Allen-Bradley

Bulletin 1336 PLUS
Adjustable Frequency
AC Drive
Series A, B, C, D

A040 – A060
B060 – B125, BX150
C075 – C125

Troubleshooting Guide

Important User Information

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage or economic loss.

Attentions help you:

- Identify a hazard.
- Avoid the hazard.
- Recognize the consequences.

IMPORTANT: Identifies information that is especially important for successful application and understanding of the product.

DANGER labels may be located on or inside the drive to alert people that dangerous voltage may be present.

The information below summarizes the changes to the company-wide templates since the last release.

Updated Information

Information has been added to Overtemp Fault 08 in Table 2.A on page 2-6.

Information has been added to Test 3, Testing the Power Modules, beginning on page 4-7.

Rating information has been changed in Table 2 on page S-5.

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Preface

Control Logic Wiring and Adapters

Chapter 1

Troubleshooting and Error Codes

Chapter 2

Disassembly and Access Procedures

Chapter 3

Preface

Manual Objective

The information in this manual is designed to help troubleshoot or repair an Allen-Bradley Bulletin 1336 PLUS Adjustable Frequency AC Drive with ratings A040 – A060, B060 – B125, BX150, and C075 – C125.

Who Should Use This Manual

This manual is intended for qualified service personnel responsible for troubleshooting and repairing the 1336 PLUS Adjustable Frequency AC Drive. You should:

- Read this entire manual before performing maintenance or repairs to drives.
- Have previous experience with, and basic understanding of, electrical terminology, procedures, required troubleshooting equipment, equipment protection procedures and methods, and safety precautions.

This manual describes equipment, troubleshooting, and disassembly procedures. You begin with general illustrations and end with greater detail concerning replacement parts and part locations on the drives. Later chapters may refer you back to earlier chapters for information on basic equipment and steps necessary to perform detailed diagnostics and part replacement.

Safety Precautions

ATTENTION: Some printed circuit boards and drive components may contain hazardous voltage levels. Remove and lock out power before you disconnect or reconnect wires, and before you remove or replace fuses and circuit boards. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Hazard of electric shock exists. Up to 1,000V DC may be present on Snubber Capacitors. Measure for zero (0)V DC across capacitors C2, C3, and C4. Use a resistor greater than 1ohm and less than 100 ohm, rated for 25 watts minimum to discharge any voltage. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board.

ATTENTION: Potentially fatal voltages may result from improper usage of oscilloscope and other test equipment. The oscilloscope chassis may be at a potentially fatal voltage if not properly grounded. If an oscilloscope is used to measure high voltage waveforms, use only a dual channel oscilloscope in the differential mode with X 100 probes. It is recommended that the oscilloscope be used in the A minus B Quasi-differential mode with the oscilloscope chassis correctly grounded to an earth ground.

ATTENTION: Only personnel familiar with the 1336 PLUS Adjustable Frequency AC Drive and associated machinery should plan or implement the installation, start-up and subsequent maintenance of the system. Failure to comply may result in personal injury and/or equipment damage.

Electrostatic Discharge Precautions

ATTENTION: This assembly contains parts and sub-assemblies that are sensitive to electrostatic discharge. Static control precautions are required when servicing this assembly. Component damage may result if you ignore electrostatic discharge control procedures. If you are not familiar with static control procedures, reference Allen-Bradley Publication 8000-4.5.2, Guarding Against Electrostatic Damage, or any other applicable ESD protection handbook.

Electrostatic discharge generated by static electricity can damage the complimentary metallic oxide semiconductor devices on various drive boards. It is recommended that you perform these procedures to guard against this type of damage when circuit boards are removed or installed:

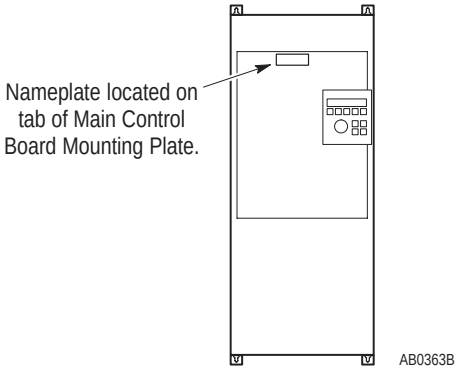
- Wear a wrist type grounding strap that is grounded to the drive chassis.
- Attach the wrist strap before removing the new circuit board from the conductive packet.
- Remove boards from the drive and immediately insert them into their conductive packets.

1336 PLUS
Product Identification

Drive Nameplate Location

The drive nameplate is located on the face of the Main Control Board Mounting Plate. The drive nameplate contains the drive's catalog number and other important drive information. Reference the catalog number when ordering replacement parts.

Figure 1.1
Drive Nameplate Location



Software Compatibility

ATTENTION: To guard against machine damage and/or personal injury, drives with ratings above 45 kW (60 HP) must not be used with software versions below 1.07. Refer to the table below.

Three-Phase Drive Rating [1]

200–240V	380–480V	500–600V	Compatible with Version	Frame Reference
30 – 45 kW 40 – 60 HP	45, 75, 94, 112 kW 60, 100, 125, 150 HP	56 – 93 kW 75 – 125 HP	2.01 & Up	D
—	81 kW 75 HP	—	2.04 & Up	D

[1] kW and HP are constant torque (CT) ratings.

Drive and Option Identification

The following is an explanation of the catalog numbering system for 1336 PLUS Adjustable Frequency AC Drives and options. The catalog number is coded to identify the drive power rating and can be found on the drive shipping carton and nameplate.

1336 PLUS Drive Catalog Numbers

Table 1.A

1336S	– A040-AA	– EN	– L6	– HA1	– GM1
BULLETIN NO.	RATING-ENCLOSURE (MUST BE SPECIFIED)	LANGUAGE MODULE [4] (MUST BE SPECIFIED)	CONTROL INTERFACE [4] (OPTIONAL)	HUMAN INTERFACE [4] (OPTIONAL)	COMMUNICATION CARD [4] (OPTIONAL)

200 – 240V AC Input, Constant or Variable Torque Drive

Drive Rating [1]					Enclosures			
					Open IP00 No Enclosure	NEMA Type 1 IP20 General Purpose	NEMA Type 4 IP56 Resist Water, Dust	NEMA Type 12 IP54 Industrial Use
Frame Designation	Constant Torque		Variable Torque [3]					
D	Output Amps	Nominal HP	Output Amps	Nominal HP	Code	Code	Code	Code
	120.0	40	120.0	40	A040–AN	A040–AA	[2]	[2]
	150.0	50	150.0	50	A050–AN	A050–AA	[2]	[2]
	180.0	60	180.0	60	A060–AN	A060–AA	[2]	[2]

Table 1.B

1336S	– B060-AA	– EN	– L6	– HA1	– GM1
BULLETIN NO.	RATING-ENCLOSURE (MUST BE SPECIFIED)	LANGUAGE MODULE[4] (MUST BE SPECIFIED)	CONTROL INTERFACE[4] (OPTIONAL)	HUMAN INTERFACE[4] (OPTIONAL)	COMMUNICATION CARD[4] (OPTIONAL)

380 – 480V AC Input, Constant or Variable Torque Drive

Drive Rating[1]				Enclosures			
				Open IP00 No Enclosure	NEMA Type 1 IP20 General Purpose	NEMA Type 4 IP56 Resist Water, Dust	NEMA Type 12 IP54 Industrial Use
Frame Designation	Constant Torque		Variable Torque[3]				
D	Output Amps	Nominal HP	Output Amps	Nominal HP	Code	Code	Code	Code
	85.0	60	96.0	75	B060–AN	B060–AA	[2]	[2]
	106.0	75	120.0	100	B075–AN	B075–AA	[2]	[2]
	138.0	100	150.0	125	B100–AN	B100–AA	[2]	[2]
	173.0	125	180.0	150	B125–AN	B125–AA	[2]	[2]
	180.0	150	180.0	150	BX150–AN	BX150–AA	[2]	[2]

Table 1.C

1336S	– C075-AA	– EN	– L6	– HA1	– GM1
BULLETIN NO.	RATING-ENCLOSURE (MUST BE SPECIFIED)	LANGUAGE MODULE[4] (MUST BE SPECIFIED)	CONTROL INTERFACE[4] (OPTIONAL)	HUMAN INTERFACE[4] (OPTIONAL)	COMMUNICATION CARD[4] (OPTIONAL)

500 – 600V AC Input, Constant or Variable Torque Drive

Drive Rating[1]				Enclosures			
				Open IP00 No Enclosure	NEMA Type 1 IP20 General Purpose	NEMA Type 4 IP56 Resist Water, Dust	NEMA Type 12 IP54 Industrial Use
Frame Designation	Output Amps	Nominal HP– CT	Nominal HP– VT	Code	Code	Code	Code
D	85.0	75	75	C075–AN	C075–AA	[2]	[2]
	109.0	100	100	C100–AN	C100–AA	[2]	[2]
	138.0	125	125	C125–AN	C125–AA	[2]	[2]

Table 1.D

Language Modules

Description	Option Code
English/English	EN
English/French	FR
English/German	DE
English/Italian	IT
English/Japanese	JP
English/Spanish	ES

Table 1.E

Options

Code	Description
Human Interface Modules, NEMA Type 1 (IP 20)	
HAB	Blank – No Functionality
HAP	Programmer Only
HA1	Programmer, LCD/Analog Pot
HA2	Programmer, LCD/Digital Pot
Human Interface Modules, NEMA Type 4 (IP 56)	
HFB	Blank – No Functionality
HFP	Programmer Only
HF1	Programmer, LCD/Analog Pot
HF2	Programmer, LCD/Digital Pot
Human Interface Modules, NEMA Type 12 (IP 54)	
HJB	Blank – No Functionality
HJP	Programmer Only
HJ1	Programmer, LCD/Analog Pot
HJ2	Programmer, LCD/Digital Pot

Code	Description
Communication Options	
GM1	Single Point Remote I/O
GM2	RS-232/422/485, DF1
GM3	RS-232/422/485, DH485
Control Interface Options	
L4	TTL Contacts
L4E	Contacts & Encoder Feedback
L5	24V DC
L5E	24V DC & Encoder Feedback
L6	115V AC
L6E	115V AC & Encoder Feedback

[1] Drive rating is based on a carrier frequency of 4kHz maximum, an altitude of 1,000 meters or less, and a maximum ambient temperature of 40°C. Refer to Qualifications on page P-8.

[2] Not available.

[3] VT Ratings do not apply to 380V Input.

[4] Refer to the Language Module and Options tables following these Catalog Number tables.

Table 1.F
200 – 240 Drives

Catalog Number	Maximum Amp Rating	Derate Curve[1][2]	Heat Dissipation Drive Watts[2][3]	Heat Sink Watts	Total Watts
A040	120	[4]	[4]	[4]	[4]
A050	150	[4]	[4]	[4]	[4]
A060	180	[4]	[4]	[4]	[4]

Table 1.G
380 – 480V Drives

Catalog Number	Maximum Amp Rating	Derate Curve[1][2]	Heat Dissipation Drive Watts[2][3]	Heat Sink Watts	Total Watts
B060	85	[4]	[4]	[4]	[4]
B075	106	[4]	[4]	[4]	[4]
B100	138	[4]	[4]	[4]	[4]
B125	173	[4]	[4]	[4]	[4]
BX150	180	[4]	[4]	[4]	[4]

Table 1.H
500 – 600V Drives

Catalog Number	Maximum Amp Rating	Derate Curve[1][2]	Heat Dissipation Drive Watts[2][3]	Heat Sink Watts	Total Watts
C075	85	[4]	[4]	[4]	[4]
C100	109	[4]	[4]	[4]	[4]
C125	138	[4]	[4]	[4]	[4]

[1] Amp Rating is at 4kHz. If carrier frequencies above 4kHz are selected, drive Amp Rating must be derated.

[2] Drive Ambient Temperature Rating is 40°C. If ambient exceeds 40°C, the drive must be derated.

[3] Drive Rating is based on altitudes of 1,000m (3,000 ft) or less. If installed at higher altitude, drive must be derated.

[4] Refer to the 1336 PLUS User Manual, Appendix A.

Drive Rating Qualifications

Several factors can affect drive rating. If more than one factor exists, derating percentages must be multiplied. For example, if a 14-amp drive is installed at a 2km (6,600 ft.) altitude and has a 2% high-input line voltage, the actual amp rating is:
14 x 94% altitude derating x 96% high-input line derating = 12.6 amps

Note: Calculate the drive rating using the amp rating of your drive.

Enclosure Type

The first character, A, indicates the Enclosure Code.

The second character indicates the type of enclosure shipped from the factory:

Table 1.I
Enclosure Type Code Description

Enclosure Type Code	Description
N	Open style (IP 00)
A	NEMA Type 1 (IP 20)
F	NEMA Type 4 (IP 56)
J	NEMA Type 12 (IP 54)

Conventions

To help differentiate parameter names and display text from other text in this manual, the following conventions will be used:

- Parameter Names will appear in [brackets].
- Display Text will appear in “quotes”.

The following is a list of conventions used throughout this manual, and definitions of the conventions. For a list of terminology and definitions, refer to the Glossary in the back of this manual.

Auxiliary Input

The Auxiliary Input is a terminal connection on the Control Interface Board. This connection provides an external input for use as an Auxiliary Interlock. Unless this interlock is closed, the drive will be faulted with an Auxiliary Fault.

Auxiliary Interlock

The Auxiliary Interlock is a user supplied circuit consisting of reset, overload, or other interlocking circuitry. The Interlock is wired to the drive Auxiliary input.

Bit

A bit is a single character or status point used in programmable logic. Eight bits form a BYTE, 16 bits form a word. Drive parameters are actually eight bits or 16 bit words.

Check

To check means to examine either the physical condition of something or the setting of some control, such as a Parameter. Checking a drive board or component may also require measurements and tests.

Connector

A connector connects one drive board to another. Connectors come in two designs, male and female. Male connectors are stationary and contain pins, which are sometimes joined by jumpers. Female connectors are at the ends of wires or ribbon cables and plug into male connectors.

Default

When a drive function defaults, it automatically changes to a pre-programmed setting.

Enable Input

The Enable Input is a terminal connection on the Control Interface Board. This connection provides an external input to enable or disable the Drive Output section. It must be true to permit the drive to operate.

False

False refers to a logical false state. For instance, a Control Interface signal on TB3 is false when the input contact is open or the appropriate voltage is not applied to the Control Interface Board.

Jumper

A jumper completes a circuit between two pins within a male connector on a drive board. In the absence of certain optional equipment using female connectors, jumpers are applied to certain pins within a male connector to complete specific and necessary circuits.

Control Interface Board

A Control Interface Board plugs into connectors J7 and J9, located on the lower portion of the Main Control Board. This board is identified as L4/4E, L5/5E or L6/6E and provides optional control wiring configurations for a drive.

Parameter

Parameters are programmable drive functions that define various operating functions or status displays of a drive. Refer to Bulletin 1336 PLUS Adjustable Frequency AC Drive User Manual for Parameter details.

Press

Press a button on the Human Interface Module to change Parameter settings and drive functions.

True

True refers to a logical true state. For instance, a Control Interface signal on TB3 is true when: L4/L4E contact input is closed, L5/L5E input terminal registers 24V, or L6/L6E input terminal registers 115V AC.

Related Publications

The following lists other Allen-Bradley publications that apply to the 1336 PLUS Adjustable Frequency AC Drives with ratings A040 – A060, B060 – B125, BX150, and C075 – C125:

- Product Data (1336 PLUS-1.0)
- User Manual (1336 PLUS-5.0)
- Option Manuals/Instructions
- Renewal Parts List (1336-6.5)

Chapter 1

Control Logic Wiring and Adapters

Chapter Objectives

This chapter introduces you to terminal block locations and wiring, and adapter locations and functions.

Chapter Overview

This chapter illustrates and describes:

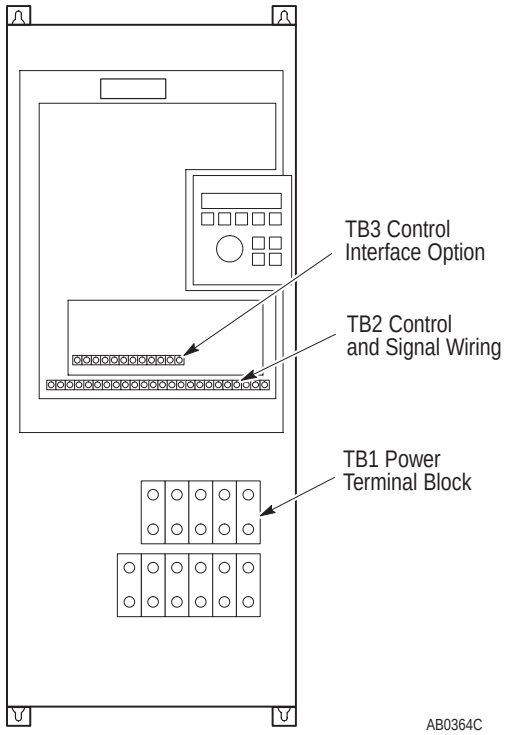
- Control Logic Interface Options L4, L5, and L6, including Terminal Block TB3
- TB3 input mode selections and functions
- TB3 terminal designations

IMPORTANT: All printed circuit boards, except the Main Control Board assembly, are referenced to negative ground (–bus).

ATTENTION: Some printed circuit boards and drive components may contain hazardous voltage levels. Remove power before you disconnect or reconnect wires, and before you remove or replace fuses and circuit boards. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: This assembly contains parts and sub-assemblies that are sensitive to electrostatic discharge. Static control precautions are required when servicing this assembly. Component damage may result if you ignore electrostatic discharge control procedures. If you are not familiar with static control procedures, reference Allen-Bradley Publication 8000-4.5.2, Guarding Against Electrostatic Discharge, or any other applicable ESD protection handbook.

Figure 1.1
Terminal Block Locations



ATTENTION: The National Electrical Code (NEC) and local codes outline provisions for safely installing electrical equipment. Installation must comply with specifications regarding wire types, conductor sizes, branch circuit protection and disconnect devices. Failure to do so may result in personal injury and/or equipment damage.

Control Interface Option

The Control Interface Option provides a means of interfacing various signals and commands to the 1336 PLUS by using contact closures.

Six different versions of the option are available:

L4	Contact Closure Interface[1]
L4E	Contact Closure Interface with Encoder Feedback Inputs[1]
L5	+24V AC/DC Interface
L5E	+24V AC/DC Interface with Encoder Feedback Inputs
L6	115V AC Interface
L6E	115V AC Interface with Encoder Feedback Inputs

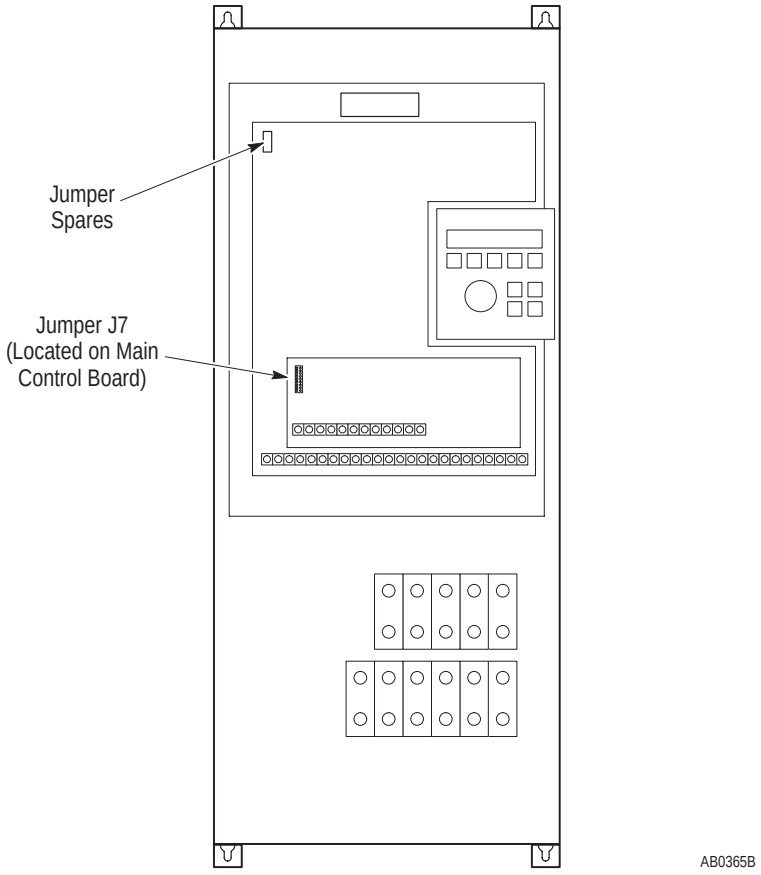
[1] Uses internal +5V DC supply.

The user inputs are connected to the option board through TB3. The L4, L5 and L6 options each have nine control inputs. The function of each input must be selected through programming as explained later in this section. The L4E, L5E and L6E options are similar to L4, L5 and L6 with the addition of encoder feedback inputs.

Control Interface Board Jumpers

IMPORTANT: If the Control Interface Board is being installed, Main Control Board jumpers at pins 3 & 4 and 17 & 18 of J4 (J7 on 7.5 HP and larger drives) must be removed. If removed, these jumpers can be stored on the "spares" location on the Main Control Board. If this board is removed, these jumpers must be reinstalled and the [Input Mode] parameter must be programmed to "1".

Figure 1.2
Jumper Locations



Available Inputs

A variety of combinations made up of the following inputs are available.

Start	Enable
Stop/Clear Fault	Auxiliary
Reverse	2 Stop Mode Selects
Digital Potentiometer (MOP)	Run Forward
2 Accel/Decel Rates	Run Reverse
3 Speed Selects	Local Control

The available combinations are shown in Figure 1.2. Programming the [Input Mode] parameter to one of the Input Mode numbers listed selects that combination of input functions.

IMPORTANT: The [Input Mode] parameter can be changed at any time, however, programming changes will not take affect until power has been cycled to the drive. When changing an input mode, it is important to note that the corresponding inputs to TB3 may also change.

The programming options of the Control Interface Option allow the user to select an input combination to meet the needs of a specific installation. Appropriate selection of a combination may be done by using Table 1.A. First determine the type of start/stop/direction control desired. Then select the remaining control functions available. After selecting a group of Input Modes use Figure 1.4 for specific mode selection. Record the selected mode number below.

Selected Mode Number:_____

Local Programming

For local programming and control information, refer to the 1336 PLUS User Manual.

Table 1.A
Input Mode Selection

Start/Stop Type	Direction Control	Communication Compatibility	Mode(s) to Use
Stop & Enable Only	None	Control must be provided by HIM or Communication Option.	1
Momentary Pushbutton (3 Wire)	Maintained Switch (Open-Forward, Closed-Reverse)	Start/Stop – works in parallel with HIM and Communication Options. Direction Control will not work in parallel with HIM or Communication Options. User must select direction control from either HIM and Communication Options or TB3 input.	2–6
Momentary Pushbutton (3 Wire)	Momentary Pushbuttons (Forward and Reverse)	Start/Stop – works in parallel with HIM and Communication Options. Direction – works in parallel with HIM or Communication Options.	7–11
Maintained switches for combined run and direction control (2 wire, Run Forward, Run Reverse)		Start/Stop – not compatible with HIM or Communication Options. Direction – not compatible with HIM or Communication Options.	12–16

The maximum and minimum wire sizes accepted by TB3 is 2.1 and 0.30 mm^2 (14 and 22 AWG). Maximum torque for all terminals is 0.9 – 1.13 N-m (8 – 10 in.-lb).

Figure 1.3
TB3 Terminal Designations L4E, L5E, and L6E Only

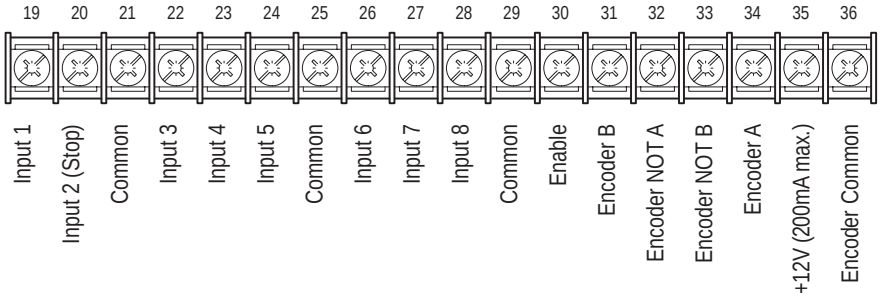


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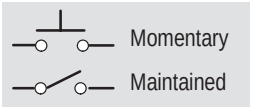
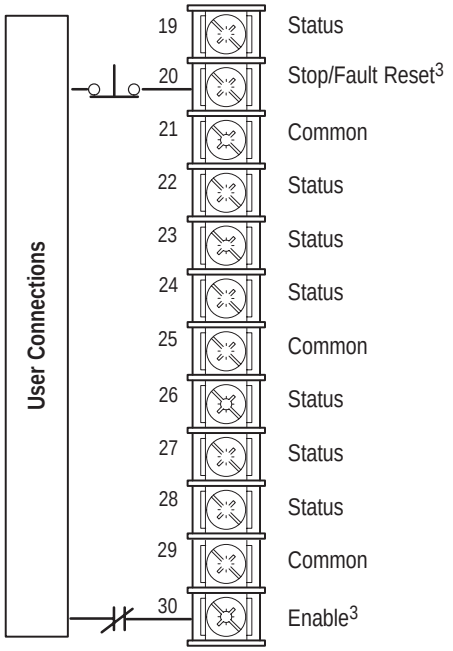
Figure 1.4
Input Mode Selection and Typical TB3 Connections



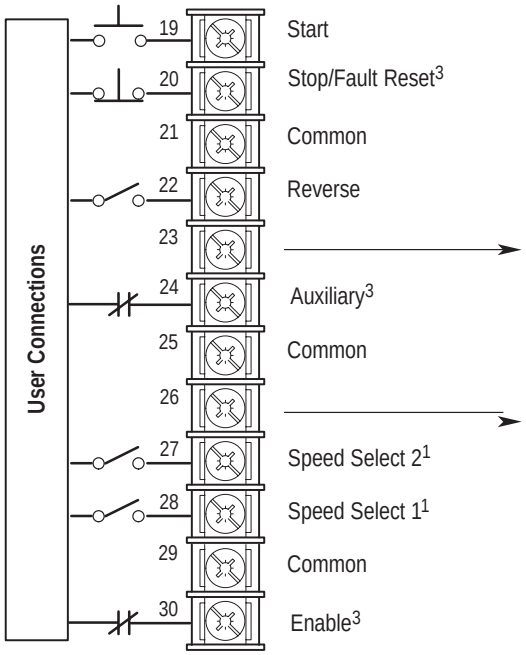
[Input Mode] 1
Factory Default



Note: If this mode is selected, the status of all inputs can be read at the [Input Status] parameter. However, only "Stop/Fault Reset" and "Enable" will have control function.

[Input Mode] 2 – 6
Three-Wire Control with Single-Source Reversing

ATTENTION: The JOG function will not operate properly unless a SCANport option is connected to the drive. To assure proper JOG function, install at least one of the following:
1201-HAP, 1201-HA1, 1201-HA2, 1336-GM1. Applies to 1305 with firmware FRN 2.01 or earlier and 1336 PLUS with Language Module 1336S-EN firmware FRN 1.05 or earlier.



Mode	2	3	4	5	6
	Jog	Stop Type	2nd Accel	Digital Pot Up	Jog
	Speed Select 3[1]	Speed Select 3[1]	2nd Decel	Digital Pot Dn	Local Control[2]

1 See Table 1.B.

2 Drive must be stopped to take Local Control. Control by all other adapters is disabled (except Stop).

3 These inputs must be present before drive will start.

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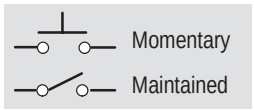
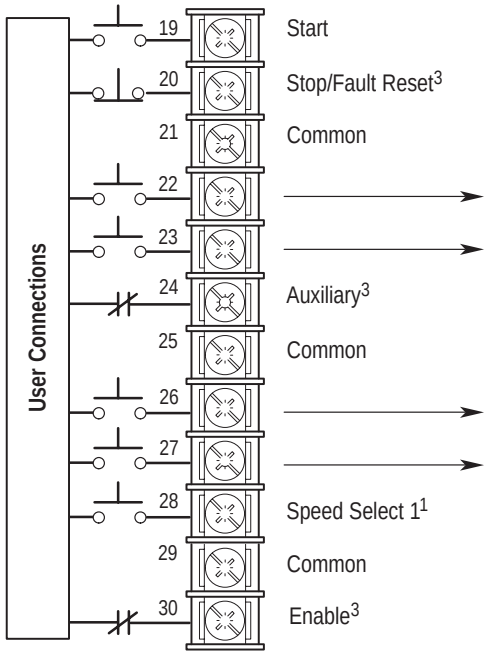
Figure 1.4 *(continued)*
Input Mode Selection and Typical TB3 Connections



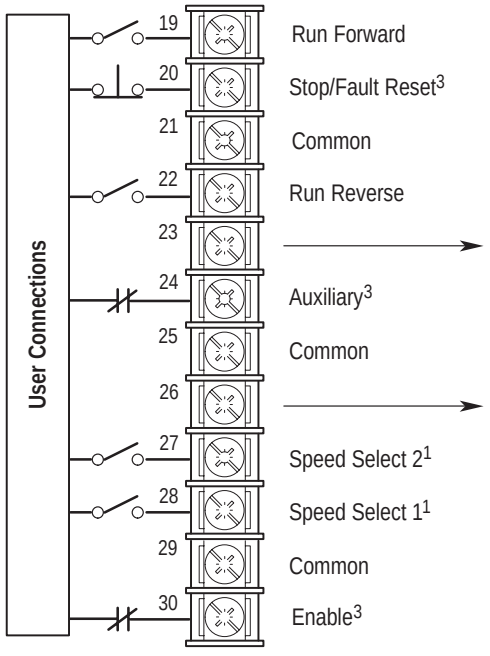
ATTENTION: The JOG function will not operate properly unless a SCANport option is connected to the drive. To assure proper JOG function, install at least one of the following:
1201-HAP, 1201-HA1, 1201-HA2, 1336-GM1. Applies to 1305 with firmware FRN 2.01 or earlier and 1336 PLUS with Language Module 1336S-EN firmware FRN 1.05 or earlier.

[Input Mode] 7 – 11
Three-Wire Control with Multi-Source Reversing



	Mode				
	7	8	9	10	11
22	Reverse	Reverse	Digital Pot Up	Reverse	1st Accel
23	Forward	Forward	Digital Pot Dn	Forward	2nd Accel
26	Jog	Speed Select 31	Speed Select 31	Digital Pot Up	1st Decel
27	Speed Select 21	Speed Select 21	Speed Select 21	Digital Pot Dn	2nd Decel

[Input Mode] 12 – 16
Two-Wire Control, Single-Source Control



	Mode				
	12	13	14	15	16
23	Local Control2	Stop Type	2nd Accel	Digital Pot Up	Local Control2
26	Speed Select 31	Speed Select 31	2nd Decel	Digital Pot Dn	Stop Type

1 See Table 1.B.

2 Drive must be stopped to take Local Control.
Control by all other adapters is disabled (except Stop).

3 These inputs must be present before drive will start.

AB0291B

The following table defines the input state of the Speed Select inputs for a desired frequency source.

Table 1.B
Speed Select Input State vs. Frequency Source

Speed Select 3	Speed Select 2	Speed Select 1	Frequency Source
O	O	O	[Freq Select 1]
O	O	X	[Freq Select 2]
O	X	O	[Preset Freq 2]
O	X	X	[Preset Freq 3]
X	O	O	[Preset Freq 4]
X	O	X	[Preset Freq 5]
X	X	O	[Preset Freq 6]
X	X	X	[Preset Freq 7]

O = Open
X = Closed

Human Interface Module (HIM)

Description

When the drive mounted HIM is supplied, it will be connected as Adapter 1 (refer to Figure 1.5 and Figure 1.6) and visible from the front of the drive. The HIM can be divided into two sections; Display Panel and Control Panel. The Display Panel provides a means of programming the drive and viewing the various operating parameters. The Control Panel allows different drive functions to be controlled. Refer to the 1336 PLUS User Manual for HIM operation.

IMPORTANT: The operation of HIM functions depends upon drive parameter settings. Default parameter values allow full HIM functionality.

Figure 1.5
Human Interface Module

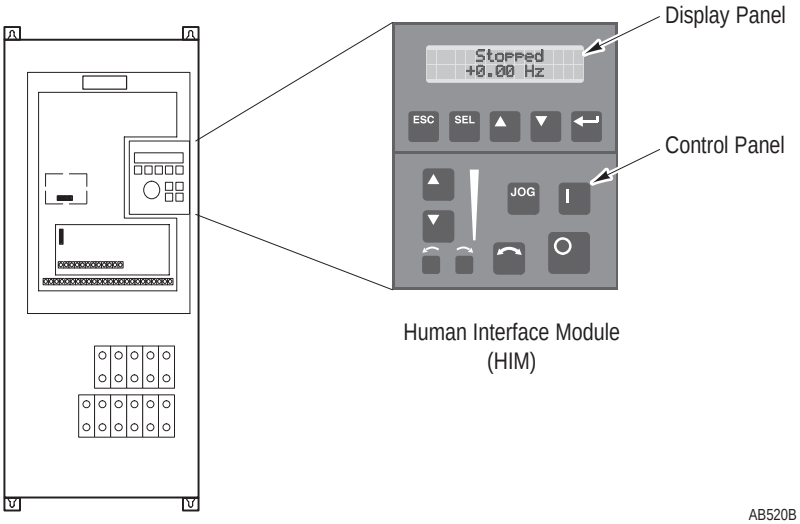
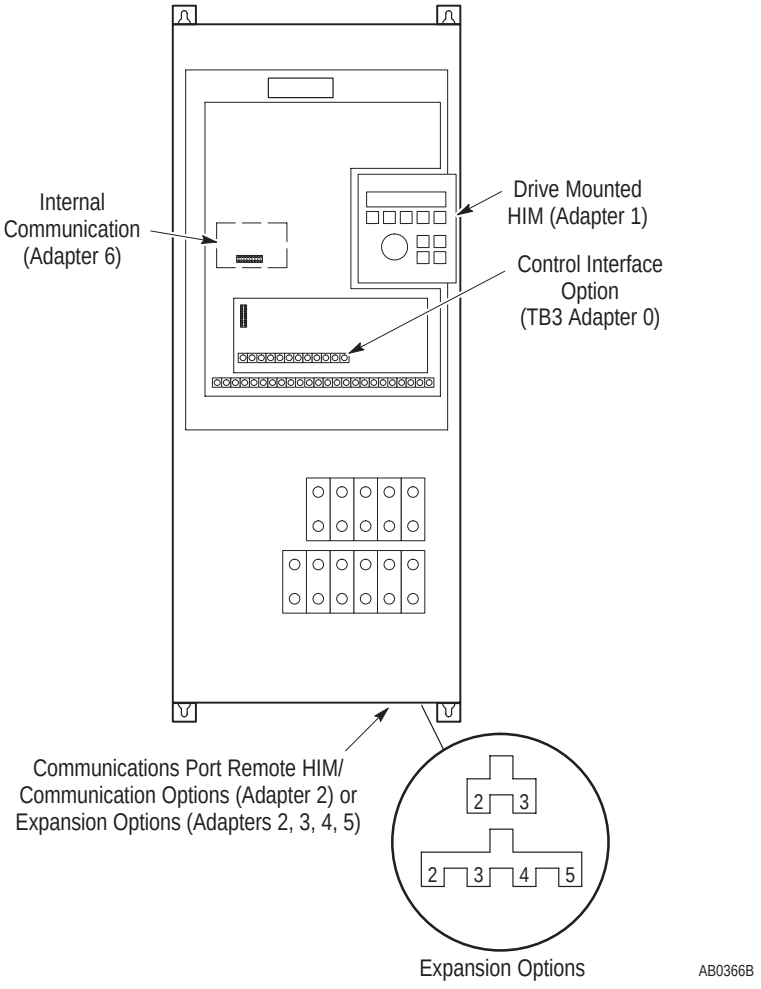


Figure 1.6
Adapter Locations



Module Removal

ATTENTION: Some voltages present behind the drive front cover are at incoming line potential. To avoid an electric shock hazard, use extreme caution when removing/replacing the HIM.

For handheld operation, the module can be removed and located up to 10 meters (33 feet) from the drive.

IMPORTANT: Power must be removed from the drive or Bit 1 of the [Logic Mask] parameter must be set to "0" to allow removal of the HIM module without causing a Communication Fault. Setting Bit 1 of the [Logic Mask] parameter to "0" allows HIM removal while power is applied to the drive. Note that this also disables all HIM control functions except Stop.

To remove the module:

1. Assure that power has been removed or [Logic Mask] has been set to "0".
2. Take the drive front cover off and simply slide the module down and out of its cradle. Remove cable from module.
3. Connect the appropriate cable between the HIM and the Communications Port (Adaptor 2, 3, 4, or 5).
4. Reverse the above steps to replace the module. Apply power or reset Bit 1 of the [Logic Mask] parameter to "1" to enable HIM control.

HIM Operation

When power is first applied to the drive, the HIM will cycle through a series of displays. These displays will show drive ID and communication status. Upon completion, the Status Display (see Figure 1.7) will be shown. This display shows the current status of the drive (i.e. Stopped, Running, etc.) or any faults that may be present (Not Enabled, etc.). Refer to the 1336 PLUS user Manual for HIM operation.

Figure 1.7
Status Display

Chapter 2

Troubleshooting and Error Codes

Chapter Objectives

This chapter helps you trace faults to field-replaceable components.

Troubleshooting Overview

To troubleshoot a 1336 PLUS Adjustable Frequency AC Drive, you need a Range DVM, DMM, or VOM with a range capacity of at least 1000 V.

IMPORTANT: All printed circuit boards, except the Main Control Board assembly, are referenced to negative ground (–bus).

ATTENTION: Power circuits are optically isolated from control driver circuits. Power circuit components are “floating” with respect to “ground.” Use only approved methods of isolating test equipment when making measurements in power circuits.

ATTENTION: Some printed circuit boards and drive components may contain hazardous voltage levels. Remove power before you disconnect or reconnect wires, and before you remove or replace fuses and circuit boards. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Hazard of electric shock exists. Up to 1,000V DC may be present on Snubber Capacitors. Measure for zero (0)V DC across capacitors C2, C3, and C4. Use a resistor greater than 1 ohm and less than 100 ohm, rated for 25 watts minimum to discharge any voltage. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board.

ATTENTION: Potentially fatal voltages may result from improper usage of oscilloscope and other test equipment. The oscilloscope chassis may be at a potentially fatal voltage if not properly grounded. We do not recommend use of an oscilloscope to directly measure high voltages. Use an isolated measuring device with a high voltage probe. Contact Allen-Bradley for recommendations.

ATTENTION: To guard against equipment damage when troubleshooting the drive, always check the following before issuing a Start command:

- Set the Speed Reference to minimum.
- Select the proper motor-rotation direction.
- Disconnect the motor from its mechanical load.

ATTENTION: This assembly contains parts and sub-assemblies that are sensitive to electrostatic discharge. Static control precautions are required when servicing this assembly. Component damage may result if you ignore electrostatic discharge control procedures. If you are not familiar with static control procedures, reference Allen-Bradley Publication 8000-4.5.2, Guarding Against Electrostatic Discharge, or any other applicable ESD protection handbook.

Electrostatic Discharge Precautions

Electrostatic Discharge generated by static electricity can damage the complimentary metallic oxide semiconductor devices on various drive boards. It is recommended that you perform these procedures to guard against this type of damage when circuit boards are removed or installed:

- Wear a wrist type grounding strap that is grounded to the chassis.
- Attach the wrist strap before removing the new circuit board from the conductive packet.
- Remove boards from the drive and immediately insert them into their conductive packets.

Fault Descriptions

Fault Display

The LCD display is used to indicate a fault by showing a brief text statement relating to the fault (see figure below). The fault will be displayed until a drive reset is initiated. Refer to Table 2.A for a listing and description of the various faults. Table 2.B provides a listing of faults by number.

IMPORTANT: Before clearing a fault, refer to the Fault Descriptions table and Diagnostic Procedures by Symptom flowcharts in this chapter to isolate and correct faults.

To help differentiate parameter names and display text from other text in this manual, the following conventions will be used:

Parameter Names	will appear in [brackets]
Display Text	will appear in “quotes”

Contact Description

During normal operating conditions (no faults present, drive powered) the CR3 fault contacts at TB2-13 & 14 are open, and the contacts at TB2-14 & 15 are closed. When a fault occurs, the state of these contacts changes.

Table 2.A
1336 PLUS Fault Descriptions

Name & Fault #	Description	Action
Adptr Freq Err 65	The SCANport adapter that was the selected frequency reference sent a frequency greater than 32767 to the drive.	Correct the problem that is causing the SCANport adapter to send the illegal frequency reference to the drive.
Auxiliary Fault 02	The auxiliary input interlock is open.	If Control Interface option is installed, check connections at TB3-24. If option is not installed, set [Input Mode] to "1".
BGND 10ms Over 51	Microprocessor loop fault. Occurs if the 10ms background task hasn't been run in 15 ms.	Replace Main Control Board or complete drive as required.
Blwn Fuse Flt 58	If the difference between the commanded voltage and the measured voltage is greater than 1/8 of rated voltage for 0.5 seconds, then a fault will be issued indicating that the bus fuse in 30 kW (40 HP) and up drives has blown.	Locate cause, replace Fuse.
Diag C Lim Flt 36	The drive output current has exceeded the hardware current limit and the [Cur Lim Trip En] parameter was enabled.	Check programming of [Cur Lim Trip En] parameter. Check for excess load, improper DC boost setting, DC brake volts set too high or other causes of excess current.
Drive Fault Reset 22	Power-up has been attempted with an Open Stop contact or Closed Start contact.	Check/verify wiring and contact operation.
Drive –> HIM	Error 1 – The checksum read from the EEPROM does not match the checksum calculated from the EEPROM data.	Repeat operation. Replace HIM.
EE Init Read 53	1. Gate Driver Board replacement (requires re-initialization). 2. Trouble reading EEPROM during initialization.	1. Reset to factory defaults & cycle input power. 2. Check all connections to the Power/Driver Board. Replace the board or complete drive as needed.
EE Init Value 54	Stored parameter value is out of range on initialization.	1. Reset to factory defaults & cycle input power. 2. Check all connections to the Power/Driver Board. Replace the board or complete drive as needed.
EEprom Checksum 66	The checksum read from the EEPROM does not match the checksum calculated from the EEPROM data.	1. Reset to factory defaults & cycle input power. 2. Check all wire and cable connections to the Power/Driver Board. Replace the Power/Driver Board or complete drive as required.
EEprom Fault 32	EEPROM is being programmed and will not write a new value.	Check all wire and cable connections to the Main Control Board. Replace Main Control Board or complete drive as required.
FGND 10ms Over 52	Microprocessor loop fault. Occurs if a 10ms interrupt is pending before the current interrupt is complete.	Replace Main Control Board or complete drive as required.
Ground Fault 13	A current path to earth ground in excess of 100A has been detected at one or more of the drive output terminals. NOTE: If ground current exceeds 220% of drive rated current, "Overcurrent Flt" may occur instead of Ground Fault.	Check the motor and external wiring to the drive output terminals for a grounded condition.

Table 2.A *(continued)*
1336 PLUS Fault Descriptions

Name & Fault #	Description	Action
Ground Warning 57	A current path to earth ground in excess of 2A has been detected at one or more of the drive output terminals. See [Ground Warning].	Check the motor and external wiring to the drive output terminals for a grounded condition.
Hertz Err Fault 29	This fault indicates that there is not a valid operating frequency. It can be caused by any of the following: 1. [Maximum Freq] is less than [Minimum Freq]. 2. Skip frequencies and skip bandwidth eliminate all operating frequencies. 3. 4–20mA input signal speed reference has been lost and [4–20mA Loss Sel] is set for "Stop-Fault."	1. Check [Minimum Freq] and [Maximum Freq] parameters. 2. Check [Skip Freq 1], [Skip Freq 2], [Skip Freq 3] and [Skip Freq Band] parameters. 3. Check for broken wires, loose connections or transducer loss at 4–20mA input, TB2.
Hertz Sel Fault 30	A frequency select parameter has been programmed with an out of range value.	Reprogram [Freq Select 1] and/or [Freq Select 2] with a correct value. If problem persists, replace Main Control Board or complete drive.
HIM –> Drive	Error 1 – The checksum read from the EEPROM does not match the checksum calculated from the EEPROM data. Error 2 – Number of parameters in saved profile does not equal master. Error 3 – Download was attempted to a different type drive (i.e. 1336 –> 1305). Error 4 – Saved data not correct for new drive. Error 5 – Drive is running while attempting download.	Retry download. Replace HIM. Retry download. Replace HIM. Download can only take place with same type drive. Capabilities of drive different than master drive. Reprogram param. Stop drive, then perform download.
Loop Overrn Flt 23	An overrun of the 2.5ms control loop has occurred.	Check all connections to the Power/Driver Board. Replace the board or complete drive as required.
Max Retries Fault 33	Drive unsuccessfully attempted to reset a fault and resume running for the programmed number of [Reset/Run Tries].	Check fault buffer for fault code requiring reset. Correct the cause of the fault and manually clear by pressing the local Stop key or cycling the TB3 Stop input.
Motor Mode Flt 24	A fault has been detected originating from the Control Board.	Check all connections to the Control Board. Replace the board, Language Module, or complete drive as required.
Motor Stall Fault 06	Current remained over 150% for more than 4 seconds.	If the motor is drawing excessive current (over 150%), the motor load is excessive and will not allow the drive to accelerate to set speed. A longer accel time or a reduced load may be required.

Table 2.A *(continued)*
1336 PLUS Fault Descriptions

Name & Fault #	Description	Action
Neg Slope Fault 35	Drive software detected a portion of the volts/hertz curve with a negative slope.	Check drive programming: 1. [Maximum Voltage] parameter must be greater than [Base Voltage]. 2. [Maximum Freq] parameter must be greater than [Base Frequency]. 3. [Base Voltage] parameter must be greater than [Start Boost]. 4. If the [DC Boost Select] parameter is set to "Custom" [Base Voltage] must be greater than [Break Voltage] and [Break Voltage] must be greater than [Start Boost].
Open Pot Fault 09	An external pot is connected and the common side of the pot is open. The drive generates this fault when the voltage between TB2-2 and TB2-3 exceeds 3.9V DC.	Check the external potentiometer circuit at TB2, terminals 1, 2 and 3 for an open circuit.
Op Error Fault 11	A SCANport™ device requests a Read or Write of a data type not supported. This will also occur if: 1. [Motor Type] is set to "Sync PM" and [Stop Mode Used] is set to "DC Brake", or 2. [Motor Type] is set to "Sync Reluc" or "Sync PM" and [Speed Control] is set to "Slip Comp".	Check programming.
Overcurrent Flt 12	Overcurrent is detected in overcurrent hardware trip circuit.	Check for a short circuit at the drive output or excessive load conditions at the motor.
Overload Fault 07	Internal electronic overload trip.	An excessive motor load exists. It must be reduced such that drive output current does not exceed the current set by the [Overload Amps] parameter.
Overtemp Fault 08	Heat sink temperature exceeds a predefined value of 90°C (195°F).	Check for blocked or dirty heat sink fins. Check that the ambient temperature has not exceeded 40°C (104°F). Check fan. Check thermistor. Thermistor should register 100kΩ at room temperature.
Overvolt Fault 05	DC bus voltage exceeded maximum value.	Monitor the AC line for high line voltage or transient conditions. Bus overvoltage can also be caused by motor regeneration. Extend the decel time or install dynamic brake option.
Phase U Fault 38	A phase to ground fault has been detected between the drive and motor in this phase.	Check the wiring between the drive and motor. Check motor for grounded phase.
Phase V Fault 39	A phase to ground fault has been detected between the drive and motor in this phase.	Check the wiring between the drive and motor. Check motor for grounded phase.
Phase W Fault 40	A phase to ground fault has been detected between the drive and motor in this phase.	Check the wiring between the drive and motor. Check motor for grounded phase.
P Jump Err Flt 37	Reserved for future use.	

Table 2.A *(continued)*
1336 PLUS Fault Descriptions

Name & Fault #	Description	Action
Pole Calc Fault 50	Generated if the calculated value of [Motor Poles] is less than 2 or greater than 32.	Check [Motor NP RPM] and [Motor NP Hertz] programming.
Power Loss Fault 03	DC bus voltage remained below 85% of nominal for longer than 0.500ms. [Line Loss Fault] parameter is set to "enabled."	Monitor the incoming AC line for low voltage or line power interruption.
Power Mode Fault 26	The internal power mode variable received an incorrect value.	Check all connections to the Control Board. Replace the board, Language Module, or complete drive as required.
Power Overload 64	The drive rating of 150% for 1 minute has been exceeded.	Reduce load.
Power Test Flt 46	The internal power mode variable received an incorrect value.	Check all connections to the Power/Driver Board. Replace the board or complete drive as required.
Precharge Fault 19	Occurs if precharge device is open 20ms after the end of a line loss condition or if the bus charging alarm remains on for 20 seconds (precharge did not complete).	All larger frames – Check the precharge circuit. Replace the input SCRs, SCR Firing Board, Power Driver Board or complete drive as needed.
Precharge Open 56	The precharge circuit was commanded to close, but was detected to be open.	All larger frames – Check the precharge circuit. Replace the input SCRs, SCR Firing Board, Power Driver Board or complete drive as needed.
Reprogram Fault 48	The drive was commanded to write default values to EEPROM.	1. Clear the fault or cycle power to the drive. 2. Program the drive parameters as needed. **Important:** If [Input Mode] has been changed from its original value, power must be cycled before the new value will take affect.
ROM or RAM Flt 68	Internal power-up ROM or RAM tests have not executed properly.	Check Language Module. Replace Control Board or complete drive as required.
Run Boost Fault 34	An attempt has been made to set the [Run Boost] parameter to a value greater than the [Start Boost] parameter.	Verify that parameter has been programmed correctly.
Serial Fault 10	A SCANport adapter has been disconnected and the [Logic Mask] bit for that adapter is set to "1."	1. If no adapter was intentionally disconnected, check wiring to the SCANport adapters. Replace wiring, SCANport expander, SCANport adapters, Main Control Board or complete drive as required. 2. If an adapter was intentionally disconnected and the [Logic Mask] bit for that adapter is set to "1", this fault will occur. To guard against this fault occurring, set the [Logic Mask] bit for the adapter to "0."
Shear Pin Fault 63	Programmed [Current Limit] amps has been exceeded and [Shear Pin Fault] is enabled.	Check load requirements and [Current Limit] setting.

Table 2.A *(continued)*
1336 PLUS Fault Descriptions

Name & Fault #	Description	Action
Temp Sense Open 55	Heat sink thermistor is open or malfunctioning.	Check thermistor and connections.
Undervolt Fault 04	DC Bus voltage fell below the minimum value (388V DC at 460V AC input). [Line Loss Fault] and [Low Bus Fault] set to “enabled.”	Monitor the incoming AC line for low voltage or line power interruption.
UV Short Fault 41	Excessive current has been detected between these two output terminals.	Check the motor and external wiring to the drive output terminals for a shorted condition.
UW Short Fault 42	Excessive current has been detected between these two output terminals.	Check the motor and external wiring to the drive output terminals for a shorted condition.
VW Short Fault 43	Excessive current has been detected between these two output terminals.	Check the motor and external wiring to the drive output terminals for a shorted condition.
Xsistr Desat Flt 47	One or more of the output transistors were operating in the active region instead of desaturation. This can be caused by excessive transistor current or insufficient base drive voltage.	Check for damaged output transistors. Replace output transistors, Power Driver Board or complete drive as needed.

Table 2.B
Fault Code Cross Reference

Fault #	Display Name	Reset/Run
02	Auxiliary Fault	Yes
03	Power Loss Fault	Yes
04	Undervolt Fault	Yes
05	Overvolt Fault	Yes
06	Motor Stall Fault	Yes
07	Overload Fault	Yes
08	Overtemp Fault	Yes
09	Open Pot Fault	No
10	Serial Fault	No
11	Op Error Fault	No
12	Overcurrent Flt	Yes
13	Ground Fault	No
19	Precharge Fault	No
22	Drive Fault Reset	Yes
23	Loop Overrn Flt	Yes
24	Motor Mode Flt	Yes
26	Power Mode Fault	Yes
28	Timeout Fault	No
29	Hertz Err Fault	No
30	Hertz Set Fault	No
31	Timeout Fault	No
32	EEprom Fault	No
33	Max Retries Fault	No
34	Run Boost Fault	No
35	Neg Slope Fault	No

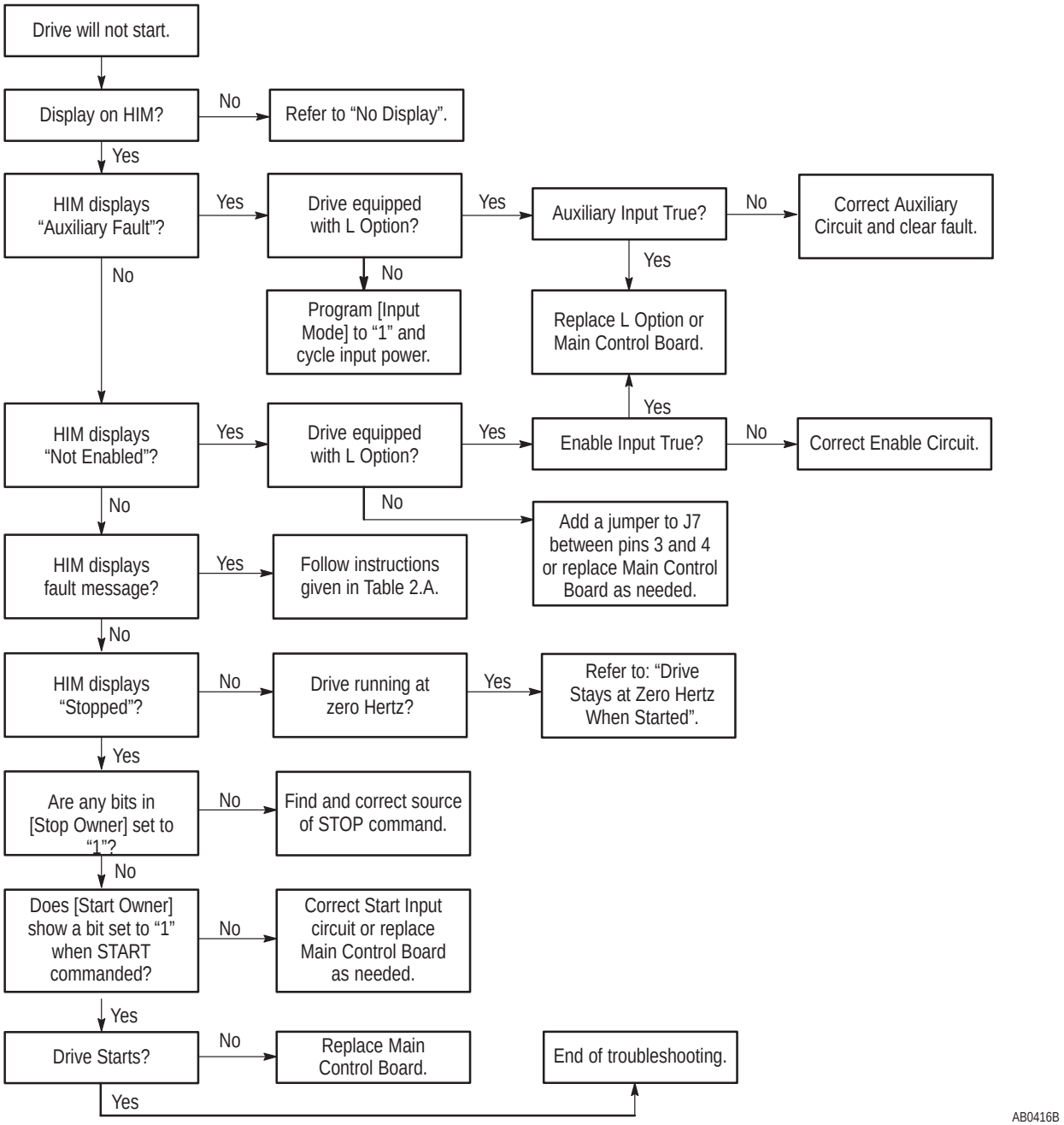
Table 2.B *(continued)*
Fault Code Cross Reference

Fault #	Display Name	Reset/Run
36	Diag C Lim Flt	No
37	P Jump Err Flt	No
38	Phase U Fault	No
39	Phase V Fault	No
40	Phase W Fault	No
41	UV Short Fault	No
42	UW Short Fault	No
43	VW Short Fault	No
46	Power Test Flt	No
47	Xsistr Desat Flt	No
48	Reprogram Fault	No
50	Pole Calc Fault	No
51	BGND 10ms Over	Yes
52	FGND 10ms Over	Yes
53	EE Init Read	No
54	EE Init Value	No
55	Temp Sense Open	No
56	Precharge Open	No
57	Ground Warning	No
58	Blwn Fuse Flt	No
63	Shear Pin Fault	No
64	Power Overload	No
65	Adptr Freq Err	No
66	EEprom Checksum	No
68	ROM or RAM Flt	No

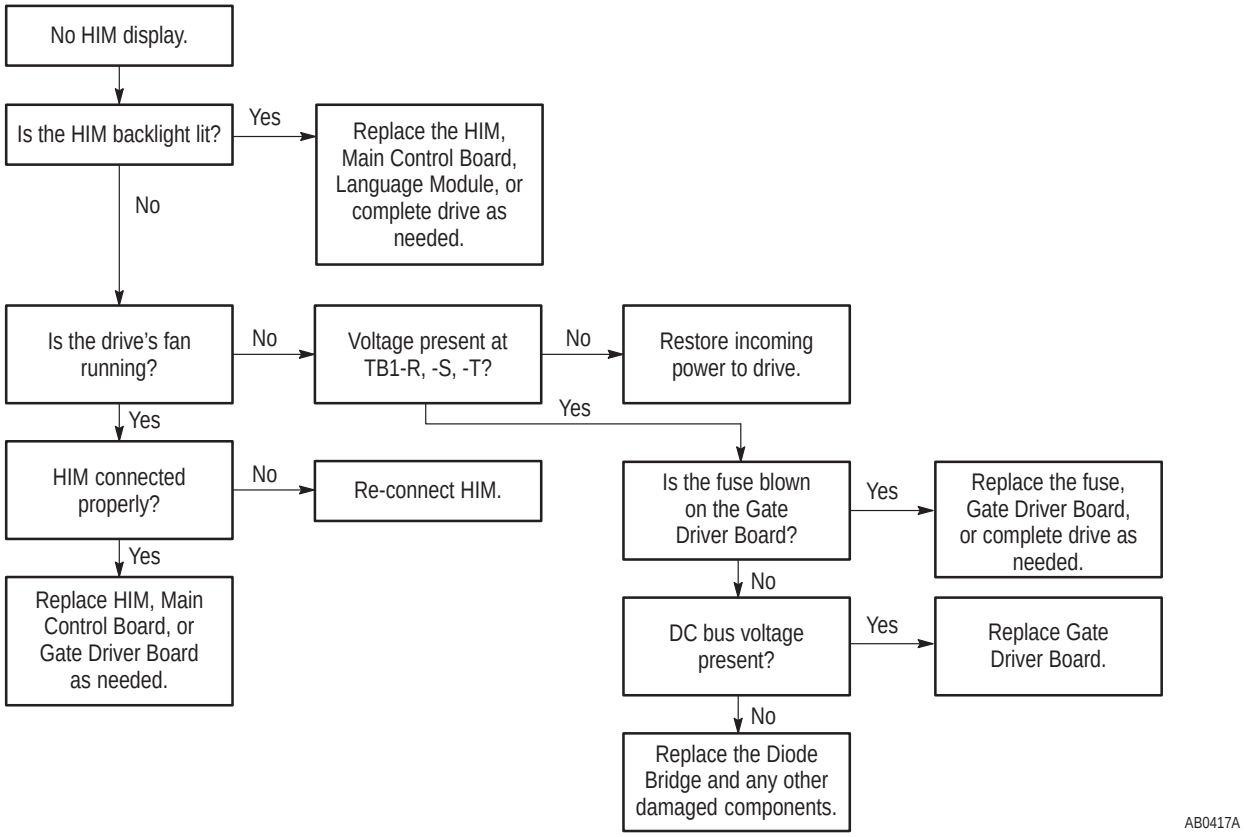
Diagnostic Procedures by Symptom

These charts list drive symptoms, symptom descriptions, and recommended actions to remedy the symptoms.

Drive Will Not Start



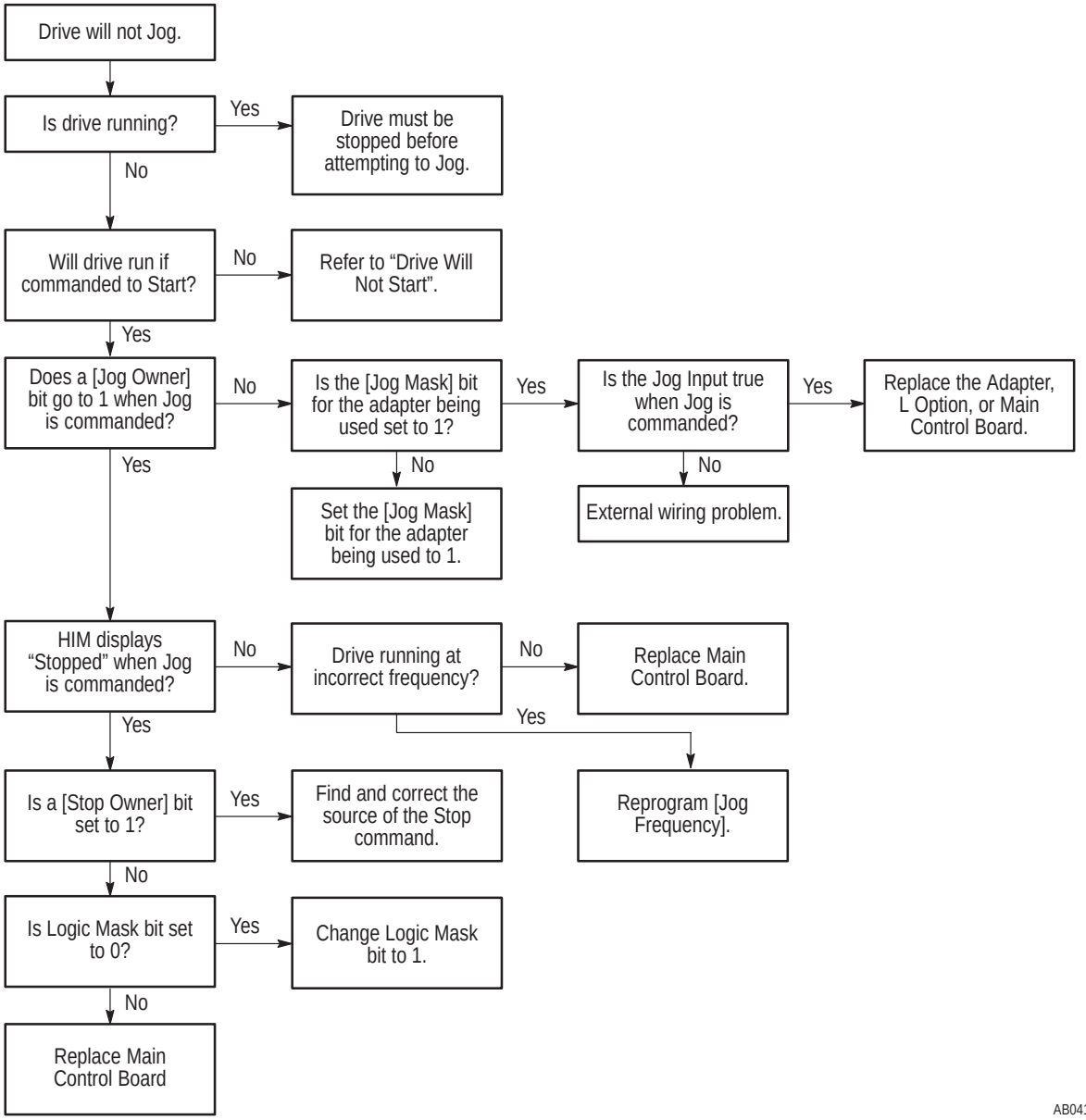
No Display


No HIM display.
Is the HIM backlight lit?
Yes
Replace the HIM, Main Control Board, Language Module, or complete drive as needed.
No
Is the drive's fan running?
No
Voltage present at TB1-R, -S, -T?
No
Restore incoming power to drive.
Yes
Yes
HIM connected properly?
No
Re-connect HIM.
Yes
Replace HIM, Main Control Board, or Gate Driver Board as needed.
Is the fuse blown on the Gate Driver Board?
Yes
Replace the fuse, Gate Driver Board, or complete drive as needed.
No
DC bus voltage present?
Yes
Replace Gate Driver Board.
No
Replace the Diode Bridge and any other damaged components.
AB0417A

Drive Will Not Jog

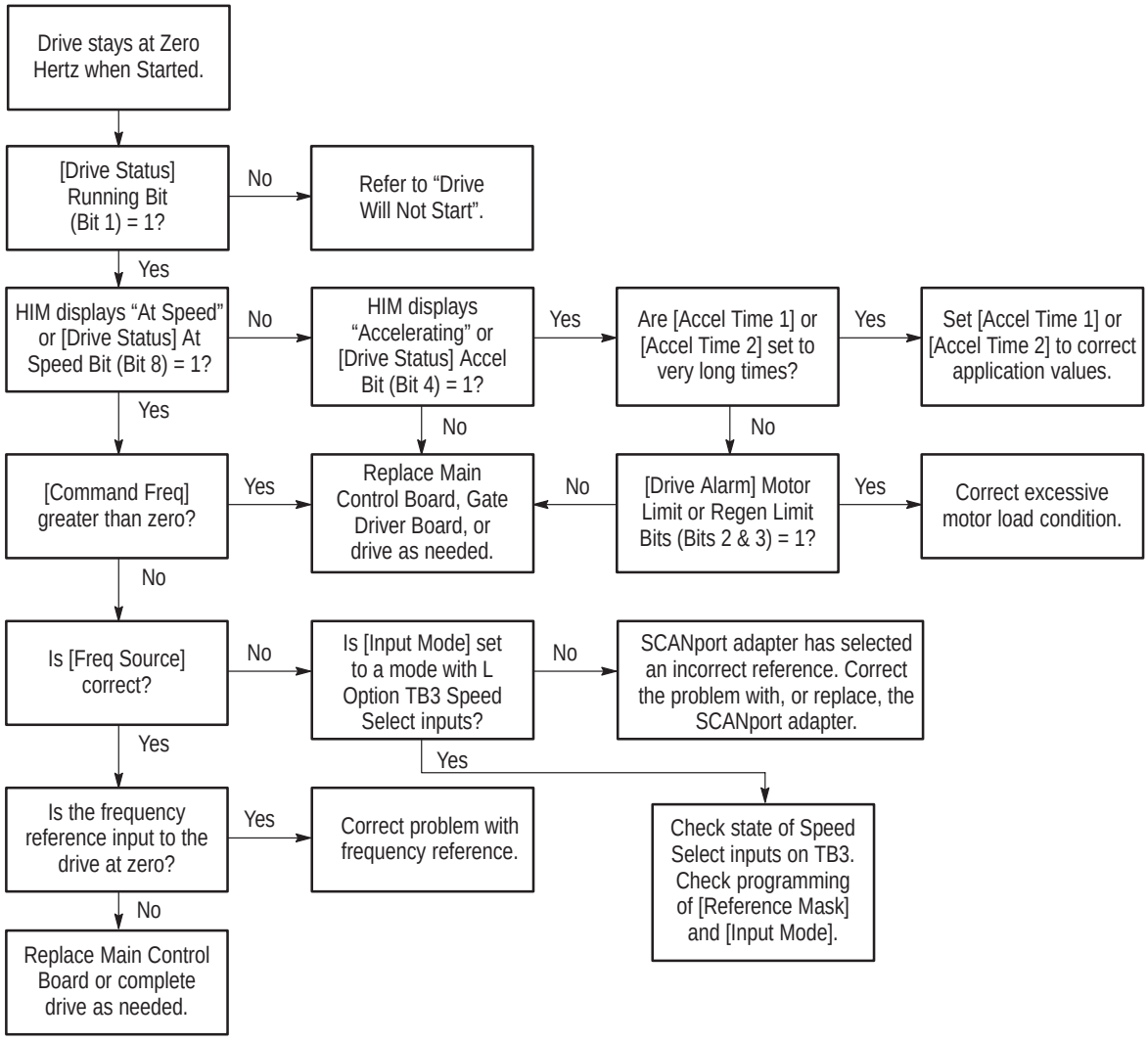
Local Human Interface Module used to control drive.

JOG is not active if a START command is present. START command always overrides a JOG command.



Drive Stays at Zero Hertz When Started

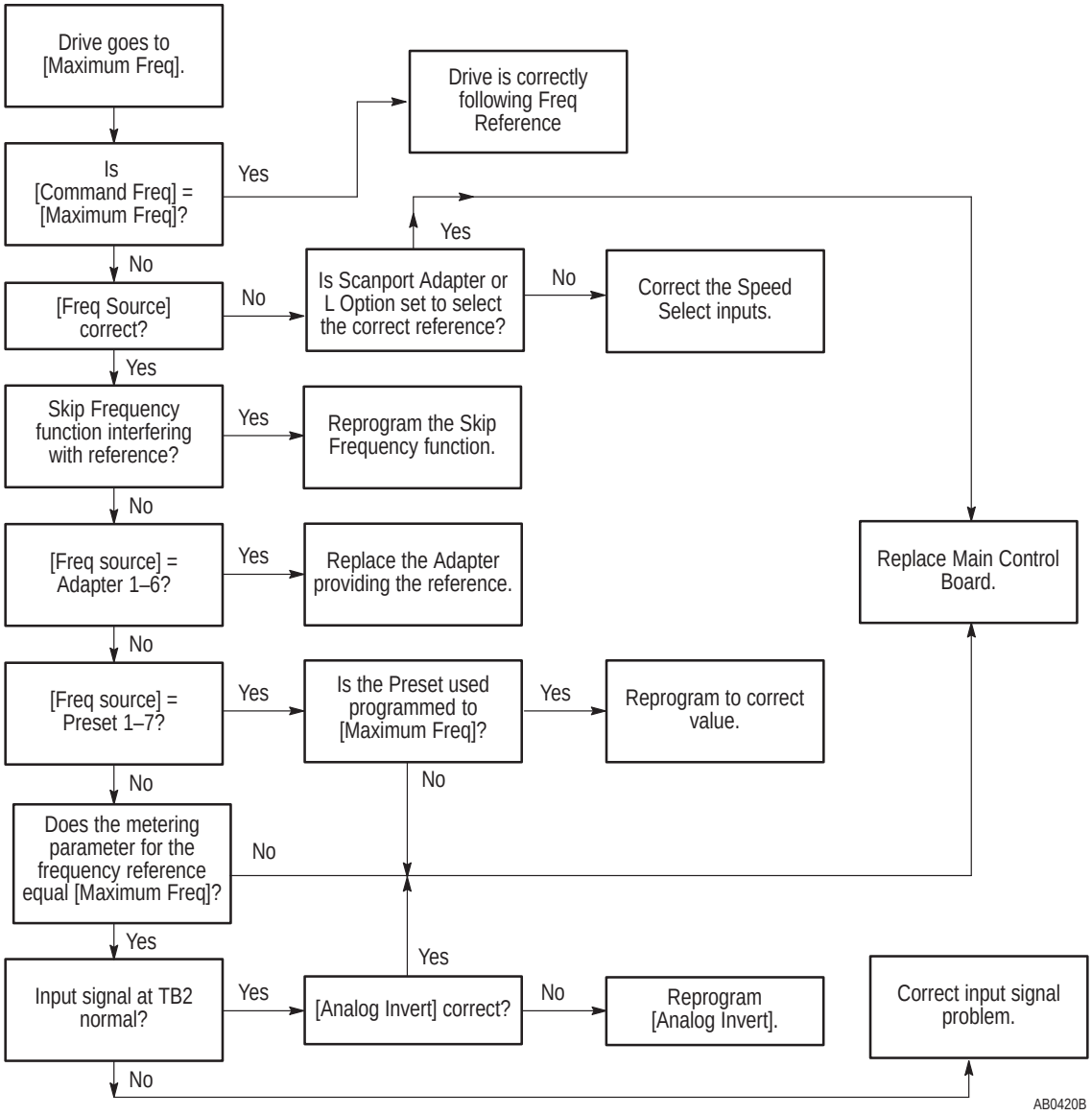
IMPORTANT: [Command Frequency] parameter in the Metering Group can be checked using the HIM.



AB0419A

Drive Goes to Max Frequency

IMPORTANT: [Command Frequency] parameter in the Metering Group can be checked using the HIM.



Clearing Faults

After correcting a fault, you can clear a fault from the drive in one of three ways:

1. Cycle the input power to the drive.
2. Press the Stop button. This works only if [Fault Clear Mode] is set to “Enabled”.
3. Issue a reset command from a serial device.

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Chapter 3

Disassembly and Access Procedures

Chapter Objectives

This chapter describes general disassembly procedures required to access internal drive components.

Disassembly and Access Overview

ATTENTION: Some printed circuit boards and drive components may contain hazardous voltage levels. Remove and lock out power before you disconnect or reconnect wires, and before you remove or replace fuses and circuit boards. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Hazard of electric shock exists. Up to 1,000V DC may be present on Snubber Capacitors. Measure for zero (0)V DC across capacitors C2, C3, and C4. Use a resistor greater than 1 ohm and less than 100 ohm, rated for 25 watts minimum to discharge any voltage. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board.

ATTENTION: Servicing energized industrial control equipment can be hazardous. Electrical shock, burns, or unintentional actuation of controlled industrial equipment may cause death or serious injury. Follow the safety-related practices of NFPA 70E, Electrical Safety for Employee Workplaces, when working on or near energized equipment. Do not work alone on energized equipment.

Electrostatic Discharge Precautions

ATTENTION: This assembly contains parts and sub-assemblies that are sensitive to electrostatic discharge. Static control precautions are required when servicing this assembly. Component damage may result if you ignore electrostatic discharge control procedures. If you are not familiar with static control procedures, reference Allen-Bradley Publication 8000-4.5.2, Guarding Against Electrostatic Discharge, or any other applicable ESD protection handbook.

Electrostatic discharge generated by static electricity can damage the complimentary metallic oxide semiconductor devices on various drive boards. It is recommended that you perform these procedures to guard against this type of damage when circuit boards are removed or installed:

- Wear a wrist type grounding strap that is grounded to the chassis.
- Attach the wrist strap before removing the new circuit board from the conductive packet.
- Remove boards from the drive and immediately insert them into their conductive packets.

Tools

You need the following tools to disassemble and assemble the drive:

- Pliers
- Phillips screwdrivers (medium and large)
- Standard screwdrivers (small, medium, and large)
- 10 mm socket
- 13 mm deep-well socket
- 5/16-inch or 8 mm open-end wrench
- Torque wrench, metered in in.-lb or N-m
- Nylon tie wraps
- Side cutters
- 17 mm socket

Fastener Torque Specifications

Torque Sequence

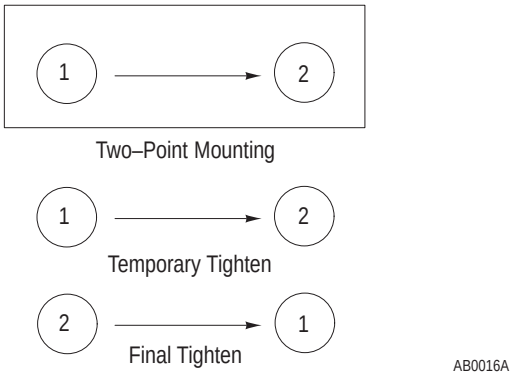
When mounting components to a drive's heat sink, component-fastener torque sequences and tolerances are crucial to component-to-heat sink heat dissipation.

ATTENTION: Component can be damaged if temporary tightening procedure is not performed to specification.

Two-Point Mounting

The following illustrates temporary and final tightening sequences for components fastened to a heat sink using two screws. Temporary torque is 1/2 (50%) of final torque. The numeric illustration labels are for your assistance. Drive components do not carry these labels.

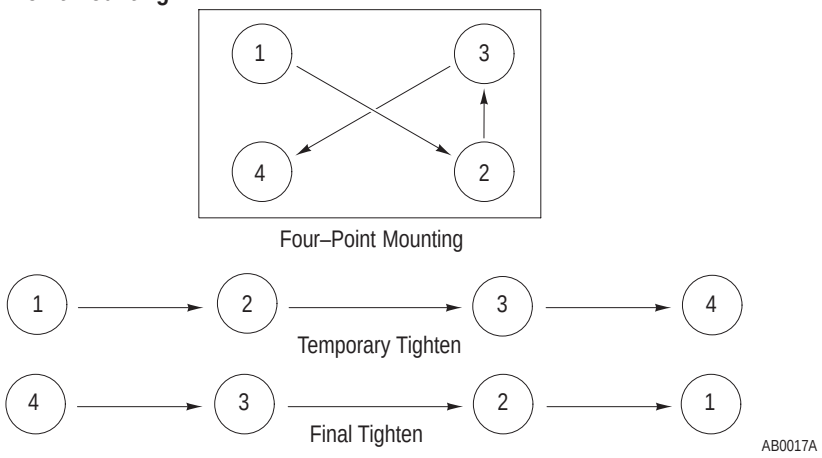
Figure 3.1
Two-Point Mounting



Four-Point Mounting

The following illustrates temporary and final tightening sequences for components fastened to a heat sink using four screws. Temporary torque is 1/2 (50%) of final torque. The numeric illustration labels are for your assistance. Drive components do not carry these labels.

Figure 3.2
Four-Point Mounting



Torque Specifications

The following table lists fastener locations by component, how the fasteners are used, and torque specifications. Refer to Torque Sequence in this chapter for fastening two-point and four-point components to the heat sink.

Table 3.A
Fastener Torque Specifications — Parts Common to "D" Frame Drives

Component	Fastener Application	Fastener Used	Torque in.-lb	Torque N-m
Voltage Sharing Resistor (R1 – R3)	Voltage Sharing Resistor to Heat Sink	M5 x 10 mm Screw	23 – 36	2.6 – 4.1
Snubber Resistor (R20 – R22)	Snubber Resistor to Heat Sink	M5 x 10 mm Screw	23 – 36	2.6 – 4.1
Power Modules (Q1 – Q6)	Power Modules to Heat Sink	M6 x 16 mm Screw	26	2.9
Input Rectifiers (SCR1 – SCR6)	Input Rectifiers to Heat Sink	M6 x 16 mm Screw	52	5.9
Thermistor	Thermister to Heat Sink	Thermister	14	1.6
Fan Finger Guard	Fan Finger Guard to Chassis	M4 x 8 mm Screw	12 – 16	1.4 – 1.8
Fan Cover	Fan Cover to Fan	M4 x 8 mm Screw	12 – 16	1.4 – 1.8
Fan Cover	Fan Cover to Chassis	M4 x 12 mm Screw	12 – 16	1.4 – 1.8
Capacitor Retainer (C1 – C9)	Capacitor Retainer to Chassis	M4 x 8 mm Screw	12 – 16	1.4 – 1.8
Capacitor Bracket (C1 – C9)	Capacitor Bracket to Capacitor Latch	M5 x 10 mm Screw	23 – 36	2.6 – 4.1
MOV Surge Suppressor	Surge Suppressor to Chassis	M4 or M5 x 10 mm Screw	12 – 16	1.4 – 1.8
Link Inductor (L1)	Link Inductor to Chassis	M5 x 10 mm Screw	23 – 26	2.6 – 4.1
Fan Capacitor (C-HB1)	Fan Capacitor to Chassis	M8 Nut	32 – 40	3.6 – 4.5
Autotransformer (T1)	Autotransformer to Chassis	M5 x 10 mm Screw	23 – 26	2.6 – 4.1
LEM Support Plate	LEM Support Plate to Chassis	M5 x 10 mm Screw	23 – 26	2.6 – 4.1
Motor Bus Bar Insulated Standoff	Motor Bus Bar Insulated Standoff to Chassis	M5 x 10 mm Screw	23 – 36	2.6 – 4.1
Capacitor Bus Bar (C1 – C9)	Capacitor Bus Bar to Capacitors	M6 x 12 mm Screw	55	6.2
IGBT Bus Bar	IGBT Bus Bar to Motor Bus Bar	M5 x 10 mm Screw	23 – 26	2.6 – 4.1
IGBT Bus Bar	IGBT Bus Bar to Distribution Bus Bar	M5 x 10 mm Screw	23 – 36	2.6 – 4.1
Motor Bus Bar	Motor Bus Bar to Insulated Standoff	M5 x 10 mm Screw	23 – 36	2.6 – 4.1
Distribution Bus Bar	Distribution Bus Bar to Capacitor Bus Bar	M10 x 20 mm Bolt	97 – 111	11 – 12.5
SCR Standoff (SCR1 – SCR6)	SCR Standoff Through Converter Bus Bar and Into SCR	SCR Standoff	34	3.8
Converter Snubber Board (A11)	Converter Snubber Board to SCR Standoff	M4 x 8 mm Screw	12 – 16	1.4 – 1.8
Power Module Snubber Board (A20 – A22)	Power Module Snubber Board to IGBT Standoffs	M4 x 8 mm Screw	12 – 16	1.4 – 1.8
Bus Fuse (F1)	Bus Fuse to Capacitor Bus Bar	M10 x 20 mm Bolt	97 – 111	11 – 12.5
Bus Fuse (F1)	Bus Fuse to Distribution Bus Bar	M8 or M10 x 20 mm Bolt	97 – 111	11 – 12.5
TB1 Terminal Block DIN Rail	DIN Rail to Chassis	M5 x 10 mm Screw	23 – 36	2.6 – 4.1
Gate Drive Board Sheet Metal	Gate Drive Board Sheet Metal to Chassis	M5 x 10 mm Screw	23 – 36	2.6 – 4.1
"S" Control Board	"S" Control Board to Sheet Metal	M4 x 8 mm Screw	12 – 16	1.4 – 1.8
TE Ground Block	TE Ground Block to Gate Drive Board Sheet Metal	M2.5 x 12 mm Screw	6 – 9	0.7 – 1.0
Control Board Sheet Metal	Control Board Sheet Metal to Gate Drive Board Sheet Metal	M6 Nut	23 – 36	2.6 – 4.1
Control Board Sheet Metal	Control Board Sheet Metal to Gate Drive Board Sheet Metal	M4 x 8 mm Screw	12 – 16	1.4 – 1.8
HIM Holder	HIM Holder to Control Board Sheet Metal	M4 x 20 mm Screw	12 – 16	1.4 – 1.8
Capacitor Shield (C1 – C9)	Capacitor Shield to Capacitor Brackets	M4 x 20 mm Screw	12 – 16	1.4 – 1.8
Link Inductor Shield (L1)	Link Inductor Shield to Link Inductor	M6 Nut	23 – 36	2.6 – 4.1
Enclosure Bottom, Top, and Side Panels	Enclosure Sheet Metal	M5 x 10 mm Screw	23 – 36	2.6 – 4.1

Table 3.B
Fastener Torque Specifications — Parts Common to "D" Frame Drives A040, A050, B060 – B100, C075, C100

Component	Fastener Application	Fastener Used	Torque in.-lb	Torque N-m
IGBT Standoff	IGBT Standoff Through IGBT Busbar and Into IGBT	IGBT Standoff	36 – 44	2.6 – 4.1
Power Module Snubber Board (A20 – A22)	Power Module Snubber Board to Gate and Emitter Connection on IGBT	M4 x 24 mm Screw	12 – 16	1.4 – 1.8

Table 3.C
Fastener Torque Specifications — Parts Common to "D" Frame Drives A060, B125, BX150, C125

Component	Fastener Application	Fastener Used	Torque in.-lb	Torque N-m
IGBT Standoff	IGBT Standoff Through IGBT Busbar and Into IGBT	IGBT Standoff	65 – 79	7.3 – 8.9
Power Module Snubber Board (A20 – A22) (Present Design)	Power Module Snubber Board to Gate and Emitter Connection on IGBT	M4 x 35 mm Screw	12 – 16	1.4 – 1.8
*Power Module Snubber Board (A20 – A22) (Original Design)	Power Module Snubber Board to Gate and Emitter "C" Brackets	M4 x 8 mm Screw	12 – 16	1.4 – 1.8
*Gate & Emitter Terminals (Original Design)	Gate and Emitter "C" Brackets to IGBTs	M4 x 8 mm Screw	12 – 16	1.4 – 1.8

* Parts pertain only to original Snubber Board design which uses "C" shaped Gate and Emitter brackets. Refer to Power Modules in Chapter 5 – Part Replacement Procedures.

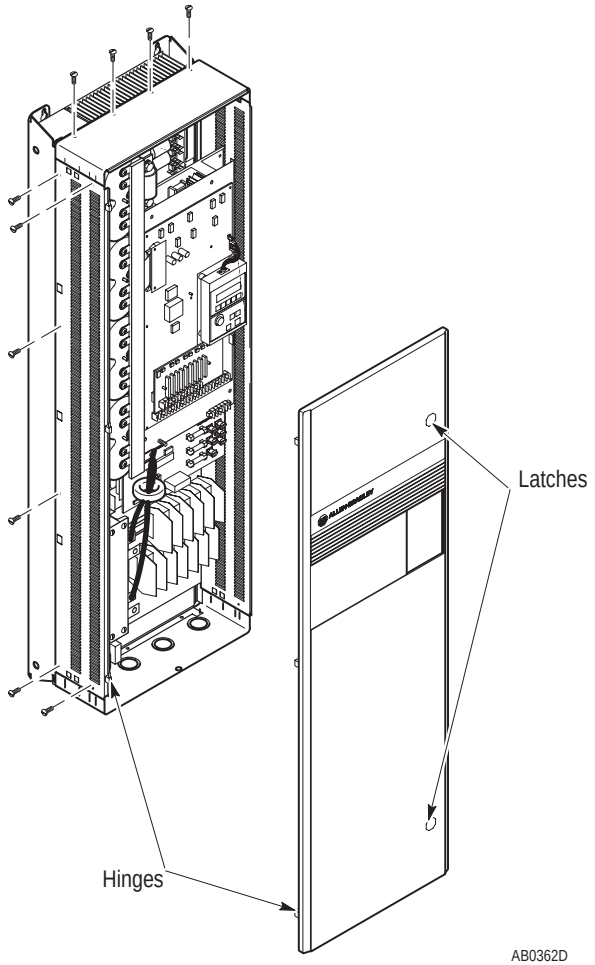
Table 3.D
Fastener Torque Specifications — Wires Common to "D" Frame Drives

Component	Fastener Application	Fastener Used	Torque in.-lb	Torque N-m
MOV Ground Wire (MOV1) Drive	MOV Ground Wire & Drive Ground Wire to Chassis	M6 Nut	23 – 36	2.6 – 4.1
Ground Wire TE (Gate Driver Bd)	Wire Connected to TB1 Terminal TE	Compression	6 – 8	0.7 – 0.9
Link Inductor Wires	Wires Connected to Link Inductor	M6 x 12 mm Screw	50 – 72	5.6 – 8.1
Capacitor Bus Bar Wires	Wires Connected to Capacitor Bus Bar	M6 x 12 mm Screw	50 – 72	5.6 – 8.1
Converter Bus Bar Wires	Wires Connected to Converter Bus Bar	M6 x 12 mm screw	50 – 72	5.6 – 8.1
Motor Bus Bar Wires	Wires Connected to Motor Bus Bar	M6 x 12 mm Screw	50 – 72	5.6 – 8.1
TB1 Wires	Wires Connected to TB1	M8 Nut	52	5.9
TB2 Wires	Wires Connected to TB2 on Main Control Board	Captive Screw	6 – 9	0.7 – 1.0
TB3 Wires	Wires Connected to TB3 on Control Interface Board	Captive Screw	8 – 10	0.9 – 1.1
TB7 Wires	Wires Connected to TB7 on Control Board Sheet Metal	Captive Screw	12 – 16	1.4 – 1.8
Enclosure Door Ground Wire	Ground Wire to Enclosure Door	M6 Nut	23 – 36	2.6 – 4.1

Disassembly and Access Procedures

Removing the Drive Enclosure

Figure 3.3
Drive Enclosure



Removal

ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.

IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Turn the Enclosure Door latches, located on the right side of the Enclosure Door, 90 degrees counterclockwise.
3. Open the Enclosure Door.
4. Check for zero volts at TB1 terminals +DC and –DC before proceeding with tests or part replacement.
5. Check for absence of control voltage at TB2, TB3, and any other external connections.
6. Remove the ground wire from the Enclosure Door.
7. Lift the Enclosure Door toward the top of the drive to remove the door from the hinges.
8. Remove the customer-supplied wiring from the drive.
9. Remove the screws from the Enclosure top, bottom, and side panels to remove the panels.

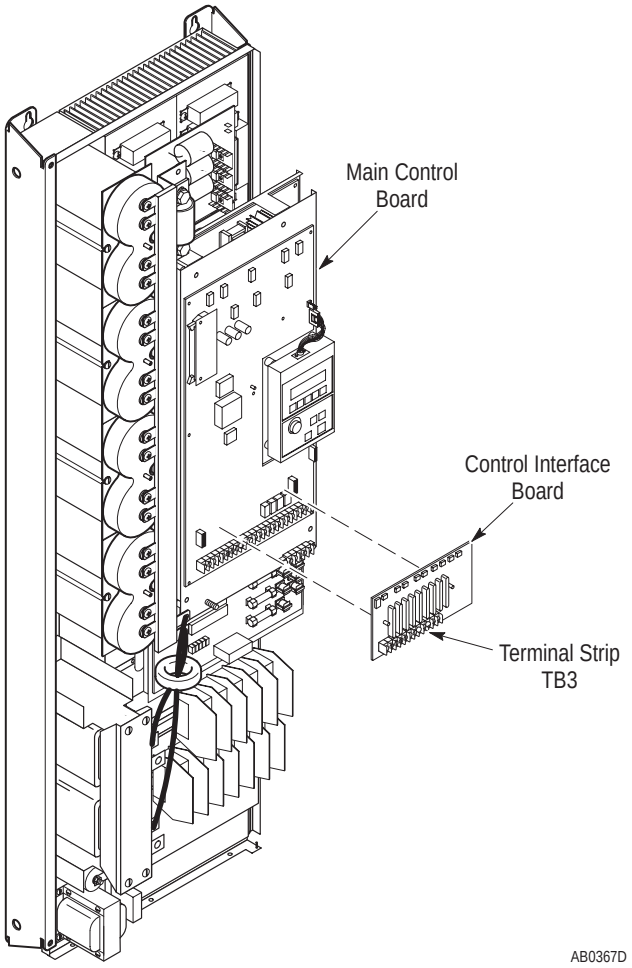
Installation

Install the Enclosure in reverse order of removal. Refer to Fastener Torque Specifications in this chapter.

ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.

Removing Control Interface Board MOD-L4, -L5, or -L6

Figure 3.4
Control Interface Board



Removal

ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.

IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Open the Enclosure Door.
3. Check for zero volts at TB1 terminals +DC and –DC.
4. Check for absence of control voltage at TB2 and TB3.
5. Remove all wires from the terminals on TB3.
6. Loosen the two captive screws fastening the Control Interface Board to the Main Control Board.
7. Grip the right and left sides of the Control Interface Board and pull the board straight outward from the Main Control Board.

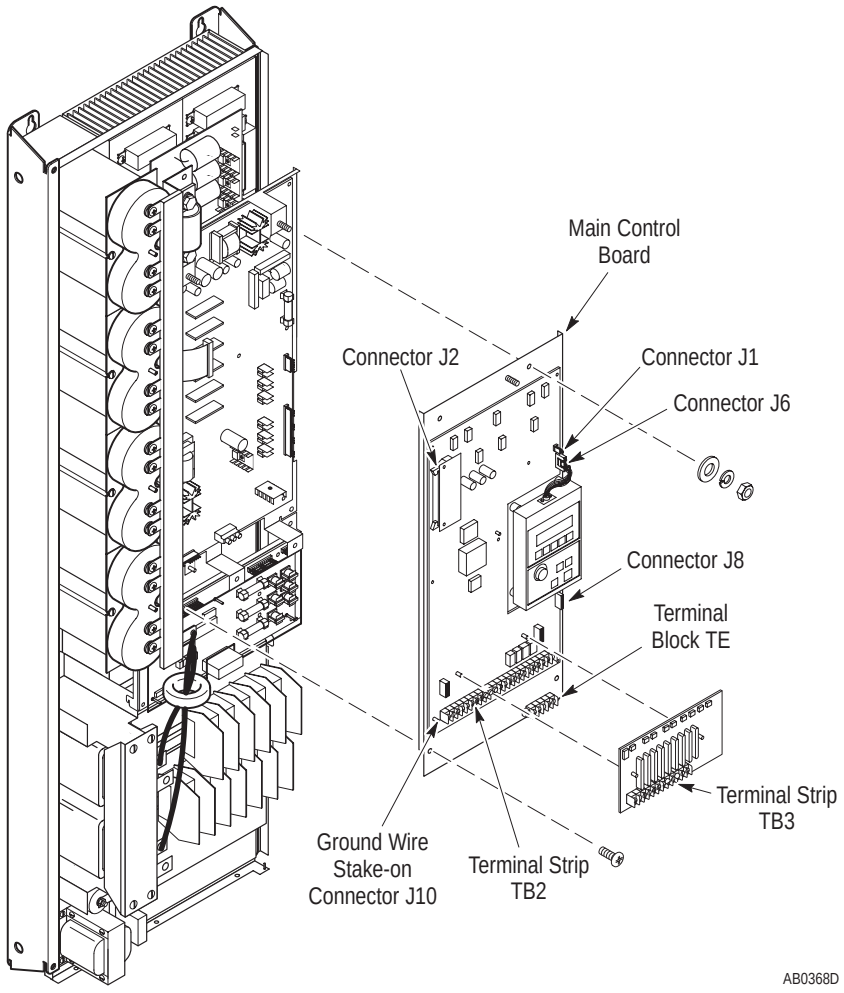
Installation

Install the Control Interface Board in reverse order of removal. Refer to Fastener Torque Specifications in this chapter.

ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.

Removing the Main Control Board Mounting Plate

Figure 3.5
Main Control Board Mounting Plate



Removal

ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.

IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Open the Enclosure Door.
3. Check for zero volts at TB1 terminals +DC and –DC.
4. Check for absence of control voltage at TB2 and TB3.
5. Disconnect the following from the Main Control Board:
   - J2 ribbon cable connector
   - J1 connector
   - Ground wire at terminal block TE.
   - J10 ground wire at the stake-on connector.
   - J6 connector
   - J8 connector
   - All wires from the terminals on TB2 and TB3.
6. Remove the nuts at the top of the Main Control Board Mounting Plate.
7. Remove the two screws at the bottom of the Main Control Board Mounting Plate.
8. Lift the Main Control Board Mounting Plate out of the drive.

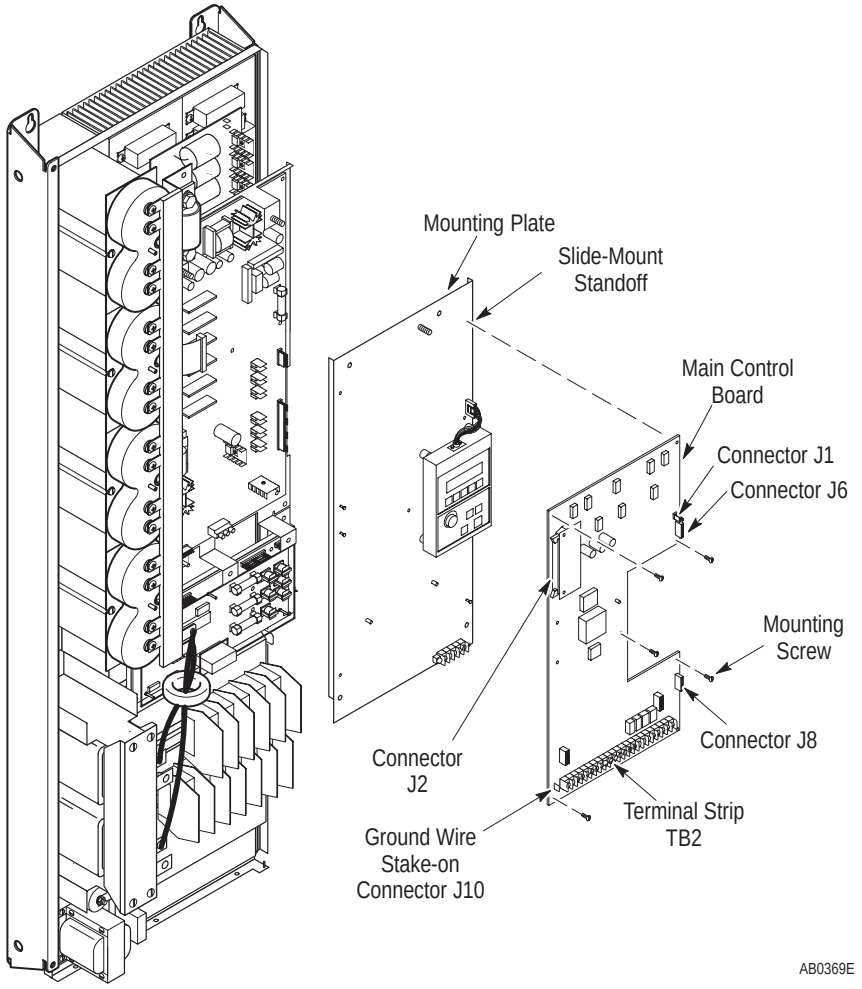
Installation

Install the Main Control Board Mounting Plate in reverse order of removal. Refer to Fastener Torque Specifications in this chapter.

ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.

Removing the Main Control Board

Figure 3.6
Main Control Board and Mounting Plate



Removal

ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.

IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Open the Enclosure Door.
3. Check for zero volts at TB1 Terminals +DC and –DC.
4. Check for absence of control voltage at TB2 and TB3.
5. Disconnect the following from the Main Control Board:
   - J2 ribbon cable connector
   - J1 connector
   - J10 ground wire at the stake-on connector
   - J6 connector
   - J8 connector
   - All wires from the terminals on TB2 and TB3
6. Remove the five screws fastening the Main Control Board to the mounting plate.
7. Slide the Main Control Board toward the top of the drive to release it from the slide-mount stand-offs.
8. Lift the Main Control Board away from the mounting plate.

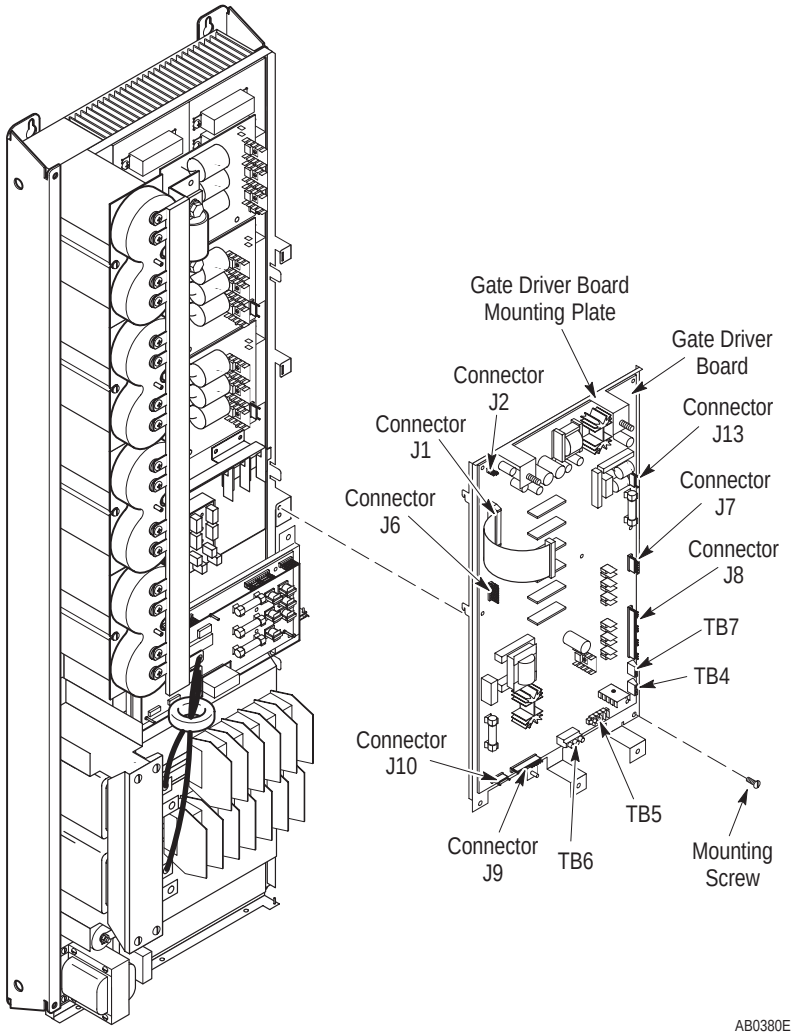
Installation

Install the Main Control Board in reverse order of removal. Refer to Fastener Torque Specifications in this chapter.

ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.

Removing the Gate Driver Board Mounting Plate

Figure 3.7
Gate Driver Board Mounting Plate



Removal

ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Hazard of electric shock exists. Up to 1,000V DC may be present on Snubber Capacitors. Measure for zero (0)V DC across capacitors C2, C3, and C4. Use a resistor greater than 1ohm and less than 100 ohm, rated for 25 watts minimum to discharge any voltage. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.

IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Open the Enclosure Door.
3. Check for zero volts at TB1 terminals +DC and –DC.
4. Check for absence of control voltage at TB2 and TB3.
5. Remove the Main Control Board Mounting Plate. Refer to Removing the Main Control Board Mounting Plate in this chapter.
6. Remove Gate Driver Board connections:
   - TB7 ground wire
   - J2 Ground Sense CT connector
   - J13 connector
   - J7 Power Module connector
   - J8 Power Module connector
   - J10 Bus Capacitor Bank connector
   - J6 connector
   - J9 Precharge Board connector
   - TB6 Fan connector if applicable
7. Remove the screws fastening the bottom of the Mounting Plate to the drive.
8. Slide the plate toward the top of the drive until the tabs disengage from the slots.
9. Lift the plate out of the drive.

Installation

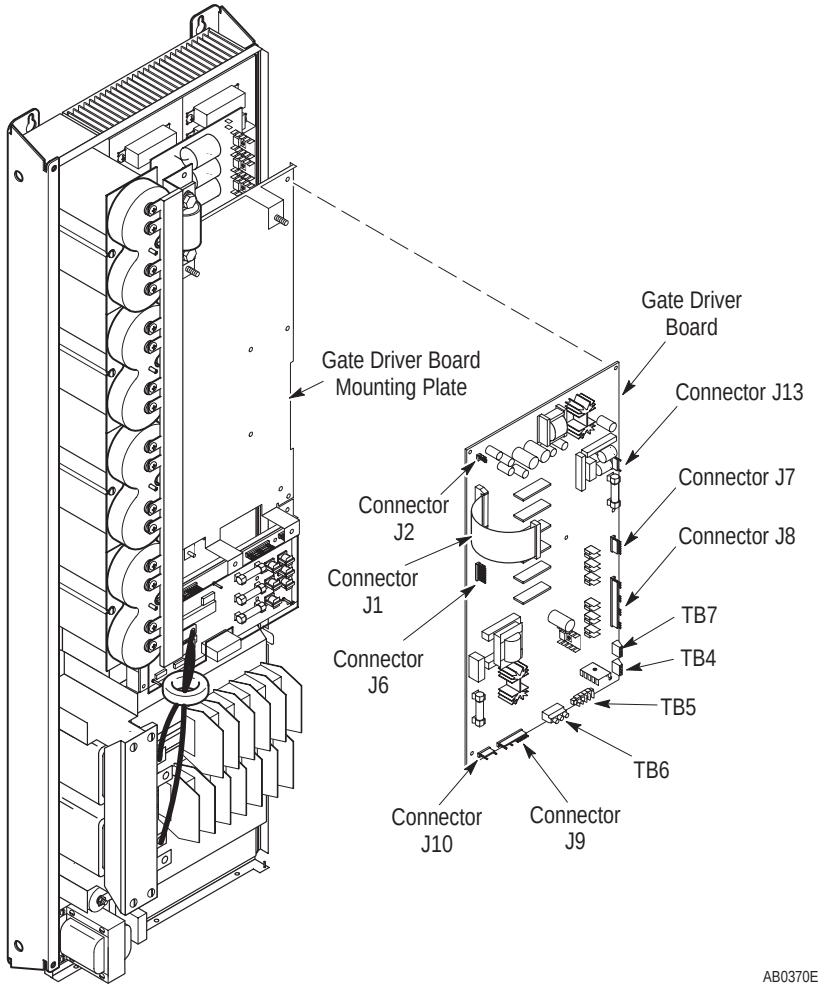
Install the Gate Driver Board Mounting Plate in reverse order of removal. Refer to Fastener Torque Specifications in this chapter.

ATTENTION: When removing the entire wire harness connecting Gate Driver Board connector J9 to Precharge Board connector J3, align the wires on the harness terminals with the pins on the board connectors. Incorrect harness connection may result in faulty drive operation and may damage the equipment.

ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.

Removing the Gate Driver Board

Figure 3.8
Gate Driver Board



Removal

ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Hazard of electric shock exists. Up to 1,000V DC may be present on Snubber Capacitors. Measure for zero (0)V DC across capacitors C2, C3, and C4. Use a resistor greater than 1ohm and less than 100 ohm, rated for 25 watts minimum to discharge any voltage. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.

IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Open the Enclosure Door.
3. Check for zero volts at TB1 terminals +DC and –DC.
4. Check for absence of control voltage at TB2 and TB3.
5. Remove the Main Control Board Mounting Plate. Refer to Removing the Main Control Board Mounting Plate in this chapter.
6. Disconnect the following from the Gate Driver Board:
   - J9 Precharge Board connector
   - J10 Bus Capacitor Bank connector
   - J2 Ground Sense CT connector
   - J7 Power Module connector
   - J8 Power Module connector
   - J6 LEM Harness connector
   - TB6 Fan connector
   - J13 connector
   - Ground wire from TB7.
7. Turn the eight stand-off screws, fastening the Gate Driver Board to the Mounting Plate, 1/4 turn counterclockwise.
8. Remove the Gate Driver Board from the enclosure.

Installation

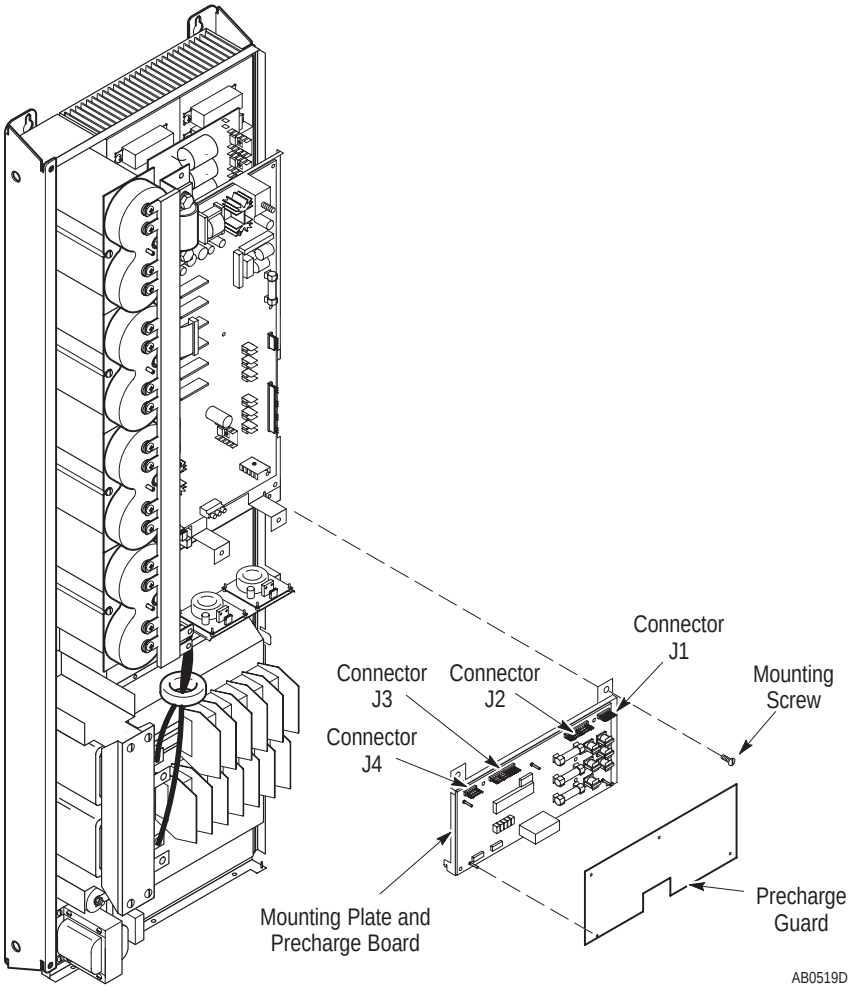
Install the Gate Driver Board in reverse order of removal. Refer to Fastener Torque Specifications in this chapter.

ATTENTION: When removing the entire wire harness connecting Gate Driver Board connector J9 to Precharge Board connector J3, align the wires on the harness terminals with the pins on the board connectors. Incorrect harness connection may result in faulty drive operation and may damage the equipment.

ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.

Removing the Precharge Board Mounting Plate

Figure 3.9
Precharge Board and Mounting Plate



Removal

ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.

IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Open the Enclosure Door.
3. Check for zero volts at TB1 terminals +DC and –DC.
4. Check for absence of control voltage at TB2 and TB3.
5. Remove the guard from the Precharge Board.
6. Disconnect the following from the Precharge Board:
   - J1 connector
   - J2 connector
   - J3 connector
   - J4 connector
7. Remove the screws fastening the top of the Mounting Plate to the Drive.
8. Lift the Precharge Board and Mounting Plate out of the enclosure.

Installation

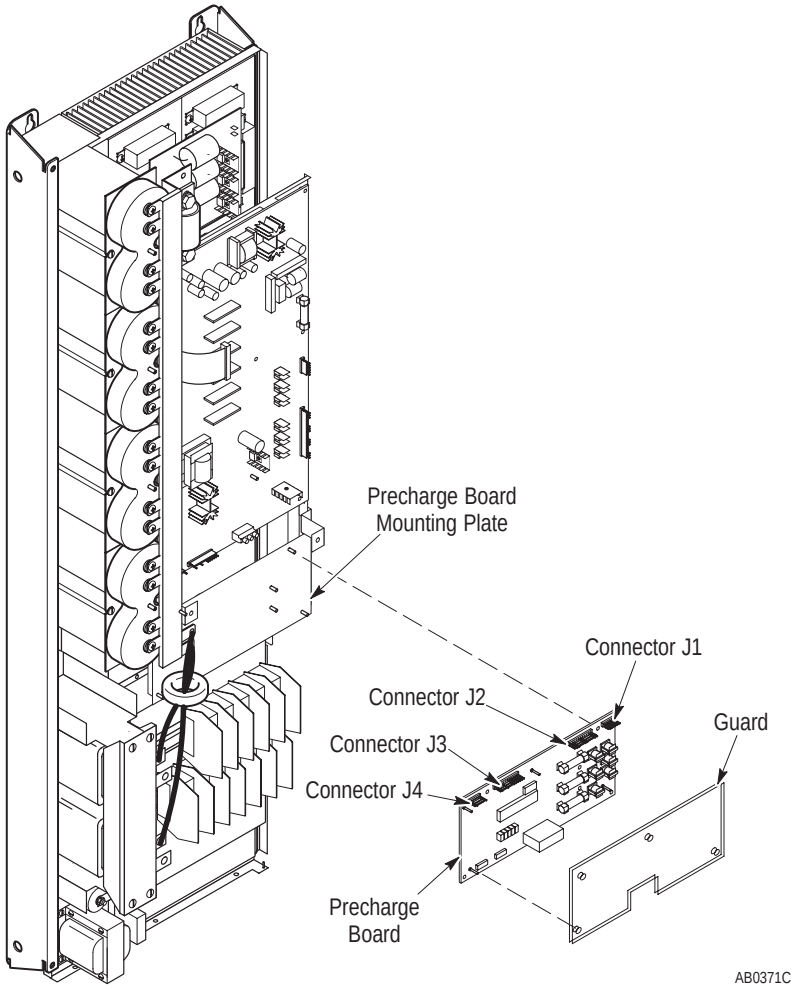
Install the Precharge Board Mounting Plate in reverse order of removal. Refer to Fastener Torque Specifications in this chapter.

ATTENTION: When removing the entire wire harness connecting Gate Driver Board connector J9 to Precharge Board connector J3, align the wires on the harness terminals with the pins on the board connectors. Incorrect harness connection may result in faulty drive operation and may damage the equipment.

ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.

Removing the Precharge Board

Figure 3.10
Precharge Board



Removal

ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.

IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Open the Enclosure Door.
3. Check for zero volts at TB1 terminals +DC and –DC.
4. Check for absence of control voltage at TB2 and TB3.
5. Disconnect the following from the Precharge Board:
   - J1 connector
   - J2 connector
   - J3 connector
   - J4 connector
6. Turn the six stand-off screws, fastening the Precharge Board to the Mounting Plate, 1/4 turn counterclockwise.
7. Remove the Precharge Board Mounting Plate from the drive.

Installation

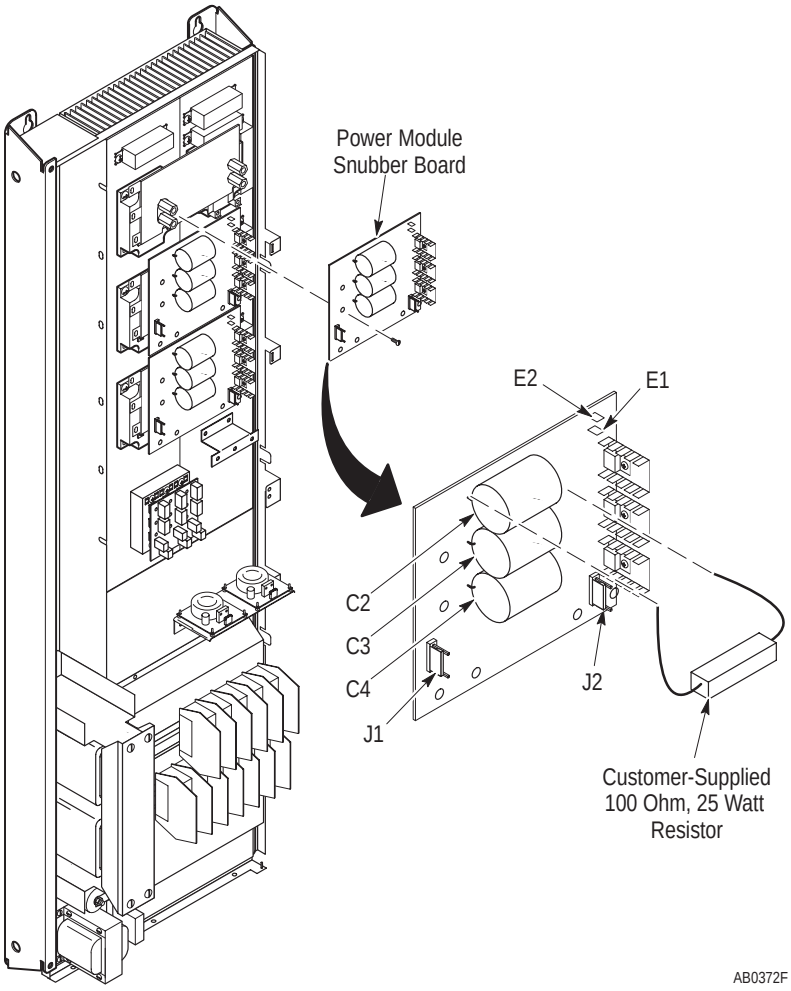
Install the Precharge Board in reverse order of removal. Refer to Fastener Torque Specifications in this chapter.

ATTENTION: When removing the entire wire harness connecting Gate Driver Board connector J9 to Precharge Board connector J3, align the wires on the harness terminals with the pins on the board connectors. Incorrect harness connection may result in faulty drive operation and may damage the equipment.

ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.

Removing a Power Module Snubber Board

Figure 3.11
Power Module Snubber Board



Removal

ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Hazard of electric shock exists. Up to 1,000V DC may be present on Snubber Capacitors. Measure for zero (0)V DC across capacitors C2, C3, and C4. Use a resistor greater than 1ohm and less than 100 ohm, rated for 25 watts minimum to discharge any voltage. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.

IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Open the Enclosure Door.
3. Check for zero volts at TB1 terminals +DC and –DC.
4. Check for absence of control voltage at TB2 and TB3.
5. Remove the Main Control Board Mounting Plate. Refer to Removing the Main Control Board Mounting Plate in this chapter.
6. Remove the Gate Driver Board Mounting Plate. Refer to Removing the Gate Driver Board Mounting Plate in this chapter.
7. Remove the wires from stake-on connectors E1 and E2.
8. Remove J1 and J2 connectors.
9. Remove the eight screws fastening the snubber board to the Power Module.
10. Lift the snubber board out of the enclosure.

Installation

ATTENTION: Do not substitute longer or shorter hardware when fastening the Power Module Snubber Boards to the Power Modules. Use the same size fastener to fasten the components as was originally used. Using different fastener lengths will damage the Power Modules.

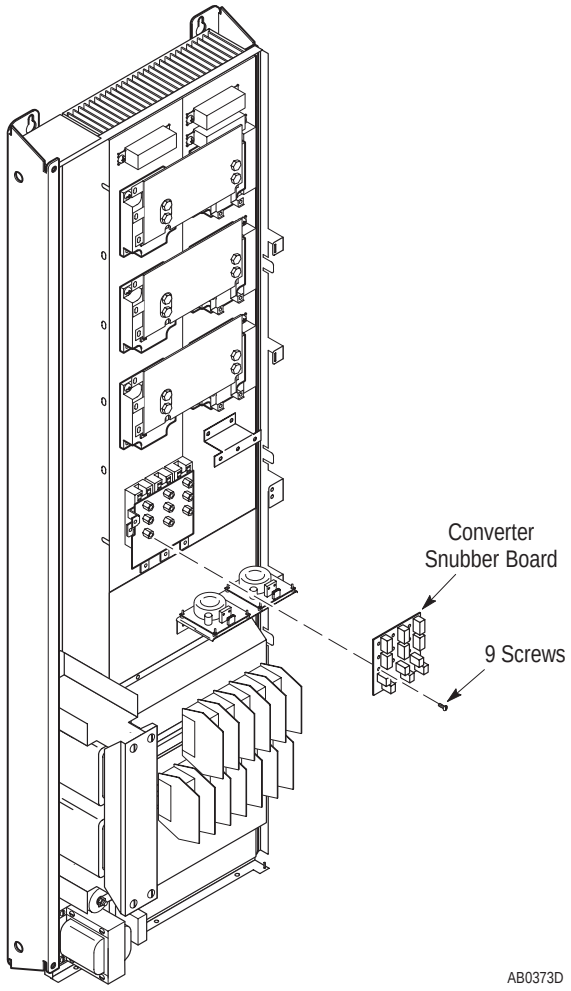
Install the snubber board in reverse order of removal. Refer to Fastener Torque Specifications in this chapter.

IMPORTANT: Line-up the bottom edge of the snubber board with the metal posts on the Power Module Brackets.

ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.

Removing the Converter Snubber Board

Figure 3.12
Converter Snubber Board



Removal

ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Hazard of electric shock exists. Up to 1,000V DC may be present on Snubber Capacitors. Measure for zero (0)V DC across capacitors C2, C3, and C4. Use a resistor greater than 1ohm and less than 100 ohm, rated for 25 watts minimum to discharge any voltage. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.

IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Open the Enclosure Door.
3. Check for zero volts at TB1 terminals +DC and –DC.
4. Check for absence of control voltage at TB2 and TB3.
5. Remove the Gate Driver Board Mounting Plate. Refer to Removing the Gate Driver Board Mounting Plate in this chapter.
6. Remove the Precharge Board Mounting Plate. Refer to Removing the Precharge Board Mounting Plate in this chapter.
7. Remove the nine screws fastening the snubber board to the Input Rectifier.
8. Lift the snubber board out of the enclosure.

Installation

Install the snubber board in reverse order of removal. Refer to Fastener Torque Specifications in this chapter.

ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.

Accessing Power Plane Components

To access the power plane components located on the chassis, refer to Removing a Power Module Snubber Board in this chapter.

Chapter 4

Component Test Procedures

Chapter Objectives

The following tests help you troubleshoot A040 – A060, B060 – B125, BX150, and C075 – C125 drives.

Component Test Overview

In some cases, different tests troubleshoot components of the same name. These similar tests vary according to the rating of the drive being tested. Verify that the rating on the drive matches the rating for the test you are performing.

ATTENTION: Some printed circuit boards and drive components may contain hazardous voltage levels. Remove and lock out power before you disconnect or reconnect wires, and before you remove or replace fuses and circuit boards. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Hazard of electric shock exists. Up to 1,000V DC may be present on Snubber Capacitors. Measure for zero (0)V DC across capacitors C2, C3, and C4. Use a resistor greater than 1ohm and less than 100 ohm, rated for 25 watts minimum to discharge any voltage. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board.

ATTENTION: Servicing energized industrial control equipment can be hazardous. Electrical shock, burns, or unintentional actuation of controlled industrial equipment may cause death or serious injury. Follow the safety-related practices of NFPA 70E, Electrical Safety for Employee Workplaces, when working on or near energized equipment. Do not work alone on energized equipment.

Electrostatic Discharge Precautions

ATTENTION: This assembly contains parts and sub-assemblies that are sensitive to electrostatic discharge. Static control precautions are required when servicing this assembly. Component damage may result if you ignore electrostatic discharge control procedures. If you are not familiar with static control procedures, reference Allen-Bradley Publication 8000-4.5.2, Guarding Against Electrostatic Discharge, or any other applicable ESD protection handbook.

Electrostatic discharge generated by static electricity can damage the complimentary metallic oxide semiconductor devices on various drive boards. It is recommended that you perform these procedures to guard against this type of damage when circuit boards are removed or installed:

- Wear a wrist type grounding strap that is grounded to the chassis.
- Attach the wrist strap before removing the new circuit board from the conductive packet.
- Remove boards from the drive and immediately insert them into their conductive packets.

Tools

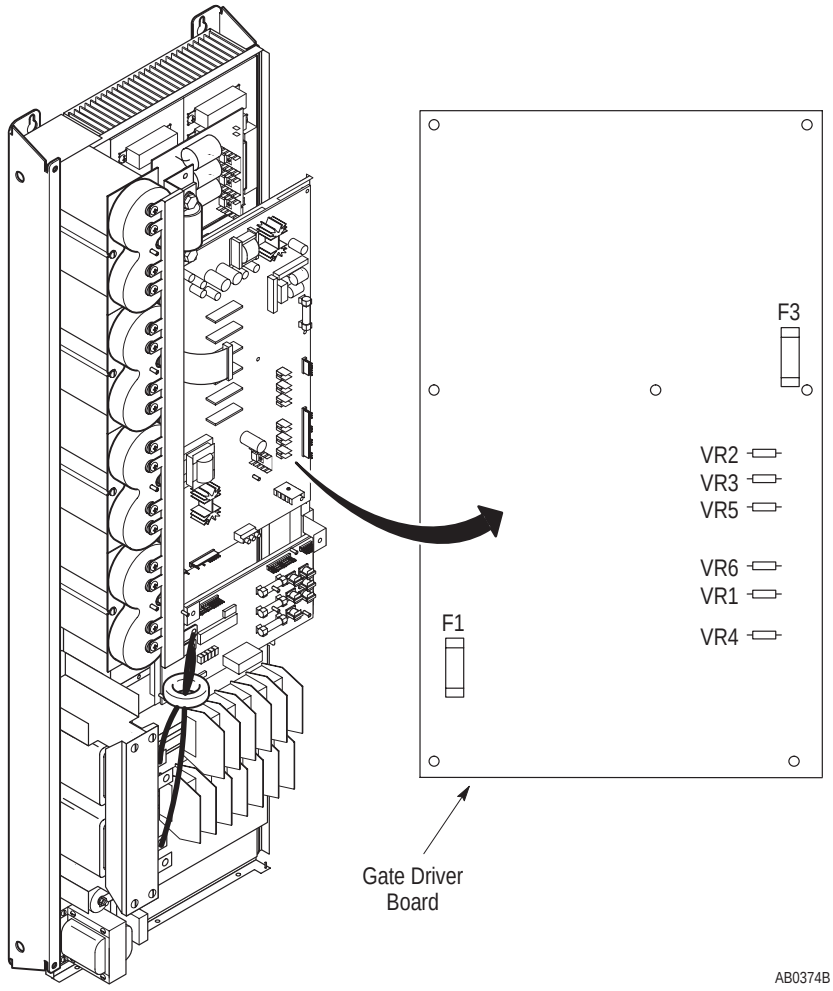
You need the following tools to disassemble and assemble the drive:

- Pliers
- Phillips screwdrivers (medium and large)
- Standard screwdrivers (small, medium, and large)
- 10 mm socket
- 13 mm deep-well socket
- 5/16-inch or 8 mm open-end wrench
- Torque wrench, metered in in.-lb or N-m
- Nylon tie wraps
- Side cutters
- 17 mm socket

Test 1
Testing the Gate Driver Board

The Gate Driver Board is located between the Main Control Board and the Main Chassis. If one or more Power Modules has been replaced, you must test the Gate Driver Board.

Figure 4.1
Gate Driver Board Test



ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Check for zero volts at TB1 terminals +DC and –DC.
3. Check for absence of control voltage at TB2 and TB3.
4. Remove the Main Control Board Mounting Plate. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Main Control Board Mounting Plate.
5. Set your meter to test resistance.
6. Test Fuses F1 and F3 for an open condition. Replace the Gate Driver Board if either fuse shows an open condition.
7. Set your meter to test diodes.
8. Test VR1 – VR6. The following table shows meter connections at the components and ideal meter readings for those connections. Refer to the former illustration for component locations.

Table 4.A
Gate Driver Board Test

Component	Meter (+) Lead	Meter (–) Lead	Nominal Meter Reading
VR1	+	–	0.9
	–	+	1.5
VR2	+	–	0.9
	–	+	1.5
VR3	+	–	0.9
	–	+	1.5
VR4	+	–	0.9
	–	+	1.5
VR5	+	–	0.9
	–	+	1.5
VR6	+	–	0.9
	–	+	1.5

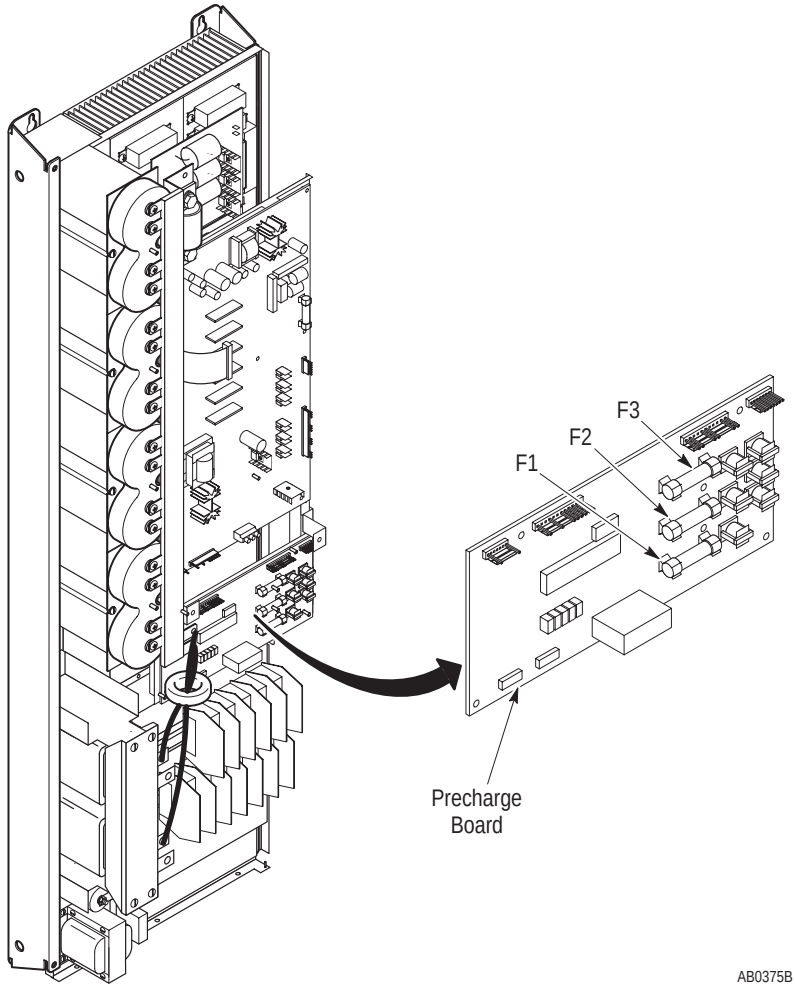
NOTE: Typical malfunction is shorted in both directions.

9. Replace the Gate Driver Board if your readings do not match the table readings. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Gate Driver Board.

ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.

Test 2
Testing the Precharge Board

Figure 4.2
Precharge Board Test



ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

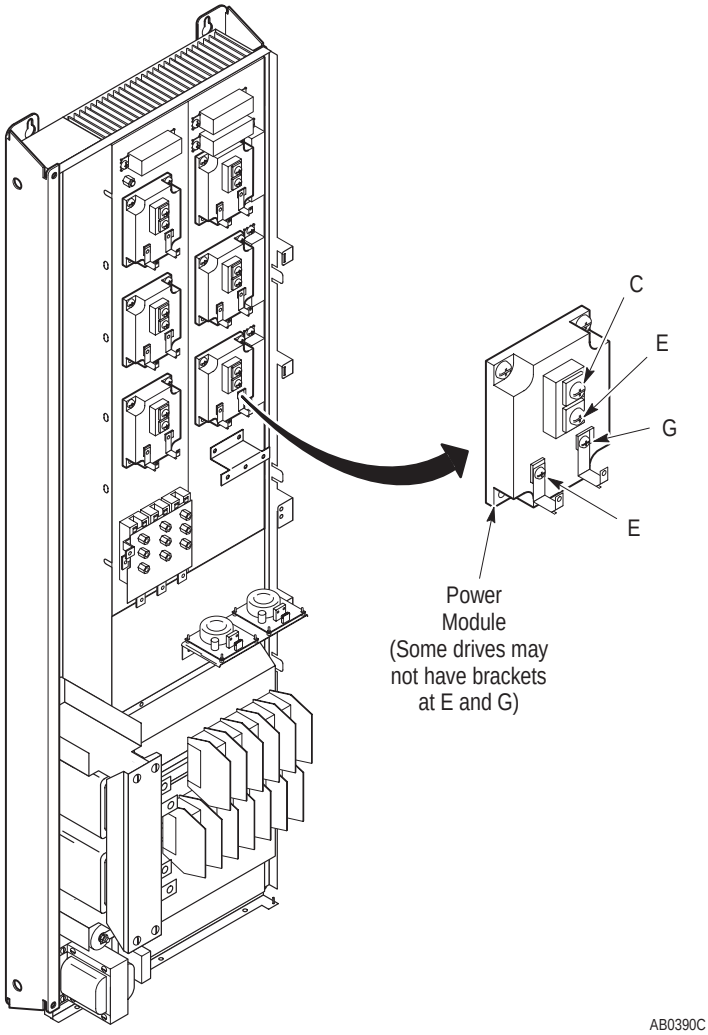
1. Remove power from the drive.
2. Check for zero volts at TB1 terminals +DC and –DC.
3. Check for absence of control voltage at TB2 and TB3.
4. Set your meter to test resistance.
5. Test fuses F1, F2, and F3 for open conditions.
6. Replace the Precharge Board if any fuse shows an open condition. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Precharge Board.

ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.

Test 3
Testing the Power Modules

The Power Modules are located near the top of the heat sink.

Figure 4.3
Power Module Test



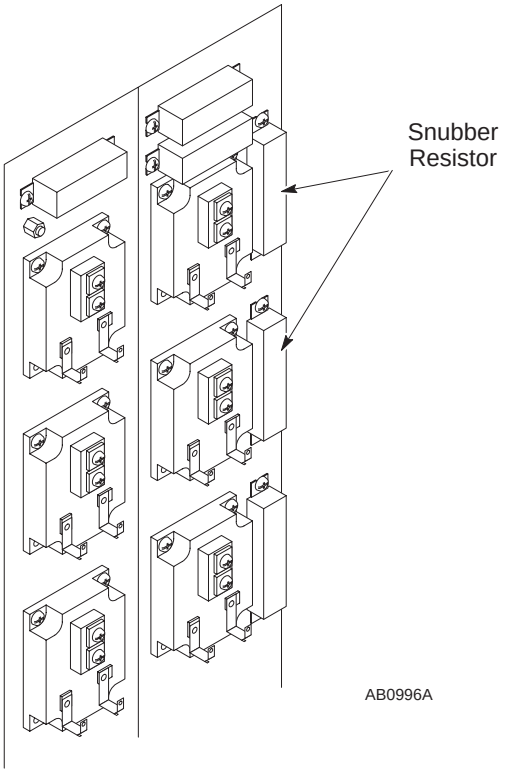
ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Hazard of electric shock exists. Up to 1,000V DC may be present on Snubber Capacitors. Measure for zero (0)V DC across capacitors C2, C3, and C4. Use a resistor greater than 1ohm and less than 100 ohm, rated for 25 watts minimum to discharge any voltage. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board.

IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Check for zero volts at TB1 terminals +DC and –DC.
3. Check for absence of control voltage at TB2 and TB3.
4. Remove the Main Control Board Mounting Plate. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Main Control Board Mounting Plate.
5. Remove the Gate Driver Board Mounting Plate. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Gate Driver Board Mounting Plate.
6. Remove the Power Module Snubber Boards. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board.
7. Test the Snubber Resistor. The Power Module Snubber Resistor will read 0.5 ohm with meter on resistance. Refer to Figure 4.4.

Figure 4.4
Power Module Snubber Resistors



8. Remove the Inverter Bus Bar. Refer to Chapter 5 – Part Replacement Procedures, Power Modules.
9. Set your meter to test diodes.
10. Test the Power Modules. The following table shows meter connections and ideal meter readings for those connections. Refer to Figure 4.3 for meter connection locations.

Table 4.B
Power Modules

Meter (+) Lead	Meter (–) Lead	Nominal Meter Reading
E	C	0.318
E	B	Infinite
C	E	Infinite
C	B	Infinite
B	E	Infinite
B	C	Infinite

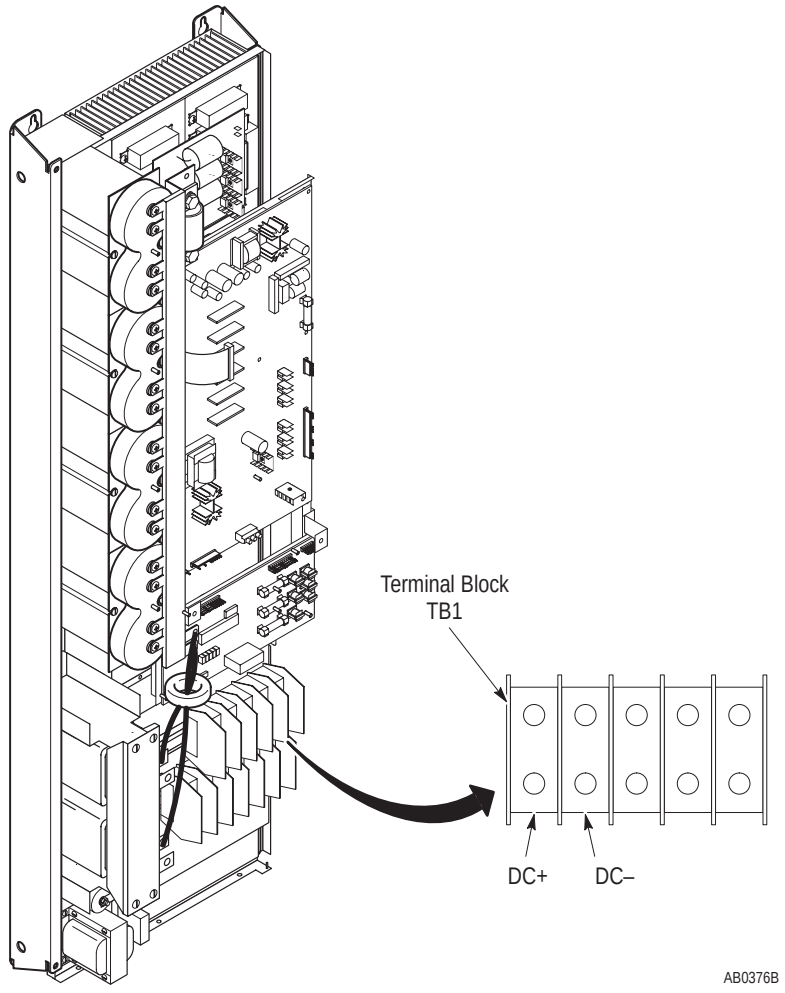
11. Replace both Power Modules in the same phase if meter readings are not as shown. Refer to Chapter 5 – Part Replacement Procedures, Power Modules.
12. If one or more Power Modules is replaced, test the Gate Driver Board. Refer to Testing the Gate Driver Board in this chapter.

ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.

Test 4
Testing the Bus Capacitors

The Bus Capacitor Bank is located on the left side of the Main Chassis.

Figure 4.5
Bus Capacitor Bank Test



ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Hazard of electric shock exists. Up to 1,000V DC m ay be present on Snubber Capacitors. Measure for zero (0)V DC across capacitors C2, C3, and C4. Use a resistor greater than 1ohm and less than 100 ohm, rated for 25 watts minimum to discharge any voltage. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board.

IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Check for zero volts at TB1 terminals +DC and –DC.
3. Check for absence of control voltage at TB2 and TB3.
4. Remove the guard from the bus capacitors.
5. Set your meter to test voltage.
6. Connect the negative (–) lead of your meter to the (–) DC Bus terminal on TB1 and the positive lead to the (+) DC Bus terminal. Refer to the following tables and former illustration for meter readings and terminal locations.

ATTENTION: Servicing energized industrial control equipment can be hazardous. Electrical shock, burns, or unintentional actuation of controlled industrial equipment may cause death or serious injury. Follow the safety-related practices of NFPA 70E, Electrical Safety for Employee Workplaces, when working on or near energized equipment. Do not work alone on energized equipment.

7. Apply power **AFTER** the meter is connected, otherwise your meter will read zero volts. Expand readings for all input voltage ratings.

Table 4.C
Bus Capacitor Bank Test

Drive Rating	Input Volts	Meter Reading
A	200	280V DC +/–10%
	230	322V DC +/–10%
	240	336V DC +/–10%
B	380	535V DC +/–10%
	415	580V DC +/–10%
	480	650V DC +/–10%
C	500	700V DC +/–10%
	575	800V DC +/–10%
	600	850V DC+/–10%

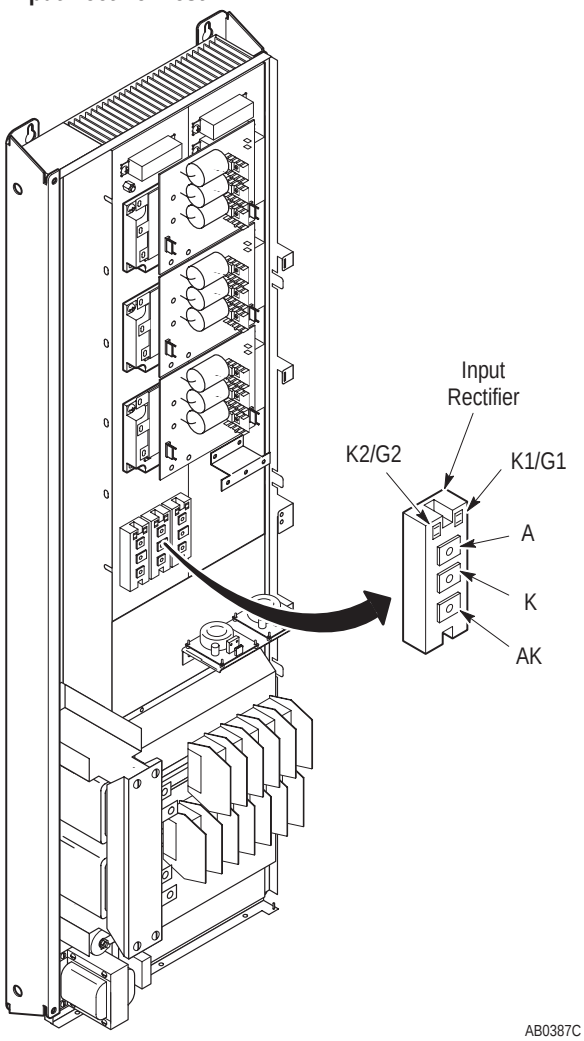
8. If the voltage is out of tolerance, check the following:
   - An open condition at an Input Rectifier.
   - A voltage drop due to Bus Inductor L1 resistance.
   - A voltage drop between an Input Rectifier and the bus capacitors due to loose or resistive wires or connections.
   - Precharge circuit problems.
9. If the above check does not reveal a problem, replace the Bus Capacitor Bank and Load-Sharing Resistors. Refer to Chapter 5 – Part Replacement Procedures, Bus Capacitor Bank.

ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.

Test 5
Testing the Input Rectifiers

The Input Rectifiers are located on the bottom of the heat sink.

Figure 4.6
Input Rectifier Test



ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Hazard of electric shock exists. Up to 1,000V DC may be present on Snubber Capacitors. Measure for zero (0)V DC across capacitors C2, C3, and C4. Use a resistor greater than 1ohm and less than 100 ohm, rated for 25 watts minimum to discharge any voltage. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board.

IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Check for zero volts at TB1 terminals +DC and –DC.
3. Check for absence of control voltage at TB2 and TB3.
4. Remove the Gate Driver Board Mounting Plate. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Gate Driver Board Mounting Plate.
5. Remove the Precharge Board Mounting Plate. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Precharge Board Mounting Plate.
6. Remove the Converter Snubber Board. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Converter Snubber Board.
7. Remove the Converter Bus Bar.
8. Set your meter to test diodes.

9. The following table shows meter connections and ideal meter readings for those connections. Refer to the former illustration for meter connection locations.

Table 4.D
Input Rectifier Test

Meter (+) Lead	Meter (–) Lead	Nominal Meter Reading
AK	K	Infinite
AK	A	Infinite
K	A	Infinite
K	AK	Infinite
A	AK	Infinite
A	K	Infinite
G1	K1	0.008
K1	G1	0.008
G2	K2	0.008
K2	G2	0.008

10. Replace the Input Rectifier if any meter readings are not as shown. Refer to Chapter 5 – Part Replacement Procedures, Input Rectifiers.
11. If the Input Rectifier shorted, check the Power Modules for damage. Refer to Testing the Power Modules in this chapter.

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Chapter 5

Part Replacement Procedures

Chapter Objective

This chapter describes procedures required to replace drive components. This chapter references Chapter 3 – Disassembly and Access Procedures for basic drive component access.

Part Replacement Overview

The part replacement procedures in this chapter assume that the drive you are servicing either has no enclosure or that the enclosure is removed from the drive. For more information on removing the Drive Enclosure, refer to Chapter 3 – Disassembly and Access Procedures, Removing the Drive Enclosure.

Safety Precautions

ATTENTION: Some printed circuit boards and drive components may contain hazardous voltage levels. Remove power before you disconnect or reconnect wires, and before you remove or replace fuses and circuit boards. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Hazard of electric shock exists. Up to 1,000V DC may be present on Snubber Capacitors. Measure for zero (0)V DC across capacitors C2, C3, and C4. Use a resistor greater than 1ohm and less than 100 ohm, rated for 25 watts minimum to discharge any voltage. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board.

Electrostatic Discharge Precautions

ATTENTION: This assembly contains parts and sub-assemblies that are sensitive to electrostatic discharge. Static control precautions are required when servicing this assembly. Component damage may result if you ignore electrostatic discharge control procedures. If you are not familiar with static control procedures, reference Allen-Bradley Publication 8000-4.5.2, Guarding Against Electrostatic Discharge, or any other applicable ESD protection handbook.

Electrostatic discharge generated by static electricity can damage the complimentary metallic oxide semiconductor devices on various drive boards. It is recommended that you perform these procedures to guard against this type of damage when circuit boards are removed or installed:

- Wear a wrist type grounding strap that is grounded to the chassis.
- Attach the wrist strap before removing the new circuit board from the conductive packet.
- Remove boards from the drive and immediately insert them into their conductive packets.

Tools

You need the following tools to disassemble and assemble the drive:

- Pliers
- Phillips screwdrivers (medium and large)
- Standard screwdrivers (small, medium, and large)
- 10 mm socket
- 13 mm deep-well socket
- 5/16-inch or 8 mm open-end wrench
- Torque wrench, metered in in.-lb or N-m
- Nylon tie wraps
- Side cutters
- 17 mm socket

Major Component Replacement

This section explains in detail how to replace the following drive components:

- Bus Capacitors
- Thermistor
- Power Modules
- Input Rectifiers
- Fan Assembly
- Autotransformer
- DC Bus Inductor L1
- Ground Sense CT
- Bus Fuse
- LEMs
- MOV Surge Suppressor

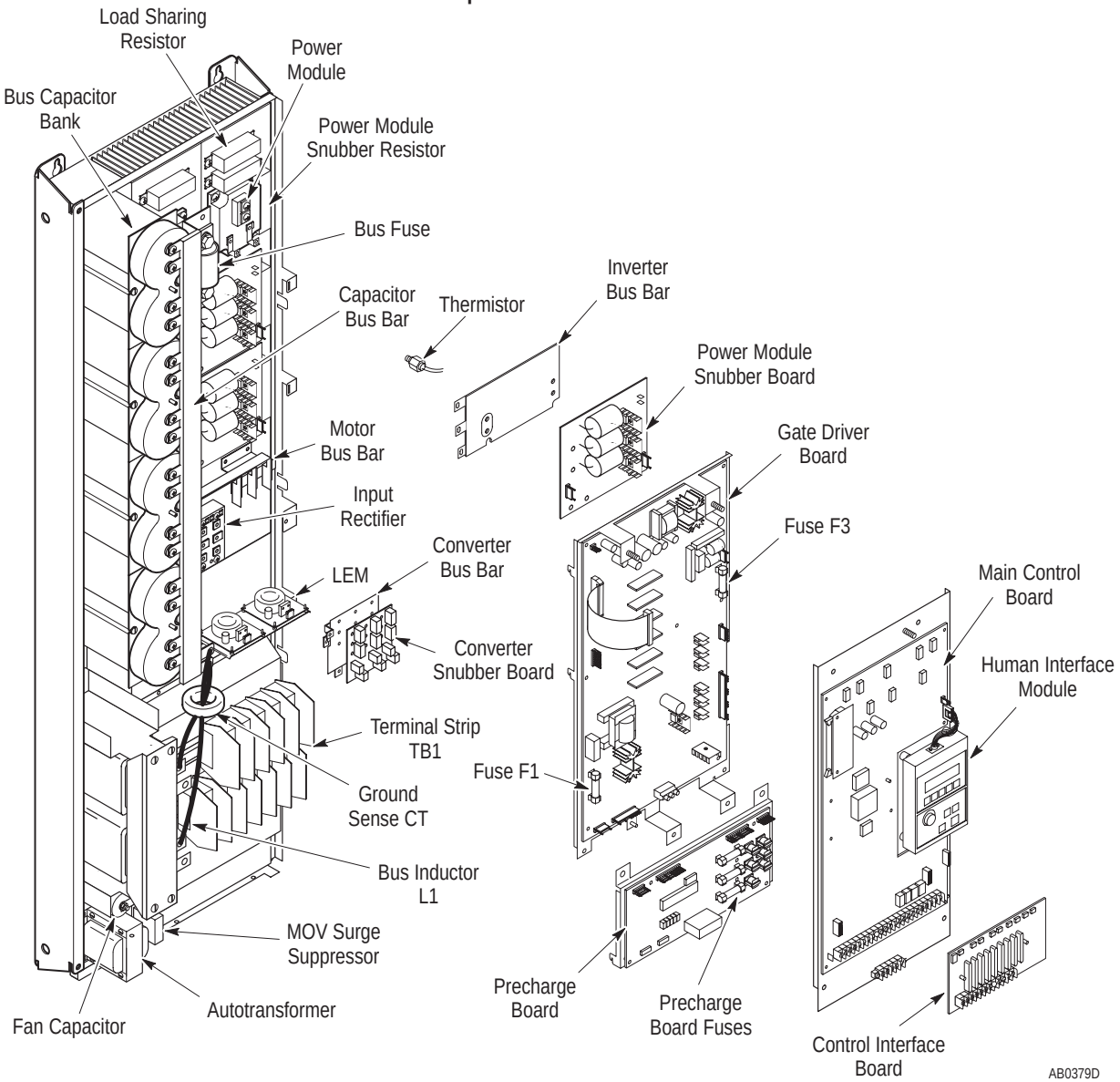
For Gate Driver, Precharge Board, Main Control Board, Snubber Board, and Control Interface Board installation and removal procedures, refer to Chapter 3 – Disassembly and Access Procedures.

Detailed Product Identification

Allen-Bradley Adjustable Frequency AC Drives are modular by design to enhance troubleshooting and spare parts replacement, thereby helping reduce production down-time.

The following illustration calls out the main components of a typical drive. Component designs vary slightly among the different drive ratings, but component locations are identical.

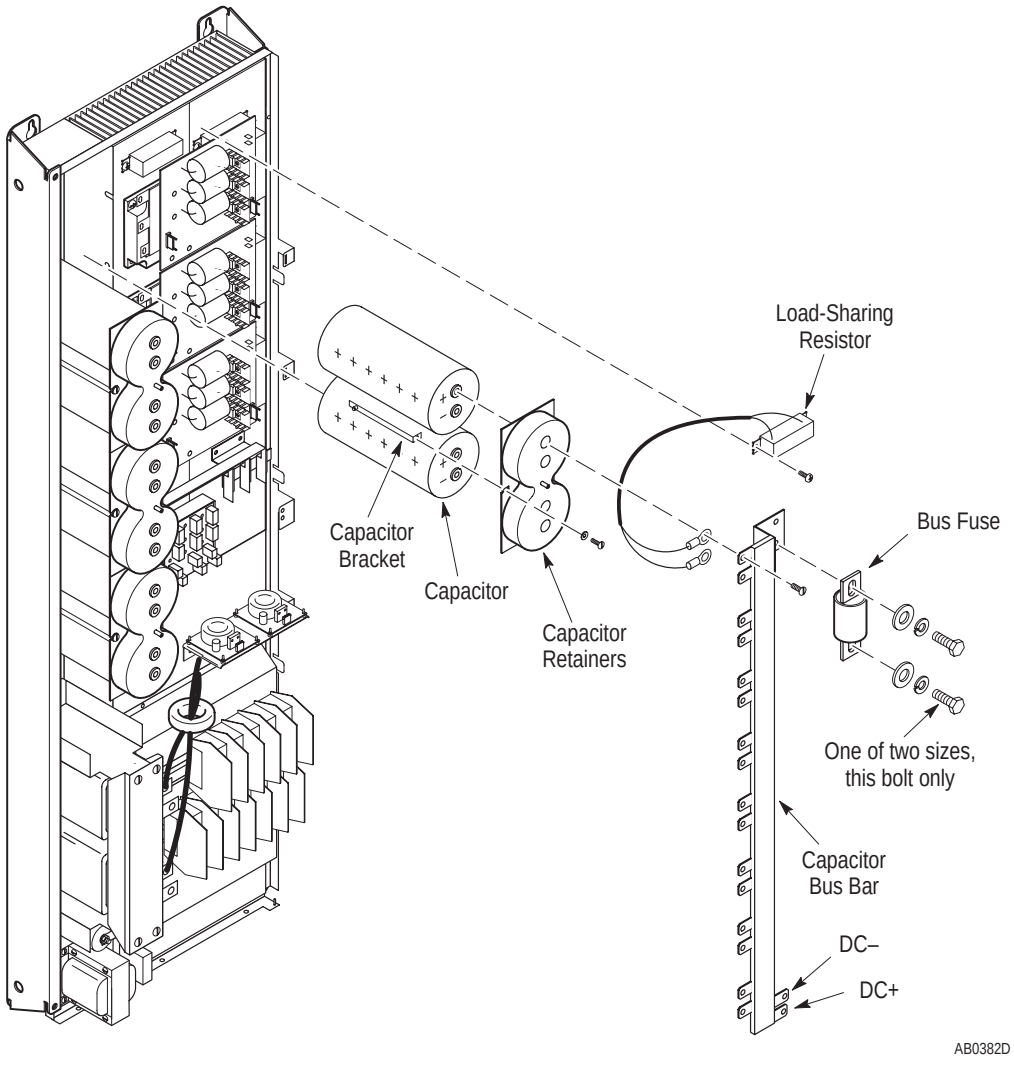
Figure 5.1
Main Drive Components



Bus Capacitor Bank

The Bus Capacitor Bank is located on the left side of the Main Chassis.

Figure 5.2
Bus Capacitor Bank



Removal

ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Hazard of electric shock exists. Up to 1,000V DC may be present on Snubber Capacitors. Measure for zero (0)V DC across capacitors C2, C3, and C4. Use a resistor greater than 1ohm and less than 100 ohm, rated for 25 watts minimum to discharge any voltage. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.

IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Check for zero volts at TB1 terminals +DC and –DC.
3. Check for absence of control voltage at TB2 and TB3.
4. Remove the screws fastening the Bus Capacitor Guard to the Capacitor Bank. Slide the Capacitor Guard toward the center of the drive to disengage the tabs. Lift the Capacitor Guard out of the Drive.
5. Remove the Bus Fuse. Refer to Bus Fuse in this chapter.
6. Remove the bolt and washer assembly fastening the Capacitor Bus Bar to the Transition Bus Bar. The Transition Bus Bar assembly is located under, and attached to, the Bus Fuse.
7. Remove the Load-Sharing Resistor wires and the Capacitor Bus Bar screws.
8. Remove the Bus Inductor L1 cables and Bus Voltage wire harness from the Capacitor Bus Bar.
9. Remove the Capacitor Bus Bar.
10. Loosen the screws on the Capacitor Brackets. Slide the brackets away from the Capacitor Retainers and down to remove.
11. Remove the Capacitor Retainers.
12. Lift the Bus Capacitors out of the Drive.

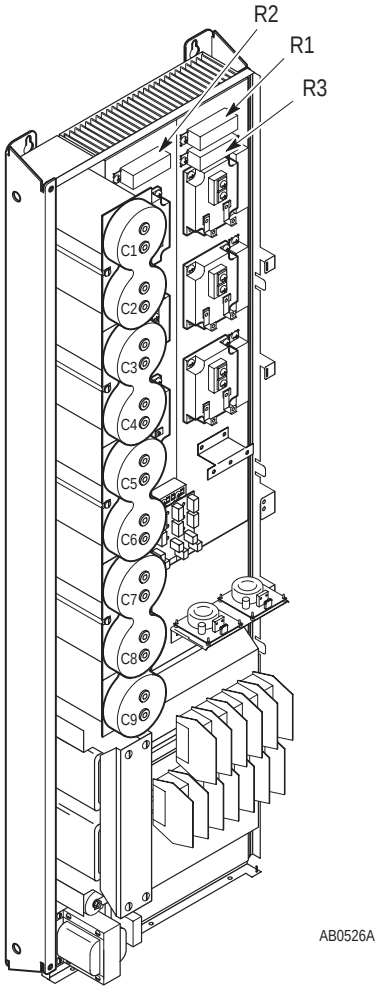
Installation

1. Fasten the capacitor assembly in reverse order of removal. Refer to Chapter 3 – Disassembly and Access Procedures, Fastener Torque Specifications.

IMPORTANT: Refer to Bus Fuse in this chapter for correct Bus Fuse fastener size and type.

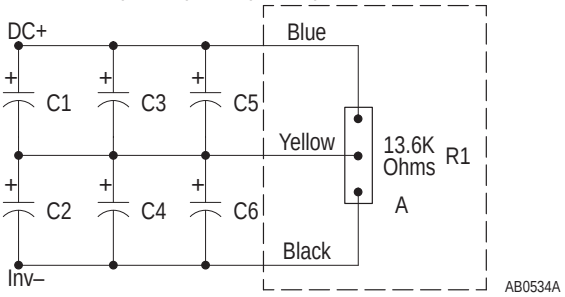
2. Connect the Load-Sharing Resistors to the Bus Capacitors according to the following diagrams.

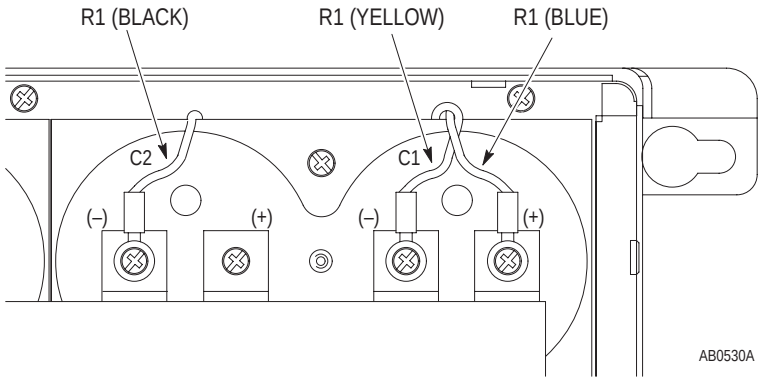
Figure 5.3
Load-Sharing Resistor Connections to Bus Capacitors



Load sharing resistor R1 has three color coded leads coming out of the resistor body. Connect as shown in Figure 5.4.

Figure 5.4
Wiring Detail for A040, A050, B060, B075, and B100 Drives

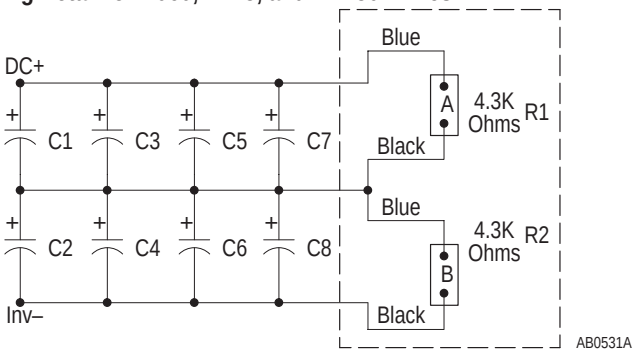


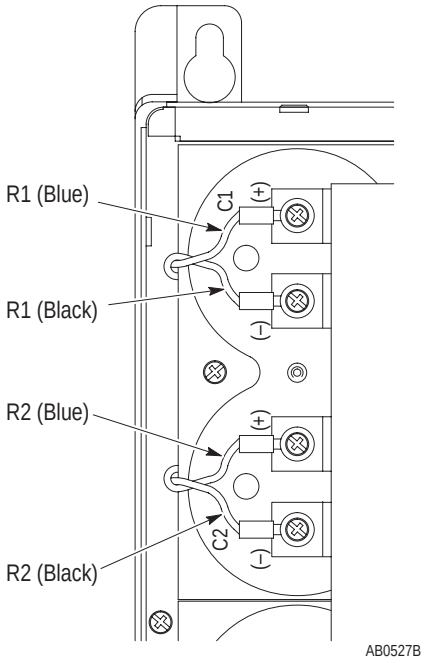


ATTENTION: The Capacitor Bus must connect a positive (+) capacitor terminal to a negative (–) capacitor terminal. Capacitors not connected correctly will explode and cause death or serious injury.

Load sharing resistors R1 and R2 have two color coded leads coming out of each resistor body. Connect as shown in Figure 5.5.

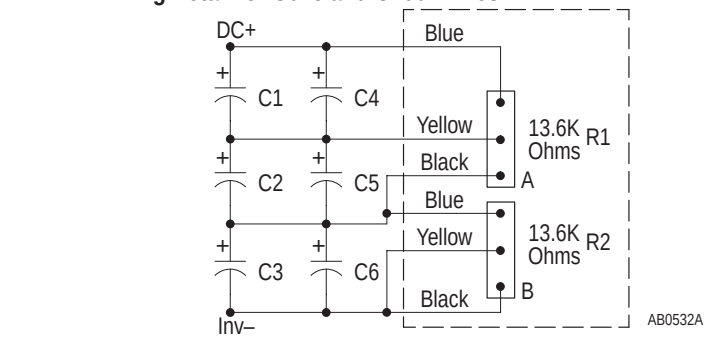
Figure 5.5
Wiring Detail for A060, B125, and BX150 Drives

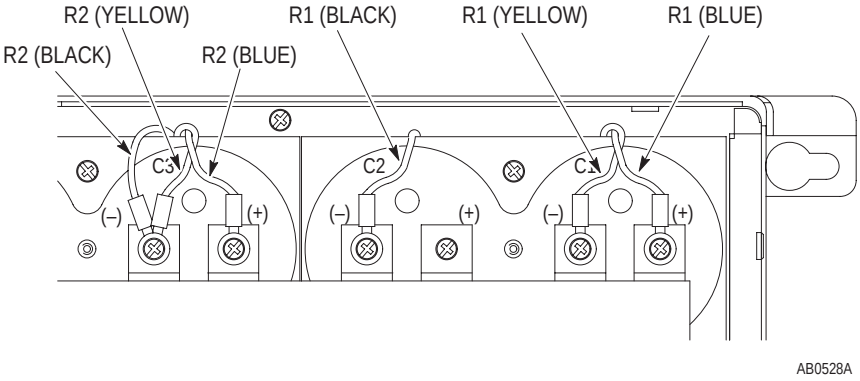




Load sharing resistors R1 and R2 have three color coded leads coming out of each resistor body. Connect as shown in Figure 5.6.

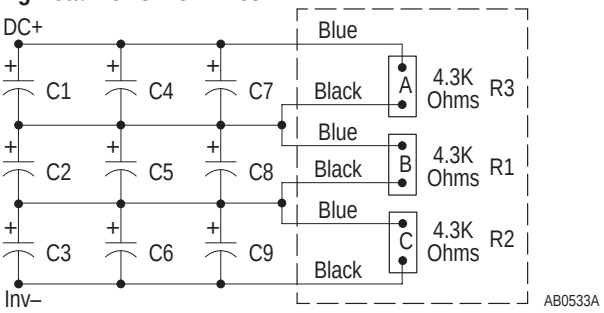
Figure 5.6
Wiring Detail for C075 and C100 Drives

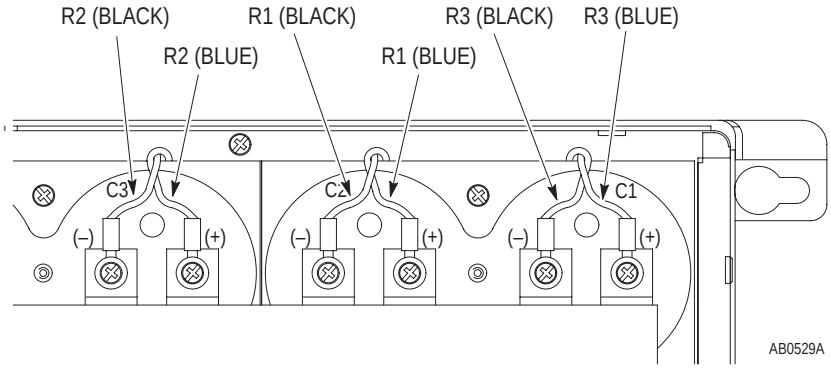




Load sharing resistors R1, R2, and R3 have two color coded leads coming out of each resistor body. Connect as shown in Figure 5.7.

Figure 5.7
Wiring Detail for C125 Drives

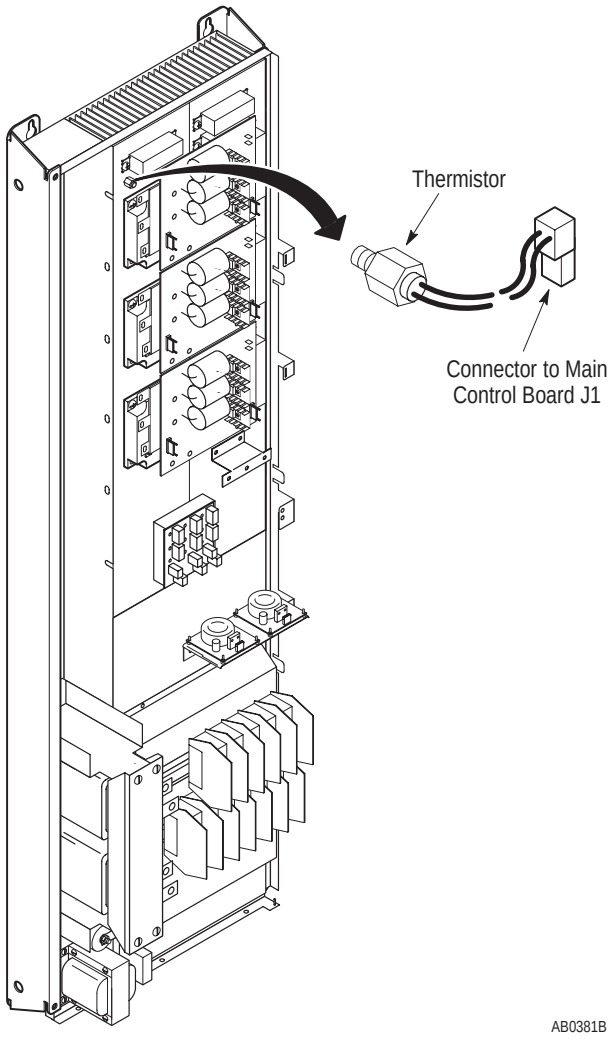




Thermistor

The Thermistor is located on the top-left corner of the heat sink.

Figure 5.8
Thermistor



Removal

ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Hazard of electric shock exists. Up to 1,000V DC may be present on Snubber Capacitors. Measure for zero (0)V DC across capacitors C2, C3, and C4. Use a resistor greater than 1ohm and less than 100 ohm, rated for 25 watts minimum to discharge any voltage. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.

IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Check for zero volts at TB1 terminals +DC and –DC.
3. Check for absence of control voltage at TB2 and TB3.
4. Disconnect the Thermistor connector at J1 on the Main Control Board.
5. Remove the Gate Driver Board Mounting Plate. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Gate Driver Board Mounting Plate.
6. Cut and remove tie wraps along the wire routing path of the Thermistor.
7. Remove the Thermistor from the heat sink.

Installation

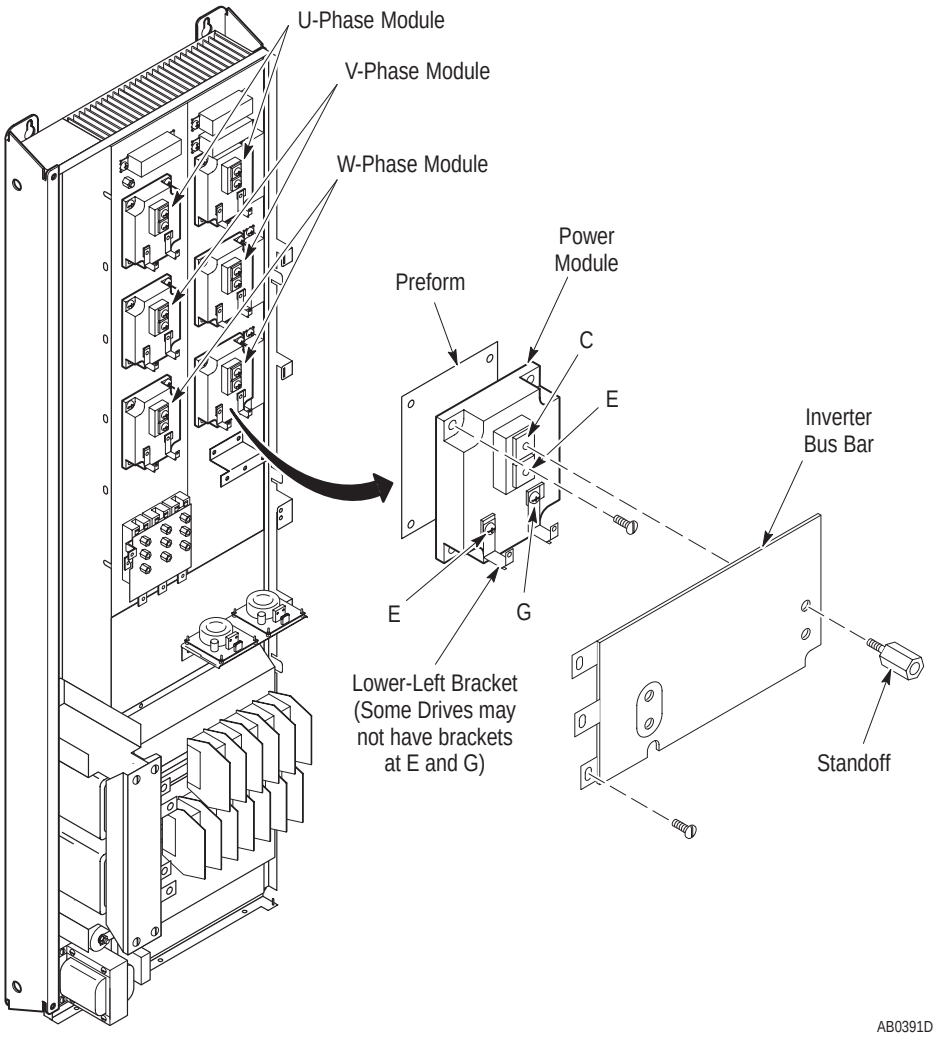
Install the Thermistor in reverse order of removal, replacing tie wraps as needed. Refer to Chapter 3 – Disassembly and Access Procedures, Fastener Torque Specifications.

ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.

Power Modules

The Power Modules are located near the top of the heat sink.

Figure 5.9
Power Modules



Removal

ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Hazard of electric shock exists. Up to 1,000V DC may be present on Snubber Capacitors. Measure for zero (0)V DC across capacitors C2, C3, and C4. Use a resistor greater than 1ohm and less than 100 ohm, rated for 25 watts minimum to discharge any voltage. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.

IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Check for zero volts at TB1 terminals +DC and –DC.
3. Check for absence of control voltage at TB2 and TB3.
4. Remove the Gate Driver Board Mounting Plate. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Gate Driver Board Mounting Plate.
5. Remove the Power Module Snubber Board. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board.
6. Remove the three screws located at (+), (–), and MTR on the Inverter Bus Bar.
7. Remove the four Standoffs from the Inverter Bus Bar.
8. Remove the four screws fastening the Power Module to the Drive.

Installation

1. Clean all surfaces between the Power Module and the heat sink using a soft, clean cloth.
2. Replace the Preform between the Power Module and the heat sink.
3. Install the Power Module in reverse order of removal. Refer to Chapter 3 – Disassembly and Access Procedures, Fastener Torque Specifications.

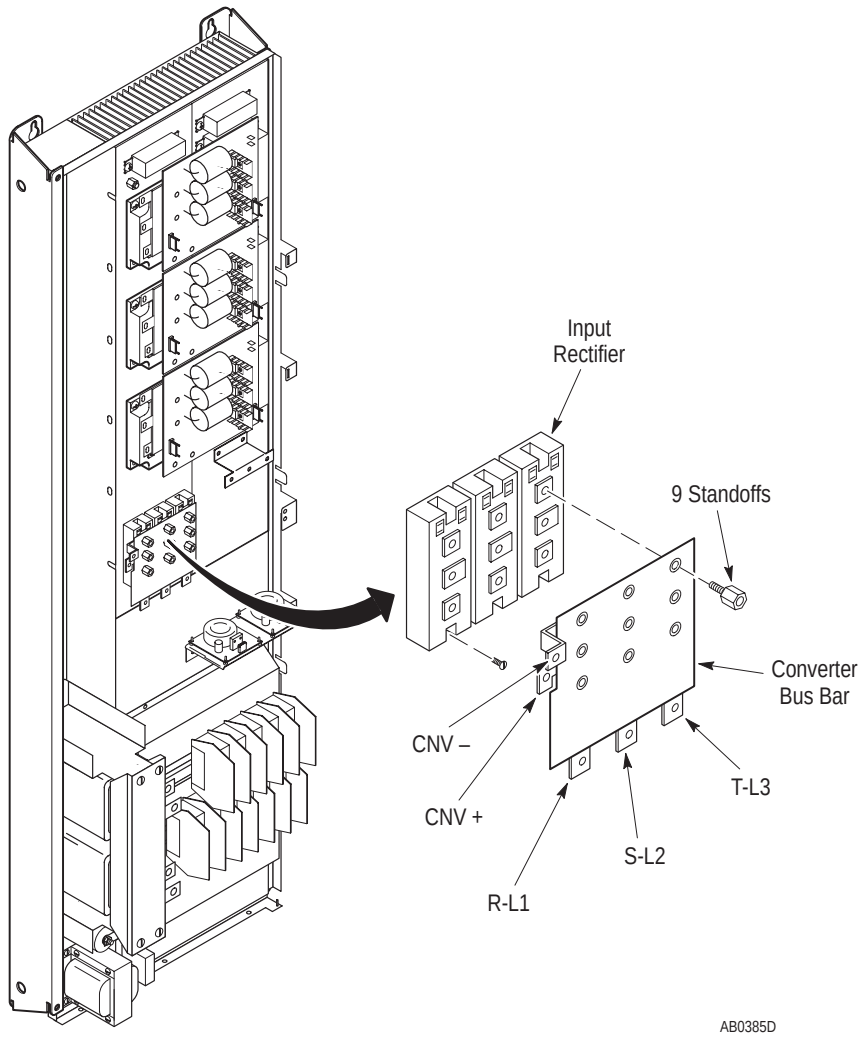
IMPORTANT: Slide the MTR tab on the Inverter Bus Bar under the corresponding tab on the Transition Bus Bar.

ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.

Input Rectifiers

The Input Rectifiers are located at the bottom of the heat sink.

Figure 5.10
Input Rectifiers



Removal

ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Hazard of electric shock exists. Up to 1,000V DC may be present on Snubber Capacitors. Measure for zero (0)V DC across capacitors C2, C3, and C4. Use a resistor greater than 1ohm and less than 100 ohm, rated for 25 watts minimum to discharge any voltage. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.

IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Check for zero volts at TB1 terminals +DC and –DC.
3. Check for absence of control voltage at TB2 and TB3.
4. Remove the Gate Driver Board Mounting Plate. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Gate Driver Board Mounting Plate.
5. Remove the Precharge Board Mounting Plate. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Precharge Board Mounting Plate.
6. Remove the Converter Snubber Board. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Converter Snubber Board.
7. Remove all cable connections from the Convertor Bus Bars.
8. Remove the Standoffs and the Converter Bus Bar from the rectifiers.
9. Remove the screws fastening the Input Rectifier to the drive.

Installation

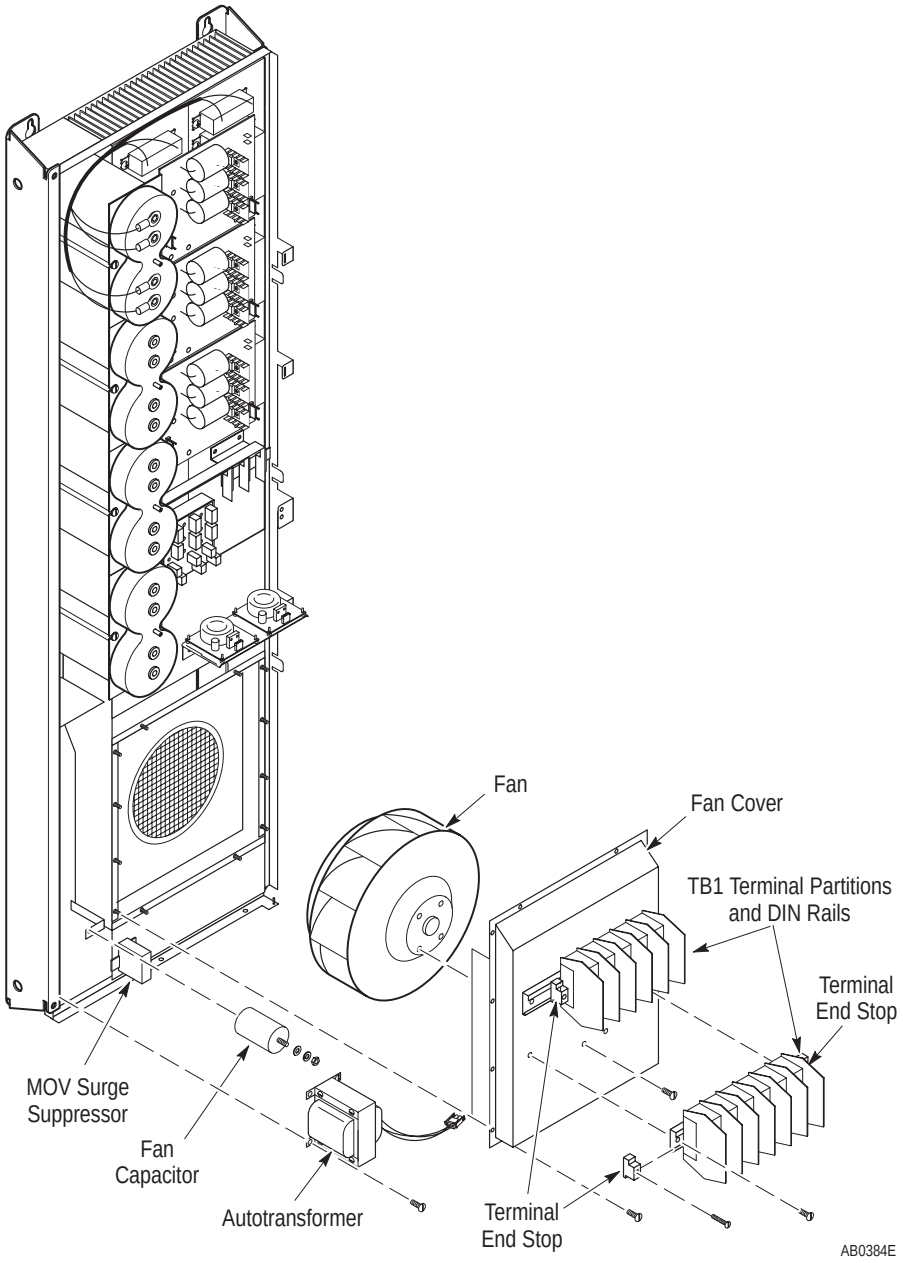
1. Clean all surfaces between the Input Rectifier and the heat sink using a soft, clean cloth.
2. Replace the Preform between the Input Rectifier and the heat sink.
3. Install the Input Rectifier in reverse order of removal. Refer to Chapter 3 – Disassembly and Access Procedures, Fastener Torque Specifications.

ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.

Fan Assembly

The Fan is located under TB1 at the bottom of the Main Chassis. The Autotransformer and Fan Capacitor are located in the bottom left corner of the Main Chassis.

Figure 5.11
Fan Assembly



Removal

ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.

IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

Access the Drive:

1. Remove power from the drive.
2. Turn the Enclosure Door latches, located on the right side of the Enclosure Door, 90 degrees counterclockwise.
3. Open the Enclosure Door.
4. Check for zero volts at TB1 terminals +DC and –DC before proceeding with tests or part replacement.
5. Check for the absence of control voltage at TB2, TB3, and any other external connections.
6. Disconnect the wiring as follows:
   - Wire harness connecting the Fan to the Autotransformer
   - Ground wire from the ground stud
   - MOV Surge Suppressor wire from the ground stud
   - All wires from TB1

Remove the Upper DIN Rail:

1. Loosen the screw fastening the Terminal End Stop to the left side of the Upper DIN Rail to remove the end stop, exposing a screw on the DIN rail.
2. Remove the exposed screw from the DIN rail.
3. Slide the TB1 terminals to the left to expose the other screw on the Upper DIN Rail.
4. Remove the exposed screw from the DIN rail to remove the Upper DIN Rail from the Fan Cover.

Remove the Lower DIN Rail:

1. Loosen the screw fastening the Terminal End Stop to the right side of the Lower DIN Rail to remove the end stop.
2. Slide TB1 terminal W-M3 off the DIN rail to expose a screw on the DIN rail.
3. Remove the exposed screw from the DIN rail.
4. Slide the TB1 terminals to expose the other screw on the lower DIN rail.
5. Remove the exposed screw from the DIN rail to remove the lower DIN rail from the Fan Cover.
6. Remove the screws fastening the Fan Cover to the Main Chassis.
7. Lift the fan and cover from the Drive.
8. Remove the screws fastening the Fan to the Fan Cover to remove the Fan from the cover.
9. Remove the nut fastening the Fan Capacitor to the bracket to remove the capacitor.

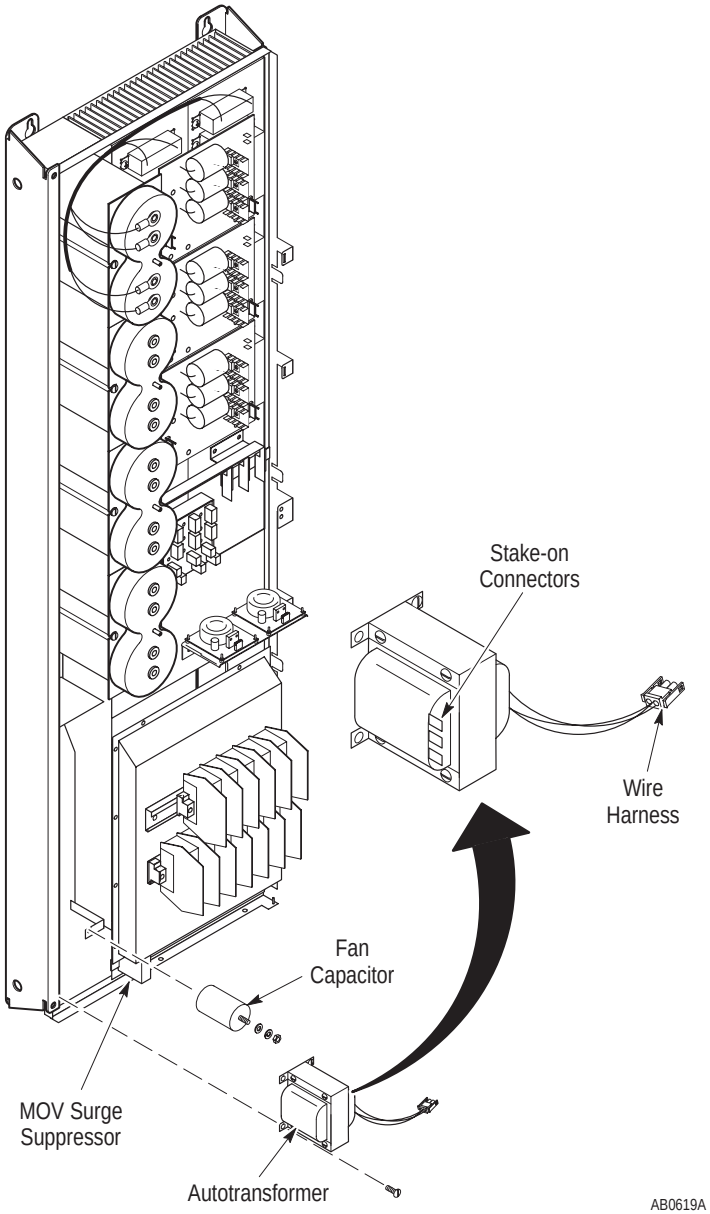
Installation

1. Thread the Fan wire through the hole in the Fan Cover.
2. Fasten the Fan to the Fan Cover.
3. Install the Fan and capacitor in reverse order of removal. Refer to Chapter 3 – Disassembly and Access Procedures, Fastener Torque Specifications.

ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.

Autotransformer

Figure 5.12
Autotransformer



Removal

1. Remove power from the drive.
2. Check for zero volts at TB1 terminals +DC and –DC before proceeding with tests or part replacement.
3. Check for the absence of control voltage at TB2, TB3, and any other external connections.
4. Remove the Autotransformer wire from TB1 terminal S-L2.

5. Remove the wire from the Autotransformer Stake-on connector. Note the location of the stake-on connector for installation.
6. Disconnect the wire harness connecting the Autotransformer to the Fan.
7. Remove the screws fastening the Autotransformer to the chassis.

Installation

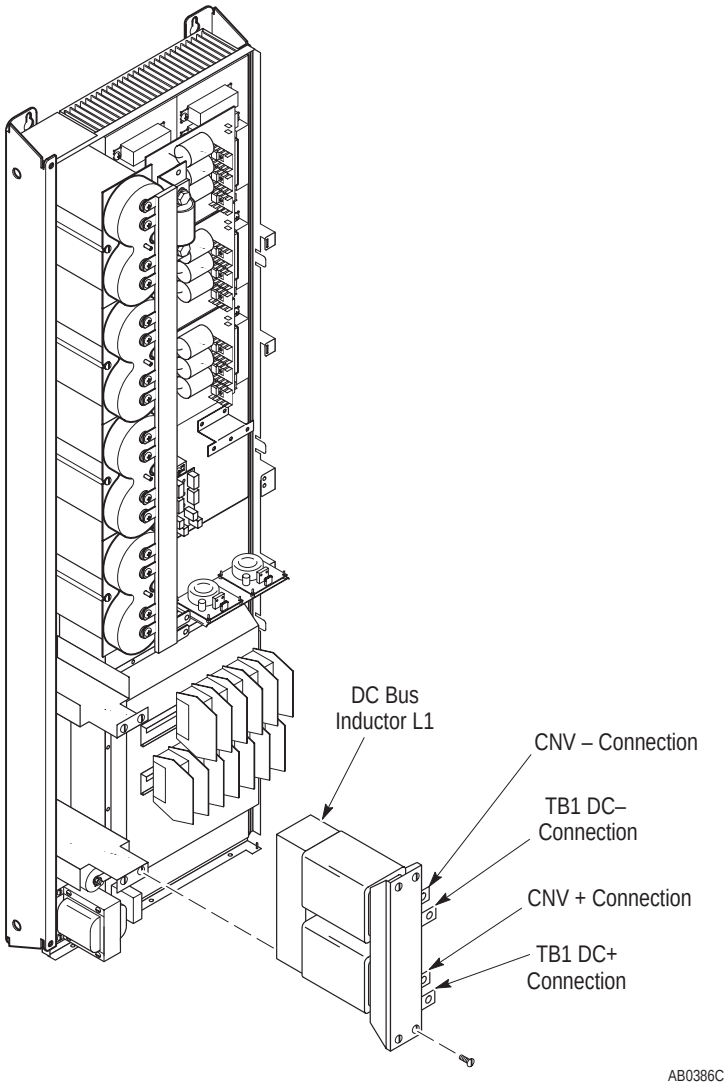
Install the Autotransformer in reverse order of removal. Refer to Chapter 3 – Disassembly and Access Procedures, Fastener Torque Specifications.

IMPORTANT: On the replacement Autotransformer, connect the wire from Removal Step 5, above, to the same stake-on connector from which the wire was removed. Refer to the Fan wiring diagram in the Schematics section of this manual for correct transformer-tap voltage.

DC Bus Inductor L1

DC Bus Inductor L1 is located on the lower left corner of the Drive.

Figure 5.13
DC Bus Inductor L1



Removal

ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.

IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Check for zero volts at TB1 terminals +DC and –DC.
3. Check for absence of control voltage at TB2 and TB3.
4. Remove the guard.
5. Remove the wires from the Bus Inductor terminals.
6. Remove the four screws fastening Bus Inductor L1 to the Drive.
7. Lift the Bus Inductor out of the Drive.

Installation

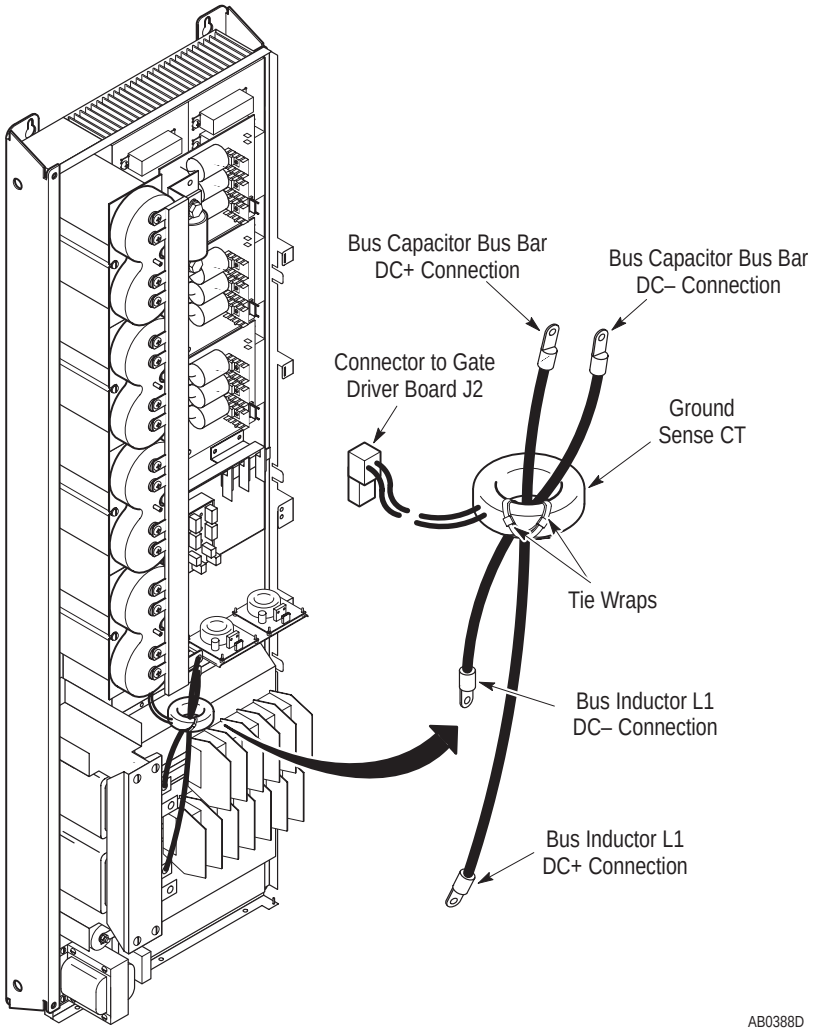
1. Lower the inductor into the Main Chassis, inserting the inductor into the bottom inductor bracket.
2. Install DC Bus Inductor L1 in reverse order of removal. Refer to Chapter 3 – Disassembly and Access Procedures, Fastener Torque Specifications.

ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.

Ground Sense CT

The Ground Sense CT is located in the lower left of the Drive.

Figure 5.14
Ground Sense CT



Removal

ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.

IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Check for zero volts at TB1 terminals +DC and –DC.
3. Check for absence of control voltage at TB2 and TB3.
4. Disconnect the Ground Sense CT from Gate Driver Board connector J2.
5. Remove the Bus Capacitor Guard.
6. Remove the following:
   - Bus Capacitor Bus Bar DC+ wire.
   - Bus Capacitor Bus Bar DC– wire.
   - Bus Voltage Wire Harness
7. Cut the tie wraps from the Ground Sense CT.
8. Slide the Ground Sense CT off the Bus Capacitor wires.

Installation

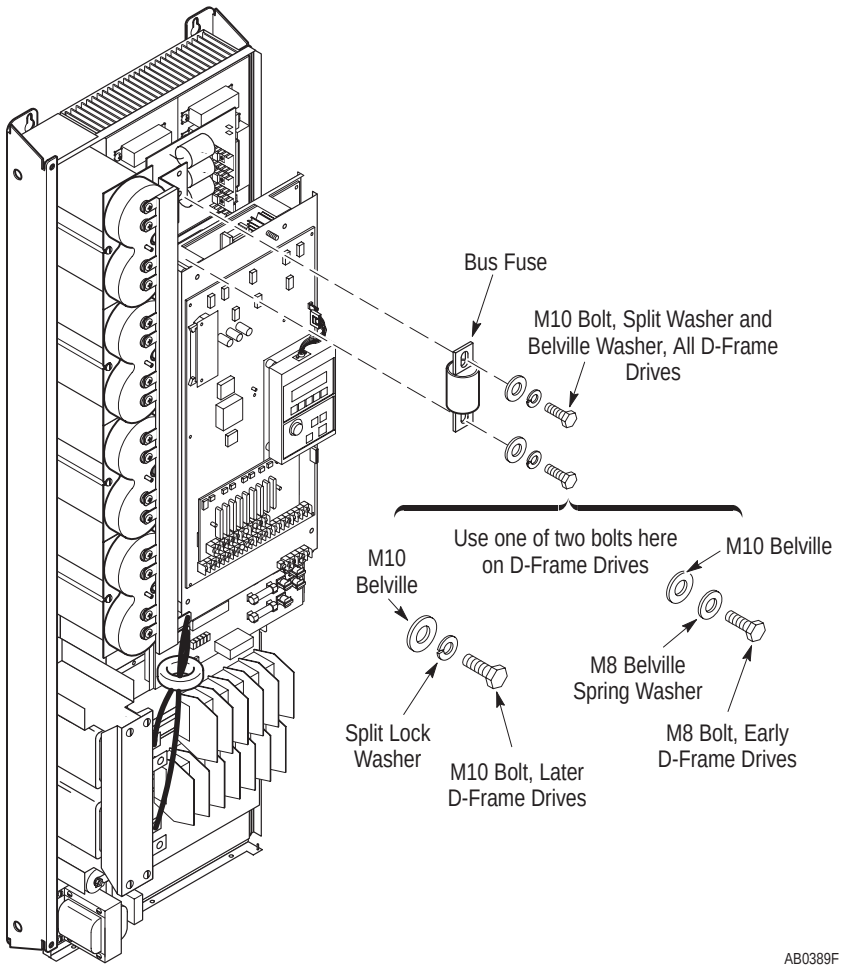
1. Place the Bus Capacitor wires through the center of the Ground Sense CT.
2. Install the Ground Sense CT in reverse order of removal. Refer to Chapter 3 – Disassembly and Access Procedures, Fastener Torque Specifications.

ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.

Bus Fuse

The Bus Fuse is located at the top-center of the Drive.

Figure 5.15
Bus Fuse



Removal

ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Hazard of electric shock exists. Up to 1,000V DC may be present on Snubber Capacitors. Measure for zero (0)V DC across capacitors C2, C3, and C4. Use a resistor greater than 1ohm and less than 100 ohm, rated for 25 watts minimum to discharge any voltage. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.

IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Check for zero volts at TB1 terminals +DC and –DC.
3. Check for absence of control voltage at TB2 and TB3.
4. Remove the Bus Capacitor Shield. Refer to Bus Capacitor Bank in this chapter.
5. Remove the two bolt-and-washer assemblies fastening the Bus Fuse to the drive.

Installation

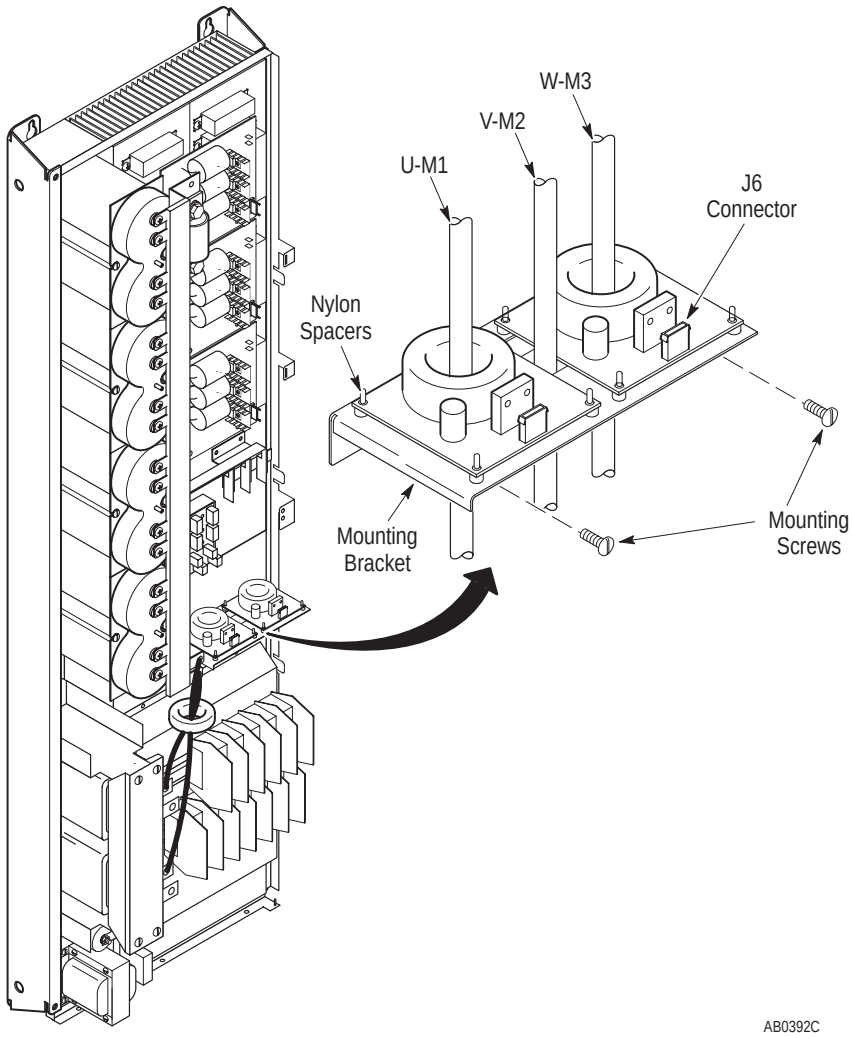
Install the Bus Fuse in reverse order of removal. Refer to Chapter 3 – Disassembly and Access Procedures, Fastener Torque Specifications.

ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.

LEMs

The LEMs are located near the bottom of the heat sink.

Figure 5.16
LEMs



Removal

ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

ATTENTION: Hazard of electric shock exists. Up to 1,000V DC m ay be present on Snubber Capacitors. Measure for zero (0)V DC across capacitors C2, C3, and C4. Use a resistor greater than 1ohm and less than 100 ohm, rated for 25 watts minimum to discharge any voltage. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.

IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Check for zero volts at TB1 terminals +DC and –DC.
3. Check for absence of control voltage at TB2 and TB3.
4. Remove the Precharge Board Mounting Plate. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Precharge Board Mounting Plate.
5. Remove Gate Driver Board Mounting Plate. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Gate Driver Board Mounting Plate.
6. Disconnect the Inverter Output Wires, running through the LEMs, from Motor Bus Bar terminals:
   - U-M1
   - V-M2
   - W-M3
7. Disconnect the J6 Connector wiring harness from the LEMs.
8. Remove the screws fastening the LEM mounting bracket to the heat sink.
9. Slide the LEM mounting bracket off of Inverter Output wires.
10. Compress the tabs on the nylon spacers to remove the LEM from the mounting bracket.

Installation

Install the LEMs in reverse order of removal. Refer to Chapter 3 – Disassembly and Access Procedures, Fastener Torque Specifications.

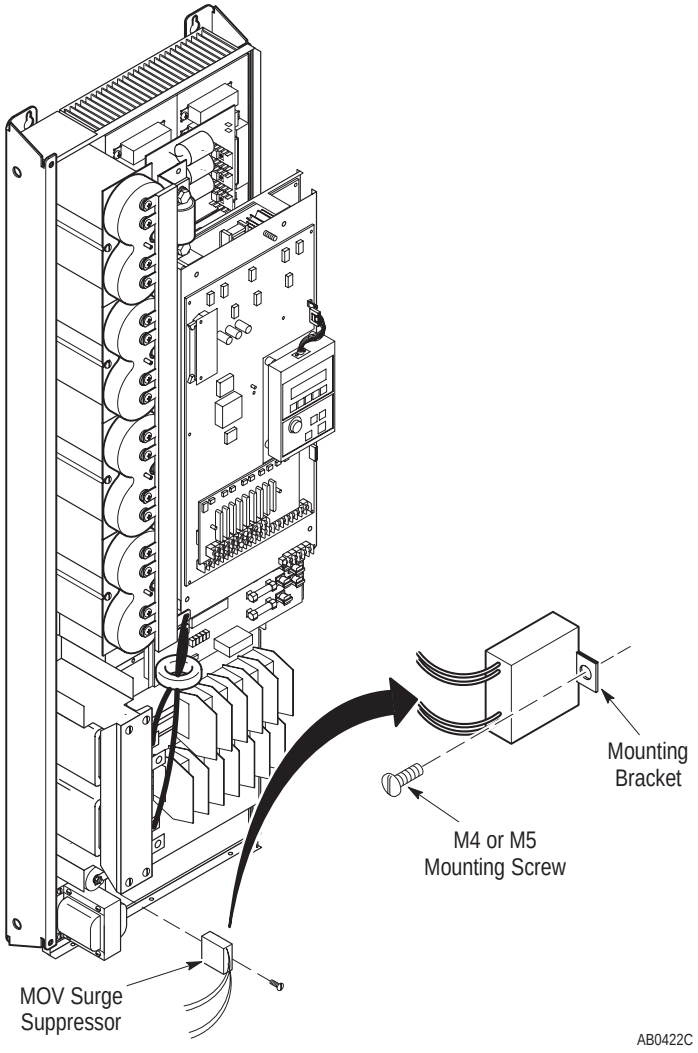
ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.

MOV Surge Suppressor

The MOV Surge Suppressor is located in the bottom-left corner of the Drive near the Autotransformer and Fan Capacitor.

The MOV protects the drive from high voltage surges above approximately 1,000 volts. Replace the MOV if it is burned, expanded, or ruptured after such events as a lightening strike, or inadvertent connection of the drive input to a voltage source substantially above nameplate voltage.

Figure 5.17
MOV Surge Suppressor



Removal

ATTENTION: Hazard of electric shock exists. Up to 1,000V DC may be present on Snubber Capacitors. Measure for zero (0)V DC across capacitors C2, C3, and C4. Use a resistor greater than 1ohm and less than 100 ohm, rated for 25 watts minimum to discharge any voltage. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.

IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Check for zero volts at TB1 terminals +DC and –DC.
3. Check for absence of control voltage at TB2 and TB3.
4. Disconnect the MOV wires from TB1 terminals L1, L2, and L3 (R, S, and T).
5. Disconnect the MOV wire from the Ground Stud.
6. Remove the screw fastening the MOV to the Main Chassis.

Installation

Install the MOV Surge Suppressor in reverse order of removal. Refer to Chapter 3 – Disassembly and Access Procedures, Fastener Torque Specifications.

IMPORTANT: Install the MOV using the same M4 or M5 screw as was removed.

ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.

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Chapter 6

Replacement Parts List

Chapter Objectives

This chapter illustrates and lists replacement parts for the 1336 PLUS Drives rated A040 – A060, B060 – B125, BX150, and C075 – C125 and describes replacement parts ordering procedures.

The following illustration and table show you parts, part names, part numbers, locations, and chapters for replacement procedures.

Ordering Replacement Parts

For your convenience, the Allen-Bradley Drives Division and the Allen-Bradley Support Division provide efficient and convenient repair and exchange for eligible equipment.

A product service report number is required to return any equipment for repair. Your local Allen-Bradley distributor or area sales and support office can provide you with a product service report number.

You should return equipment to be repaired to the area sales and support center nearest you. Reference the product service report number on the carton and packing slip. Include:

- Your company name
- Your company address
- The repair purchase order number
- A brief description of the problem

Contact your local Allen-Bradley distributor or sales office for a complete listing of area sales and support centers near you.

For parts catalog numbers, refer to the 1336 PLUS Spare Parts Pricing publication included with your drive documentation set.

Replacement Parts Listing

Figure 6.1
Parts for A040 – A060, B060 – B125, BX150, and C075 – C125 Drives

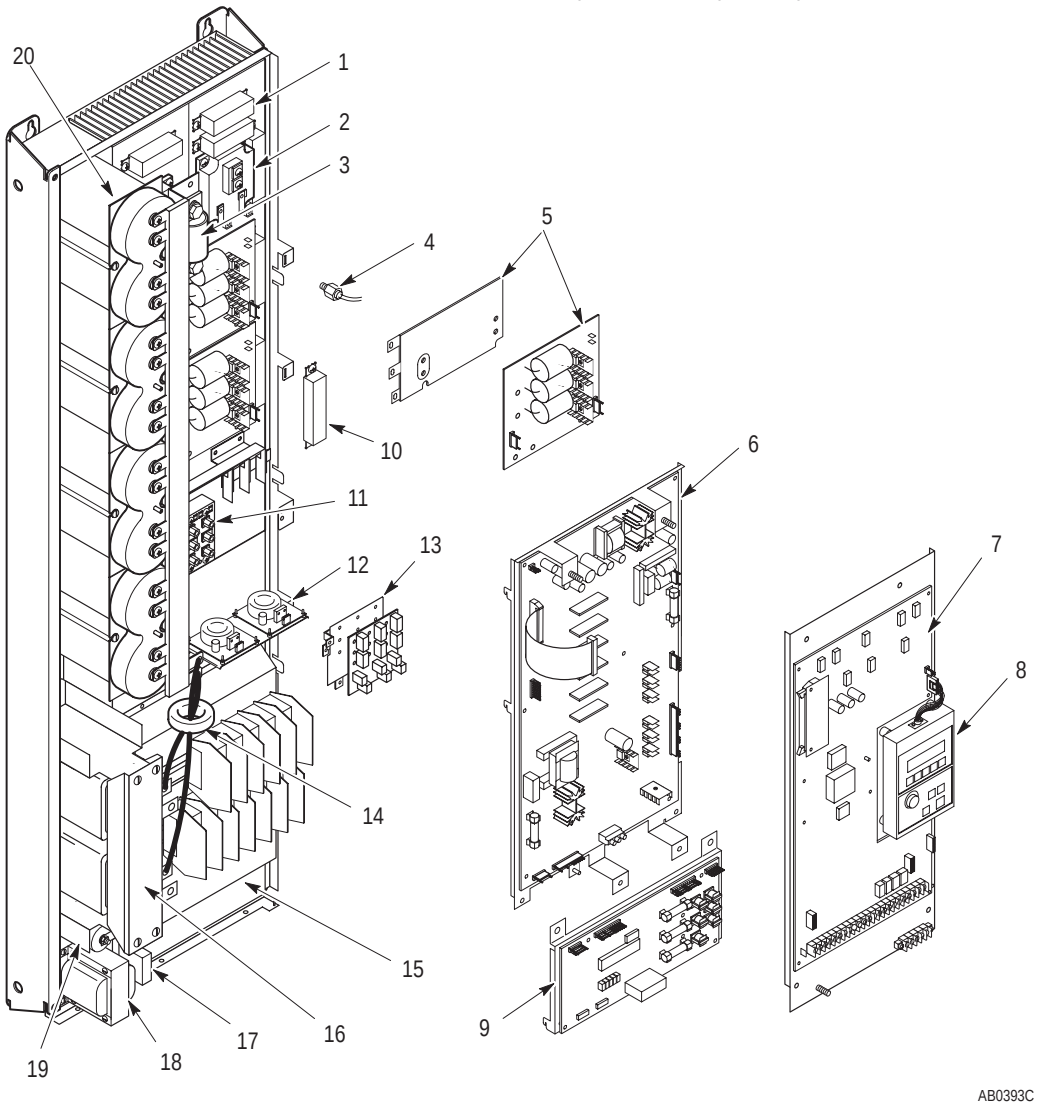


Table 6.A
Replacement Parts for A040 – A060, B060 – B125, BX150, and C075 – C126 Drives

Callout	Symbol	Description	Location	Replacement Procedures
1	R1 – R3	Load-Sharing Resistor	Main Chassis	Chapter 5, Bus Capacitor Bank
2	Q1 – Q6	IGBT	Heat Sink	Chapter 5, Power Modules
3	F1	Bus Fuse	Cap Bus Bar	Chapter 5, Bus Fuse F1
4	ST NTCI	Thermistor	Heat Sink	Chapter 5, Thermistor
5	SNUBBER BOARD	Inverter Bus Bar and Snubber Board	Heat Sink	Chapter 3, Removing a Power Module Snubber Board
6	BASEDR/PWRSPLY	Gate Driver Board	Gate Driver Board Mounting Plate	Chapter 3, Removing the Gate Driver Board
7	MAIN CTL	Main Control Board	Main Control Board Mounting Plate	Chapter 3, Removing the Main Control Board
8	HIM	Human Interface Module	Main Control Board Mounting Plate	Chapter 1, Module Removal
9	PRECHARGE	Precharge Board	Precharge Board Mounting Plate	Chapter 3, Removing the Precharge Board
10	R20 – R22	Power Module Snubber Resistor	Main Chassis	Chapter 3, Removing a Power Module Snubber Board
11	SCR1 – SCR3	Input Rectifier	Heat Sink	Chapter 5, Input Rectifiers
12	CT1, CT2	LEM	Main Chassis	Chapter 5, LEMs
13	SCR SNUBBER BOARD	Converter Snubber Board	Heat Sink	Chapter 3, Removing the Converter Snubber Board
14	CT3	Ground Sense CT	—	Chapter 5, Ground Sense CT
15	FAN	Fan	Main Chassis	Chapter 5, Fan and Transformer
16	L1	DC Bus Inductor	Main Chassis	Chapter 5, DC Bus Inductor L1
17	MOV1	MOV Surge Suppressor	Main Chassis	Chapter 5, Autotransformer
18	T1	Autotransformer	Main Chassis	Chapter 5, Autotransformer
19	C-HB1	Fan Capacitor	Main Chassis	Chapter 5, Autoransformer
20	C1 – C6	Bus Capacitors	Main Chassis	Chapter 5, Bus Capacitor Bank

Spare Parts Information

1336 PLUS Spare Parts Information

Current 1336 PLUS spare parts information including recommended parts, catalog numbers and pricing can be obtrained from the following sources:

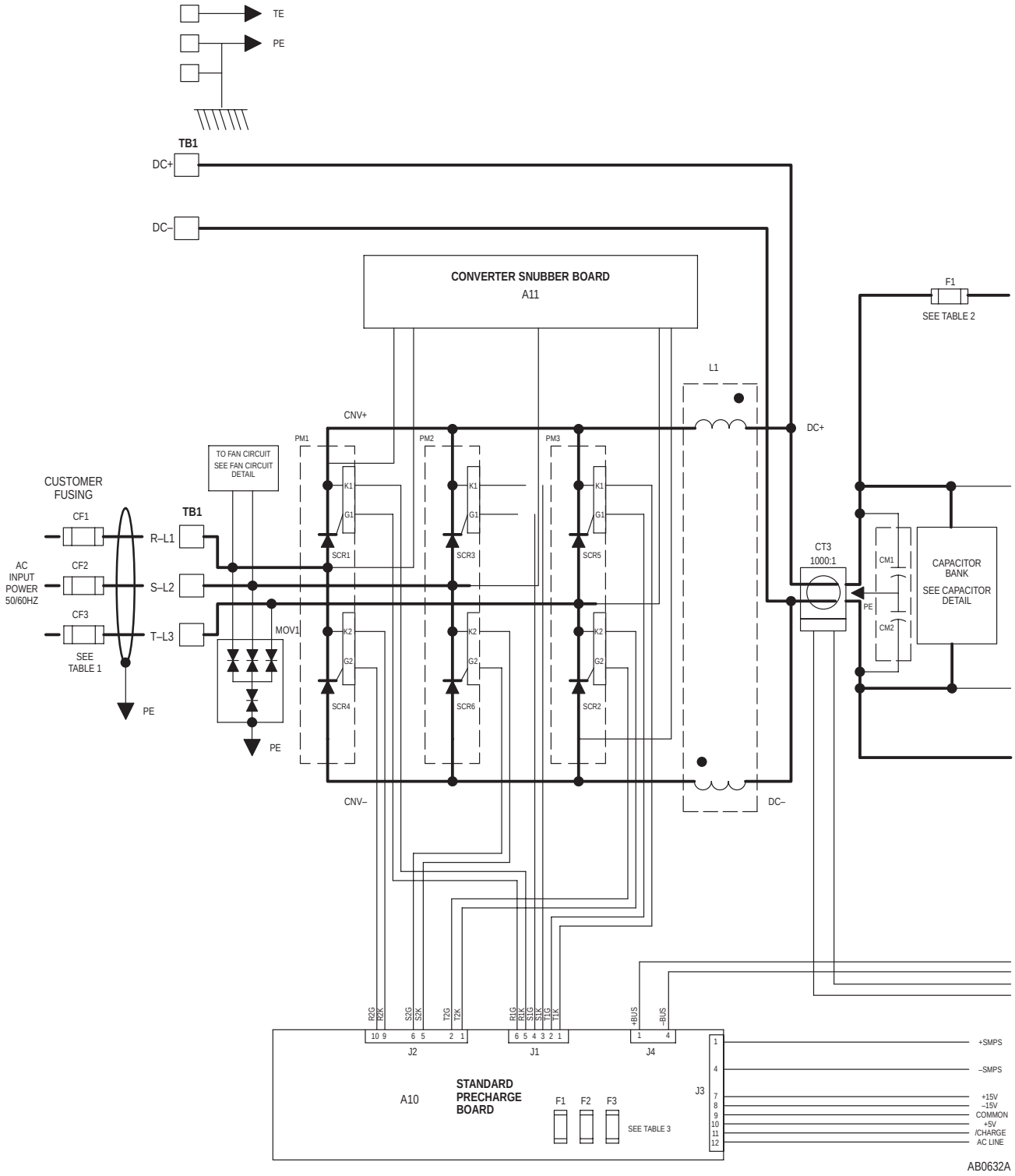
- Allen-Bradley home page on the World Wide Web at:
  http://www.ab.com

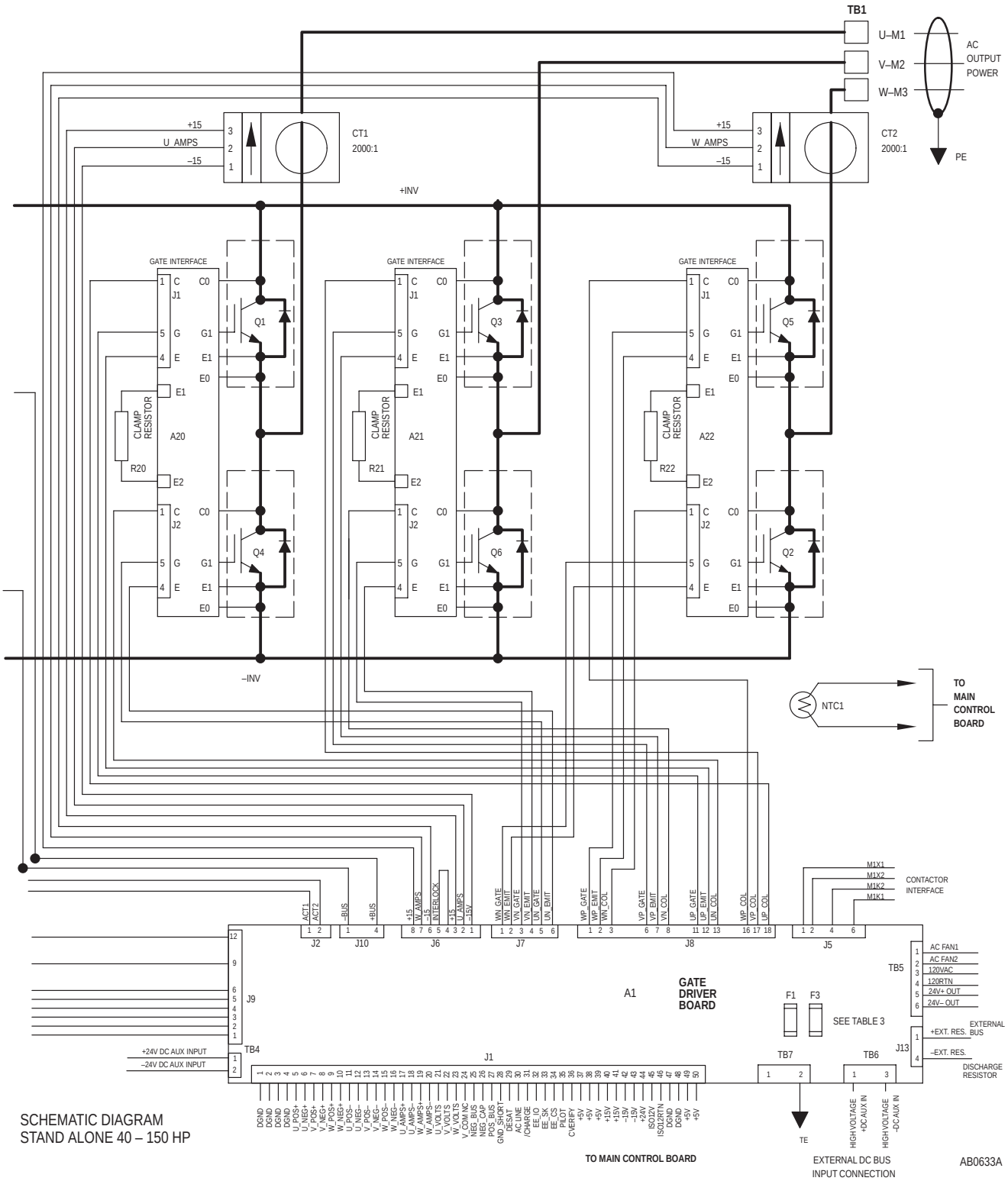
  then select . . .
  "Drives" *followed by . . .*
  "Product Information" *and . . .*
  "Service Information . . ."
  Select document **1060.pdf**

- Standard Drives "AutoFax" service — An automated system that you can call to request a "faxed" copy of the spare parts information (or other technical document).

  Simply call **440-646-6701** and follow the phone prompts to request document **1060.**

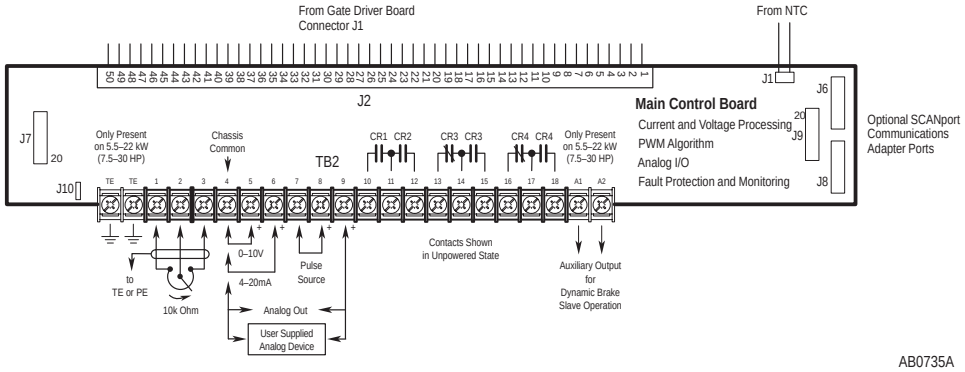
40 – 150 HP 1336 PLUS Drives


TE
PE
TB1
DC+
DC–
CONVERTER SNUBBER BOARD
A11
F1
SEE TABLE 2
L1
CNV+
PM1
PM2
PM3
TO FAN CIRCUIT
SEE FAN CIRCUIT DETAIL
CUSTOMER FUSING
CF1
CF2
CF3
AC INPUT POWER 50/60HZ
SEE TABLE 1
R–L1
S–L2
T–L3
MOV1
K1
G1
K2
G2
SCR1
SCR3
SCR5
SCR4
SCR6
SCR2
CT3
1000:1
CM1
CM2
CAPACITOR BANK
SEE CAPACITOR DETAIL
CNV–
DC+
DC–
R2G
R2K
S2G
S2K
T2G
T2K
R1G
R1K
S1G
S1K
T1G
T1K
+BUS
–BUS
J2
J1
J4
A10
STANDARD PRECHARGE BOARD
F1
F2
F3
SEE TABLE 3
J3
+SMPS
–SMPS
+15V
–15V
COMMON
+5V
/CHARGE
AC LINE
AB0632A



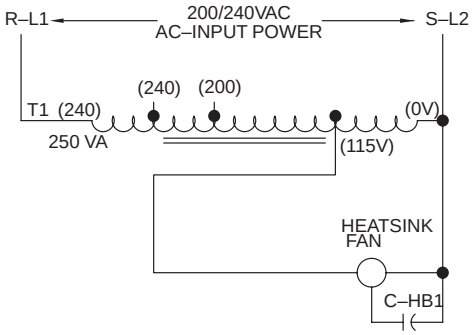
SCHEMATIC DIAGRAM
STAND ALONE 40 – 150 HP

Main Control Board Detail

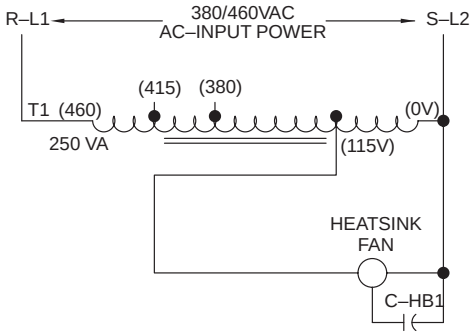


AB0735A

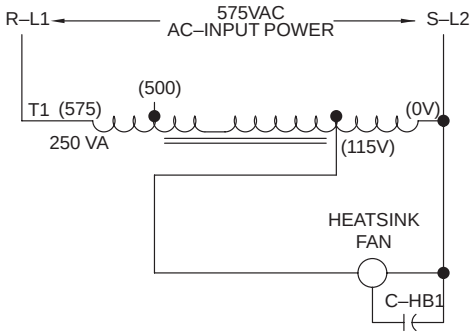
Fan Circuit Detail



200/240V



380/460V



575V

Capacitor Detail

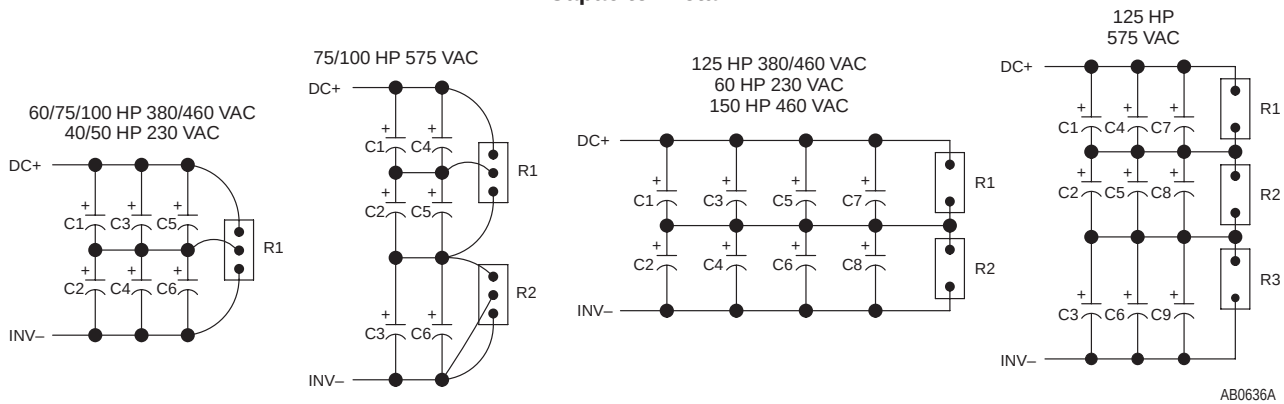


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TABLE 1: CUSTOMER FUSING
BASED ON MAXIMUM DRIVE RATING THE FOLLOWING FUSES OR APPROVED EQUIVALENT MUST BE USED:

HORSEPOWER	230VAC FUSE CURRENT/TYPE	380/460VAC FUSE CURRENT/TYPE	575VAC FUSE CURRENT/TYPE
40	150 AMP, CLASS T, JJS	–	–
50	200 AMP, CLASS T, JJS	–	–
60	250 AMP, CLASS T, JJS	125 AMP, CLASS T, JJS	–
75	–	150 AMP, CLASS T, JJS	110 AMP, CLASS T, JJS
100	–	200 AMP, CLASS T, JJS	150 AMP, CLASS T, JJS
125	–	250 AMP, CLASS T, JJS	175 AMP, CLASS T, JJS
150	–	250 AMP, CLASS T, JJS	

TABLE 2: BASED ON DRIVE HORSEPOWER, THE INVERTER DC + BUS FUSE WILL CHANGE AMP RATING. THE TABLE BELOW DEFINES THE FUSE RATING.

DRIVE HORSEPOWER, INPUT VOLTAGE	FUSE INFORMATION		
	RATING	TYPE	P/N
40HP, 230VAC	150 AMP	A70Q150–4	25178–310–10
50HP, 230VAC	200 AMP	A70Q200–4	25178–310–12
60HP, 230VAC	250 AMP	A70Q250–4	25178–310–13
60HP, 380VAC	125 AMP	A70Q125–4	25178–310–09
75HP, 380/460VAC	250 AMP	A70Q150–4	25178–310–10
75HP, 575VAC	200 AMP	A70Q125–4	25178–310–09
100HP, 380/460VAC	300 AMP	A70Q200–4	25178–310–12
100HP, 575VAC	250 AMP	A70Q175–4	25178–310–11
125HP, 380/460VAC	350 AMP	A70Q250–4	25178–310–13
125HP, 575VAC	300 AMP	A70Q200–4	25178–310–12
150HP, 460VAC	350 AMP	A70Q250–4	25178–310–13

TABLE 3: THE FOLLOWING IS A LISTING OF ALL PRINTED CIRCUIT ASSEMBLIES VERSUS FUSE & DOCUMENTATION INFORMATION.

ITEM	B/M	SCHEMATIC DIAGRAM	FUSE INFORMATION			
			DESIGNATOR	RATING	TYPE	P/N
A1	74101–169–XX	74101–167	F1	1.0A/600V	KTK–R	25172–260–08
			F3	1.5A/600V	KTK–R	25172–260–09
A10	74101–181–XX	74101–179	F1–F3	1.5A/600V	KTK–R	25172–260–09
A11	74101–099–51	74101–077	NONE	–	–	–
A20–22	74101–032–XX	74101–022	NONE	–	–	–

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Glossary

AC Contactor: An alternating-current (AC) contactor is designed for the specific purpose of establishing or interrupting an AC Power circuit.

Adjustable Speed: The concept of varying the speed of a motor, either manually or automatically. The desired operating speed (set speed) is relatively constant regardless of load.

Adjustable Speed Drive (Electrical): The adjustable speed drive is comprised of the motor, drive controller and operator's controls (either manual or automatic).

Ambient Temperature: The temperature of the medium (air, water, earth) into which the heat of the equipment is dissipated.

Base Speed: The manufacturer's nameplate rating where the motor will develop rated power at rated load and voltage. With DC drives, it is commonly the point where full armature voltage is applied with full-rated field excitation. With AC systems, it is commonly the point where 60 Hz is applied to the induction motor.

BR: Refer to *Bridge Rectifier.*

Braking: A method of stopping or reducing the time required to stop an AC motor, and can be accomplished in several ways:

1. DC-Injection braking (AC drives) — A method which produces electromagnetic braking forces in the motor by removing 2 AC motor (stator) phases and injecting DC current. The result is a linear braking characteristic (ramp) that does not diminish with motor speed. Application is normally limited to 10–20% of rated motor speed due to increased heating in the rotor.
2. Dynamic braking (AC drives) — A method which produces electromagnetic braking forces in the motor by dissipating generated power into the DC bus through a resistive load. Braking force remains constant and is only limited by the thermal capacity of the resistors. The result is a linear braking characteristic (ramp) that does not diminish with motor speed.
3. Regenerative braking — A method which produces electromagnetic braking forces in the motor by electronically controlling the return of generated power to the AC supply. The result is a controllable linear braking characteristic (ramp) that does not diminish with motor speed.

4. Motor-mounted or separately-mounted brake — A positive-action, mechanical friction device. Normal configuration is such that when the power is removed, the brake is set. This can be used as a holding brake. (Note: A separately mounted brake is not one which is located on some part of the mechanical drive train other that the motor.)

Breakaway Torque: The torque required to start a machine from standstill. Breakaway torque is always greater than the torque needed to maintain motion.

Breakdown Torque: The breakdown torque of an AC motor is the maximum torque which it will develop with rated voltage applied at rated frequency.

Bridge Rectifier (Diode, SCR): A non-controlled, full-wave rectifier that produces a constant, rectified, DC voltage. An SCR bridge rectifier is a full-wave rectifier with a DC output that can be controlled by switching on the gate control element.

Bridge Rectifier: A full-wave rectifier that conducts current in only one direction of the input current. AC applied to the input results in approximate DC at the output.

British Thermal Unit (BTU): The quantity of heat required to raise one pound of water by one degree Fahrenheit.

BTU: Refer to *British Thermal Unit*.

Bus: A single path or multiple parallel paths for power or data signals to which several devices may be connected at the same time. A bus may have several sources of supply and/or several sources of demand.

Bus Sense: A signal transducer that generates a signal proportional to the current in the drive's DC bus. The control logic uses this signal to sense the presence or absence of bus voltage.

CEMF: Refer to *Counter Electromotive Force*.

CMOS: Complimentary Metallic Oxide Semiconductor. A semiconductor device in which an electric field controls the conductance of a channel under a metal electrode called a gate.

Cogging: A condition in which a motor does not rotate smoothly but steps or jerks from one position to another during shaft revolution. Cogging is most pronounced at low motor speeds and can cause objectionable vibrations in the driven machinery.

Constant Torque Range: A speed range in which a motor is capable of delivering a constant torque, subject to cooling limitations of the motor.

Constant Voltage Range: (AC Drives) The range of motor operation where the drive's output voltage is held constant as output frequency is varied. This speed range produces motor performance similar to a DC drive's constant horsepower range.

Constant Volts per Hertz (V/Hz): The V/Hz relationship exists in AC drives where the output voltage is directly proportional to frequency. This type of operation produces constant rated torque as the motor's speed varies.

Continuous Duty (CONT): A motor that can continue to operate without stopping and remain within the insulation temperature limits after it has reached normal operating (equilibrium) temperature.

Converter:

1. A device for changing AC to DC. This is accomplished through use of a diode rectifier or thyristor rectifier circuit.
2. A device for changing AC to DC to AC (e.g., adjustable frequency drive). A frequency converter, such as that found in an adjustable frequency drive, consists of a rectifier, a DC intermediate circuit, an inverter, and a control unit.

Counter Electromotive Force (CEMF): The product of a motor armature rotating in a magnetic field. This generating action takes place whenever a motor is rotating. Under stable motoring conditions the generated voltage (CEMF) is equal to the voltage supplied to the motor minus small losses. However, the polarity of the CEMF is opposite to that of the power being supplied to the armature.

Current Limiting: An electronic method of limiting the maximum current available to the motor. This is adjustable so that the motor's maximum current can be controlled. It can also be preset as a protective device to protect both the motor and the control from extended overloads.

DC Boost: Compensates for the voltage drop across the resistance of an AC motor circuit and the resulting reduction in torque.

DC Bus: A drive's power structure that transmits a rectified AC line power from the bridge rectifier to the output transistors.

DC Hold: Describes a "holding brake" function to stop motor rotation after a ramp-to-stop function is activated.

Diode: A solid-state uni-directional conductor.

Drift: A slow change in some characteristic of a device. For a drive, it is the deviation from the initial set speed with no load change over a specific time period. Normally the drive must be operated for a specified warm-up time at a specified ambient temperature before drift specifications apply. Drift is normally caused by random changes in operating characteristics of various control components.

Drive Controller (Variable Speed Drive) (Drive): An electronic device that can control the speed, torque, horsepower, and direction of an AC or DC motor.

1. PWM drive — is a motor drive using pulse-width modulation techniques to control power to the motor. A high-efficiency drive used for high-response applications.
2. SCR drive — is a motor drive that uses SCRs as the power control elements. Usually used for low-bandwidth high-power applications.
3. Servo drive — is a motor drive that uses internal feedback loops for motor current and/or velocity.
4. Vector drive — is an AC static motor drive using power-control techniques that produce motor performance similar to DC static drives.

Duty Cycle:

1. The ratio of working time to total time for an intermittently operating device. Usually expressed as a percentage.
2. The ratio of pulse width to the interval between like portions of successive pulses. Usually expressed as a percentage.

Dynamic Braking: Refer to *Braking*.

Efficiency: Ratio of output to input, indicated by a percentage. In a motor, it is the effectiveness with which the motor converts electrical energy into mechanical energy. In a power supply, it is the effectiveness with which the power supply converts AC power into DC power.

Electrostatic Discharge (ESD): A static-electricity discharge that may damage drive components. Refer to the ESD precautions found in this manual to guard against damage to drive components.

Enable: To activate logic by the removal of a suppression signal.

Enclosure: The housing in which equipment is mounted. They are available in designs for various environmental conditions. Refer to NEMA standard for specifications of different types of enclosures.

ENUM (Enumeration): An ANSI C standard extension to the C language. An ENUM is a set of named integer constants that specify all the legal values a variable of a given type may have. The keyword ENUM signals the start of an enumeration type.

ESD: Refer to *Electrostatic Discharge*.

Floating Ground: An electrical circuit common which is not at earth ground potential or the same ground potential as circuitry with which it interfaces. A voltage difference can exist between the floating ground and earth ground.

Force: The tendency to change the motion of an object with an exertion of energy from a separate source.

Full Load Torque: The full-load torque of a motor is the torque necessary to produce rated horsepower at full-load speed.

Gate:

1. A logic element that blocks or passes a signal, depending on the status of specified input signals.
2. The control element of an SCR.

GND Sense: A current transducer that detects an unequal or imbalanced current in the three-phase AC line or DC bus of the drive. The imbalance indicates an output ground fault condition.

Horsepower (hp): A unit of power: 1 hp = 33,000 ft-lb/min. = 746 watts.

IEC: International Electrotechnical Commission.

IGBT: Refer to *Insulated Gate Bipolar Transistor.*

Induction Motor: An induction motor is an alternating-current motor in which the primary winding on one member is connected to the power source. A secondary winding on the other member carries the induced current. There is no physical electrical connection to the secondary winding; its current is induced.

Inertia: A measure of a body's resistance to change in velocity, whether a body is at rest or moving at a constant velocity. The velocity can be either linear or rotational. The moment of inertia (WK^2) is the product of the weight (W) of an object and the square of the radius of gyration (K^2). The radius of gyration is a measure of how the mass of the object is distributed about the axis of rotation. WK^2 is usually expressed in units of lb-ft^2.

Insulated Gate Bipolar Transistor (IGBT): A type of transistor commonly used in drive-control devices.

Integral-Horsepower Motor: A motor that has a continuous rating of 1 hp or more, built into a frame.

International Organization for Standards (ISO): An organization established to promote development of international standards.

Interposing Relay: An interposing relay is a relay that accepts control signals of one logic level in order to provide isolated contact signals in a circuit operating at a different logic level.

Inverter:

1. An AC adjustable frequency drive.
2. A particular section of an AC drive. This section uses the DC voltage from a previous circuit stage (intermediate DC circuit) to produce a pulse-width-modulated or stepped AC current or voltage waveform that has characteristics similar to the desired sine-wave frequency.
3. A circuit whose output signal is the inverse of its input (a positive-going pulse is inverted to a negative-going pulse, and vise versa).

ISO: Refer to *International Organization for Standards*.

Isolation Transformer:

1. A transformer that provides DC isolation from other equipment not connected to that transformer secondary.
2. A transformer that provides noise isolation between the primary and secondary by such means as a Faraday shield.

Jogging:

1. In a numerical control system, an operator manually generating motion (continuously or incrementally) by closing a switch.
2. An operator generating motion by closing a switch.

Kinetic Energy: The energy of motion of a moving body.

LAD: Refer to *Linear Acceleration/Deceleration*.

LEM: A hall-effect current transducer that senses drive output current and generates a signal for the control logic.

Linear Acceleration/Deceleration (LAD): A circuit that controls the rate at which a motor is allowed to accelerate to a set speed or decelerate to zero speed. On most drives, this circuit is adjustable and can be set to accommodate a particular application.

Linearity: A measure of how closely a characteristic follows a straight-line function.

Locked-Rotor Current: Steady-state current taken from the line current with the a rotor at standstill (at rated voltage and frequency). This is the current when starting the motor and load.

Locked-Rotor Torque: The minimum torque that a motor will develop at rest for all angular positions of the rotor (with rated voltage applied at rated frequency).

Meggar Test: A test used to measure an insulation system's resistance. This is usually measured in megohms by applying a high voltage.

MOV: Refer to *Surge Protection*.

National Electrical Code (NEC): A set of regulations governing the construction and installation of electrical wiring and apparatus, established by the National Fire Protection Association and suitable for mandatory application by governing bodies exercising legal jurisdiction. It is widely used by state and local authorities within the United States.

National Electrical Manufacturer's Association (NEMA): A non-profit organization organized and supported by electrical equipment and supply manufacturers. Some NEMA motor standards include horsepower (hp) ratings, speeds, frame sizes and dimensions, torques, and drive enclosures.

NEC: Refer to *National Electrical Code*.

Negative Slope: The location on a V/Hz curve where the break voltage exceeds the base voltage.

NEMA: Refer to *National Electrical Manufacturer's Association*.

Offset: The steady-state deviation of a controlled variable from a fixed setpoint.

Op Amp: An operational amplifier. A high-gain stable linear DC amplifier that is designed to be used with external circuit elements.

Open Loop System: A control system that has no means of comparing the output with the input for control purposes.

Overload Capacity: The ability of the drive to withstand currents beyond the system's continuous rating. It is normally specified as a percentage of full-load current endured for a specified time period. Overload capacity is defined by NEMA as 150% of rated full load current for one minute for "standard industrial DC motors."

PC:

1. Personal Computer.
2. Programmable Controller.
3. Printed Circuit.

Plugging: A type of motor braking provided by reversing either line voltage polarity or phase sequence so that the motor develops a counter torque that exerts a retarding force to brake the motor.

Pot: A potentiometer, or variable resistor.

Power: Work done per unit of time. Measured in horsepower (hp) or watts (W): 1 hp = 33,000 ft-lb/min. = 746 W.

Power Factor (Displacement): A measurement of the time phase difference between the fundamental voltage and fundamental current in an AC circuit. It represents the cosine of the phase angle difference.
$Fp = \cos(\alpha - \beta)$

Power Factor (Distortion): A measurement of the ratio of the real power (kW) to the apparent power (kVA). Distortion power factor takes into account harmonic voltage and current distortion as well as voltage-to-current displacement.

Preform: A flexible material used between an electronic component and the heat sink to which the component is attached. Preform provides maximum heat dissipation from the component to the heat sink.

Preset Speed: Describes one or more fixed speeds at which a drive operates.

Programmable Controller: A solid-state control system that has a user-programmable memory for storage of instructions to implement specific functions such as I/O control, logic, timing, counting, report generation, communication, arithmetic, and data file manipulation. A controller consists of a central processor, input/output interface, and memory. A controller is designed as an industrial control system.

Pull-In Torque: The maximum constant torque to which a synchronous motor accelerates into synchronism at rated voltage and frequency.

Pull-Out Torque: The maximum running torque of a synchronous motor.

Pull-Up Torque: The torque required to accelerate the load from standstill to full speed (where breakdown torque occurs), expressed in percent of running torque. It is the torque required not only to overcome friction, windage, and product loading but also to overcome the inertia of the machine. The torque required by a machine may not be constant after the machine has started to turn. This load type is characteristic of fans, centrifugal pumps, and certain machine tools.

PWM: Pulse-width Modulation. A technique used to eliminate or reduce unwanted harmonic frequencies when inverting DC voltage to sine wave AC.

Reactance: Pure inductance or capacitance, expressed in ohms, in a circuit. It is the component of impedance to alternating current that is not resistance.

Rectifier: A device that conducts current in only one direction, thereby transforming alternating current to direct current.

Regeneration: (AC drives) When the rotor synchronous frequency is greater than the applied frequency.

Regenerative Braking: Slows or stops a motor through regeneration. Refer to *Regeneration* and *Braking*.

Resolution: The smallest distinguishable increment into which a quantity can be divided (e.g., position or shaft speed). It is also the degree to which nearly equal values of a quantity can be discriminated. For rotary encoders, it is the number of unique electrically identified positions occurring in 360 degrees of input shaft rotation. For D/A or A/D conversion, may be expressed as the number of bits in the digital value that corresponds to a full-scale analog value.

SCR: Silicon Controlled Rectifier. A solid-state uni-directional latching switch.

Service Factor: When used on a motor nameplate, a number that indicates how much above the nameplate rating a motor can be loaded without causing serious degradation (i.e., a motor with 1.15 S-F can produce 15% greater torque than one with 1.0 S-F).

Set Speed: The desired operating speed.

Shock Load: The load seen by a clutch, brake, or motor in a system that transmits high peak loads. This type of load is present in crushers, separators, grinders, conveyors, winches, and cranes.

Slip: The difference between rotating magnetic field speed (synchronous speed) and rotor speed of AC induction motors. Usually expressed as a percentage of synchronous speed.

Slip Compensation: Monitors motor current and compensates for speed lost due to increased motor slip. The amount of slip is proportional to the motor load.

Speed Range: The speed minimum and maximum at which a motor must operate under constant or variable torque load conditions. A 50:1 speed range for a motor with top speed 1800 rpm means the motor must operate as low as 36 rpm and still remain within regulation specification. Controllers are capable of wider controllable speed ranges than motors because there is no thermal limitation, only electrical. Controllable speed range of a motor is limited by the ability to deliver 100% torque below base speed without additional cooling.

Speed Regulation: The numerical measure (percent) of how accurately the motor speed can be maintained. It is the percentage of change in speed between full load and no load. The ability of a drive to operate a motor at constant speed (under varying load), without “hunting” (alternately speeding up and slowing down). It is related to both the characteristics of the load being driven and electrical time constants in the drive regulator circuits.

Surge Protection: The process of absorbing and clipping voltage transients on an incoming AC power line or control circuit. Surge protectors include MOVs (Metal Oxide Varistors) and specially designed R-C networks.

Synchronous Speed: The speed of an AC induction motor’s rotating magnetic field. It is determined by the frequency applied to the stator and the number of magnetic poles present in each phase of the stator windings. Mathematically, it is expressed as: Sync Speed (rpm) = 120 x Applied Freq. (Hz) / Number of poles per phase.

Torque: A turning force applied to a shaft, tending to cause rotation. Torque is equal to the force applied, times the radius through which it acts. Torque is measured in pound-feet, ounce-inches, Newton-meters, or gram-centimeters.

Transducer: A device that converts one energy form to another (e.g., mechanical to electrical). When a transducer is actuated by signals from one system or medium, it can supply a related signal to the other system or medium.

Transient: A momentary power deviation in an electrical or mechanical system.

Transistor: An active solid-state semiconductor device.

Work: A force moving an object over a distance.
(work = force x distance)

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❑ SUGGEST / RESPONSIBLE FOR THE PURCHASE OF EQUIPMENT
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❑ DESIGN / IMPLEMENT ELECTRICAL SYSTEMS
❑ TRAIN/EDUCATE MACHINE USERS
❑ SUPERVISE FLOOR OPERATIONS

✓ **WHAT LEVEL OF EXPERIENCE DO YOU HAVE WITH EACH OF THE FOLLOWING PRODUCTS?**

	NONE	LITTLE	MODERATE	EXTENSIVE
PROGRAMMABLE CONTROL	❑	❑	❑	❑
AC / DC DRIVES	❑	❑	❑	❑
PERSONAL COMPUTERS	❑	❑	❑	❑
NC / CNC CONTROLS	❑	❑	❑	❑
DATA COMMUNICATIONS / LAN	❑	❑	❑	❑

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