changes. With the addition of a remote mounting kit, the LCP can be mounted in a remote location of up to 3 m (10 ft) away.

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

The control card logic can communicate via serial link with outside devices such as personal computers or programmable logic controllers (PLC).

The control card also provides 2 voltage supplies for use from the control terminals. The 24 V DC is used for switching functions such as start, stop, and forward/reverse. The 24 V DC supply can supply 200 mA of power, part of which can be used to power external encoders or other devices. A 10 V DC supply on terminal 50 rated at 17 mA is also available for use with speed reference circuitry.

The analog and digital output signals are powered through an internal drive supply.

Two relays for monitoring the status of the drive are on the power card. They are programmable through *parameter group 5-4* Relays*. The relays have different ratings. See the corresponding *operating guide* or *design guide* for more information on ratings.

The control card logic circuitry allows for the addition of option modules for synchronizing the following types of software:

- Control.
- Serial communications.
- Extra relays.
- Cascade pump controller.
- Custom operating.

5.2.2 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 section consists of the power card and gatedrive card.

Control card
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. The control card also handles scaling of current and voltage feedback.

Power card
The power card contains a switch mode power supply (SMPS), which provides the unit with 24 V DC, (+) 18 V DC, (–) 18 V DC, and 5 V DC operating voltage. The SMPS powers the logic and interface circuitry. The SMPS is

supplied by the DC bus voltage. The drives can be purchased with an optional secondary SMPS, which is powered from a customer-supplied 24 V DC source. This secondary SMPS provides power to the logic circuitry with mains input disconnected. It can keep units with communication options live on a network when the drive is not powered from the mains.

The power card also supplies circuitry for controlling the speed of the cooling fans.

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

5.2.3 Power Section

The high voltage power section consists of the following components:

- AC input and motor output terminals.
- AC and DC busbars.
- Fuses.
- Wiring harness.
- Circuitry.
    - Soft charge and SCR/diode modules in the rectifier.
    - DC bus filter circuitry containing the DC coils (intermediate or DC bus circuit).
    - Output IGBT modules that make up the inverter section.
- Optional components.

The inrush circuit controls the firing of the SCRs in the rectifier. When power is applied, the SCRs limit the charging rate of the DC capacitors. Once the capacitors are charged, the inrush circuit sequences the firing of the SCRs to maintain the proper charge on the DC capacitors.
The DC bus circuitry regulates the pulsating DC voltage created by the input AC supply.

The DC coil is a single unit with 2 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 insulated-gate bipolar transistors, commonly referred to as IGBTs or switches.

A Hall-effect type current sensor is used on each phase of the output to measure motor current. With Hall sensors, the drive can monitor:

- Average current.
- Peak current.
- Ground leakage current.

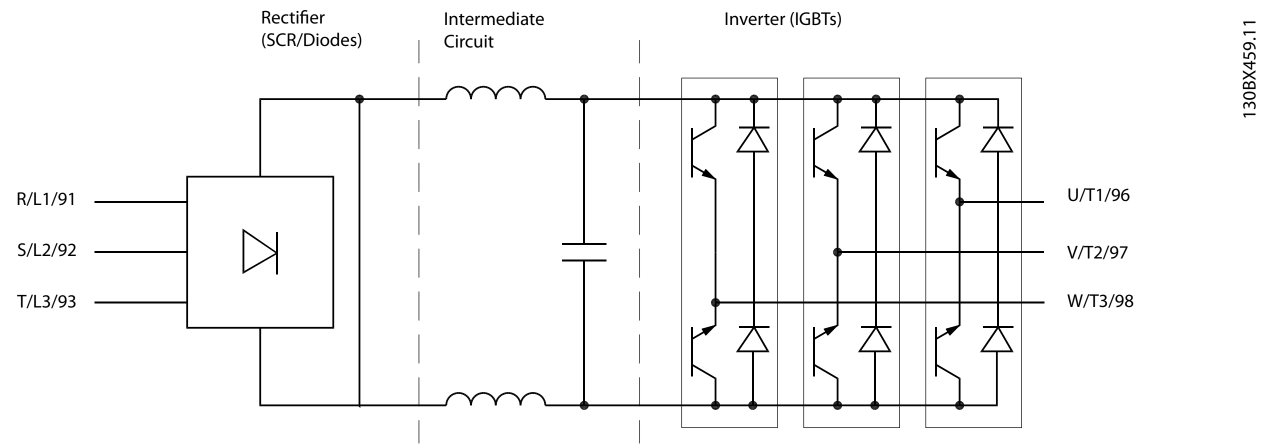


Illustration 5.3 Typical Power Section of an Individual Drive

5.3 Sequence of Operation

5.3.1 Rectifier Section

When power is first applied to the drive, it enters through the input terminals (R/L1/91, S/L2/92, and T/L3/93). Then, power moves to the disconnect and/or RFI filter option, depending on the configuration. If equipped with optional fuses, these fuses limit damage caused by a short circuit in the power section. The input power is also connected to the inrush circuit. This circuit supplies gate signals to the SCRs, initially with a high firing angle (near 180°). The firing angle decreases with every successive AC cycle until it reaches 0°. This process increases the DC voltage slowly over a period of several line cycles, thus greatly reducing the current for charging the DC capacitors.

The low voltage supplies are activated when the DC bus reaches approximately 50 V DC less than the alarm voltage low for the DC bus. See *chapter 14 Technical Specifications*. After a short delay, an inrush enable signal is sent from the control card to the inrush card SCR gating circuit. The SCRs are automatically gated when forward biased, acting similar to an uncontrolled rectifier as a result.

When the DC bus capacitors are fully charged, the voltage on the DC bus equals the peak voltage of the input AC line. Theoretically, this figure can be calculated by multiplying the AC line value by 1.414 (V AC x 1.414). However, since AC ripple voltage is present on the DC bus, the actual DC value is closer to V AC x 1.38 under unloaded conditions. It can drop to V AC x 1.32 while running under load. For example, a drive connected to a nominal 460 V line, while sitting idle, the DC bus voltage is approximately 635 V DC (460 x 1.38).

As long as power is applied to the drive, this voltage is present in the DC-link and inverter circuits. It is also fed to the switch mode power supply on the power card and is used for generating all other low voltage supplies.

5.3.2 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. It aids the filtering process while reducing harmonic distortion to the input AC current waveform normally present in rectifier circuits.

The DC capacitor bank assembly consists of up to 6 capacitors arranged in series/parallel configuration. The assembly also contains the bleeder/balance circuitry. This circuitry maintains equal voltage drops across each capacitor, and provides a current path for discharging the capacitors when the drive is powered down.

The intermediate section also includes the high frequency (HF) filter card. This card contains a high frequency filter circuit to reduce naturally occurring currents in the HF range to prevent interference with sensitive equipment nearby. The circuit, as with other RFI filter circuitry, can be sensitive to unbalanced phase-to-ground voltages in the 3-phase AC input line. This sensitivity occasionally results in nuisance overvoltage alarms. For this reason, the high frequency filter card contains a set of relay contacts in the ground connection of the filter capacitors. The relay is tied to the RFI/HF switch, which can be switched on or off in *parameter 14-50 RFI Filter*. This setting disconnects the ground references to all filters in case unbalanced phase-to-ground voltages create nuisance overvoltage conditions.

5.3.3 Inverter Section

In the inverter section, gate signals are delivered from the control card, through the power card and gatedrive card to the gates of the IGBTs.

Once a run command and speed reference are present, the IGBTs begin switching to create the output waveform, as shown in *Illustration 5.4*. Looking at the phase-to-phase voltage waveform with an oscilloscope, the pulse width modulation (PWM) principal creates a series of pulses which vary in width.

Basically, the pulses narrow as they approach 0 crossing and grow wider when further away from 0 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 averages the voltage delivered. As the pulse width of the waveform varies, the average voltage that the motor detects also varies. The resulting current waveform takes on the sine-wave shape common to an AC system. The rate at which the pulses occur determines the frequency of the waveform. By employing a sophisticated control scheme, the drive delivers a current waveform that nearly replicates a true AC sine-wave.

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 overcurrent conditions, including ground faults and phase-to-phase shorts on the output.

During normal use, the power card and control card are monitoring various functions within the drive. The current sensors provide current feedback information. The DC bus voltage is monitored along with the voltage delivered to the motor. A thermal sensor mounted inside each IGBT module provides heat sink temperature feedback.

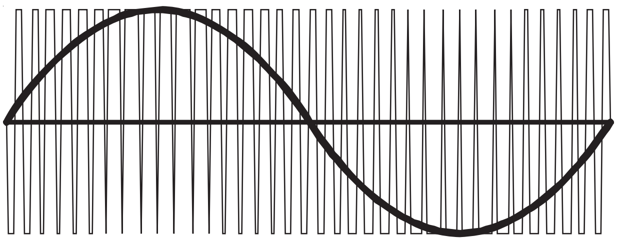


Illustration 5.4 Output Voltage and Current Waveforms

5.3.4 Brake Option

Drives equipped with the dynamic brake option can connect to an external brake resistor using the brake IGBT and terminals 81(R-) and 82(R+).

The function of the brake IGBT is to limit the voltage in the DC link, whenever the maximum voltage limit is exceeded. To limit the voltage, it switches the externally mounted resistor across the DC bus to remove excess DC voltage from the bus capacitors. Typically, excess DC bus voltage is a result of an overhauling load causing regenerative energy to be returned to the DC bus. This excess occurs, for example, when the load drives the motor causing the voltage to return to the DC bus circuit.

External placement of the brake resistor offers multiple advantages:

- Selecting the resistor based on application need.
- Dissipating the energy outside of the control panel.
- Protecting the drive from overheating when the brake resistor is overloaded.

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

5.3.5 Cooling Fans

All drives in this size range are equipped with cooling fans to provide airflow for temperature regulation. On/off and speed control of the fans is provided to reduce overall acoustic noise and extend the life of the fans. Fan speed is controlled by *parameter 14-52 Fan Control*.

5

Option		Function
[0]	Auto	The fan runs only when internal temperature in drive is between 35 °C (95 °F) and approximately 55 °C (131 °F). The fan runs at low speed below 35 °C (95 °F), and at full speed at approximately 55 °C (131 °F).
[1]	On 50%	The fan always runs at 50% speed or above. The fan runs at 50% speed at 35 °C (95 °F), and at full speed at approximately 55 °C (131 °F).
[2]	On 75%	The fan always runs at 75% speed or above. The fan runs at 75% speed at 35 °C (95 °F), and at full speed at approximately 55 °C (131 °F).
[3]	On 100%	The fan always runs at 100% speed.
[4]	Auto (Low temp environment)	This option is the same as *[0] Auto*, but with special considerations around and below 0 °C (32 °F). In option *[0] Auto* there is a risk that the fan starts running around 0 °C as the drive detects a sensor fault and thus protects the drive while reporting *warning 66, Heat Sink Temperature Low*. Option *[4] Auto (Low temp env.)* can be used in very cold environments and prevents the negative effects of this further cooling and avoids *warning 66, Heat Sink Temperature Low*.

Table 5.1 ***Parameter 14-52 Fan Control*** **Options**

5.3.6 Load Sharing

Units with the built-in load sharing option contain terminals 89 DC(+) and 88 DC(-). Within the drive, these terminals connect to the DC bus on the input side of the DC link reactor. The use of the load sharing terminals has 2 configurations.

In the 1st configuration, the terminals are used to tie the DC bus circuits of multiple drives together. This configuration allows a drive in a regenerative mode to share its excess bus voltage with another drive in motoring mode. This configuration reduces the need for external dynamic brake resistors while also saving energy. Any number of drives can be connected in this way, as long as they are of the same voltage rating. Also, it can be necessary to install DC reactors and DC fuses and mains AC reactors on the mains. Attempting such a configuration requires detailed considerations. Do not attempt this configuration without first consulting Danfoss Application Engineering.

In the 2nd configuration, the drive is powered exclusively from a DC source. An external DC source is required. Do not attempt this configuration without first consulting Danfoss Application Engineering

6 Troubleshooting

6.1 Troubleshooting Tips

- Some points in the drive are referenced to the negative DC bus. These points are at bus potential even though diagrams can show them as a neutral reference.
- If any of the DC bus fuses are blown, always ensure that no DC bus voltage is present on either side of the DC fuses. When any DC bus fuse is blown, capacitor banks in the other modules are no longer electrically connected. As a result, a module can have stored voltage even when the rest of the system has none.
- Do not assume that the drive contains no voltage when the LCP indicator lights are off.
- Never apply power to a unit that is suspected of being faulty. Many faulty components within the drive can damage other components when power is applied. Always complete the steps described in *chapter 8.6 After-repair Tests*.
- With an external supply and cable assembly, the logic section of the drive can be powered without applying power to the rest of the unit. This method of power isolation is recommended for troubleshooting logic problems.
- Never attempt to defeat any fault protection circuitry within the drive. Doing so results in unnecessary component damage and can cause personal injury.
- Always use factory approved replacement parts. The drive has been designed to operate within certain specifications. Incorrect parts can affect tolerances and damage the unit.
- Read the instruction and service guides. A thorough understanding of the unit is the best approach. If in doubt, consult the factory or authorized repair center for assistance.

6.2 Exterior Fault Troubleshooting

Servicing a drive that has been operational for an extended period is slightly different from a new installation. When using proper troubleshooting procedures on a long-term installation, do not assume that a motor is wired properly. Look for issues such as loose connections, improper programming, or added equipment. It is best to develop a detailed approach, beginning with a physical inspection of the system. Refer to *Table 6.1*.

6.3 Fault Symptom Troubleshooting

This troubleshooting section is organized based on the symptom being experienced. Refer to *chapter 6.5 Fault Symptoms*.

Typical symptoms include:

- Unrecognizable display on the LCP.
- Problems with motor operation.
- Warning or alarm shown by the drive.

The drive processor monitors inputs and outputs along with internal drive functions. Thus, an alarm or warning does not necessarily indicate a problem within the drive itself. For a list of warnings and alarms, refer to *Table 6.2*.

Chapter 6.7 Alarm and Warning Definitions describes how to troubleshoot that particular symptom. When necessary, detailed discussions of drives and system troubleshooting are provided in this chapter for the qualified repair technician to analyze the problem effectively.

Always perform a system test when the following conditions apply:

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

Refer to *chapter 8.6 After-repair Tests*.

6

6.4 Visual Inspection

Table 6.1 lists conditions that require visual inspection as part of any initial troubleshooting procedure.

Inspect for	Description
Auxiliary equipment	Check auxiliary equipment, switches, disconnects, or input fuses/circuit breakers on the input side of the drive or the output side of the motor. Check the function and installation of pressure sensors, encoders, or other devices that provide feedback to the drive.
Cable routing	Avoid routing the following in parallel: • Motor wiring. • Mains wiring. • Signal wiring. If parallel routing is unavoidable, maintain a separation of 150–200 mm (6–8 in) between 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. Use of shielded cable or a twisted pair is recommended. Ensure that the shield is terminated correctly. See *chapter 4.9 Grounded Shielded Cables*.
Cooling	Check the operation of all cooling fans. Check for blocked air passages.
Display	Check the LCP display for warning/alarm messages, system status, and fault history.
Interior	Check that the drive interior is free of dirt, metal chips, moisture, and corrosion. Check for burnt or damaged power components, or carbon deposits resulting from component failure. Check for cracks in the housings of power semiconductors, or for pieces of broken component housings inside the unit.
EMC considerations	Check for proper installation regarding electromagnetic compatibility (EMC). Refer to the drive operating instructions and *chapter 7.3.5 Proper EMC Installation*.
Environmental conditions	The drive can operate within a maximum ambient temperature of 50 °C (122 °F). Humidity levels must be less than 95% non-condensing. Check for harmful airborne contaminates such as sulphur-based compounds.
Grounding	The drive requires a dedicated ground wire from its enclosure to the building ground. Grounding the motor to the drive enclosure is recommended. The use of a conduit or mounting the drive onto a metal surface is not considered a suitable ground. Check that ground connections are tight and free of oxidation.
Input power wiring	Check for loose connections, proper fusing, and blown fuses.
Motor	Check the nameplate ratings of the motor. Ensure that the motor ratings correspond with the drive ratings. Check that the motor parameters (*parameter 1-20 Motor Power [kW]* to *parameter 1-25 Motor Nominal Speed*) are set according to the motor ratings.
Output to motor wiring	Check for loose connections. Check for switching components in the output circuit. Check for faulty contacts in the switchgear. One missing wire can cause an overcurrent trip.
Programming	Make sure that the drive parameter settings are correct according to motor, application, and I/O configuration.
Proper clearance	Drives require adequate top and bottom clearance to ensure proper airflow for cooling. Drives with exposed heat sinks (in the back) must be mounted on a flat solid surface.
Vibration	Look for unusual amounts of vibration around the drive. Mount the unit solidly or use shock mounts.

Table 6.1 Visual Inspection

6.5 Fault Symptoms

6.5.1 No Display

- Check that power is supplied.
- Cycle power to the unit.
- Reinitialize the drive (refer to *chapter 4.2.5 Restoring Factory Default Settings*).

6.5.2 Intermittent Display

Cutting out or flashing of the entire display and power LED indicates that the supply (SMPS) is shutting down due to an overload. Check for:

- Improper control wiring.
- Overload of the 24 V supply output.
- Fault within the drive.

Check for a problem in the control wiring by disconnecting all control wiring from the control terminal blocks on the installation card.

If the display stays lit, then the problem is in the control wiring (external to the drive). Check all control wiring for shorts or incorrect connections.

If the display continues to cut out, refer to *chapter 6.5.1 No Display*.

6.5.3 Motor Does Not Run

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

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

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

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

Action: Ensure that a start command is present at terminal 18. Refer to *chapter 8.5.12 Input Terminal Signal Tests*.

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

Action: Ensure that terminal 27 is logic 1. Refer to *chapter 8.5.12 Input Terminal Signal Tests*.

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

To ensure that the proper reference signal is present at the drive input terminals, check the control wiring. Also check that the unit is programmed properly to accept the signal. Refer to *chapter 8.5.12 Input Terminal Signal Tests*.

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

A correct control word must be transmitted to the drive over the communication bus to correct this error.

STOP
One of the digital input terminals 18, 19, 27, 29, 32, or 33 (*parameter group 5-1* Digital Inputs*) is programmed for *[6] Stop Inverse.* The corresponding terminal is low (logic 0).

Ensure that the parameters are programmed correctly and that any digital input programmed for *[6] Stop Inverse* is high (logic 1).

DC undervolt
If the unit is equipped with an external 24 V DC option, check that mains power is supplied to the drive.

6.5.4 Incorrect Motor Operation

Occasionally, a fault occurs when the motor continues to run, but not in the correct manner. Possible causes are listed by symptom.

Wrong speed; unit does not respond to command
Cause: Possible incorrect reference (speed command).

Action: Check that the unit is programmed correctly for the relevant reference signal, and that all reference limits are set correctly. To check for faulty reference signals, see *chapter 8.5.12 Input Terminal Signal Tests*.

Motor speed unstable

Cause:

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

Action: Check the settings of all motor parameters, including motor compensation settings such as slip compensation and load compensation. For closed-loop operation, check PID settings. To check for faulty reference signals, refer to *chapter 8.5.12 Input Terminal Signal Tests*. To check for loss of motor phase, refer to *chapter 8.5.8 Output Imbalance of Motor Voltage and Current*.

Motor runs rough

Cause:

- Possible overmagnetization.
- IGBT misfiring.
- Motor under heavy load.
- *Alarm 13, Overcurrent* tripping intermittently.

Action: Check settings of all motor parameters. Refer to *chapter 8.5.8 Output Imbalance of Motor Voltage and Current*.

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

Action: To check the motor for opening windings and unbalanced resistance, run an AMA. To ensure that the drive is providing correct output, refer to *chapter 8.5.8 Output Imbalance of Motor Voltage and Current*. Inspect all motor wiring connections.

Motor does not brake
Cause: Possible fault in the brake circuit. Possible incorrect setting in the brake parameters. The ramp-down time is too short. The LCP shows an alarm or warning message.

Action: Check all brake parameters and ramp-down time (*parameter groups 2-0* DC-Brake* and *3-4* Ramp 1*). Perform the procedures in *chapter 8.4.4 Brake IGBT Test*.

6.6 Alarms and Warnings

6.6.1 Overview of Alarms and Warnings

The drive indicates a warning or an alarm by the relevant indicator light on the LCP and a code on the display.

A warning remains active until its cause is no longer present. Under certain circumstances, operation of the motor can be continued. Warning messages can be critical, but are not necessarily so.

An alarm indicates that the drive tripped. The alarm must be reset to restart operation once its problem is fixed. Resetting can be done in any of 4 ways:

- Via [Reset] on the LCP.
- Via a digital input with the reset function.
- Via serial communication/optional fieldbus.
- Via the [Auto Reset] function.

NOTICE

MANUAL RESET

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

If an alarm cannot be reset, it is possible that the problem is not fixed or that the alarm is a trip lock. Refer to *Table 6.2*.

Trip lock alarms offer extra protection, since the mains supply must be switched off before the alarm can be reset. After being switched back on, the drive is no longer blocked and can be reset once the problem is fixed.

Alarms that are not trip locks can also be reset using the automatic reset function in *parameter 14-20 Reset Mode*.

⚠WARNING

AUTOMATIC RESET

Automatic reset is not recommended in industrial applications where it can cause the drive and motor to restart unexpectedly. Failure to use manual reset in industrial applications can cause death or serious injury.

- **Always use the manual restart setting in *parameter 14-20 Reset Mode*.**

If both a warning and alarm are marked for a code in *Table 6.2*, it means that either:

- A warning occurs before an alarm.
- It can be specified whether a warning or an alarm is shown for a given fault.

This situation is possible, for instance, in *parameter 1-90 Motor Thermal Protection*.

After an alarm or trip, the motor coasts, and the alarm and warning flash on the drive. Once the problem has been fixed, only the alarm continues flashing.

6.6.2 Alarm/Warning Identification Tables

Number	Description	Warning	Alarm/trip	Alarm/trip lock
1	10 V low	X	–	–
2	Live zero error	(X)	(X)	–
3	No motor	(X)	–	–
4	Mains phase loss	(X)	(X)	(X)
5	DC-link voltage high	X	–	–
6	DC-link voltage low	X	–	–
7	DC overvoltage	X	X	–
8	DC undervoltage	X	X	–
9	Inverter overloaded	X	X	–
10	Motor overtemperature	(X)	(X)	–
11	Motor thermistor overtemperature	(X)	(X)	–
12	Torque limit	X	X	–
13	Overcurrent	X	X	X
14	Ground fault	X	X	X
15	Hardware mismatch	–	X	X
16	Short circuit	–	X	X
17	Control word timeout	(X)	(X)	–
18	Start failed	–	X	–
19	Discharge temperature high	X	X	–
20	Temperature input error	X	X	–
21	Parameter error	X	X	–
22	Hoist mechanical brake	(X)	(X)	–
23	Internal fan fault	X	–	–
24	External fan fault	X	–	–
25	Brake resistor short circuit	X	–	–
26	Brake resistor power limit	(X)	(X)	–
27	Brake chopper fault	X	X	–
28	Brake check failed	(X)	(X)	–
29	Heat sink temp	X	X	X
30	Motor phase U missing	(X)	(X)	(X)
31	Motor phase V missing	(X)	(X)	(X)
32	Motor phase W missing	(X)	(X)	(X)
33	Inrush fault	–	X	X
34	Fieldbus communication fault	X	X	–
35	Option fault	(X)	–	–
36	Mains failure	X	X	–
37	Phase imbalance	–	X	–
38	Internal fault	–	X	X
39	Heat sink sensor	–	X	X
40	Overload of digital output terminal 27	(X)	–	–
41	Overload of digital output terminal 29	(X)	–	–
42	Overload X30/6 or X30/7	(X)	–	–
43	External supply	–	X	–
45	Ground fault 2	X	X	X
46	Power card supply	–	X	X
47	24 V supply low	X	X	X
48	1.8 V supply low	–	X	X
49	Speed limit	X	–	–
50	AMA calibration failed	–	X	–
51	AMA check U_{nom} and I_{nom}	–	X	–

Number	Description	Warning	Alarm/trip	Alarm/trip lock
52	AMA low I_{nom}	–	X	–
53	AMA motor too large	–	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	X	–
61	Feedback error	(X)	(X)	–
62	Output frequency at maximum limit	X	–	–
63	Mechanical brake low	–	(X)	–
64	Voltage limit	X	–	–
65	Control card overtemperature	X	X	X
66	Heat sink temperature low	X	–	–
67	Option configuration has changed	–	X	–
68	Safe stop activated	(X)	(X) 1)	–
69	Power card temperature	–	X	X
70	Illegal FC configuration	–	–	X
71	PTC 1 safe stop	X	X	–
72	Dangerous failure	X	X	X
73	Safe stop auto restart	(X)	(X)	–
74	PTC thermistor	–	–	X
75	Illegal profile sel.	–	X	–
76	Power unit setup	X	–	–
77	Reduced power mode	X	–	–
78	Tracking error	(X)	(X)	–
79	Illegal power section configuration	–	X	–
80	Drive initialized to default value	–	X	–
81	CSIV corrupt	–	X	–
82	CSIV parameter error	–	X	–
83	Illegal option combination	–	–	X
84	No safety option	–	X	–
85	Dang fall PB	–	X	–
88	Option detection	–	–	X
89	Mechanical brake sliding	X	–	–
90	Feedback monitor	(X)	(X)	–
91	Analog input 54 wrong settings	–	–	X
92	No flow	(X)	(X)	–
93	Dry pump	(X)	(X)	–
94	End of curve	(X)	(X)	–
95	Broken belt	(X)	(X)	–
96	Start delayed	(X)	–	–
97	Stop delayed	(X)	–	–
98	Clock fault	X	–	–
99	Locked rotor	–	X	–
104	Mixing fan fault	(X)	(X)	–
122	Motor rotat. unexp.	X	X	–
144	Inrush supply	–	X	–
145	External SCR disable	–	X	–
146	Mains voltage	X	X	–
147	Mains frequency	X	X	–

Number	Description	Warning	Alarm/trip	Alarm/trip lock
148	System temp	X	X	–
163	ATEX ETR cur.lim.warning	X	–	–
164	ATEX ETR cur.lim.alarm	–	X	–
165	ATEX ETR freq.lim.warning	X	–	–
166	ATEX ETR freq.lim.alarm	–	X	–
200	Fire mode	(X)	–	–
201	Fire mode was active	(X)	–	–
202	Fire mode limits exceeded	(X)	–	–
203	Missing motor	(X)	–	–
204	Locked rotor	(X)	–	–
219	Compressor interlock	(X)	–	–
243	Brake IGBT	X	X	–
244	Heat sink temperature	X	X	X
245	Heat sink sensor	–	X	X
246	Power card supply	–	X	X
247	Power card temperature	–	X	X
248	Illegal power section configuration	–	X	X
250	New spare part	–	–	X
251	New type code	–	X	X
421	Temperature fault	–	X	–

Table 6.2 Alarm/Warning Code List

(X) This variable is programmable. Warnings/alarms depend on parameter setting.

1) Cannot be auto reset via parameter selection.

Alert type	LED indication
Warning	Yellow
Alarm	Red (flashing)
Trip lock	Yellow and red

Table 6.3 Description of LED Indicator Lights

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Alarm word and extended status word					
Bit	Hex	Dec	Alarm word	Warning word	Extended status word
0	00000001	1	Brake check	Brake check	Ramping
1	00000002	2	Pwr. card temp	Pwr. card temp	AMA running
2	00000004	4	Ground fault	Ground fault	Start CW/CCW
3	00000008	8	Ctrl. card temp	Ctrl. card temp	Slow down
4	00000010	16	Ctrl. word TO	Ctrl. word TO	Catch up
5	00000020	32	Overcurrent	Overcurrent	Feedback high
6	00000040	64	Torque limit	Torque limit	Feedback low
7	00000080	128	Motor Th over	Motor Th over	Output current high
8	00000100	256	Motor ETR over	Motor ETR over	Output current low
9	00000200	512	Inverter overld.	Inverter overld.	Output freq high
10	00000400	1024	DC under volt	DC under volt	Output freq low
11	00000800	2048	DC over volt	DC over volt	Brake check ok
12	00001000	4096	Short circuit	DC voltage low	Braking max
13	00002000	8192	Inrush fault	DC voltage high	Braking
14	00004000	16384	Mains ph. loss	Mains ph. loss	Out of speed range
15	00008000	32768	AMA not OK	No motor	OVC active
16	00010000	65536	Live zero error	Live zero error	–
17	00020000	131072	Internal fault	10 V low	–
18	00040000	262144	Brake overload	Brake overload	–
19	00080000	524288	U phase loss	Brake resistor	–
20	00100000	1048576	V phase loss	Brake IGBT	–
21	00200000	2097152	W phase loss	Speed limit	–
22	00400000	4194304	Fieldbus fault	Fieldbus fault	–
23	00800000	8388608	24 V supply low	24 V supply low	–
24	01000000	16777216	Mains failure	Mains failure	–
25	02000000	33554432	1.8 V Supply low	Current limit	–
26	04000000	67108864	Brake resistor	Low temp	–
27	08000000	134217728	Brake IGBT	Voltage limit	–
28	10000000	268435456	Option change	Unused	–
29	20000000	536870912	Drive initialized	Unused	–
30	40000000	1073741824	Safe Torque Off	Unused	–

Table 6.4 Description of Alarm Word, Warning Word, and Extended Status Word

The alarm words, warning words, and extended status words can be read via fieldbus or optional fieldbus for diagnosis. Also, refer to *parameter 16-90 Alarm Word*, *parameter 16-92 Warning Word*, and *parameter 16-94 Ext. Status Word*.

Bit	Hex	Dec	Alarm word 2	Warning word 2
0	00000001	1	–	Start delayed
1	00000002	2	–	Stop delayed
9	00000200	512	Discharge temperature high	Discharge temperature high
10	00000400	1024	Start limit	–
11	00000800	2048	Speed limit	–

Table 6.5 Description of Alarm Word 2 and Warning Word 2

6.7 Alarm and Warning Definitions

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

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

A short circuit in a connected potentiometer or incorrect wiring of the potentiometer can cause this condition.

Troubleshooting

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

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

Troubleshooting

- Check connections on all analog mains terminals.
    - Control card terminals 53 and 54 for signals, terminal 55 common.
    - VLT® General Purpose I/O MCB 101 terminals 11 and 12 for signals, terminal 10 common.
    - VLT® Analog I/O Option MCB 109 terminals 1, 3, and 5 for signals, terminals 2, 4, and 6 common.
- Check that the drive programming and switch settings match the analog signal type.
- Perform an input terminal signal test.

WARNING/ALARM 3, No motor
No motor has been connected to the output of the drive. This warning or alarm appears only if programmed in *parameter 1-80 Function at Stop*.

Troubleshooting

- Check the connection between the drive and the motor.

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

Troubleshooting

- Check the supply voltage and supply currents to the drive.

WARNING 5, DC link voltage high
The DC-link voltage (DC) is higher than the high-voltage warning limit. The limit depends on the drive voltage rating. The unit is still active.

WARNING 6, DC link voltage low
The DC-link voltage (DC) is lower than the low-voltage warning limit. The limit depends on the drive voltage rating. The unit is still active.

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

Troubleshooting

- Connect a brake resistor.
- Extend the ramp time.
- Change the ramp type.
- Activate the functions in *parameter 2-10 Brake Function*.
- Increase *parameter 14-26 Trip Delay at Inverter Fault*.
- If the alarm/warning occurs during a power sag, use kinetic back-up (*parameter 14-10 Mains Failure*).

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

Troubleshooting

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

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

Troubleshooting

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

WARNING/ALARM 10, Motor overload temperature
According to the electronic thermal protection (ETR), the motor is too hot.

Select 1 of these options:

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

The fault occurs when the motor runs with more than 100% overload for too long.

Troubleshooting

- Check for motor overheating.
- Check if the motor is mechanically overloaded.
- Check that the motor current set in *parameter 1-24 Motor Current* is correct.
- Ensure that the motor data in *parameters 1-20 to 1-25* is set correctly.
- If an external fan is in use, check that it is selected in *parameter 1-91 Motor External Fan*.
- Running AMA in *parameter 1-29 Automatic Motor Adaptation (AMA)* tunes the drive to the motor more accurately and reduces thermal loading.

WARNING/ALARM 11, Motor thermistor overtemp

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

Troubleshooting

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

WARNING/ALARM 12, Torque limit

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

Troubleshooting

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

WARNING/ALARM 13, Over current

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

Troubleshooting

- Remove power to the drive.
- Check that the motor shaft can be turned.
- Check that the motor size matches the drive.
- Check that the motor data is correct in *parameters 1-20 to 1-25*.

ALARM 14, Earth (ground) fault

There is current from the output phase to ground, either in the cable between the drive and the motor, or in the motor itself. The current transducers detect the ground fault by measuring current going out from the drive and current going into the drive from the motor. Ground fault is issued if the deviation of the 2 currents is too large. The current going out of the drive must be the same as the current going into the drive.

Troubleshooting

- Remove power to the drive and repair the ground fault.
- Check for ground faults in the motor by measuring the resistance to ground of the motor cables and the motor with a megohmmeter.
- Reset any potential individual offset in the 3 current transducers in the drive. Perform the manual initialization or perform a complete AMA. This method is most relevant after changing the power card.

ALARM 15, Hardware mismatch

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

Record the value of the following parameters and contact Danfoss.

- *Parameter 15-40 FC Type*.
- *Parameter 15-41 Power Section*.

- *Parameter 15-42 Voltage*.
- *Parameter 15-43 Software Version*.
- *Parameter 15-45 Actual Typecode String*.
- *Parameter 15-49 SW ID Control Card*.
- *Parameter 15-50 SW ID Power Card*.
- *Parameter 15-60 Option Mounted*.
- *Parameter 15-61 Option SW Version* (for each option slot).

There is short-circuiting in the motor or motor wiring.

⚠WARNING

HIGH VOLTAGE

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

ALARM 16, Short circuit

Troubleshooting

- Remove the power to the drive and repair the short circuit.
- Check that the drive contains the correct current scaling card and the correct number of current scaling cards for the system.

WARNING/ALARM 17, Control word timeout

There is no communication to the drive.
The warning is only active when *parameter 8-04 Control Timeout Function* is NOT set to *[0] Off*.
If *parameter 8-04 Control Timeout Function* is set to *[5] Stop and trip*, a warning appears, and the drive ramps down to a stop and shows an alarm.

Troubleshooting

- Check the connections on the serial communication cable.
- Increase *parameter 8-03 Control Timeout Time*.
- Check the operation of the communication equipment.
- Verify that proper EMC installation was performed.

ALARM 18, Start failed

The speed has not been able to exceed *parameter 1-77 Compressor Start Max Speed [RPM]* during start within the allowed time that was set in *parameter 1-79 Compressor Start Max Time to Trip*. A blocked motor can cause this alarm.

WARNING/ALARM 19, Discharge temperature high

The warning indicates that the discharge temperature exceeds the level programmed in *parameter 28-24 Warning Level*. If so programmed in *parameter 28-25 Warning Action*, the drive lowers the speed of the compressor in an attempt to lower the discharge temperature.

The alarm indicates that the discharge temperature exceeds the level programmed in *parameter 28-26 Emergency Level*.

WARNING/ALARM 20, Temp. input error

The temperature sensor is not connected.

WARNING/ALARM 21, Parameter error

The parameter is out of range. The parameter number is shown in the display.

Troubleshooting

- Set the affected parameter to a valid value.

WARNING 22, Hoist mechanical brake

0 = The torque reference was not reached before timeout.
1 = There was no brake feedback before the timeout.

WARNING 23, Internal fan fault

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

There is a feedback sensor mounted in the fan. If the fan is commanded to run and there is no feedback from the sensor, this alarm appears. This alarm also shows if there is a communication error between the fan power card and the control card.

Check the alarm log for the report value associated with this warning.

If the report value is 2, there is a hardware problem with 1 of the fans. If the report value is 12, there is a communication problem between the fan power card and the control card.

Fan troubleshooting

- Cycle power to the drive and check that the fan operates briefly at start-up.
- Check for proper fan operation. Use *parameter group 43-** Unit Readouts* to show the speed of each fan.

Fan power card troubleshooting

- Check the wiring between the fan power card and the control card.
- Fan power card may need to be replaced.
- Control card may need to be replaced.

WARNING 24, External fan fault

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

A feedback sensor is mounted in the fan. If the fan is commanded to run and there is no feedback from the sensor, this alarm appears. This alarm also shows if there is a communication error between the power card and the control card.

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Check the alarm log for the report value associated with this warning.

If the report value is 1, there is a hardware problem with 1 of the fans. If the report value is 11, there is a communication problem between the power card and the control card.

Fan troubleshooting

- Cycle power to the drive and check that the fan operates briefly at start-up.
- Check for proper fan operation. Use *parameter group 43-** Unit Readouts* to show the speed of each fan.

Power card troubleshooting

- Check the wiring between the power card and the control card.
- Power card may need to be replaced.
- Control card may need to be replaced.

WARNING 25, Brake resistor short circuit
The brake resistor is monitored during operation. If a short circuit occurs, the brake function is disabled and the warning appears. The drive is still operational, but without the brake function.

Troubleshooting

- Remove the power to the drive and replace the brake resistor (refer to *parameter 2-15 Brake Check*).

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

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

⚠WARNING

OVERHEATING RISK

A surge in power can cause the brake resistor to overheat and possibly catch fire. Failure to remove power to the drive and remove the brake resistor can cause equipment damage.

Troubleshooting

- Remove power to the drive.
- Remove the brake resistor.
- Troubleshoot the short circuit.

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

Troubleshooting

- Check *parameter 2-15 Brake Check*.

ALARM 29, Heat sink temp
The maximum temperature of the heat sink has been exceeded. The temperature fault does not reset until the temperature drops below a defined heat sink temperature. The trip and reset points are different based on the drive power size.

Troubleshooting

Check for the following conditions:

- Ambient temperature too high.
- Motor cable too long.
- Incorrect airflow clearance above and below the drive.
- Blocked airflow around the drive.
- Damaged heat sink fan.
- Dirty heat sink.

Troubleshooting

- Check fan resistance.
- Check soft charge fuses.
- Check IGBT thermal.

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

⚠WARNING

HIGH VOLTAGE

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

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

Troubleshooting

- Remove the power from the drive and check motor phase U.

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

⚠WARNING

HIGH VOLTAGE

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

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

Troubleshooting

- Remove the power from the drive and check motor phase V.

ALARM 32, Motor phase W missing

Motor phase W between the drive and the motor is missing.

⚠WARNING

HIGH VOLTAGE

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

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

Troubleshooting

- Remove the power from the drive and check motor phase W.

ALARM 33, Inrush fault

Too many power-ups have occurred within a short time period.

Troubleshooting

- Let the unit cool to operating temperature.
- Check potential DC-link fault to ground.

WARNING/ALARM 34, Fieldbus communication fault

The fieldbus on the communication option card is not working.

WARNING/ALARM 35, Option fault

An option alarm is received. The alarm is option-specific. The most likely cause is a power-up or a communication fault.

ALARM 37, Phase imbalance

There is a current imbalance between the power units.

ALARM 38, Internal fault

When an internal fault occurs, a code number defined in *Table 6.6* is shown.

Troubleshooting

- Cycle power.
- Check that the option is properly installed.
- Check for loose or missing wiring.

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

Number	Text
0	The serial port cannot be initialized. Contact the Danfoss supplier or Danfoss Service Department.
256–259, 266, 268	The power EEPROM data is defective or too old. Replace the power card.
512–519	Internal fault. Contact the Danfoss supplier or Danfoss Service Department.
783	Parameter value outside of minimum/maximum limits.
1024–1284	Internal fault. Contact the Danfoss supplier or Danfoss Service Department.
1299	The option SW in slot A is too old.
1300	The option SW in slot B is too old.
1301	The option SW in slot C0 is too old.
1302	The option SW in slot C1 is too old.
1315	The option SW in slot A is not supported (not allowed).
1316	The option SW in slot B is not supported (not allowed).
1317	The option SW in slot C0 is not supported (not allowed).
1318	The option SW in slot C1 is not supported (not allowed).
1360–2819	Internal fault. Contact the Danfoss supplier or Danfoss Service Department.
2561	Replace control card.
2820	LCP stack overflow.
2821	Serial port overflow.
2822	USB port overflow.
3072–5122	Parameter value is outside its limits.
5123	Option in slot A: Hardware incompatible with control board hardware.
5124	Option in slot B: Hardware incompatible with control board hardware.
5125	Option in slot C0: Hardware incompatible with control board hardware.
5126	Option in slot C1: Hardware incompatible with control board hardware.
5127	Illegal option combination (2 options of the same kind mounted, or encoder in E0 and resolver in E1 or similar).

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Number	Text
5168	Safe stop/safe torque off was detected on a control card that does not have safe stop/safe torque off.
5376–65535	Internal fault. Contact the Danfoss supplier or Danfoss Service Department.

Table 6.6 Internal Fault Codes

ALARM 39, Heat sink sensor
No feedback from the heat sink temperature sensor.

The signal from the IGBT thermal sensor is not available on the power card.

Troubleshooting

- Check the ribbon cable between the power card and gate drive card.
- Check for a defective power card.
- Check for a defective gate drive card.

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

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

WARNING 42, Overload of digital output on X30/6 or overload of digital output on X30/7
For terminal X30/6, check the load connected to terminal X30/6 or remove the short-circuit connection. Also check *parameter 5-32 Term X30/6 Digi Out (MCB 101)* (VLT® General Purpose I/O MCB 101).

For terminal X30/7, check the load connected to terminal X30/7 or remove the short-circuit connection. Check *parameter 5-33 Term X30/7 Digi Out (MCB 101)* (VLT® General Purpose I/O MCB 101).

ALARM 43, Ext. supply
VLT® Extended Relay Option MCB 113 is mounted without external 24 V DC. Either connect a 24 V DC external supply or specify that no external supply is used via *parameter 14-80 Option Supplied by External 24VDC*, *[0] No*. A change in *parameter 14-80 Option Supplied by External 24VDC* requires a power cycle.

ALARM 45, Earth fault 2
Ground fault.

Troubleshooting

- Check for proper grounding and loose connections.
- Check for proper wire size.
- Check the motor cables for short circuits or leakage currents.

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

Troubleshooting

- Check for a defective power card.
- Check for a defective control card.
- Check for a defective option card.
- If a 24 V DC supply is used, verify proper supply power.

WARNING 47, 24 V supply low
The supply on the power card is out of range.

Troubleshooting

- Check for a defective power card.

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

Troubleshooting

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

WARNING 49, Speed limit
The warning is shown when the speed is outside of the specified range in *parameter 4-11 Motor Speed Low Limit [RPM]* and *parameter 4-13 Motor Speed High Limit [RPM]*. When the speed is below the specified limit in *parameter 1-86 Trip Speed Low [RPM]* (except when starting or stopping), the drive trips.

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

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

Troubleshooting

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

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

Troubleshooting

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

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

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

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

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

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

ALARM 58, AMA Internal fault
Contact the Danfoss supplier.

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

WARNING 60, External interlock
A digital input signal indicates a fault condition external to the drive. An external interlock has commanded the drive to trip. Clear the external fault condition. To resume normal operation, apply 24 V DC to the terminal programmed for external interlock and reset the drive.

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

Troubleshooting

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

WARNING 62, Output frequency at maximum limit
If the output frequency reaches the value set in *parameter 4-19 Max Output Frequency*, the drive issues a warning. The warning ceases when the output drops below the maximum limit. If the drive is unable to limit the frequency, it trips and issues an alarm. The latter may happen in the flux mode if the drive loses control of the motor.

Troubleshooting

- Check the application for possible causes.
- Increase the output frequency limit. Ensure that the system can operate safely at a higher output frequency.

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

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

WARNING/ALARM 65, Control card over temperature
The cutout temperature of the control card is 85 °C (185 °F).

Troubleshooting

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

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

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

ALARM 68, Safe Stop activated
Safe Torque Off (STO) has been activated. To resume normal operation, apply 24 V DC to terminal 37, then send a reset signal (via bus, digital I/O, or by pressing [Reset]).

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

Troubleshooting

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

ALARM 70, Illegal FC configuration
The control card and power card are incompatible. To check compatibility, contact the Danfoss supplier with the type code from the unit nameplate and the part numbers of the cards.

WARNING/ALARM 71, PTC 1 Safe Stop
Safe Torque Off (STO) has been activated from the VLT® PTC Thermistor Card MCB 112 because the motor is too warm. Once the motor cools and the digital input from the MCB 112 is deactivated, normal operation can resume when the MCB 112 applies 24 V DC to terminal 37 again. When the motor is ready for normal operation, a reset signal is sent (via serial communication, digital I/O, or by pressing [Reset] on the LCP). If automatic restart is enabled, the motor can start when the fault is cleared.

ALARM 72, Dangerous failure
Safe Torque Off (STO) with trip lock. Unexpected signal levels on safe torque off and digital input from the VLT® PTC Thermistor Card MCB 112.

WARNING 73, Safe Stop auto restart
Safe Torque Off (STO) activated. With automatic restart enabled, the motor can start when the fault is cleared.

ALARM 74, PTC Thermistor
Alarm related to VLT® PTC Thermistor Card MCB 112. The PTC is not working.

ALARM 75, Illegal profile sel.
Do not write the parameter value while the motor is running. Stop the motor before writing the MCO profile to *parameter 8-10 Control Profile*.

WARNING 76, Power unit setup
The required number of power units does not match the detected number of active power units. If the power card connection is lost, the unit also triggers this warning.

Troubleshooting

- Confirm that the spare part and its power card are the correct part number.
- Ensure that the 44-pin cables between the MDCIC and power cards are mounted properly.

WARNING 77, Reduced power mode
This alarm applies to only multi-drive systems. The system is operating in reduced power mode (fewer than the allowed number of drive modules). This warning is generated on power cycle when the system is set to run with fewer drive modules and remains on.

ALARM 78, Tracking error
The difference between setpoint value and actual value exceeds the value in *parameter 4-35 Tracking Error*.

Troubleshooting

- Disable the function or select an alarm/warning in *parameter 4-34 Tracking Error Function*.
- Investigate the mechanics around the load and motor. Check feedback connections from motor encoder to drive.
- Select motor feedback function in *parameter 4-30 Motor Feedback Loss Function*.
- Adjust the tracking error band in *parameter 4-35 Tracking Error* and *parameter 4-37 Tracking Error Ramping*.

ALARM 79, Illegal power section configuration
The scaling card has an incorrect part number or is not installed. Also, the MK101 connector on the power card could not be installed.

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

ALARM 81, CSIV corrupt
CSIV file has syntax errors.

ALARM 82, CSIV parameter error
CSIV failed to initialize a parameter.

ALARM 83, Illegal option combination
The mounted options are incompatible.

ALARM 84, No safety option
The safety option was removed without applying a general reset. Reconnect the safety option.

ALARM 85, Dang fail PB
PROFIBUS/PROFIsafe error.

ALARM 88, Option detection
A change in the option layout is detected.
Parameter 14-89 Option Detection is set to *[0] Frozen configuration* and the option layout has been changed.

- To apply the change, enable option layout changes in *parameter 14-89 Option Detection*.
- Alternatively, restore the correct option configuration.

WARNING 89, Mechanical brake sliding
The hoist brake monitor detects a motor speed exceeding 10 RPM.

ALARM 90, Feedback monitor
Check the connection to encoder/resolver option and, if necessary, replace VLT® Encoder Input MCB 102 or VLT® Resolver Input MCB 103.

ALARM 91, Analog input 54 wrong settings
Set switch S202 in position OFF (voltage input) when a KTY sensor is connected to analog input terminal 54.

ALARM 92, No flow
A no-flow condition is detected in the system.
Parameter 22-23 No-Flow Function is set for alarm.

Troubleshooting

- Troubleshoot the system and reset the drive after clearing the fault.

ALARM 93, Dry pump
A no-flow condition in the system with the drive operating at high speed can indicate a dry pump.
Parameter 22-26 Dry Pump Function is set for alarm.

Troubleshooting

- Troubleshoot the system and reset the drive after clearing the fault.

ALARM 94, End of curve
The feedback is lower than the setpoint. This condition can indicate leakage in the system. *Parameter 22-50 End of Curve Function* is set for alarm.

Troubleshooting

- Troubleshoot the system and reset the drive after clearing the fault.

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

Troubleshooting

- Troubleshoot the system and reset the drive after clearing the fault.

ALARM 96, Start delayed
The motor start has been delayed due to short-cycle protection. *Parameter 22-76 Interval between Starts* is enabled.

Troubleshooting

- Troubleshoot the system and reset the drive after clearing the fault.

WARNING 97, Stop delayed
Stopping the motor has been delayed because the motor has been running for less than the minimum time specified in *parameter 22-77 Minimum Run Time*.

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

ALARM 99, Locked rotor
The rotor is blocked.

WARNING/ALARM 104, Mixing fan fault
The fan is not operating. The fan monitor checks that the fan is spinning at power-up or whenever the mixing fan is turned on. The mixing-fan fault can be configured as a warning or an alarm trip in *parameter 14-53 Fan Monitor*.

Troubleshooting

- Cycle power to the drive to determine if the warning/alarm returns.

WARNING/ALARM 122, Mot. rotat. unexp.
The drive performs a function that requires the motor to be at standstill, for example DC hold for PM motors.

ALARM 144, Inrush Supply
A supply voltage on the inrush card is out of range. See the bit field result report value for more details.

- Bit 2: Vcc high.
- Bit 3: Vcc low.
- Bit 4: Vdd high.
- Bit 5: Vdd low.

ALARM 145, External SCR disable
The alarm indicates a series DC-link capacitor voltage imbalance.

WARNING/ALARM 146, Mains voltage
Mains voltage is outside valid operating range. The following report values provide more details.

- Voltage too low: 0=R-S, 1=S-T, 2=T-R
- Voltage too high: 3=R-S, 4=S-T, 5=T-R

WARNING/ALARM 147, Mains frequency
Mains frequency is outside valid operating range. Report value provides more details.

- 0: frequency too low.
- 1: frequency too high.

WARNING/ALARM 148, System temp
One or more of the system temperature measurements is too high.

WARNING 163, ATEX ETR cur.lim.warning
The drive has run above the characteristic curve for more than 50 s. The warning is activated at 83% and deactivated at 65% of the allowed thermal overload.

ALARM 164, ATEX ETR cur.lim.alarm
Operating above the characteristic curve for more than 60 s within a period of 600 s activates the alarm, and the drive trips.

WARNING 165, ATEX ETR freq.lim.warning
The drive is running for more than 50 s below the allowed minimum frequency (*parameter 1-98 ATEX ETR interpol. points freq.*).

ALARM 166, ATEX ETR freq.lim.alarm
The drive has operated for more than 60 s (in a period of 600 s) below the allowed minimum frequency (*parameter 1-98 ATEX ETR interpol. points freq.*).

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

WARNING 201, Fire mode was active
The drive has entered fire mode. Cycle power to the unit to remove the warning. Refer to the fire mode data in the alarm log.

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

WARNING 203, Missing motor
With a drive operating multi-motors, an underload condition was detected. This condition can indicate a missing motor. Inspect the system for proper operation.

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

WARNING 219, Compressor interlock
At least 1 compressor is inversely interlocked via a digital input. The interlocked compressors can be viewed in *parameter 25-87 Inverse Interlock*.

ALARM 244, Heat sink temperature
The maximum temperature of the heat sink has been exceeded. The temperature fault cannot reset until the temperature drops below a defined heat sink temperature. The trip and reset points are different based on the power size. This alarm is equivalent to *alarm 29, Heat Sink Temp*.

Troubleshooting
Check for the following conditions:

- Ambient temperature too high.
- Motor cables too long.
- Incorrect airflow clearance above or below the AC drive.
- Blocked airflow around the unit.
- Damaged heat sink fan.

- Dirty heat sink.

WARNING 250, New spare part
The power or switch mode supply has been exchanged. Restore the drive type code in the EEPROM. Select the correct type code in *parameter 14-23 Typecode Setting* according to the label on the drive. Remember to select Save to EEPROM at the end.

WARNING 251, New type code
The power card or other components have been replaced and the type code has been changed.

Troubleshooting

- Reset to remove the warning and to resume normal operation.

ALARM 421, Temperature fault
A fault caused by the on-board temperature sensor is detected on the fan power card.

Troubleshooting

- Check wiring.
- Check sensor.
- Replace fan power card.

ALARM 422, Communication fault
A fan power card (FPC) communication failure is detected. The alarm report value indicates which card generated the fault, and whether the fault is upstream or downstream. A value <100 indicates upstream card communication failure. A value >100 indicates a downstream card communication failure. A report value of 255 indicates that the control card generated the fault.

Troubleshooting:

- Check the wiring between the cards that generated the fault. It could be either 2 FPCs or the control card and the first FPC.
- Replace the faulty FPC.
- Replace the faulty control card.

ALARM 423, FPC updating
The alarm is generated when the fan power card reports it has an invalid PUD. The control card attempts to update the PUD. A subsequent alarm can result depending on the update. See alarm 424 and alarm 425.

ALARM 424, FPC update successful
This alarm is generated when the control card has successfully updated the fan power card PUD. The drive must be reset to stop the alarm.

ALARM 425, FPC update failure
This alarm is generated after the control card failed to update the fan power card PUD.

Troubleshooting

- Check the fan power card wiring.
- Replace fan power card.
- Contact supplier.

ALARM 426, FPC config
The number of found fan power cards does not match the number of configured fan power cards. See *parameter group 15-6* Option Ident* for the number of configured fan power cards.

Troubleshooting

- Check fan power card wiring.
- Replace fan power card.

ALARM 427, FPC supply
Supply voltage fault (5 V, 24 V, or 48 V) on fan power card is detected.

Troubleshooting

- Check fan power card wiring.
- Replace fan power card.

7 Drive and Motor Applications

7.1 Torque Limit, Current Limit, and Unstable Motor Operation

Excessive loading of the drive can result in warning or tripping on torque limit, overcurrent, or inverter time. This situation is not a concern if the drive is properly sized for the application and intermittent load conditions cause an occasional trip. However, nuisance or unexplained occurrences can be the result of improperly set parameters. The following parameters are important in matching the drive to the motor for optimum operation.

- *Parameter 1-00 Configuration Mode* sets the drive for open or closed-loop operation, or torque mode operation.
- *Parameter 1-03 Torque Characteristics* sets the mode in which the drive operates.
- *Parameters 1-20* to *1-29* match the drive to the motor and adapt to the motor characteristics.
- *Parameter 4-16 Torque Limit Motor Mode*, *parameter 4-17 Torque Limit Generator Mode*, and *parameter 14-25 Trip Delay at Torque Limit* set the torque control features of the drive for the application.

Parameter 1-00 Configuration Mode
This parameter sets the drive for open loop, closed loop, or torque mode operation. In a closed-loop configuration, a feedback signal controls the drive speed. The settings for the PID controller play a key role for stable operation in closed loop, as described in the operating instructions. In open loop, the drive calculates the torque requirement based on current measurements of the motor.

Parameter 1-03 Torque Characteristics
This parameter sets the drive for constant or variable torque operation. It is imperative that the correct torque characteristic is selected. For example, if the load type is constant torque, such as a conveyor, and *[1] Variable torque* is selected, the drive can have difficulty starting the load. Consult Danfoss if uncertain about the torque characteristics of an application.

Parameter 1-20 Motor Power [kW]* and *parameter 1-25 Motor Nominal Speed
These parameters configure the drive for the connected motor. These parameters are motor power, voltage, frequency, current, and nominal motor speed. Accurate setting of these parameters is important. Enter the required motor data as listed on the motor nameplate. For proper load control, the drive relies on this information for calculating the output waveform in response to the application demands.

Parameter 1-29 Automatic Motor Adaptation (AMA)
This parameter activates the automatic motor adaptation (AMA) function. When AMA is performed, the drive measures the electrical resistance of the motor stator windings (R1). *Parameter 1-31 Rotor Resistance (Rr) – parameter 1-35 Main Reactance (Xh)* must be requested from the motor manufacturer for optimal performance of the drive data. To set *parameter 1-31 Rotor Resistance (Rr) – parameter 1-35 Main Reactance (Xh)*, use the values supplied by the motor manufacturer or leave at the factory default values.

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

Parameter 4-17 Torque Limit Generator Mode* and *parameter 4-16 Torque Limit Motor Mode
These parameters set the limit for the drive torque. The factory setting is 160% for VLT® AutomationDrive FC 302 and 110% for VLT® HVAC Drive FC 102/VLT® AQUA Drive FC 202 and varies with motor power setting. For example, a drive programmed to operate a smaller motor yields a higher torque limit value than when programmed for a larger motor. It is important that this value is not set too low for the requirements of the application. Sometimes, it can be desirable to have a torque limit set at a lower value. This offers protection for the application as the drive limits the torque. It can, however, require higher torque at initial start-up, which can cause nuisance tripping.

Parameter 14-25 Trip Delay at Torque Limit
This parameter works with torque limit. This parameter selects the period in which the drive operates in torque limit before a trip. The factory default value is Off. This setting means that the drive does not trip on torque limit, although the unit can still trip from an overload condition. Built into the drive is an internal inverter thermal protection circuit. This circuit monitors the output load on the inverter. If the load exceeds 100% of the continuous rating of the drive, a timer is activated. If the load remains excessive long enough, the drive trips on inverter time. Adjustments cannot be made to alter this circuit. Improper parameter settings effecting load current can result in premature trips of this type. The timer can be shown on the LCP.

7.1.1 Overvoltage Trips

This trip occurs when the DC bus voltage reaches its DC bus alarm voltage high. Before tripping, the drive shows a high-voltage warning. Usually, the cause of an overvoltage condition is fast deceleration ramps relative to the inertia of the load. During deceleration of the load, inertia of the system acts to sustain the running speed. Once the motor frequency drops below the running speed, the load begins overtaking the motor. The motor becomes a generator and starts returning energy to the drive. This process is called regenerative energy. Regen occurs when the speed of the load is greater than the commanded speed. The diodes in the IGBT modules rectify this return voltage, which raises the DC bus. If the amount of returned voltage is too high, the drive trips.

Ways to avoid overvoltage trips

- Reduce the deceleration rate. The drive can only decelerate the load slightly faster than it would take for the load to naturally coast to a stop.
- Allow the overvoltage control circuit to take care of the deceleration ramp. When enabled, the overvoltage control circuit regulates deceleration at a rate that maintains the DC bus voltage at a level that keeps the unit from tripping. Overvoltage control corrects minor, but not major discrepancies between ramp rates. For example, if a deceleration ramp of 100 s is required, and the ramp rate is set at 70 s, the overvoltage control corrects it. However, with the same inertia, if the ramp is set at a larger difference, such as 3 s, overvoltage control engages initially, and then disengages, allowing the drive to trip. This trip is done deliberately to avoid confusion about the operation of the drive.
- Control regenerated energy with a dynamic brake. If the DC bus level becomes too high, the drive switches the resistor across the DC bus. The unwanted energy is dissipated into the external resistor bank mounted outside of the drive. This process increases deceleration rate.

Less often, the load causes an overvoltage condition while running at speed. When this condition occurs, the dynamic brake option or the overvoltage control circuit can be used. For example, if the speed of the load is greater than the commanded speed, the overvoltage circuit increases the frequency to match. The same restriction on the amount of influence applies.

The drive adds about 10% to the base speed before a trip occurs. Otherwise, the speed could continue to rise to potentially unsafe levels.

7.1.2 Mains Phase Loss Trips

Mains phase loss trips
B and C-sized drives monitor phase loss by monitoring the amount of ripple voltage on the DC bus. Ripple voltage on the DC bus is a product of a phase loss and can cause overheating in the DC bus capacitors and DC coil. If the ripple voltage on the DC bus is unchecked, the lifetime of the capacitors is reduced significantly.

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

Possible sources of disturbance
Loads affecting the form factor of the AC waveform cause line disturbances. For example, notching or defective transformers can cause disturbances.

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

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

Checks
When a mains imbalance trip occurs, check both the input and output voltage of the drive. Significant imbalance of supply voltage or phase loss is detectable with a voltmeter. View line disturbances through an oscilloscope. Conduct tests for:

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

Refer to *chapter 8.5.2 Input Voltage Test*, *chapter 8.5.6 Input Imbalance of Supply Voltage Test*, and *chapter 8.5.8 Output Imbalance of Motor Voltage and Current*.

7.1.3 Control Logic Problems

Problems with control logic can often be difficult to diagnose since there is usually no associated fault indication. Typically, the drive does not respond to a given command.

To obtain an output, provide these basic commands to the drive:

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

The drives are designed to accept various signals. First determine which of these signals the drive is receiving:

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

The presence of a correct reading indicates that the microprocessor of the drive has detected the signal. Refer to *chapter 4.9 Grounded Shielded Cables* and *chapter 8.5.12 Input Terminal Signal Tests*.

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

If there is no correct indication, check that the signal is present at the input terminals of the drive. Refer to *chapter 8.5.12 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 drive. Check the circuitry providing the signal along with its associated wiring.

7.1.4 Programming Problems

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

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

Refer to *chapter 4.6 Drive Inputs and Outputs*.

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

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

Incorrectly set I/O configuration usually results in the drive 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 drive responds to an input signal or the type of signal present at that output. Utilizing an I/O function involves a 2-step process. First, wire the I/O terminal properly, and then set the corresponding parameter. Control terminals are programmed in *parameter groups 5-0* Digital I/O Mode* and *6-0* Analog I/O Mode*.

7.1.5 Motor Load Problems

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

A motor with unbalanced or asymmetrical impedances on all 3 phases can result in rough operation or unbalanced output currents. For measurements, use a clamp-on style ammeter to determine whether the current is balanced on the 3 output phases. Refer to *chapter 4.6 Drive Inputs and Outputs*.

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

Often, the indications of motor problems are similar to the problems of a defective drive. To determine whether the problem is with the drive, disconnect the motor from the motor terminals. Perform the test in *chapter 8.5.8 Output Imbalance of Motor Voltage and Current*. If the 3 voltage measurements are balanced, the drive functions correctly.

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

7.2 Internal Drive Problems

To identify most problems related to failed power components, perform a visual inspection and the static tests as described in *chapter 8.4 Static Test Procedures*.

The following problems must be diagnosed in a different manner.

7.2.1 Overtemperature Faults

When an overtemperature indication occurs, determine whether this condition exists within the drive or whether the thermal sensor is defective. If an overtemperature condition is present in the drive, the outside of the unit is warm. If the exterior is not warm, check the temperature sensor with an ohmmeter.

7.2.2 Current Sensor Faults

An overcurrent alarm that cannot be reset, even with the motor cables disconnected, sometimes indicates current sensor failure. In this case, the drive experiences frequent false ground fault trips due to the DC offset failure mode of the sensors.

An explanation of the internal composition of a Hall-effect type current sensor helps to explain these faults. Included inside the device is an op-amp to amplify the signal to usable levels in the receiving circuitry. The output at 0 input level (0 A flow being measured) is 0 V, exactly halfway between the plus and minus supply voltages. A tolerance of ±15 mV is acceptable. In a 3-phase system that operates correctly, the sum of the 3 output currents is always 0.

When the sensor becomes defective, the output voltage level varies by more than the 15 mV. The defective current sensor in that phase indicates current flow when there is none. This condition results in the sum of the 3 output currents being a value other than 0. If the deviation from 0 (current amplitude) approaches a specific level, the drive assumes a ground fault and issues an alarm.

To determine whether a current sensor is defective, disconnect the motor from the drive and observe the current in the drive display. With the motor disconnected, the current must be 0. A drive with a defective current sensor indicates some current flow. Because the current sensors for the drives with higher power ratings have less resolution, an indication of a fraction of 1 A is tolerable. However, that value must be considerably lower than 1 A. If the display shows more than 1 A of current, the current sensor is defective.

To determine which current sensor is defective, measure the voltage offset at zero current for each current sensor. Refer to *chapter 8.5.10 Current Sensors Test*.

7.3 Electromagnetic Interference

The following is an overview of general signal and power wiring considerations when addressing the electromagnetic compatibility (EMC) concerns for typical commercial and industrial equipment. High-frequency RF emissions and immunity are discussed. Compliance to national and European CE EMC directives are required.

7.3.1 Effects of EMI

While electromagnetic interference (EMI) disturbances to the operation of the unit are uncommon, the following detrimental EMI effects can be seen:

- Motor speed fluctuations.
- Serial communication transmission errors.
- Drive CPU exception faults.
- Unexplained drive trips.

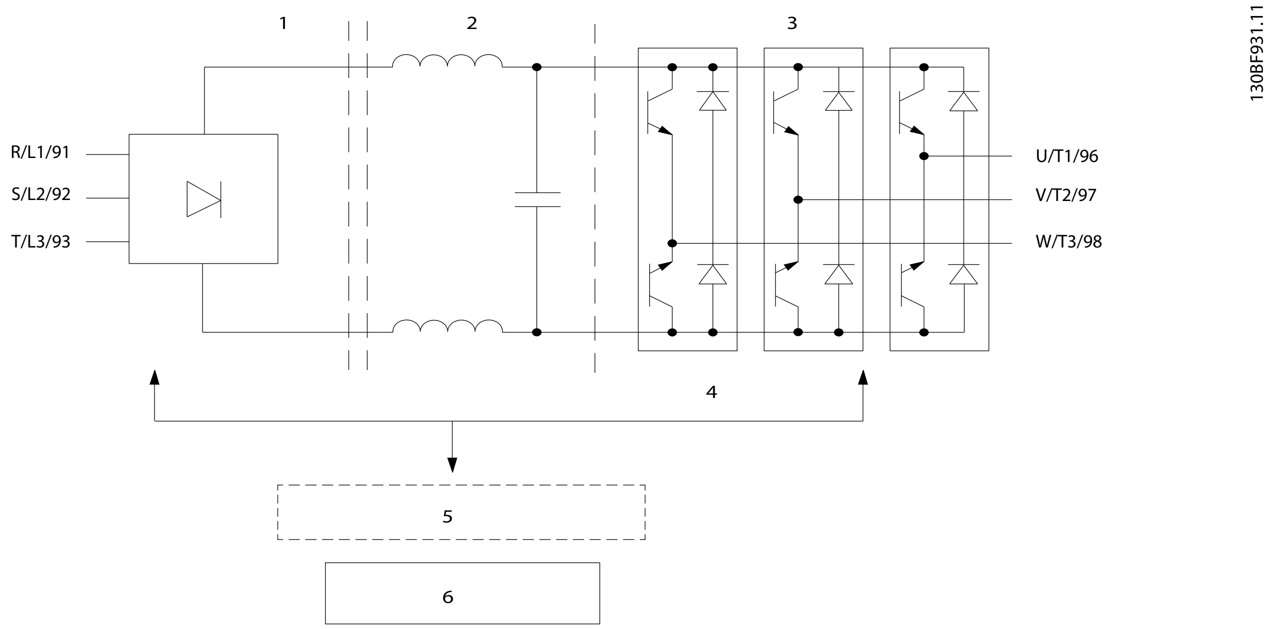
A disturbance resulting from other nearby equipment is more common. Generally, other industrial control equipment has a high level of EMI immunity. However, non-industrial, commercial, and consumer equipment is often susceptible to lower levels of EMI.

Detrimental effects to these systems can include the following:

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

7.3.2 Sources of EMI

B-sized and C-sized drives (*Illustration 7.1*) use IGBTs to create the pulse-width modulated (PWM) output waveform necessary for accurate motor control. These IGBTs rapidly switch the fixed DC bus voltage creating a variable frequency and a variable voltage PWM waveform. This high rate of voltage change [dU/dt] is the primary source of generated EMI of the drives.



1	Rectifier (SCR/diodes)	4	Power section
2	DC link (DC bus)	5	Logic-to-power interface
3	Inverter (IGBTs)	6	Control logic

Illustration 7.1 Functionality Diagram for B and C-sized Drives

7.3.3 EMI Propagation

Drive-generated EMI is both conducted to the mains and radiated to nearby conductors. Refer to *Illustration 7.2*. Stray capacitance between the motor conductors, equipment ground, and other nearby conductors results in induced high-frequency currents.

High ground circuit impedance at high frequencies results in an instant voltage at points reputed to be at ground potential. This voltage appears throughout a system as a common mode signal that interferes with control signals. Theoretically, these currents return to the DC bus via the ground circuit and a high-frequency (HF) bypass network within the drive itself. However, imperfections in the drive grounding or the equipment ground system can cause some of the currents to travel out to the power network.

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 parallel to the power conductors for any distance. EMI coupled into these conductors can affect either the drive or the interconnected control device. Refer to *Illustration 7.4*.

These currents tend to travel back to the drive. However, imperfections in the system cause some current to flow in undesirable paths and expose other locations to EMI. When the mains conductors are close to the motor cables, high-frequency currents can be coupled into the mains supply.

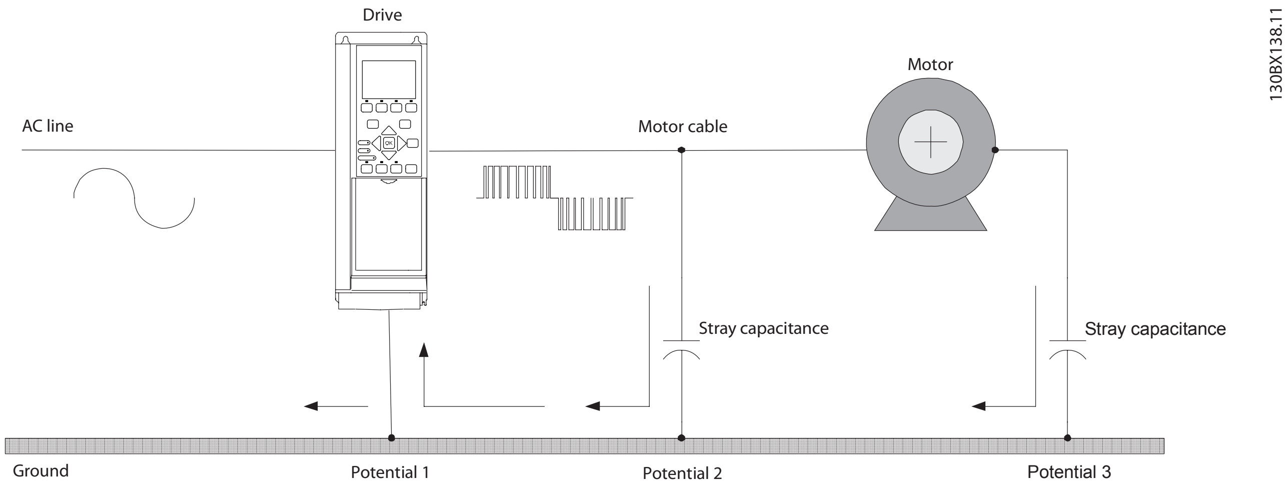


Illustration 7.2 Ground Currents

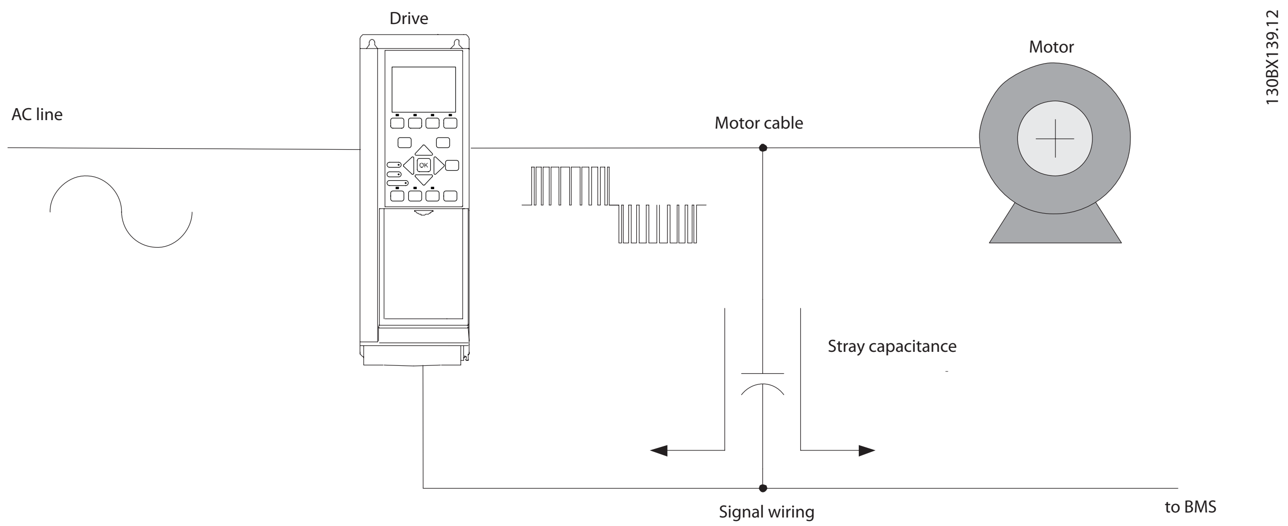


Illustration 7.3 Signal Conductor Currents

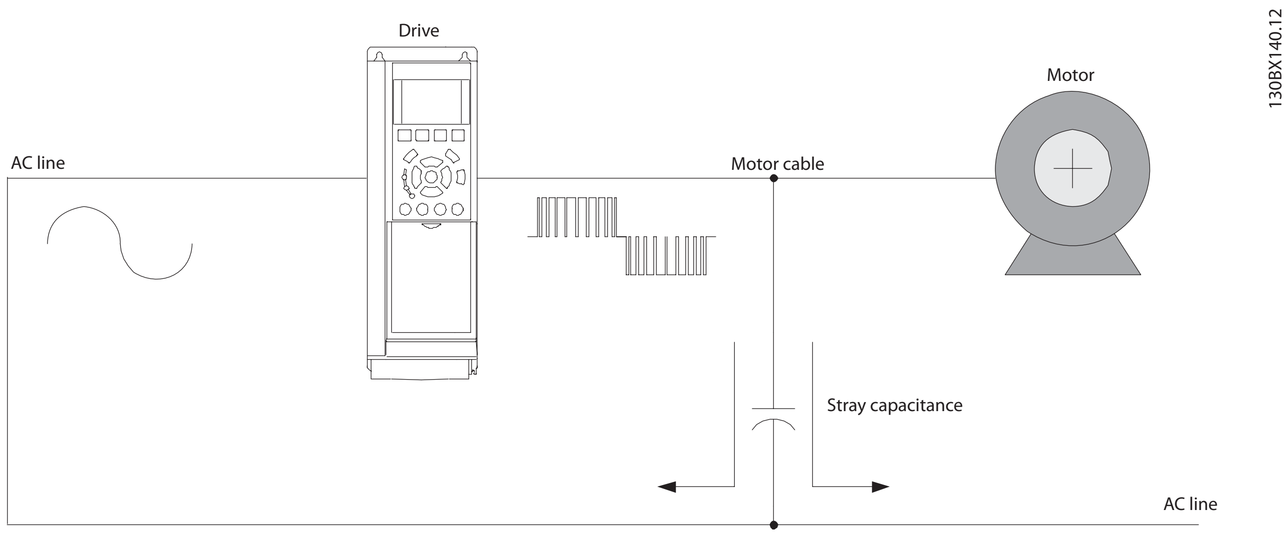


Illustration 7.4 Alternate Signal Conductor Currents

7.3.4 Preventive Measures

EMI-related problems are more effectively alleviated during the design and installation phases rather than during service.

Grounding
The drive and motor must be solidly grounded to the equipment enclosure. A good high-frequency connection is necessary to allow the high-frequency currents to return back to the drive rather than to travel through the power network. The ground connection is ineffective if it has high impedance to high-frequency currents. Therefore it must be as short and direct as practical. Flat-braided cable has lower high-frequency impedance than round cable. Simply mounting the drive or motor onto a painted surface does not create an effective ground connection. In addition, running a separate ground conductor directly between the drive and the running motor is recommended.

Cable routing

Avoid routing the following in parallel:

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

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

Signal cable selection
Single conductor 600 V rated wires provide the least protection from EMI. Twisted-pair cables and shielded twisted-pair cables are available that are designed to minimize the effects of EMI. While unshielded twisted-pair cables are often adequate, shielded twisted-pair cables provide another degree of protection. Terminate the signal cable shield in a manner that is appropriate for the connected equipment. Avoid terminating the shield through a pigtail connection as this method increases the high-frequency impedance and reduces the effectiveness of the shield. Refer to *chapter 4.9 Grounded Shielded Cables*.

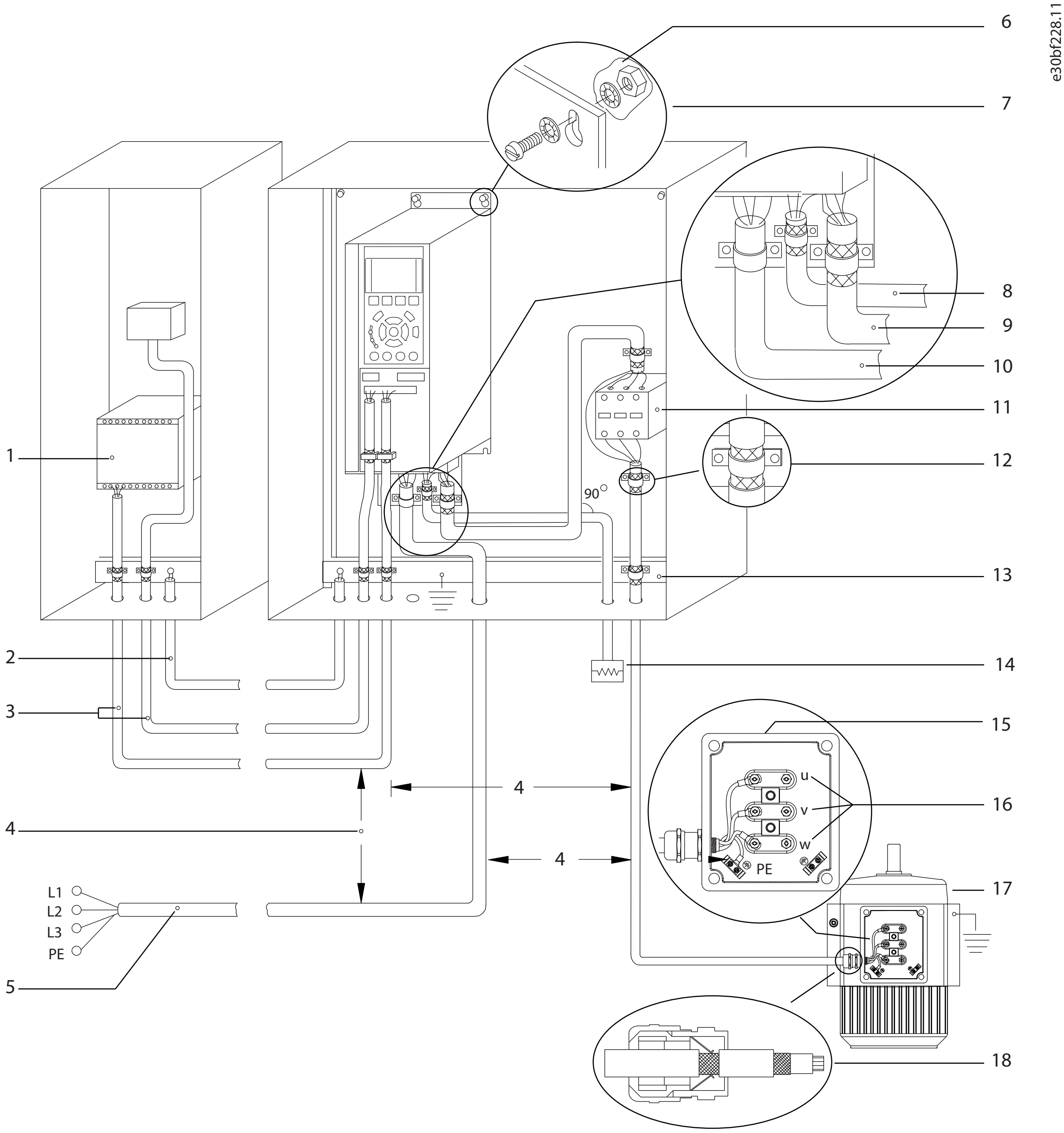
A simple alternative is to twist the existing single conductors to provide a balanced capacitive and inductive coupling. This method cancels differential mode interference. While not as effective as true twisted-pair cable, it can be implemented in the field using the available materials.

Motor cable selection
The management of the motor conductors has 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 a shielded power cable is the most effective method to alleviate EMI problems. The shield forces the noise current to flow directly back to the drive. This prevents it from flowing back into the power network or other undesirable high-frequency paths. Unlike most signal wiring, the shielding on the motor cable must be terminated at both ends.

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

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



1	PLC	10	Mains cable (unshielded)
2	Minimum 16 mm^2 (6 AWG) equalizing cable	11	Output contactor
3	Control cables	12	Cable insulation stripped
4	Minimum 200 mm (7.9 in) between control cables, motor cables, and mains cables	13	Common ground busbar. Follow local and national requirements for cabinet grounding
5	Mains supply	14	Brake resistor
6	Bare (unpainted) surface	15	Metal box
7	Star washers	16	Connection to motor
8	Brake cable (shielded)	17	Motor
9	Motor cable (shielded)	18	EMC cable gland

Illustration 7.5 Example of Proper EMC Installation

8 Test Procedures

8.1 Introduction

⚠WARNING

DISCHARGE TIME

The drive contains DC-link capacitors, which can remain charged even when the drive is not powered. High voltage can be present even when the warning LED indicator lights are off. Failure to wait 15 minutes after power has been removed before performing service or repair work can result in death or serious injury.

- **Stop the motor.**
- **Disconnect AC mains and remote DC-link power supplies, including battery back-ups, UPS, and DC-link connections to other drives.**
- **Disconnect or lock the motor.**
- **Disconnect any brake option.**
- **Disconnect any regen/load share option.**
- **Wait 15 minutes for the capacitors to discharge fully. The minimum waiting time is also specified on the drive label.**
- **Before performing any service or repair work, use an appropriate voltage measuring device to make sure that the capacitors are fully discharged.**

This section contains detailed procedures for testing drives. The results of these tests indicate the appropriate repair actions. The source of fault conditions is not always internal to the drive. For example, the drive monitors:

- I/O signals.
- Motor conditions.
- AC and DC power.
- Other functions.

Testing described in this chapter isolates many of these conditions.

Drive testing is divided into 3 types:

- Static tests.
- Dynamic tests.
- After-repair tests.

Static tests

Static tests are conducted without power applied to the drive. Most drive problems can be diagnosed 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.

Dynamic tests

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

After-repair tests

After-repair tests are performed following service work or parts replacement. These procedures retest the drive with the new component before power is applied.

8.2 Tools Required

Item	Description
ESD protection kit	Wrist strap and mat
Metric socket set	7–19 mm
Socket extensions	100–150 mm (4 in and 6 in)
Magnetic sockets	–
Ratchet wrench	–
Torque wrench	Torque range 0.5–19 Nm (6–170 in-lb)
Torx driver set	T10–T50
Needle nose pliers	–
Screwdrivers	Standard and Phillips

Table 8.1 Tools Required to Service Drives

Item	Description
Digital Volt-Ohm Meter (PWM-compatible)	• Rated for true RMS. • Rated for the mains AC voltage and DC-link voltage of the drive. (DC-link voltage = 1.414 x mains voltage). • Supports the diode mode.
Analog voltmeter (with safety probe tip extenders)	–
Oscilloscope	–
Clamp-on ammeter	Rated for true RMS

Table 8.2 Instruments Recommended to Test Drives

8

8.2.1 Metering Tools

For best troubleshooting results, perform the static test procedures described in this section in the order presented.

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

Diode drop
A diode drop reading varies depending on the model of ohmmeter. Whatever the ohmmeter shows as a typical forward bias diode, it is defined as a diode drop in these procedures. With a typical DVM, the voltage drop across most components is around 0.300 to 0.500. The opposite reading is referred to as infinity, and most show the value OL for overload.

8.3 Test Preparations

NOTICE

TEST ORDER

For best results, perform the static test procedures in this section in the order they appear.

Observe the following safety precautions before performing the 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 drive is always present while performing service.
- Handle disassembled electronic parts with care.
- Perform the static tests before powering up the faulty unit.
- Perform the static tests after completing the repair and assembly of the drive.
- Connect the drive to the mains only after completion of static tests.
- Complete all necessary precautions for system start-up before applying power to the drive.

⚠WARNING

DISCHARGE TIME

The drive contains DC-link capacitors, which can remain charged even when the drive is not powered. High voltage can be present even when the warning LED indicator lights are off. Failure to wait 15 minutes after power has been removed before performing service or repair work can result in death or serious injury.

- **Stop the motor.**
- **Disconnect AC mains and remote DC-link power supplies, including battery back-ups, UPS, and DC-link connections to other drives.**
- **Disconnect or lock the motor.**
- **Disconnect any brake option.**
- **Disconnect any regen/load share option.**
- **Wait 15 minutes for the capacitors to discharge fully. The minimum waiting time is also visible on the drive label.**
- **Before performing any service or repair work, use an appropriate voltage measuring device to make sure that the capacitors are fully discharged.**

8.3.1 Card Connectors

This section includes illustrations of printed circuit cards and descriptions of their connectors used during testing and servicing. Some connectors are optional and not found on all configurations. The printed circuit cards shown include:

- Switch mode power supply (SMPS) card.
- Power card.
- Inrush card.

8.3.2 Switch Mode Power Supply (SMPS) Card Connections

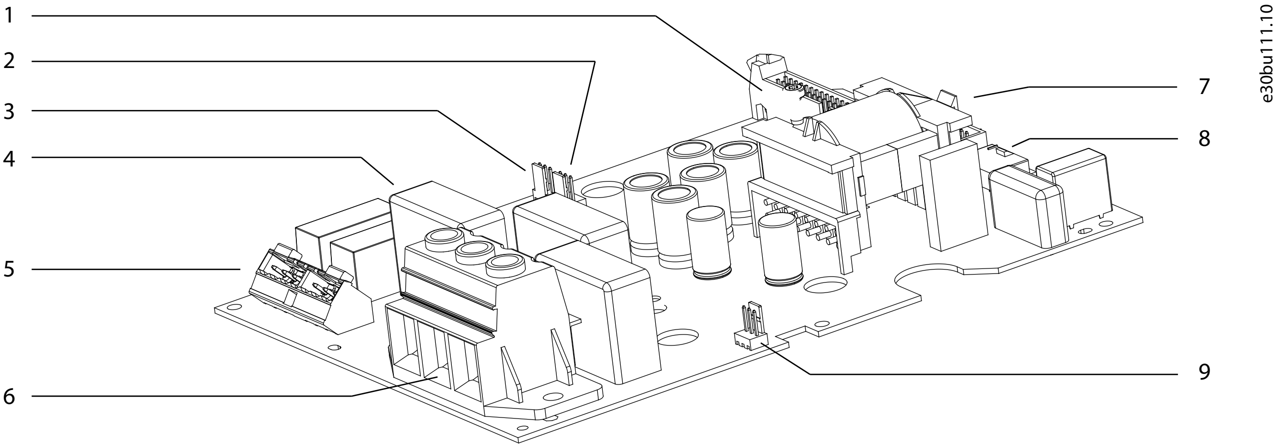


Illustration 8.1 SMPS Card in B-sized Drives

8.3.3 Power Card Connections

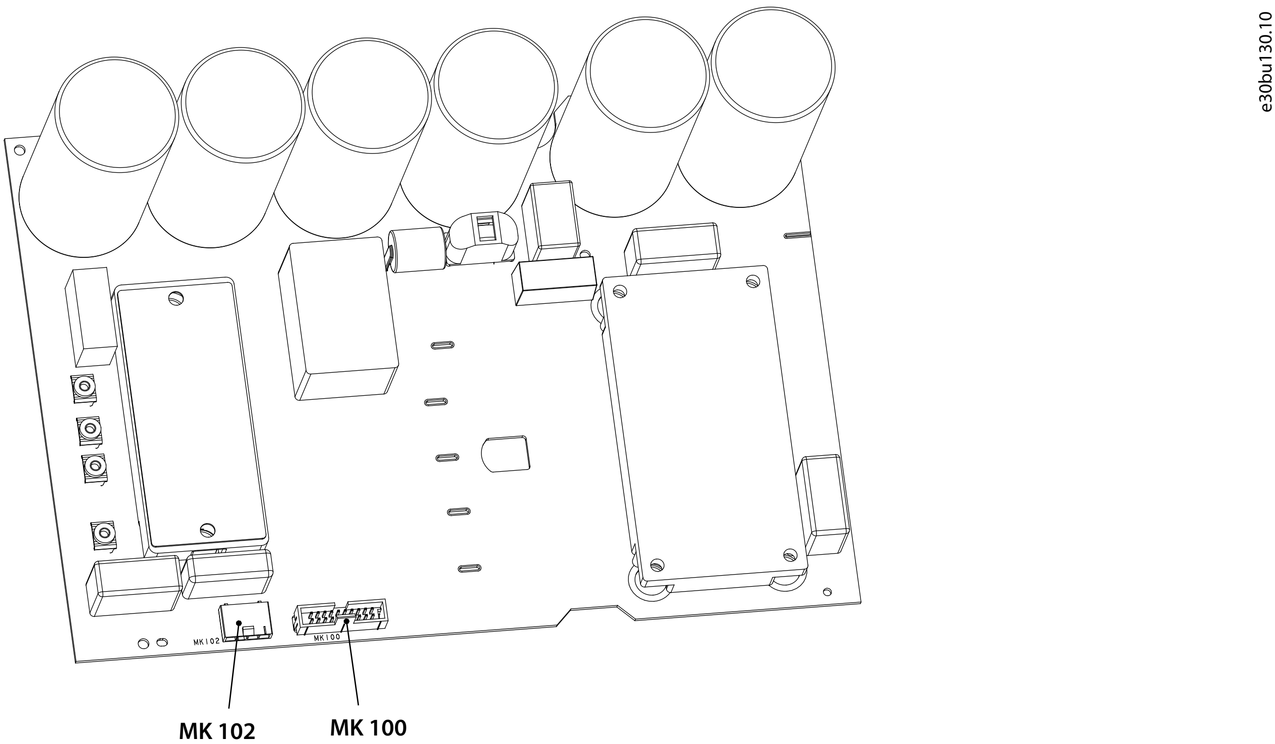


Illustration 8.2 Power Card in B-sized Drives

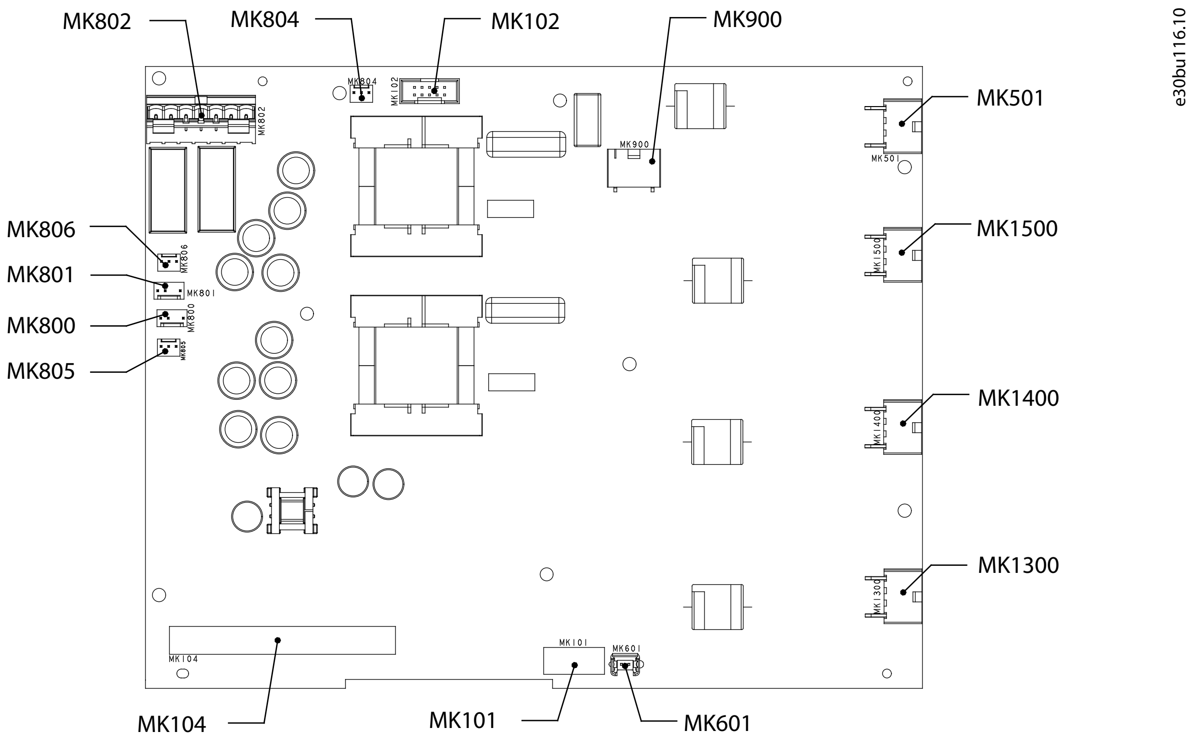


Illustration 8.3 Power Card in C-sized Drives

8.3.4 Inrush Card Connections

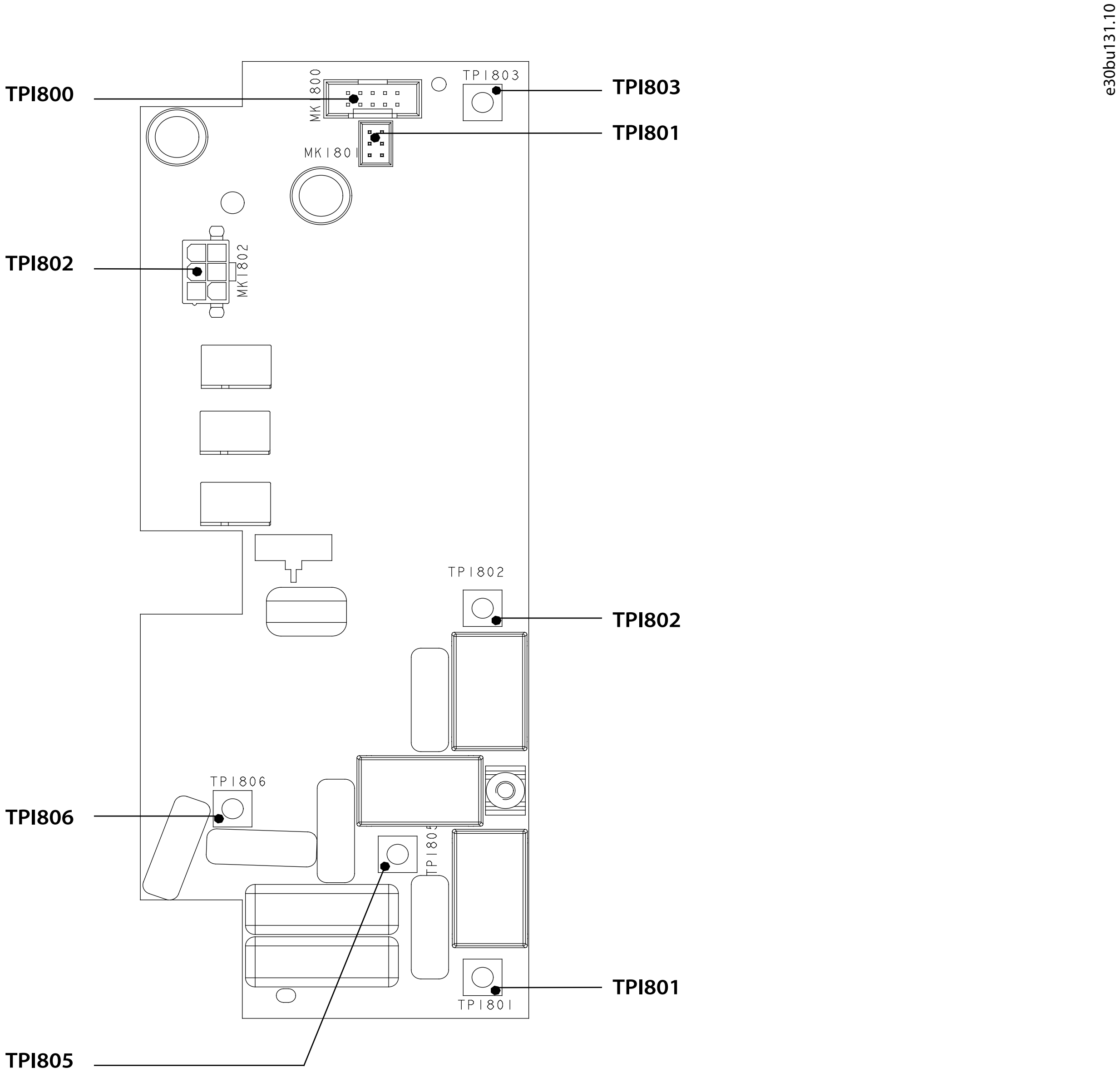


Illustration 8.4 Inrush Card in C-sized Drives

8.4 Static Test Procedures

NOTICE

TEST ORDER

For best troubleshooting results, perform the static test procedures described in this section in the order presented.

To find the appropriate card connectors for performing the tests in this section, see *chapter 8.3.1 Card Connectors*. Some connectors are optional and not found on all configurations.

8.4.1 Rectifier Circuits Test for B-sized Enclosures

Pay close attention to the polarity of the meter leads to identify a faulty component if an incorrect reading appears.

8

NOTICE

OPTIONAL EQUIPMENT TESTS

For a unit with a circuit breaker, contactor, disconnect, or mains fuse option, make test connections R/L1/91, S/L2/92, and T/L3/93 to the output side of the device.

Main rectifier circuit test part I

1. Connect the positive (+) meter lead to the positive DC(+) bus.
2. Connect the negative (–) meter lead to terminals L1, L2, and L3 in sequence.

The correct reading is infinity. The meter starts at a low value and slowly climbs toward infinity due to the meter charging capacitance within the drive.

Incorrect reading

With this test connection, the SCRs in the SCR/diode modules are reverse biased so they are blocking current flow. If a short circuit exists, it indicates that the SCRs are shorted. Replace the shorted SCR/diode module.

Main rectifier circuit test part II

1. Reverse meter leads by connecting the negative (–) meter lead to the positive DC(+) bus.
2. Connect the positive (+) meter lead to L1, L2, and L3 in sequence.

The correct reading is infinity.

Incorrect reading

With this test connection, the SCRs in the SCR/diode modules are forward biased by the meter. However, current does not flow through the SCRs without providing a signal to the gates.

A short circuit reading indicates that 1 or more of the SCRs are shorted in the SCR/diode module. Replace the shorted SCR/diode module.

Main rectifier circuit test part III

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

A diode drop indicates a correct reading.

Incorrect reading

With this test connection, the diodes in the SCR/diode modules are forward biased. The meter reads the diode drops. If a short circuit exists, it is possible that the SCR/diode modules are shorted. Replace the shorted SCR/diode module.

If an open reading occurs, replace the open SCR/diode module.

Main rectifier circuit test part IV

1. Reverse meter leads by connecting the negative (–) meter lead to the negative DC(-) bus.
2. Connect the positive (+) meter lead to L1, L2, and L3 in sequence.

Infinity is the correct reading. The meter starts at a low value and slowly climbs toward infinity due to the meter charging capacitance within the drive.

Incorrect reading

With this test connection, the diodes in the SCR/diode modules are reverse biased. If a short circuit exists, the diodes in the SCR/diode modules are shorted. Replace the shorted SCR/diode module.

8.4.2 Rectifier Circuits Test for C-sized Enclosures

Pay close attention to the polarity of the meter leads to identify a faulty component if an incorrect reading appears.

NOTICE

OPTIONAL EQUIPMENT TESTS

For a unit with a circuit breaker, contactor, disconnect, or mains fuse option, make test connections R/L1/91, S/L2/92, and T/L3/93 to the output side of the device.

Main rectifier circuit test part I

1. Connect the positive (+) meter lead to the positive DC(+) bus.
2. Connect the negative (–) meter lead to terminals L1, L2, and L3 in sequence.

The correct reading is infinity. The meter starts at a low value and slowly climbs toward infinity due to the meter charging capacitance within the drive.

Incorrect reading
With this test connection, the SCRs in the SCR/diode modules are reverse biased so they are blocking current flow. If a short circuit exists, it indicates that the SCRs are shorted. Replace the shorted SCR/diode module.

Main rectifier circuit test part II

1. Reverse meter leads by connecting the negative (–) meter lead to the positive DC(+) bus.
2. Connect the positive (+) meter lead to L1, L2, and L3 in sequence.

The correct reading is infinity.

Incorrect reading
With this test connection, the SCRs in the SCR/diode modules are forward biased by the meter. However, current does not flow through the SCRs without providing a signal to the gates.

A short circuit reading indicates that 1 or more of the SCRs are shorted in the SCR/diode module. Replace the shorted SCR/diode module.

Main rectifier circuit test part III

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

A diode drop indicates a correct reading.

Incorrect reading
With this test connection, the diodes in the SCR/diode modules are forward biased. The meter reads the diode drops. If a short circuit exists, it is possible that the SCR/ diode modules are shorted. Replace the shorted SCR/diode module.

If an open reading occurs, replace the open SCR/diode module.

Main rectifier circuit test part IV

1. Reverse meter leads by connecting the negative (–) meter lead to the negative DC(-) bus.
2. Connect the positive (+) meter lead to L1, L2, and L3 in sequence.

Infinity is the correct reading. The meter starts at a low value and slowly climbs toward infinity due to the meter charging capacitance within the drive.

Incorrect reading
With this test connection, the diodes in the SCR/diode modules are reverse biased. If a short circuit exists, the diodes in the SCR/diode modules are shorted. Replace the shorted SCR/diode module.

8.4.3 Inverter Section Tests

NOTICE

MOTOR CABLE REMOVAL
Disconnect motor cables when testing the inverter section. When leads are connected, a short circuit in a single phase reads in all phases, making isolation difficult.

The inverter section consists primarily of the IGBTs used for switching the DC bus voltage to create the output to the motor.

Inverter test part I

1. Set the meter to diode scale.
2. Connect the positive (+) meter lead to the (+) positive DC bus.
3. Connect the negative (–) meter lead to terminals U, V, and W in sequence.

Infinity is the correct reading. The meter starts at a low value and slowly moves toward infinity due to the meter charging capacitance within the drive.

Inverter test part II

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

A diode drop indicates a correct reading.

Inverter test part III

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

A diode drop indicates a correct reading.

Inverter test part IV

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

Infinity is the correct reading. The meter starts at a low value and slowly moves toward infinity due to the meter charging capacitance within the drive.

Incorrect reading
An incorrect reading in any inverter test indicates a failed IGBT module. Replace all the IGBT modules. Following an IGBT failure, verify that the gate drive signals are present and the wave form is correct.

8.4.4 Brake IGBT Test

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

Brake IGBT test part I

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

Infinity is a correct reading. The meter starts at a value and climbs toward infinity as capacitance is charged within the drive.

Brake IGBT test part II

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

A diode drop indicates a correct reading.

Brake IGBT test part III

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

Infinity is a correct reading. The meter starts at a value and climbs toward infinity as capacitance is charged within the drive.

Brake IGBT test part IV

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

A diode drop indicates a correct reading.

Incorrect reading
An incorrect reading on any of these tests indicates that the brake IGBT is defective. Replace the brake IGBT module.

8.4.5 Intermediate Section Tests

The intermediate section of the drive is composed of the:

- DC bus capacitors.
- DC coils.
- Balance circuit for the capacitors.

Intermediate section test

1. Test for short circuits with the ohmmeter set to Rx100 scale. If using a digital meter, select diode.
2. Connect the positive (+) meter lead to the DC(+) and the negative (-) meter lead to the negative DC(-).
3. The meter starts with low ohms and then moves toward infinity as the meter charges the capacitors.
4. Reverse the meter leads so that the (-) meter lead is connected to the positive DC(+) and the positive (+) meter lead is connected to the negative DC(-).

The meter pegs at 0 while the meter discharges the capacitors. The meter then begins moving slowly toward 2. The diode drops as the meter charges the capacitors in the reverse direction. Although the test does not ensure that the capacitors are fully functional, it ensures that no short circuits exist in the DC link.

Incorrect reading
A short in the rectifier or inverter section could cause a short circuit reading. Ensure that the tests for these circuits have already been performed successfully. A failure in 1 of these sections could be read in the intermediate section since they are all routed via the DC bus.

If a short circuit is present, and the unit is equipped with a brake, perform the brake IGBT test next. The only other likely cause for failure would be a defective capacitor.

There is not an effective test of the capacitor bank when it is fully assembled. It is unlikely that a physically damaged capacitor would indicate a failure within the capacitor bank. If a failure is suspected, all the capacitors must be replaced. Replace the capacitors in accordance with the *Drive Disassembly and Assembly* sections. Further static tests could require some disassembly.

8.4.6 IGBT Temperature Sensor Test

The temperature sensor is an NTC (negative temperature coefficient) device. As a result, high resistance means low temperature. As the temperature increases, resistance decreases. Each IGBT module has a temperature sensor mounted internally. The sensor is wired from each IGBT module to the gatedrive card connector MK100.

On the gatedrive card, the resistance signal is converted to a frequency signal. The frequency signal is sent to the power card for processing. The temperature data is used to regulate fan speed and to monitor for over and under temperature conditions.

IGBT section test

1. Use an ohmmeter set to measure the ohms.
2. Unplug connector MK100 on the gatedrive card and measure the resistance across each black and white pair.

The relationship between temperature and resistance is nonlinear. The higher the temperature, the lower the resistance. At 25 °C (77 °F), the resistance is approximately 5k Ω. At 0 °C (32 °F), the resistance is approximately 13.7 k Ω. At 60 °C (140 °F), the resistance is approximately 1.5 k Ω.

8.4.7 Gate Resistor Test

Mounted to each IGBT module is an IGBT gate resistor card containing gate resistors for the IGBT transistors. Occasionally, a defective IGBT can produce correct readings in the previous tests. Typically, an IGBT failure results in the failure of the gate resistors, so the gate resistor test can identify an IGBT failure.

In B and C-sized drives, a 3-pin test connector is found on the gatedrive card near each gate signal lead. These leads are labeled:

- MK500
- MK502
- MK600
- MK602
- MK700
- MK702
- MK200 (if brake option is present)

See *chapter 8 Test Procedures*.

For clarification, refer to the 3 pins as 1, 2, and 3, reading bottom to top. Pins 1 and 2 of each connector are in parallel with the gate drive signal sent to the IGBTs. Pin 1 is the signal and pin 2 is common.

Gate resistor test

1. With an ohmmeter, measure pins 1 and 2 of each test connector.
2. Confirm that the reading is the same for each test connector.

Incorrect reading

An incorrect reading can indicate that:

- The gate signal wires are not connected from the gatedrive card to the gate resistor board.
- The gate resistors are defective.

Connect the gate signal wires if necessary. If any of the resistors are defective, replace the entire IGBT module assembly. See the *Drive Disassembly and Assembly* section.

8.4.8 Mains Fuse/DC Fuse Test

Mains fuse/DC fuse test

1. Use an ohmmeter set to measure the ohms.
2. Measure the resistance across each fuse.

A short circuit indicates good continuity.

Incorrect reading

An open circuit means that the fuse requires replacement. Perform the additional static checks before replacing the fuse.

8.4.9 Disconnect Test

If the unit contains the mains disconnect option, perform this test.

1. Use an ohmmeter set to measure the ohms.
2. Open the disconnect switch.
3. Measure the resistance across each of the 3 phases.

An open circuit (infinite resistance) is a correct reading. A short circuit (0 Ω) indicates a problem with the switch.

1. Close the disconnect switch.
2. Measure the resistance across each of the 3 phases.

A short circuit (0 Ω) is a correct reading. An open circuit (infinite resistance) or high-resistance reading indicates a problem with the switch. Replace the disconnect switch.

8

8.5 Dynamic Test Procedures

WARNING

RISK OF INJURY/SHOCK HAZARD

Contact with powered components can result in death or serious injury. Before starting the drive or performing any dynamic test procedures, take all the necessary safety precautions for system start-up. Refer to *chapter 2 Safety*.

- **Do not disconnect the input cabling with power applied to the drive.**
- **Do not touch energized parts of the drive when connected to mains.**

NOTICE

TEST ORDER

Test procedures in this section are numbered for reference only. Perform dynamic tests in any order and only as necessary. Always perform static tests (*chapter 8.4 Static Test Procedures*) before applying power to the unit.

Whenever possible, perform these procedures with a split bus power supply.

8.5.1 No Display Test

A drive with no display can be the result of several causes. Verify first that there is no display.

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

8.5.2 Input Voltage Test

If the drive is equipped with optional equipment, ensure that it is functioning properly. See *chapter 8.4.8 Mains Fuse/DC Fuse Test* and *chapter 8.4.9 Disconnect Test*.

Input voltage test

1. Apply power to the drive.
2. Use the voltmeter to measure the input mains voltage between the drive input terminals in sequence:

   R/L1/91 to S/L2/92

   R/L1/91 to T/L3/93

   S/L2/92 to T/L3/93

For 380–480 V/380–500 V drives, 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 525–690 V drives, all measurements must be within the range of 446–759 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 drive can operate within specifications as long as the imbalance of supply voltage is not more than 3%.

Danfoss calculates mains imbalance per IEC specification.

- Imbalance = 0.67 X (V_{max} – V_{min})/V_{avg}

For example, if 3-phase readings are taken and the results are 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 drive can operate at higher mains imbalances, this condition can shorten the lifetime of some components, such as DC bus capacitors.

Incorrect reading

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.

CAUTION

TEST ORDER

Open (blown) input fuses or tripped circuit breakers usually indicate a more serious problem. Before replacing fuses or resetting breakers, perform static tests described in *chapter 8.4 Static Test Procedures*.

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

8.5.3 Basic Control Card Voltage Test

1. Measure the control voltage at terminal 12 in relation to terminal 20. A correct reading is 24 V DC (21–27 V DC).
   An incorrect reading can indicate that a fault in the customer connections is loading down the supply. Check the customer connections. Unplug the terminal strip and repeat the test.
2. Measure the 10 V DC control voltage at terminal 50 in relation to terminal 55. A correct reading is 10 V DC (9.2–11.2 V DC).
   An incorrect reading can indicate that a fault in the customer connections is loading down the supply. Check the customer connections. Unplug the terminal strip and repeat the test. A correct reading of both control card voltages indicates that the LCP or the control card is defective. Replace the LCP. If the problem persists, replace the control card.

8.5.4 DC Bus Voltage Test

DC bus voltage test part I

1. Using a voltmeter, read the DC bus voltage.

Check that the measured voltage is at least 1.35 x the AC input voltage.

Incorrect reading
An incorrect reading can indicate a problem in the inrush circuit, or with the rectifier. See *chapter 8.4.1 Rectifier Circuits Test for B-sized Enclosures* and *chapter 8.4.2 Rectifier Circuits Test for C-sized Enclosures*.

DC bus voltage test part II

1. Power down the drive.
2. Wait for the DC bus to discharge. See the label on the drive or control shelf for discharge times.
3. Remove the control card mounting plate. See the *Drive Disassembly and Assembly* section.
4. Use an ohmmeter set to measure ohms.
5. Measure between MK902 pin 1 to DC(+).
6. Measure between MK902 pin 2 to DC(-).

A short circuit (0 Ω) is the correct reading for both measurements.

Incorrect reading
An incorrect reading indicates that the wire harness is defective. Replace the wire harness.

DC bus voltage test part III

1. Measure across fuse F901 on the top of the power card.

An open fuse indicates a failure of a supply on the power card. Replace the power card.

8.5.5 Switch Mode Power Supply Test

The switch mode power supply (SMPS) derives its power from the DC bus. The first indication that the DC bus is charged is a lit DC bus charge indicator light on the power card. This LED, however, can be lit by a voltage still too low to enable the power supplies.

First test for the presence of the DC bus voltage.

1. Install the signal test board.
2. Connect the negative (-) meter lead to terminal 4 (common) of the signal board. With a positive (+) meter lead, check the following terminals on the signal board.

Terminal	Supply	Voltage range
11	(+)18 V	16.5–19.5 V DC
12	(-)18 V	(-)16.5–19.5 V DC
23	(+) 24 V	23–25 V DC
24	(+) 5 V	4.75–5.25 V DC

Table 8.3 Measured Voltages at Selected Terminals

In addition, the signal test board contains 3 LED indicators that show the presence of voltage as follows:

- Red LED (±) 18 V DC supplies present.
- Yellow LED (+) 24 V DC supply present.
- Green LED (+) 5 V DC supply present.

The lack of any of these power supplies indicates that the low voltage supplies on the power card are defective. Replace the power card as described in the *Drive Disassembly and Assembly* sections.

8.5.6 Input Imbalance of Supply Voltage Test

Ideally, all 3 phases have an equal current draw. Some imbalance is possible, however, due to variations in the phase-to-phase input voltage.

A current measurement of each phase reveals the balanced condition of the line. To obtain an accurate reading, it is necessary for the drive to run at more than 40% of its rated load.

1. Perform the input voltage test before checking the current as described in *chapter 8.5.2 Input Voltage Test*. Voltage imbalances automatically result in a corresponding current imbalance.
2. Apply power to the drive and place it in run mode.
3. Using a clamp-on amp meter (analog preferred), read the current on each of 3 input lines at R/L1/91, S/L2/92, and T/L3/93. Typically, the current does not vary from phase to phase by more than 5%. If a greater current variation exists, it indicates a possible problem with the mains supply, or a problem within the drive itself.
   One way to determine if the mains supply is at fault is to swap 2 of the incoming phases. If all 3 phases are different, swap the phase with the highest current with the phase with the lowest current.
4. Remove power to drive.
5. Swap the phase.
6. Reapply power to the drive and place it in run.
7. Repeat the current measurements.

If the imbalance of supply current moves when swapping the leads, then the mains supply is suspect. Otherwise, there could be a problem with the gating of the SCR, possibly due to a defective SCR/diode module. This result can also indicate a problem in the gate signals from the inrush card to the module. Check the wire harness from the inrush card to the SCR gates. Proceed to testing the input waveform and input SCR in accordance with *chapter 8.5.7 Input Waveform Test*.

8.5.7 Input Waveform Test

Testing the current waveform on the input of the drive helps in troubleshooting mains phase loss conditions or suspected problems with the SCR/diode modules. This test easily detects phase loss caused by the mains supply.

The SCR/diode modules control the rectifier section. If an SCR/diode module is defective or the gate signal to the SCR is lost, the drive responds as if losing a phase.

The following measurements require an oscilloscope with voltage and current probes. Under normal operating conditions, the waveform of a phase of input AC voltage to the drive appears as in *Illustration 8.5*.

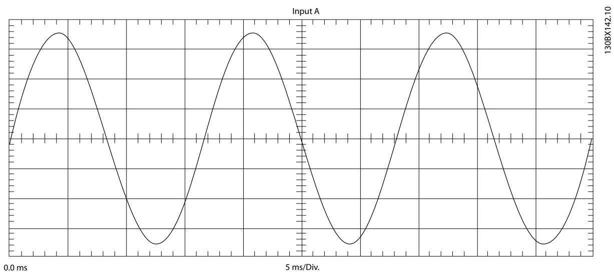


Illustration 8.5 Normal AC Input Voltage Waveform

The waveform shown in *Illustration 8.6* shows the input current waveform for the same phase as in *Illustration 8.5* while the drive is running at 40% load. The 2 positive and 2 negative humps are typical of any 6 diode bridge. It is the same for drives with SCR/diode modules. With a phase loss, the current waveform of the remaining phases resembles *Illustration 8.7*.

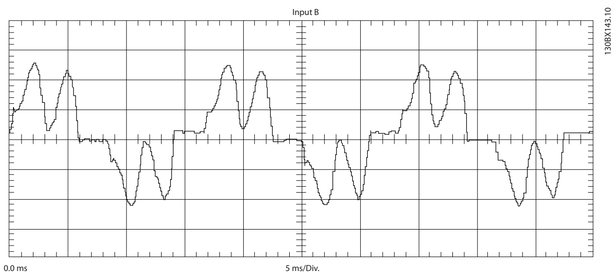


Illustration 8.6 AC Input Current Waveform with Diode Bridge

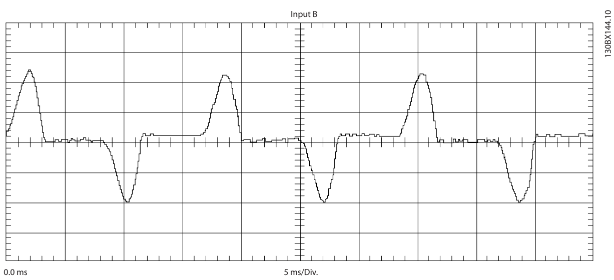


Illustration 8.7 Input Current Waveform with Phase Loss

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, investigate the reason for the AC supply problem. If the voltage waveform on all 3 phases is correct, but the current waveform is not, then check the input rectifier circuit. Perform the rectifier tests. Refer to *chapter 8.4.1 Rectifier Circuits Test for B-sized Enclosures* and *chapter 8.4.2 Rectifier Circuits Test for C-sized Enclosures*.

8.5.8 Output Imbalance of Motor Voltage and Current

Checking the balance of the drive output voltage and current is a way to measure the electrical functioning between the drive 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 drive before performing this procedure.

If the voltage is balanced but the current is not, the motor can draw an uneven load. This condition can be the result of:

- A defective motor.
- A poor connection in the wiring between the drive and the motor.
- A defective motor overload, if applicable.

If the output current and the voltage are unbalanced, the drive is not gating the output properly. This condition can be the result of:

- A defective control card.
- A defective power card.
- A defective gatedrive card.
- Improper connections between the gatedrive card and IGBTs.
- Improper connections in the output circuitry of the drive.

NOTICE

COMPATIBLE VOLTMETERS

Use a PWM-compatible digital or 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. Monitor 3 output phases at 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 drive above 40 Hz, which is normally the frequency limitation of such meters.
   A balanced output current from phase to phase is correct. A variation of more than 2–3% is not correct. If the test is successful, the drive is operating normally.
2. Using a voltmeter, measure AC output voltage at 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.
   A variation of more than 8 V AC among the 3 readings is not correct. The actual value of the voltage depends on the speed at which the drive is running. The volts/hertz ratio is relatively linear (except in VT mode) so at 50 Hz/60 Hz the voltage is approximately equal to the mains voltage applied. At 25 Hz/30 Hz, it is about half of that voltage. The exact voltage reading is less important than balance between phases.

If a greater imbalance exists, 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 drive problem. If a voltage imbalance in the output occurs with the motor disconnected, test the gate drive circuit for proper firing. Proceed to *chapter 8.5.9 IGBT Switching Test*.

If the voltage was balanced but the current imbalanced when the motor was connected, then the load is suspect. There could be a faulty connection between the drive 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.

8.5.9 IGBT Switching Test

⚠WARNING

PERSONAL INJURY RISK/DISCHARGE TIME

The drive contains DC-link capacitors, which can remain charged even after the drive is disconnected from AC power. High voltage can be present even when the warning LED indicator lights are off. To avoid death or serious injury, remove AC input voltage and wait 15 minutes for the DC bus capacitors to discharge fully before testing.

1. **Stop the motor.**
2. **Disconnect AC mains and remote DC-link supplies, including battery back-ups, UPS, and DC-link connections to other drives.**
3. **Disconnect or lock the motor.**
4. **Wait 15 minutes for the capacitors to discharge fully.**
5. **Before performing any service or repair work, use an appropriate voltage measuring device to make sure that the capacitors are fully discharged.**

To determine whether the IGBTs are switching correctly, use the following procedure.

1. Connect the split bus power supply.
2. Switch on the 650 V DC supply and 24 V DC supply.
3. Measure the phase-to-phase output waveform on all 3 output phases of the drive using an oscilloscope (preferred) or a voltmeter.
   - 3a When measuring with an oscilloscope, the waveform appears the same as in normal operation, except that the amplitude is 24 V peak. See *Illustration 8.8*.
   - 3b When measuring with a voltmeter set to read AC voltage, the meter reads approximately 17 V AC on all 3 phases. Differences in drive settings can cause a slight variation in this reading, but it is important that the readings are equal on all 3 phases.

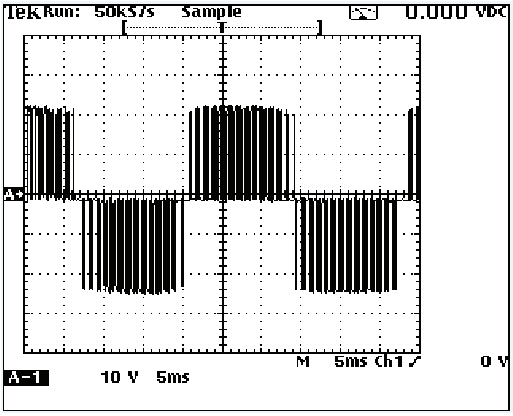


Illustration 8.8 Output Waveform

An incorrect reading indicates either a defective IGBT or gate drive signal.

8.5.10 Current Sensors Test

The current sensors are Hall-effect devices that send a signal proportional to the actual output current waveform to the power card. The current scaling card scales the signals from the current sensors to the proper level for monitoring and processing motor control data. A defective current sensor can cause erroneous ground faults and overcurrent trips. In these instances, the faults occur only at higher loads. If the incorrect current scaling card is installed, the current signals are not scaled properly. Incorrect scaling could cause erroneous overcurrent trips. If the current scaling card is not installed, the drive trips.

To determine the status of the sensors, use the following tests.

If the control card parameters are set to provide holding torque at 0 speed, the current shown is greater than expected. To perform the sensor tests, disable these parameters.

1. Apply power to the drive.
2. Ensure that the following parameter settings are disabled:
    - Motor check.
    - Premagnetizing.
    - DC hold.
    - DC brake.
    - Any others that create a holding torque while at 0 speed.
3. Run the drive with a 0 speed reference and check the output current reading in the display. A correct reading is approximately 1–2 A. If these parameters are not disabled, the current shown exceeds 1–2 A.

If the current is greater than 1–2 A and no current-producing parameters are active, run the following test:

1. Remove power from the drive.
2. Remove the output motor cables from terminals U, V, and W.
3. Apply power to the drive.
4. Run the drive with a 0 speed reference, and check the output current reading in the display. A correct reading is less than 1 A.

If these tests result in incorrect readings, perform the following test of the current feedback signals using the signal test board:

1. Remove power to the drive. Make sure that the DC bus is fully discharged.
2. Connect the signal test board to power card connector MK104.
3. Using an ohmmeter, measure the resistance between terminals 1 and 4, 2 and 4, and 3 and 4 of the signal test board. The correct resistance is an identical reading on all 3 terminals.
4. Reapply power to the drive.
5. Using a voltmeter, connect the negative (-) meter lead to terminal 4 (common) of the signal test board.
6. Run the drive with a 0 speed reference.
7. Measure the AC voltage in sequence at terminals 1, 2, and 3 of the signal test board. These terminals correspond with current sensor outputs U, V, and W, respectively. Expect a reading near 0 V, and no greater than 15 mV.

The current sensor feedback signal in the circuit reads approximately 400 mV at a drive load of 100%. When the drive is at 0 speed, any reading above 15 mV negatively impacts the way the drive interprets the feedback signal. Replace the corresponding current sensor if the reading is greater than 15 mV.

When measuring with the signal test board, the reading could be higher due to meter lead resistance. A reading of no resistance indicates a missing scaling card.

8.5.11 Fan Tests

All fan tests can be performed with the unit powered from the AC mains or with the power card powered in split bus mode. Any time a fan is commanded to start, the control card checks the fan feedback signal. If the feedback is missing, the drive issues an alarm or warning based on which fan feedback is missing.

Incorrect reading
If neither fan is running, the most likely cause is that the fan control circuit on the power card is faulty. Replace the power card or fan power card. If only 1 fan is running, the most likely cause is that the other fan is faulty. Replace the failed fan.

8.5.12 Input Terminal Signal Tests

The presence of signals on either the digital or analog input terminals of the drive can be verified on the drive display. *Parameter 16-60 Digital Input – parameter 16-64 Analog Input 54* show the status for the standard inputs. Other parameters show the status of option inputs.

Digital inputs
View the digital inputs by using *parameter 16-60 Digital Input*. The status of control terminals 18, 19, 27, 29, 32, and 33 are shown (left to right) with terminal 33 on the right of the display. A 1 indicates the presence of a signal, which means the logic is true and the input is on.

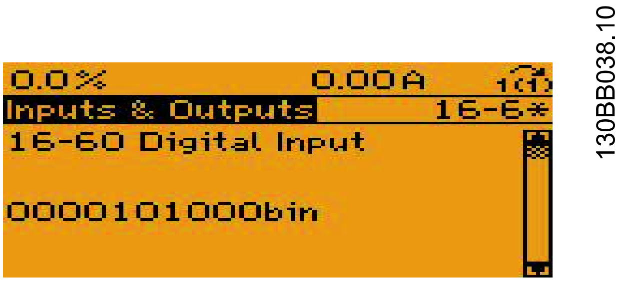


Illustration 8.9 Digital Inputs Display

If the display does not show the correct signal, investigate the following:

- External control wiring to the drive.
- Incorrect programming of *parameter 5-00 Digital I/O Mode*.
- Faulty control card.

8

Use *parameter 5-00 Digital I/O Mode* to program the digital inputs to either accept a sourcing output (PNP) or a sinking output (NPN). When programmed for PNP (factory default), the digital input turns on when 24 V DC is applied to the digital input terminal. When programmed for NPN, the digital input turns on when the terminal is connected to signal common (terminal 20).

The power for the digital inputs can either come from the (+) 24 V DC built into the drive, or from an external supply. If an external supply is used, reference the common of the supply to terminal 20.

Check for an internal power supply

1. Connect the (-) negative meter lead to terminal 20.
2. Connect the (+) positive meter lead to terminal 12 or terminal 13 and measure the DC voltage.

A correct reading is 21–27 V DC. If the supply voltage is not present, perform the basic control card voltage test. See *chapter 8.5.3 Basic Control Card Voltage Test*.

Check the individual inputs if *parameter 5-00 Digital I/O Mode* is PNP

1. Connect the (-) negative meter lead to terminal 20.
2. Connect the (+) positive meter lead to each digital input in sequence and measure the DC voltage.

The correct display for each digital input where the voltage reading is greater than 10 V DC is 1. The correct display for each digital input where the voltage reading is less than 5 V DC is 0. If the display does not correspond with the measured inputs, the digital inputs on the control card have failed. Replace the control card.

Check the individual inputs if *parameter 5-00 Digital I/O Mode* is NPN

1. Connect the (-) negative meter lead to terminal 20.
2. Connect the (+) positive meter lead to each digital input in sequence and measure the DC voltage.

The correct display for each digital input where the voltage reading is less than 14 V DC is 1. The correct display for each digital input where the voltage reading is greater than 19 V DC is 0. If the display does not correspond with the measured inputs, the digital inputs on the control card have failed. Replace the control card.

Analog inputs

Terminals 53 and 54 are the standard analog input terminals. Each terminal can be configured as a voltage input or a current input. Switch S201 on the control card configures terminal 53. Switch S202 configures terminal 54.

Use *parameter 16-62 Analog Input 53* to show the value on terminal 53 and *parameter 16-64 Analog Input 54* to show the value on terminal 54.

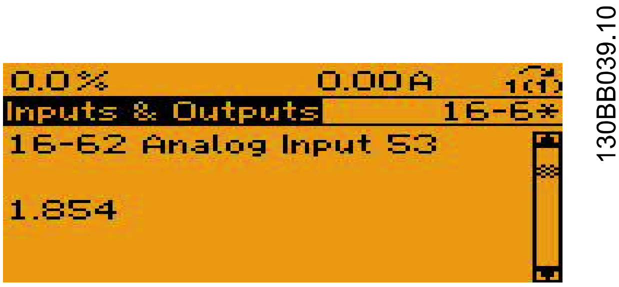


Illustration 8.10 Analog Inputs Display

Incorrect signals indicate problems in the external control wiring to the drive, configuration of the switches, or a faulty control card.

The power for the analog inputs either comes from the supply built into the drive, or from an external supply. If an external supply is used, reference the common of the supply to terminal 55.

Verify the control voltage supply

1. Connect the (-) negative meter lead to terminal 55.
2. Connect the (+) positive meter lead to terminal 50.

The correct reading is 9.2–11.2 V DC. If the supply voltage is not present, perform the basic control card voltage test.

Verify that the analog input is configured for the type of signal being sent to the drive. *Parameter 16-61 Terminal 53 Switch Setting* shows the configuration of terminal 53, and *parameter 16-63 Terminal 54 Switch Setting* shows the configuration of terminal 54. If the inputs are not configured correctly, power down the drive and change switches S201 and S202.

Check the individual inputs if configured for voltage

1. Connect the (-) negative meter lead to terminal 55.
2. Connect the (+) positive meter lead to terminal 53 or terminal 54 and measure the DC voltage.

For each analog input, the measured DC voltage must match the value shown in the display parameter. If the display does not correspond with the measured input and the switch is configured for voltage, the analog input on the control card has failed. Replace the control card.

Check the individual inputs if configured for current

1. Connect the (-) negative meter lead to terminal 55.
2. Connect the (+) positive meter lead to terminal 53 or terminal 54 and measure the DC voltage.

When configured for current, the current flows through a 200 Ω resistor to create a voltage drop. A 4 mA current flow creates approximately a 0.8 V DC voltage reading. A 20 mA current flow creates approximately a 4.0 V DC voltage reading. The display shows the mA value. If the display does not correspond with the measured input, the analog input on the control card has failed. Replace the control card.

Incorrect reading

A negative voltage reading indicates a reversed polarity. Reverse the wiring to the analog input.

8.6 After-repair Tests

8.6.1 After-repair Tests for B-sized and C-sized Drives

Following testing or repair of a unit, use these steps to ensure that all circuitry is functioning properly before putting the unit into operation.

1. Perform visual inspection procedures as described in *chapter 6.4 Visual Inspection*.
2. Perform static test procedures to ensure that the unit is safe to start.
3. Disconnect motor cables from output terminals (U/T1/96, V/T2/97, W/T3/98).
4. Apply AC power to the unit.
5. Give the unit 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/T1/96 to V/T2/97, U/T1/96 to W/T3/98, and V/T2/97 to W/T3/98. All voltages must be balanced within 8 V. If unbalanced voltage is measured, refer to *chapter 8.5.2 Input Voltage Test*.
7. Stop the unit and remove input power. Allow DC capacitors to discharge fully.
8. Reconnect motor cables to the output terminals (U/T1/96, V/T2/97, W/T3/98).
9. Reapply power and restart the unit. Adjust the 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.

9 B1–B2 Drive Disassembly and Assembly

9.1 Before Proceeding

Review all safety warnings and cautions.

- DO NOT touch electrical parts of the drive when connected to mains. Also make sure that other voltage inputs have been disconnected (linkage of DC intermediate circuit). There can be high voltage on the DC-link even when the indicator lights are turned off. Before touching any potentially live parts of the drive, wait at least 40 minutes.
- Before conducting repair or inspection, disconnect mains.
- [Off] on the LCP does not disconnect mains.
- During operation and while programming parameters, the motor can start without warning. Press [Stop] when changing data.
- When operating on a PM motor, disconnect the motor cable.

9

WARNING

DISCHARGE TIME

The drive contains DC-link capacitors, which can remain charged even when the drive is not powered. High voltage can be present even when the warning LED indicator lights are off. Failure to wait for 15 minutes after power has been removed before performing service or repair work can result in death or serious injury.

- **Stop the motor.**
- **Disconnect AC mains and remote DC-link power supplies, including battery back-ups, UPS, and DC-link connections to other drives.**
- **Disconnect or lock the motor.**
- **Disconnect any brake option.**
- **Disconnect any regen/load share option.**
- **Wait 15 minutes for the capacitors to discharge fully. The minimum waiting time is also visible on the drive label.**
- **Before performing any service or repair work, use an appropriate voltage measuring device to make sure that the capacitors are fully discharged.**

NOTICE

INTERLOCKED DOORS

If supplied with a circuit breaker or disconnect switch, the cabinet doors are interlocked. To open the cabinet doors, set the circuit breaker and disconnect switch to the OFF position.

NOTICE

ELECTROSTATIC DISCHARGE (ESD)

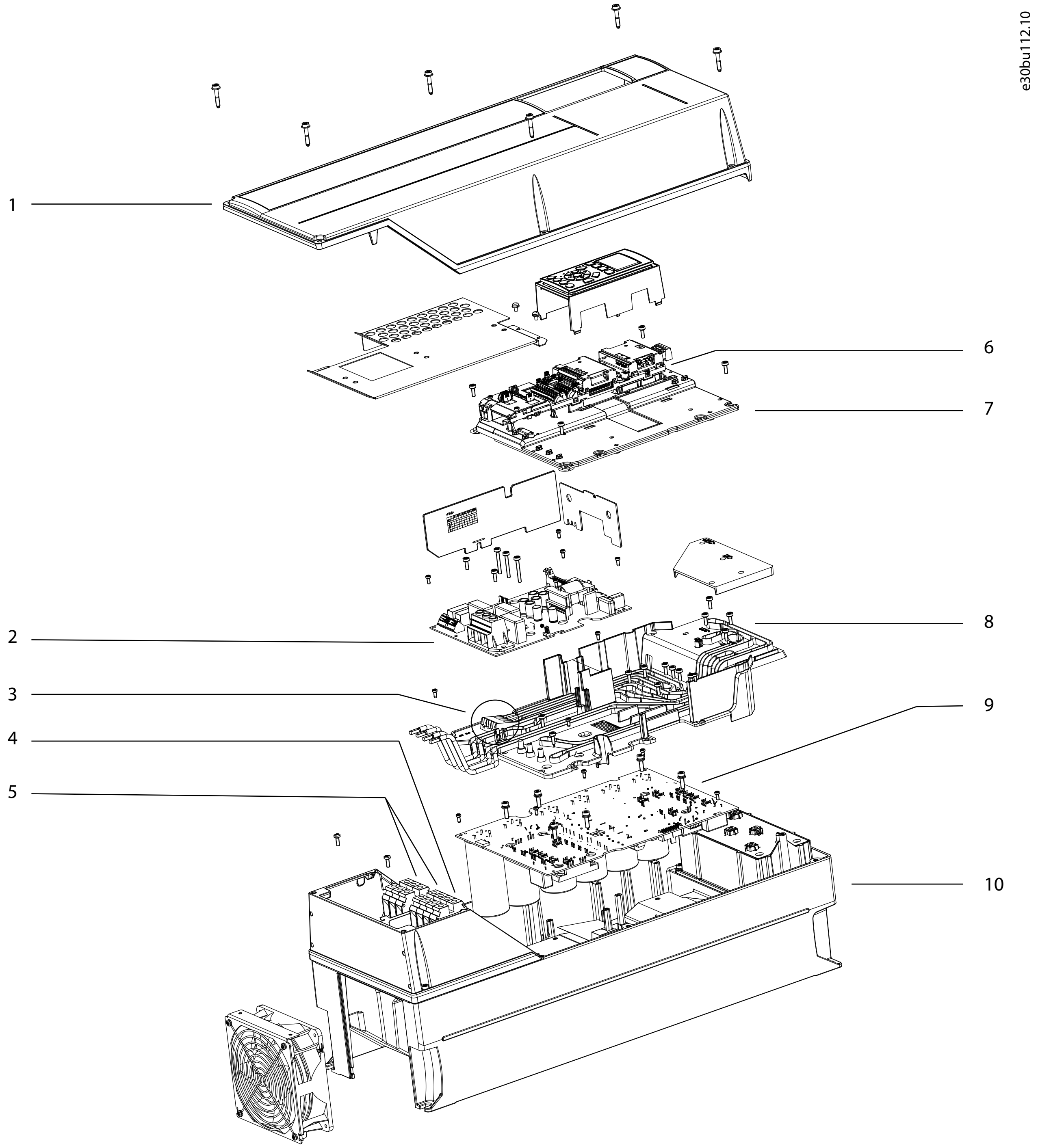
Many electronic components within the drive are sensitive to static electricity. Voltages so low that they cannot be felt, seen, or heard can be harmful to electronic components. Use standard ESD protective procedures whenever handling ESD sensitive components. Failure to conform to standard ESD procedures can reduce component life, diminish performance, or completely destroy sensitive electronic components.

NOTICE

ENCLOSURE SIZE

Enclosure size designations are used throughout this guide where procedures or components differ between drives based on size. See *chapter 3.4 Enclosure Size Identification*.

9.2 B1–B2 Disassembly and Assembly



1	Front cover	6	Control card
2	SMPS card (see *Illustration 9.2* for connector locations)	7	Control card plate
3	Mains/power card connector	8	Busbar unit
4	Load share connector	9	Power card
5	Brake connector	10	Enclosure

Illustration 9.1 Exploded View of B1/B2 Enclosure

9.2.1 Front Cover

Disassembly
For the location of the parts mentioned in these steps, refer to *Illustration 9.1*.

1. Remove the front cover (1) of the drive by unscrewing the 6 screws using a T10-Torx driver.

Reassembly
Tighten fasteners according to *chapter 14.1 Fastener Torque Ratings*.

1. Place the front cover on the drive.
2. Secure the front cover using the 6 screws from the disassembly. Torque to 2.0 Nm (18 in-lb).

9.2.2 Control Card Unit

Disassembly
For the location of the parts mentioned in these steps, refer to *Illustration 9.1*.

1. Remove the front cover (1).
2. Unscrew the 4 screws securing the control card plate (7) using a T10-Torx driver.
3. Lift up the control plate and disconnect the ribbon cable from the SMPS card (2).

Reassembly
Tighten fasteners according to *chapter 14.1 Fastener Torque Ratings*.

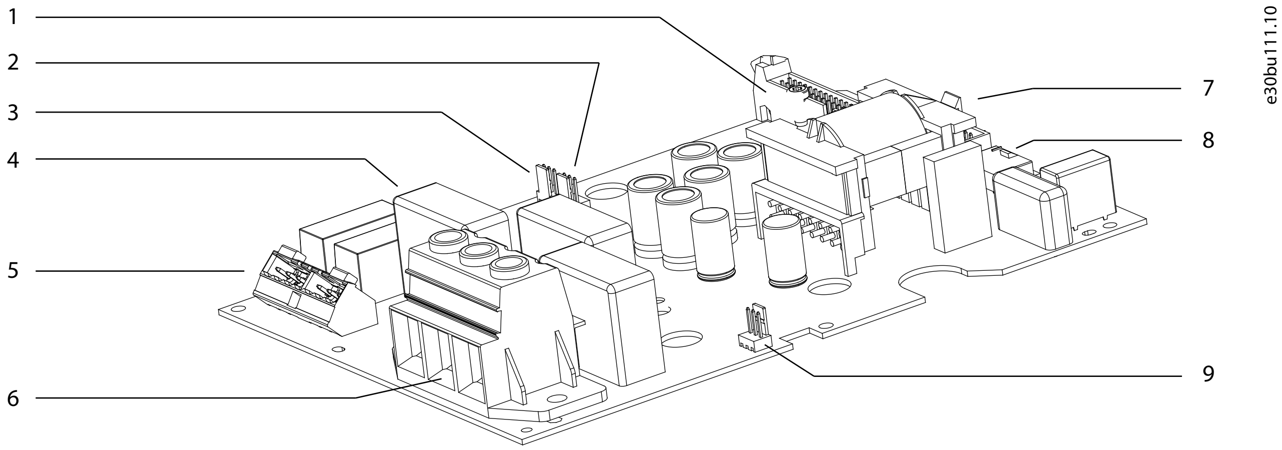
1. Connect the ribbon cable to the SMPS card.
2. Reinstall the control card plate. Secure with 4 screws. Torque to 1.5 Nm (13 in-lb).
3. Secure the front cover to the drive.

9.2.3 SMPS Card

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 9.1*.

1. Remove the front cover (1).
2. Remove the control card unit (7).
3. Unplug the cables from the SMPS card (2) connectors. Refer to *Illustration 9.2*.
    - MK900
    - MK804
    - MK801
    - MK800
    - MK100
    - MK104



1	MK104	6	MK101
2	MK806	7	MK800
3	MK801	8	MK900
4	MK804	9	MK100
5	MK802	–	–

Illustration 9.2 Location of SMPS Card Connectors

4. Unfasten the SMPS card fasteners.
    - For the B1 enclosure:
        - Unscrew the 5 corner screws on the SMPS card using a T10-Torx driver.
        - Unscrew the 3 screws from the center of the SMPS card using a T10-Torx driver.
    - For the B2 enclosure:
        - Unscrew the 5 corner screws on the SMPS card using a T10-Torx driver.
        - Unscrew the 2 screws at MK101 (M4x12mm) on the SMPS card using a T10-Torx driver.
        - Unscrew the 3 screws from the center of the SMPS card using a T10-Torx driver.
5. Lift the SMPS card by gently removing it from the standoffs.

Reassembly

1. Place the SMPS card onto the standoffs and secure with the 3 center screws. Torque to 1.2 Nm (11 in-lb).
2. Install the remaining fasteners to the SMPS card.
    - For the B1 enclosure:
        - Tighten the 6 remaining screws on the SMPS card. Torque to 1.2 Nm (11 in-lb).
    - For the B2 enclosure:
        - Tighten the remaining 5 screws. Torque to 1.2 Nm (11 in-lb).
        - Tighten the 1 screw at ET900. Torque to 1.2 Nm (11 in-lb).
        - Tighten the 2 screws at MK101. Torque to 1.5 Nm (13 in-lb).
3. Reconnect the cables from the following SMPS card connectors. Refer to *Illustration 9.2*.
    - MK900
    - MK804
    - MK801
    - MK800
    - MK100
    - MK104
4. Reinstall the control card unit.
5. Secure the front cover to the drive.

9.2.4 Power Card

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 9.1*.

1. Remove the front cover (1).
2. Remove the control card unit (7).
3. Remove the SMPS card (2).
4. Loosen, but do not remove the 4 screws from the load share (4) connector and brake connector (5) using an Allen key.
5. Remove the 3 (B1) or 4 (B2) screws that connect the busbar unit (8) to the enclosure (10) using a T10-Torx driver.
6. Unplug the mains/power card connector (3).
7. Remove busbar unit from the power card (9) by unscrewing the 9 (B1) or 13 (B2) screws using a T10-Torx driver.
8. Remove the 4 (B1) or 5 (B2) screws that secure the power card to the enclosure using a T10-Torx driver.
9. Remove the remaining 4 (B1) or 6 (B2) screws securing the power card to the rectifier and IGBT modules using a T10-Torx driver. Carefully lift the power card out of the drive.

Reassembly

Tighten fasteners according to *chapter 14.1 Fastener Torque Ratings*.

1. Apply heat compound to the front of the heat sink.
    - 1a Remove previously applied heat compound areas on the heat sink without scratching the surface.
    - 1b Spread the new heat compound evenly to the surface of the heat sink that makes contact with the power card.
2. Reconnect the 20-pin ribbon cable to MK100P on the power card and the DC supply cable to MK102P. In a B1 enclosure, also reconnect the mains/power connector to FK100P.
3. Reinstall the power card into the enclosure.
    - 3a Secure the card with 4 (B1) or 6 (B2) screws. Following the initial tightening sequence in *Illustration 9.3*, torque to 0.8 Nm (7 in-lb).
    - 3b Following the final tightening sequence in *Illustration 9.4*, torque to 3.5 Nm (31 in-lb).
4. Secure the power card to the enclosure with 4 (B1) or 5 (B2) screws. Torque to 1.2 Nm (11 in-lb).
5. Reinstall the busbar unit.
    - 5a Position the busbar unit onto the power card and secure with 9 (B1) or 13 (B2) screws. Torque to 1.2 Nm (11 in-lb).
    - 5b Tighten the 3 (B1) or 4 (B2) screws that attach the busbar unit to the enclosure. Torque to 1.2 Nm (11 in-lb).
    - 5c (B2 only) Reconnect the mains/power card connector to the busbar unit.
6. Tighten the load share and brake connectors using an Allen key.
7. Reinstall the SMPS card.
8. Reinstall the control card unit.
9. Secure the front cover to the drive.

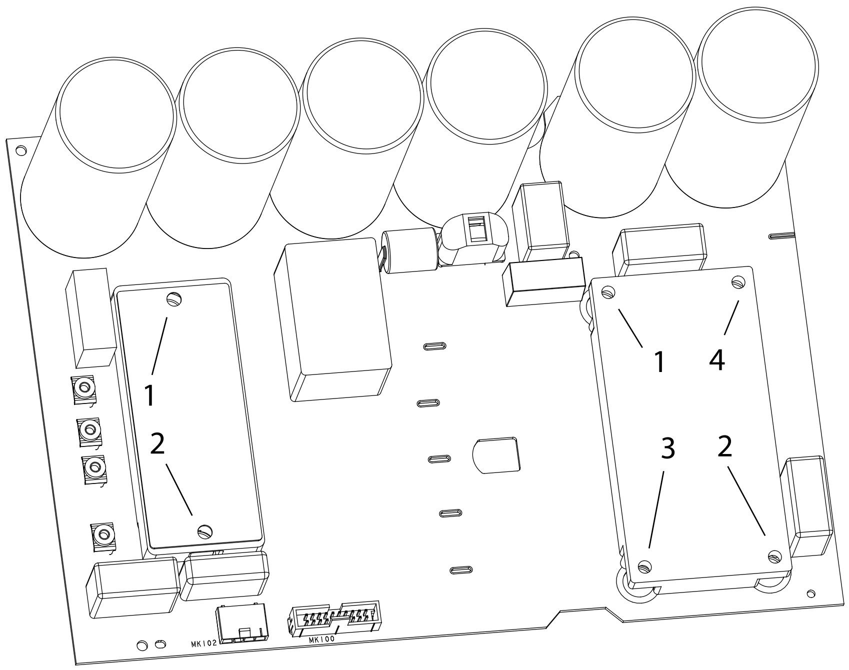


Illustration 9.3 Power Card Tightening Sequence (Initial Tightening)

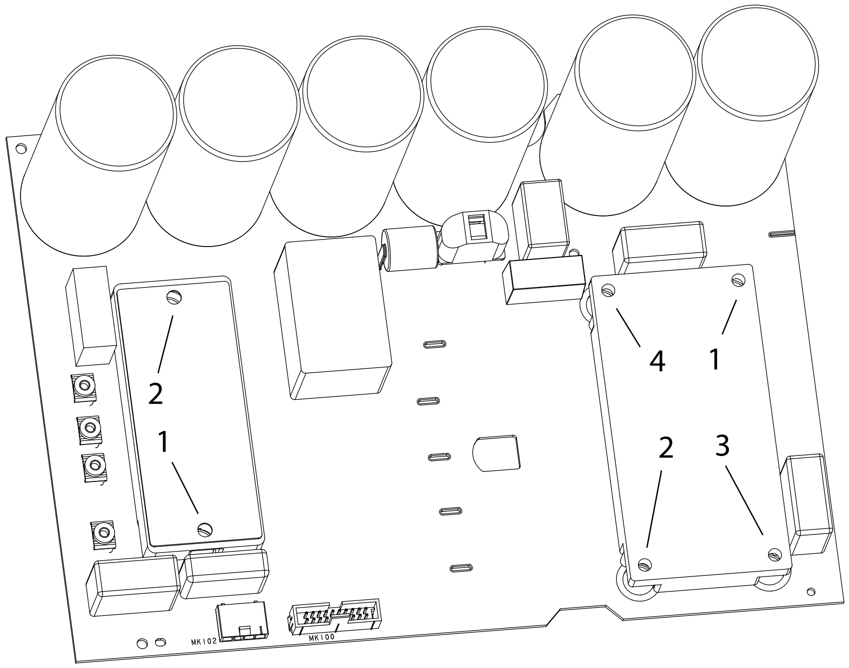


Illustration 9.4 Power Card Tightening Sequence (Final Tightening)

10 B3 Drive Disassembly and Assembly

10.1 Before Proceeding

Review all safety warnings and cautions.

- DO NOT touch electrical parts of the drive when connected to mains. Also make sure that other voltage inputs have been disconnected (linkage of DC intermediate circuit). There can be high voltage on the DC-link even when the indicator lights are turned off. Before touching any potentially live parts of the drive, wait at least 40 minutes.
- Before conducting repair or inspection, disconnect mains.
- [Off] on the LCP does not disconnect mains.
- During operation and while programming parameters, the motor can start without warning. Press [Stop] when changing data.
- When operating on a PM motor, disconnect the motor cable.

WARNING

DISCHARGE TIME

The drive contains DC-link capacitors, which can remain charged even when the drive is not powered. High voltage can be present even when the warning LED indicator lights are off. Failure to wait for 15 minutes after power has been removed before performing service or repair work can result in death or serious injury.

- **Stop the motor.**
- **Disconnect AC mains and remote DC-link power supplies, including battery back-ups, UPS, and DC-link connections to other drives.**
- **Disconnect or lock the motor.**
- **Disconnect any brake option.**
- **Disconnect any regen/load share option.**
- **Wait 15 minutes for the capacitors to discharge fully. The minimum waiting time is also visible on the drive label.**
- **Before performing any service or repair work, use an appropriate voltage measuring device to make sure that the capacitors are fully discharged.**

NOTICE

INTERLOCKED DOORS

If supplied with a circuit breaker or disconnect switch, the cabinet doors are interlocked. To open the cabinet doors, set the circuit breaker and disconnect switch to the OFF position.

NOTICE

ELECTROSTATIC DISCHARGE (ESD)

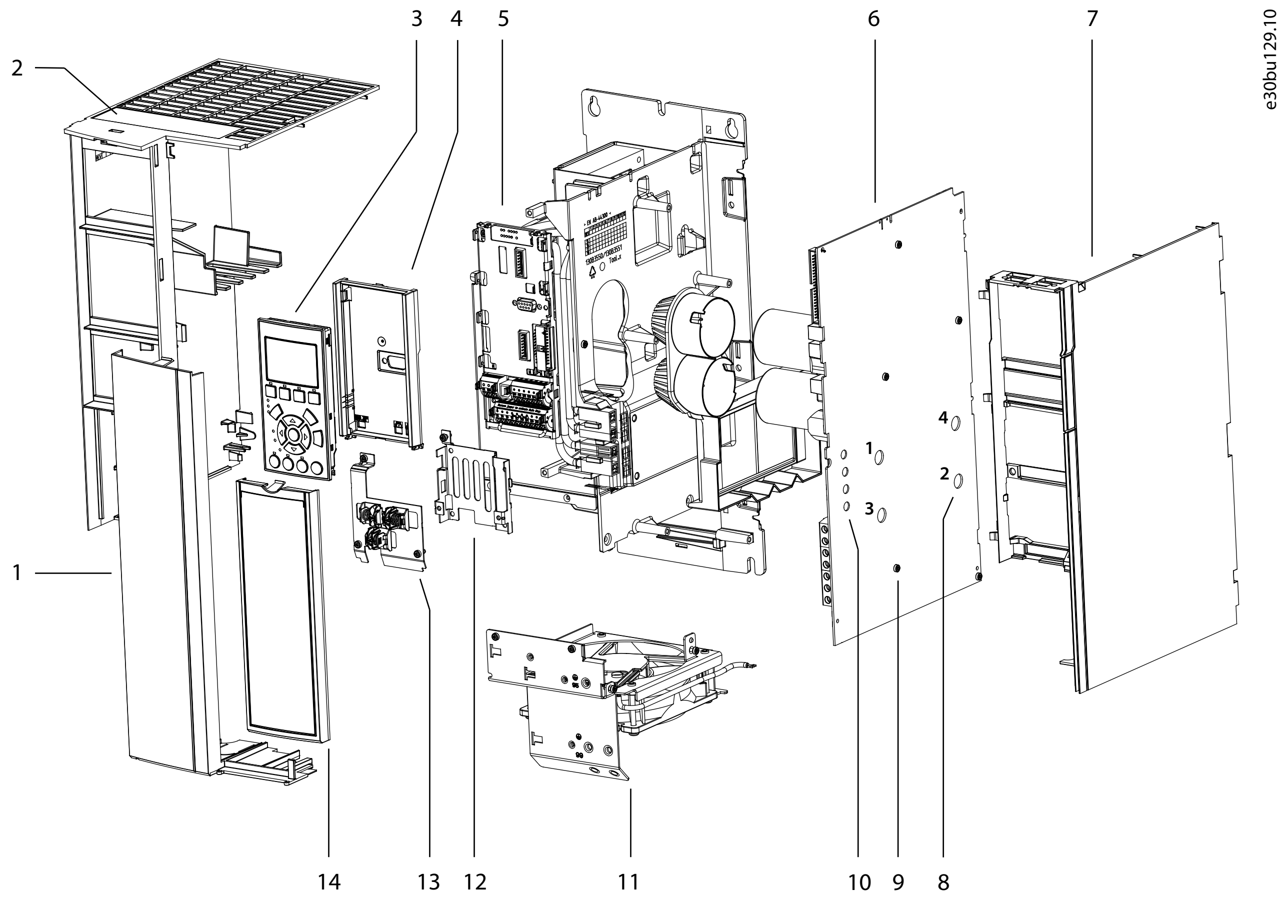
Many electronic components within the drive are sensitive to static electricity. Voltages so low that they cannot be felt, seen, or heard can be harmful to electronic components. Use standard ESD protective procedures whenever handling ESD sensitive components. Failure to conform to standard ESD procedures can reduce component life, diminish performance, or completely destroy sensitive electronic components.

NOTICE

ENCLOSURE SIZE

Enclosure size designations are used throughout this guide where procedures or components differ between drives based on size. See *chapter 3.4 Enclosure Size Identification*.

10.2 B3 Disassembly and Assembly



1	Front cover	8	IGBT module screws
2	Left side cover	9	Grounding screws
3	Local control panel (LCP)	10	DC-link choke coil screws
4	LCP cradle	11	Fan assembly housing
5	Screening plate (control card is beneath screening plate)	12	Grounding plate
6	Power card	13	Decoupling plate
7	Right side cover	14	Terminal cover

Illustration 10.1 Exploded View of B3 Enclosure

10.2.1 Terminal Cover

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 10.1*.

1. Remove the terminal cover (11) by inserting a flat head screwdriver into the hole at the top of the cover and gently pressing down on the tab until the cover pops out.

Reassembly

1. Place the base of the terminal cover in first.
2. While pressing the tab down, gently press the cover into place until you hear a click.

10.2.2 Front Cover

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 10.1*.

1. Remove the front cover (1) of the drive by unscrewing the 3 screws using a T10-Torx driver.

Reassembly

1. Place the front cover on the drive.
2. Secure the front cover with the 3 screws from the disassembly. Torque to 1.3 Nm (13 in-lb).

10.2.3 Control Card Unit

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 10.1*.

1. Remove the terminal cover.
2. Remove the front cover.
3. Remove the local control panel (3) from the LCP cradle (4).
4. Remove the LCP cradle (4) by inserting the screwdriver into the slot on the side of the mounting cradle and gently pulling the cradle.
5. Remove the decoupling plate (13) by unscrewing the 3 screws using a T10-Torx driver.
6. If there is an option D cover plate beneath the decoupling plate, remove the cover plate using a screwdriver.
7. Remove the screening plate (5) by unscrewing the 2 screws using a T10-Torx driver, and lift the control card from the enclosure.

Reassembly

1. Place the control card into the unit.
2. Place the screening plate over the control card and secure to the unit with the 2 screws. Torque to 1.3 Nm (12 in-lb).
3. If applicable, reinstall the option D cover plate.
4. Secure the decoupling plate with the 3 screws. Torque to 1.3 Nm (12 in-lb).
5. Reinstall the LCP cradle, making sure that all connectors are fully seated into the cradle.
6. Place the base of the LCP into the LCP cradle and gently push until the LCP is secure.
7. Reinstall the front cover.
8. Reinstall the terminal cover.

10.2.4 Power Card

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 10.1*.

1. Remove the terminal cover.
2. Remove the front cover.
3. Remove the control card.
4. Remove the grounding plate (12) by unscrewing the 1 screw securing the plate using a T10-Torx driver.
5. Remove the right side cover (7) by inserting a flat head screwdriver into the slots on the side of the drive and gently pulling out the cover.
6. Unscrew the 5 grounding screws (9) using a T10-Torx driver.
7. Unscrew the 4 DC-link choke coil screws (10) using a T10-Torx driver.
8. Unscrew the 4 IGBT module screws (11) using a T20-Torx driver.
9. Unplug the fan connector from the power card and gently remove the power card.

Reassembly

1. Apply heat compound to the front of the heat sink.
   - 1a Remove previously applied heat compound areas on the heat sink without scratching the surface.
   - 1b Spread the new heat compound evenly to the surface of the heat sink that makes contact with the power card case.
2. Reconnect the fan connector to the power card and place the power card into the enclosure.
3. Reinstall the power card.
   - 3a Using a diagonal tightening pattern, secure with the 4 IGBT module screws. Torque to 3.3 Nm (29 in-lb). Refer to the numbers shown in *Illustration 10.1*.
   - 3b Secure with the 4 DC-link choke coil screws. Torque to 1.1 Nm (10 in-lb).
   - 3c Secure with the 5 grounding screws. Torque to 1.6 Nm (14 in-lb).
4. Reinstall the right side cover of the drive.
5. Secure the grounding plate to the unit with the 1 screw. Torque to 1.3 Nm (12 in-lb).
6. Reinstall the control card.
7. Reinstall the front cover.
8. Reinstall the terminal cover.

10.2.5 Internal Fan

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 10.1*.

1. Remove the fan assembly from the bottom of the enclosure by unscrewing the 4 screws using a T20-Torx driver.
2. Lift the fan from the fan assembly housing (11).

Reassembly

1. Reinstall the fan into fan assembly housing.
2. Secure the fan assembly housing to the enclosure with 4 screws. Torque to 0.8 Nm (7 in-lb).

11 B4 Drive Disassembly and Assembly

11.1 Before Proceeding

Review all safety warnings and cautions.

- DO NOT touch electrical parts of the drive when connected to mains. Also make sure that other voltage inputs have been disconnected (linkage of DC intermediate circuit). There can be high voltage on the DC-link even when the indicator lights are turned off. Before touching any potentially live parts of the drive, wait at least 40 minutes.
- Before conducting repair or inspection, disconnect mains.
- [Off] on the LCP does not disconnect mains.
- During operation and while programming parameters, the motor can start without warning. Press [Stop] when changing data.
- When operating on a PM motor, disconnect the motor cable.

WARNING

DISCHARGE TIME

The drive contains DC-link capacitors, which can remain charged even when the drive is not powered. High voltage can be present even when the warning LED indicator lights are off. Failure to wait for 15 minutes after power has been removed before performing service or repair work can result in death or serious injury.

- **Stop the motor.**
- **Disconnect AC mains and remote DC-link power supplies, including battery back-ups, UPS, and DC-link connections to other drives.**
- **Disconnect or lock the motor.**
- **Disconnect any brake option.**
- **Disconnect any regen/load share option.**
- **Wait 15 minutes for the capacitors to discharge fully. The minimum waiting time is also visible on the drive label.**
- **Before performing any service or repair work, use an appropriate voltage measuring device to make sure that the capacitors are fully discharged.**

NOTICE

INTERLOCKED DOORS

If supplied with a circuit breaker or disconnect switch, the cabinet doors are interlocked. To open the cabinet doors, set the circuit breaker and disconnect switch to the OFF position.

NOTICE

ELECTROSTATIC DISCHARGE (ESD)

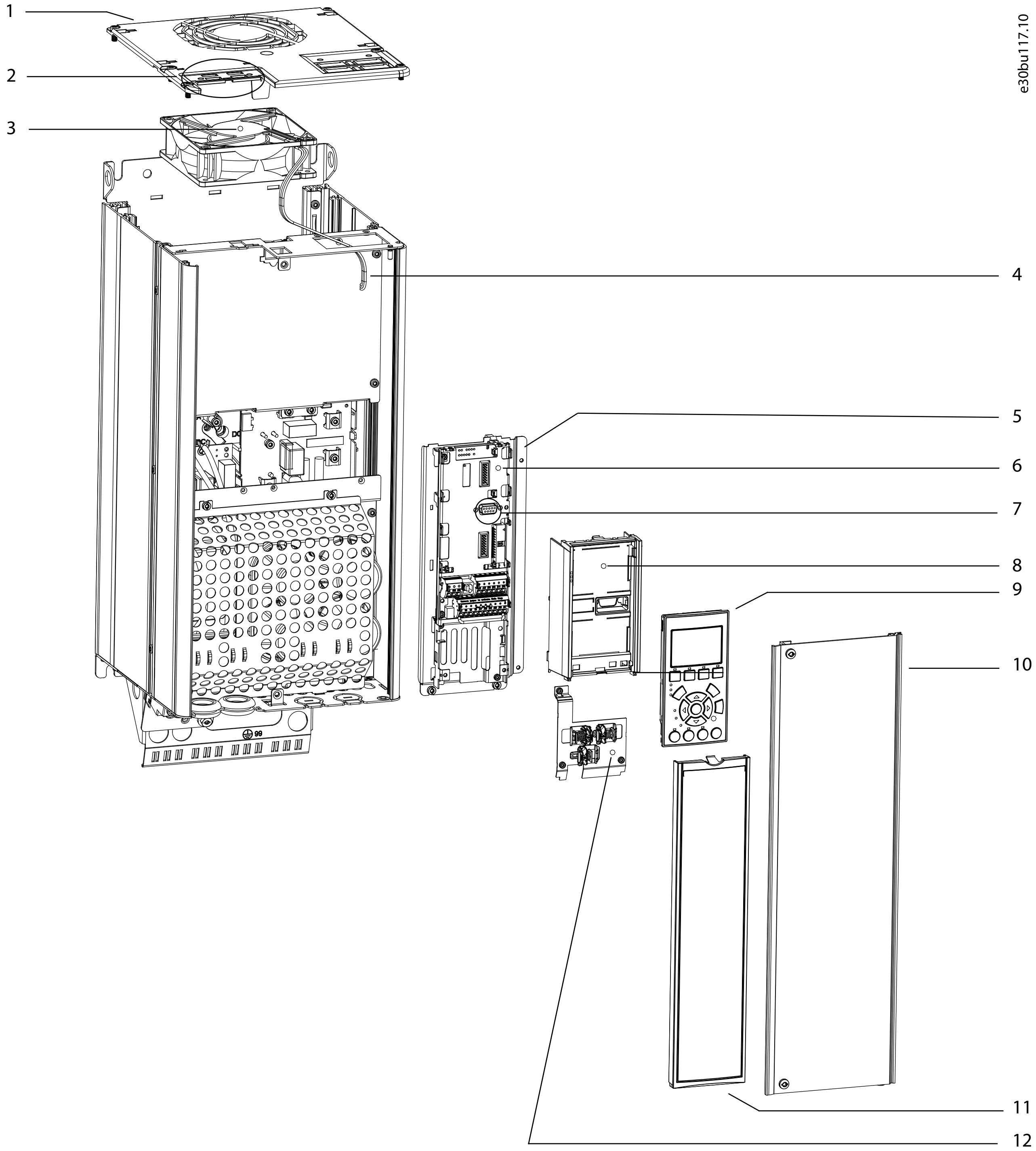
Many electronic components within the drive are sensitive to static electricity. Voltages so low that they cannot be felt, seen, or heard can be harmful to electronic components. Use standard ESD protective procedures whenever handling ESD sensitive components. Failure to conform to standard ESD procedures can reduce component life, diminish performance, or completely destroy sensitive electronic components.

NOTICE

ENCLOSURE SIZE

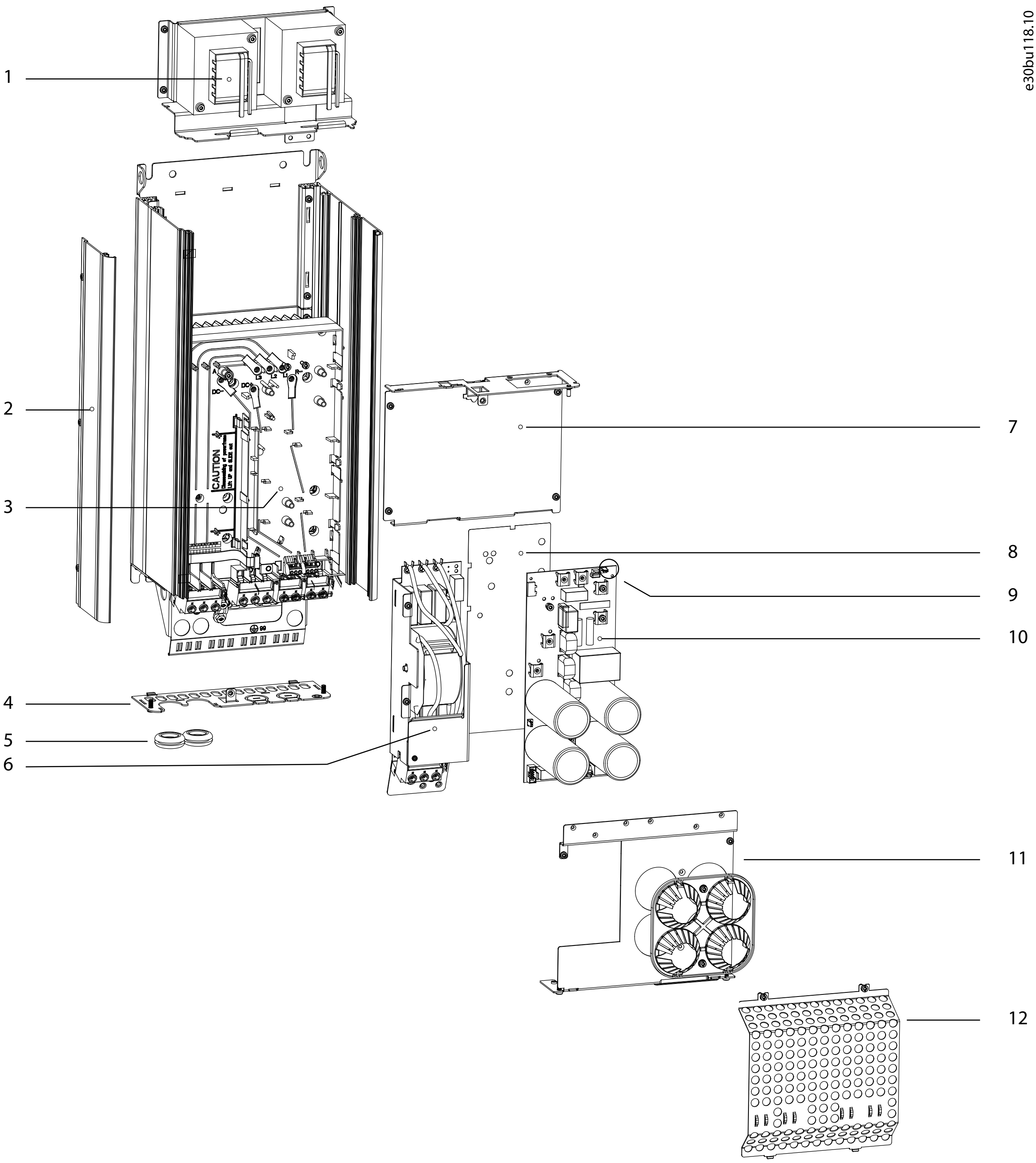
Enclosure size designations are used throughout this guide where procedures or components differ between drives based on size. See ***chapter 3.4 Enclosure Size Identification*****.**

11.2 B4 Disassembly and Assembly



1	Top cover	7	LCP connector
2	Top retaining screws for control card	8	LCP cradle
3	Fan assembly	9	LCP
4	Fan cable	10	Front cover
5	Mounting plate	11	Terminal cover
6	Control card	12	Decoupling plate

Illustration 11.1 Top Layer Exploded View of B4 Enclosure



1	DC link chokes	7	DC coil cover
2	Side cover	8	Insulating foil
3	Power card case	9	Fan connector
4	Bottom cover	10	DC link PCB
5	Rubber grommet	11	Intermediate plate
6	RFI assembly	12	Internal shield

Illustration 11.2 Bottom Layer Exploded View of B4 Enclosure

11.2.1 Terminal Cover

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 11.1*.

1. Remove the terminal cover (11) by inserting a flat head screwdriver into the hole at the top of the cover and gently pressing down on the tab until the cover pops out.

Reassembly

1. Place the base of the terminal cover in first.
2. While pressing the tab down, gently press the cover into place until you hear a click.

11.2.2 Control Card

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 11.1*.

1. Remove the terminal cover (11).
2. Remove the LCP (9) by pulling it towards you.
3. Open the front cover (10) by removing the 2 screws with a T20-Torx driver. The door will swing open.
4. Remove the decoupling plate (12) by unscrewing the 3 screws using a T10-Torx driver.
5. Remove the 2 screws securing the control card to the top of the enclosure (3) using a T20-Torx driver.
6. Remove the plastic cover beneath the control terminals by inserting a flat blade screwdriver into the side of the plastic cover and gently pulling the cover.
7. Remove the LCP cradle (8) by inserting the screwdriver into the slot between the side of the mounting cradle and the top of the enclosure. Gently pull the cradle.
8. Remove the control card (6) by unscrewing the 2 screws securing the control card with a T10-Torx driver.

For the location of the parts mentioned in these steps, refer to *Illustration 11.1*.

Reassembly

Tighten fasteners according to *chapter 14.1 Fastener Torque Ratings*.

1. Reinstall the control card to the mounting plate and secure with the 2 screws. Torque to 1.3 Nm (12 in-lb).
2. Reinstall the LCP cradle, making sure that the LCP connector (7) is fully seated into the cradle.
3. Reinstall the plastic cover beneath the control terminals.
4. Secure the top cover to the control card with the 2 screws. Torque to 0.8 Nm (7 in-lb).
5. Reinstall the decoupling plate and secure with the 3 screws. Torque to 1.3 Nm (12 in-lb).
6. Close the front cover and secure with 2 screws. Torque to 1.5 Nm (13 in-lb).
7. Place the base of the LCP into the LCP cradle and gently push until the LCP is secure.
8. Reinstall the terminal cover.

11.2.3 Internal Fan

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 11.1*, unless otherwise specified.

1. Unscrew the 6 screws on the top cover (1).
2. Disconnect the fan connector (9) from the DC link PCB (10). Refer to *Illustration 11.2*.
3. Lift the fan assembly (3) from the enclosure.

Reassembly

Tighten fasteners according to *chapter 14.1 Fastener Torque Ratings*.

1. Reinstall the fan into the enclosure, making sure that the fan cable is routed through the cable guide at the front of the enclosure.
2. Reconnect the fan connector to the DC link PCB.
3. Reinstall and secure the top cover with the 6 screws. Torque to 2.5 Nm (22 in-lb).

11.2.4 Power Card

Disassembly

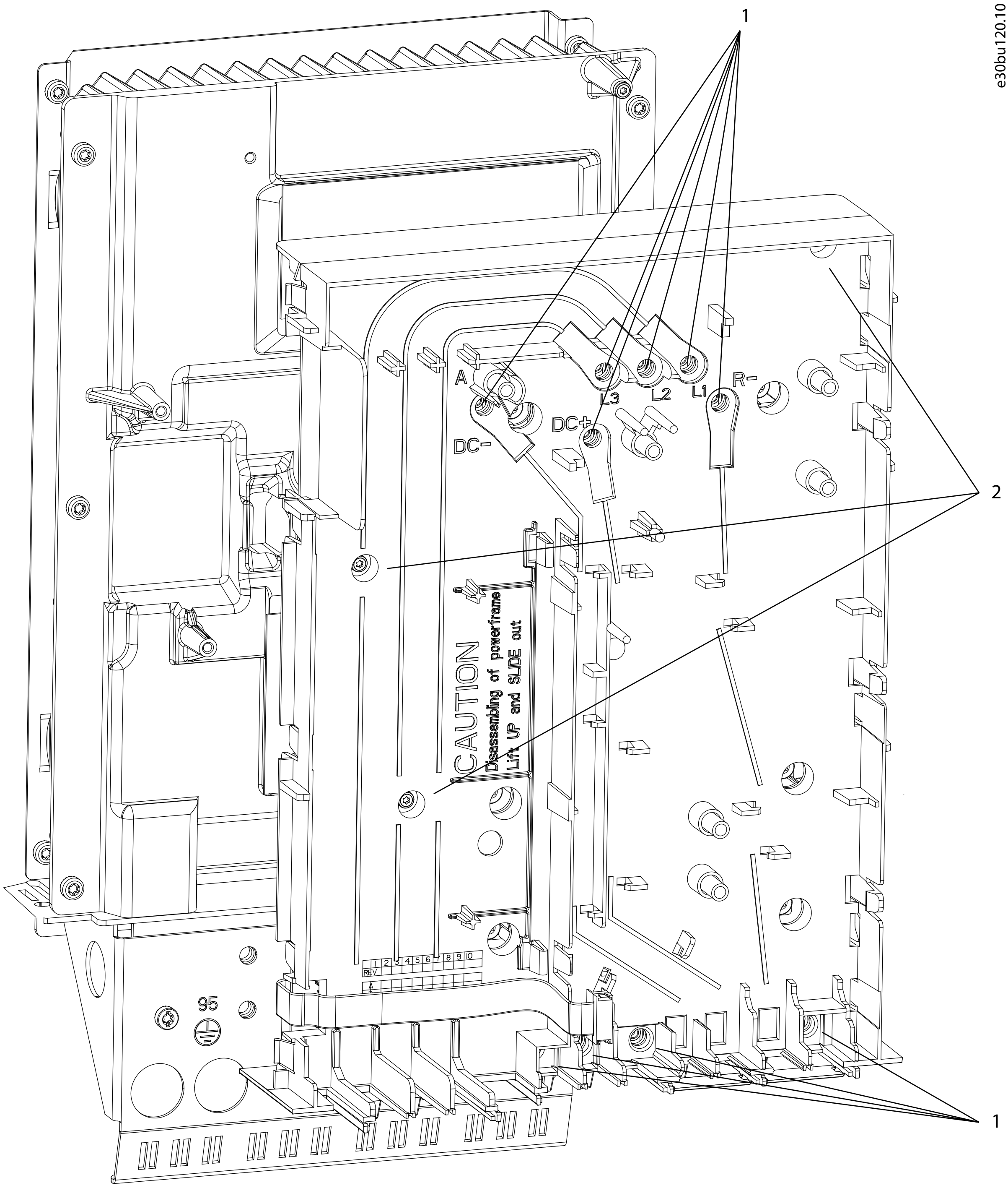
For the location of the parts mentioned in these steps, refer to *Illustration 11.2*, unless otherwise specified.

1. Remove the control card.
2. Remove the fan assembly.
3. Remove the front cover (10) by unscrewing the bottom screw with a T20-Torx driver. Then push down on the metal pin at the top of the door to release the front cover. Refer to *Illustration 11.1*.
4. Remove the 2 rubber grommets (5).
5. Remove the internal shield (12).
6. Remove the mounting plate (5). Refer to *Illustration 11.1*.
   - 6a Unscrew the 2 screws on the bottom of the plate using a T20-Torx driver.
   - 6b Press the tabs to release the 44-pin connector from the mounting plate.
7. Remove the bottom cover (4) by unscrewing the 2 screws using a T20-Torx driver.
8. Remove the intermediate plate (11) by unscrewing the 4 screws using a T20-Torx driver.
9. Unscrew the 5 screws securing the DC coil cover (7) using a T20-Torx driver.
10. Making sure to mark all cable positions for reinstallation, unscrew all cables from the DC-link PCB (10) and the power card case (3) using a T20-Torx driver.
11. Unscrew the 3 connector screws securing the DC-link PCB using a T20-Torx driver.
12. Unscrew the 4 fixing screws of the DC-link PCB using a T20-Torx driver, and then remove the PCB.
13. Remove the DC link chokes.
14. Remove the insulating foil (8).
15. Unscrew the 16 screws from the front of the plastic power card case (3) using a T20-Torx driver.
16. Unscrew the 3 retaining screws on the power card case (1 top and 2 left side) using a T10-Torx driver.
17. Release the plastic snaps from the plastic card case using the Allen key.
18. Unplug the 2 ribbon cables from the connector and remove the power card from the plastic power case.

Reassembly

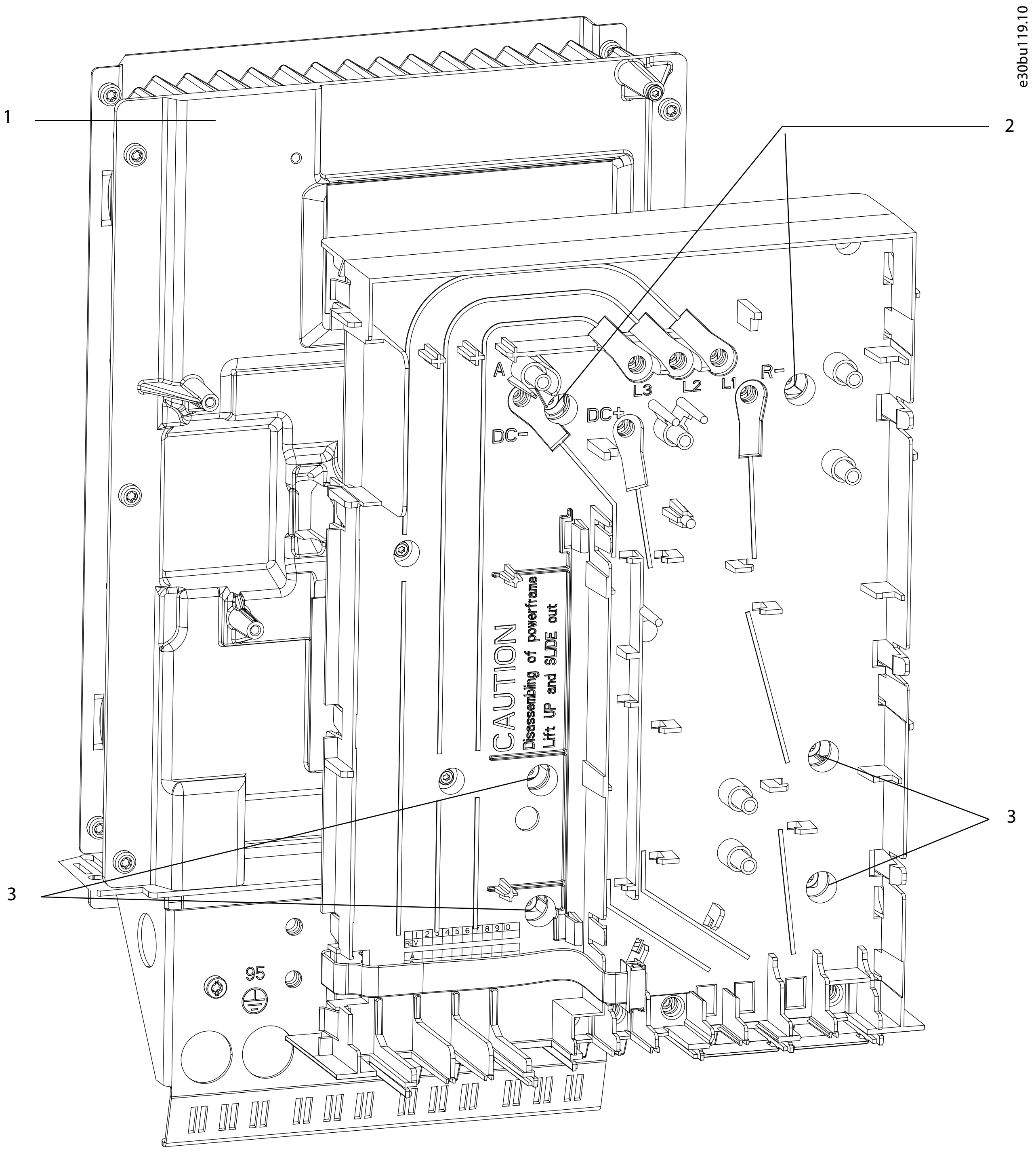
Tighten fasteners according to *chapter 14.1 Fastener Torque Ratings*, unless otherwise specified.

1. Apply heat compound to the front of the heat sink.
   - 1a Remove previously applied heat compound areas on the heat sink without scratching the surface.
   - 1b Spread the new heat compound evenly to the surface of the heat sink that makes contact with the power card case.
2. Reconnect the 2 ribbon cables to the power card.
3. Slide the power card case into the enclosure.
4. Tighten the 10 screws into the power card plastic case. See *Illustration 11.3*.
5. Tighten the 3 retaining screws into the power card case. See *Illustration 11.3*.
6. Install the rectifier screws into the power card case. See *Illustration 11.4*.
   - 6a Pre-tighten the 2 screws to 0.8 Nm (7 in-lb).
   - 6b Then torque to 3.5 Nm (31 in-lb).
7. Install the IGBT screws into the power card case. See *Illustration 11.4*.
   - 7a Follow the tightening sequence as shown in *Illustration 11.5*.
   - 7b Pre-tighten the 4 screws to 0.8 Nm (7 in-lb).
   - 7c Then torque to 3.5 Nm (31 in-lb).
8. Place the insulating foil on top of the power card case.



1	Power card case screws	2	Retaining screws

Illustration 11.3 Location of Power Card Case Screws



1	Heat sink	3	IGBT screws
2	Rectifier screws	–	–

Illustration 11.4 Rectifier and IGBT Screw Locations in the Plastic Card Case for B4 Enclosure

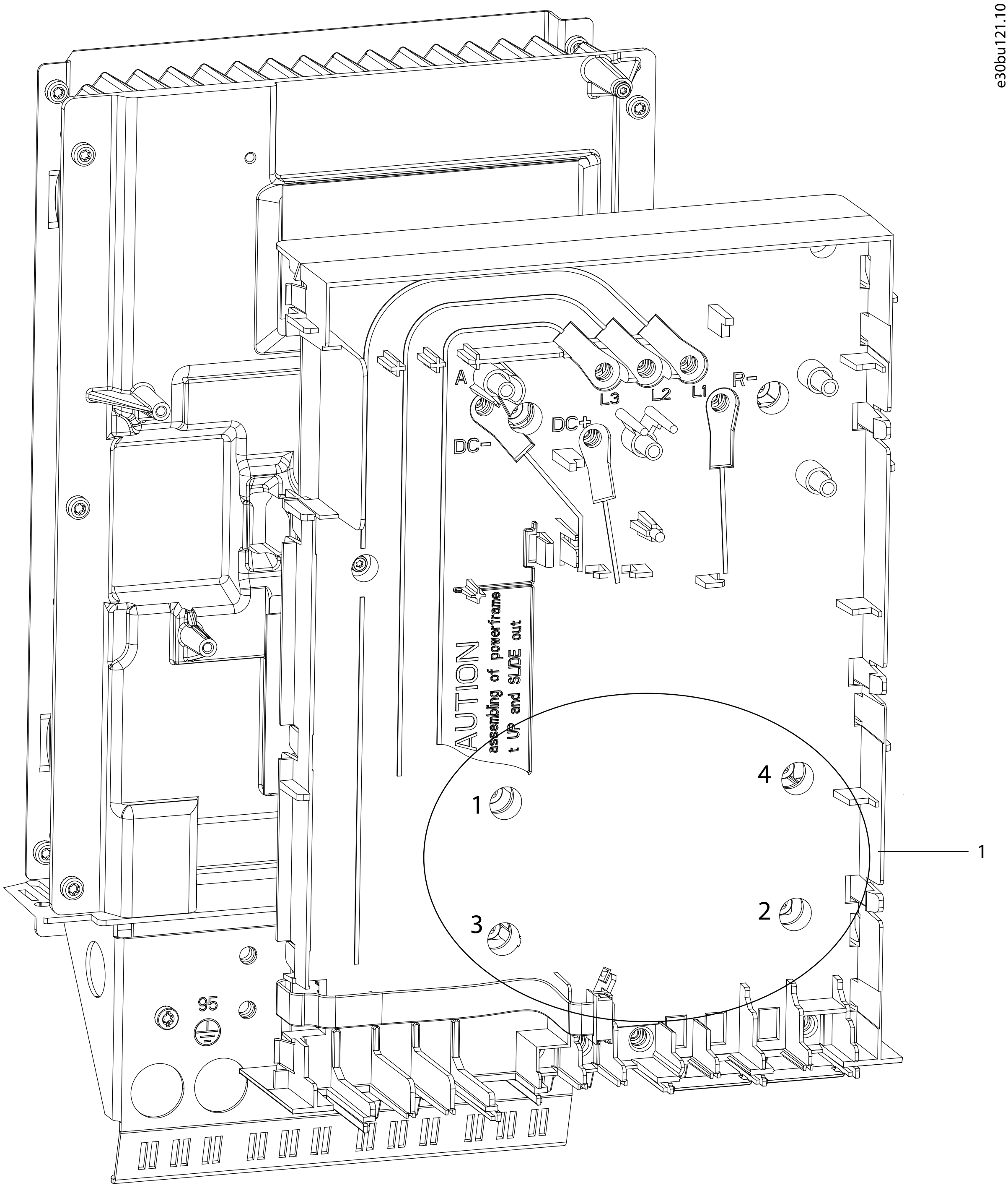


Illustration 11.5 Tightening Sequence for the IGBT Fasteners

9. Reinstall the DC-link PCB on top of the insulating foil and secure with the 3 screws using a T20-Torx driver. Torque to 2.8 Nm (24 in-lb).
10. Reinstall the DC-link chokes and secure with the 5 screws. Torque to 1.5 Nm (13 in-lb).
11. Reconnect all cables to the DC-link PCB. Torque to 2.8 Nm (24 in-lb).
12. Reinstall the intermediate cover. Torque the 2 top screws to 1.5 Nm (13 in-lb) and the 2 bottom screws to 3.5 Nm (31 in-lb).
13. Reinstall the bottom cover. Torque the 2 screws to 3.5 Nm (31 in-lb).
14. Press the 44-pin connector into the upper right corner of the mounting plate. Insert the 2 tabs of the mounting plate into the 2 slots in the top of the enclosure and secure with the 2 screws. Torque to 1.5 Nm (13 in-lb).
15. Reinstall the internal shield and secure with the 2 screws. Torque to 1.5 Nm (13 in-lb).
16. Reinstall the 2 rubber grommets at the bottom of the enclosure.
17. Reinstall the front cover. Secure with the 1 screw at the bottom of the front cover. The steel pin in the top of the front cover is secured once the top cover is installed.
18. Reinstall the fan assembly.
19. Reinstall the control card.

12 C1–C2 Drive Disassembly and Assembly

12.1 Before Proceeding

Review all safety warnings and cautions.

- DO NOT touch electrical parts of the drive when connected to mains. Also make sure that other voltage inputs have been disconnected (linkage of DC intermediate circuit). There can be high voltage on the DC-link even when the indicator lights are turned off. Before touching any potentially live parts of the drive, wait at least 40 minutes.
- Before conducting repair or inspection, disconnect mains.
- [Off] on the LCP does not disconnect mains.
- During operation and while programming parameters, the motor can start without warning. Press [Stop] when changing data.
- When operating on a PM motor, disconnect the motor cable.

WARNING

DISCHARGE TIME

The drive contains DC-link capacitors, which can remain charged even when the drive is not powered. High voltage can be present even when the warning LED indicator lights are off. Failure to wait for 15 minutes after power has been removed before performing service or repair work can result in death or serious injury.

- **Stop the motor.**
- **Disconnect AC mains and remote DC-link power supplies, including battery back-ups, UPS, and DC-link connections to other drives.**
- **Disconnect or lock the motor.**
- **Disconnect any brake option.**
- **Disconnect any regen/load share option.**
- **Wait 15 minutes for the capacitors to discharge fully. The minimum waiting time is also visible on the drive label.**
- **Before performing any service or repair work, use an appropriate voltage measuring device to make sure that the capacitors are fully discharged.**

NOTICE

INTERLOCKED DOORS

If supplied with a circuit breaker or disconnect switch, the cabinet doors are interlocked. To open the cabinet doors, set the circuit breaker and disconnect switch to the OFF position.

NOTICE

ELECTROSTATIC DISCHARGE (ESD)

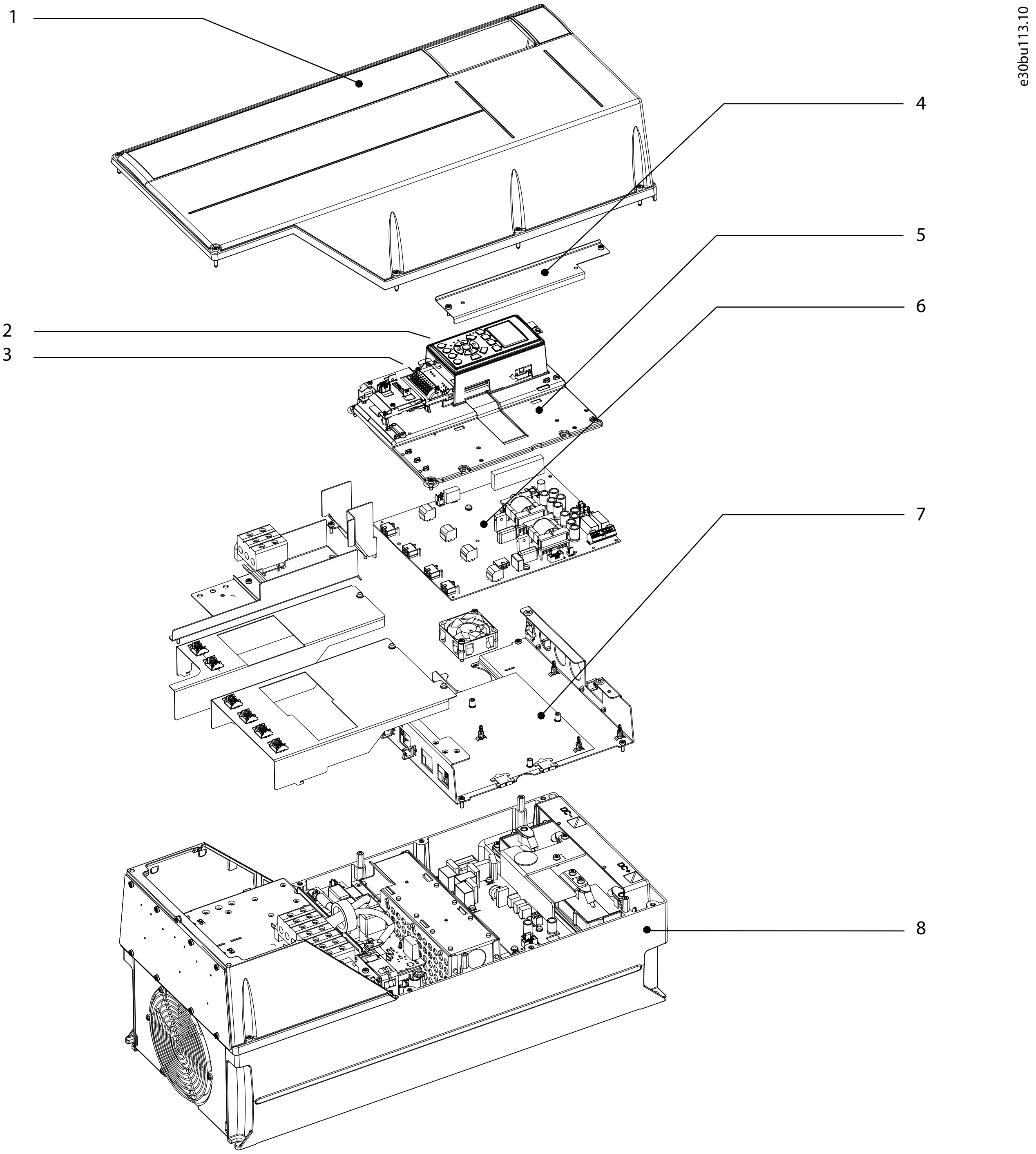
Many electronic components within the drive are sensitive to static electricity. Voltages so low that they cannot be felt, seen, or heard can be harmful to electronic components. Use standard ESD protective procedures whenever handling ESD sensitive components. Failure to conform to standard ESD procedures can reduce component life, diminish performance, or completely destroy sensitive electronic components.

NOTICE

ENCLOSURE SIZE

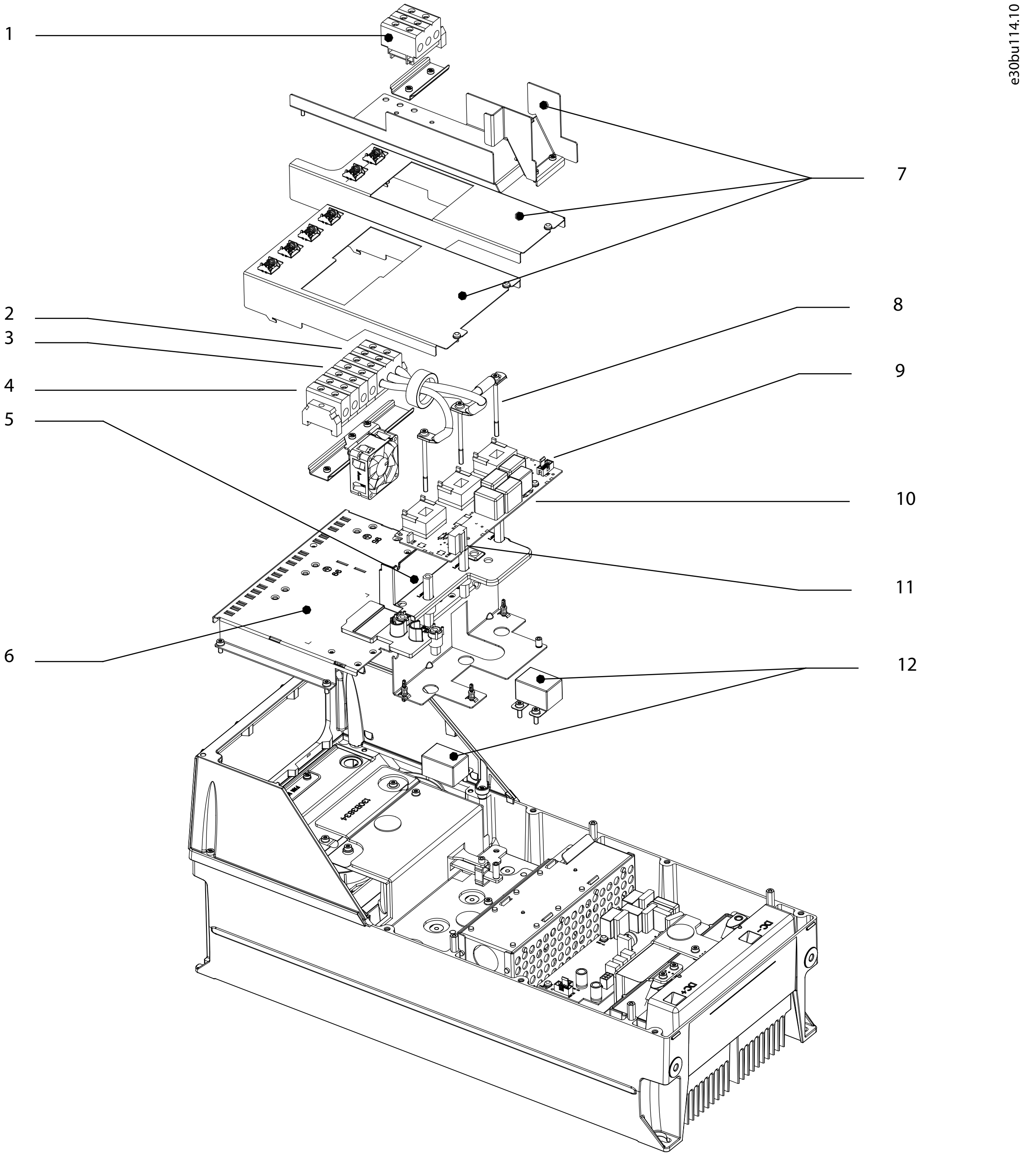
Enclosure size designations are used throughout this guide where procedures or components differ between drives based on size. See *chapter 3.4 Enclosure Size Identification*.

12.2 C1–C2 Disassembly and Assembly



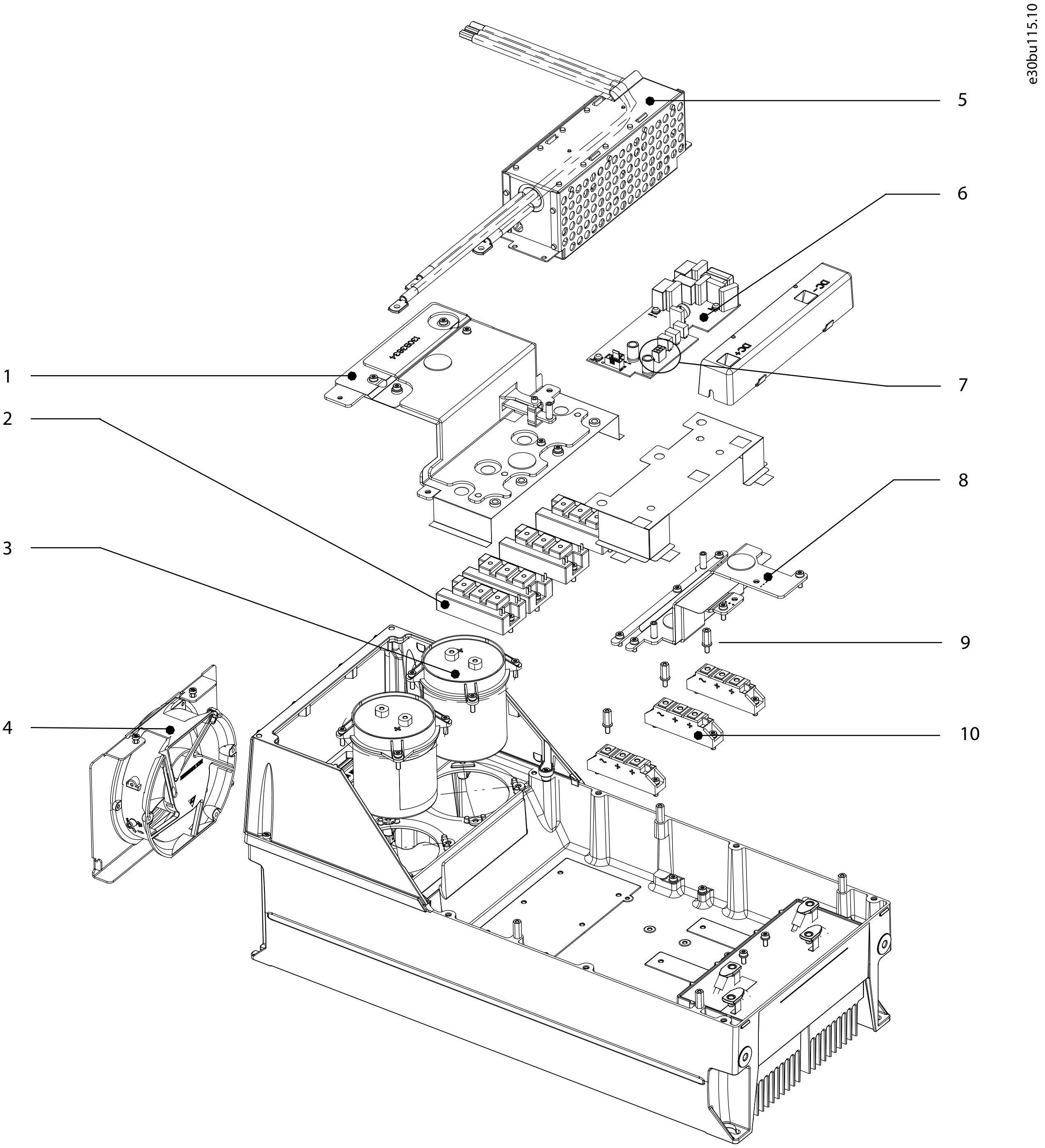
1	Front cover	5	Control card plate
2	Local control panel (LCP) and cover	6	Power card
3	Control card	7	Mounting plate
4	Power card shield plate	8	Enclosure

Illustration 12.1 Top Layer Exploded View of C1–C2 Enclosures



1	Input terminals (L1, L2, L3)	7	Shield plates
2	Motor terminals (U, V, W)	8	Retaining screw for current sensor
3	DC bus terminals (+/-)	9	MK1 connector
4	Brake terminals	10	Current sensor card
5	Motor terminal busbar	11	MK2 connector
6	Terminal plate	12	Clamping capacitors

Illustration 12.2 Middle Layer Exploded View of C1–C2 Enclosures



1	IGBT busbar unit	6	Inrush PCB
2	IGBT module	7	TP1 806 connector
3	Capacitor banks	8	Rectifier busbar unit
4	Fan assembly	9	Busbar channel retaining screws
5	RFI filter	10	Rectifier modules

Illustration 12.3 Bottom Layer Exploded View of C1–C2 Enclosures

12.2.1 Front Cover

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 9.1*.

1. Remove the front cover (1) of the drive by unscrewing the 8 screws using a T10-Torx driver.

Reassembly

1. Place the front cover on the drive.
2. Secure the front cover using the 8 screws from the disassembly. Torque to 2.0 Nm (18 in-lb).

12.2.2 Control Card Unit

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 9.1*.

1. Remove the front cover (1).
2. Unscrew the 4 screws securing the control card plate (5) using a T10-Torx driver.
3. Lift up the control plate and disconnect the ribbon cable from the power card (6).

Reassembly

1. Connect the ribbon cable to the power card.
2. Place the control card plate on top of the power card. Secure with 4 screws. Torque to 1.5 Nm (13 in-lb).
3. Secure the front cover to the drive.

12.2.3 Power Card

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 9.1*.

1. Remove the front cover (1).
2. Remove the control card unit (5).
3. Remove the power card shield plate (4) by unscrewing 3 screws using a T10-Torx driver.
4. Disconnect the following connectors on the power card (6). Refer to *Illustration 12.4*.
    - MK900
    - MK101
    - MK102
    - MK601
    - MK800
    - MK804
    - MK805
    - MK806
    - MK807 (Enclosure C2 only)
    - MK801 (Enclosure C2 only)
    - MK1300
    - MK1400
    - MK1500
    - MK501

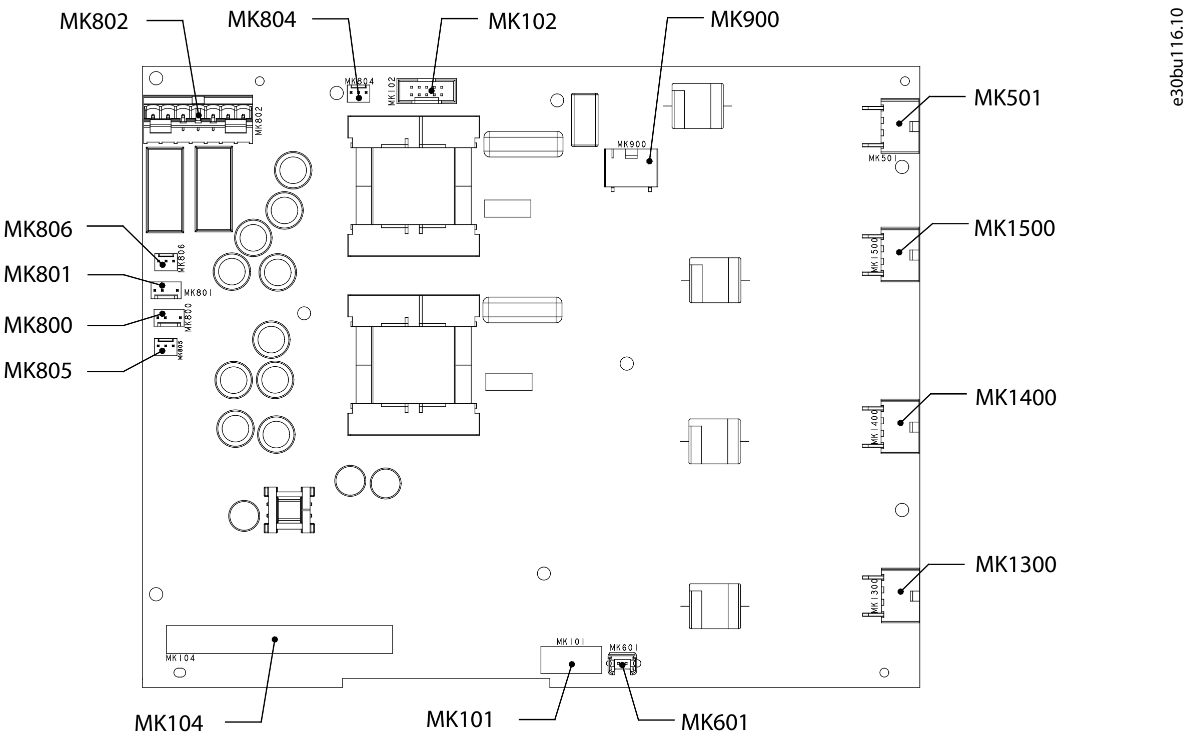


Illustration 12.4 Power Card Connectors for C1–C2 Enclosures

5. Unscrew the 3 remaining screws using a T10-Torx driver.
6. Release the power card from the 5 retaining clips and remove the power card.
7. Remove the mounting plate (7) by unscrewing 4 screws using a T10-Torx driver.

Reassembly

1. Reinstall the mounting plate.
   - For the C1 enclosure:
     - Tighten the 4 corner screws. Torque to 1.5 Nm (13 in-lb).
   - For the C2 enclosure:
     - Install the terminal plastic cover on the UDC+ and UDC- terminals.
     - Secure the power card shield plate with 3 screws. Torque to 1.5 Nm (13 in-lb).
     - Secure the mounting plate with the 4 corner screws. Torque to 1.5 Nm (13 in-lb).
2. Gently reinstall the power card onto the mounting plate. Secure with the 5 retaining clips.
3. Secure the power card to the mounting plate with the 3 screws.
4. Reconnect the following power card connectors.
   - MK1300
   - MK1400
   - MK1500
   - MK501
   - MK900
   - MK101
   - MK102
   - MK601
   - MK800
   - MK804
   - MK805
   - MK806
   - MK807 (Enclosure C2 only)
   - MK801 (Enclosure C2 only)
5. Reinstall the power card shield plate. Secure using the 4 screws. Torque to 1.5 Nm (13 in-lb).
6. Reinstall the control card unit.
7. Reinstall and secure the front cover.

12.2.4 Current Sensor

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 12.2*.

1. Remove the front cover.
2. Remove the control card unit.
3. Remove the power card.
4. Use an Allen key to loosen the following terminals and remove the cables:
   - Input terminals (1).
   - Motor terminals (2).
   - DC bus terminals (3).
   - Brake terminals (4).
5. Unscrew the 4 screws that secure the shield plates (7) using a T-10 Torx driver.
6. Unscrew the 3 retaining screws (8) securing the current sensors using a T-10 Torx driver.

7. Unplug the MK1 connector (9) from the current sensor card (10).
8. Disconnect 1 end of the MK2 connector (11), which is connected to a blue wire.
9. Remove the current sensor card by unscrewing the 3 screws connecting the current sensor card to the motor terminal busbar (5).

Reassembly

1. Gently place the current sensor card onto the 3 clips on the motor terminal busbar.
2. Secure the current sensor card with 3 screws. Torque to 1.5 Nm (13 in-lb).
3. Reconnect the MK2 (blue wire) and MK1 connectors.
4. Tighten the 3 retaining screws. Torque to 1.5 Nm (13 in-lb).
5. Secure the 2 shield plates with 4 screws. Torque to 1.5 Nm (13 in-lb).
6. Insert the terminal cables into the brake terminals and tighten the Allen screws. Torque to 1.5 Nm (13 in-lb).
7. Insert the terminal cables into the DC bus terminals and tighten the Allen screws. Torque to 1.5 Nm (13 in-lb).
8. Insert the terminal cables into the motor terminals and tighten the Allen screws. Torque to 1.5 Nm (13 in-lb).
9. Insert the terminal cables into the input terminals and tighten the Allen screws. Torque to 1.5 Nm (13 in-lb).
10. Reinstall the power card.
11. Reinstall the control card unit.
12. Reinstall the front cover.

12.2.5 IGBT Modules

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 12.3*, unless otherwise specified.

1. Remove the front cover. Refer to *Illustration 12.1*.
2. Remove the control card unit.
3. Remove the power card.
4. Remove the current sensor.
5. Remove the 2 brake cables connected to the brake IGBT (2).
6. Remove the terminal plate (6) by unscrewing the 4 screws with a T20-Torx driver. Refer to *Illustration 12.2*.
7. Remove the 2 clamping capacitors (12) by unscrewing the 4 screws. Refer to *Illustration 12.2*.
8. Disconnect the end of the MK2 connector that is secured to the IGBT busbar unit (1).
9. Unscrew the 7 screws securing the IGBT busbar unit using a T10-Torx driver.
10. Remove the DC- and DC+ busbar cables that are connected to the IGBT busbar unit and then remove the unit.
11. Unplug the gate wires that connect to the IGBT modules.
12. Remove the IGBTs by unscrewing the 8 screws using a T20-Torx driver. There are 2 screws for each of the 4 IGBT modules.

Reassembly

1. Apply heat compound to the front of the heat sink.
   - 1a Without scratching the surface, remove previously applied heat compound from the surface of the enclosure that contained the IGBTs.
   - 1b Spread the new heat compound evenly to the surface of the enclosure where the IGBTs will be placed.
2. Reinstall the IGBTs into the enclosure.
   - For the C1 enclosure:
     - First tighten the screws until the screw head is flush.
     - Initially tighten the 2 screws per IGBT to 1.5 Nm (13 in-lb).
     - Finally, tighten each IGBT to 3.5 Nm (31 in-lb).
   - For the C2 enclosure:
     - First tighten the screws until the screw head is flush.
     - Using a diagonal tightening sequence, initially tighten the 4 screws per IGBT to 1.5 Nm (13 in-lb).
     - Using a diagonal tightening sequence, finish tightening each IGBT to 3.5 Nm (31 in-lb).
3. Reconnect the gate wires to the IGBT modules.
4. Secure the IGBT busbar unit with the 7 screws. Torque to 2.2 Nm (20 in-lb).
5. Reconnect the MK2 connector (blue wire) to the IGBT busbar unit.
6. Reconnect the DC- and DC+ busbar cables to the IGBT busbar unit.
7. Secure the 2 clamping capacitors with the 4 screws. Torque to 2.2 Nm (20 in-lb).
8. Reinstall the terminal plate with 4 screws. (1.5 Nm (13 in-lb)).
9. Reconnect the 2 brake cables to the brake IGBT. Torque to 1.2 Nm (11 in-lb).
10. Reinstall the current sensor.
11. Reinstall and secure the power card.
12. Reinstall the control card unit.
13. Reinstall and secure the front cover.

12.2.6 RFI Filter

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 9.1*.

1. Remove the front cover.
2. Remove the control card unit.
3. Remove the power card.
4. Remove the current sensor.
5. Remove the IGBT modules.
6. Unscrew the 3 screws that connect the cables to the rectifier busbar unit (8).
7. Remove the RFI filter (5) by using a T10-Torx driver to unscrew the 4 screws that secure the filter to the enclosure.

Reassembly

1. Place the RFI filter back into the enclosure.
2. Secure the filter to the enclosure using 4 screws. Torque to 2.2 Nm (20 in-lb).
3. Secure the cables to the rectifier busbar unit with the 3 screws. Torque to 2.2 Nm (20 in-lb).
4. Reinstall the IGBT modules.
5. Reinstall the current sensor.
6. Reinstall and secure the power card.
7. Reinstall the control card unit.
8. Reinstall and secure the front cover.

12.2.7 Inrush PCB

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 9.1*.

1. Remove the front cover.
2. Remove the control card unit.
3. Remove the power card.
4. Remove the current sensor.
5. Remove the IGBT modules.
6. Remove the RFI filter.
7. Unplug the TP1 806 connector from the inrush PCB.
8. Unscrew the 6 screws securing the inrush PCB with a T10-Torx driver. Remove the inrush PCB.

Reassembly

1. Install the inrush PCB onto the rectifier. Secure with the 6 screws. Torque to 2.2 Nm (20 in-lb).
2. Reconnect the TP1 806 connector to the inrush PCB.
3. Reinstall the RFI filter.
4. Reinstall the IGBT modules.
5. Reinstall the current sensor.
6. Reinstall and secure the power card.
7. Reinstall the control card unit.
8. Reinstall and secure the front cover.

12.2.8 Rectifier Module

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 9.1*.

1. Remove the front cover.
2. Remove the control card unit.
3. Remove the power card.
4. Remove the current sensor.
5. Remove the IGBT modules.
6. Remove the RFI filter.
7. Remove the inrush PCB.
8. Unplug the 6 strips of wires from the TP1 806 connector that connect to the rectifier modules (10).
9. Remove the rectifier busbar unit by unscrewing the 8 screws that secure it with a T10-Torx driver.
10. Unscrew the 3 retaining screws securing the busbar channel and remove the channel.
11. Remove the 3 rectifier modules by unscrewing the 2 screws per module using a T20-Torx driver.

Reassembly

1. Install and secure the 3 rectifier modules with 2 screws per module. Initially tighten both screws to 1.5 Nm (13 in-lb), and then tighten them to 3.5 Nm (31 in-lb).
2. Install the busbar channel and secure the busbar channel with the 3 retaining screws. Torque to 2.2 Nm (20 in-lb).
3. Reinstall and secure the rectifier busbar unit with the 8 screws. Torque to 2.2 Nm (20 in-lb).
4. Reconnect the 6 strips of wires to the TP1 806 connector.
5. Reinstall the inrush PCB.
6. Reinstall the RFI filter.
7. Reinstall the IGBT modules.
8. Reinstall the current sensor.
9. Reinstall and secure the power card.
10. Reinstall the control card unit.
11. Reinstall and secure the front cover.

12.2.9 Capacitor Banks

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 9.1*.

1. Remove the front cover.
2. Remove the control card unit.
3. Remove the power card.
4. Remove the current sensor.
5. Remove the IGBT modules.
6. Unscrew the 4 screws securing each capacitor (3) to the enclosure. There are 2 capacitors in the C1 enclosure and 4 capacitors in the C2 enclosure.

Reassembly

1. Reinstall each capacitor into the enclosure and tighten the capacitor clamps to 4 Nm (35 in-lb).
2. Reinstall the IGBT modules.
3. Reinstall the current sensor.
4. Reinstall and secure the power card.
5. Reinstall the control card unit.
6. Reinstall and secure the front cover.

12.2.10 Fan Assembly

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 9.1*.

1. Remove the front cover.
2. Unscrew the screws that secure the fan assembly (4). The C1 fan assembly is secured by 2 screws inside the enclosure near the front cover. The C2 fan assembly is secured by 3 screws near the front cover, as well as 2 screws at the base of the exterior near the fan grill.
3. Remove the fan assembly.

Reassembly

1. Reinstall the fan assembly into the enclosure.
2. Secure the fan assembly with 2 screws (C1 enclosure) or 5 screws (C2 enclosure). Torque to 2.2 Nm (20 in-lb).
3. Replace the front cover.

13 C3–C4 Drive Disassembly and Assembly

13.1 Before Proceeding

Review all safety warnings and cautions.

- DO NOT touch electrical parts of the drive when connected to mains. Also make sure that other voltage inputs have been disconnected (linkage of DC intermediate circuit). There can be high voltage on the DC-link even when the indicator lights are turned off. Before touching any potentially live parts of the drive, wait at least 40 minutes.
- Before conducting repair or inspection, disconnect mains.
- [Off] on the LCP does not disconnect mains.
- During operation and while programming parameters, the motor can start without warning. Press [Stop] when changing data.
- When operating on a PM motor, disconnect the motor cable.

WARNING

DISCHARGE TIME

The drive contains DC-link capacitors, which can remain charged even when the drive is not powered. High voltage can be present even when the warning LED indicator lights are off. Failure to wait for 15 minutes after power has been removed before performing service or repair work can result in death or serious injury.

- **Stop the motor.**
- **Disconnect AC mains and remote DC-link power supplies, including battery back-ups, UPS, and DC-link connections to other drives.**
- **Disconnect or lock the motor.**
- **Disconnect any brake option.**
- **Disconnect any regen/load share option.**
- **Wait 15 minutes for the capacitors to discharge fully. The minimum waiting time is also visible on the drive label.**
- **Before performing any service or repair work, use an appropriate voltage measuring device to make sure that the capacitors are fully discharged.**

NOTICE

INTERLOCKED DOORS

If supplied with a circuit breaker or disconnect switch, the cabinet doors are interlocked. To open the cabinet doors, set the circuit breaker and disconnect switch to the OFF position.

NOTICE

ELECTROSTATIC DISCHARGE (ESD)

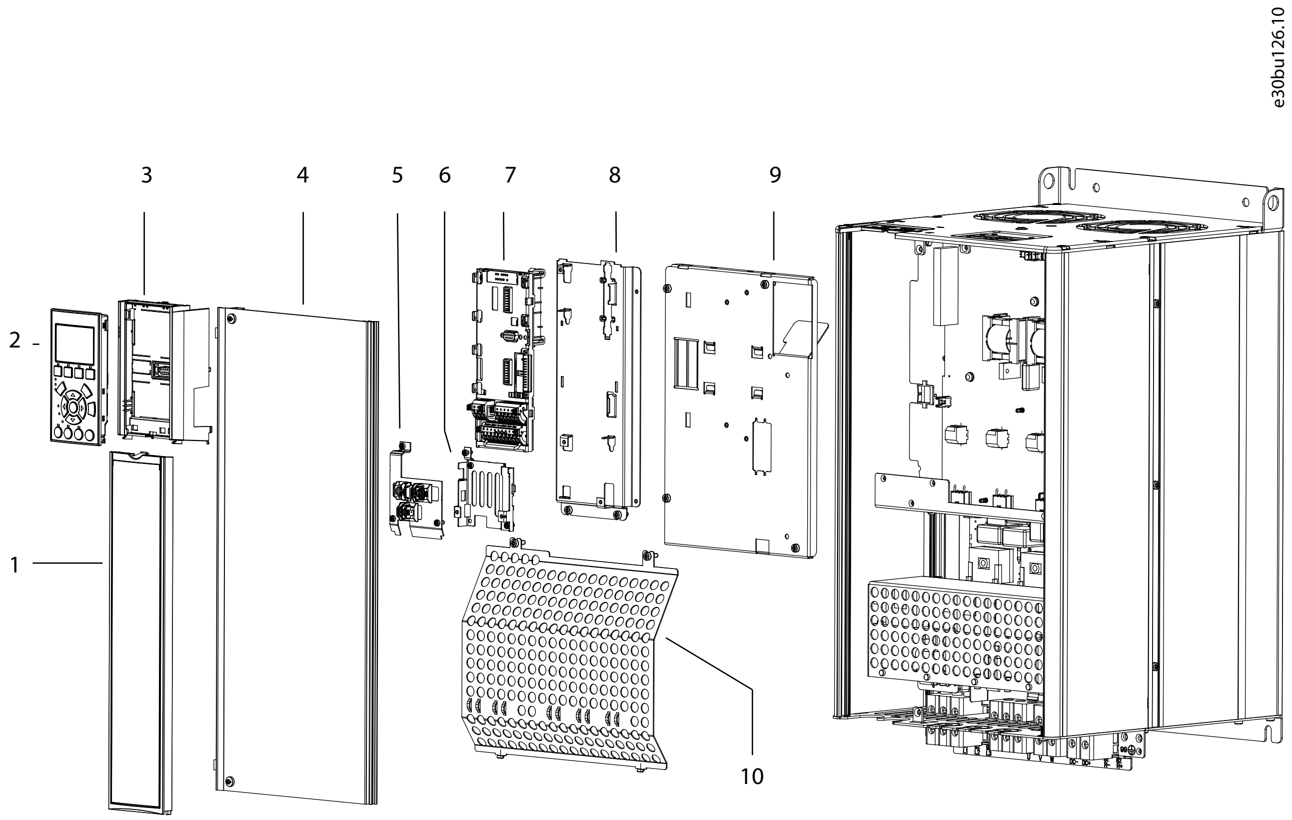
Many electronic components within the drive are sensitive to static electricity. Voltages so low that they cannot be felt, seen, or heard can be harmful to electronic components. Use standard ESD protective procedures whenever handling ESD sensitive components. Failure to conform to standard ESD procedures can reduce component life, diminish performance, or completely destroy sensitive electronic components.

NOTICE

ENCLOSURE SIZE

Enclosure size designations are used throughout this guide where procedures or components differ between drives based on size. See *chapter 3.4 Enclosure Size Identification*.

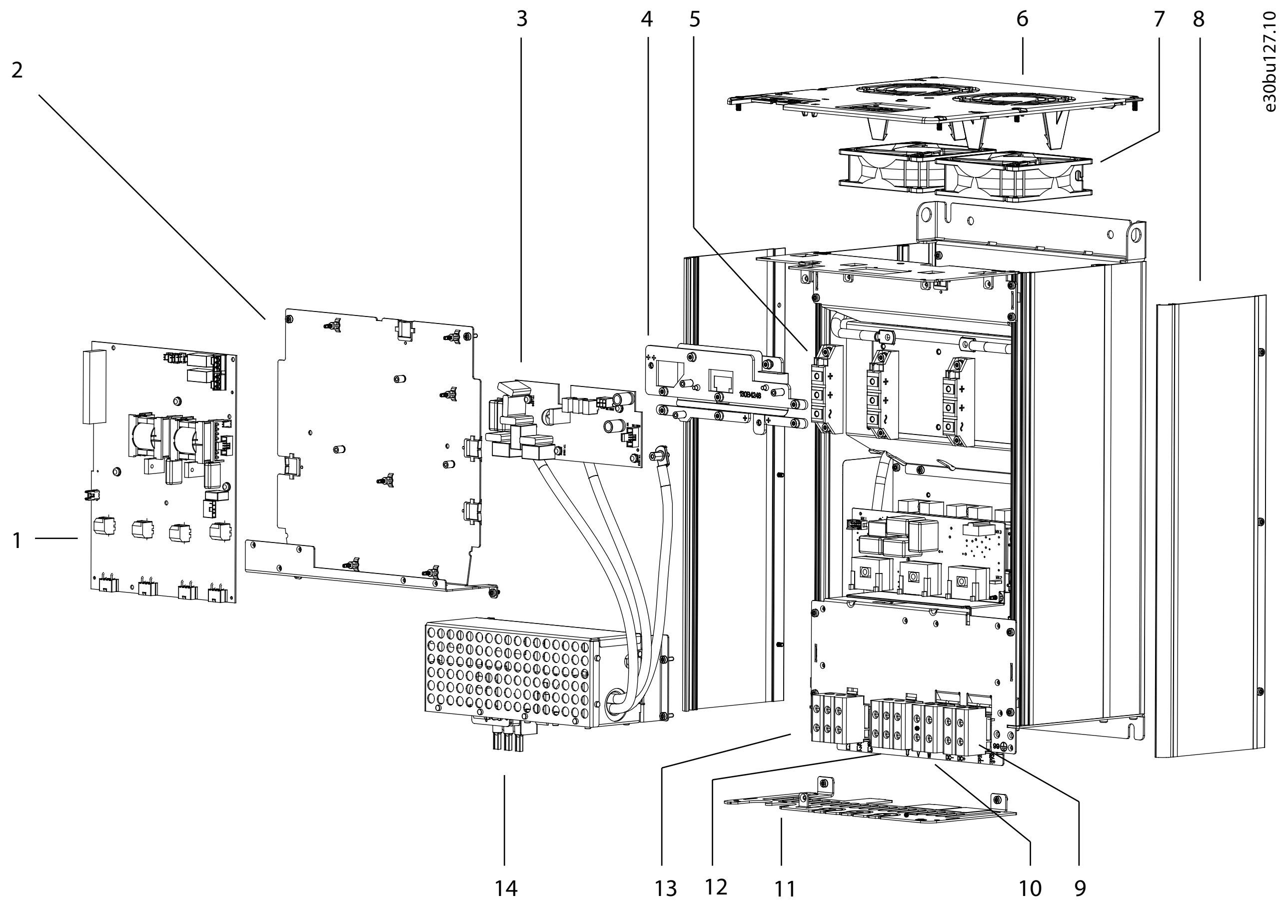
13.2 C3–C4 Disassembly and Assembly



1	Terminal cover	6	Grounding plate
2	Local control panel (LCP)	7	Screening plate (on top) with control card (underneath)
3	LCP cradle	8	Control card plate
4	Front cover	9	Option C mounting plate
5	Decoupling plate	10	RFI shield plate

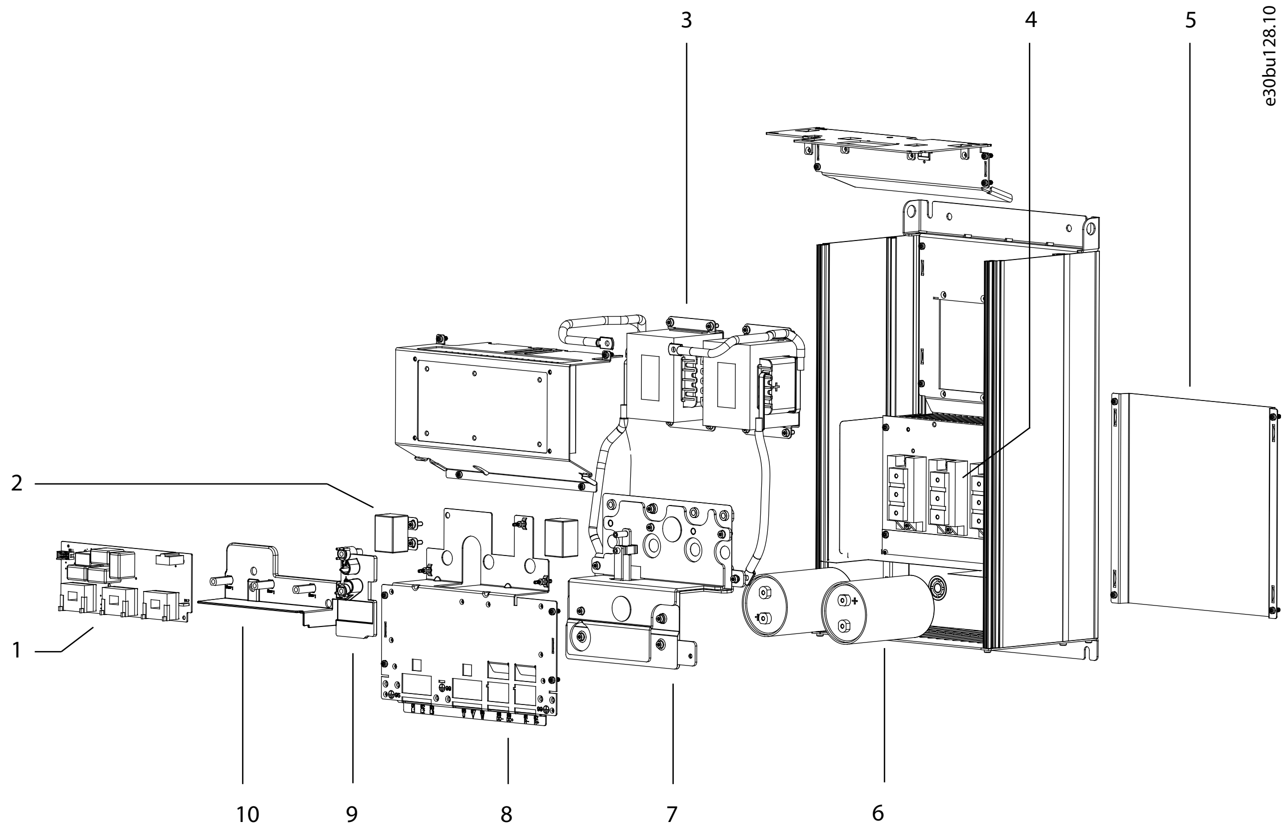
Illustration 13.1 Top Layer Exploded View of C3 Enclosure. C4 Enclosure is Similar

13



1	Power card	8	Side cover
2	Power card mounting plate	9	Brake terminal block
3	Inrush card	10	DC bus terminal block
4	Rectifier busbar	11	Bottom cover
5	Rectifier modules	12	Motor terminal block
6	Top cover	13	Mains terminal block
7	Fan	14	RFI filter

Illustration 13.2 Middle Layer Exploded View of C3 Enclosure. C4 Enclosure is Similar



1	Current sensor card	6	Capacitor bank
2	Clamping capacitor	7	Busbar IGBT
3	DC choke	8	Terminal plate
4	IGBT modules	9	CT busbar
5	Base plate	10	Brake IGBT

Illustration 13.3 Bottom Layer Exploded View of C3 Enclosure. C4 Enclosure is Similar

13

13.2.1 Terminal Cover

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 13.1*.

1. Remove the terminal cover (1) by inserting a flat head screwdriver into the hole at the top of the cover and gently press down on the tab until the cover pops out.

Reassembly

1. Place the base of the terminal cover in first.
2. While pressing the tab down, press the cover gently into place until you hear a click.

13.2.2 Front Cover

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 13.1*.

1. Remove the front cover (4) of the drive by unscrewing the 3 screws using a T10-Torx driver.

Reassembly

1. Place the front cover on the drive.
2. Secure the front cover with the 3 screws from the disassembly. Torque to 1.3 Nm (13 in-lb).

13.2.3 Control Card Unit

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 13.1*, unless otherwise specified.

1. Remove the terminal cover.
2. Remove the front cover.
3. Remove the local control panel (2) from the cradle (3).
4. Remove the decoupling plate (5) by unscrewing the 3 screws using a T10-Torx driver.
5. Insert the flat blade screw driver into the side of the option C mounting plate (9) and gently pull the plate.
6. Remove the control terminals by disconnecting any wires and gently pulling on the control terminals.
7. Remove the LCP cradle (3) by inserting the flat blade screw driver into the slot of the LCP cradle and gently pulling the cradle.
8. Remove the screening plate (7) by unscrewing the 2 screws with a T10-Torx driver, and lift the control card from the unit.

Reassembly

1. Place the control card onto the control card plate.
2. Reinstall the screening plate to the control card. Secure to the control card plate using the 2 screws. Torque to 1.5 Nm (13 in-lb).
3. Reinstall the LCP cradle onto the screening plate.
4. Reinstall the control terminals.
5. Reinstall the decoupling plate and secure with the 3 screws. Torque to 1.5 Nm (13 in-lb).
6. Attach the LCP to the LCP cradle.
7. Reinstall the front cover.
8. Reinstall the terminal cover.

13.2.4 Power Card

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 13.1*, unless otherwise specified.

1. Remove the terminal cover.
2. Remove the front cover.
3. Remove the control card.
4. Remove the grounding plate (6) by unscrewing the 1 screw securing the plate using a T10-Torx driver.
5. Unscrew the 4 screws securing the control card plate (8) using a T10-Torx driver.
6. Remove the left and right side covers (8) by unscrewing the 5 screws per cover using a T20-Torx driver. See *Illustration 13.2*.
7. Remove the RFI shield plate (10) by unscrewing the 2 screws using a T10-Torx driver.
8. Unscrew the 4 screws of the option C mounting plate (9) using a T20-Torx driver.
9. Remove the control card plate by unscrewing the 2 screws using a T10-Torx driver.
10. Unplug the following connectors from the power card:
    - MK104
    - MK102
    - MK804
    - MK101
    - MK601
    - UDC+/-
    - Brake terminals
    - Motor terminals
    - Fan connector EX1
    - Fan connector EX2
11. Remove the power card by unscrewing the 3 screws securing it using a T10-Torx driver.

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Reassembly

1. Secure the power card to the power card mounting plate and secure with the 3 screws. Torque to 1.5 Nm (13 in-lb).
2. Reconnect the 2 cooling fan connectors (EX1 and EX2) to the power card.
3. Reconnect the following connectors to the power card:
    - MK102
    - MK804
    - MK101
    - MK601
    - UDC+/-
    - Brake terminals
    - Motor terminals
    - MK104
4. Secure the control card plate to the power card mounting plate with the 2 screws. Torque to 2.2 Nm (19 in-lb).
5. Reinstall the option C mounting plate and secure with the 4 screws. Torque to 1.5 Nm (13 in-lb).
6. Secure the RFI shield plate to the power card mounting plate with 2 screws. Torque to 1.5 Nm (13 in-lb).

7. Reinstall the left and right side covers to the enclosure. Secure with the 5 screws per cover. Torque to 2.5 Nm (22 in-lb).
8. Secure the grounding plate to the control card plate with the 1 screw. Torque to 1.5 Nm (13 in-lb).
9. Reinstall the control card.
10. Reinstall the front cover.
11. Reinstall the terminal cover.

13.2.5 Inrush Card

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 13.2*.

1. Remove the terminal cover.
2. Remove the front cover.
3. Remove the control card.
4. Remove the power card.
5. Remove the power card mounting plate (2) by unscrewing the 4 screws using a T20-Torx driver.
6. Disconnect the MK1800 and MK1802 connectors from the inrush card (3).
7. Remove the inrush card by unscrewing the 6 screws using a T10-Torx driver.

Reassembly

1. Secure the inrush card to the rectifier busbar with the 6 screws.
2. Reconnect MK1800 and MK1802 to the inrush card.
3. Reinstall the power card mounting plate and secure with the 4 screws. Torque to 1.5 Nm (13 in-lb).
4. Reinstall the power card.
5. Reinstall the control card.
6. Reinstall the front cover.
7. Reinstall the terminal cover.

13.2.6 Rectifier Module

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 13.2*, unless otherwise specified.

1. Remove the terminal cover.
2. Remove the front cover.
3. Remove the control card.
4. Remove the power card.
5. Remove the inrush card.
6. Disconnect the cables to the DC choke (3) and DC bus terminals by unscrewing the 4 screws using a T20-Torx driver. Refer to *Illustration 13.3*.
7. Remove the rectifier busbar (4) by unscrewing the 6 screws using a T10-Torx driver.
8. Loosen the 3 cables connected to the RFI filter (14) using a socket wrench (NV8 for C3 enclosure and NV10 for C4 enclosure).
9. Remove the rectifier (5) using a T20-Torx driver.

Reassembly

1. Apply heat compound to the enclosure surface where the rectifier modules will be mounted.
   - 1a Remove previously applied heat compound areas on the surface without scratching the surface.
   - 1b Spread the new heat compound evenly to the enclosure surface that makes contact with the rectifier modules.
2. Reinstall the rectifier modules into the enclosure.
   - 2a First tighten the screws until the screw head is flush.
   - 2b Initially tighten the 2 screws per rectifier module to 1.5 Nm (13 in-lb).
   - 2c Finally, tighten the rectifier module to 3.5 Nm (31 in-lb).
3. Reconnect the rectifier cables to the RFI filter using a NV8 socket wrench (C3 enclosure) or NV10 socket wrench (C4 enclosure). Torque to 3.5 Nm (31 in-lb).
4. Secure the rectifier busbar to the rectifier modules with the 6 screws. Torque to either 3.5 Nm (31 in-lb) for the C3 enclosure or 4.5 Nm (40 in-lb) for the C4 enclosure.
5. Tighten the 4 screws in the rectifier busbar that connect the cables to the DC choke and DC bus terminals. Torque to 4.5 Nm (40 in-lb).
6. Reinstall the inrush card.
7. Reinstall the power card.
8. Reinstall the control card.
9. Reinstall the front cover.
10. Reinstall the terminal cover.

13.2.7 RFI Filter

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 13.2*, unless otherwise specified.

1. Remove the terminal cover.
2. Remove the front cover.
3. Remove the control card.
4. Remove the power card.
5. Remove the inrush card.
6. Disconnect the cables to the DC choke (3) and DC bus terminals by unscrewing the 4 screws using a T20-Torx driver. Refer to *Illustration 13.3*.
7. Remove the rectifier busbar (4) by unscrewing the 6 screws using a T10-Torx driver.
8. Loosen the 3 cables connected to the RFI filter (14) using an Allen key (NV8 for C3 enclosure and NV10 for C4 enclosure).
9. Remove the rectifier (5) using a T20-Torx driver.

Reassembly

1. Reinstall the RFI filter and secure it with the 4 screws. Torque to 1.5 Nm (13 in-lb).
2. Tighten the 3 screws of the input line cables using an NV5 (C3 enclosure) or NV8 (C4 enclosure) Allen key. Torque to 10 Nm (89 in-lb).
3. Reinstall the base plate and tighten the 3 (C3 enclosure) or 4 (C4 enclosure) screws. Torque to 1.5 Nm (13 in-lb).
4. Reinstall the rectifier modules.
5. Reinstall the inrush card.
6. Reinstall the power card.

7. Reinstall the control card.
8. Reinstall the front cover.
9. Reinstall the terminal cover.

13.2.8 Current Sensor Card

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 13.3*, unless otherwise specified.

1. Remove the terminal cover.
2. Remove the front cover.
3. Remove the control card.
4. Remove the power card.
5. Remove the inrush card.
6. Remove the RFI filter.
7. Disconnect the cables to the current sensor card (1) by unscrewing the 3 screws connecting the cables with a T20-Torx driver.
8. Remove the rectifier busbar (4) by unscrewing the 6 screws using a T10-Torx driver.
9. Remove the current sensor card.
    - 9a Unscrew the 3 screws securing the current sensor card using a T20-Torx driver.
    - 9b Unscrew the 2 screws on the brake IGBT (9) using a T20-Torx driver.
    - 9c Unplug the MK1, MK2, and MK3 connectors from the current sensor card.

Reassembly

1. Place the current sensor board to the CT busbar.
2. Reconnect connectors MK1, MK2, and MK3 to the current sensor card.
3. Secure the current sensor board to the CT busbar with the 3 screws. Torque to 1.5 Nm (13 in-lb).
4. Tighten the 3 screws securing the motor terminal block using an Allen key. Torque to 10 Nm (89 in-lb).
5. Secure the 3 motor cables to the 3 current sensors with 1 screw per sensor. Torque to 4.5 Nm (40 in-lb).
6. Tighten the 2 screws securing the brake terminal block using an Allen key. Torque to 10 Nm (89 in-lb).
7. Secure the 2 brake cables to the brake IGBT module (far right when facing the front of unit) with 2 screws. Torque to 4.5 Nm (40 in-lb).
8. Tighten the 2 screws securing the DC bus terminal block using an Allen key. Torque to 10 Nm (89 in-lb).
9. Reinstall the RFI filter.
10. Reinstall the rectifier modules.
11. Reinstall the inrush card.
12. Reinstall the power card.
13. Reinstall the control card.
14. Reinstall the front cover.
15. Reinstall the terminal cover.

13.2.9 Capacitor Banks

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 13.3*, unless otherwise specified.

1. Remove the terminal cover.
2. Remove the front cover.
3. Remove the control card.
4. Remove the power card.
5. Remove the inrush card.
6. Remove the RFI filter.
7. Remove the current sensor card.
8. Remove the terminal plate (8) by unscrewing the 4 screws using a T20-Torx driver.
9. Remove the CT busbar (10).
10. Remove the 2 clamping capacitors (2) by unscrewing the 4 screws using a T20-Torx driver.
11. Remove the IGBT busbar (7).
    - 11a Unscrew the 6 screws securing the busbar using a T10-Torx driver.
    - 11b Disconnect the DC cables from the DC chokes (3) using a T10-Torx driver.
    - 11c Disconnect the balancing (blue) wire from the busbar.
12. Remove the capacitor banks (6) by unscrewing the 4 screws securing each capacitor using a T20-Torx driver.

Reassembly

1. Reinstall the capacitor banks and secure each bank with 2 screws (C3 enclosure) or 4 screws (C4 enclosure). Torque to 3.5 Nm (31 in-lb).
2. Reinstall the CT busbar and tighten the 6 screws to 3.5 Nm (31 in-lb).
3. Secure each of the 2 clamping capacitors with 3 screws. Torque to 3.5 Nm (31 in-lb).
4. Reconnect the DC bus cables to the DC chokes. Torque to 3.5 Nm (31 in-lb).
5. Reconnect the balancing wire (blue) to the IGBT busbar. Torque to 3.5 Nm (31 in-lb).
6. Reinstall the terminal plate and secure with the 4 screws. Torque to 1.5 Nm (13 in-lb).
7. Reinstall the current sensor card.
8. Reinstall the RFI filter.
9. Reinstall the inrush card.
10. Reinstall the power card.
11. Reinstall the control card.
12. Reinstall the front cover.
13. Reinstall the terminal cover.

13.2.10 IGBT Modules

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 13.3*, unless otherwise specified.

1. Remove the terminal cover.
2. Remove the front cover.
3. Remove the control card.
4. Remove the power card.
5. Remove the inrush card.
6. Remove the RFI filter.
7. Remove the current sensor card.
8. Remove the capacitor banks.
9. Remove the IGBT modules (4) by unscrewing the 8 screws (C3 enclosure) or 6 screws (C4 enclosure) using a T20-Torx driver.

Reassembly

1. Apply heat compound to the enclosure surface where the IGBT modules will be mounted.
   - 1a Remove previously applied heat compound areas on the surface without scratching the surface.
   - 1b Spread the new heat compound evenly to the enclosure surface that makes contact with the IGBT modules.
2. Reinstall the IGBTs into the enclosure.
   - For the C3 enclosure:
     - First tighten the screws until the screw head is flush.
     - Initially tighten the 2 screws per IGBT to 1.5 Nm (13 in-lb).
     - Finally, tighten the IGBT to 3.5 Nm (31 in-lb).
   - For the C4 enclosure:
     - First tighten the screws until the screw head is flush.
     - Using a diagonal tightening sequence, initially tighten the 4 screws per IGBT to 1.5 Nm (13 in-lb).
     - Using a diagonal tightening sequence, finish tightening each IGBT to 3.5 Nm (31 in-lb).
3. Reinstall the capacitor banks.
4. Reinstall the current sensor card.
5. Reinstall the RFI filter.
6. Reinstall the inrush card.
7. Reinstall the power card.
8. Reinstall the control card.
9. Reinstall the front cover.
10. Reinstall the terminal cover.

13.2.11 Fan Assembly

Disassembly

For the location of the parts mentioned in these steps, refer to *Illustration 13.2*.

1. Remove the plastic top cover (6) by unscrewing the 4 screws using a T20-Torx driver.
2. Remove the fan from the plastic top cover and lift the fan (7) from its housing.

Reassembly

1. Reinstall the fan into fan housing/plastic top cover.
2. Secure the top cover to the enclosure with 4 screws. Torque to 2.5 Nm (22 in-lb).

14 Technical Specifications

14.1 Fastener Torque Ratings

14.1.1 General Torque Tightening Values

Use a torque wrench to ensure that correct torque is applied. Incorrect torque can cause electrical connection problems. For fastening hardware described in this guide, use the values listed in *Table 14.1* to *Table 14.3*.

NOTICE

TORQUE VALUES

The torque values in the following tables are not intended for SCR, diode, or IGBT fasteners. Refer to the instructions included with those replacement parts for correct values.

Shaft size	Torx/hex drives size	Class A Nm (in-lb)	Class B Nm (in-lb)
M4	T20/7 mm	1.2 (10)	0.8 (7)
M5	T25/8 mm	2.3 (20)	1.2 (10)
M6	T30/10 mm	3.9 (35)	2.3 (20)
M8	T40/13 mm	9.6 (85)	3.9 (35)
M10	T50/17 mm	19.1 (169)	9.6 (85)
M12	–/18 mm or 19 mm	37.9 (335)	–

Table 14.1 Torque Values Standard Thread

Shaft size	Torx drives size	Class A Nm (in-lb)	Class B Nm (in-lb)
M4.8	T25	5.7 (50)	3.1 (27)
M5	T25	1.7 (15)	1.7 (15)

Table 14.2 Torque Values for Thread-cutting into Metal

Shaft size	Torx drives size	Class A Nm (in-lb)	Class B Nm (in-lb)
M4	T20	2.8 (24)	2.8 (24)
M5	T25	5.1 (45)	4.0 (35)

Table 14.3 Torque Values for Thread-forming into Plastic

Class A: *Clamping metal*
Class B: *Clamping PCA or plastic*

14.2 DC Voltage Levels

FC 102/FC 103/FC 202/FC 300	380–480/500 V units		525–690 V units
Inrush circuit enabled [V DC]	370		550
Inrush circuit disabled [V DC]	395		570
Inverter undervoltage disable [V DC]	373		553
Undervoltage warning [V DC]	410		585
Inverter undervoltage re-enable (warning reset) [V DC]	413		602
	380–480 V units	**380–500 V units**	**525–690 V units**
Overvoltage warning (without brake) [V DC]	778	817	1084
Dynamic brake turn on [V DC]	778	810	1099
Inverter overvoltage re-enable (warning reset) [V DC]	786	821	1099
Overvoltage warning (with brake) [V DC]	810	828	1109
Overvoltage trip [V DC]	820	855	1130

Table 14.4 DC Voltage Levels

14.3 Warning and Alarm Trips Points

200–240 V AC	FC 102/ FC 103/ FC 202	P5.5K	P7.5K	P11K	P15K	P18K	–	–	–
	FC 300	**P5.5K**	**P7.5K**	**P11K**	**P15K**	**P18K**	**P22K**	**P30K**	**P37K**
Overcurrent warning	$[A_{rms}]$	–	–	–	–	–	–	–	–
Overcurrent alarm[1] (1.5 s delay)	$[A_{rms}]$	–	–	–	–	–	–	–	–
Earth (ground) fault alarm	$[A_{rms}]$	–	–	–	–	–	–	–	–
Short circuit alarm	$[A_{pk}]$	–	–	–	–	–	–	–	–
Heat sink overtemperature	[°C]	–	–	–	–	–	–	–	–
Heat sink undertemperature warning	[°C]	–	–	–	–	–	–	–	–
Control card overtem-perature	[°C]	–	–	–	–	–	–	–	–
Mains phase warning (30 s delay)	DC bus ripple V_{pkpk}	–	–	–	–	–	–	–	–
Mains phase alarm (60 s delay)	DC bus ripple V_{pkpk}	–	–	–	–	–	–	–	–

Table 14.5 Warning/Alarm Trip Points, B-sized Drives, 200–240 VAC

1) Based on crest factor of 1.414

14

380–480 V AC	FC 102/ FC 103/ FC 202	P11K	P15K	P18K	P22K	P30K	P37K	–	–	–
380–500 V AC	**FC 300**	**P11K**	**P15K**	**P18K**	**P22K**	**P30K**	**P37K**	**P45K**	**P55K**	**P75K**
Overcurrent warning	[A_{rms}]	–	–	–	–	–	–	–	–	–
Overcurrent alarm[1] (1.5 s delay)	[A_{rms}]	–	–	–	–	–	–	–	–	–
Earth (ground) fault alarm	[A_{rms}]	–	–	–	–	–	–	–	–	–
Short circuit alarm	[A_{pk}]	–	–	–	–	–	–	–	–	–
Heat sink overtemperature	[°C]	–	–	–	–	–	–	–	–	–
Heat sink undertemperature warning	[°C]	–	–	–	–	–	–	–	–	–
Control card overtem-perature	[°C]	–	–	–	–	–	–	–	–	–
Mains phase warning (30 s delay)	DC bus ripple V_{pkpk}	–	–	–	–	–	–	–	–	–
Mains phase alarm (60 s delay)	DC bus ripple V_{pkpk}	–	–	–	–	–	–	–	–	–

Table 14.6 Warning/Alarm Trip Points, B-sized Drives, 380–500 VAC

1) Based on crest factor of 1.414

525–600 V AC	FC 102/ FC 103/ FC 202	P11K	P15K	P18K	P22K	P30K	P37K	–	–	–
	FC 300	**P11K**	**P15K**	**P18K**	**P22K**	**P30K**	**P37K**	**P45K**	**P55K**	**P75K**
Overcurrent warning	[A_{rms}]	–	–	–	–	–	–	–	–	–
Overcurrent alarm[1] (1.5 s delay)	[A_{rms}]	–	–	–	–	–	–	–	–	–
Earth (ground) fault alarm	[A_{rms}]	–	–	–	–	–	–	–	–	–
Short circuit alarm	[A_{pk}]	–	–	–	–	–	–	–	–	–
Heat sink overtemperature	[°C]	–	–	–	–	–	–	–	–	–
Heat sink undertemperature warning	[°C]	–	–	–	–	–	–	–	–	–
Control card overtem-perature	[°C]	–	–	–	–	–	–	–	–	–
Mains phase warning (30 s delay)	DC bus ripple V_{pkpk}	–	–	–	–	–	–	–	–	–
Mains phase alarm (60 s delay)	DC bus ripple V_{pkpk}	–	–	–	–	–	–	–	–	–

Table 14.7 Warning and Alarm Trip Points, B-sized Drives, 525–600 VAC

1) Based on crest factor of 1.414

525–690 V AC	FC 102/ FC 103/ FC 202	P11K	P15K	P18K	P22K	P30K	P37K	–	–	–
	FC 300	P11K	P15K	P18K	P22K	P30K	P37K	P45K	P55K	P75K
Overcurrent warning	[A_{rms}]	–	–	–	–	–	–	–	–	–
Overcurrent alarm1) (1.5 s delay)	[A_{rms}]	–	–	–	–	–	–	–	–	–
Earth (ground) fault alarm	[A_{rms}]	–	–	–	–	–	–	–	–	–
Short circuit alarm	[A_{pk}]	–	–	–	–	–	–	–	–	–
Heat sink overtemperature	[°C]	–	–	–	–	–	–	–	–	–
Heat sink undertemperature warning	[°C]	–	–	–	–	–	–	–	–	–
Control card overtem-perature	[°C]	–	–	–	–	–	–	–	–	–
Mains phase warning (30 s delay)	DC bus ripple V_{pkpk}	–	–	–	–	–	–	–	–	–
Mains phase alarm (60 s delay)	DC bus ripple V_{pkpk}	–	–	–	–	–	–	–	–	–

Table 14.8 Warning and Alarm Trip Points, B-sized Drives, 525–690 VAC

1) Based on crest factor of 1.414

200–240 V AC	FC 102/ FC 103/ FC 202	P18K	P22K	P30K	P37K	P45K
	FC 300	P15K	P18K	P22K	P30K	P37K
Overcurrent warning	[A_{rms}]	–	–	–	–	–
Overcurrent alarm1) (1.5 s delay)	[A_{rms}]	–	–	–	–	–
Earth (ground) fault alarm	[A_{rms}]	–	–	–	–	–
Short circuit alarm	[A_{pk}]	–	–	–	–	–
Heat sink overtemperature	[°C]	–	–	–	–	–
Heat sink undertemperature warning	[°C]	–	–	–	–	–
Control card overtemperature	[°C]	–	–	–	–	–
Mains phase warning (30 s delay)	DC bus ripple V_{pkpk}	–	–	–	–	–
Mains phase alarm (60 s delay)	DC bus ripple V_{pkpk}	–	–	–	–	–

Table 14.9 Warning/Alarm Trip Points, C-sized Drives, 200–240 VAC

1) Based on crest factor of 1.414

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380–480 V AC	FC 102/ FC 103/ FC 202	P37K	P45K	P55K	P75K	P90K
380–500 V AC	FC 300	P30K	P37K	P45K	P55K	P75K
Overcurrent warning	[A_{rms}]	–	–	–	–	–
Overcurrent alarm1) (1.5 s delay)	[A_{rms}]	–	–	–	–	–
Earth (ground) fault alarm	[A_{rms}]	–	–	–	–	–
Short circuit alarm	[A_{pk}]	–	–	–	–	–
Heat sink overtemperature	[°C]	–	–	–	–	–
Heat sink undertemperature warning	[°C]	–	–	–	–	–
Control card overtemperature	[°C]	–	–	–	–	–
Mains phase warning (30 s delay)	DC bus ripple V_{pkpk}	–	–	–	–	–
Mains phase alarm (60 s delay)	DC bus ripple V_{pkpk}	–	–	–	–	–

Table 14.10 Warning/Alarm Trip Points, C-sized Drives, 380–500 VAC

1) Based on crest factor of 1.414

525–600 V AC	FC 102/ FC 103/ FC 202	P37K	P45K	P55K	P75K	P90K
	FC 300	P30K	P37K	P45K	P55K	P75K
Overcurrent warning	[A_{rms}]	–	–	–	–	–
Overcurrent alarm[1] (1.5 s delay)	[A_{rms}]	–	–	–	–	–
Earth (ground) fault alarm	[A_{rms}]	–	–	–	–	–
Short circuit alarm	[A_{pk}]	–	–	–	–	–
Heat sink overtemperature	[°C]	–	–	–	–	–
Heat sink undertemperature warning	[°C]	–	–	–	–	–
Control card overtemperature	[°C]	–	–	–	–	–
Mains phase warning (30 s delay)	DC bus ripple V_{pkpk}	–	–	–	–	–
Mains phase alarm (60 s delay)	DC bus ripple V_{pkpk}	–	–	–	–	–

Table 14.11 Warning and Alarm Trip Points, C-sized Drives, 525–600 VAC

1) Based on crest factor of 1.414

525–690 V AC	FC 102/ FC 103/ FC 202	P37K	P45K	P55K	P75K	P90K
	FC 300	P30K	P37K	P45K	P55K	P75K
Overcurrent warning	[A_{rms}]	–	–	–	–	–
Overcurrent alarm[1] (1.5 s delay)	[A_{rms}]	–	–	–	–	–
Earth (ground) fault alarm	[A_{rms}]	–	–	–	–	–
Short circuit alarm	[A_{pk}]	–	–	–	–	–
Heat sink overtemperature	[°C]	–	–	–	–	–
Heat sink undertemperature warning	[°C]	–	–	–	–	–
Control card overtemperature	[°C]	–	–	–	–	–
Mains phase warning (30 s delay)	DC bus ripple V_{pkpk}	–	–	–	–	–
Mains phase alarm (60 s delay)	DC bus ripple V_{pkpk}	–	–	–	–	–

Table 14.12 Warning and Alarm Trip Points, C-sized Drives, 525–690 VAC

1) Based on crest factor of 1.414

15 Block Diagrams

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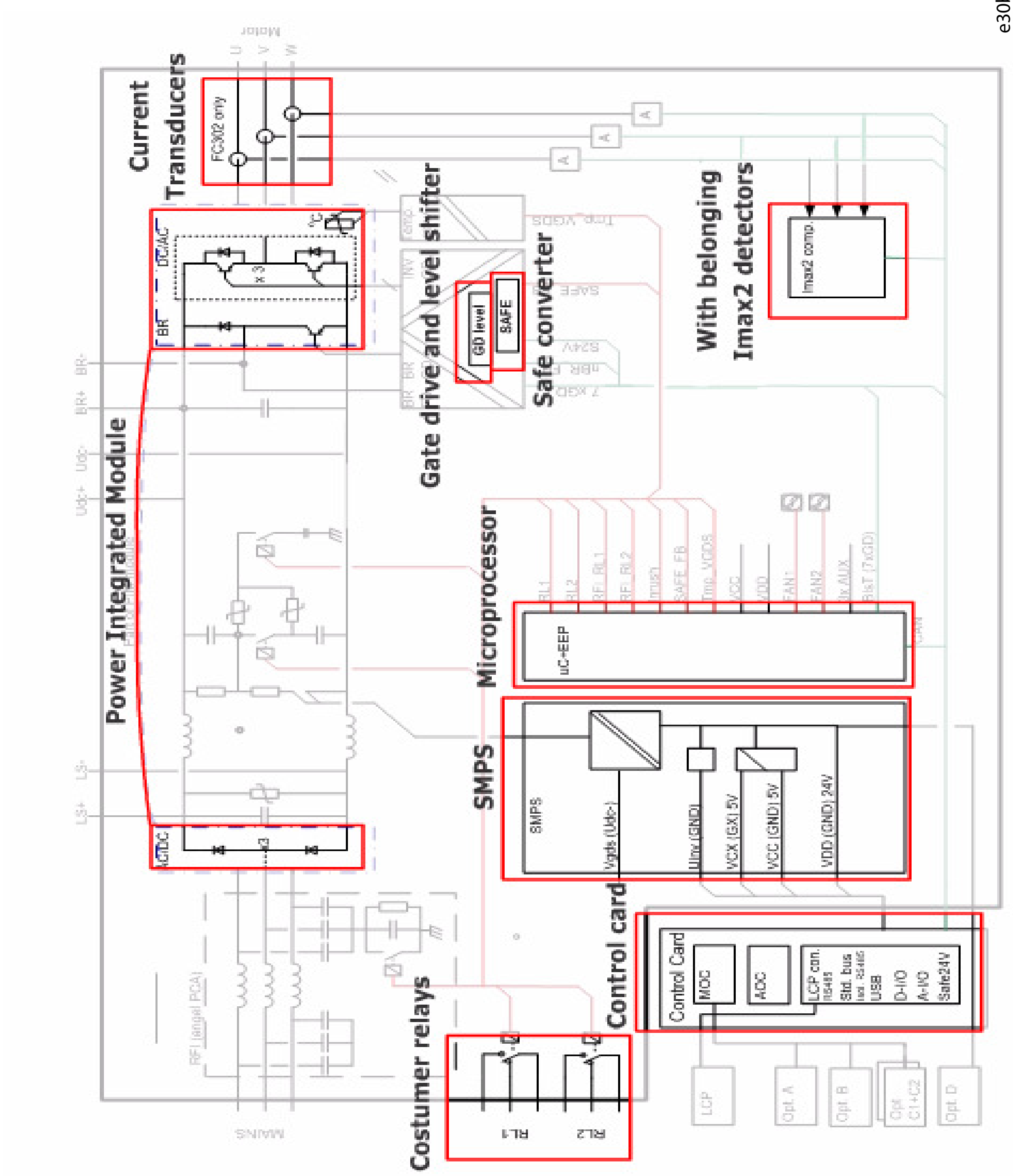

Illustration 15.1 Electrical Block Diagram for Enclosures B1 and B2

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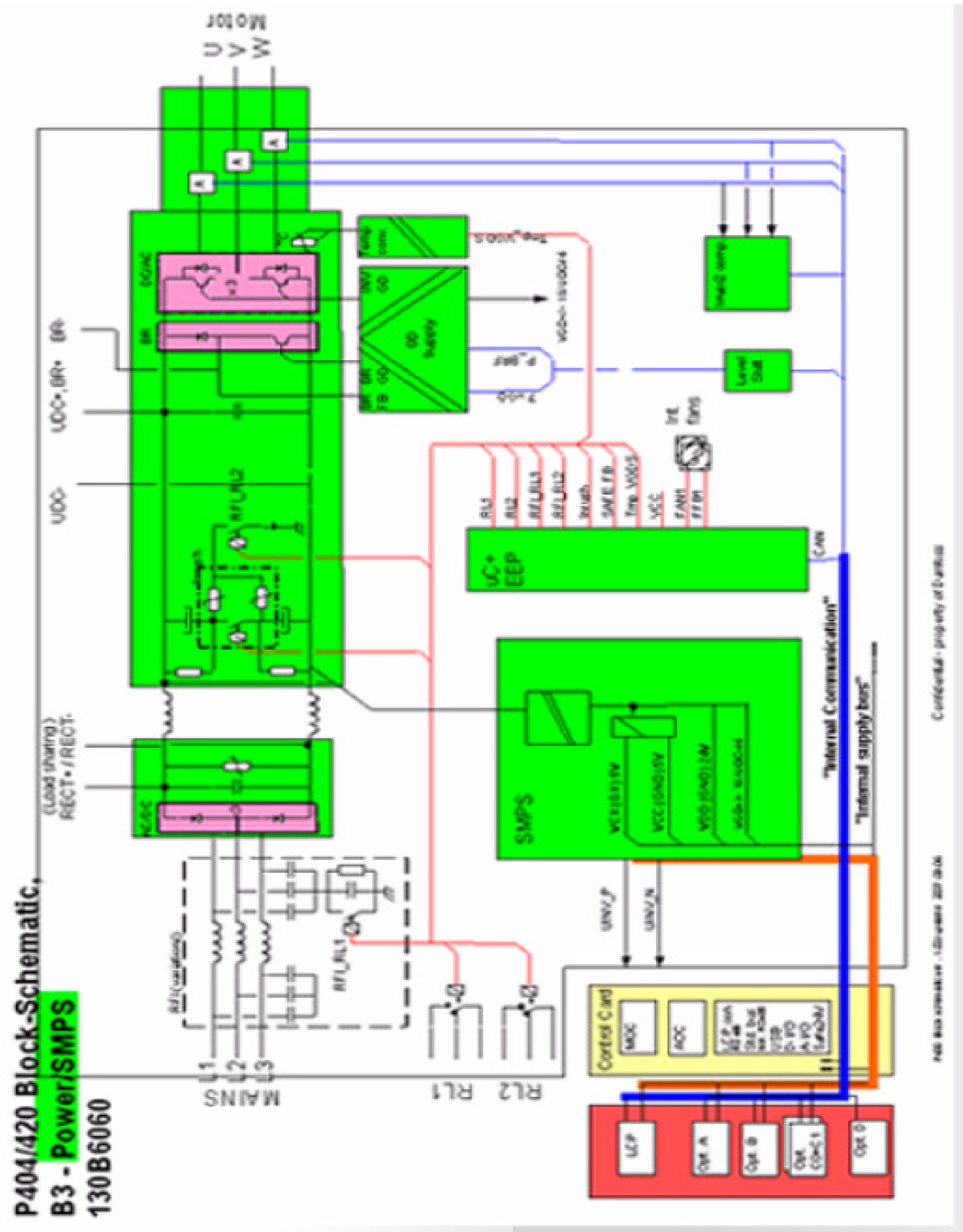

Illustration 15.2 Electrical Block Diagram for Enclosure B3

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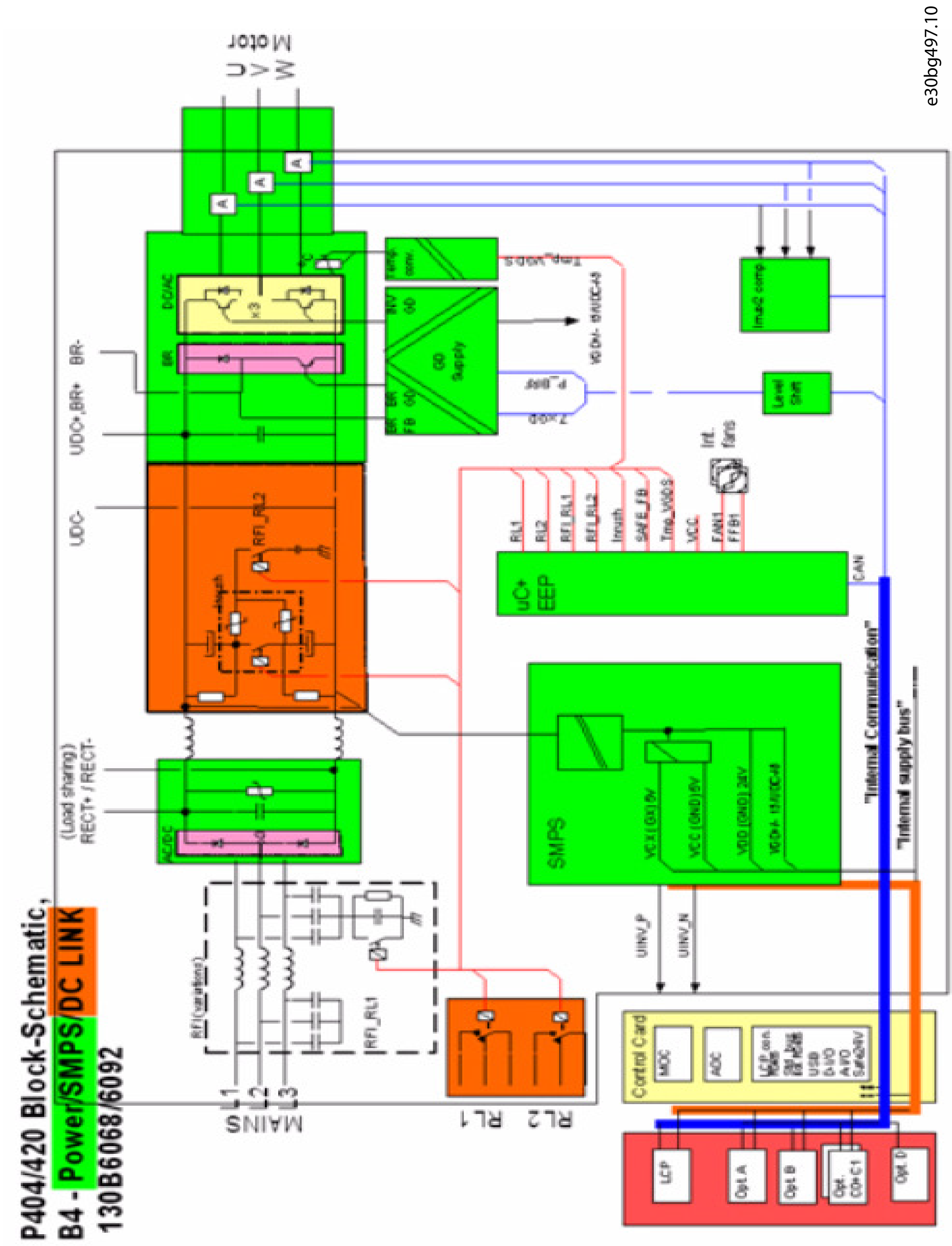

Illustration 15.3 Electrical Block Diagram for Enclosure B4

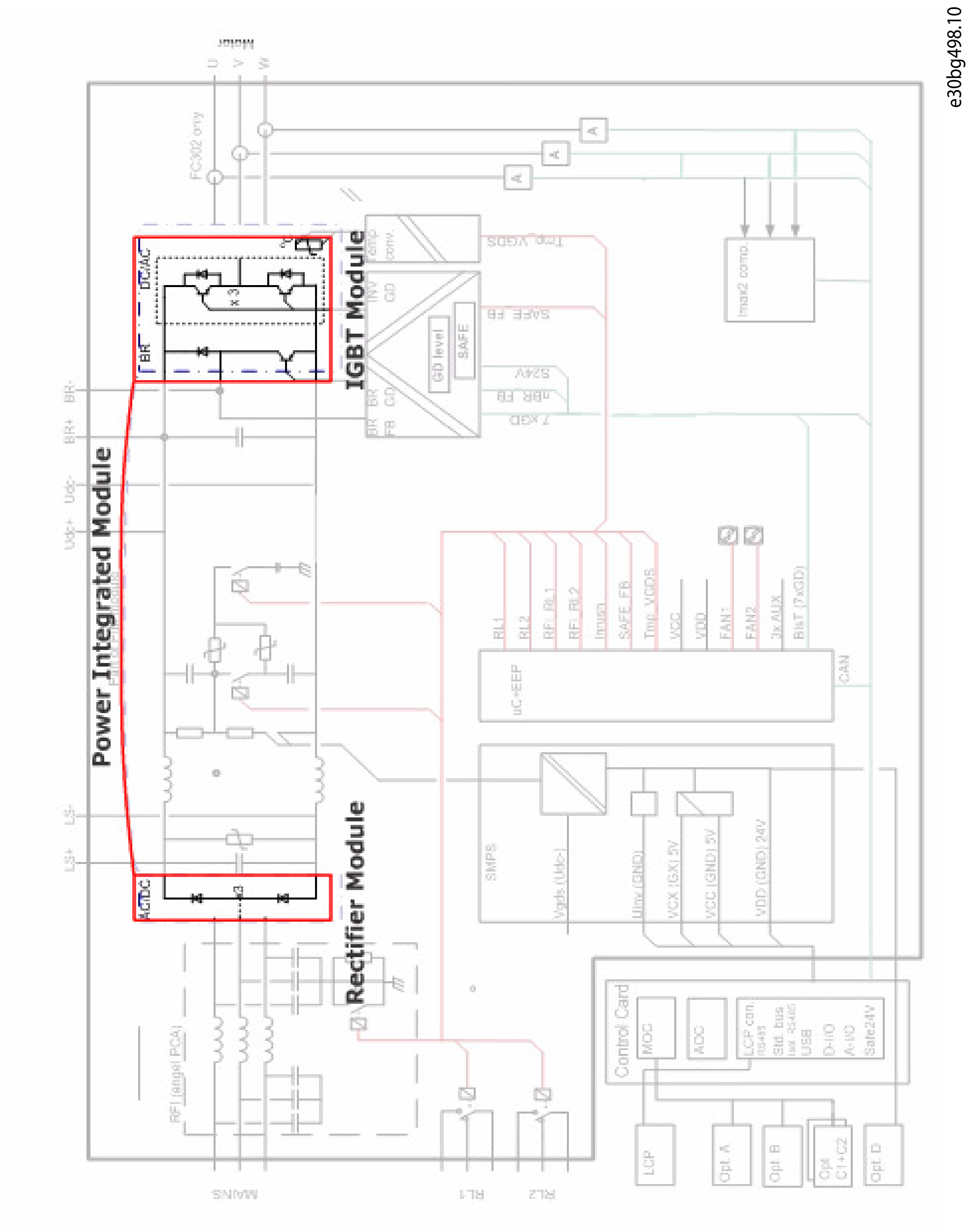

Illustration 15.4 Electrical Block Diagram for Enclosures C1 and C2

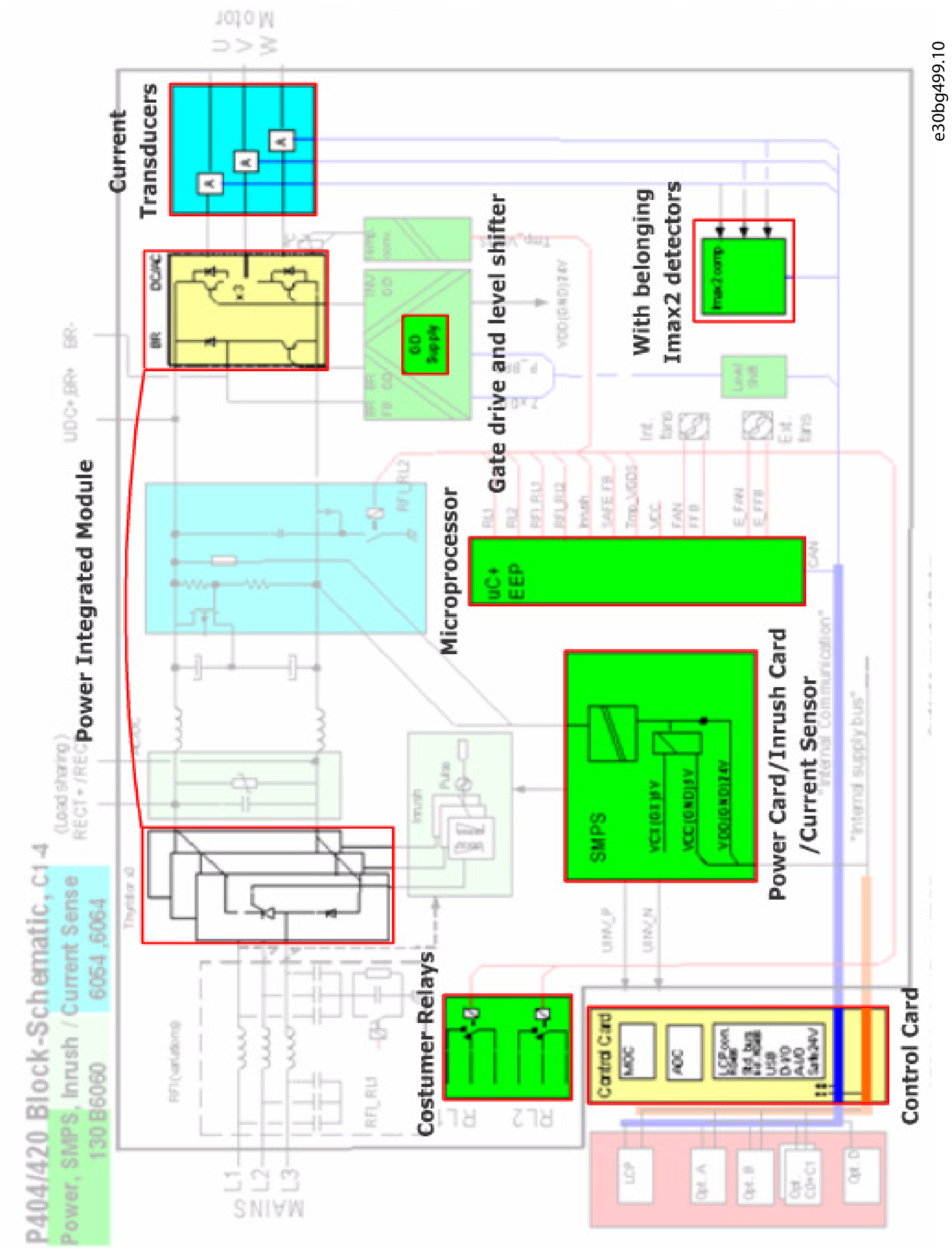

Illustration 15.5 Electrical Block Diagram for Enclosures C3 and C4

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