ALLEN-BRADLEY

Bulletin 1336
Adjustable Frequency AC Drive

1336 B075 – B125
1336 C075 – C125
1336VT B075 – B150

Troubleshooting Guide

1336 Adjustable Frequency AC Drive Troubleshooting Guide Publication 1336-6.3 – October, 1995

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.

Summary Information

We would like to call your attention to the following changes to this manual which have occurred since the previous version published in June, 1995. All references to page numbers refer to the June publication. Page numbers in the October, 1995 publication may not match the page-number references mentioned here due to omissions or inclusions and, likewise, text and graphics shifting somewhat from page to page.

Chapter 3

A Precharge Resistors section has been added.

Chapter 4

- Figure 4.1 on page 4-2 has been modified.
- Table 4.A on page 4-3 includes information for the 1336 C075 – C125 and 1336VT B075 – B125 Drives.
- Tables 4.B and 4.C on pages 4-4 through 4-6 have been removed.

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Preface

Troubleshooting and Error Codes . . . . . Chapter 1

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Preface

Manual Objective

The information in this manual is designed to help troubleshoot or repair an Allen-Bradley Bulletin 1336 Adjustable Frequency AC Drive with ratings B075 – B125, C075 – C125, and VT B075 – B150.

Who Should Use This Manual

This manual is intended for qualified service personnel responsible for troubleshooting and repairing the 1336 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. If neon light DS 1 on the Base Driver Board is illuminated, hazardous voltages are present in the drive circuit boards. 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 neon indicator has extinguished and the bus voltage has discharged to zero volts.

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.

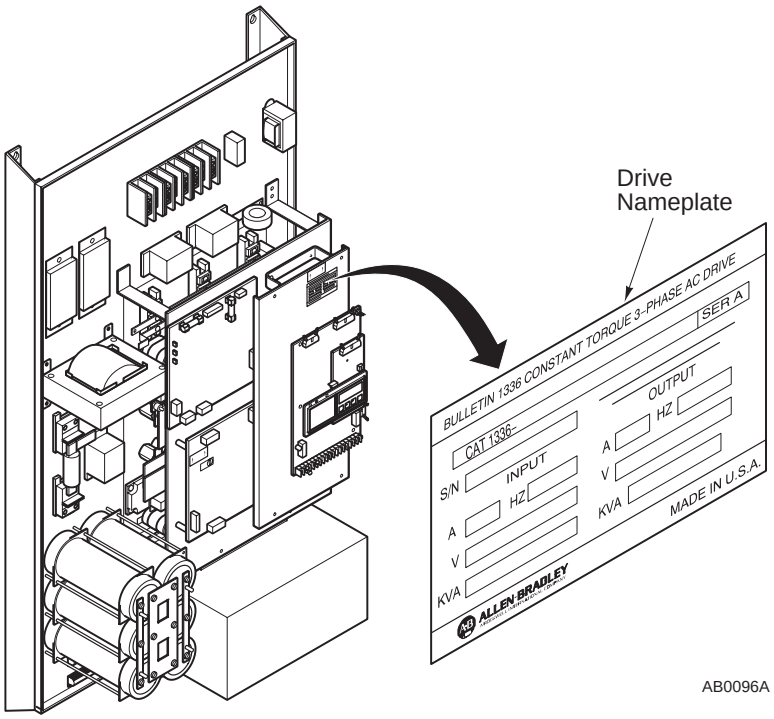
Electrostatic discharge generated by static electricity can damage the complimentary metallic oxide semiconductor devices on various drive boards. It is recommended that you perform these procedures to guard against this type of damage when circuit boards are removed or installed:

- 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 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.



Drive and Option Identification

The following is an explanation of the catalog numbering system for 1336 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 Drive Catalog Numbers

1336	—	B075	—	EAE	—	FA2	—	L2	—	S1
Bulletin Number		Drive Rating		Enclosure Type		Options		Options		Options

Bulletin Number

The Bulletin Number is the Allen-Bradley reference number identifying the type or family of products.

Drive Rating

A Drive Rating is a coded group of four characters indicating input voltage and output power rating.

The first character indicates the input voltage range of the drive:

- Drives with a code “B” are suitable for operating from any one of the following input voltages: 380/415/460V AC, 50/60 Hz, 3-phase.
- Drives with a code “C” are suitable for operating only from 500/575/600V AC, 50/60 Hz, 3-phase input voltages.

Fan Transformer Reconnection for Alternate Drive Input Voltages

IMPORTANT:

For drives rated C003 – C200, reconnection of Fan Transformer T1 is not necessary.

For drives rated B003 – B030, reconnection of Fan Transformer T1 is not necessary.

For drives rated B040 – B200, Fan Transformer T1 must be reconnected for 380 or 415V operation. If Fan Transformer T1 is not connected to match the incoming voltage, overtemperature fault F08 may occur. Refer to Chapter 1 – Troubleshooting and Error Codes, Wiring and Interface Options, for wiring details.

The second, third, and fourth characters in the Drive Rating indicate the power rating of the drive, as shown in Tables 1.A ,1.B, and 1.C.

Table 1.A
B003 – B200 Output Current and KVA

Rating Code	Amp Out	KVA Out at 380V AC	KVA Out at 415V AC	KVA Out at 460V AC
B003	6.0	3.9	4.3	4.8
B005	9.6	6.3	6.9	7.6
B007	13.0	8.6	9.3	10.4
B010	17.0	11.2	12.2	13.5
B015	25.0	16.5	18.0	20.0
B020	33.0	22.0	24.0	26.0
B025	41.0	27.0	29.0	33.0
B030	48.0	32.0	35.0	38.0
B040	60.0	39.0	43.0	48.0
B050	75.0	49.0	54.0	60.0
B075	120.0	79.0	86.0	96.0
B100	150.0	99.0	108.0	120.0
B125	180.0	118.0	129.0	143.0
B150	218.0	143.0	157.0	174.0
B200	290.0	191.0	208.0	231.0

Table 1.B
C003 – C200 Output Current and KVA

Rating Code	Amp Out	KVA Out 500V AC	KVA Out 575V AC	KVA Out 600V AC
C003	4.3	3.7	4.3	4.3
C005	6.7	5.8	6.7	6.7
C007	9.9	8.6	9.9	9.9
C010	12.1	10.5	12.1	12.1
C015	19.1	16.5	18.9	18.9
C020	24.0	20.8	23.9	23.9
C025	30.0	26.0	29.9	23.9
C030	35.0	30.3	34.9	34.9
C040	45.0	39.0	44.9	44.9
C050	57.0	49.4	56.8	56.8
C075	85.0	73.6	84.7	84.7
C100	109.0	94.4	108.6	108.6
C125	138.0	119.5	137.4	137.4
C150	158.0	136.8	157.4	157.4
C200	210.0	181.9	209.1	209.1

Table 1.C
1336VT B003 – B250 Output Current and KVA

Rating Code	Amp Out	KVA Out at 380V AC	KVA Out at 415V AC	KVA Out at 460V AC
B003	5.0	3.3	3.6	4.0
B005	8.0	5.3	5.8	6.4
B007	11.0	7.2	7.9	8.8
B010	14.0	9.2	10.1	11.2
B015	21.0	13.8	15.1	16.7
B020	27.0	17.8	19.4	21.5
B025	34.0	22.4	24.4	27.1
B030	40.0	26.3	28.8	31.9
B040	52.0	34.2	37.4	41.4
B050	65.0	42.8	46.7	51.8
B060	77.0	50.7	55.3	61.3
B075	96.0	63.2	69.0	76.5
B100	124.0	81.6	89.1	98.8
B125	156.0	102.7	112.1	124.3
B150	180.0	118.5	129.4	143.4
B200	240.0	158.0	172.5	191.2
B250	300.0	197.4	215.6	239.0

Enclosure Type

The first character, E, indicates the Enclosure Code.

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

Table 1.D
Enclosure Type Code Description

Enclosure Type Code	Description
0	Open style (IP00)
A	NEMA Type 1 (IP20)
C*	NEMA Type 4 (IP56)
J*	NEMA Type 12 (IP54)

*Not available on 1336VT.

The third character indicates enclosure size by frame size:

Table 1.E
Enclosure Amp Rating Code Description

Enclosure Type Code	HP/Amp Drive Rating
D	003, 005, 007, or 010
E	015 or 020
F	025 or 030
G	040 or 050
H	075, 100, or 125
J	150 or 200
N	VT 5.0, 8.0, 11.0, 14.0, or 21.0
P	VT 27.0 or 34.0
R	VT 40 or 52
S	VT 65.0 or 77.0
T	VT 96.0, 124.0, 156.0, or 180.0
W	VT 240.0 or 300.0

Factory Installed Options

All additional characters in the catalog number indicate drive options installed at the factory. Each Option Code is added to the catalog number and each is separated by a hyphen.

Table 1.F
Drive Option Code Description

Option Code	Description
FA2	Basic control panel for open or NEMA Type 1 enclosures.
FC3	Basic control panel for NEMA Type 4 enclosures.
FJ3	Basic control panel for NEMA Type 12 enclosure.
L1	+5V DC TTL Logic Contact Closure Interface Board.
L2	+24 V DC Logic Interface Board.
L3	115 V AC Logic Interface Board.
S1	Serial Port connector.

Conventions

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.

AUX Input

The AUX (Auxiliary Interlock) Input is a terminal connection on the Logic Interface Board. This connection provides a mandatory input for start commands. The drive will not recognize a Start command unless the AUX Input is logically true.

Auxiliary Interlock

The Auxiliary Interlock is a user supplied circuit such as reset, overload, or some logical true-state connection associated with the drive AUX 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 mobile 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 Logic Interface Board. This connection provides similar functions as the AUX Input. It must also be true to permit the drive to operate.

False

False refers to a logical false state. For instance, the Logic Interface signals on TB3, Terminal 22, are false when MOD-L1 contact is open or the appropriate voltage is not applied to the L2 or L3.

Hand-Held Terminal

A hand-held terminal is a 1336-MOD-E1 programming terminal that plugs into the Serial Interface Port. This terminal allows you to adjust Parameters while the drive is operating.

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.

Logic Interface Board

A Logic Interface Board connects to junctions J8 and J9, located on the lower portion of the Main Control Board. This board is identified as MOD-L1, -L2, or -L3 and provides optional control wiring configurations for a drive.

Parameter

Parameters are programmable drive functions that define various operating modes of a drive. Refer to Bulletin 1336 Adjustable Frequency AC Drive Programming Manual for Parameter details.

Press

Press a button on the drive's Programming and Display Board to change Parameter settings and drive functions, or to program the drive.

Set

In this manual, set refers to entering information into the drive by changing Parameter values or by changing a setting on a selector switch.

True

True refers to a logical true state. For instance, the Logic Interface signals on TB3, Terminal 22, are true when: MOD-L1 is controlled by a contact closure only and no voltage is present; MOD-L2 registers 24V DC; MOD-L3 registers 115V AC.

Related Publications

The following lists other Allen-Bradley publications that apply to the 1336 Adjustable Frequency AC Drives with ratings B075 – B125, C075 – C125, and VT B075 – B150:

- Hardware Manual
- Programming Manual
- Renewal Parts List

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Chapter 1

Troubleshooting and Error Codes

Chapter Objectives

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

Troubleshooting Overview

To troubleshoot a 1336 Adjustable Frequency AC Drive, you need the following:

- A Range DVM, DMM, or VOM with a range capacity of at least 1000 V.
- An oscilloscope with a frequency-response range of at least 1 MHz.
- A1336-MOD-E1.

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. If neon light DS1 on the Base Driver Board is illuminated, hazardous voltages are present in the drive circuit boards. 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 neon indicator has extinguished and the bus voltage has discharged to zero volts.

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.

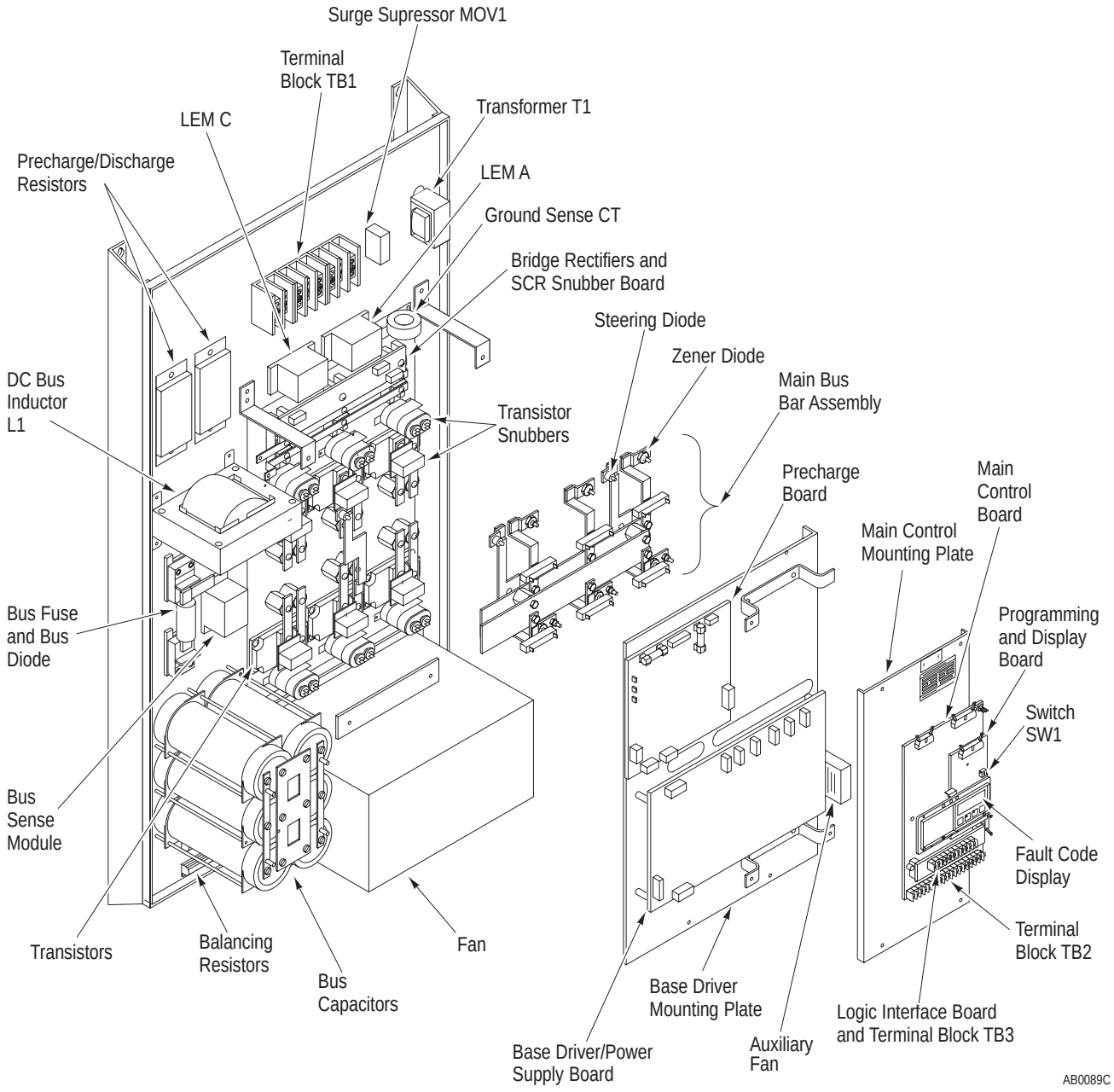
IMPORTANT: Before clearing a fault, refer to the Fault Code Description table and Diagnostic Procedures by Symptom flowchart in this chapter to isolate and correct faults.

Detailed Product Identification

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

The following illustration calls out the main components of a B075, C075, or 1336VT B075 drive, as discussed in this chapter. Component designs vary slightly among the different drive ratings, but component locations are identical.

Figure 1.1
Main Drive Components



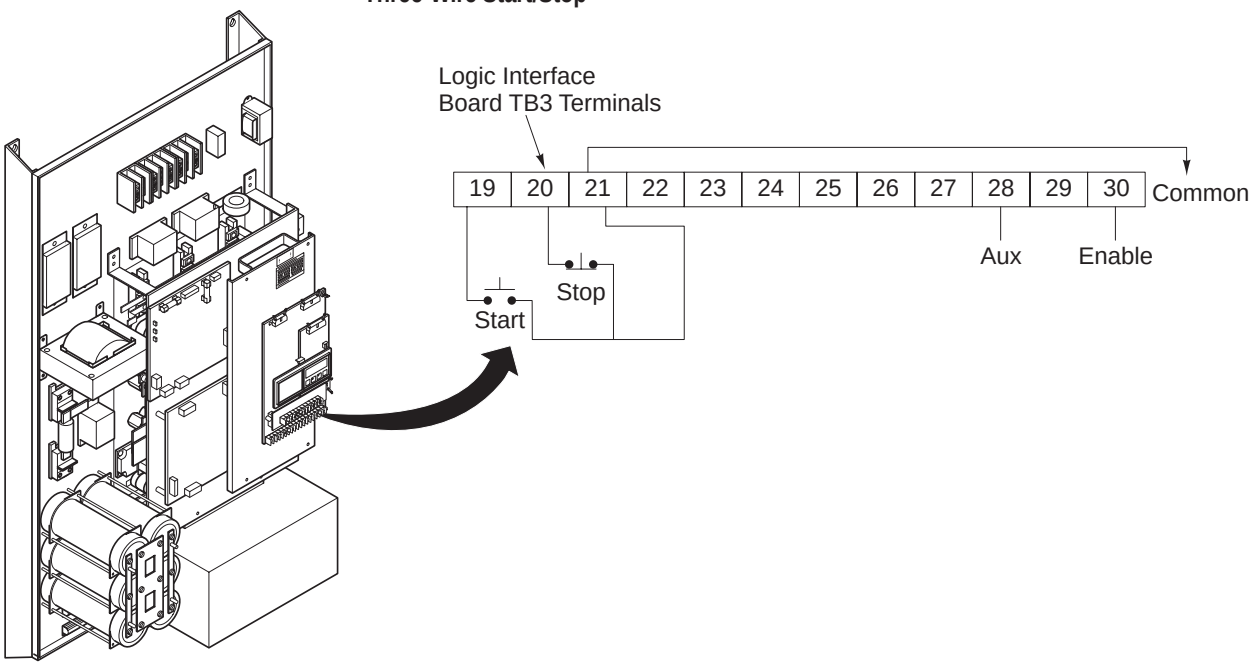
Logic Interface Options

The following logic interface conventions for Logic Interface Boards 1336-MOD-L1, -L2, and -L3 will help you avoid controller hangups and error loops.

The 1336 Logic Interface Board is located on the Main Control Board, below the Programming and Display Board. This interface, labeled TB3, connects to Connectors J8 and J9 on the Main Control Board.

1336-MOD-L1 Logic Interface Options

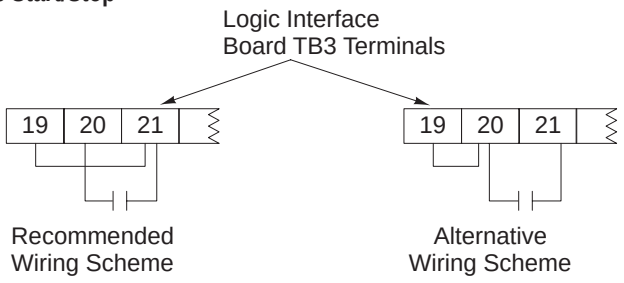
Figure 1.2
Three-Wire Start/Stop



AB0091A

IMPORTANT: AUX and Enable inputs must be true before the drive can be started.

Figure 1.3
Two-Wire Start/Stop



AB0004B

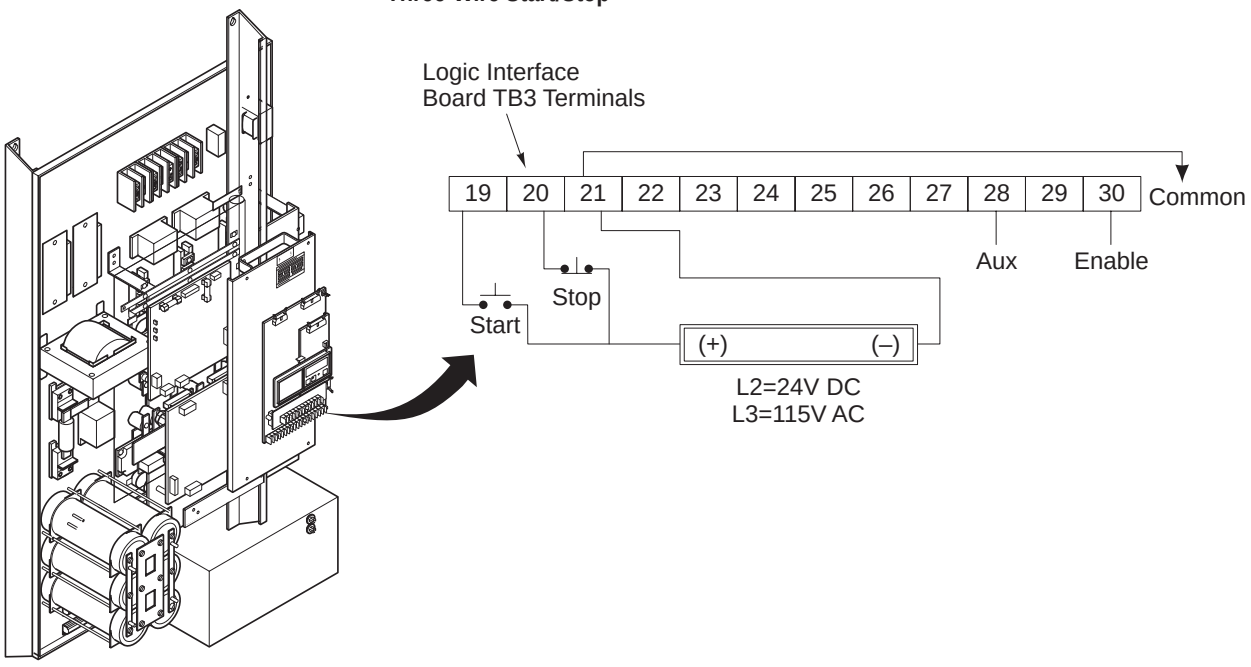
NOTE: You can clear a fault by pressing the Start/Stop button. This works if:

1. Parameter 14 is set to 1.
2. Parameter 39 is set to 1.

If Parameter 14 is not set to 1, or if an other wiring scheme is used, the drive can get stuck in an Operator Error F11 Fault Code loop. Refer to the description of Parameters 14 and 39 in the 1336 Programming Manual.

1336-MOD-L2 and-L3 Logic Interface Options

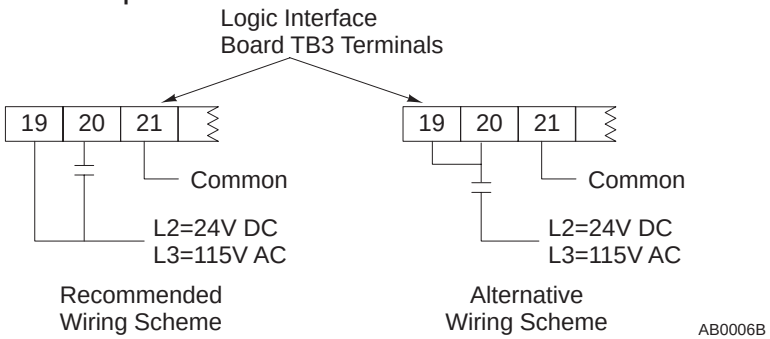
Figure 1.4
Three-Wire Start/Stop



AB0090A

IMPORTANT: AUX and Enable inputs must be true before the drive can be started.

Figure 1.5
Two-Wire Start/Stop



AB0006B

NOTE: You can clear a fault by pressing the Start/Stop button. This works if:

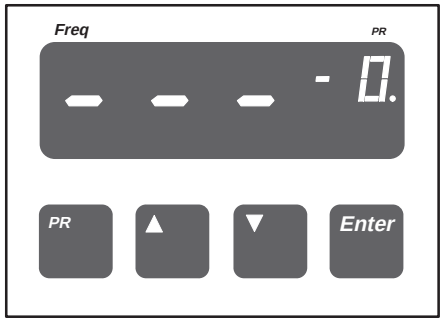
1. Parameter 14 is set to 1.
2. Parameter 39 is set to 1.

If Parameter 14 is not set to 1, or if an other wiring scheme is used, the drive can get stuck in an Operator Error F11 Fault Code loop. Refer to the description of Parameters 14 and 39 in the 1336 Programming Manual.

Basic Drive Control and Fault Display

Diagnostic procedures refer to **both** program panel and optional local control panel. The following information on operation is also located in the Hardware Manual and Programming Manual. It is provided here for your convenience during troubleshooting.

Local Programming



Four pushbuttons on the Local Display and Programming Panel are used for both viewing and programming parameters. Parameters may be viewed while the drive is running, but not changed.

A decimal point displayed in the far right corner indicates that the programming mode was selected and the enter button was pressed. Parameter values may be changed if the decimal is present.

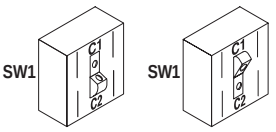
The PR pushbutton is used to switch from the operating display to the parameter viewing display. Once in the viewing display, the PR pushbutton is used to increment through the parameters.

The Enter pushbutton is used to switch from viewing to programming but only when Parameter 0 is displayed, and only if switch SW1 is set to allow parameter programming. When programming parameters, the Enter pushbutton is also used to store the displayed value.

These buttons are only functional in the programming mode. When programming parameters, the increment and decrement pushbuttons are used to scroll up or down to the parameter value to be entered. Pressing both buttons simultaneously will end programming and return the drive to the operating display.

After exiting the programming mode, the stop command must be cycled to reset the drive and confirm that programming is complete. Failure to follow these instructions will result in a F11 operator error fault.

SW1 Operation



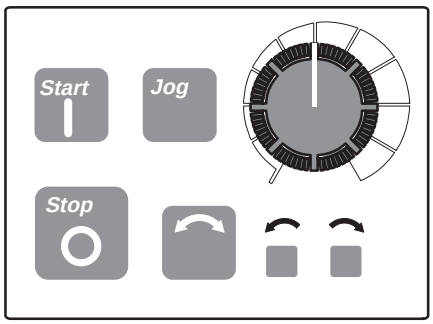
ENABLED **DISABLED**

SW1 is a switch on the Local Display and Programming Panel that can be accessed only with the drive cover removed. This rocker switch may be used to disable the Enter pushbutton and control access to drive programming.

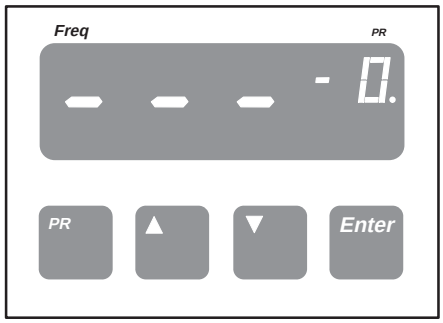
Enter button enabled — Access to programming allowed if SW1 is set to position C1.

Enter button disabled — Access to programming not allowed if SW1 is set to position C2.

Operation



OPTIONAL LOCAL CONTROL PANEL



STANDARD LOCAL DISPLAY AND PROGRAMMING PANEL

The Local Display and Programming Panel is supplied on all drives as standard.

The Local Control Panel is an optional feature. It may be installed at the factory or added in the field at a later date. If the Local Control Panel is not specified when the drive is ordered, a blank plate will be installed in its place.

IMPORTANT: The 1336 Local Control Panel is not intended to replace or be considered a suitable alternative for the Operator Control Station for all applications. Refer to codes and standards applicable to your particular system for specific requirements and additional information.

Drive Restart

IMPORTANT: The 1336 drive is programmed to avoid responding to unintentional start commands. The stop input to the drive must first be false, then returned to true to restart the drive:

- When exiting programming at the Local Programming and Display Panel.
- After a power-on reset fault has occurred, if Parameter 14 is set to **0**.
  - F01 power-on reset is displayed when power is first applied to the drive and when a fault is cleared.
  - If Parameter 14 is set to **1**, cycling a stop input is not required after reapplying power or clearing a fault.

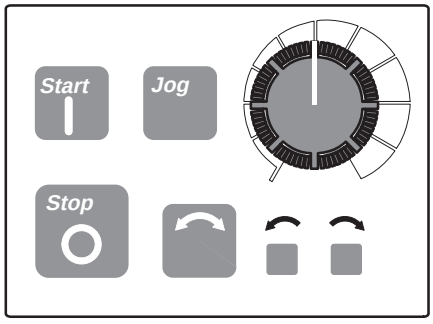
If this sequence is not followed, the drive will fault and display F11.

When Parameter 14 is set to 0, the stop command must be repeated twice, once to clear the fault, then again to reset drive logic once the fault has been cleared.

A stop input is any valid stop signal that the drive receives. Valid stop inputs are:

- The Stop pushbutton on the Local Control Panel — As shown on the following page.
- The stop input wired to TB3 at Terminal 20 — As explained in Appendix A, Logic Interface Options.
- When serial communications is used, writing to Parameter 51 to clear the fault, then setting the stop bit of the serial input control word in Parameter 57 — As explained in the 1336 Programming Manual.

Optional Local Control Panel



IMPORTANT: The local Stop pushbutton remains operational when remote stop devices are used. However, drive parameter settings determine whether other operator elements will be functional or non-functional.

To allow local control:

- The local Start pushbutton requires that Parameter 21 be set to on **1**.
- The local Jog pushbutton requires that Parameter 23 be set to on **1**.
- The direction pushbutton requires that Parameter 22 be set to on **1**.
- The local speed potentiometer is dependent upon the programming of Parameters 5 and 6 and the status of speed select. Speed select is controlled by TB3, Terminal 27 or serial programming. Refer to Chapter 8 — Speed Selection for additional details.

Pressing the Start pushbutton will initiate drive operation and accelerate the drive to the selected speed if:

Parameter 21 is set to on **1**.

The Stop pushbutton remains operational when remote stop devices are used. Pressing the stop pushbutton will initiate the stop sequence and the drive will cause the motor to:

- Coast-to-stop if Parameter 10 is set to **0**.
- Brake-to-stop by DC injection if Parameter 10 is set to **1**.
- Ramp-to-stop if Parameter 10 is set to **2**.

If the drive has stopped due to a fault, pressing the Stop pushbutton will only clear the display and reset the drive, not correct the fault.

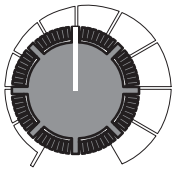
Pressing the Jog pushbutton will jog the drive if:

Parameter 23 is set to (on) **1** .

Pressing the direction pushbutton will cause the motor to ramp down to zero, then ramp up to set speed in the opposite direction if:

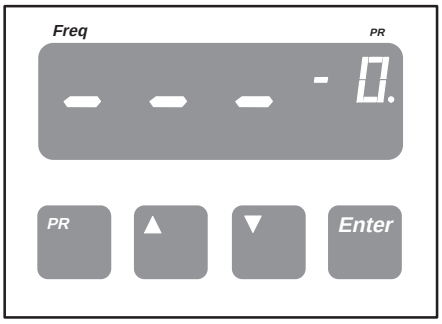
Parameter 22 is set to (on) **1**.

When power is applied to the drive, one of these two lights will be lit to indicate the selected direction of motor rotation.



Turning the speed potentiometer will adjust or set drive output frequency if the speed pot has been selected and is functional.

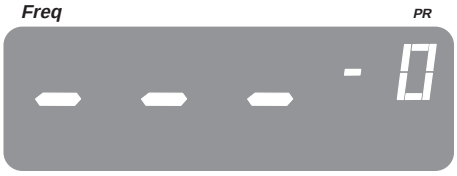
Standard Local Display and Programming Panel



The Local Display and Programming Panel provides a means of displaying different drive status conditions while providing pushbutton control for selected viewing and parameter programming. The panel is provided as standard and is a permanent part of the drive.

The Freq display is a three character display that shows:

Standby Status Display
The standby status of the drive when it is waiting for a drive start or jog command.



Output Frequency Display
The drive output frequency appears when the drive is running.

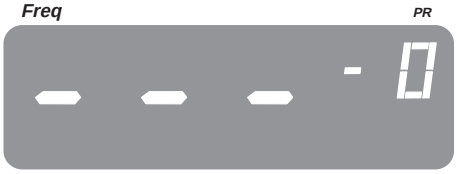
Fault Display
Fault codes appear if the drive detects a fault condition.

Parameter Programming Display

Parameter values appear when viewing or programming drive parameters.

Operating Display

The Pr display is a two character display that shows the frequency source when the drive is in Standby, Jog or Running.



- **– 0** Local speed pot
- **– 1** 0 to +10V input
- **– 2** 4-20 mA input
- **– 3** Pulse train input
- **– 4** Serial input
- **– 5** Remote speed pot input
- **– 6** Jog selected
- **– 7** Preset Speed 1
- **– 8** Preset Speed 2
- **– 9** Preset Speed 3

IMPORTANT: No dash indicates a parameter number rather than a frequency source (above).

Parameter Viewing Display

The parameter number appears when viewing parameters.

Parameter Programming

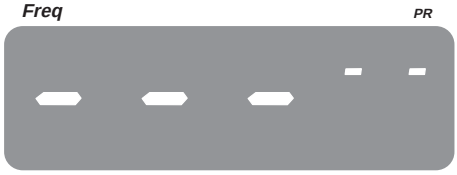
A decimal point appears if parameter programming has been selected and is allowed. If the programming function is locked out, check switch SW1 on the Local Display and Programming Panel Card. The switch must be set to C1 to allow parameter programming.

Fault Display

Two dashes appear if a fault has occurred.

Special Display — Enable Loss

All dashes appear if an enable loss has occurred.



Fault Code Descriptions

The following table describes each Fault Code. Fault Codes appear on the drive's Programming and Display Board. The following table lists the Fault Codes and describes appropriate checks or repair actions for each code. Some of the descriptions and recommended actions mention Parameters. Refer to the 1336 Programming Manual for Parameter descriptions.

Clearing Faults

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

1. Cycle the input power to the drive.
2. Press the Stop button. This works only if Parameter 39 is set to 1. Refer to Parameter 39 – Fault Clear in the 1336 Programming Manual.

Table 1.A
1336 Fault Codes

Display	Description	Recommended Action
-----	Special Display. The Enable Interlock is Open.	Check the following: 1. Main Control Board connector J9 for a jumper on pins #7 and #8 if a Logic Interface Board is not used. 2. TB3, Terminal #30 is missing the proper signal for the Logic Interface Board. MOD – L1 is a contact closure only; – L2 is 24V DC; – L3 is 115V AC. 3. Use a hand-held terminal to check Parameter 59, Bit #1. 0 equals Disabled, 1 equals Enabled. The displayed value of Bit #1 depends on the state of TB3, Terminal #30. 4. If the jumper is present at connector J9, pins #7 and #8, and Parameter 59, Bit #1 is 0, replace the jumper and/or the Main Control Board. 5. If the correct signal is present at TB3, Terminal #30 and if Parameter 59, Bit #1 is 0, replace the Logic Interface Board and/or the Main Control Board.
F01	Special Display. This is not a Fault Code. The drive displays this code each time it is powered up or when you clear a fault.	Take no action. The drive is in a diagnostic mode when this code appears.
F02	Auxiliary Fault. The Auxiliary Interlock is open.	Check the following: 1. Main Control Board Connector J9 for jumper on pins #9 and #10 if a Logic Interface Board is not used. 2. TB3, Terminal #28 is false: MOD – L1, contact is not closed; – L2, 24V DC is not present; – L3, 115V AC is not present. 3. Use a hand-held terminal to check Parameter 55, Bit #1. 0 equals Off, 1 equals On. Bit #1 should display 1. 4. If a jumper is present at Connector J9, pins #9 and #10, and Parameter 55, Bit #1 is 0, replace the jumper if the connections are faulty, or replace the Main Control Board if the jumper connections are good. 5. If the correct signal is present at TB3, Terminal #28, and Parameter 55, Bit #1 is 0, replace the Logic Interface Board and/or the Main Control Board.
F03	Input Power Loss. This fault occurs when Parameter 40 is set to 0 and input power is interrupted for 0.5 second.	Monitor the incoming AC line at TB1 Terminals L1, L2 and L3 for low voltage or line power interruption. Check for differences in the Base Driver Board Firmware revision. Firmware revision 1.01 is 380V AC, –10%. Firmware revision 1.11 or higher is 380V AC, –15%.
F04	Bus Undervoltage. The DC bus dropped below 456V DC for Firmware revision 1.01 or 338V DC for Firmware revision 1.11 software on the Base Driver Board. 485V DC for “C” ratings.	Check the incoming line voltage for correct voltage. Check voltage at the TB1, Terminals +DC and –DC. The voltage is monitored on the Base Driver Board.

Table 1.A
1336 Fault Codes (continued)

Display	Description	Recommended Action
F05	Bus Overvoltage. This fault occurs when the DC bus has risen above 810V DC for "B" ratings. 975 V DC for "C" ratings.	Check the following: 1. Incoming line voltage for excessive voltage or transient conditions. (A Line Analyzer may be required.) 2. Excessive motor regeneration due to high inertia load or excessive speed in the deceleration ramp. An extended deceleration ramp or dynamic braking may be required. 3. Voltage at TB1 Terminals +DC and –DC. The Base Driver Board monitors bus voltage. Nominal Readings Rating / Input Volts / DC Bus: "B" 380 / 535; 415 / 580; 460 / 650. "C" 500 / 700; 575 / 800; 600 / 850.
F06	Motor Stalled. The drive was unable to change frequency for 10 seconds with Firmware revision 1.01, or 4 seconds with Firmware revision 1.11 or higher (base driver). Probable causes include: 1. Excessive current. The motor is drawing over 150% of the drive rating and the motor load will not allow the drive to accelerate to set speed. 2. Bus voltage rise. A 10% rise in bus voltage above the nominal value has occurred. A regeneration condition will not allow the drive to decelerate. 3. The Boost setting is improper. If too low, the motor will not develop enough torque to "break away" the load. If too high, saturation of the motor winding may occur.	1. A longer acceleration ramp or reduced load may be required. 2. A longer deceleration time or dynamic braking may be required. 3. Check Parameters 9 and 48. Refer to the 1336 Programming Manual.
F07	Motor Overload. The output current has exceeded the percentage of current set by Parameter 38, Electronic Thermal Overload.	Check for load jams, seized bearings, machinery jams, and problems with the motor or couplings.
F08	Overtemperature. The drive has detected an over temperature/open thermal switch on the drive's heat sink. Possible causes: 1. 1005C at the thermal switch, located on the back plane of the drive. 2. Blocked or dirty heat sink cooling fins. 3. Faulty cooling fan on B010 or C015 units, or larger units. 4. The Thermal Switch connection at Main Control Board Connector J6 is faulty (gray and white wires).	1. Correct a heavy load on the motor. Cool down the room temperature in which the drive is operating. 2. Use a soft brush or air pressure to remove dust from the cooling fins. 3. Check the fan for jams or broken fan blades. Make sure the fan is operating. 4. Make sure the Thermal Switch is plugged in. Check for an open switch. Check the connector pins at the Main Control Board. Remove the white cap from the orange J6 connector (female) and check that the wires in the connector contact the leads in the connector.

Table 1.A
1336 Fault Codes (continued)

Display	Description	Recommended Action
F09	Pot Return Open. The remote speed pot is being used to control the drive frequency after the low input opens, but while the wiper and high inputs are still connected. Depending on the Main Control Board Firmware revision number, the following occurs: 1. Revision 1.01. The Fault Code does not display, but the symptoms appear. The drive will default to the Parameter 19 maximum frequency setting. An open or disconnected wire defaults the drive to the maximum frequency command. 2. Revision 1.10 or higher/later. The Fault Code displays.	Verify the wire connections. Check the resistance of the speed pot to reveal bad internal connections. Check the wiring between the speed pot and the board for continuity.
F10	Serial Time Out. This code indicates a break in communications after communication has been established between the MOD – G2 Remote I/O Board. Operator Error.	1. Check the ribbon cable between the drive and MOD – G2 Board. 2. Check Fuse F1, located on the Main Control Board behind the Local Display and Programming Panel. If the fuse is open, the Logic Power of the Control Board has drawn excessive current. Replace the fuse with a 0.5 amp/250 volt Fast-Acting 5 x 20 mm fuse.
F11	Operator Error.	Check the following for incompatible Parameters: 1. Control Board Firmware revision 1.01: a. Parameter 20 equals or is greater than Parameter 18. b. Parameter 18 equals or is greater than Parameter 50. c. Parameter 50 equals or is greater than Parameter 48. 2. Control Board Firmware revision 1.10: a. If Parameter 41 is set to a value of 2, set Parameter 10 to either 0 or 2. b. If Parameter 42 is set to a value of 0, set Parameter 41 to either 1 or 2. c. On Power Up, or after exiting the Program mode, press the Stop button before a Start. If Parameter 14 is set to 0 and power is applied to the drive, or when a fault occurs, press the Stop button twice; one press clears the fault, and the second press resets the Not Stop Bit. 3. For Fault Clear procedures, refer to the Parameter 39 description in the 1336 Programming Manual.
F12	Overcurrent. The drive has exceeded 180% of its current rating. This fault is a hardware limitation of the drive.	Check the following: 1. A short circuit at the output of the drive. 2. An excessive load on the motor. 3. Parameter 9 or 48 (DC boost) is set too high. 4. Parameter 43, Dwell Frequency, is set too high. Refer to the 1336 Programming Manual.
F13	Ground Fault. One or more of the drive output terminals is grounded.	Check the motor and external wiring to the drive output terminals for a grounded condition.
F14	Output Short. Two or more of the drive output terminals are short circuited between the terminals.	Check all three phases of the motor and external wiring for a grounded condition.
F15	Refer to Fault Code F14.	Refer to Fault Code F14.
F16	Refer to Fault Code F14.	Refer to Fault Code F14.
F17	Transistor Short. A shorted drive transistor, either positive or negative, is detected.	Refer to Test 3 – Testing the Transistor Modules in the Component Electrical Tests section of this manual.

Table 1.A
1336 Fault Codes (continued)

Display	Description	Recommended Action
F18	Refer to Fault Code F17.	Refer to Fault Code F17.
F19	Precharge Open. The precharge circuit does not allow precharge to occur. This Fault Code does not display for drives using Firmware revision 1.01, but the symptoms appear.	Test the Precharge Circuit. Refer to Test 5 – Testing Precharge SCR M1 and Test 4 – Testing the Precharge Board in the Component Electrical Tests section of this manual.
F20	Drive Hardware. A fault on the Base Driver ASIC (U14) cannot be cleared. The transistors are disabled when the drive is malfunctioned.	Clear the fault. If you cannot clear the fault, replace the Base Driver Board.
F21	Drive Hardware. The PWM algorithm in the Base Driver Board processor has been disrupted.	If the fault occurs repeatedly, replace the Base Driver Board.
F22	Drive Software. The Base Driver Board processor has been reset. The most likely causes: 1. Power supply voltage has dropped below 4.55V, causing a reset. 2. Electrical noise at the reset input of the processor. 3. Loose connection on the DC bus causing noise.	Clear the fault. If you cannot clear the fault, replace the Base Driver Board.
F23	Drive Software. The main loop of the Main Control Board microprocessor is taking more than 10 ms to complete.	Clear the fault. If you cannot clear the fault, replace the Base Driver Board.
F24	Drive Software. The Base Driver Board microprocessor has an undefined value in a RAM location.	Clear the fault. Replace the Base Driver Board if the fault occurs often.
F25	Drive Software. The commanded frequency is out of range.	Clear the fault. If you cannot clear the fault, replace the Base Driver Board.
F26	Drive Software. The Base Driver Board microprocessor has an undefined value in a RAM location.	Clear the fault. Replace the Base Driver Board if the fault occurs often.
F27	Drive Software. The processor has stopped sending PWM signals to the ASIC, disabling the transistors and setting the fault.	Clear the fault. If you cannot clear the fault, replace the Base Driver Board.
F28	Drive Software. The Base Driver Board has not received communication from the Main Control Board for over 100 ms.	Check ribbon cable between the Main Control Board and the Base Driver Board. Replace the Main Control Board and/or the Base Driver Board.
F29	Input Software. The Drive cannot find a legal frequency at which to operate due to the programming of the Parameters. This fault is set on the Main Control Board and may be tripped as Fault Code F11.	Refer to the Fault Code F11 description in this table. Clear the fault. If you cannot clear the fault, replace the Base Driver Board.

Table 1.A
1336 Fault Codes (continued)

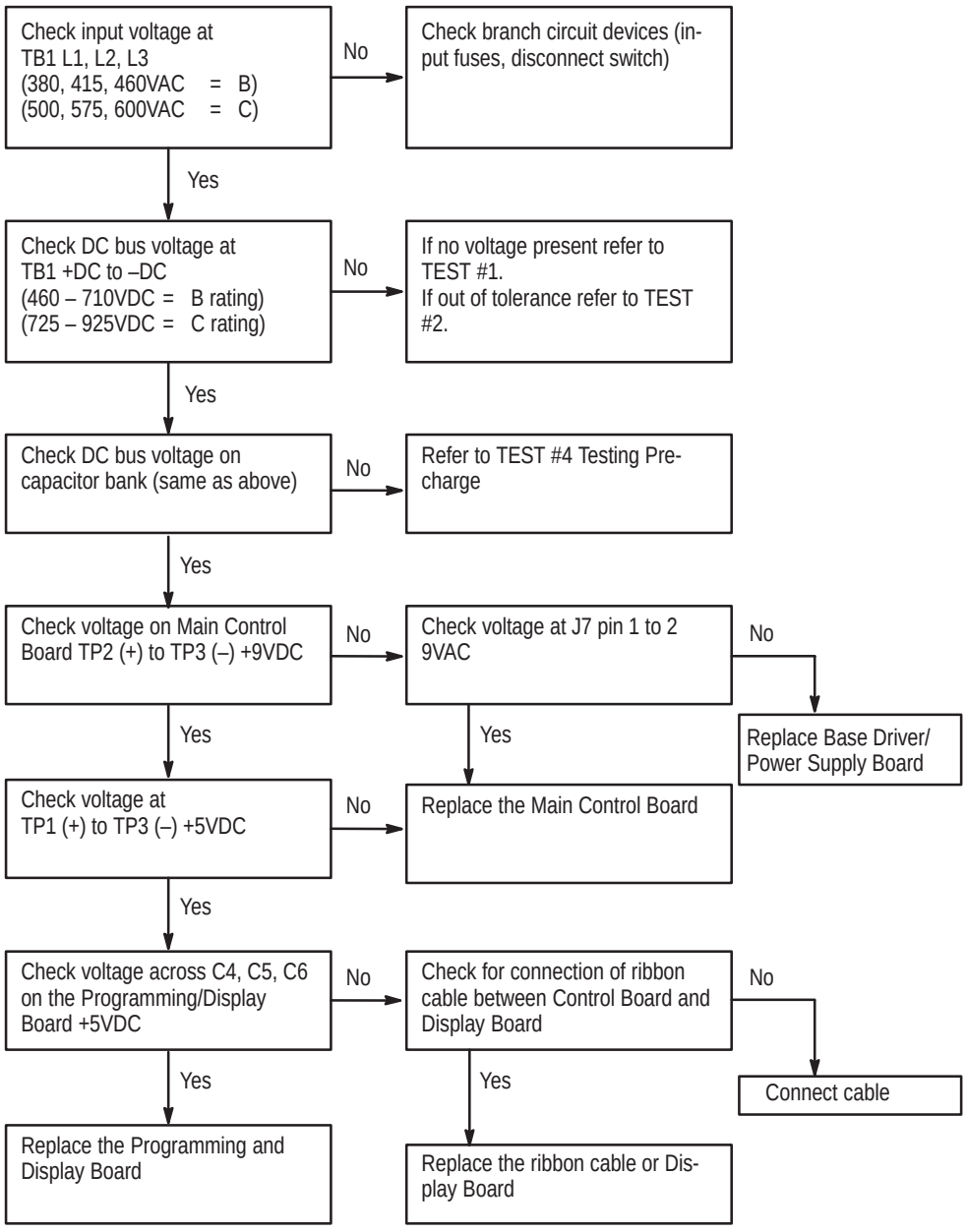
Display	Description	Recommended Action
F30	Input Software. The Base Driver Board cannot identify a valid frequency source.	Clear the fault. If you cannot clear the fault, replace the Base Driver Board.
F31	Input Software. The Base Driver Board does not respond to communications on the Main Control Board.	When F31 fault is displayed, the communication between the Main Control Board and Base Driver Board has not been established. If you attempt a fault reset before the communication is established, an F32 Fault occurs. Check the ribbon cables and connections between the Base Driver Board and the Main Control Board. Replace one or more of the following: 1. Base Driver Board. 2. Ribbon cable. 3. Main Control Board.
F32	EEPROM Error. The EEPROM reads an out-of-range Parameter.	Clear the fault. If you cannot clear the fault, replace the Main Control Board.
1336 Fault Codes for Drives with Firmware Rev. 2.01		
F33	Retries Exceeded	Refer to Fault Buffers (Parameters 86 – 89) to determine the cause of failure.
F34	Boost Error	Parameter 83 must be set to a value less than or equal to Parameter 48.
F35	Negative Slope	Check Parameters 18 and 50. Check Parameter 48 and 50. Parameter 18 must be equal to or greater than Parameter 50. Parameter 50 must be equal to or greater than Parameter 48.
F36	Diagnostic Current Limit	Used to detect the drive going into Current Limit. Check for excessive load.
F37	P-Jump Error	P-Jump and Slip Compensation cannot be used together. Check Parameters 42, 78 – 80 for correct settings.

Diagnostic Procedures by Symptom

The following flowcharts apply to drives rated B075 – B125, C075 – C125, and VT B075 – B150. The flowchart lists drive symptoms, symptom descriptions, and recommended actions to remedy the symptoms.

No Display

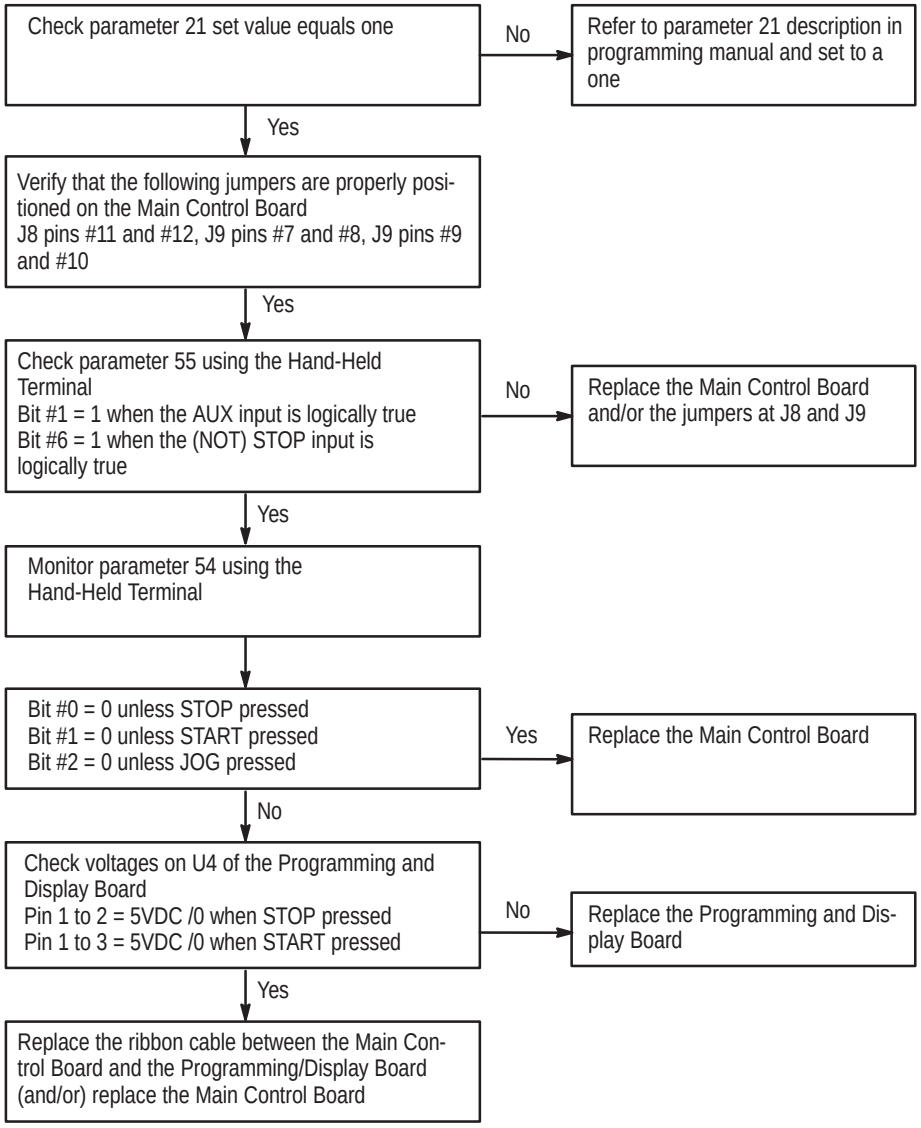
Check for illumination of Bus Indicator Light DS1. If illuminated, dangerous voltages are present within the drive.



Drive Will Not Start

Local Control Panel (MOD-FA2) used to control drive.

Check the display for a stand-by status (– – – – 0). The digit tells you what frequency reference the drive will follow.

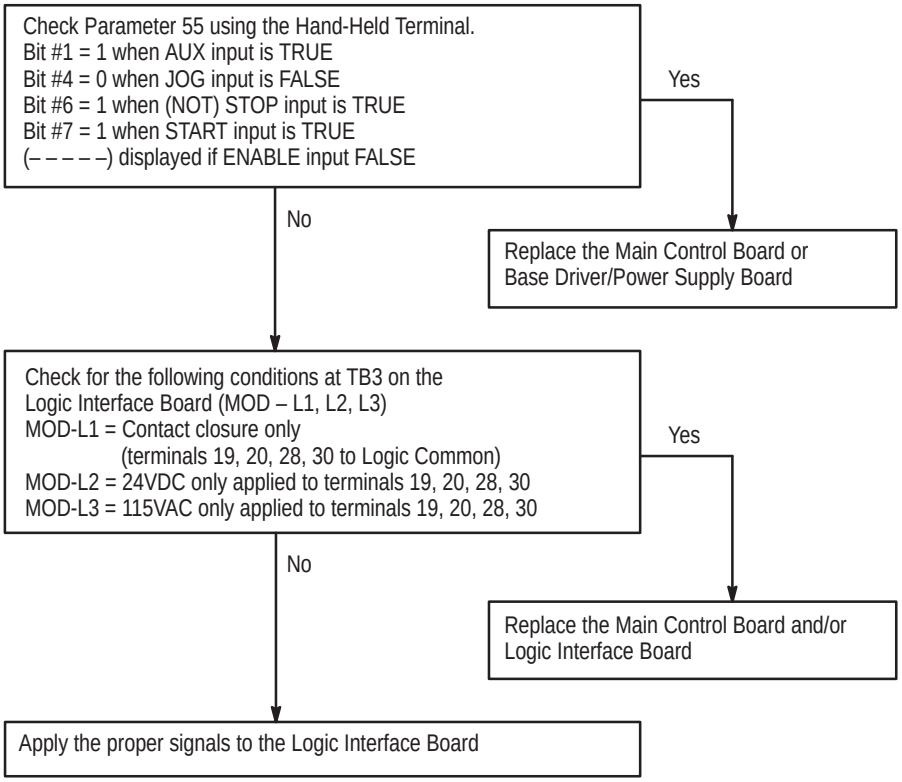


IMPORTANT: If the Base Driver Board has Firmware revision 1.01, Fault Code F09 (Precharge Open) does not display. The START or JOG command will be ignored if the precharge circuit is open. Refer to Test 2 – Testing the Bus Capacitors in the Component Electrical Tests section of this manual.

Drive Will Not Start

Remote start/stop (MOD-L1, -L2, -L3) used to control drive.

Check the display for a stand-by status (– – – – 0). The digit tells you what frequency reference the drive will follow.



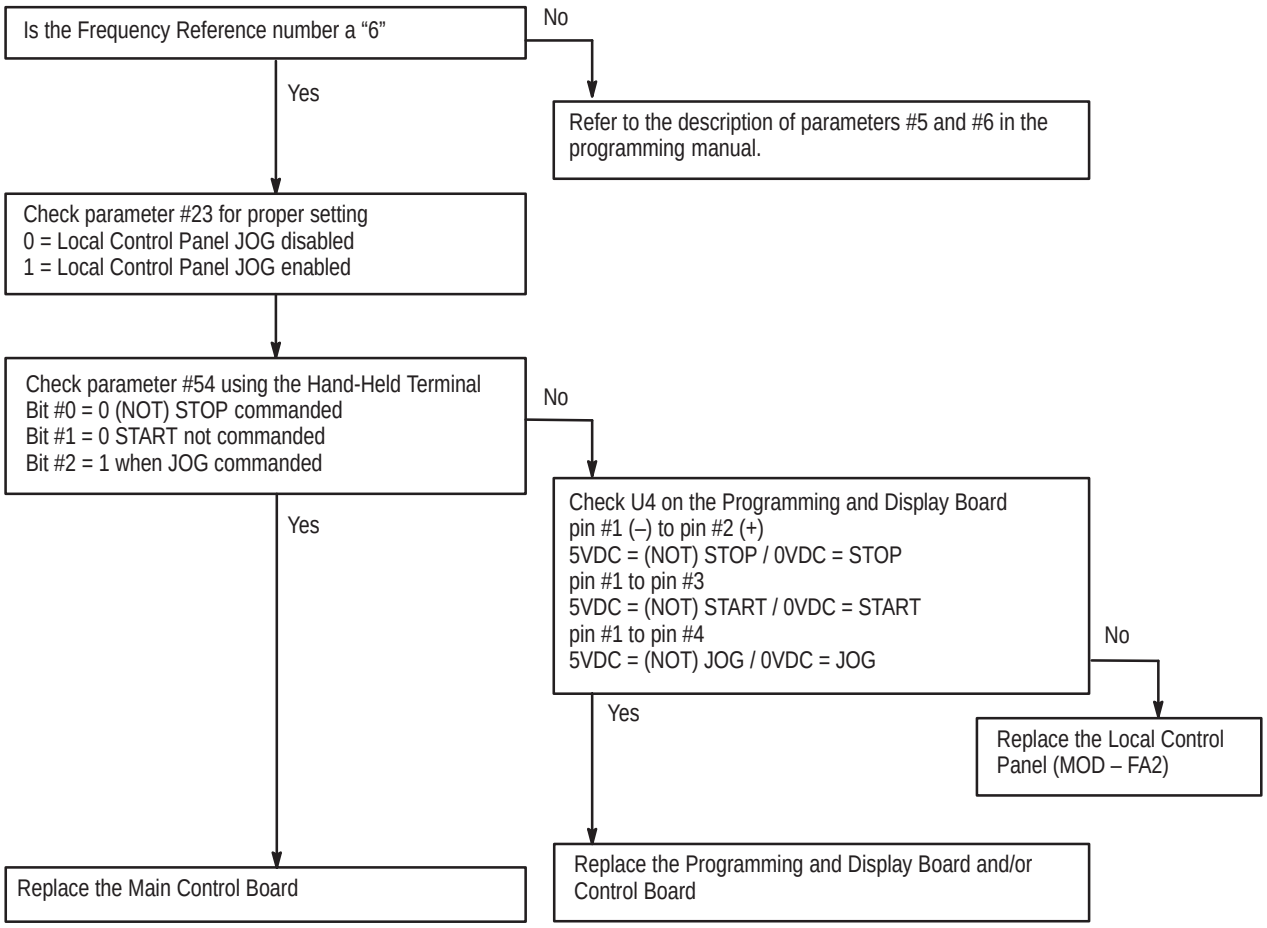
IMPORTANT: If the Base Driver Board has Firmware revision 1.01, Fault Code F09 (Precharge Open) does not display. The START or JOG command will be ignored if the precharge circuit is open. Refer to Test 2 – Testing the Bus Capacitors in the Component Electrical Tests section of this manual.

Drive Will Not Jog

Local Control Panel (MOD-FA2) used to control drive.

The JOG and START commands are mutually exclusive. JOG is not active if a START command is present. START is not active if a JOG command is present.

Check the display for (– – – – 6), this display represents a stand-by condition. The 6 is the Frequency Reference for JOG.

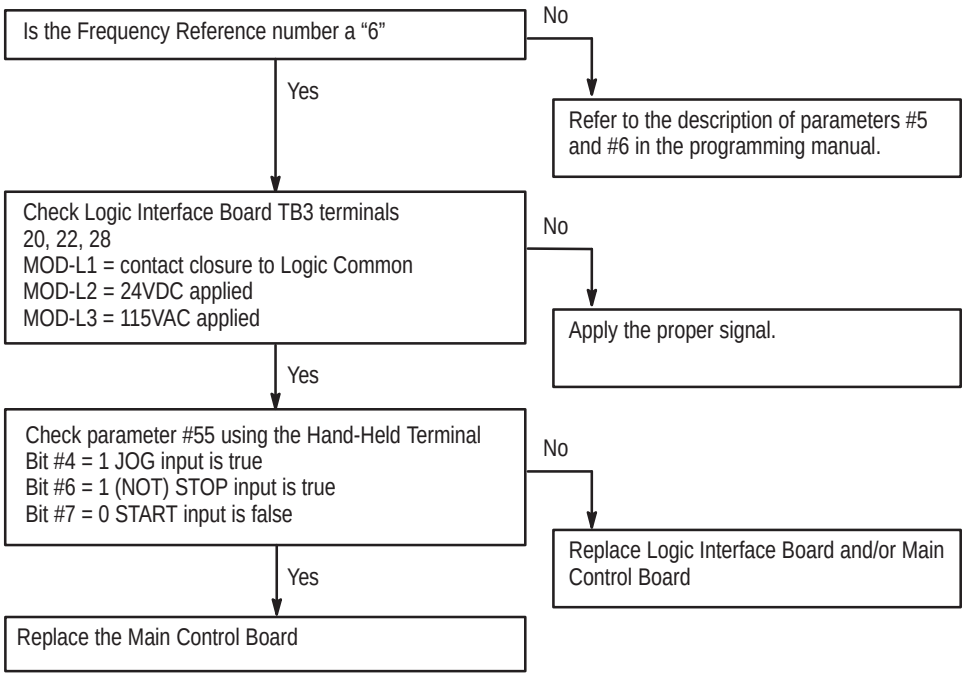


Drive Will Not Jog

Logic Interface Board (MOD-L1, -L2, -L3) used to control drive.

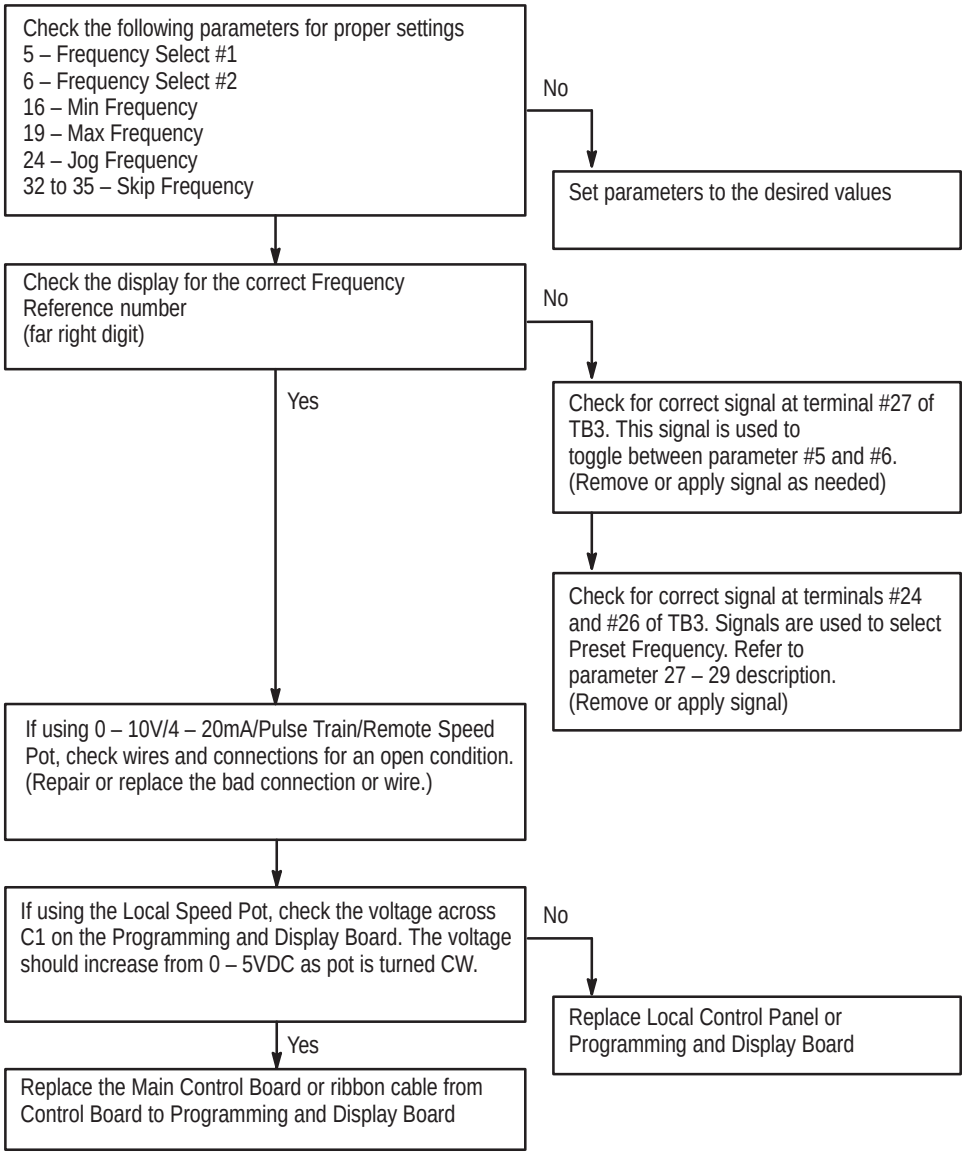
The JOG and START commands are mutually exclusive. JOG is not active if a START command is present. START is not active if a JOG command is present.

Check the display for a (– – – – 6), this display represents a stand-by condition. The 6 is the Frequency Reference for JOG.



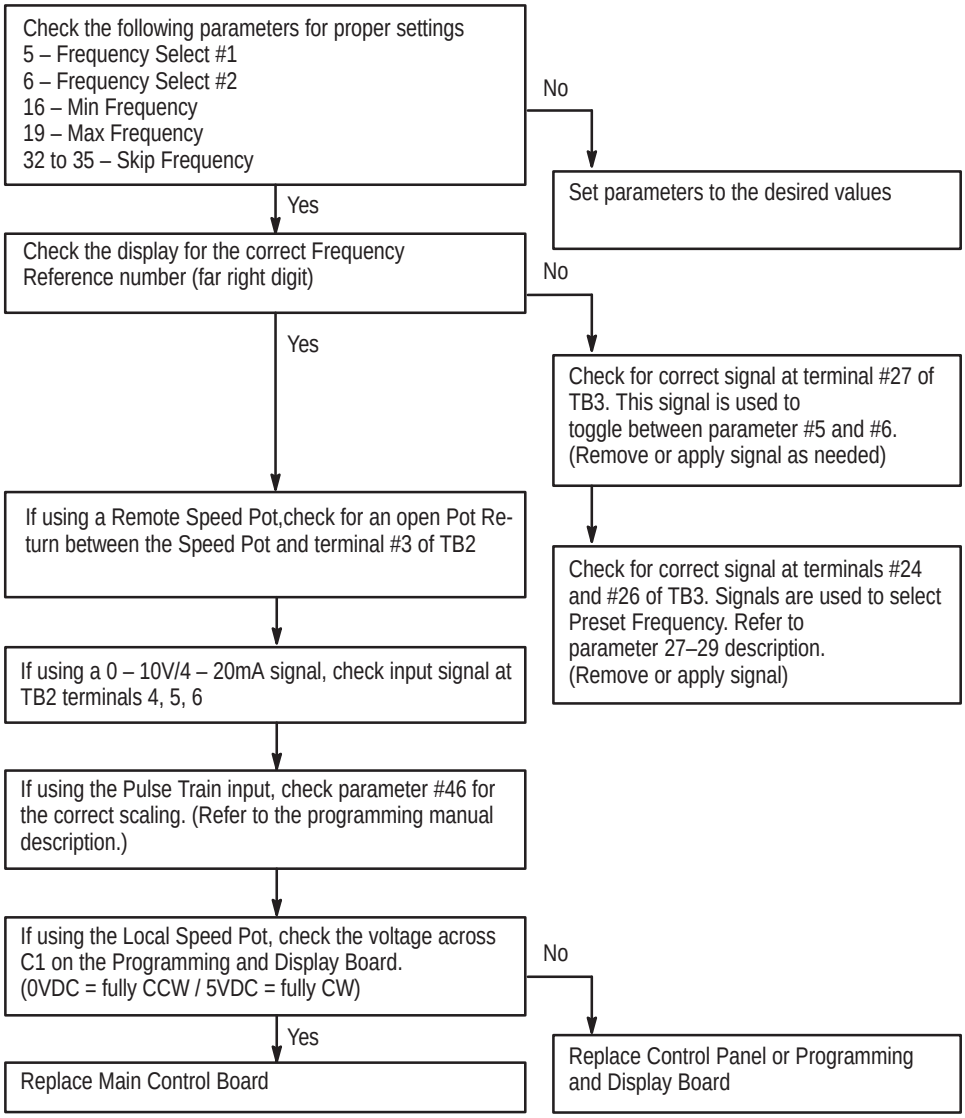
Drive Stays at Zero Hertz When Started

IMPORTANT: Parameter 65 indicates the command frequency, and can be checked using the Hand-Held Terminal.

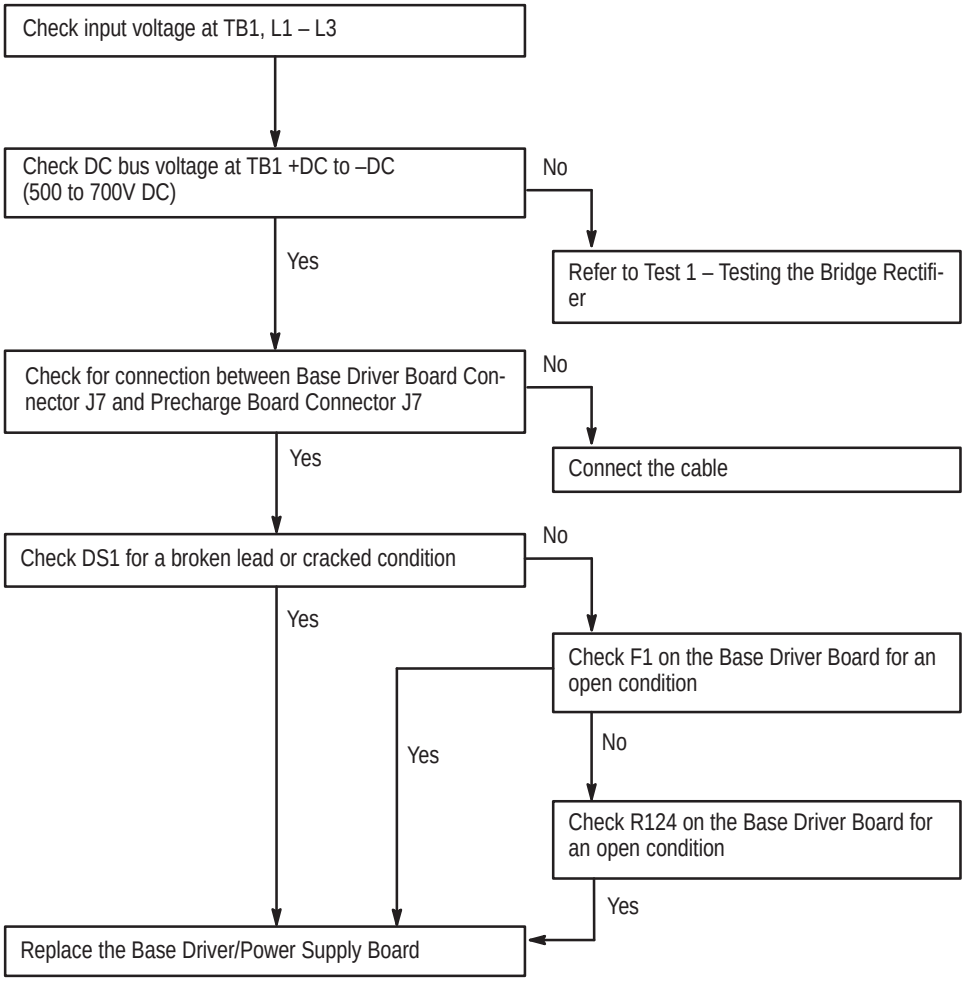


Drive Goes to Max Frequency

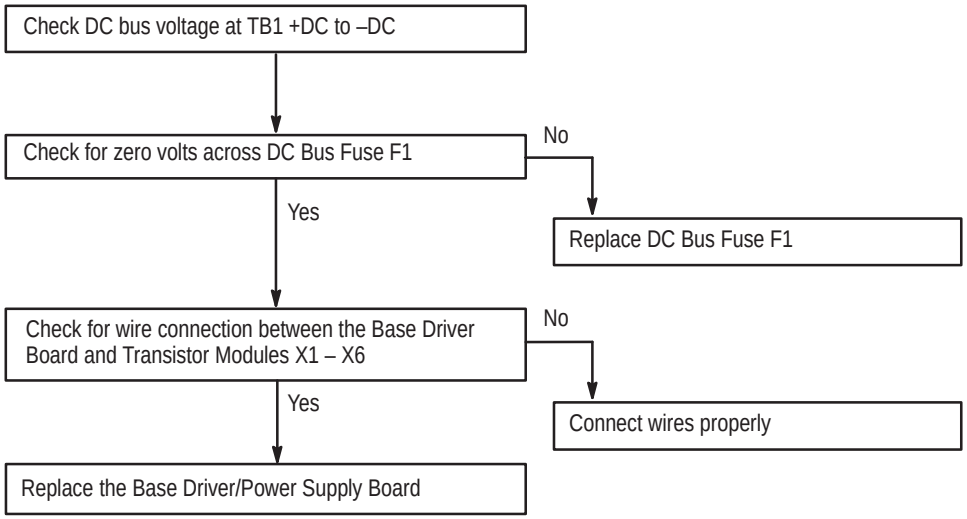
IMPORTANT: Parameter 65 indicates the command frequency, and can be checked using the Hand-Held Terminal.



Neon Bus Light Not Illuminated

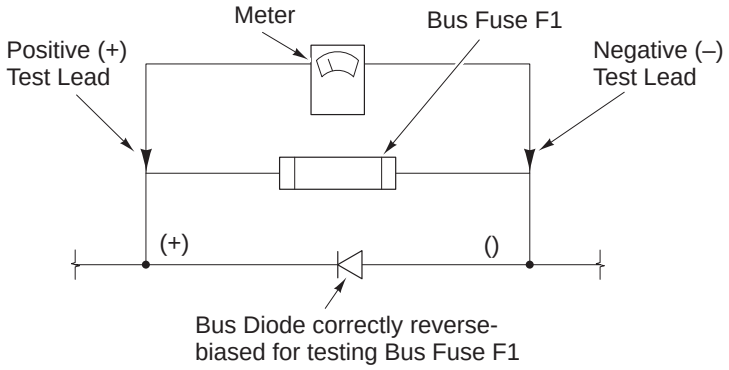


Drive Starts, No Output at M1 – M3



IMPORTANT: An open DC Bus Fuse F1 shows voltage when you measure across the fuse. An open fuse indicates probable transistor malfunction. Check Transistor Modules X1 – X6 following this troubleshooting procedure and before starting the drive.

IMPORTANT: If you disconnect power to the drive and measure the resistance across DC Bus Fuse F1 to check for an open fuse condition, your meter leads must be properly positioned on the fuse. If your meter leads are not properly positioned, Bus Diode D1 is forward biased, and the meter registers a low resistance even if DC Bus Fuse F1 has an open condition.



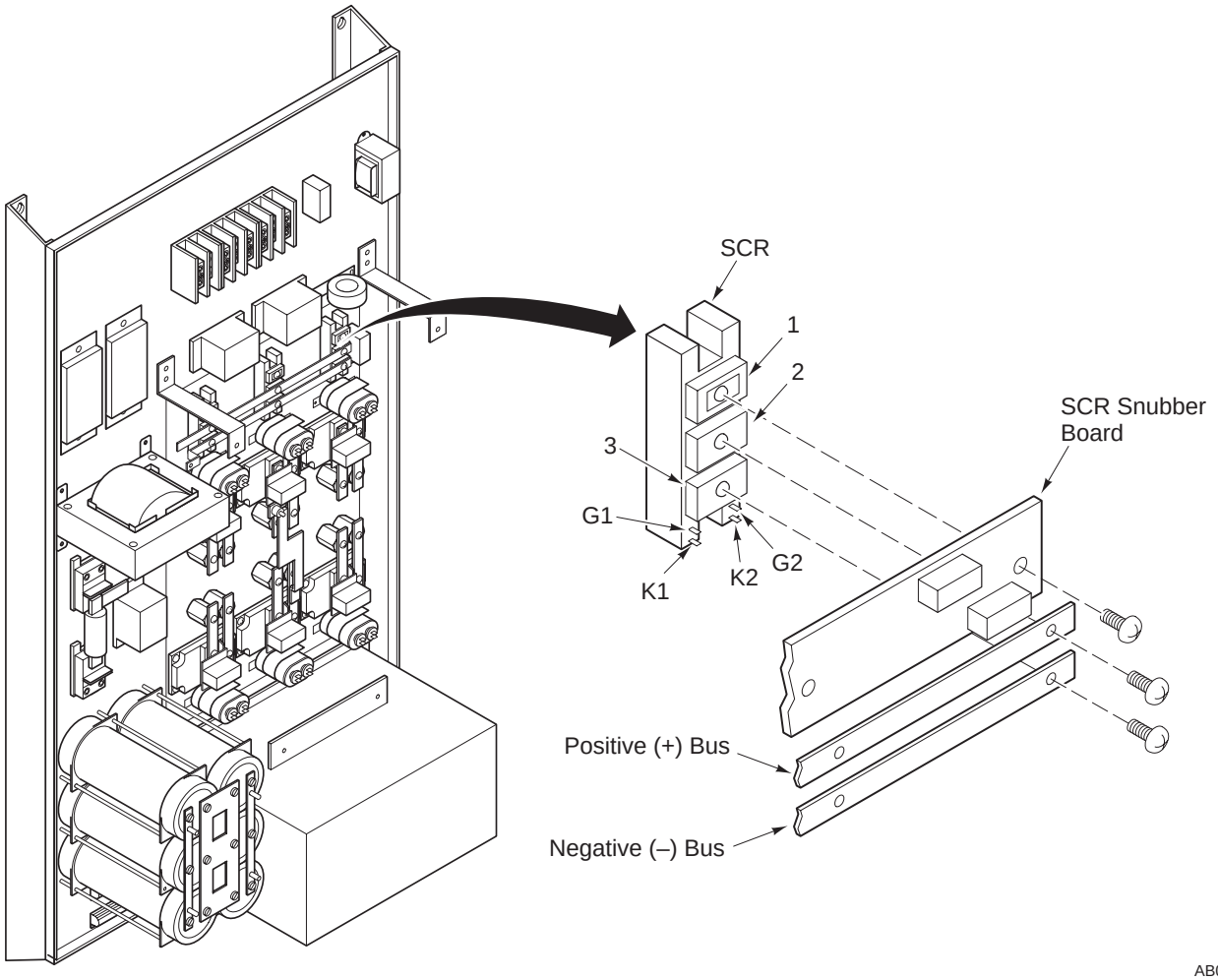
Component Electrical Tests

The following tests help you troubleshoot B075 – B125, C075 – C125, and VT B075 – B150 drives. Double check that the rating on the drive matches the rating for the test you are performing.

Test 1
Testing the Bridge Rectifiers

Bridge Rectifiers SCR1, SCR2, and SCR3 are located on the Main Chassis behind the Base Driver Mounting Plate and the SCR Snubber Board. These rectifiers are listed in Chapter 4 – Spare Parts List as BR1, BR2, and BR3.

Figure 1.6
Bridge 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. A bus charge neon indicator provides visual indication that bus voltage is present. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the neon indicator has extinguished and the bus voltage has discharged to zero volts.

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

1. Remove power from the drive.
2. Wait for Bus Indicator Light DS1 to turn off before proceeding. Check for zero volts at TB1 Terminals +DC and –DC.
3. Remove the Base Driver Mounting Plate from the Drive. Refer to Chapter 2 – Removing the Base Driver Mounting Plate.
4. Remove the SCR Snubber Board.
5. Remove the bridge rectifier bus bars.
6. Set your meter to test diodes.
7. Test each of the three bridge rectifiers. The following table shows meter connections and ideal meter readings for those connections. Refer to the former illustration for meter connection locations.

Table 1.B
Bridge Rectifier Test

Meter (+) Lead	Meter (–) Lead	Nominal Meter Reading
1	2	Infinite
3	1	Infinite

8. Attach a 9V DC battery to an SCR:
   a. Connect the positive battery lead to SCR Terminal G1
   b. Connect the negative battery lead to SCR Terminal K1.
9. Set your meter to test diodes and test the SCR. Refer to the following table and former illustration for meter lead and SCR terminal connections.

Table 1.C
Rectifier Test with 9V DC at G1 and K1

Meter (+) Lead	Meter (–) Lead	Nominal Meter Reading
1	2	0.88 Volts

10. Attach a 9V DC battery to an SCR:
    a. Connect the positive battery lead to SCR Terminal G2.
    b. Connect the negative battery lead to SCR Terminal K2.
    c. Test the SCR with your meter set to test diodes. Refer to the following table and former illustration for meter lead and SCR terminal connections.

Table 1.D
Rectifier Test with 9V DC at G2 and K2

Meter (+) Lead	Meter (–) Lead	Nominal Meter Reading
3	1	0.89 Volts

11. Replace any SCR producing readings other than those shown in the previous table. Refer to Chapter 3 – SCR Modules.

Test 2
Testing the Bus Capacitors

The bus capacitors are located on the lower left corner of the Main Chassis. Note differences in Bus Capacitor Bus Bar configurations on 1336 B and C models.

Figure 1.7
B075 – B125 Bus Capacitor Test

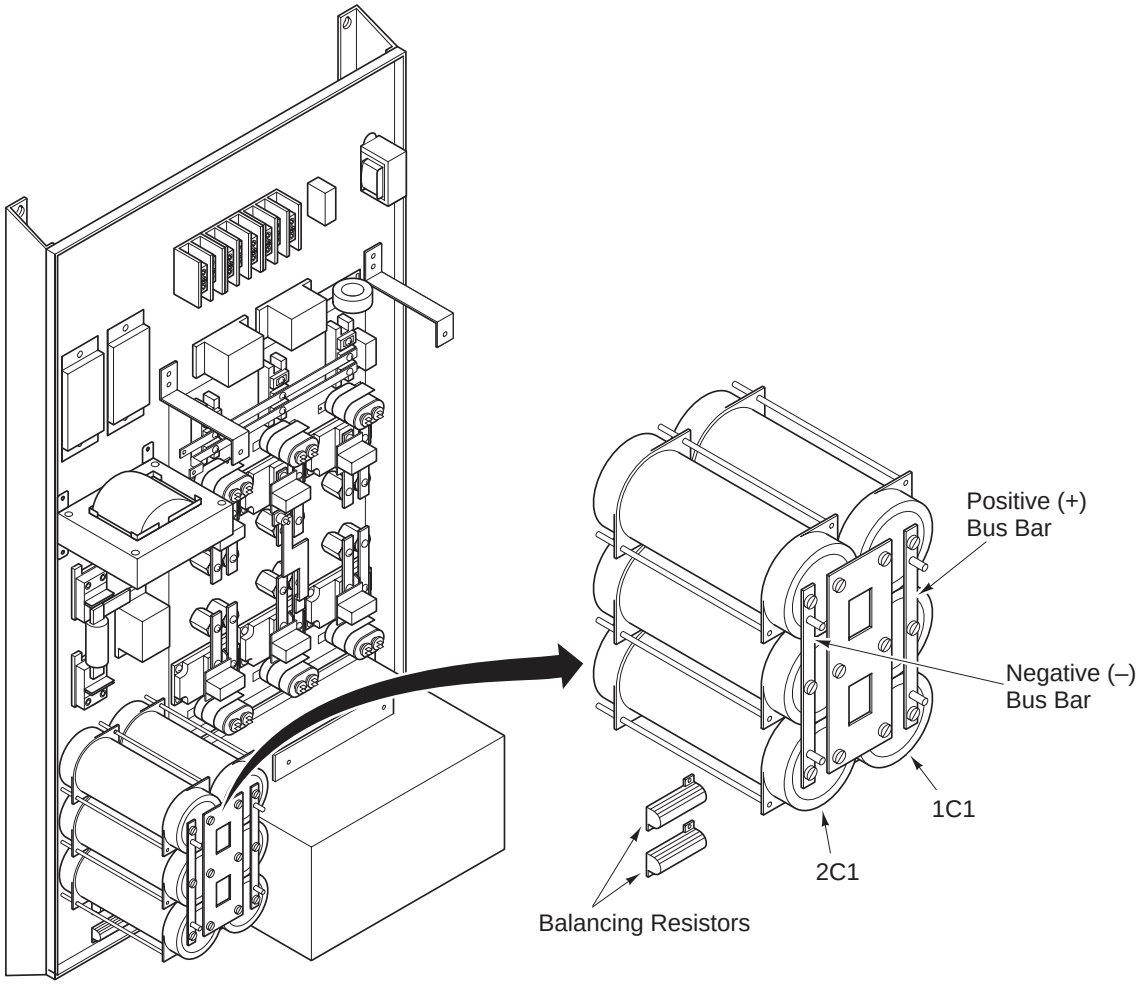
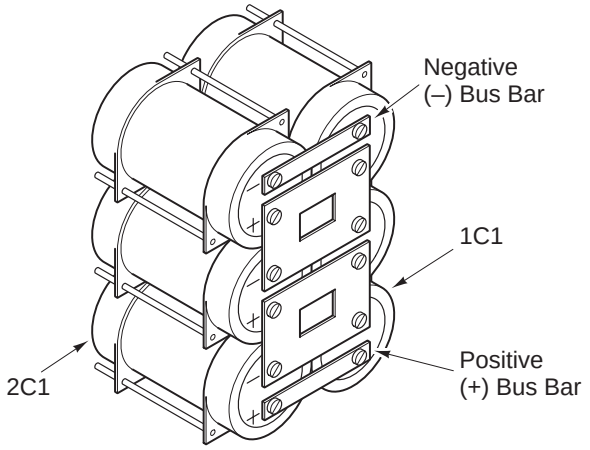


Figure 1.8
C075 – C125 Bus Capacitor Test



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

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

1. Remove power from the drive.
2. Wait for Bus Indicator Light DS1 to turn off. Check for zero volts at TB1 Terminals +DC and –DC.
3. Remove the protective plastic guard covering the capacitor terminals.
4. Restore power to the drive.

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.

5. Connect the negative lead of your meter to the capacitor (–) bus bar and the positive lead to the capacitor (+) bus bar. Refer to the following table and former illustration for meter-to-capacitor lead connections, voltages, and capacitor terminal locations.

Table 1.E
Bus Capacitor Group Test

Drive Rating	Input Volts	Meter (+) Lead	Meter (–) Lead	Meter Reading
B	380	+ Bus	– Bus	535V DC +/–10%
	415	+ Bus	– Bus	580V DC +/–10%
	460	+ Bus	– Bus	650V DC +/–10%
C	500	+ Bus	– Bus	700V DC +/–10%
	575	+ Bus	– Bus	800V DC +/_10%
	600	+ Bus	– Bus	850V DC +/–10%

6. If the voltage is not within tolerance, check the voltage across each capacitor group. Measure the voltage across 1C1, then across 2C1. Refer to the following table and former illustration for meter-to-capacitor lead connections, voltages, and capacitor terminal locations.

Table 1.F
Bus Capacitor Test for Half the DC Bus Voltage

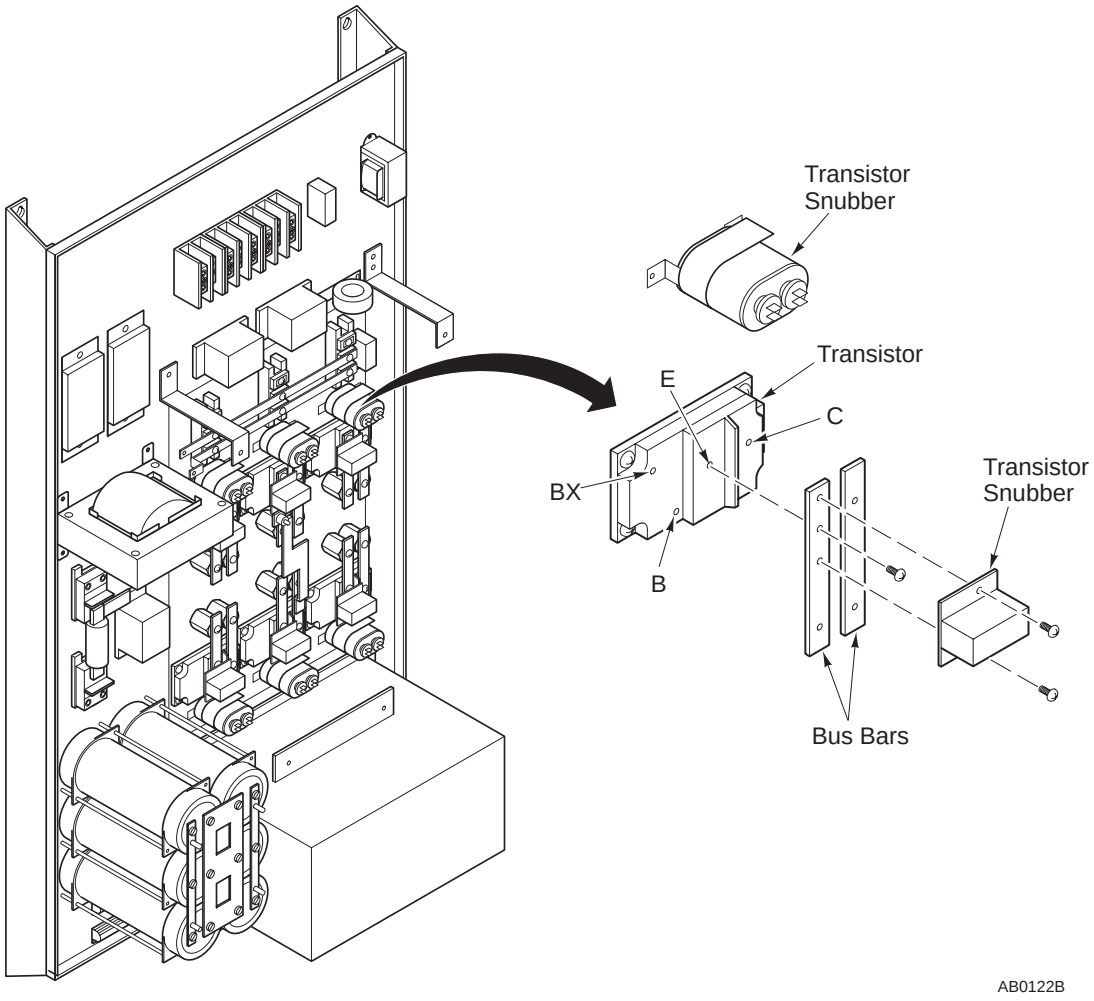
Drive Rating	Input Volts	Meter (+) Lead	Meter (–) Lead	Meter Reading
B	380	+ Bus	– Bus	267V DC +/–10%
	415	+ Bus	– Bus	290V DC +/–10%
	460	+ Bus	– Bus	325V DC +/–10%
C	500	+ Bus	– Bus	350V DC +/–10%
	575	+ Bus	– Bus	400V DC +/–10%
	600	+ Bus	– Bus	425V DC +/–10%

7. Check that the voltages across the capacitors are equal. If the voltages are unequal, replace the capacitor(s) and/or balancing resistor(s). The balancing resistors are located on the Main Chassis below the bus capacitors. Refer to Chapter 3 – Bus Capacitors.
8. If the voltages are low, check the following:
   - A Precharge Circuit problem. Refer to Test 4 – Testing the Precharge Board, and Test 1 – Testing the Bridge Rectifiers.
   - A malfunctioned Rectifier SCR1, SCR2, or SCR3.
   - An open wire between Rectifiers SCR1, SCR2, SCR3, and the capacitor group.
   - A voltage drop due to Inductor L1 resistance.

Test 3
Testing Transistor Modules X1 – X6

Transistor Modules X1 – X6 are located on the Main Chassis behind the Base Driver Mounting Plate and the Main Bus Bar assembly.

Figure 1.9
Transistor 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. A bus charge neon indicator provides visual indication that bus voltage is present. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the neon indicator has extinguished and the bus voltage has discharged to zero volts.

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

1. Remove power from the drive.
2. Wait for Bus Indicator Light DS1 to turn off before proceeding. Check for zero volts at TB1 Terminals +DC and –DC.
3. Remove the Main Bus Bar assembly. Refer to Chapter 2 – Removing the Main Bus Bar Assembly.
4. Remove the wires from the transistor modules.
5. Remove the bus bars from the transistor modules.
6. Set your meter to test diodes.
7. Test the transistors. The following table shows meter connections and ideal meter readings for those connections. Refer to the former illustration for meter connection locations.

Table 1.G
Transistor Module Test

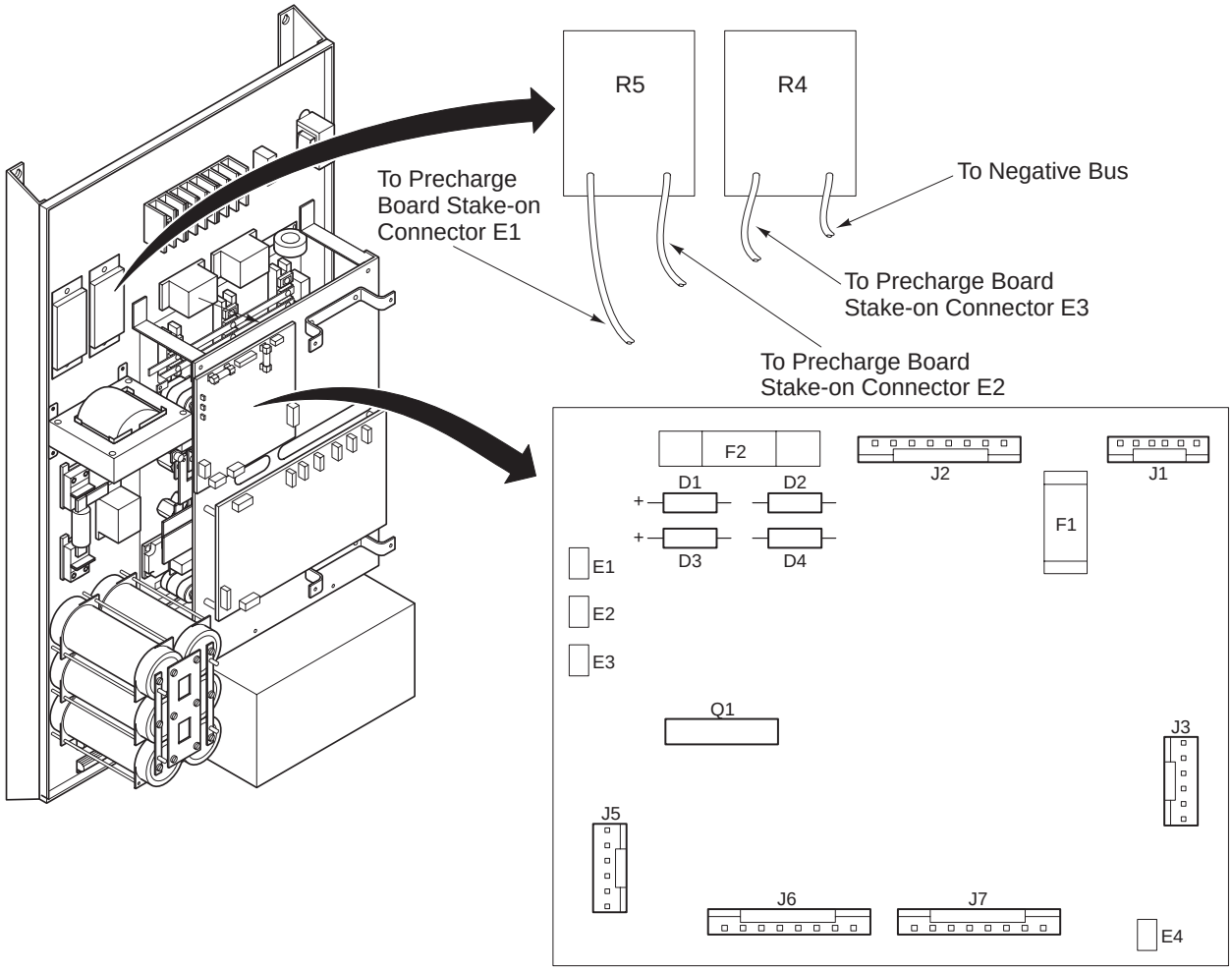
Meter (+) Lead	Meter (–) Lead	Nominal Meter Reading
C	E	Infinite
E	C	0.27 Volts
B	E	0.08 Volts

8. If your readings do not match the table readings, replace the malfunctioned transistor module, snubber, and diodes. Refer to Chapter 3 – Transistor Modules and Snubbers.

Test 4
Testing the Precharge Board

The Precharge Board is located behind the Main Control Mounting Plate. Resistors R4 and R5 are located on the Main Chassis near the upper left corner.

Figure 1.10
Precharge Board Test



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

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

1. Remove power from the drive.
2. Wait for Bus Indicator Light DS1 to turn off before proceeding. Check for zero volts at TB1 Terminals +DC and –DC.
3. Remove the Main Control Mounting Plate. Refer to Chapter 2 – Removing the Main Control Mounting Plate.
4. Remove the following from the Precharge Board:
   - Connectors J1, J2, J3, J5, J6, and J7.
   - Stake-on Connectors E1 – E4.
5. Set your meter to measure resistance.
6. Test the Precharge Board and Resistors R4 and R5. The following table shows meter connections and ideal meter readings for tested components. All values are nominal resistance in ohms. Refer to the former illustration for meter connection locations.

Table 1.H
Precharge Board Test

Component	Reading
Fuse F1	0 Ohms
Fuse F2	0 Ohms
Resistor R4	36 Ohms
Resistor R5	36 Ohms

7. If your readings match the table readings, continue to Step 8 in this test. If your readings do not match the table readings for:
   - Resistors R4 and R5, replace the resistors. Continue with Step 8 in this test.
   - Fuses F1 or F2, replace the Precharge Board. Refer to Chapter 2 – Removing the Precharge Board.
8. Set your meter to test diodes.
9. Test the Precharge Board diodes. The following table shows ideal meter readings for tested components. Refer to the former illustration for meter connection locations.

Table 1.I
Precharge Board Diode Test

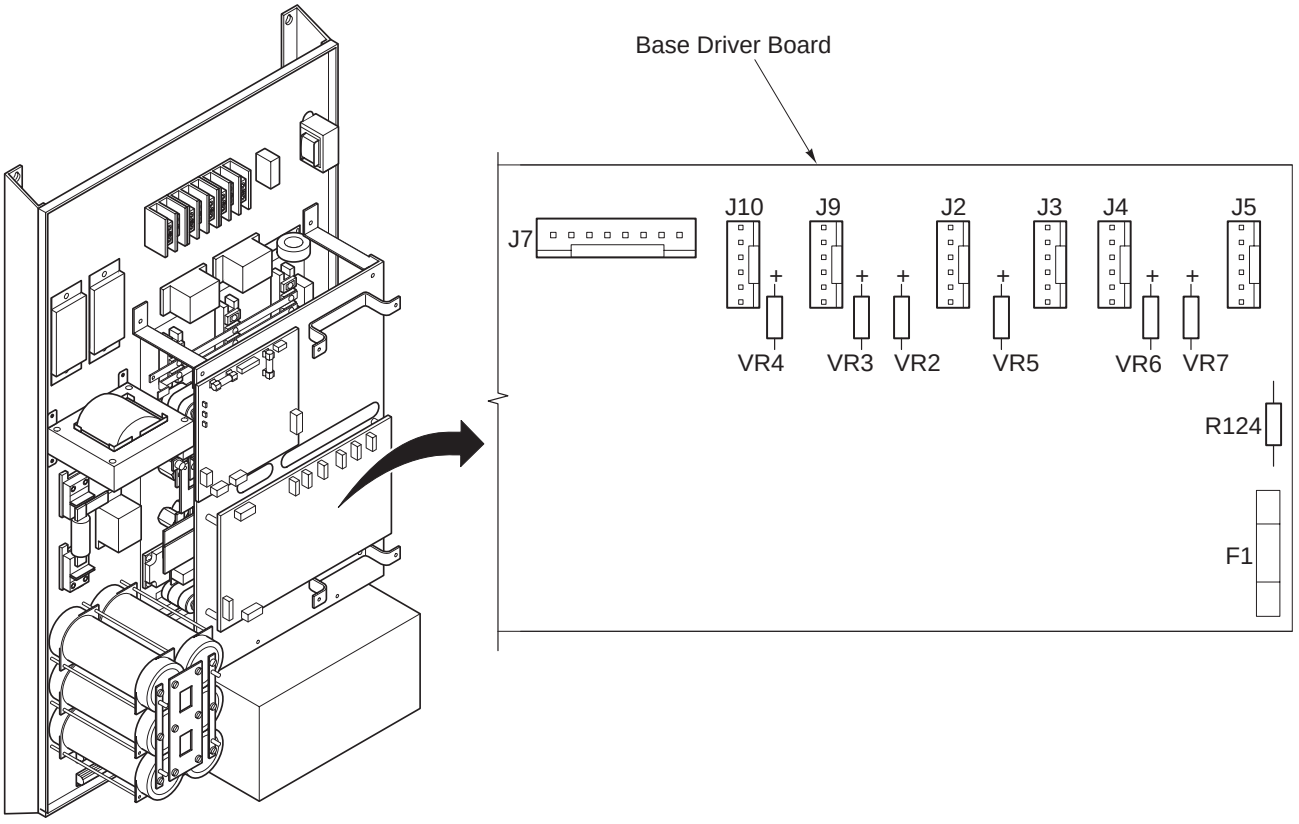
Component	Meter (+) Lead	Meter (–) Lead	Nominal Meter Reading
Diode	Cathode	Anode	Open
Diode	Anode	Cathode	0.5 Volts
Q1	Source	Drain	Open
Q1	Drain	Source	Open

10. If your readings do not match the table readings, replace the Precharge Board. Refer to Chapter 2 – Replacing the Precharge Board.

Test 5
Testing the Base Driver/ Power Supply Board

The Base Driver Board is located under the Main Control Mounting Plate. If one or more Transistor Modules has malfunctioned, you must test the Base Driver Board.

Figure 1.11
Base 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. A bus charge neon indicator provides visual indication that bus voltage is present. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the neon indicator has extinguished and the bus voltage has discharged to zero volts.

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

1. Remove power from the drive.
2. Wait for Bus Indicator Light DS1 to turn off. Check for zero volts at TB1 Terminals +DC and –DC.
3. Remove the Main Control Mounting Plate. Refer to Chapter 2 – Removing the Main Control Mounting Plate.
4. Remove Connectors J2 – J5, J9, and J10 from the Base Driver Board.
5. Set your meter to test diodes.
6. Test VR2 through VR7. The following table shows meter connections at the components and ideal meter readings for those connections. Refer to the former illustration for meter connection locations.

Table 1.J
Base Driver Board Test

	Meter (+) Lead	Meter (–) Lead	Nominal Meter Reading
VR2	+	–	2.9 Volts
	–	+	Infinite
VR3	+	–	2.9 Volts
	–	+	Infinite
VR4	+	–	1.6 Volts
	–	+	1.3 Volts
VR5	+	–	1.4 Volts
	–	+	0.5 Volts
VR6	+	–	1.4 Volts
	–	+	0.5 Volts
VR7	+	–	1.4 Volts
	–	+	0.5 Volts

7. If your readings do not match the table readings, replace the Base Driver Board. Refer to Chapter 2 – Removing the Base Driver/Power Supply Board.

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Chapter 2

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. If neon light DS1 on the Base Driver Board is illuminated, hazardous voltages are present in the drive circuit boards. 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 neon indicator has extinguished and the bus voltage has discharged to zero volts.

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
- #1 Phillips screwdriver
- #2 Phillips screwdriver
- #3 Phillips screwdriver
- #4-5 standard screwdriver
- #8-10 standard screwdriver
- 3/8-inch or 9.6mm open-end wrench
- 11/16-inch or 17.5mm open-end wrench
- 3/8-inch or 9.6mm socket driver
- 9/16-inch or 15mm socket
- 7/16-inch or 11.5mm socket driver
- 3/16-inch or 4.8mm Allen wrench (B075, B100, C075, and C100 Drives)
- 5/16-inch or 8mm Allen wrench (B125 and C125 Drives)
- Torque wrench, metered in lb-in. or N-m

Fastener Torque Specifications

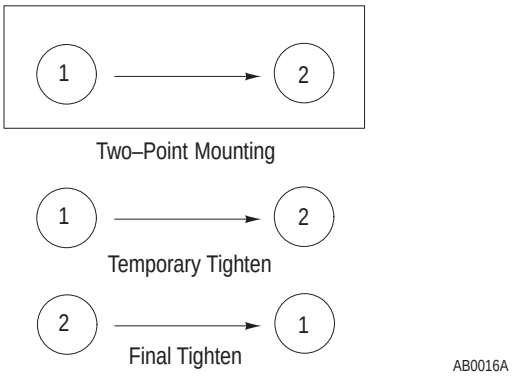
Torque Sequence

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

Two-Point Mounting

The following illustrates temporary and final tightening sequences for components fastened to a heat sink using two screws. The alpha-numeric illustration labels are for your assistance. Drive components do not carry these labels.

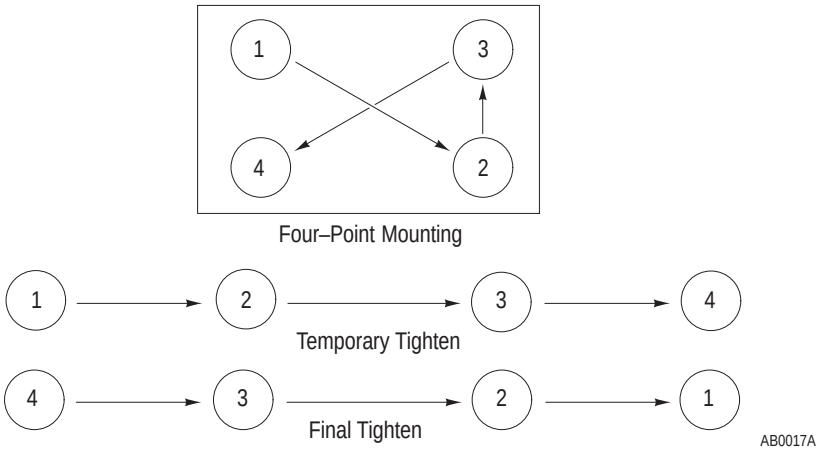
Figure 2.1
Two-Point Mounting



Four-Point Mounting

The following illustrates temporary and final tightening sequences for components fastened to a heat sink using four screws. The alpha-numeric illustration labels are for your assistance. Drive components do not carry these labels.

Figure 2.2
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.

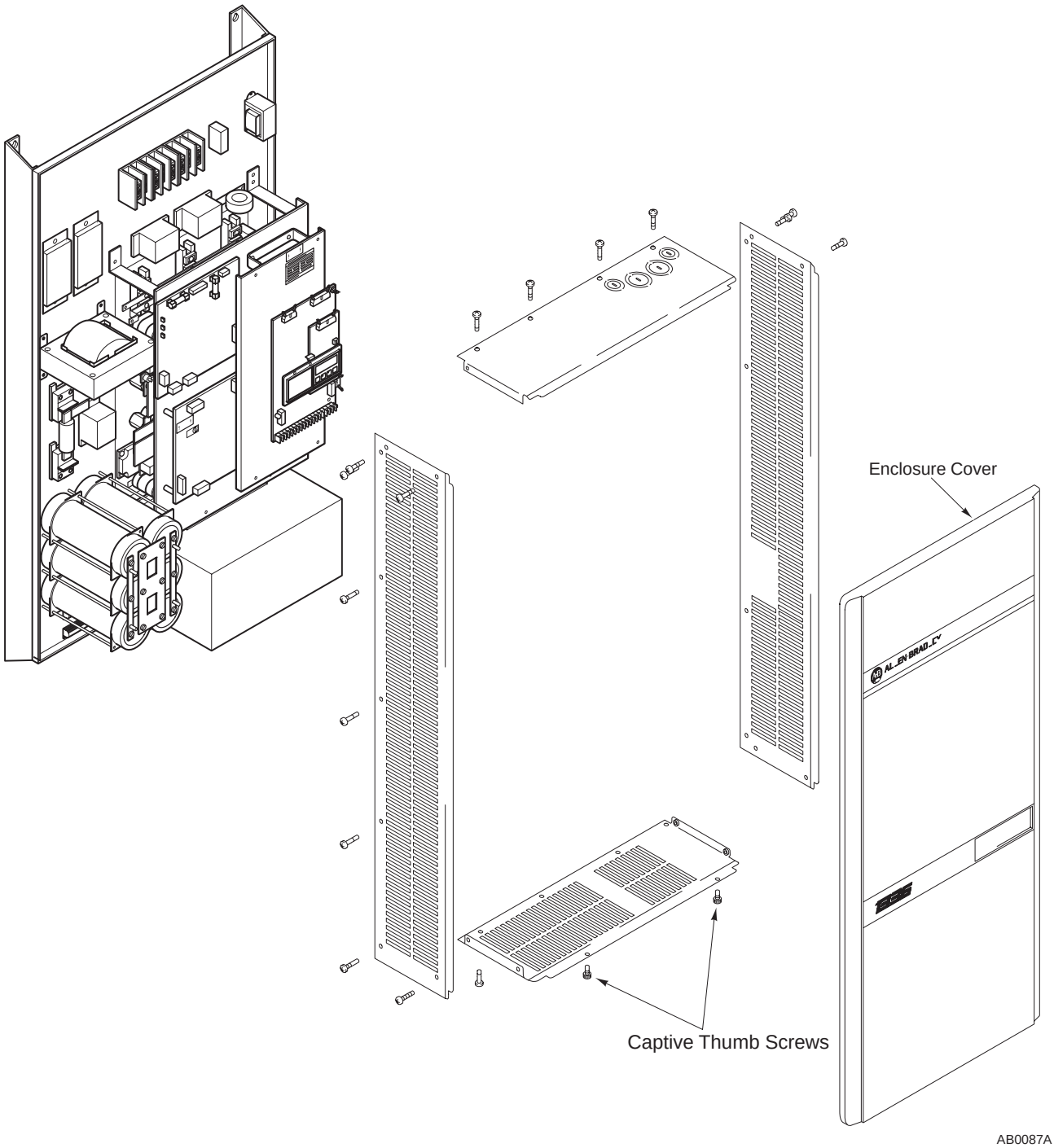
Table 2.A
Fastener Torque Specifications

Component	Fastener Application	Torque, lb-in.	Torque, N-m
Bus Capacitor	Wires to terminals	18-22	2.0-2.5
Balancing Resistors	Resistors to chassis	2.6-3.0	0.29-0.30
SCR Modules	Wires to terminals	22-31	2.5-3.6
SCR Modules	SCR to heat sink	22-31	2.5-3.6
Transistor Modules X1 – X6	C and E terminal wires	22-31	2.5-3.6
Transistor Modules X1 – X6	Module to heat sink	22-31	2.5-3.6
Transistor Modules X1 – X6	B and Bx terminal wires	9-15	1.0-1.7
Snubbers	Snubbers to transistors	9-15	1.0-1.7
Steering Diode	Diode to bus bar	10	1.1
Steering Diode	Ring lug to bus bar	65	7.3
Terminal Strip TB1, B075	Wires to terminals	120	13
Terminal Strip TB1, B100	Wires to terminals	120	13
Terminal Strip TB1, B125	Wires to terminals	275	0.8
Terminal Strip TB2	Wires to terminals	7	0.8
Terminal Strip TB3	Wires to terminals	7	0.8
Bus Resistors	Resistors to Bus Bar	2.6-3.0	0.29-0.30

Disassembly and Access Procedures

Removing the Drive Enclosure

Figure 2.3
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. A bus charge neon indicator provides visual indication that bus voltage is present. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the neon indicator has extinguished and the bus voltage has discharged to zero volts.

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

1. Remove power from the drive.
2. Remove the captive thumb screw fastening the Enclosure cover to the bottom of the Enclosure frame.
3. Pull the bottom of the cover outward to clear the Enclosure frame, then lift the cover upward to remove the cover.
4. Remove the screws from the Enclosure frame side panels.
5. Remove the screws from the Enclosure frame top and bottom panels.
6. Wait for Bus Indicator Light DS1 to turn off before proceeding with internal component disassembly. Check for zero volts at TB1 Terminals +DC and –DC.

Installation

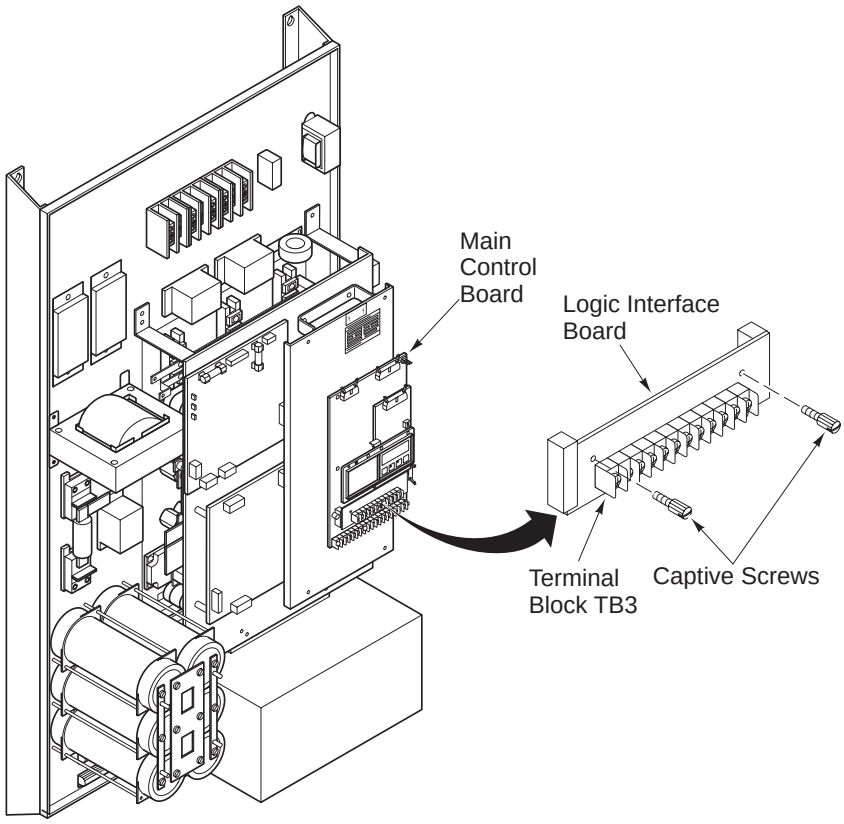
Install the Enclosure in reverse order of removal.

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

Removing Logic Interface Board MOD-L1, -L2, or -L3

The Logic Interface Board is optional equipment. This board is located on the Main Control Board, below the Programming and Display Board.

Figure 2.4
Logic 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. A bus charge neon indicator provides visual indication that bus voltage is present. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the neon indicator has extinguished and the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 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, bus bars, and wires from the drive components, mark the connections, bus bars, and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive. Check for zero volts at TB1 Terminals +DC and –DC.
2. Remove the Enclosure cover if the drive has an enclosure. Refer to Removing the Drive Enclosure in this chapter.
3. Remove all wires from the terminals on TB3.
4. Loosen the two captive screws fastening the Logic Interface Board to the Main Control Board Connectors J8 and J9.
5. Grip the right and left sides of the Logic Interface Board and pull the board straight outward from the Main Control Board.

Installation

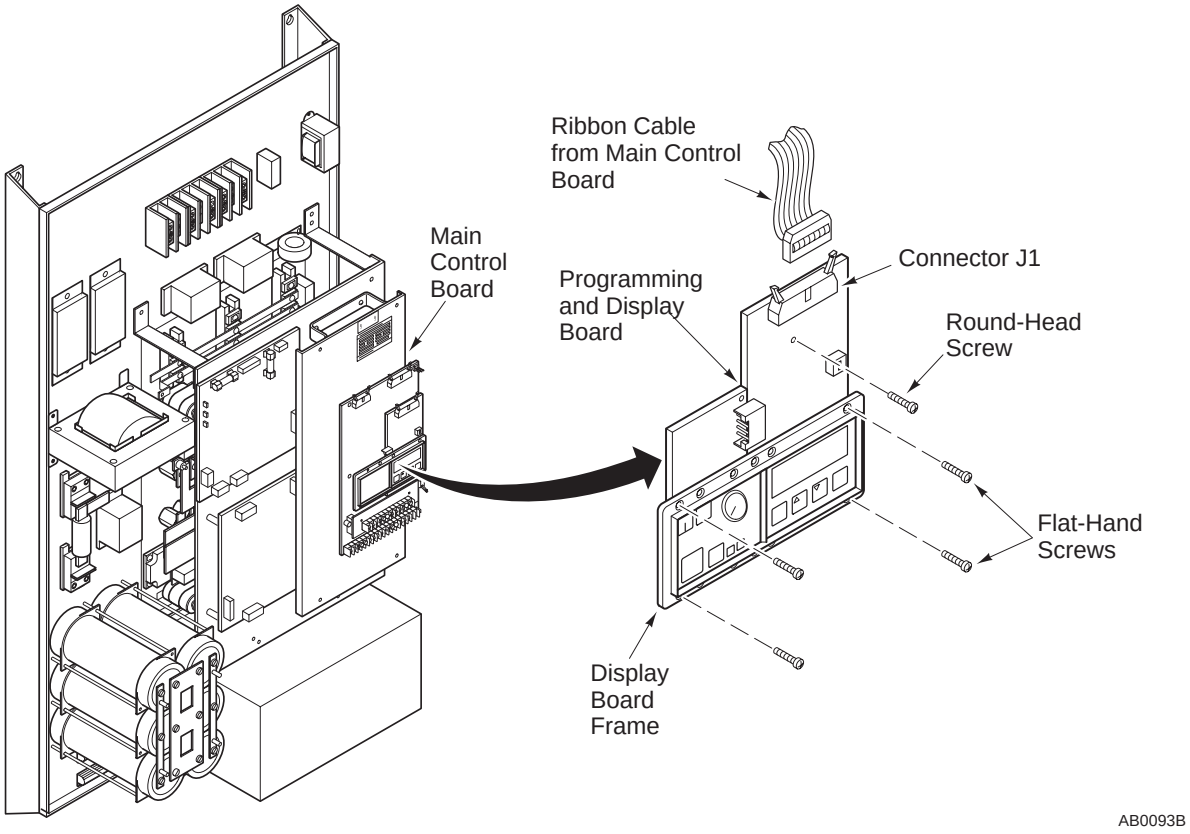
Install the Logic Interface Board in reverse order of removal.

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

Removing the Programming and Display Board

The Programming and Display Board is located on the Main Control Board.

Figure 2.5
Programming and Display 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. A bus charge neon indicator provides visual indication that bus voltage is present. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the neon indicator has extinguished and the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 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, bus bars, and wires from the drive components, mark the connections, bus bars, and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive. Check for zero volts at TB1 Terminals +DC and –DC.
2. Remove the Enclosure cover if the drive has an enclosure. Refer to Removing the Drive Enclosure in this chapter.
3. Remove the ribbon cable from Display Board Connector J1.
4. Remove the flat-head screws from the four corners of the grey Display Board frame.
5. Remove the round-head screw from the Display Board's printed circuit board.
6. Remove the Programming and Display Board from the Main Control Board.

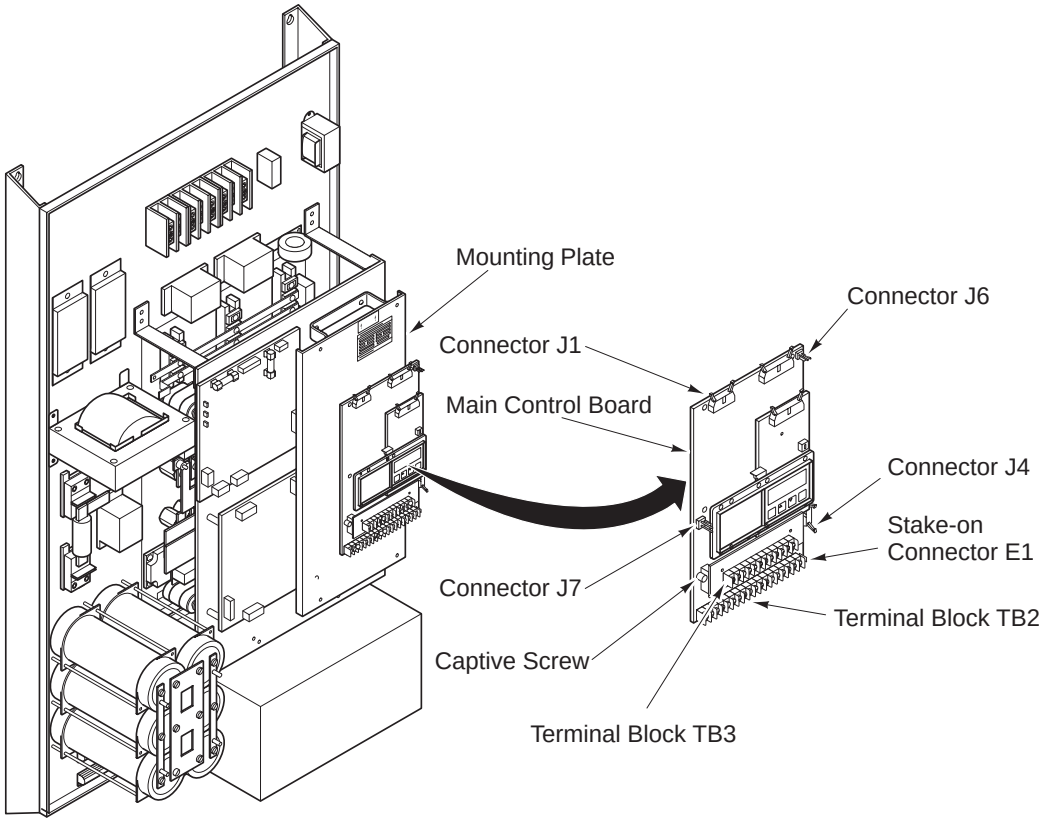
Installation

Install the Programming and Display Board in reverse order of removal.

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 from the Mounting Plate

Figure 2.6
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. A bus charge neon indicator provides visual indication that bus voltage is present. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the neon indicator has extinguished and the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 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, bus bars, and wires from the drive components, mark the connections, bus bars, and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive. Check for zero volts at TB1 Terminals +DC and –DC.
2. Remove the Enclosure cover if the drive has an enclosure. Refer to Removing the Drive Enclosure in this chapter.
3. Remove the Logic Interface Board and the Programming and Display Board. Refer to Removing the Logic Interface Board and Removing the Programming and Display Board procedures in this chapter.
4. Disconnect the following from the Main Control Board:
   - J1 ribbon cable
   - J6 connector
   - J7 connector
   - E1 stake-on connector
   - J4 ribbon cable connector, if MOD-S1 is used
   - All wires from the TB2 terminals
5. Remove the two captive screws fastening the Main Control Board to the Mounting Plate. These screws are located near Main Control Board Connectors J8 and J9.
6. Turn the six standoff screws 1/4 turn counterclockwise.
7. Pull the Main Control Board away from the standoffs.

Installation

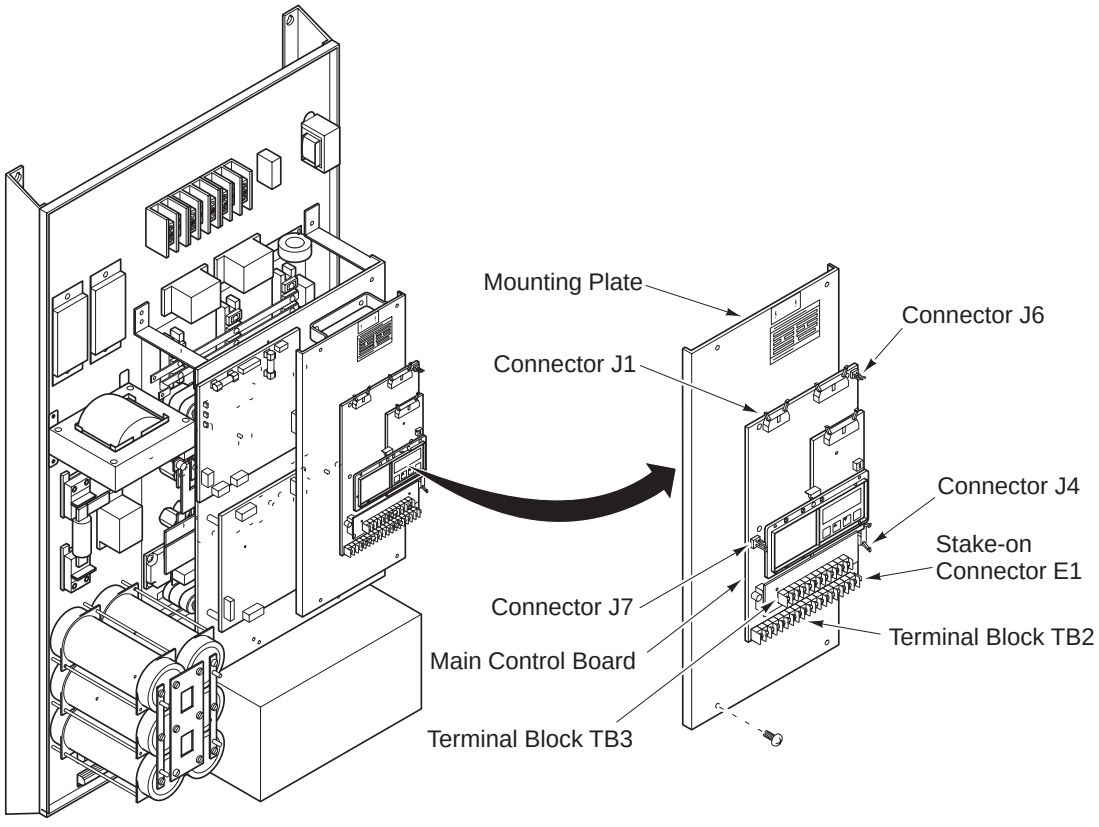
Install the Main Control Board in reverse order of removal.

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 Mounting Plate

The Main Control Mounting Plate holds the Main Control Board, the Programming and Display Board, and the optional Logic Interface Board. Drives rated B125 and C125 have a small fan mounted to the bottom left corner of the Main Control Mounting Plate. This fan and its mounting do not affect the following procedures.

Figure 2.7
Main Control Mounting Plate



Removal

ATTENTION: Disconnect power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. A bus charge neon indicator provides visual indication that bus voltage is present. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the neon indicator has extinguished and the bus voltage has discharged to zero volts.

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

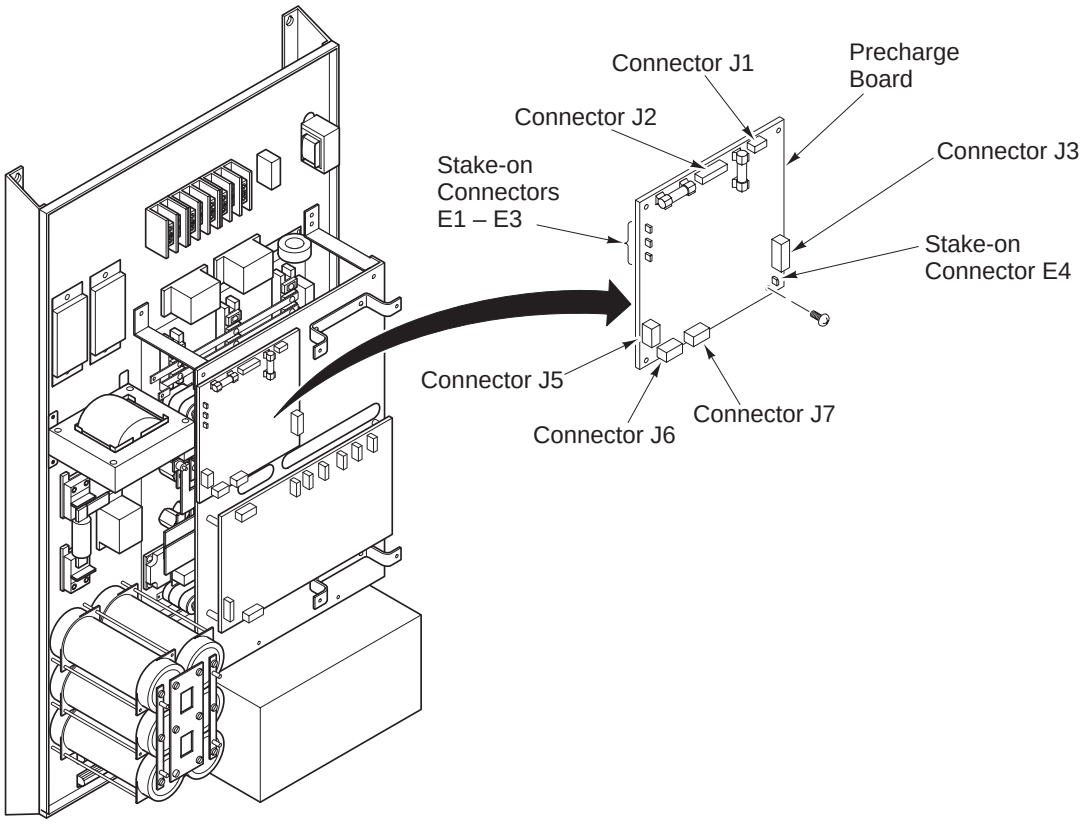
IMPORTANT: Before you remove connections, bus bars, and wires from the drive components, mark the connections, bus bars, and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Remove the Enclosure cover from the drive. Refer to Removing the Drive Enclosure in this chapter.
3. Wait for Bus Indicator Light DS1 to turn off. Check for zero volts at TB1 Terminals +DC and –DC before proceeding.
4. Remove the three screws fastening the plastic guard to the Base Driver and Main Control Mounting Plates.
5. Remove the plastic guard from the snap-on connection at the bottom left corner of the guard.
6. Remove the following from the Main Control Board:
   - J1 ribbon cable
   - J6 connector
   - J7 connector
   - E1 stake-on connector
   - J4 ribbon cable connector if MOD-S1 is used
   - All wires from TB2 terminals
7. Remove all wires from the TB3 terminals if a Logic Interface Board is being used.
8. Remove the two screws fastening the right side of Main Control Mounting Plate to the drive.

Removing the Precharge Board

The Precharge Board is located above the Base Driver/Power Supply Board on the Base Driver Mounting Plate.

Figure 2.8
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. A bus charge neon indicator provides visual indication that bus voltage is present. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the neon indicator has extinguished and the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 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, bus bars, and wires from the drive components, mark the connections, bus bars, and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly. Where connectors pass through access holes in mounting plates, mark the holes to correspond with the connectors that pass through the holes.

1. Remove the Main Control Mounting Plate from the drive. Refer to Removing the Main Control Mounting Plate in this chapter.
2. Disconnect the following from the Precharge Board:
   - J1 through J3 connectors
   - J5 through J7 connectors
   - E1 through E4 wires at the stake-on connectors.
3. Remove the standoff from the upper left corner of the Precharge Board.
4. Remove the three screws from the remaining corners of the Precharge Board.
5. Turn the two standoff screws on the Precharge Board 1/4 turn counterclockwise.
6. Pull the Precharge Board away from the standoffs.

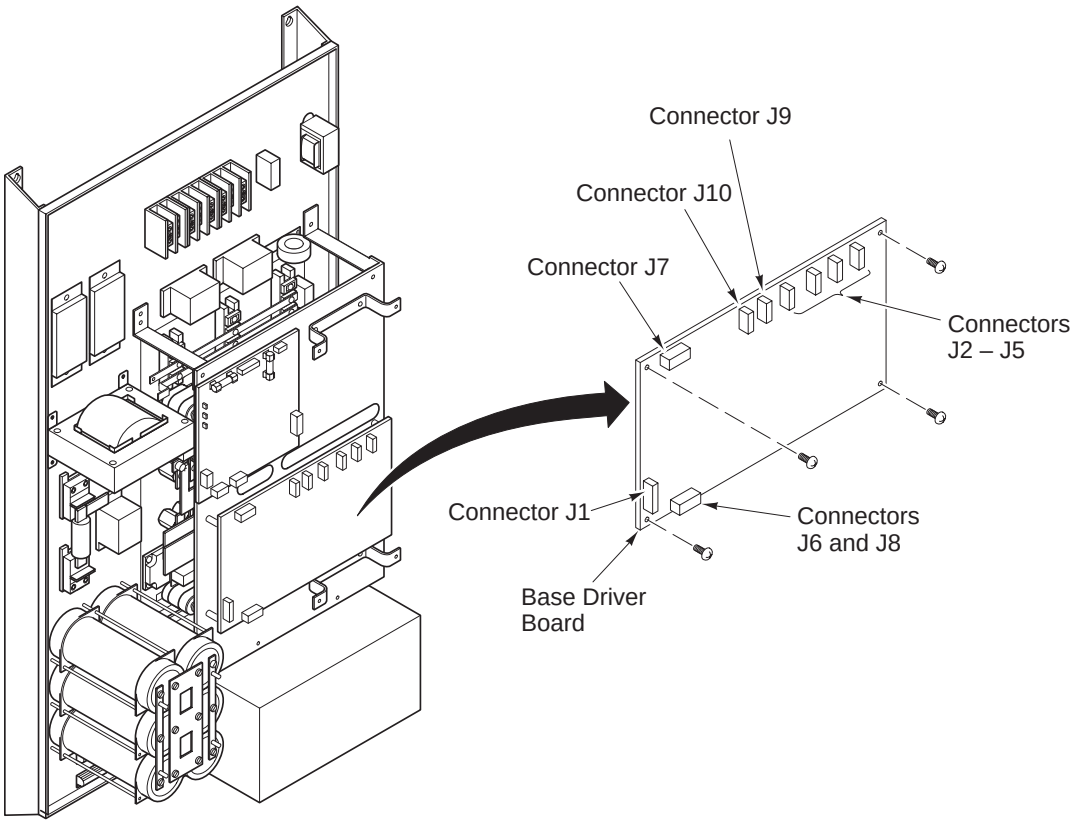
Installation

Install the Precharge Board in reverse order of removal.

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

Removing the Base Driver/Power Supply Board

Figure 2.9
Base Driver/Power Supply 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. A bus charge neon indicator provides visual indication that bus voltage is present. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the neon indicator has extinguished and the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 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, bus bars, and wires from the drive components, mark the connections, bus bars, and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly. Where connectors pass through access holes in mounting plates, mark the holes to correspond with the connectors that pass through the holes.

1. Remove power from the drive. Wait for Bus Indicator Light DS1 to turn off before proceeding.
2. Remove the Main Control Mounting Plate from the drive. Refer to Removing the Main Control Mounting Plate in this chapter.
3. Remove Connectors J2 through J10 from the Base Driver Board.
4. Remove the four screws fastening the Base Driver Board to the Base Driver Mounting Plate. These screws are located at the corners of the Base Driver Board.
5. Turn the four standoff screws 1/4 turn counterclockwise.
6. Pull the Base Driver Board away from the standoffs.

Installation

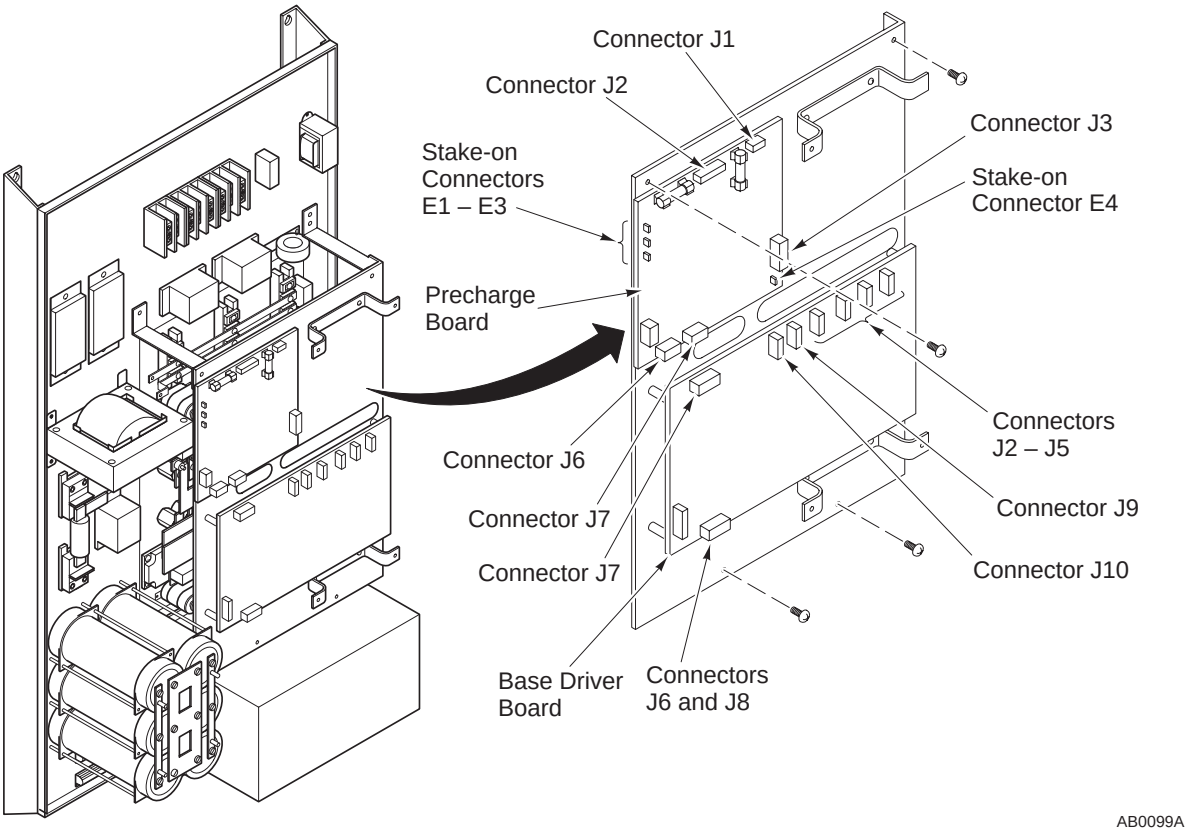
Install the Base Driver/Power Supply Board in reverse order of removal.

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

Removing the Base Driver Mounting Plate

The Base Driver Mounting Plate holds the Precharge Board and the Base Driver/Power Supply Board, and supports the Main Control Mounting Plate. This mounting plate is located behind the Main Control Mounting Plate.

Figure 2.10
Base Driver 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. A bus charge neon indicator provides visual indication that bus voltage is present. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the neon indicator has extinguished and the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 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, bus bars, and wires from the drive components, mark the connections, bus bars, and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly. Where connectors pass through access holes in mounting plates, mark the holes to correspond with the connectors that pass through the holes.

1. Remove the Main Control Mounting Plate from the drive. Refer to Removing the Main Control Mounting Plate in this chapter.
2. Remove Connectors J2 – J5 and J7 – J10 from the Base Driver Board.
3. Remove the following from the Precharge Board:
   - J1 – J3 connectors
   - J6 and J7 connectors
   - E1 – E4 wires at the stake-on connectors
4. Remove the four screws fastening the Base Driver Mounting Plate to the drive.

Installation

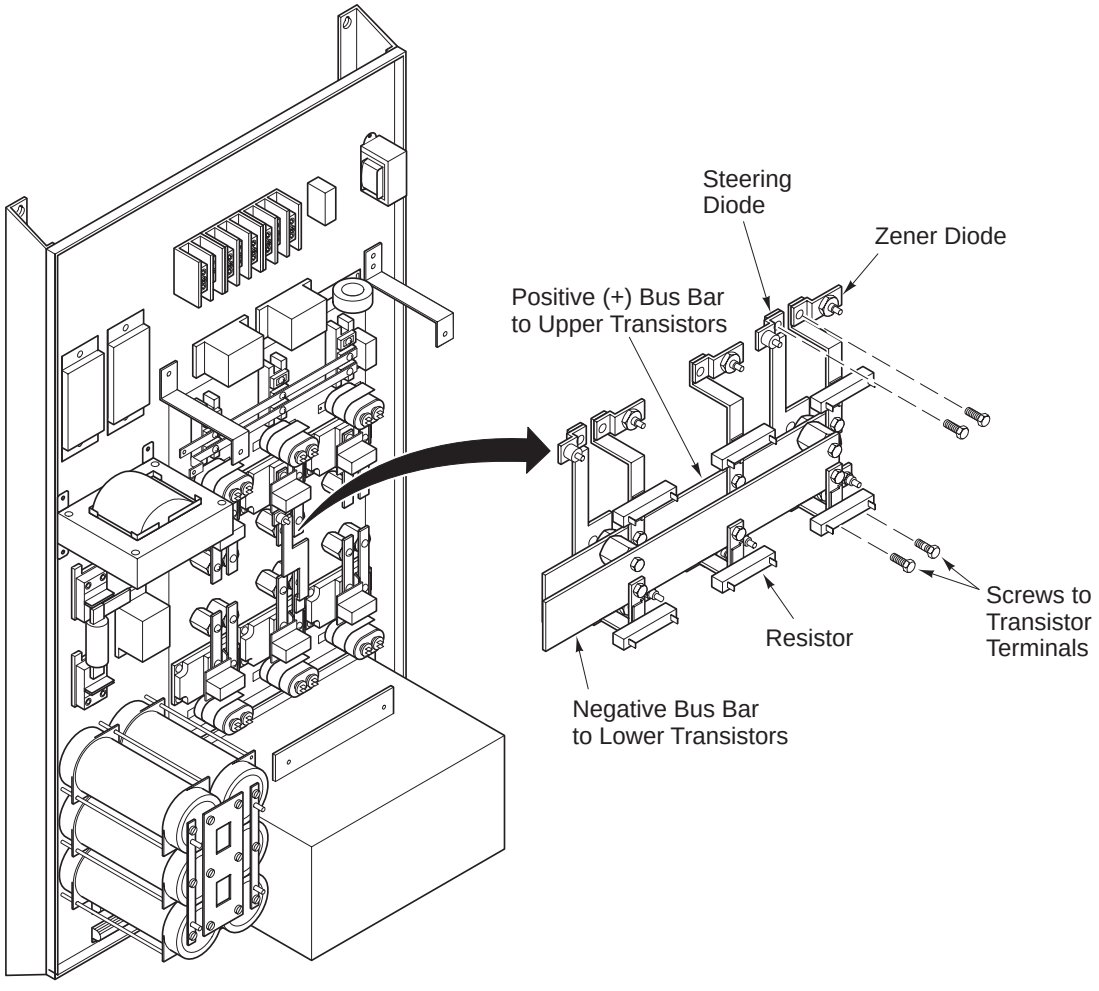
Install the Base Driver Mounting Plate in reverse order of removal.

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

Removing the Main Bus Bar Assembly

The Main Bus Bar assembly attaches to the Transistor Module. The Steering Diodes and Zener Diodes attach to the Main Bus Bar assembly, but you do not need to remove these diodes from the drive to remove the Main Bus Bar assembly.

Figure 2.11
Main Bus Bar 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. A bus charge neon indicator provides visual indication that bus voltage is present. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the neon indicator has extinguished and the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 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, bus bars, and wires from the drive components, mark the connections, bus bars, and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove the Base Driver Mounting Plate from the drive. Refer to Removing the Base Driver Mounting Plate in this chapter.
2. Remove the Bus Resistor wires from the Bus Snubber stake-on connectors.
3. Remove the screws fastening the two wires to the Main Bus Bars. The wire on the upper negative bus bar comes from the Bus Capacitor group, and the wire on the lower positive bus bar comes from Bus Fuse F1.
4. Remove the screws fastening the Main Bus Bar assembly to the Transistor Module.
5. Remove the screws fastening the M1, M2, and M3 wires to the Main Bus Bar assembly.
6. Remove the Main Bus Bar assembly from the drive.

Installation

Install the Main Bus Bar assembly in reverse order of removal.

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

Accessing Chassis Power Components

To access the power components located on the chassis, refer to Removing the Base Driver Mounting Plate, Removing the Main Control Mounting Plate, and Removing the Main Bus Bar Assembly in this chapter.

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Chapter 3

Part Replacement Procedures

Chapter Objective

This chapter describes procedures required to replace drive components. This chapter references Chapter 2 – 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 2 – Disassembly and Access Procedures, Removing the Drive Enclosure.

Safety Precautions

ATTENTION: Some printed circuit boards and drive components may contain hazardous voltage levels. If Bus Indicator neon light DS1 on the Base Driver Board is illuminated, hazardous voltages are present in the drive circuit boards. 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 neon indicator has extinguished and the bus voltage has discharged to zero volts.

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
- #1 Phillips screwdriver
- #2 Phillips screwdriver
- #3 Phillips screwdriver
- #4-5 standard screwdriver
- #8-10 standard screwdriver
- 3/8-inch or 9.6mm open-end wrench
- 11/16-inch or 17.5mm open-end wrench
- 3/8-inch or 9.6mm socket driver
- 7/16-inch or 11.5mm socket driver
- 3/16-inch or 4.8mm Allen wrench (B075, B100, C075, and C100 Drives)
- 5/16-inch or 8mm Allen wrench (B125 and C125 Drives)
- Torque wrench, metered in lb-in. or N-m
- Wire-terminal crimping tool

Fastener Torque Specifications

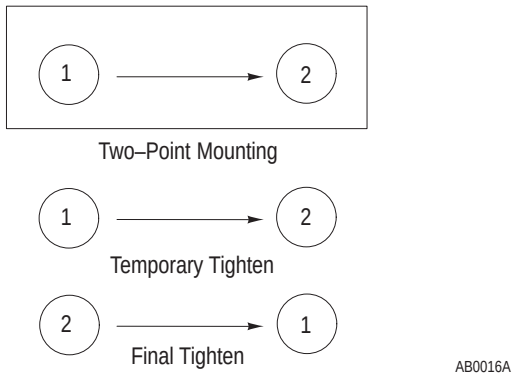
Torque Sequence

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

Two-Point Mounting

The following illustrates temporary and final tightening sequences for components fastened to a heat sink using two screws. The illustration labels are for your assistance. Drive components do not carry these labels.

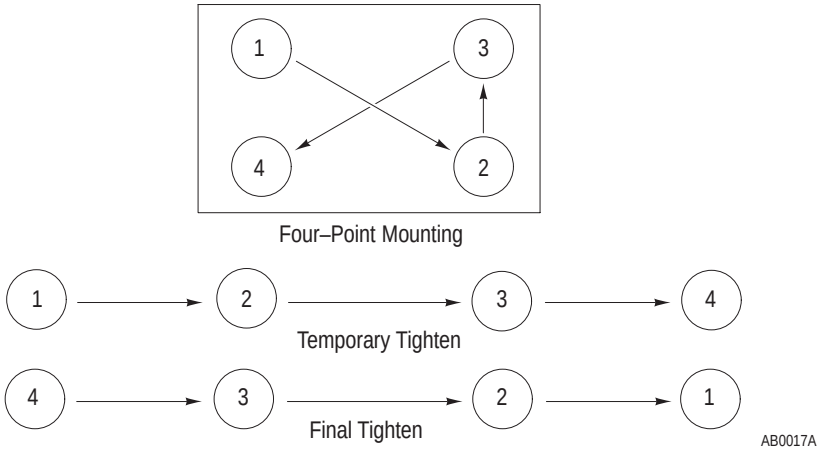
Figure 3.1
Two-Point Mounting



Four-Point Mounting

The following illustrates temporary and final tightening sequences for components fastened to a heat sink using four screws. The 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

Component	Fastener Application	Torque, lb-in.	Torque, N-m
Bus Capacitor	Wires to terminals	18-22	2.0-2.5
Balancing Resistors	Resistors to chassis	2.6-3.0	0.29-0.30
SCR Modules	Wires to terminals	22-31	2.5-3.6
SCR Modules	SCR to heat sink	22-31	2.5-3.6
Transistor Modules X1 – X6	C and E terminal wires	22-31	2.5-3.6
Transistor Modules X1 – X6	Module to heat sink	22-31	2.5-3.6
Transistor Modules X1 – X6	B and Bx terminal wires	9-15	1.0-1.7
Snubbers	Snubbers to transistors	9-15	1.0-1.7
Steering Diode	Diode to bus bar	10	1.1
Steering Diode	Ring lug to bus bar	65	7.3
Terminal Strip TB1, B075	Wires to terminals	120	13
Terminal Strip TB1, B100	Wires to terminals	120	13
Terminal Strip TB1, B125	Wires to terminals	275	0.8
Terminal Strip TB2	Wires to terminals	7	0.8
Terminal Strip TB3	Wires to terminals	7	0.8
Bus Resistors	Resistors to Bus Bar	2.6-3.0	0.29-0.30

Major Component Replacement

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

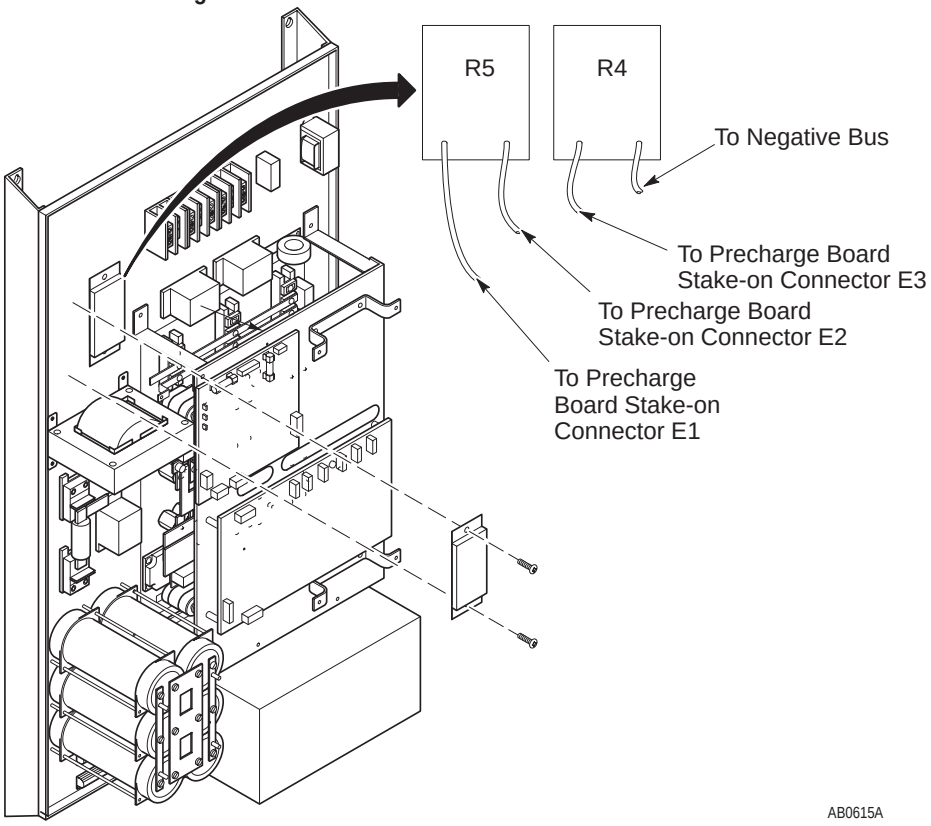
- Precharge Resistors
- SCR module
- Thermostat ST
- Transistor modules and snubbers
- Ground Sense CT
- Surge Suppressor MOV1
- Fan
- Transformer T1
- DC Bus Inductor L1
- Bus capacitors
- Bus Sense Module
- LEM A and LEM C
- Bus Diode D1
- Bus Fuse F1

For Main Control Board, Base Driver/Power Supply Board, Programming and Display Board, Precharge Board, and Main Bus Bar assembly installation and removal procedures, refer to Chapter 2.

Precharge Resistors

Two Precharge Resistors are located at the top of the heat sink.

Figure 3.3
Precharge Resistors



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. A bus charge neon indicator provides visual indication that bus voltage is present. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the neon indicator has extinguished and the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 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, bus bars, and wires from the drive components, mark the connections, bus bars, and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Wait for the Bus Indicator Light DS1 to turn off. Check for zero volts at TB1 Terminals +DC and –DC before proceeding.
3. Remove the two screws fastening the Precharge Resistor to the heat sink.
4. Remove the Precharge Resistor wires from the following:
   - Precharge Board stake-on connectors
   - Negative Bus (R4 only)

Installation

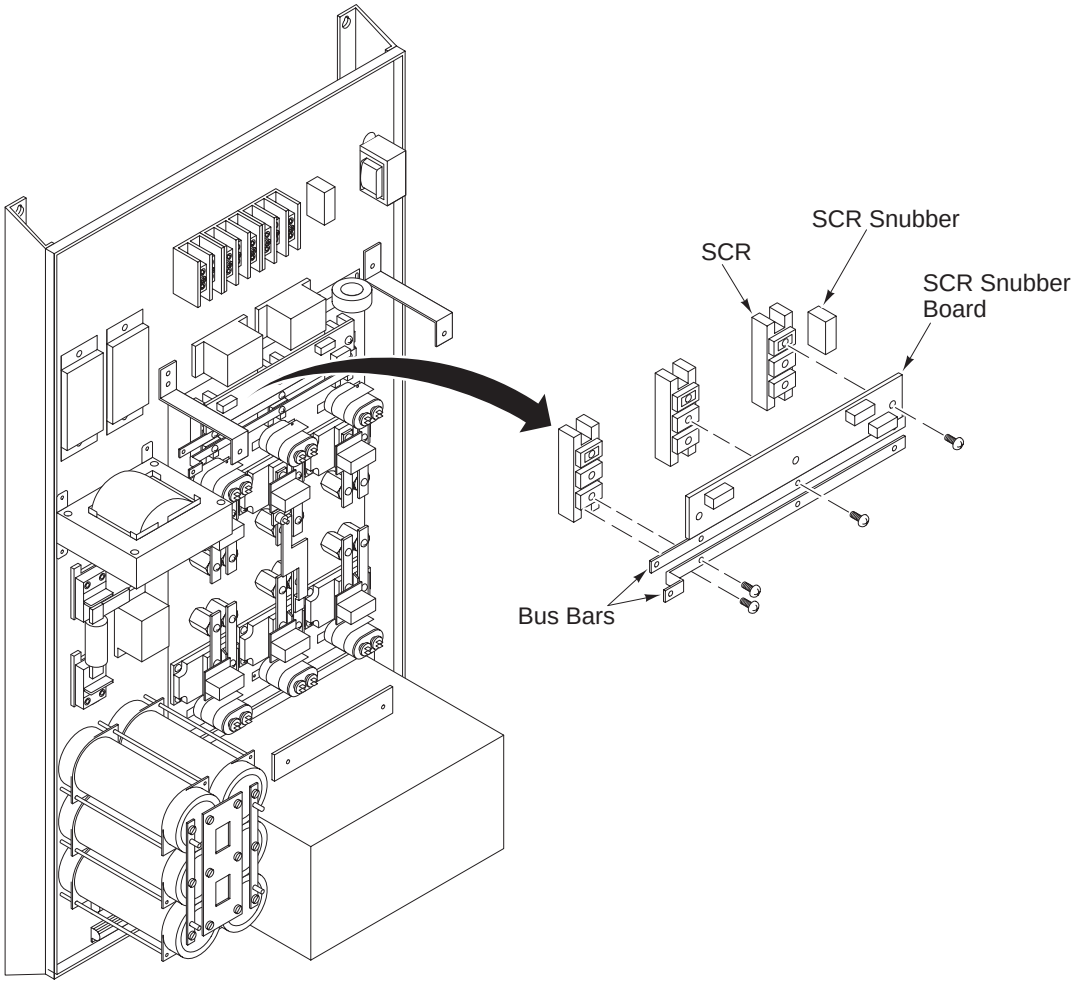
1. Clean the surfaces between the Precharge Resistor and the heat sink.
2. Install the Precharge Resistor in reverse order of removal.

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

SCR Modules

Three SCRs are located at the top of the heat sink behind the Base Driver Mounting Plate.

Figure 3.4
SCR 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. A bus charge neon indicator provides visual indication that bus voltage is present. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the neon indicator has extinguished and the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 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, bus bars, and wires from the drive components, mark the connections, bus bars, and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Wait for Bus Indicator Light DS1 to turn off. Check for zero volts at TB1 Terminals +DC and –DC before proceeding.
3. Remove the Base Driver Mounting Plate from the drive. Refer to Chapter 2 – Removing the Base Driver Mounting Plate.
4. Remove the three screws fastening the SCR Snubber Board to the #1 terminals on the SCRs.
5. Remove the standoffs fastening the L1, L2, and L3 wires to the #1 terminals of the SCRs.
6. Remove the wires from the malfunctioned SCR Stake-on connectors.
7. Remove the screws fastening the bus bars to the SCR terminals.
8. Remove the screw fastening the SCR Snubber to the heat sink. This snubber is located to the right of the SCRs.
9. Remove the screws fastening the malfunctioned SCR to the heat sink.

Installation

1. Clean the surfaces between the SCR and the heat sink.
2. Replace the Preform between the SCR and the heat sink.
3. Install SCR in reverse order of removal. Always replace the SCR snubbers when replacing an SCR.

IMPORTANT: When installing the SCR Snubber Board, fasten the following Snubber Board leads to the following wires, located at the SCR terminals:

- A∅ to L1
- B∅ to L2
- C∅ to L3

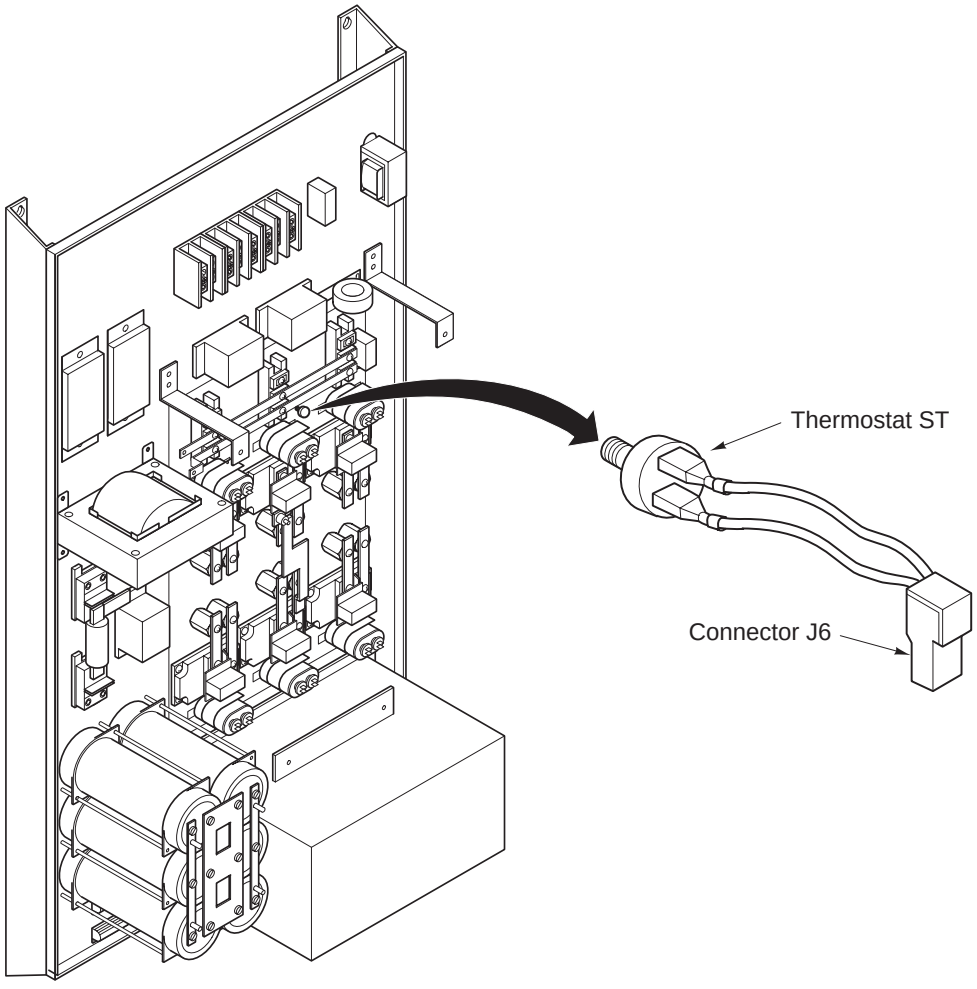
The wire from TB1, Terminal L1 connects to SCR1, Terminal 1; L2 to SCR2, Terminal 1; and L3 to SCR3, Terminal 1.

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

Thermostat ST

Thermostat ST is located behind the Base Driver Mounting Plate and is fastened to the upper middle area of the heat sink, near the SCR Module.

Figure 3.5
Thermostat ST



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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. A bus charge neon indicator provides visual indication that bus voltage is present. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the neon indicator has extinguished and the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 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, bus bars, and wires from the drive components, mark the connections, bus bars, and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Wait for Bus Indicator Light DS1 to turn off. Check for zero volts at TB1 Terminals +DC and –DC before proceeding.
3. Remove the Base Driver Mounting Plate from the drive. Refer to Chapter 2 – Removing the Base Driver Mounting Plate.
4. Remove the two wires from the Thermostat ST stake-on connectors.
5. Unscrew the thermostat from the heat sink.

Installation

Install Thermostat ST1 in reverse order of removal.

IMPORTANT: When fastening the thermostat to the heat sink, hand-tighten the thermostat to avoid damaging the porcelain thermostat body.

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

Transistor Modules and Snubbers

Transistor Modules and snubbers are located on the heat sink, behind the Base Driver Mounting Plate.
Drives rated B075 and C075 use six transistors. Drives rated B100, B125, C100 and C125 use 12 transistors paired into six groups.
1336VT B125 and B150 use 12 transistors.

Figure 3.6
B075, B100, B125, C075, C100, and C125 Transistor Modules and Snubbers

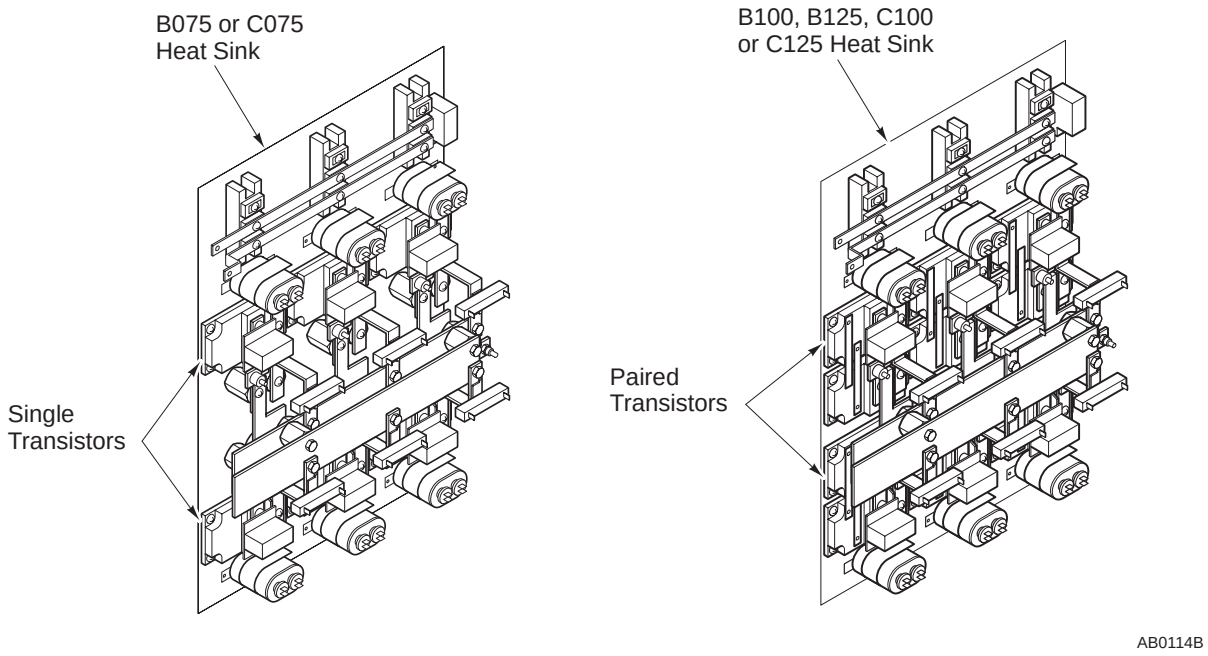
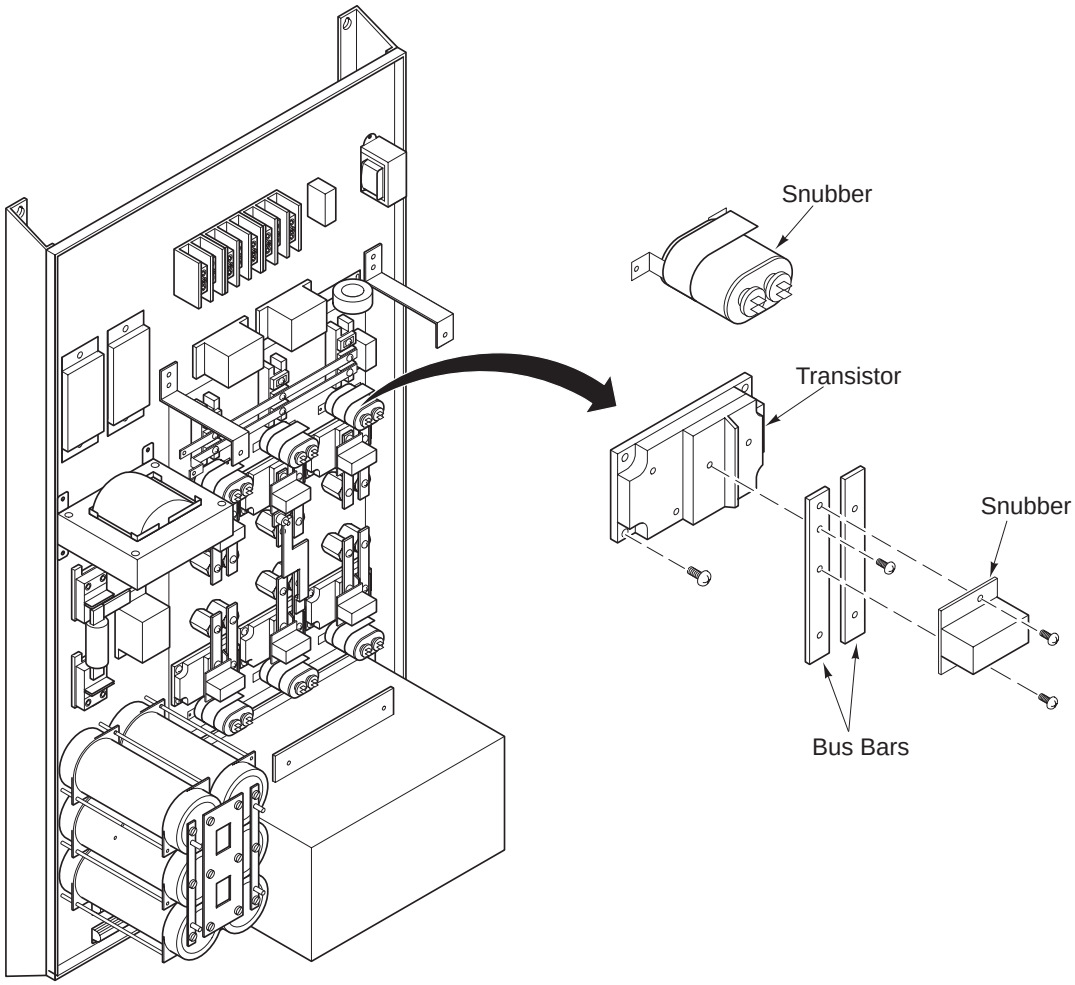


Figure 3.7
Transistor Modules and Snubbers



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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. A bus charge neon indicator provides visual indication that bus voltage is present. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the neon indicator has extinguished and the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 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, bus bars, and wires from the drive components, mark the connections, bus bars, and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Wait for Bus Indicator Light DS1 to turn off. Check for zero volts at TB1 Terminals +DC and –DC before proceeding.
3. Remove the Base Driver Mounting Plate from the drive. Refer to Chapter 2 – Removing the Base Driver Mounting Plate.
4. Remove the malfunctioned Bus Snubber Resistor from the Main Bus Bar:
   a. Remove the resistor wire from the Bus Snubber stake-on connector.
   b. Remove the screw fastening the malfunctioned snubber's resistor and wire to the Main Bus Bar assembly.
5. Remove the Main Bus Bar assembly. Refer to Chapter 2 – Removing the Main Bus Bar Assembly.
6. Remove the larger Transistor Snubbers:
   a. Remove the wires from the Transistor Snubber stake-on connectors.
   b. Remove the screws fastening the snubber bracket to the heat sink.
   c. Loosen the snubber bracket retaining strap screw, located on the right side of the Transistor Snubber. For installation, note that the bottom of the snubber is not flush with the bracket base, but is flush with the bottom edge of the retaining strap that wraps around the snubber.
   d. Remove the snubber from the bracket.
7. Remove the snubber connected to the malfunctioned transistor:
   a. Remove the Zener Diode wire from Snubber Stake-on Connector E2.
   b. Remove the screws fastening the snubber to the transistor.
8. Remove the malfunctioned transistor from the drive:
   a. Remove the connector wire from Transistor Terminal B.
      - For drives rated B125, C125, VTB125, and VTB150, remove the screws fastening the bus bars connecting the transistor pairs at Terminals Bx and B.
      - For drives rated B075, B100, C075, and C100, loosen the screws fastening the malfunctioned transistor Terminal C and Terminal E bus bars to the insulated standoffs.

b. Remove the screws fastening the bus bars to the transistor and swing the bus bars out of the way. For drives rated B125 and C125, remove these bus bars from the transistors.

c. Remove the screws fastening the transistor to the heat sink.

9. Remove the Zener Diodes and Steering Diodes from the malfunctioned transistor's connectors. These connectors connect to the Main Bus Bar assembly and the transistors.

IMPORTANT: For installation and replacement, note that the configuration on the upper transistor group Steering Diodes differs from the configuration on the lower transistor group Steering Diodes. The following illustrations show configurations.

Figure 3.8
Snubber Assembly

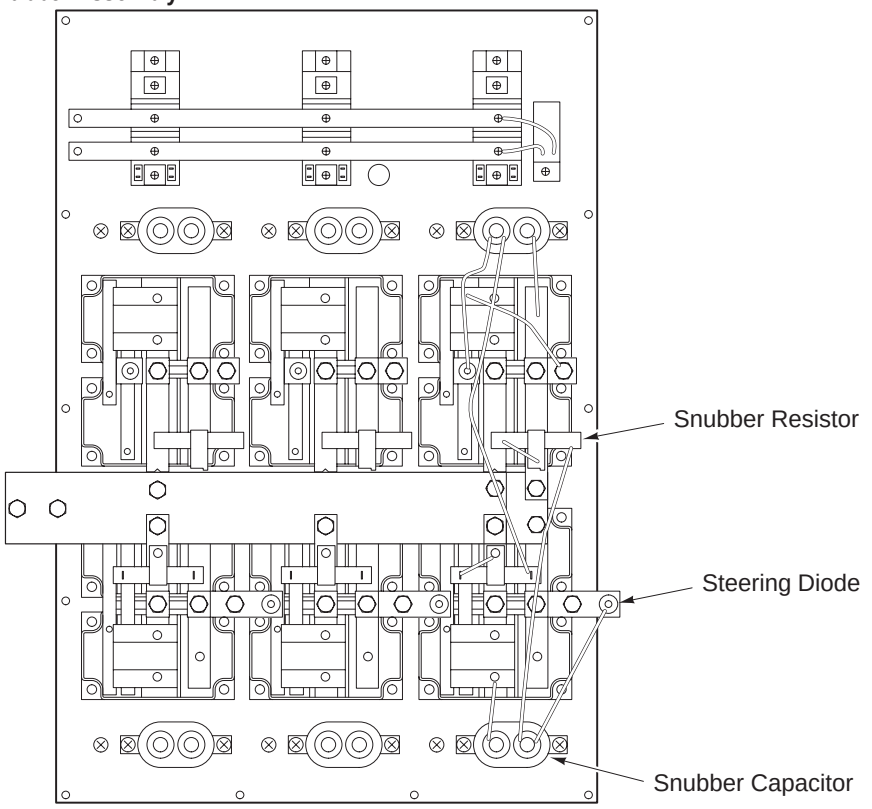

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Figure 3.9
Steering Diodes, Earlier Design

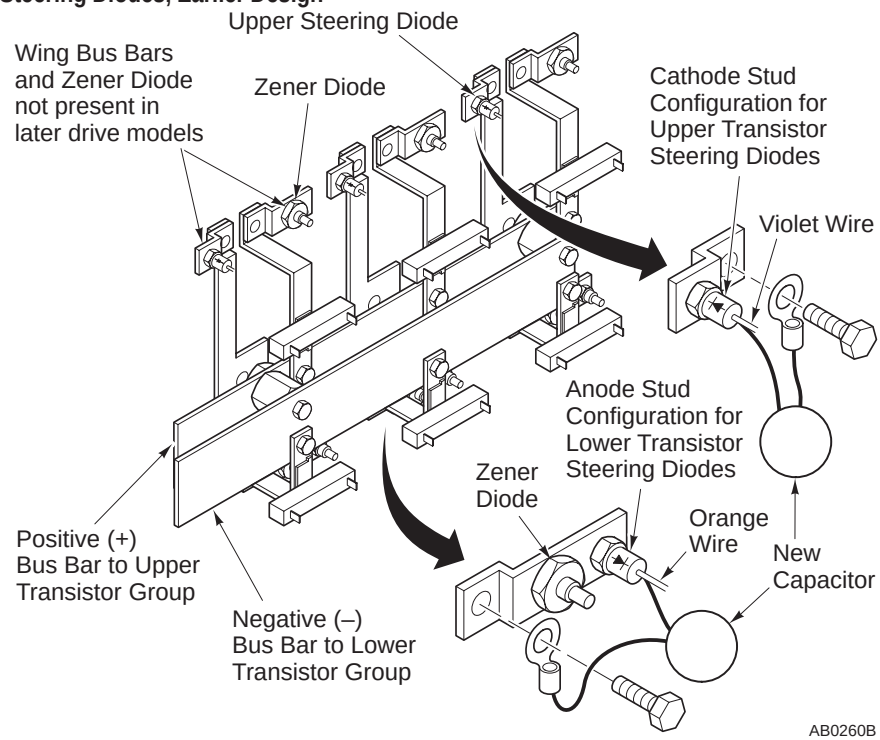
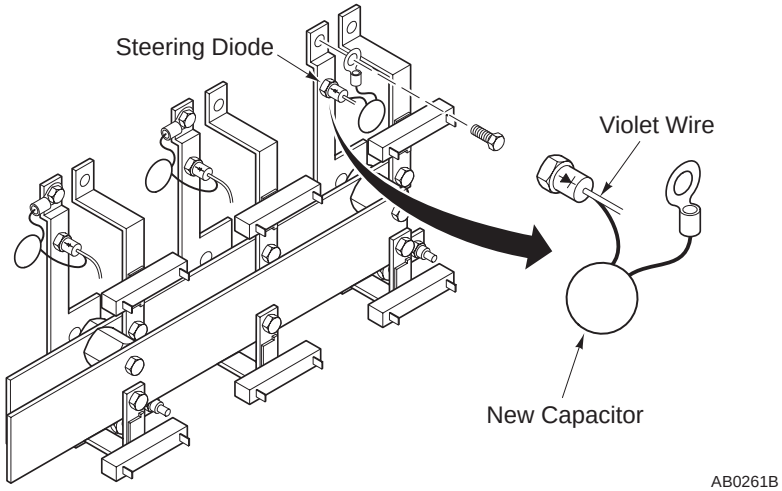


Figure 3.10
Steering Diodes, Later Design



Installation

1. Clean the surfaces between the transistor and the heat sink.
2. Replace the Preform between the transistor and the heat sink.
3. Install the transistor in reverse order of removal. Always replace the Transistor Snubbers when replacing a transistor.

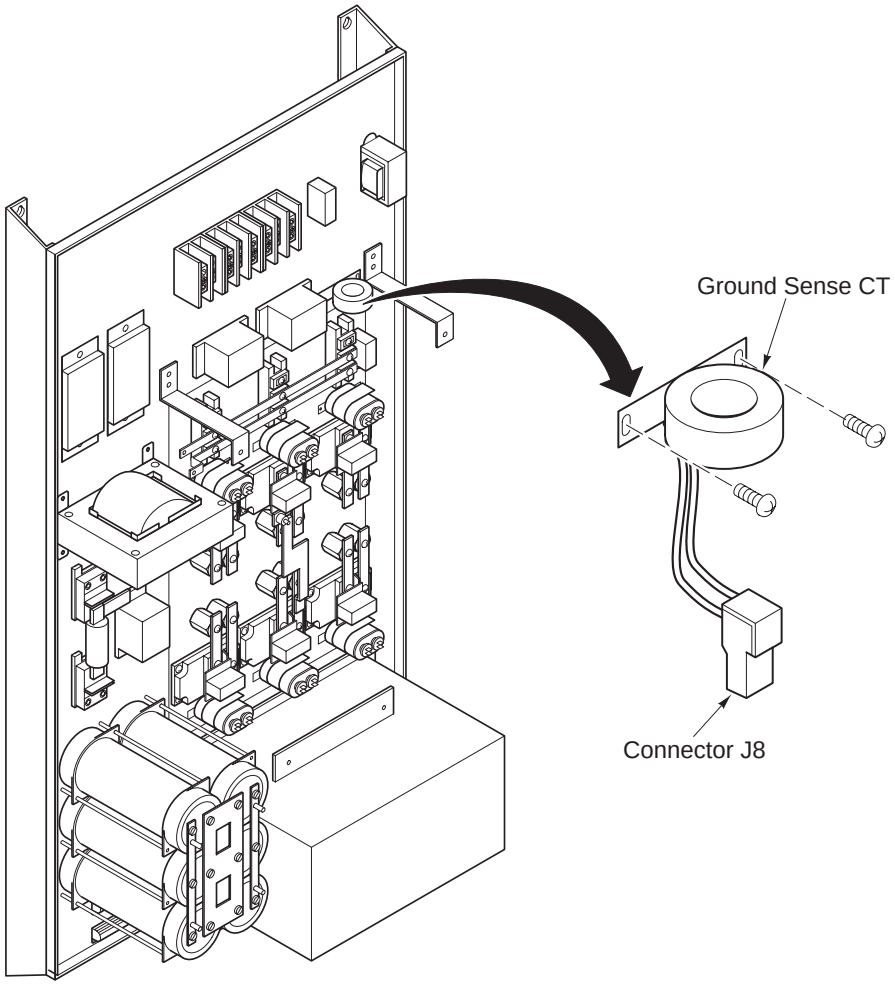
ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.

IMPORTANT: When you replace transistors, snubbers, and diodes, always replace the snubbers and diodes for the replaced transistor. Note that the larger snubbers should not touch the heat sink. Mount the base of these snubbers flush with the bottom of the snubber bracket retaining strap.

Ground Sense CT

Ground Sense CT is located on the Main Chassis above the Main Control Board.

Figure 3.11
Ground Sense CT



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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. A bus charge neon indicator provides visual indication that bus voltage is present. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the neon indicator has extinguished and the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 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, bus bars, and wires from the drive components, mark the connections, bus bars, and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Wait for Bus Indicator Light DS1 to turn off. Check for zero volts at TB1 Terminals +DC and –DC before proceeding.
3. Remove Ground Sense CT Connector J8 from the Base Driver Board.
4. Remove the wires from the TB1 Terminal L1, L2, and L3 connections.
5. Remove the two screws fastening Ground Sense CT to the Main Chassis.
6. Slide Ground Sense CT off the TB1 Terminal L1, L2, and L3 wires.

Installation

Install Ground Sense CT in reverse order of removal.

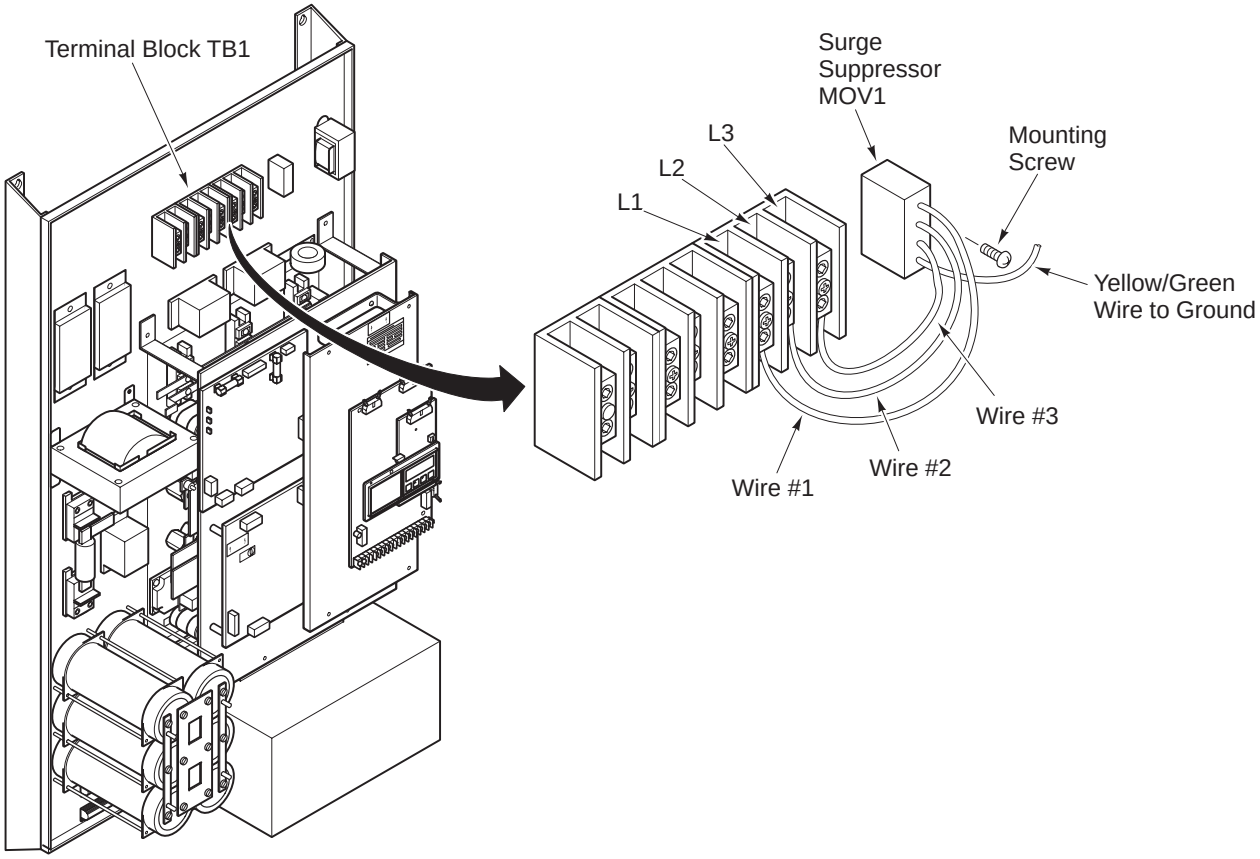
IMPORTANT: Pass the TB1 Terminal L1, L2, and L3 wires through Ground Sense CT before connecting the wires to the bridge rectifiers.

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

Surge Suppressor MOV1

Surge Suppressor MOV1 is located on the top right side of the Main Chassis, to the right of Terminal Block TB1. You do not need to remove the Base Driver Mounting Plate to access MOV1.

Figure 3.12
Surge Suppressor MOV1



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. A bus charge neon indicator provides visual indication that bus voltage is present. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the neon indicator has extinguished and the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 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, bus bars, and wires from the drive components, mark the connections, bus bars, and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Wait for Bus Indicator Light DS1 to turn off. Check for zero volts at TB1 Terminals +DC and –DC before proceeding.
3. Remove MOV1 wires from the following:
   - Yellow/green wire from the ground location on the top right corner of the Main Chassis.
   - Wire #1 from TB1, Terminal L1
   - Wire #2 from TB1, Terminal L2
   - Wire #3 from TB1, Terminal L3
4. Remove the screw fastening MOV1 to the drive.

Installation

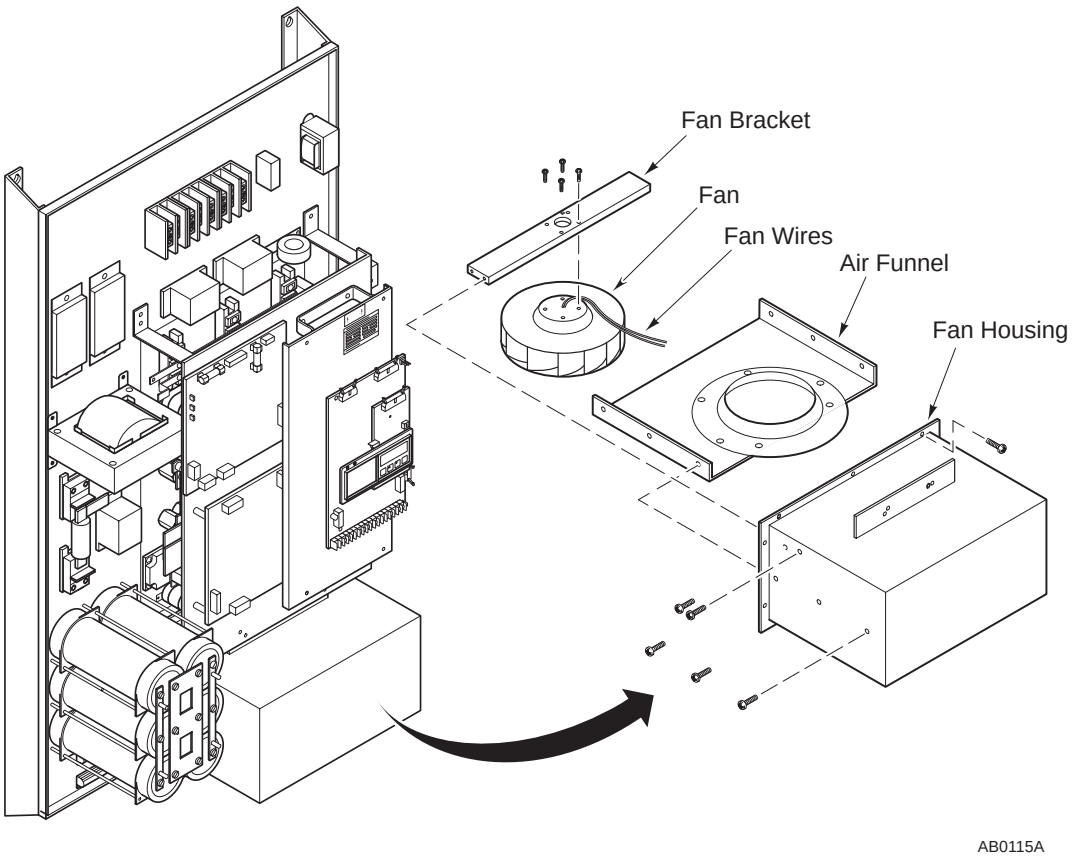
Install Surge Suppressor MOV1 in reverse order of removal. Note that the neutral-ground wire on the new MOV1 is yellow on green.

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

Fan

The Fan is located behind and below the Base Driver Mounting Plate.

Figure 3.13
Fan



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. A bus charge neon indicator provides visual indication that bus voltage is present. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the neon indicator has extinguished and the bus voltage has discharged to zero volts.

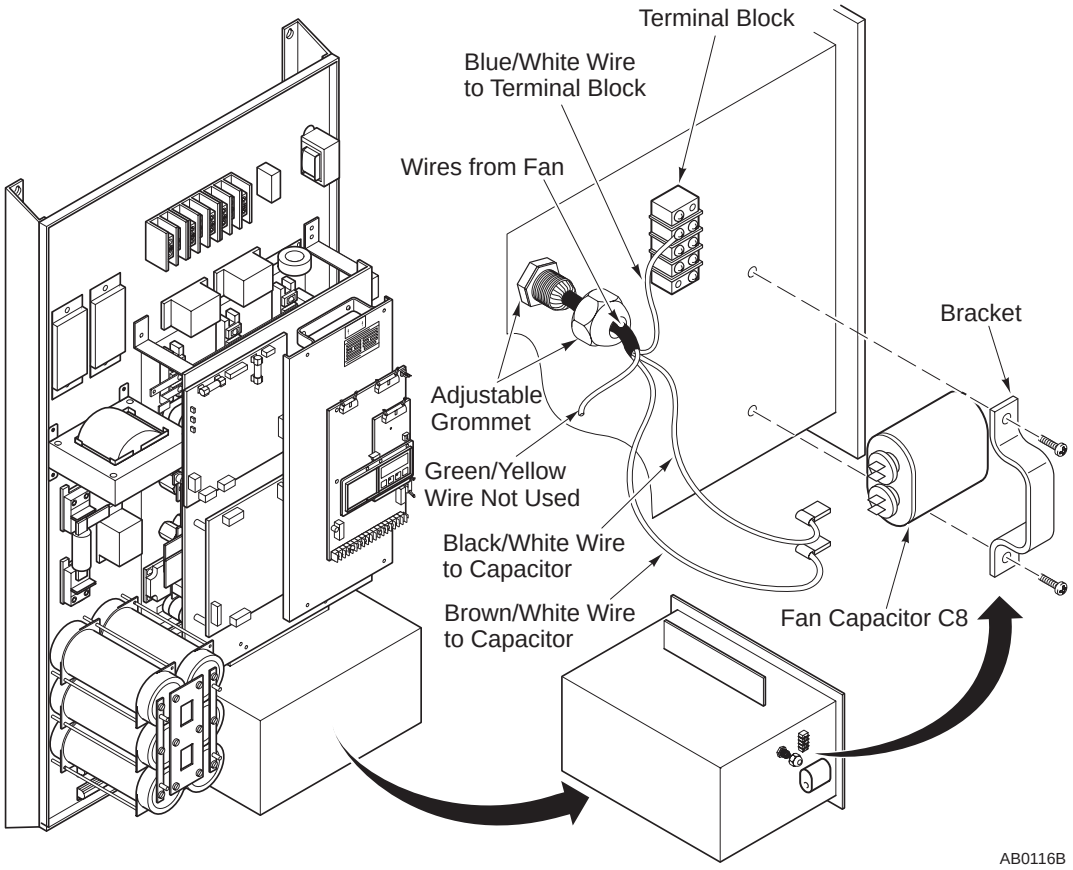
ATTENTION: Wear a wrist-type grounding strap when servicing 1336 Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.

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

1. Remove power from the drive.
2. Wait for Bus Indicator Light DS1 to turn off. Check for zero volts at TB1 Terminals +DC and –DC before proceeding.
3. Remove the Base Driver Mounting Plate from the drive. Refer to Chapter 2 – Removing the Base Driver Mounting Plate.
4. Remove the 0V and 115V wires from the terminal block located on the right side of the Fan Housing.
5. Remove the screws fastening the Fan Housing to the chassis.
6. Pull the Fan Housing away from the drive.
7. Place the Fan Housing on a surface with the open side of the housing facing up.
8. Cut all fan wires at the adjustable grommet, located on the side of the Fan Housing.
9. Remove the screws fastening the Air Funnel to the inside of the Fan Housing.
10. Remove the four screws fastening the horizontal Fan Bracket to the inside of the Fan Housing. Two screws are located near the top edge of each side of the Fan Housing.
11. Loosen the nut on the adjustable grommet and remove the wires from the grommet.
12. Remove the Fan from the Fan Housing.
13. Remove the wires from the Fan Capacitor stake-on connectors.
14. Remove the screws fastening the Fan Capacitor to the Fan Housing.

Installation

Figure 3.14
Fan Wiring



1. Feed the new Fan wires through the adjustable grommet, from the inside of the Fan Housing to the outside.
2. Cut off, insulate, and tie back the yellow-on-green Fan wire.
3. Fasten the wire terminals to the stripped ends of the Fan wires. Refer to the color schemes on the replaced Fan's wires for wire terminal placement.
4. Install the Fan and Capacitor C8 in reverse order of removal.

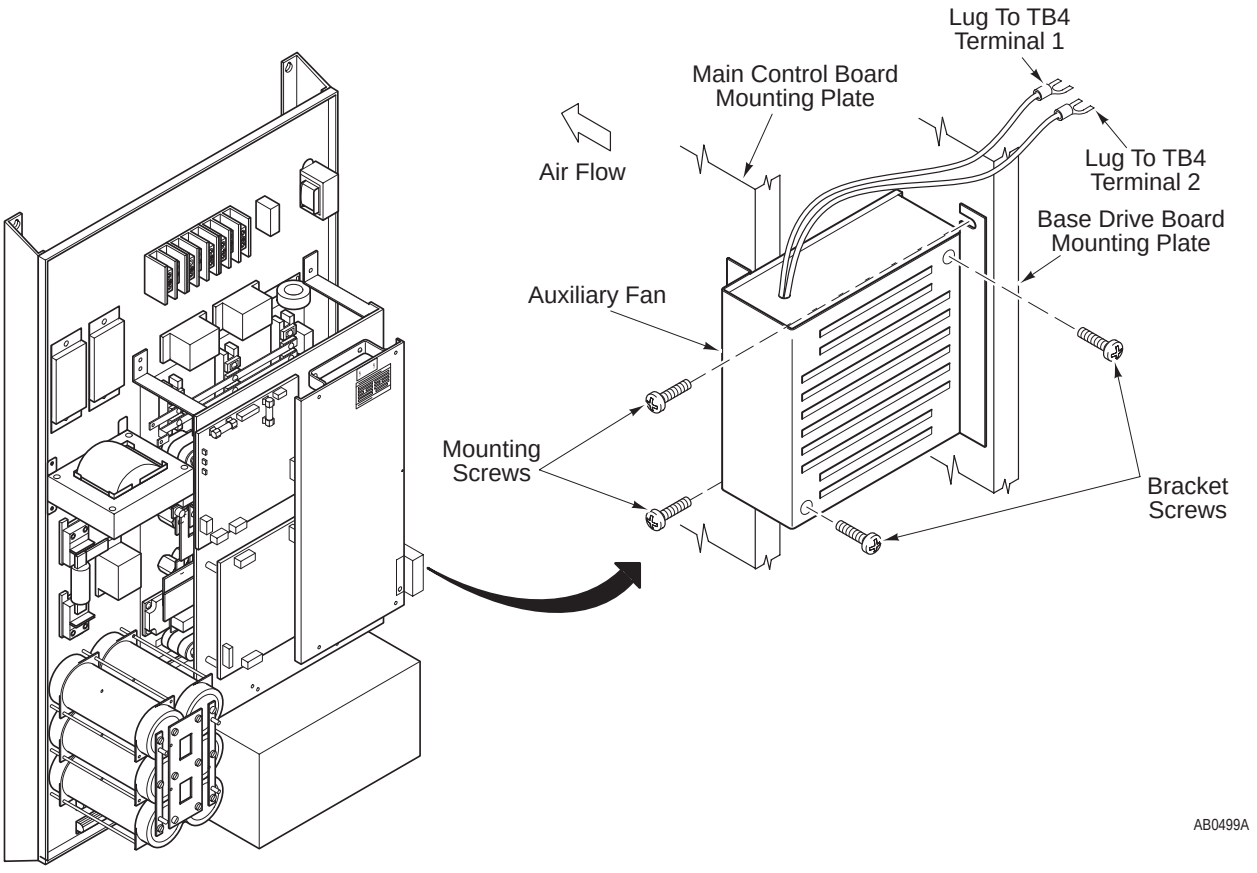
IMPORTANT: Before you mount the Fan and Fan Housing on the drive, run the Fan in the housing with the Air Funnel installed. Adjust the Fan and the Air Funnel on their horizontal mounting brackets until the Fan and Air Funnel do not rub together. Note that the oblong adjustment holes on the Fan Bracket are perpendicular to the holes on the Air Funnel Bracket.

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

Auxiliary Fan

The Auxiliary Fan on the right side of the Base Driver and Main Control Mounting Plates.

Figure 3.15
Auxiliary Fan



Removal

ATTENTION: Some printed circuit boards and drive components may contain hazardous voltage levels. If Bus Indicator neon light DS1 on the Base Driver Board is illuminated, hazardous voltages are present in the drive circuit boards. 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 neon indicator has extinguished and 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.

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

1. Remove power from the drive.
2. Wait for Bus Indicator Light DS1 to turn off. Check for zero volts at TB1 Terminals +DC and –DC before proceeding.
3. Loosen the screws fastening the fan wires to terminals 1 and 2 on Terminal Block TB4, located on the right side of the Main Fan housing.
4. Remove the fan wires from TB4 and from the nylon fasteners.
5. Loosen the two screws fastening the Auxiliary Fan bracket to the Control Main Mounting Plate and the Base Driver Mounting Plate.
6. Slide the fan to the right to remove the fan from the drive.
7. Remove the two screws fastening the fan to the bracket to remove the fan from the bracket.

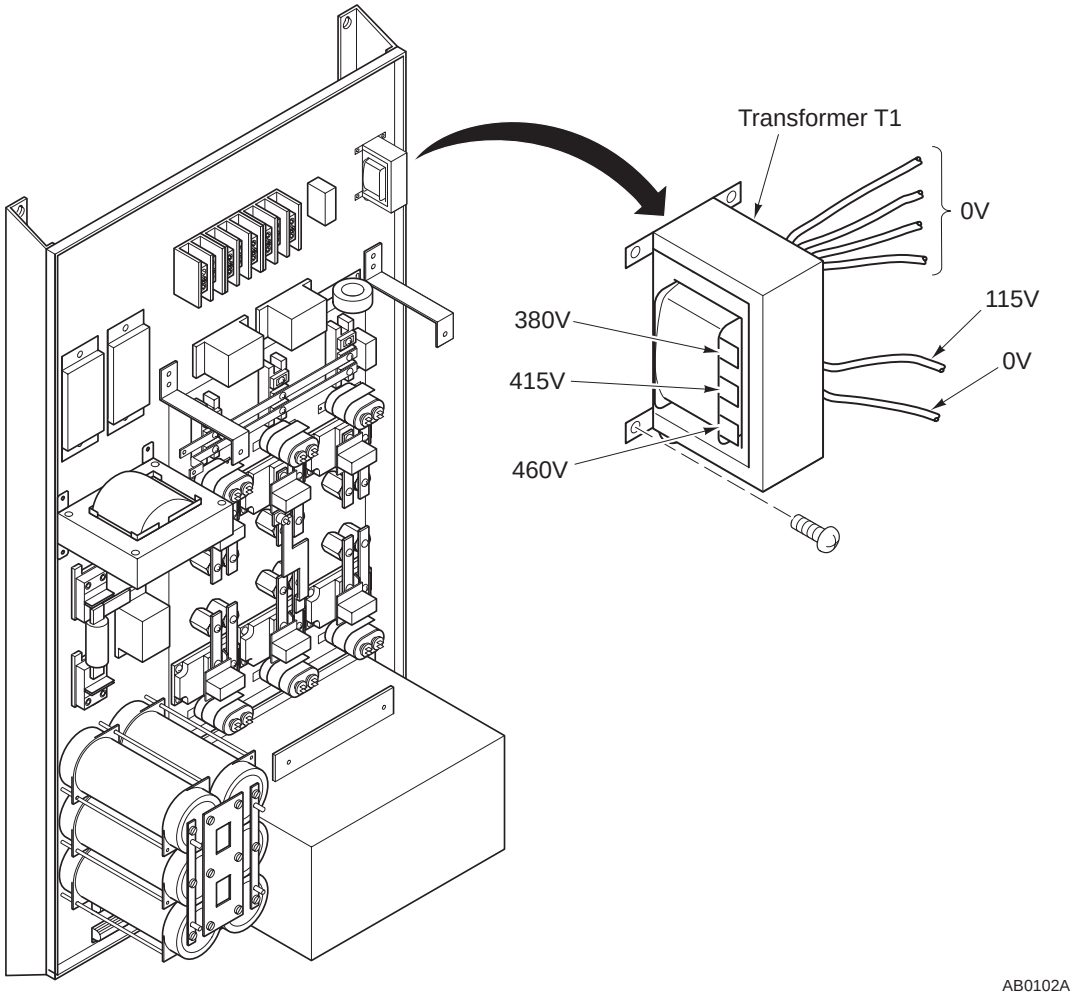
Installation

1. Cut each Auxiliary Fan wire to 11 in.
2. Strip 1/4 in. of insulation from each of the two wire ends.
3. Crimp one wire lug onto each exposed section of wire.
4. Install the Auxiliary Fan in reverse order of removal.

Transformer T1

Transformer T1 is located on the upper right corner of the Main Chassis, to the right of TB1 and MOV1.

Figure 3.16
Transformer T1



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. A bus charge neon indicator provides visual indication that bus voltage is present. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the neon indicator has extinguished and the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 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, bus bars, and wires from the drive components, mark the connections, bus bars, and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Wait for Bus Indicator Light DS1 to turn off. Check for zero volts at TB1 Terminals +DC and –DC before proceeding.
3. Remove the transformer 0V and 115V wires from the terminal block on the right side of the Fan Housing. The Fan Housing is located at the bottom of the drive.
4. Remove the wire from Transformer T1 380V, 415V, or 460V stake-on connector.
5. Remove the screws fastening T1 to the Main Chassis.
6. Remove the mounting brackets from T1.

Installation

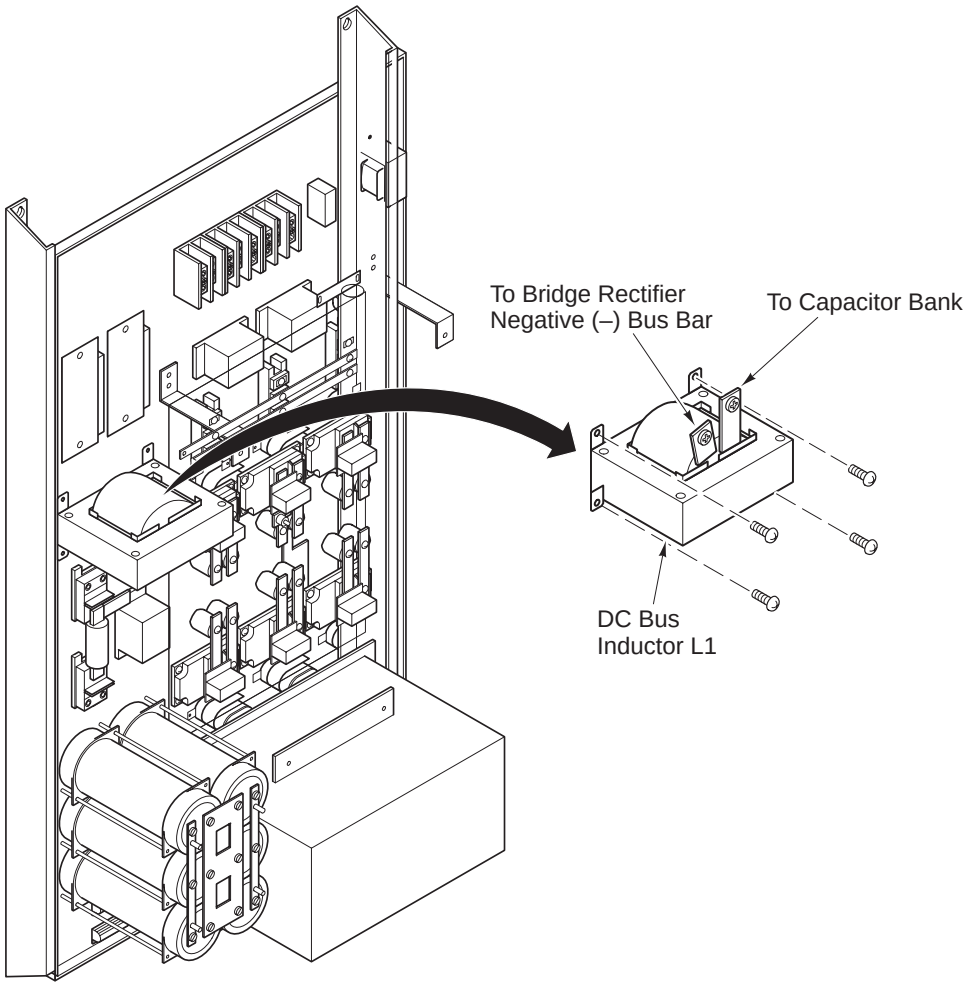
Install Transformer T1 in reverse order of removal. Insulate and tie back any unused T1 voltage taps.

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

DC Bus Inductor L1

DC Bus Inductor L1 is located on the left side of the Main Chassis.

Figure 3.17
DC Bus Inductor L1



AB0103B

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. A bus charge neon indicator provides visual indication that bus voltage is present. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the neon indicator has extinguished and the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 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, bus bars, and wires from the drive components, mark the connections, bus bars, and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Wait for Bus Indicator Light DS1 to turn off. Check for zero volts at TB1 Terminals +DC and –DC before proceeding.
3. Remove the screws fastening the wires to the inductor.
4. Remove the screws fastening the inductor to the Main Chassis.
5. Remove the brackets from the inductor.

Installation

Install DC Bus Inductor L1 in reverse order of removal.

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

Bus Capacitors

The bus capacitors are located on the lower left corner of the Main Chassis.

Figure 3.18
B075 – B125 Bus Capacitors

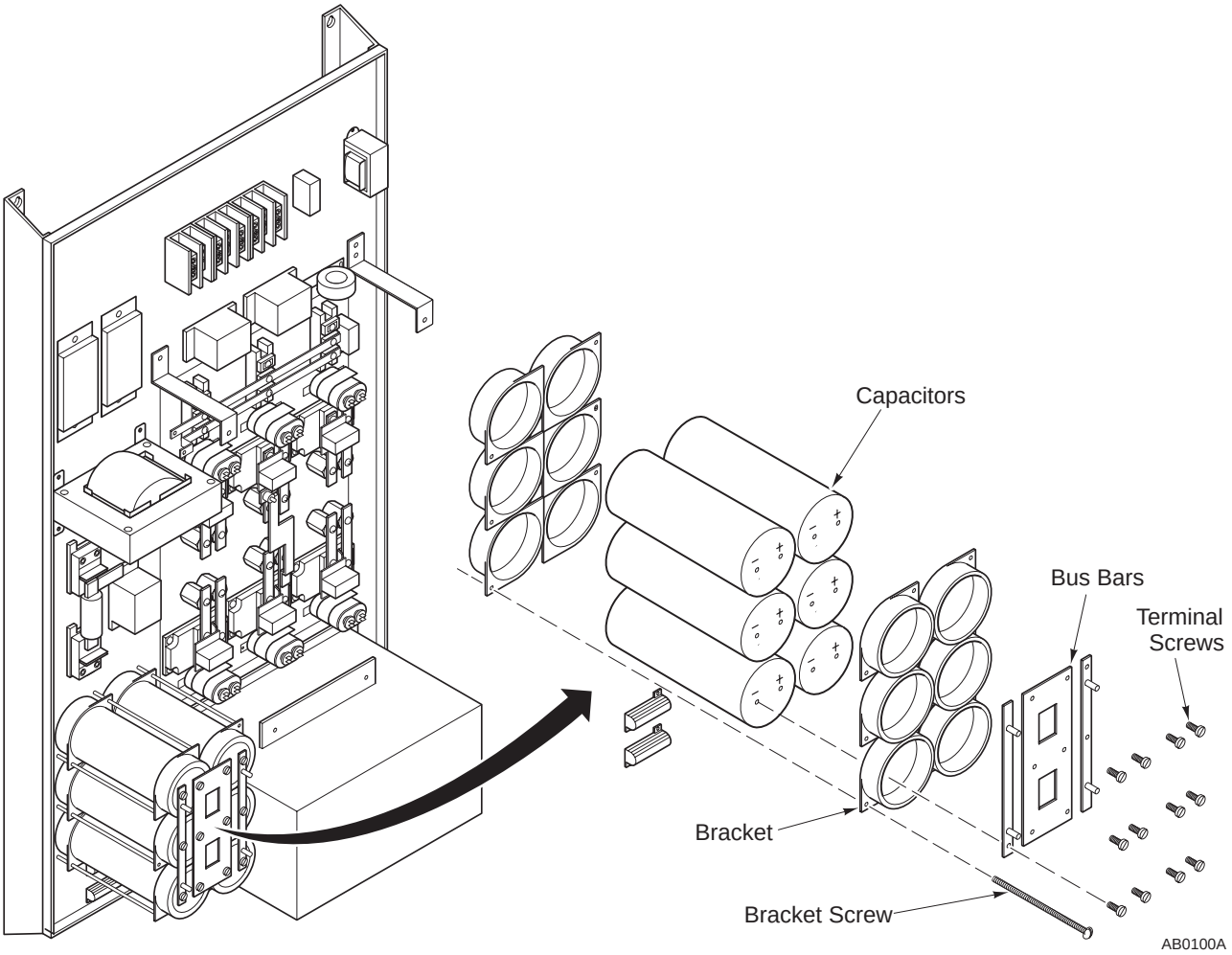
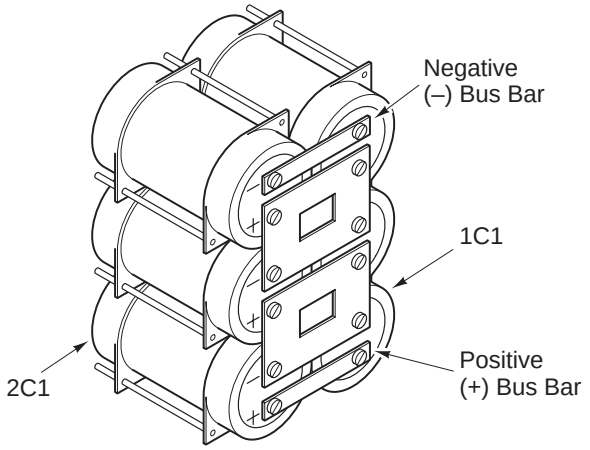


Figure 3.19
C075 – C125 Bus Capacitors



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. A bus charge neon indicator provides visual indication that bus voltage is present. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the neon indicator has extinguished and the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 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, bus bars, and wires from the drive components, mark the connections, bus bars, and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Wait for Bus Indicator Light DS1 to turn off. Check for zero volts at TB1 Terminals +DC and –DC before proceeding.
3. Remove the protective shield covering the bus capacitor terminals.
4. Remove the screws fastening the bus bars to the capacitors.
5. Remove the bus bars from the bus capacitors.

6. Remove the bracket screws fastening the malfunctioned capacitor to the Main Chassis.
7. Remove the screws fastening the malfunctioned Balancing Resistor to the Main Chassis.

Installation

1. Loosely fasten the capacitors to the Main Chassis using the brackets and screws.
2. Loosely fasten all bus bars and wires to the capacitors.

ATTENTION: Any capacitors not connected correctly will explode and may cause death or serious injury.
On B075 – B125 drives, the bus bar on the far left of the Capacitor Group must connect three negative (–) capacitor terminals. The bus bar on the far right of the Capacitor Group must connect three positive (+) capacitor terminals. The bus bar in the middle will then connect properly to the capacitor terminals.
Refer to the former illustration for C075 – C125 capacitor and bus bar configuration.

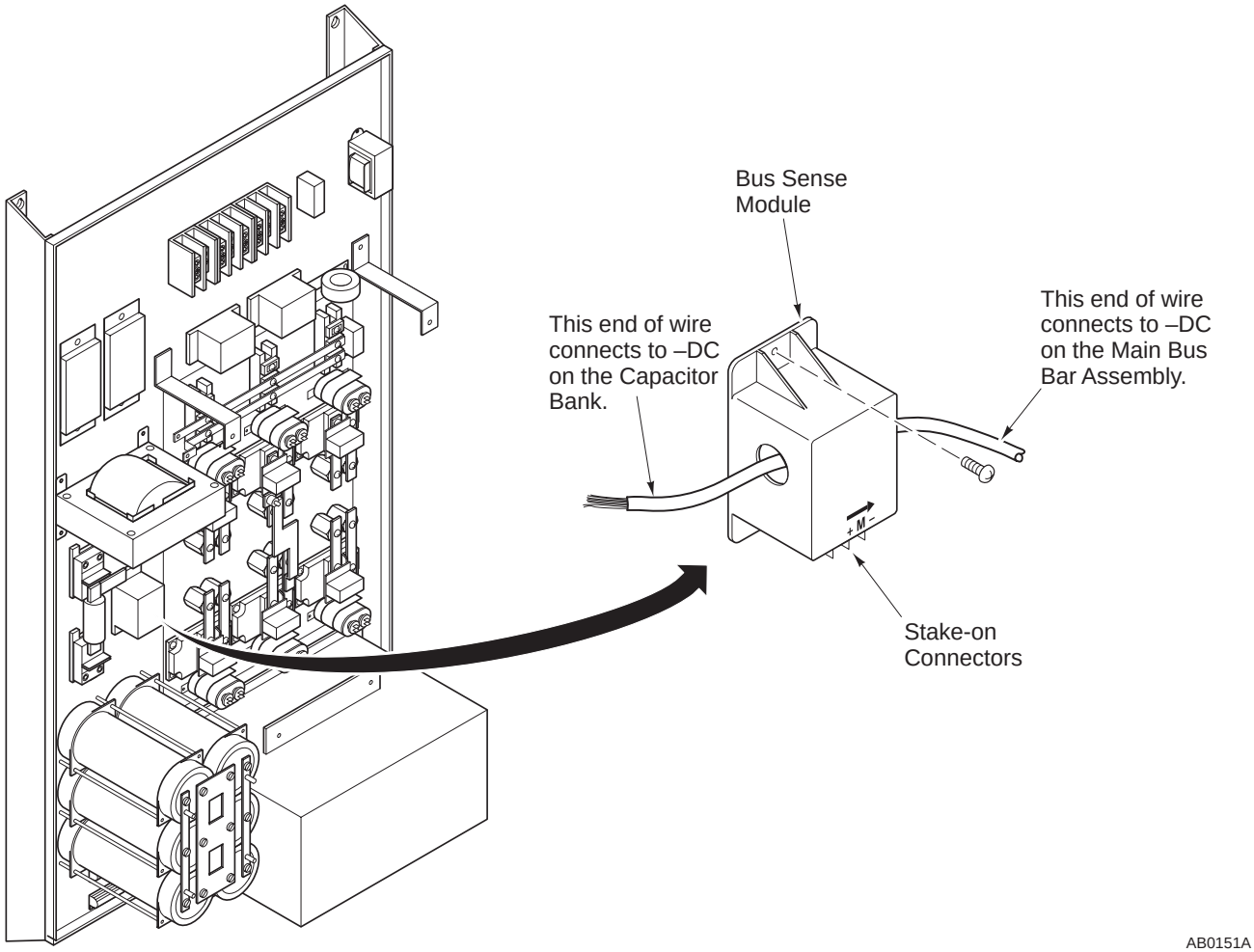
3. Tighten the capacitor bracket screws.
4. Tighten the screws fastening the bus bars to the capacitors.
5. Tighten the wires to the bus bars.
6. Fasten the protective shield to cover the capacitor terminals.

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

Bus Sense Module

The Bus Sense Module is located on the left side of the Main Chassis, near Bus Fuse F1. You do not need to remove the Base Driver Mounting Plate to access the Bus Sense Module.

Figure 3.20
Bus Sense Module



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. A bus charge neon indicator provides visual indication that bus voltage is present. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the neon indicator has extinguished and the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 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, bus bars, and wires from the drive components, mark the connections, bus bars, and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Wait for Bus Indicator Light DS1 to turn off. Check for zero volts at TB1 Terminals +DC and –DC before proceeding. These terminals are located in the upper left corner of the drive.
3. Remove the screws fastening the –DC wire to the Main Bus Bar assembly.
4. Pull the –DC wire through the hole in the Bus Sense Module.
5. Remove the wires from the Bus Sense Module stake-on connectors.
6. Remove the screws fastening the Bus Sense Module to the Main Chassis.

Installation

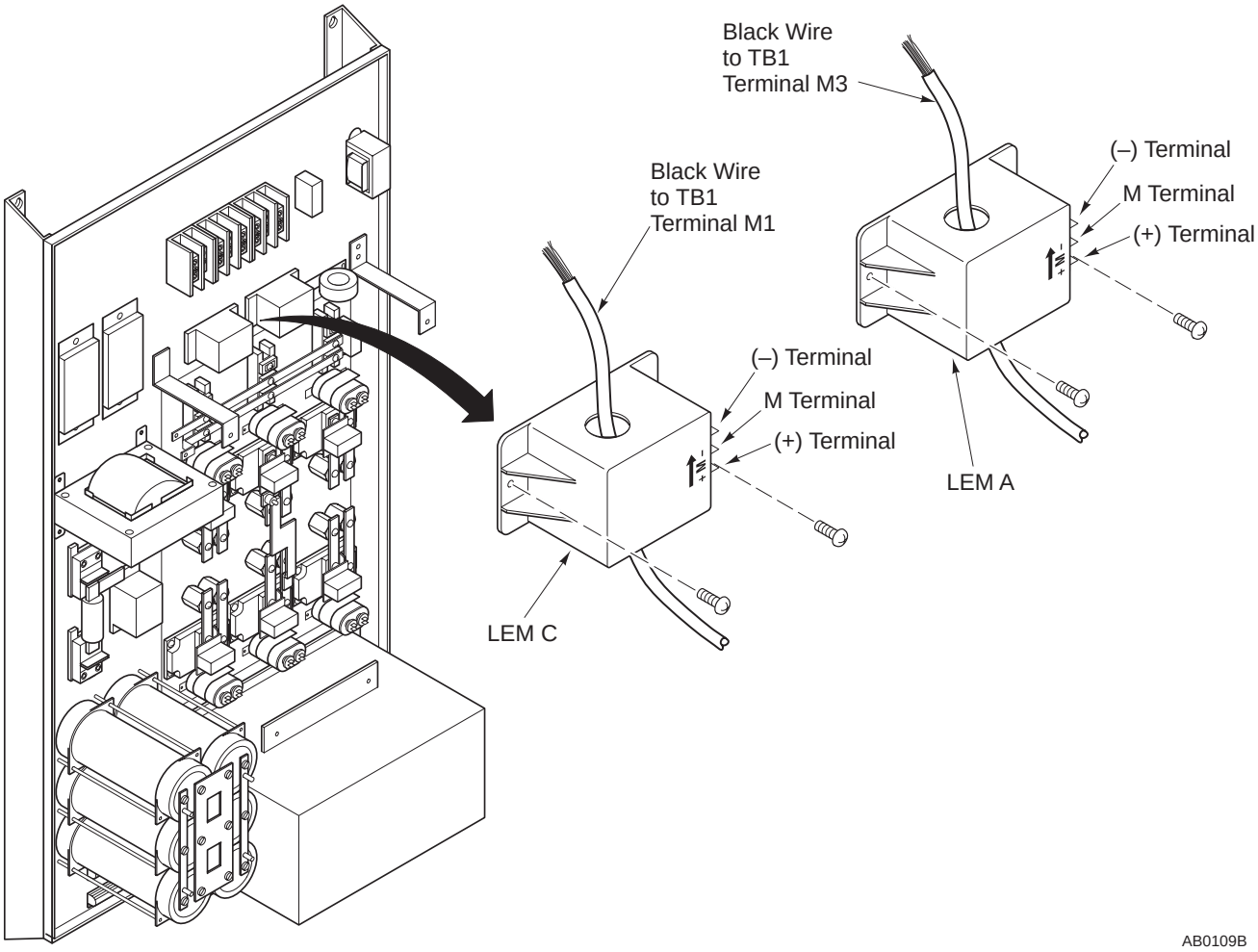
Install the Bus Sense Module in reverse order of removal.

IMPORTANT: Pass the –DC wire through the hole in the Bus Sense Module before you fasten the wire to the negative bus bar on the Main Bus Bar assembly. The arrow on the Bus Sense Module indicates the direction the –DC wire must travel as the wire passes through the Bus Sense Module and connects to the negative bus bar.

LEM A and LEM C

LEM A and LEM C are located on the Main Chassis, between TB1 and the Base Driver Mounting Plate. You do not need to remove the Base Driver Mounting Plate to access the LEMs.

Figure 3.21
LEM A and LEM C



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. A bus charge neon indicator provides visual indication that bus voltage is present. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the neon indicator has extinguished and the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 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, bus bars, and wires from the drive components, mark the connections, bus bars, and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Wait for Bus Indicator Light DS1 to turn off. Check for zero volts at TB1 Terminals +DC and –DC before proceeding.
3. Remove the wire from TB1 Terminal:
   - M3 if you are replacing LEM A
   - M1 if you are replacing LEM C
4. Remove the wires from the malfunctioned LEM stake-on connectors.
5. Remove the screws fastening the malfunctioned LEM to the Main Chassis.
6. Slide the malfunctioned LEM off of the M1 or M3 wire.

Installation

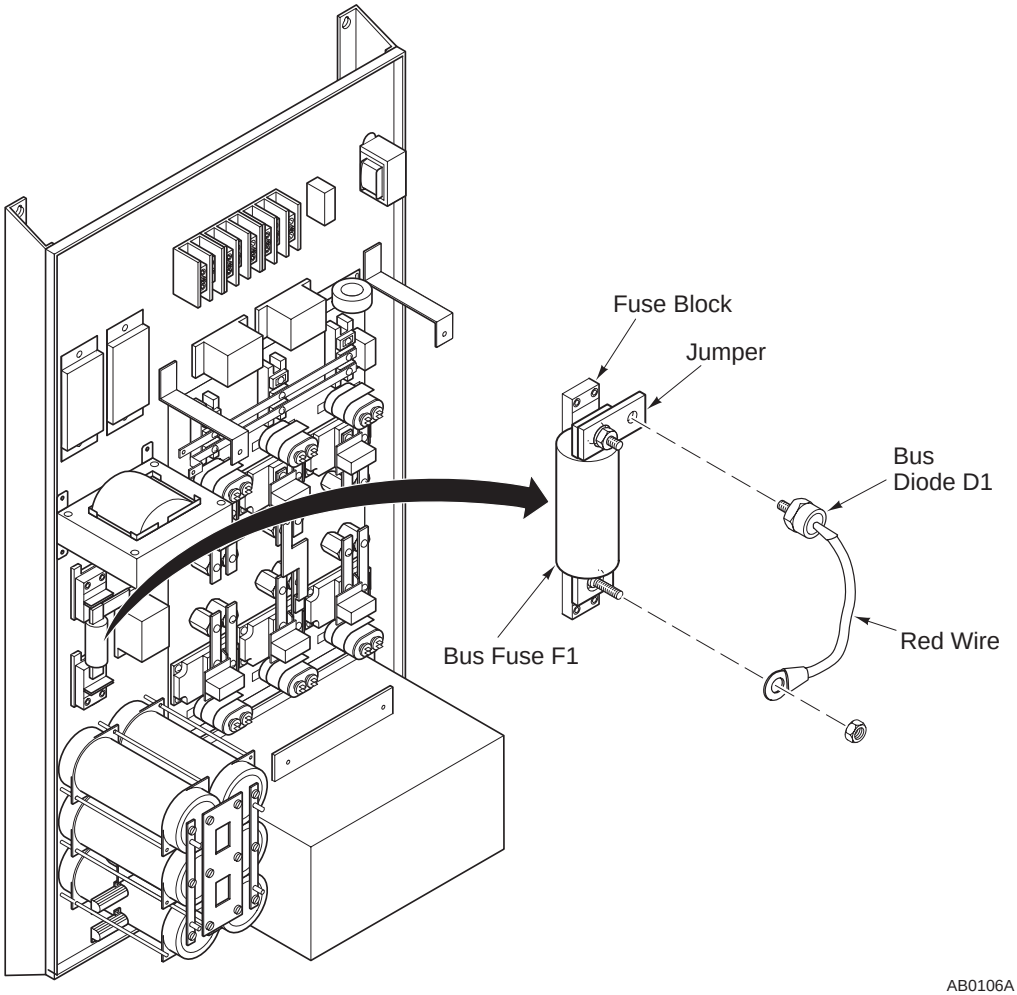
Install LEM A and LEM C in reverse order of removal.

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

Bus Diode D1

Bus Diode D1 is located above Bus Fuse F1 on the left side of the Main Chassis. You do not need to remove the Base Driver Mounting Plate to access Bus Diode D1.

Figure 3.22
Bus Diode D1



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. A bus charge neon indicator provides visual indication that bus voltage is present. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the neon indicator has extinguished and the bus voltage has discharged to zero volts.

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 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, bus bars, and wires from the drive components, mark the connections, bus bars, and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Wait for Bus Indicator Light DS1 to turn off. Check for zero volts at TB1 Terminals +DC and –DC before proceeding.
3. Remove the nut fastening the bus diode wire to the fuse block.
4. Remove Bus Diode D1 from the fuse jumper.

Installation

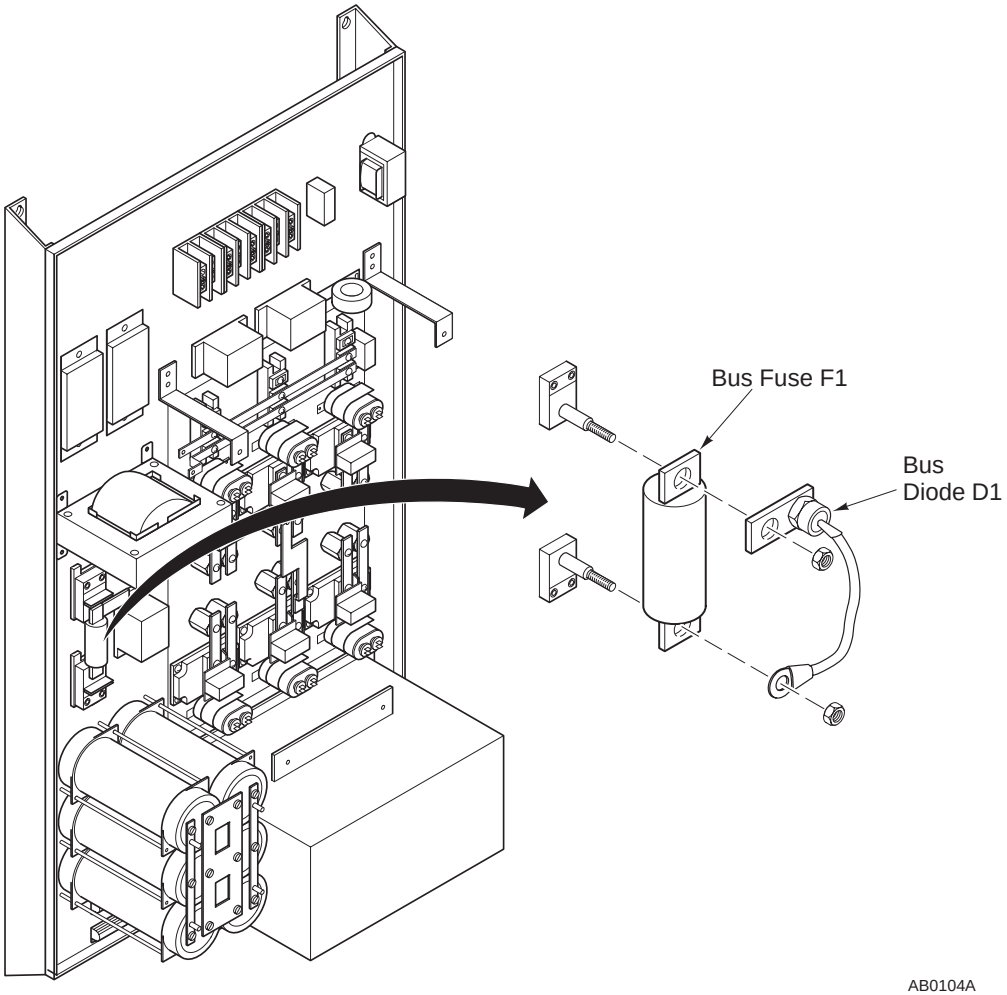
Install Bus Diode D1 in reverse order of removal.

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

Bus Fuse F1

Bus Fuse F1 is located on the Main Chassis between Inductor L1 and the Bus Capacitor group. You do not need to remove the Base Driver Mounting Plate to access Bus Fuse F1.

Figure 3.23
Bus Fuse F1



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

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 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, bus bars, and wires from the drive components, mark the connections, bus bars, and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Wait for Bus Indicator Light DS1 to turn off. Check for zero volts at TB1 Terminals +DC and –DC before proceeding.
3. Remove the screws fastening the bus fuse to the fuse block.
4. Remove the bus fuse from the fuse block.

Installation
Install Bus Fuse F1 in reverse order of removal.

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 4

Replacement Parts List

Chapter Objectives

This chapter illustrates and lists replacement parts for the 1336 Drives rated B075 – B125, C075 – C125, and 1336VT B075 – B150, and describes replacement parts ordering procedures.

Ordering Replacement Parts

For your convenience, the Allen-Bradley Motion Control 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.

Part numbers refer to publication 1336-6.0.

Replacement Parts Listing

Figure 4.1
Replacement Parts for B075 – B125, C075 – C125, and 1336VT B075 – B150 Drives

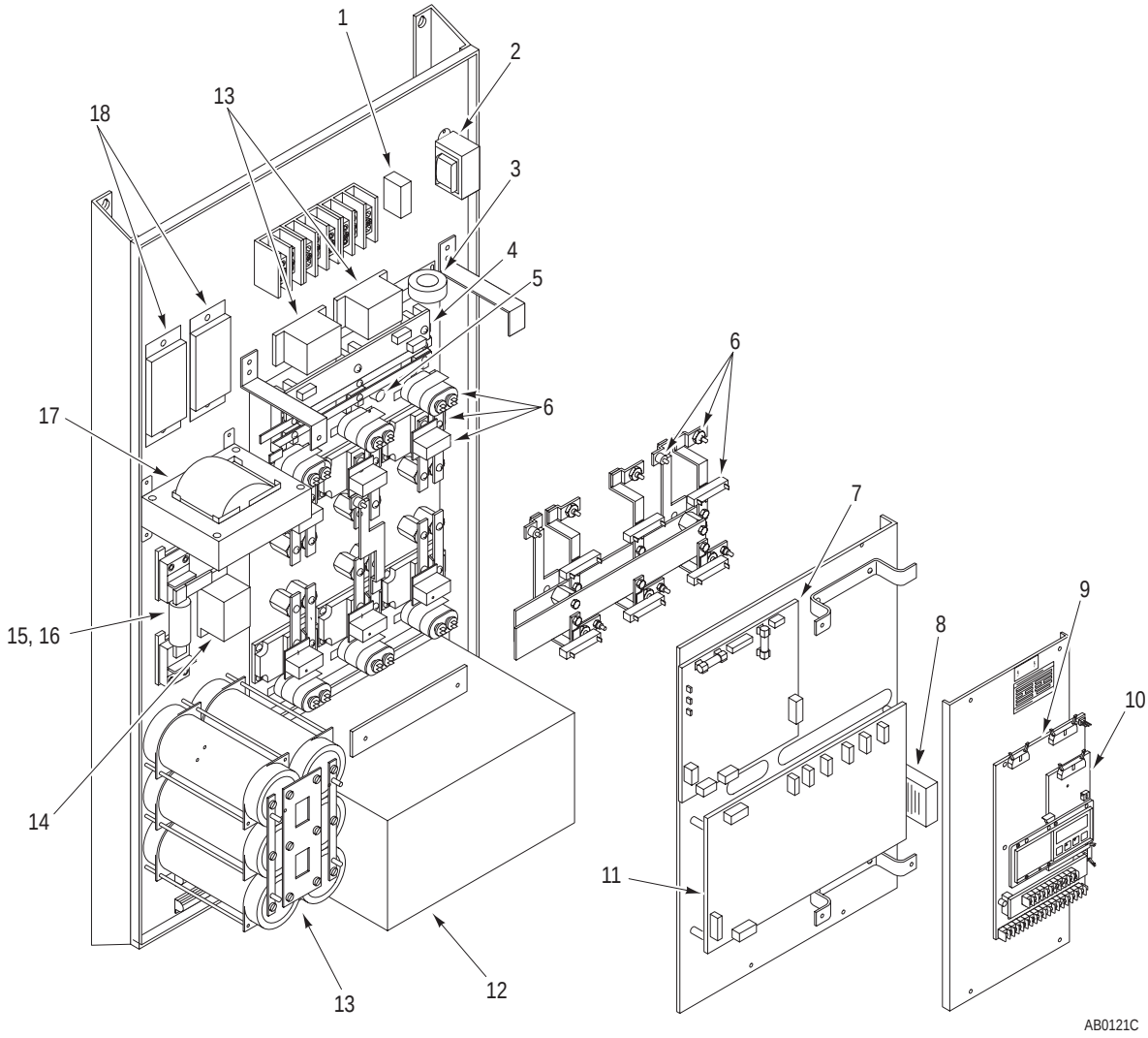

Table 4.A
Replacement Parts for 1336 B075 – B125, C075 – C125, and 1336 VT B075 – B150 Drives

Callout	Symbol	Description	Location	Replacement Procedure
1	MOV1	Surge Suppressor	Main Chassis	Chapter 3, Surge Suppressor MOV1
2	T1	Transformer	Main Chassis	Chapter 3, Transformer T1
3	GND SENSE	Current Transducer	Main Chassis	Chapter 3, Ground Sense CT
4	BR1, BR2, BR3	Bridge Rectifiers	Heat Sink	Chapter 3, SCR Modules
5	ST	Thermostat	Heat Sink	Chapter 3, Thermostat ST
6	X1–6, SN1–6, 1C4 – 6C4	Transistor Modules and Snubbers	Heat Sink	Chapter 3, Transistor Modules and Snubbers
7	PRECHARGE	Precharge Board	Base/Driver Precharge Board	Chapter 2, Precharge Board
8	AUX FAN	Fan	Main Chassis	Chapter 2, Aux Fan
9	MAIN CTL	Main Control PCB	Main Control Board	Chapter 2, Removing the Main Control Board from the Mounting Plate
10	LOCAL DIS	Program and Display PCB	Program and Display Board	Chapter 2, Removing the Programming and Display Board
11	BASEDR/ PWRSPLY	Base Driver Board	—	Chapter 2, Removing the Base Driver/Power Supply Board
12	FAN	Fan	Main Chassis	Chapter 3, Fan
13	1C1–5, 2C1–5, 3C1–3	Bus Capacitors	Main Chassis	Chapter 3, Bus Capacitors
14	BUS SENSE; LEM A, C	Current Transducer	Main Chassis	Chapter 3, Bus Sense; LEM A and LEM C
15	D1	Bus Diode	Main Chassis	Chapter 3, Bus Diode D2
16	F1	Bus Fuse	Main Chassis	Chapter 3, Bus Fuse F1
17	L1	DC Bus Inductor	Main Chassis	Chapter 3, DC Bus Inductor L1
18	R4, R5	Precharge Resistors	Main Chassis	Chapter 3, Precharge Resistors
*	Ribbon Cables	—	—	Part numbers are located on the ribbon cables

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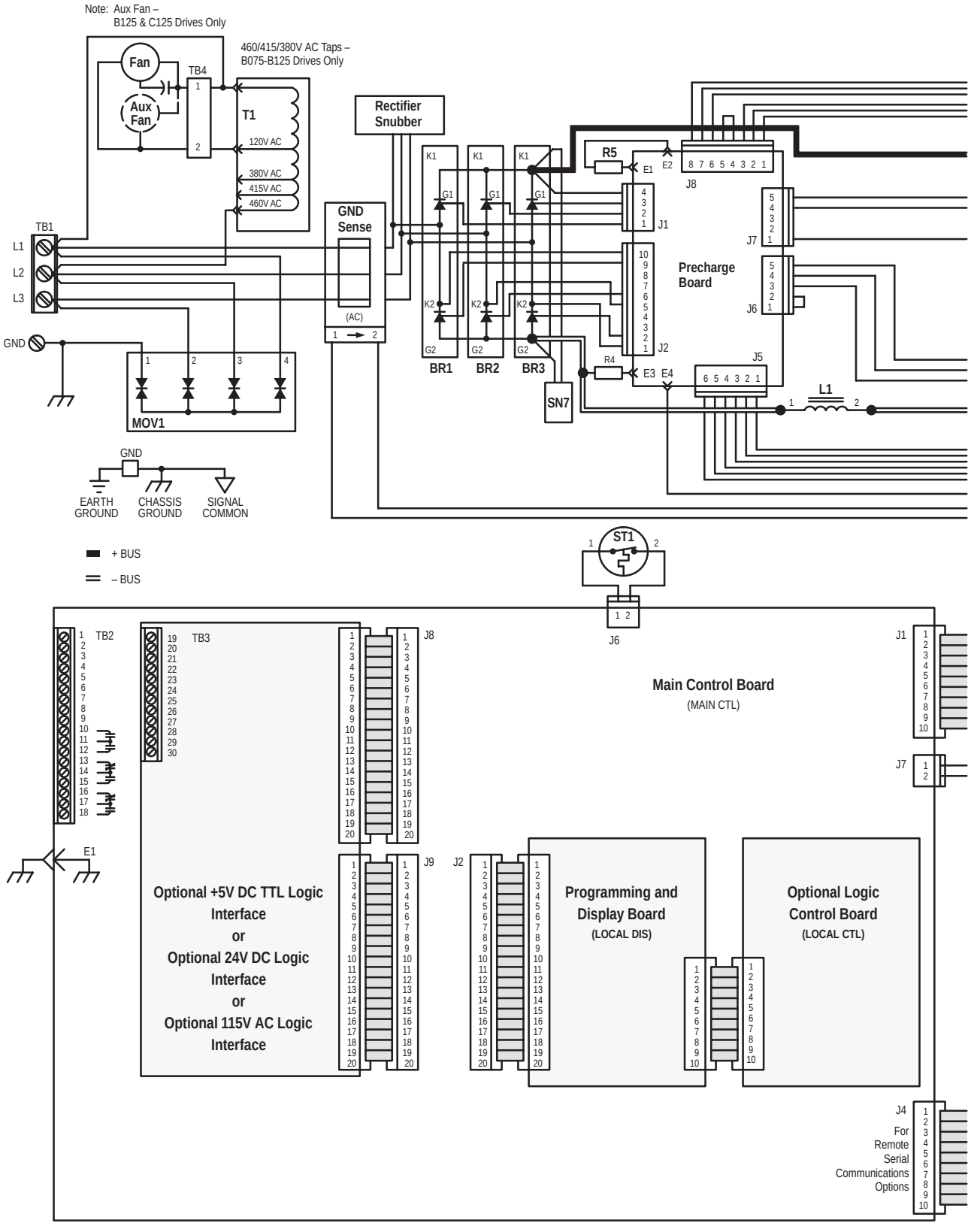
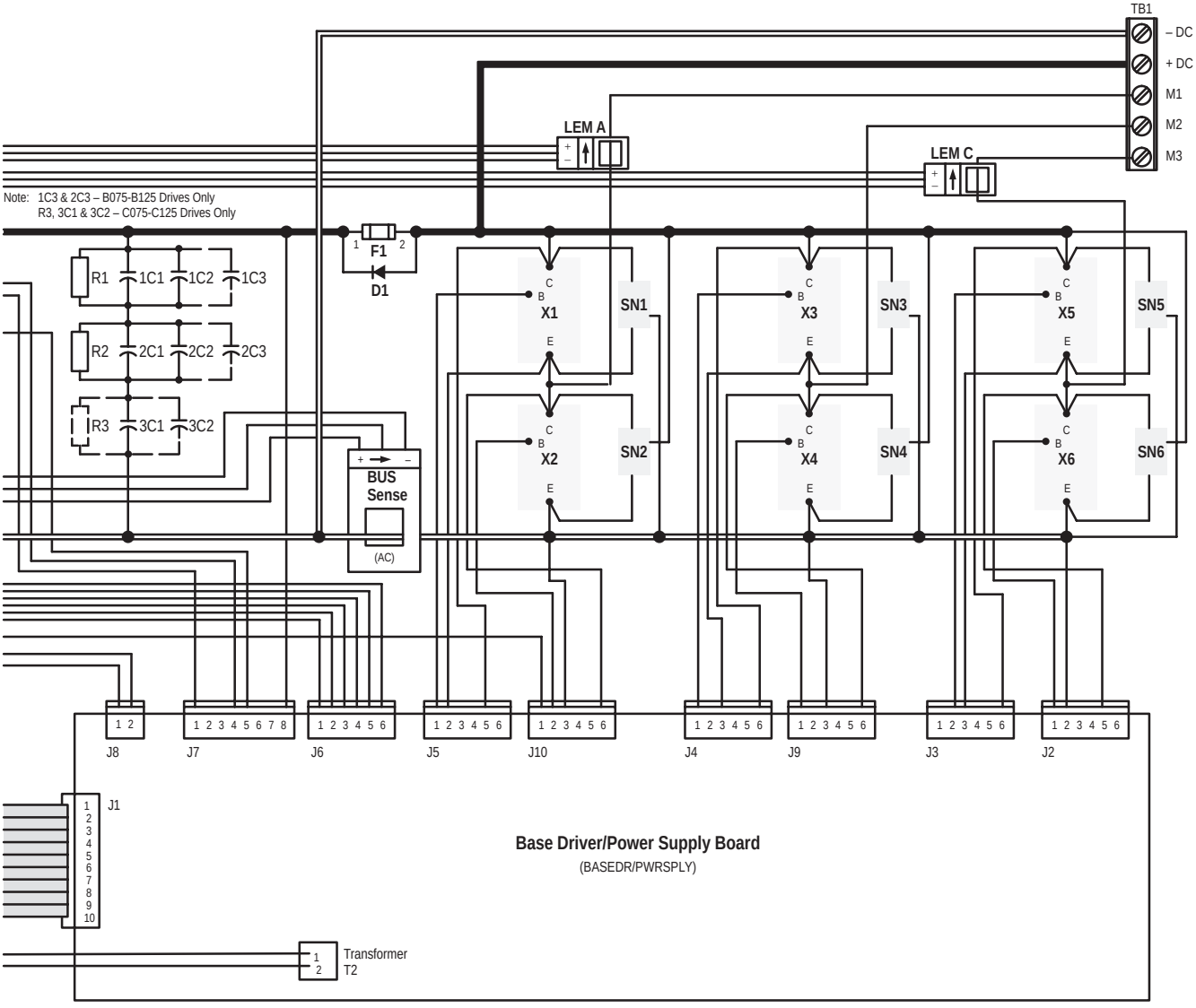
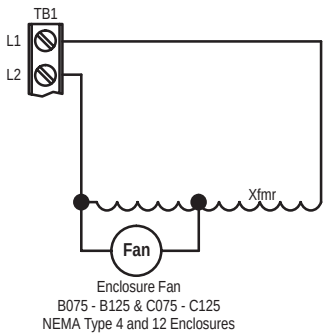
75 – 125 HP 1336 Drives

Figure S.1 – B075-B125 & C075-B125 Unit Schematic

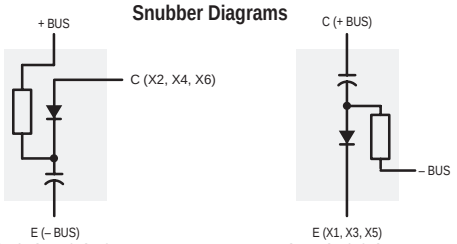






Enclosure Fan
B075 - B125 & C075 - C125
NEMA Type 4 and 12 Enclosures

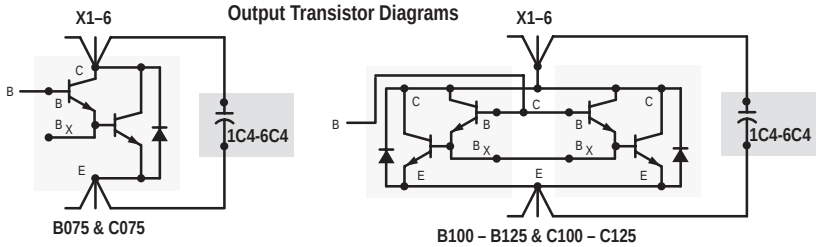
Snubber Diagrams



SN2, SN4 & SN6

SN1, SN3 & SN5

Output Transistor Diagrams



B075 & C075

B100 – B125 & C100 – C125

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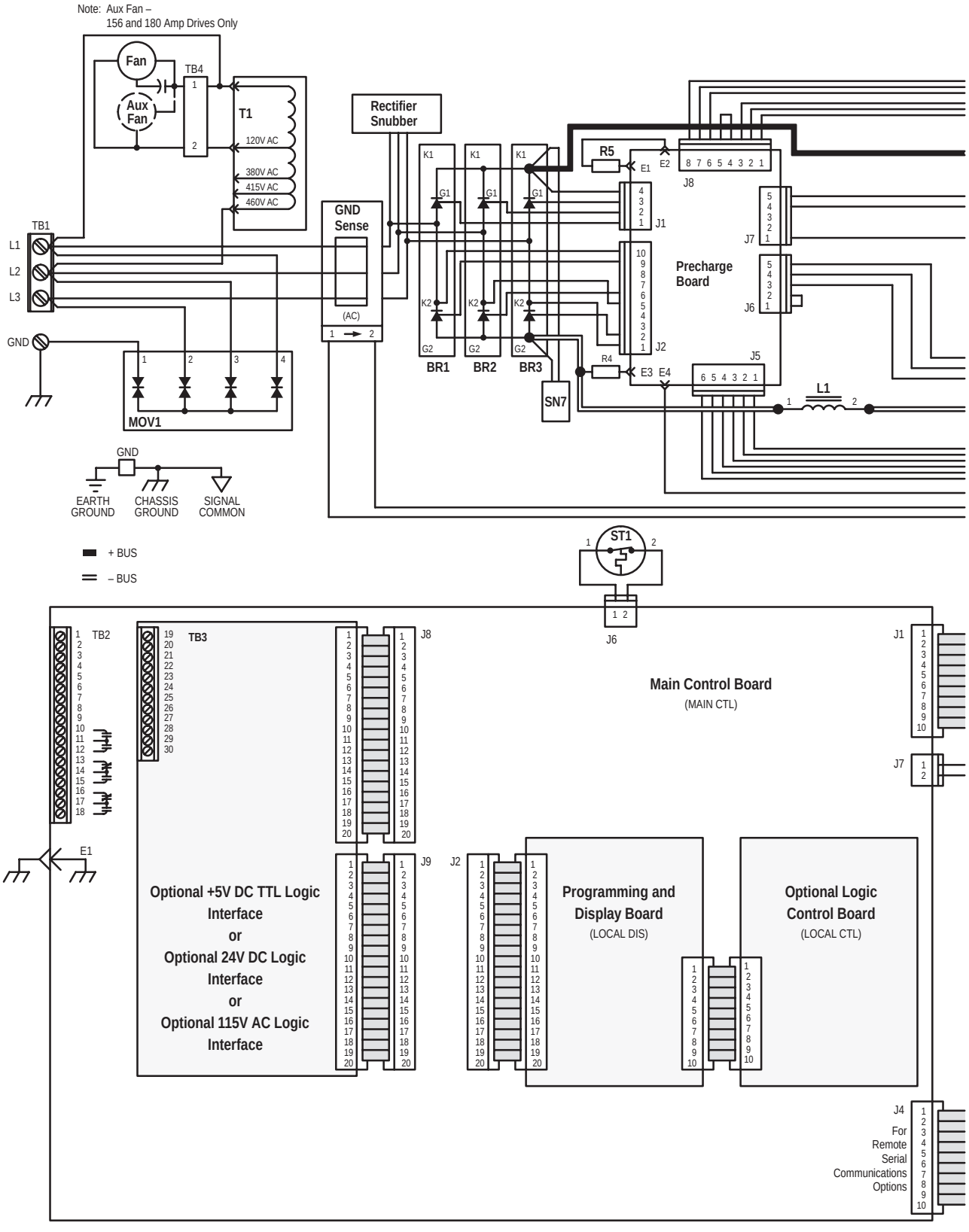
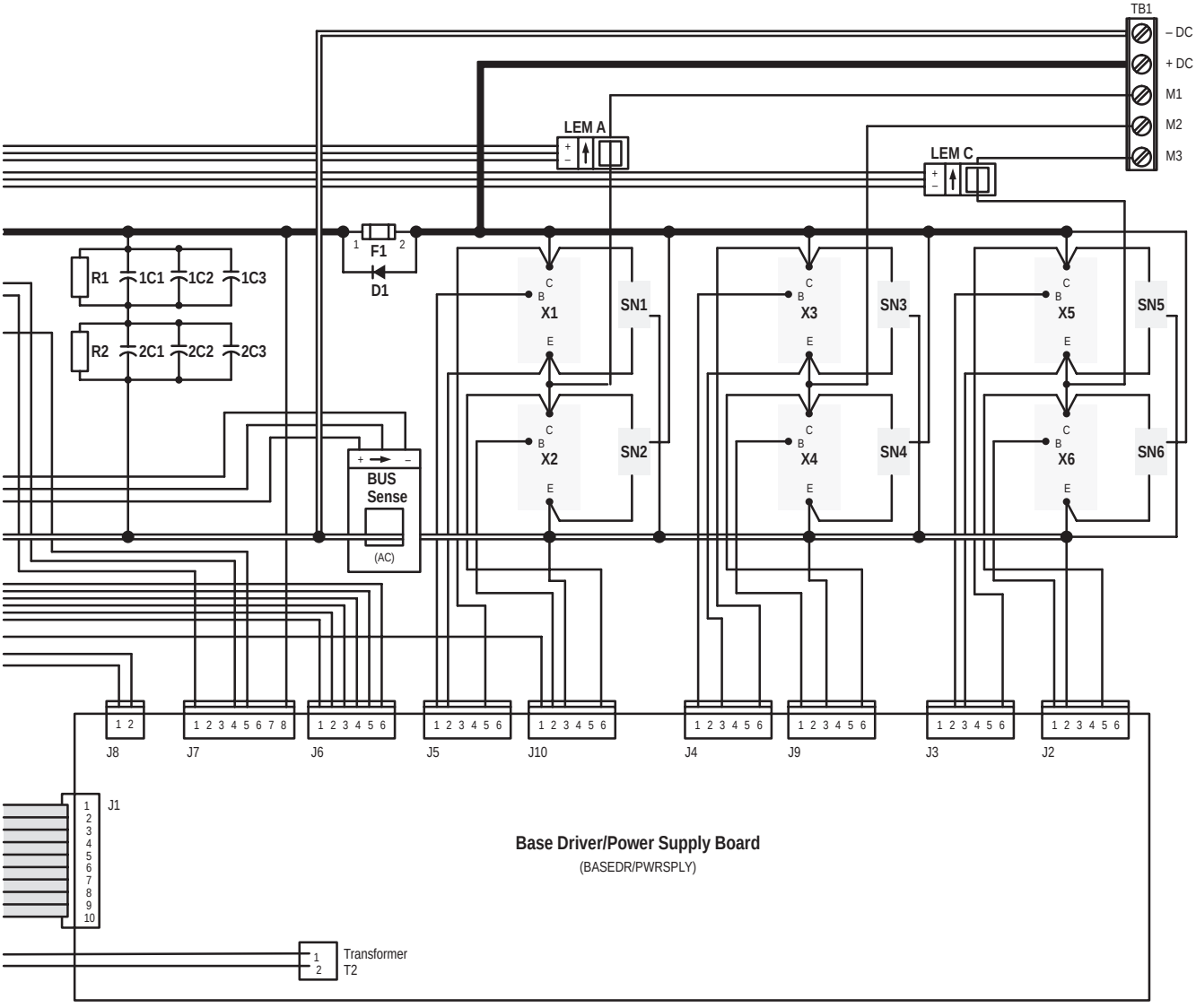
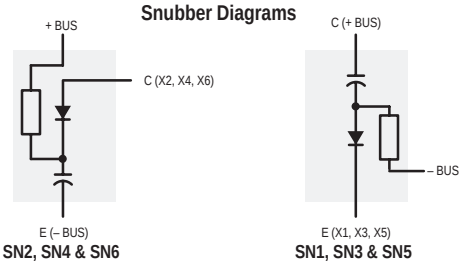
96 – 180 Amp 1336VT Drives

Figure S.2 – 1336VT 96-180 Amp Unit Schematic

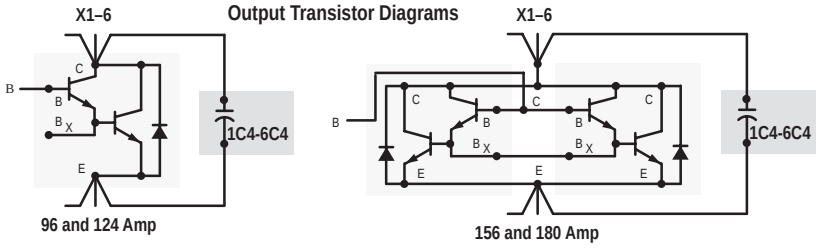




Snubber Diagrams



Output Transistor Diagrams



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Glossary

+Bus: +Bus is the portion of the DC bus that is at positive (+) potential.

–Bus: –Bus is the portion of the DC bus that is at negative (–) potential.

AC Contactor: An alternating-current (AC) contactor establishes or interrupts an AC Power circuit.

Adjustable Speed: An adjustable speed motor maintains the desired operating speed (set speed) regardless of the load.

Adjustable Speed Drive (Electrical): The adjustable speed drive consists of the motor, drive controller, and (optional) local controls. The remote operator/drive controls may be either manual or automatic.

Ambient Temperature: Ambient temperature is the temperature of the air in which equipment is operated or stored.

Base Speed: Base speed is the manufacturer's nameplate rating at which the motor develops rated horsepower (hp) at rated load and voltage. With AC systems, base speed is commonly the point at which 60 Hz is applied to the induction motor.

BR: Refer to Bridge Rectifier.

Braking: Braking stops an AC motor. Braking may be accomplished in any of the following ways:

1. Dynamic braking (AC drives) continues to excite the motor from the drive, since AC motors do not have separate field excitation. This causes a regenerative current to the drive's intermediate bus to dissipate the power returned. The brake resistor is usually switched by a transistor or other power switch controlled by the drive.
2. Regenerative braking is similar to dynamic braking but is accomplished electronically. The generated power is returned to the line through the power converter. This power may also be dissipated as losses in the converter (within its limitations).
3. A motor-mounted or separately-mounted brake is a positive-action, mechanical friction device. When power is removed, the brake is activated.

Breakaway Torque: Breakaway torque is 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 developed with rated voltage applied at rated frequency.

Bridge Rectifier (Diode, SCR): A diode bridge rectifier is 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 bridge rectifier is a full-wave rectifier that conducts current (through the load) in only one direction with respect to the alternating input voltage. AC applied to the input results in approximate DC at the output.

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

BTU: Refer to British Thermal Unit.

Bus Sense: Bus Sense is 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: Refer to Complimentary Metallic Oxide Semiconductor.

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

Complimentary Metallic Oxide Semiconductor (CMOS): A CMOS is an integrated-circuit component for logic circuits. CMOS components use very low power and have high switching rates. The CMOS is sensitive to high-voltage static discharges. Follow proper electrostatic discharge precautions to avoid damage to these components.

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

Constant Voltage Range: Constant voltage range applies to AC drives. This is the range of motor operation within which the drive's output voltage is held constant as output frequency is varied. This range produces motor performance similar to a DC drive's constant horsepower (hp) 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: Continuous duty (CONT) refers to a motor that can continue to operate within insulation temperature limits after it has reached normal operating (equilibrium) temperature.

Converter: A converter changes AC to DC, often through a diode rectifier or thyristor rectifier circuit. Converter also refers to the process of 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): CEMF is the energy per unit of charge converted into electrical form by a generator or a motor acting as a generator. This energy is in opposition to, or counters, the applied voltage.

Current Limiting: Current limiting is an electronic process of limiting the maximum current available to the motor. This is adjustable so that the motor's maximum current can be limited. Current limiting can be preset to protect both the motor and the control from extended overloads.

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

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

Diode: A diode passes current in one direction but blocks current flow in the reverse direction.

Drift: Drift is the deviation from the initial set speed with no load change over a specific time. Normally, the drive must be operated for a specific 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: A drive controller, sometimes called a variable speed drive, controls the speed, torque, horsepower, and direction of an AC or DC motor.

Duty Cycle: A time interval occupied by starting, running, stopping and idling.

Dynamic Braking: Refer to Braking.

Efficiency: Efficiency is the ratio of useful output to input, expressed in percentage. In motors, efficiency is the effectiveness with which a motor converts electrical energy into mechanical energy.

Electrostatic Discharge (ESD): ESD is 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 enable is to allow an action or acceptance of data by applying an appropriate signal to the appropriate input. Switch SW1, located on the Programming and Display Board, allows you to enable and disable the programming functions of a drive.

Enclosure: An enclosure is the housing in which a motor control is mounted. Enclosures are available for most environmental conditions.

ESD: Refer to Electrostatic Discharge.

Floating Ground: Floating ground describes a circuit in which the electrical common point is not at earth ground potential or the same ground potential as the circuitry with which the floating ground circuit is associated. Voltage differences can exist between the floating ground and earth ground.

Force: Force is the tendency to change the motion of an object with an exertion of energy from a separate source. Force is measured in pound-feet, ounce-inches, Newton-meters, or gram-centimeters.

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

Gate: A gate is the control element of the SCR (silicon-controlled rectifier), commonly referred to as a thyristor. When a small positive voltage is applied momentarily to the gate, the SCR conducts current. Current conduction continues after the gate signal is removed.

GND Sense: GND sense, or ground sense, is 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): Horsepower is a measure of the amount of work a motor can perform in a given length of time. Refer to “Power” for kilowatt equivalent.

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.

IEC: Just as the National Electrical Manufacturers Association goes by its acronym, “NEMA,” the International Electrotechnical Commission goes by “IEC.” And, like NEMA, IEC establishes and publishes mechanical and electrical standards.

Inertia: Inertia is 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 object’s weight (W) 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 on the axis of rotation. The moment of inertia is expressed in $lb\text{-}ft^2$ or $Newton\text{-}meters^2$.

Integral-Horsepower Motor: An integral-horsepower motor is any motor built in a frame having a continuous rating of 1 horsepower (hp) or more.

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: An inverter is an adjustable frequency AC drive or a particular section of an AC drive. The inverter section uses the DC voltage from a previous circuit stage (intermediate DC circuit) to produce an AC current or voltage of a desired frequency.

ISO: The International Standards Organization (ISO) based in Geneva, Switzerland, has developed a series of global standards to define and “harmonize” product, service and business practices worldwide. The ISO 9000 series, in particular, describes basic quality systems such as personnel training guidelines and quality documentation procedures.

Isolation Transformer: An Isolation Transformer electrically separates the drive from the AC power supply line. An isolation transformer:

1. Helps protect semiconductors from line voltage transients.
2. Reduces disturbances from other solid-state control equipment such as drives without isolation transformers, time clock systems, electronic counters, etc.

Jogging: Jogging is the momentary movement of a motor, usually through momentary closure of a circuit using a single pushbutton or contact element.

Kinetic Energy: Kinetic energy is an object's energy of motion.

LAD: Refer to Linear Acceleration/Deceleration.

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

Linear Acceleration/Deceleration (LAD): LAD is a circuit that controls the rate at which a motor accelerates to a set speed or decelerates to zero speed. On most motor drives, this circuit can be adjusted and set to accommodate particular applications.

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

Locked-Rotor Current: Locked-rotor current is a steady current taken from the power supply line current with the rotor at standstill, at rated voltage and frequency. This current is present when starting the motor and when the motor is under load.

Locked-Rotor Torque: Locked-rotor torque is the minimum torque a motor develops at rest for all angular positions of the rotor, with rated voltage applied at rated frequency.

Meggar Test: A Meggar test measures an insulation system's resistance. This test passes a low current, high voltage through a motor's windings and measures the resistance of the various insulation systems. Meggar test results are usually expressed in megohms. Must be done with motor disconnected from drive.

MOV: Refer to Surge Protection.

National Electrical Code (NEC): NEC is the code recommendations of the National Fire Protection Association. These codes are revised every three years. City or state code regulations take precedence over, and may differ from, NEC code regulations.

National Electrical Manufacturer's Association (NEMA): NEMA is 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.

NEMA: Refer to National Electrical Manufacturer's Association.

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

Op Amp: Refer to Operational Amplifier.

Open Loop: An open loop is a control system lacking feedback.

Operational Amplifier: An operational amplifier is usually a high-gain DC amplifier designed to be used with external circuit elements.

Overload Capacity: Overload capacity describes the ability of a drive to withstand currents beyond the system's continuous rating. Overload capacity is usually expressed as a percentage of full-load current endured in a specified time.

PC: Refer to Programmable Controller.

Plugging: Plugging is a method of motor braking that reverses either the line voltage polarity or the phase sequence. Plugging applies counter-torque to a motor, exerting a retarding, or braking, force.

Pot: A pot is a potentiometer, or variable resistor.

Power Factor (Displacement): Displacement power factor is 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): Distortion power factor is 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.

Power: Power is work accomplished per unit of time. Power is measured and expressed in horsepower (horsepower (hp)) or watts (W): 1 horsepower (hp) = 33,000 ft-lb/min. = 746 W or 24,340 N-m/min = 1 kW.

Preform: Preform is 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: Preset speed describes one or more fixed speeds at which a drive operates.

Programmable Controller: A programmable controller provides control logic for machines and processes. A sequence of operations can be changed easily through software programming.

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

Pull-Out Torque: Pull-out torque is the maximum running torque of a synchronous motor.

Pull-Up Torque: Pull-up torque is the torque required to accelerate a load from standstill to full speed. Breakdown torque occurs at full speed. Pull-up torque is expressed in percentage of running torque. This torque overcomes friction, windage, product loading, and inertial forces.

Pulse Width Modulating (PWM): PWM is an AC adjustable frequency drive that accomplishes frequency and output control at the output (inverter) section of the drive. The drive's voltage is always a constant amplitude, the average voltage of which is controlled through pulse width modulating.

PWM: Refer to Pulse Width Modulating.

Reactance: Reactance is the opposition (resistance) of a circuit or component to an alternating current. Reactance is measured and expressed in ohms.

Rectifier: A rectifier is an electrical device that transforms alternating current (AC) to direct current (DC).

Regeneration: Regeneration is the characteristic of a motor to act as a generator when a rotor synchronous frequency is greater than the applied frequency (AC drives).

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

Resolution: Resolution is the smallest distinguishable increment into which a quantity can be divided. This increment may be shaft speed or shaft position by degrees. Resolution is also the degree to which nearly-equal values of a quantity can be discriminated.

SCR: Refer to Silicon Controlled Rectifier.

Service Factor: A service factor is a number appearing on a motor nameplate. This number indicates the extent to which a motor may be overloaded above the nameplate rating without causing serious degradation. A motor with a 1.15 service factor can produce 15 percent greater torque than a motor with a 1.0 service factor. A service factor may also apply to motors and gearmotors as a figure of merit used to adjust measured loads in an attempt to compensate for conditions which are difficult to measure or define.

Set Speed: The set speed is the desired operating speed of a motor.

Shock Load: Shock loads affect clutches, brakes, and motors in systems that transmit high-peak loads. Shock loads are present in crushers, separators, grinders, conveyors, winches, and cranes.

Silicon Controlled Rectifier (SCR): The SCR is a solid-state switch sometimes referred to as a thyristor. The SCR has an anode, a cathode, and a control element called a gate. Because it can be turned on at will, the SCR provides controlled rectification. The SCR is small, lightweight, and can rapidly switch large currents at high voltages.

Slip: Slip is the difference between the rotating magnetic field speed (synchronous speed) and the rotor speed of an AC induction motor. Slip is usually expressed as a percentage of synchronous speed.

Speed Range: Speed range is the range of minimum and maximum speed within which a motor must operate under constant or variable torque conditions. A 50:1 speed range for a motor with a maximum speed of 1800 rpm means the motor must operate at a minimum speed of 36 rpm and remain within regulation specifications. Controllers are capable of wider controllable speed ranges than motors because there is no thermal limitation, only electrical.

Speed Regulation: Speed regulation is a measurement of how accurately a motor speed is maintained. Speed regulation is measured and expressed in percentage of change between full-load and no-load speeds.

Surge Protection: Surge protection is 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: Synchronous speed is the speed of the rotating magnetic field on an AC induction motor. The frequency applied to the stator and the number of magnetic poles present in each phase of the stator windings determines synchronous speed. Synchronous speed is mathematically expressed as: sync speed (rpm) = 120 x applied freq. (Hz)/number of poles per phase.

Torque: Torque is a turning force applied to a shaft. This force tends to cause shaft rotation. Torque is normally measured and expressed in ounce-inches (oz-in.) and pound-feet (lb-ft). Torque is the product of the force applied to an object and the radius through which that force acts upon the object.

Transducer: A transducer converts one energy form to another, such as mechanical energy to electrical energy. A transducer is also a device that, when actuated by signals form one or more systems or media, supplies related signals to one or more other systems or media.

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

Transistor: A transistor is a solid-state component. The terminals are called the emitter, the base, and the collector. Transistors amplify, switch, and control signals.

Work: Work is a force needed to move an object or load over a distance. Work is measured in inch-ounces (in.-oz), gram-cemtimeters (gm-cm), foot-pounds (ft-lbs), or Newton-meters (N-m). Work = force times distance.

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❑ SUGGEST / RESPONSIBLE FOR THE PURCHASE OF EQUIPMENT
❑ MAINTAIN / OPERATE PROGRAMMABLE MACHINERY
❑ 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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