Troubleshooting Guide

Bulletin 1336 PLUS
Adjustable Frequency AC Drive
Series A, B, C, D
B150 – B250
C150 – C250
CX300
ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage or economic loss.

Attentions help you:
• Identify a hazard.
• Avoid the hazard.
• Recognize the consequences.

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

DANGER labels may be located on or inside the drive to alert people that dangerous voltage may be present.
The information below summarizes the changes to the company-wide templates since the last release.

**Updated Information**

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

Information has been added to Test 3, Testing the Power Modules, beginning on page 4-7.
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## Control Logic Wiring and Adapters

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<td>Bus Fuse</td>
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Preface

Manual Objective

The information in this manual is designed to help troubleshoot or repair an Allen-Bradley Bulletin 1336 PLUS Adjustable Frequency AC Drive with ratings B150 – B250, C150 – C250, and CX300.

Who Should Use This Manual

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

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

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

Safety Precautions

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

**ATTENTION:** Potentially fatal voltages may result from improper usage of oscilloscope and other test equipment. The oscilloscope chassis may be at a potentially fatal voltage if not properly grounded. If an oscilloscope is used to measure high voltage waveforms, use only a dual channel oscilloscope in the differential mode with X 100 probes. It is recommended that the oscilloscope be used in the A minus B Quasi-differential mode with the oscilloscope chassis correctly grounded to an earth ground.
ATTENTION: Only personnel familiar with the 1336 PLUS Adjustable Frequency AC Drive and associated machinery should plan or implement the installation, start-up and subsequent maintenance of the system. Failure to comply may result in personal injury and/or equipment damage.

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.
Drive Nameplate Location

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

Figure 1.1
Drive Nameplate Location

Nameplate located on top edge of Main Control Board Mounting Plate.
Software Compatibility

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

<table>
<thead>
<tr>
<th>Three-Phase Drive Rating</th>
<th>380 – 480V</th>
<th>500 – 600V</th>
<th>Compatible with Version</th>
<th>Frame Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>112 – 187 kW</td>
<td>112 – 224 kW</td>
<td>2.01 &amp; Up</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td>150 – 250 HP</td>
<td>150 – 300 HP</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** kW and HP are constant torque (CT) ratings.
The following is an explanation of the catalog numbering system for 1336 PLUS Adjustable Frequency AC Drives and options. The catalog number is coded to identify the drive power rating and can be found on the drive shipping carton and nameplate.

1336 PLUS Drive Catalog Numbers

Table 1.A

<table>
<thead>
<tr>
<th>1336S</th>
<th>– B040-AA</th>
<th>– EN</th>
<th>– L6</th>
<th>– HA1</th>
<th>– GM1</th>
</tr>
</thead>
<tbody>
<tr>
<td>BULLETIN NO.</td>
<td>RATING-ENCLOSURE (MUST BE SPECIFIED)</td>
<td>LANGUAGE MODULE (MUST BE SPECIFIED)</td>
<td>CONTROL INTERFACE (OPTIONAL)</td>
<td>HUMAN INTERFACE (OPTIONAL)</td>
<td>COMMUNICATION CARD (OPTIONAL)</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Drive Rating</th>
<th>Enclosures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame Designation</td>
<td>Constant Torque</td>
</tr>
<tr>
<td></td>
<td>Output Amps</td>
</tr>
<tr>
<td>E</td>
<td>199.0</td>
</tr>
<tr>
<td></td>
<td>263.0</td>
</tr>
<tr>
<td></td>
<td>325.0</td>
</tr>
</tbody>
</table>

* 480 volts only
### Table 1.B

<table>
<thead>
<tr>
<th>1336S</th>
<th>– C025-AA</th>
<th>– EN</th>
<th>– L6</th>
<th>– HA1</th>
<th>– GM1</th>
</tr>
</thead>
<tbody>
<tr>
<td>BULLETIN NO.</td>
<td>RATING-ENCLOSURE (MUST BE SPECIFIED)</td>
<td>LANGUAGE MODULE(^{(MUST \ BE \ SPECIFIED)})</td>
<td>CONTROL INTERFACE(^{(OPTIONAL)})</td>
<td>HUMAN INTERFACE(^{(OPTIONAL)})</td>
<td>COMMUNICATION CARD(^{(OPTIONAL)})</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Drive Rating(^{[3]})</th>
<th>Enclosures</th>
<th>Open IP00 No Enclosure</th>
<th>NEMA Type 1 IP20 General Purpose</th>
<th>NEMA Type 4 IP65 Resist Water, Dust</th>
<th>NEMA Type 12 IP54 Industrial Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame Designation</td>
<td>Output Amps</td>
<td>Nominal HP CT</td>
<td>Nominal HP VT</td>
<td>Code</td>
<td>Code</td>
</tr>
<tr>
<td>E</td>
<td>158.0</td>
<td>150</td>
<td>150</td>
<td>C150-AN</td>
<td>C150-AA</td>
</tr>
<tr>
<td>252.0</td>
<td>200</td>
<td>200</td>
<td>C200-AN</td>
<td>C200-AA</td>
<td>C200-AJ</td>
</tr>
<tr>
<td>284.0</td>
<td>250</td>
<td>250</td>
<td>C250-AN</td>
<td>C250-AA</td>
<td>C250-AJ</td>
</tr>
<tr>
<td>300.0</td>
<td>300</td>
<td>300</td>
<td>CX300-AN</td>
<td>CX300-AA</td>
<td>CX300-AJ</td>
</tr>
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Table 1.C

<table>
<thead>
<tr>
<th>Language Modules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
</tr>
<tr>
<td>English/English</td>
</tr>
<tr>
<td>English/French</td>
</tr>
<tr>
<td>English/German</td>
</tr>
<tr>
<td>English/Italian</td>
</tr>
<tr>
<td>English/Japanese</td>
</tr>
<tr>
<td>English/Spanish</td>
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</tbody>
</table>

Table 1.D

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HAB</td>
<td>Blank – No Functionality</td>
</tr>
<tr>
<td>HAP</td>
<td>Programmer Only</td>
</tr>
<tr>
<td>HA1</td>
<td>Programmer, LCD/Analog Pot</td>
</tr>
<tr>
<td>HA2</td>
<td>Programmer, LCD/Digital Pot</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HFB</td>
<td>Blank – No Functionality</td>
</tr>
<tr>
<td>HFP</td>
<td>Programmer Only</td>
</tr>
<tr>
<td>HF1</td>
<td>Programmer, LCD/Analog Pot</td>
</tr>
<tr>
<td>HF2</td>
<td>Programmer, LCD/Digital Pot</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HJB</td>
<td>Blank – No Functionality</td>
</tr>
<tr>
<td>HJP</td>
<td>Programmer Only</td>
</tr>
<tr>
<td>HJ1</td>
<td>Programmer, LCD/Analog Pot</td>
</tr>
<tr>
<td>HJ2</td>
<td>Programmer, LCD/Digital Pot</td>
</tr>
</tbody>
</table>

1. Drive rating is based on a carrier frequency of 2kHz maximum, an altitude of 1,000 meters or less, and a maximum ambient temperature of 40°C. Refer to Qualifications on pages P-8 and P-9.
2. Not available.
3. VT Ratings do not apply to 380V Input.
4. Refer to the Language Module and Options tables following these Catalog Number tables.

Table 1.E

<table>
<thead>
<tr>
<th>380 – 480V Drives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catalog Number</td>
</tr>
<tr>
<td>B150</td>
</tr>
<tr>
<td>B200</td>
</tr>
<tr>
<td>B250</td>
</tr>
</tbody>
</table>
Table 1.F
500 – 600V Drives

<table>
<thead>
<tr>
<th>Catalog Number</th>
<th>Maximum Amp Rating</th>
<th>Derate Curve</th>
<th>Heat Dissipation Drive Watts</th>
<th>Heat Sink Watts</th>
<th>Total Watts</th>
</tr>
</thead>
<tbody>
<tr>
<td>C150</td>
<td>158</td>
<td>(1)</td>
<td>(1)</td>
<td>(1)</td>
<td>(1)</td>
</tr>
<tr>
<td>C200</td>
<td>228</td>
<td>(1)</td>
<td>(1)</td>
<td>(1)</td>
<td>(1)</td>
</tr>
<tr>
<td>C250</td>
<td>284</td>
<td>(1)</td>
<td>(1)</td>
<td>(1)</td>
<td>(1)</td>
</tr>
<tr>
<td>CX300</td>
<td>300</td>
<td>(1)</td>
<td>(1)</td>
<td>(1)</td>
<td>(1)</td>
</tr>
</tbody>
</table>

1. Amp Rating is at 2kHz. If carrier frequencies above 2kHz are selected, drive Amp Rating must be derated. Refer to the User Manual for carrier frequency vs. Amp deratings.
2. Drive Ambient Temperature Rating is 40°C. If ambient exceeds 40°C, the drive must be derated.
3. Drive Rating is based on altitudes of 1,000m (3,000 ft) or less. If installed at higher altitude, drive must be derated.
4. Refer to the 1336 PLUS User Manual, Appendix A.
Drive Rating Qualifications

Several factors can affect drive rating. If more than one factor exists, consult Allen-Bradley Company.

Enclosure Type

The first character, A, indicates the Enclosure Code. The second character indicates the type of enclosure shipped from the factory:

Table 1.G
Enclosure Type Code Description

<table>
<thead>
<tr>
<th>Enclosure Type Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>Open style (IP 00)</td>
</tr>
<tr>
<td>A</td>
<td>NEMA Type 1 (IP 20)</td>
</tr>
<tr>
<td>F</td>
<td>NEMA Type 4 (IP 65)</td>
</tr>
<tr>
<td>J</td>
<td>NEMA Type 12 (IP 54)</td>
</tr>
</tbody>
</table>
To help differentiate parameter names and display text from other text in this manual, the following conventions will be used:

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

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

### Auxiliary Input

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

### Auxiliary Interlock

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

### Bit

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

### Check

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

### Connector

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

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

Enable Input

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

False

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

Jumper

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

Control Interface Board

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

Parameter

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

Press

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

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

Related Publications

The following lists other Allen-Bradley publications that apply to the 1336 PLUS Adjustable Frequency AC Drives with ratings B150 – B250, C150 – C250, and CX300:

- Product Data (1336 PLUS-1.0)
- User Manual (1336 PLUS-5.0)
- Option Manuals/Instructions
- Renewal Parts List (1336-6.5)
Control Logic Wiring and Adapters

Chapter Objectives

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

Chapter Overview

This chapter illustrates and describes:

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

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

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

**ATTENTION:** This assembly contains parts and sub-assemblies that are sensitive to electrostatic discharge. Static control precautions are required when servicing this assembly. Component damage may result if you ignore electrostatic discharge control procedures. If you are not familiar with static control procedures, reference Allen-Bradley Publication 8000–4.5.2, Guarding Against Electrostatic Discharge, or any other applicable ESD protection handbook.
ATTENTION: The National Electrical Code (NEC) and local codes outline provisions for safely installing electrical equipment. Installation must comply with specifications regarding wire types, conductor sizes, branch circuit protection and disconnect devices. Failure to do so may result in personal injury and/or equipment damage.

Control Interface Option

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

Six different versions of the option are available:

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

1 Uses internal +5V DC supply.
The user inputs are connected to the option board through TB3. The L4, L5 and L6 options each have nine control inputs. The function of each input must be selected through programming as explained later in this section. The L4E, L5E and L6E options are similar to L4, L5 and L6 with the addition of encoder feedback inputs.

**Control Interface Board Jumpers**

**IMPORTANT:** If the Control Interface Board is being installed, Main Control Board jumpers at pins 3 & 4 and 17 & 18 of J4 (J7 on 7.5 – 30 HP drives) must be removed. If removed, these jumpers can be stored on the “spares” location on the Main Control Board. If this board is removed, these jumpers must be reinstalled and the [Input Mode] parameter must be programmed to “1”.

**Figure 1.2**
Jumper Locations
**Available Inputs**

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

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

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

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

The programming options of the Control Interface Option allow the user to select an input combination to meet the needs of a specific installation. Appropriate selection of a combination may be done by using Table 1.A. First determine the type of start/stop/direction control desired. Then select the remaining control functions available. After selecting a group of Input Modes use Figure 1.2 for specific mode selection. Record the selected mode number below.

Selected Mode Number: ________________________________

**Local Programming**

For local programming and control information, refer to the 1336 PLUS User Manual.
Table 1.A
Input Mode Selection

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

The maximum and minimum wire sizes accepted by TB3 is 2.1 and 0.30 mm² (14 and 22 AWG). Maximum torque for all terminals is 0.9 – 1.13 N-m (8 – 10 lb-in.).

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

![TB3 Terminal Designations L4E, L5E, and L6E Only](image-url)
Figure 1.4
Input Mode Selection and Typical TB3 Connections

[Input Mode] 1
Factory Default

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

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

ATTENTION: The JOG function will not operate properly unless a SCN port option is connected to the drive. At least one of the following 1201-HAP, 1201-HA1, 1201-HA2, 1336-GM1, 1356-EN, 1356-QM1, 1356-QM1-A1, 1356-GM1. Applies to 1305 with firmware FRN 2.01 or earlier 1336 PLUS with Language Module 1336S-EN firmware FRN 1.05 or earlier.

The JOG function will not operate properly unless a SCANport option is connected to the drive. To assure proper JOG function, install at least one of the following: 1201-HAP, 1201-HA1, 1201-HA2, 1336-GM1, 1356-EN, 1356-QM1, 1356-QM1-A1, 1356-GM1. Applies to 1305 with firmware FRN 2.01 or earlier 1336 PLUS with Language Module 1336S-EN firmware FRN 1.05 or earlier.

1 See Table 1.B.
2 Drive must be stopped to take Local Control. Control by all other adapters is disabled (except Stop).
3 These inputs must be present before drive will start.
Chapter 1
Control Logic Wiring and HIM Fundamentals

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

<table>
<thead>
<tr>
<th>Mode</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reverse</td>
<td>Reverse</td>
<td>Digital Pot Up</td>
<td>Reverse</td>
<td>1st Accel</td>
</tr>
<tr>
<td></td>
<td>Forward</td>
<td>Forward</td>
<td>Digital Pot Dn</td>
<td>Forward</td>
<td>2nd Accel</td>
</tr>
<tr>
<td></td>
<td>Jog</td>
<td>Speed Select 3¹</td>
<td>Speed Select 3¹</td>
<td>1st Accel</td>
<td>Decel</td>
</tr>
<tr>
<td></td>
<td>Speed Select 2¹</td>
<td>Speed Select 2¹</td>
<td>Speed Select 2¹</td>
<td>Digital Pot Up</td>
<td>2nd Decel</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Mode</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Local Control²</td>
<td>Stop Type</td>
<td>2nd Accel</td>
<td>Digital Pot Up</td>
<td>Local Control²</td>
</tr>
<tr>
<td></td>
<td>Speed Select 3¹</td>
<td>Speed Select 3¹</td>
<td>2nd Decel</td>
<td>Digital Pot Dn</td>
<td>Stop Type</td>
</tr>
</tbody>
</table>

1 See Table 1.B.
2 Drive must be stopped to take Local Control. Control by all other adapters is disabled (except Stop).
3 These inputs must be present before drive will start.
The following table defines the input state of the Speed Select inputs for a desired frequency source.

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

<table>
<thead>
<tr>
<th>Speed Select 3</th>
<th>Speed Select 2</th>
<th>Speed Select 1</th>
<th>Frequency Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>O</td>
<td>O</td>
<td>[Freq Select 1]</td>
</tr>
<tr>
<td>O</td>
<td>O</td>
<td>X</td>
<td>[Freq Select 2]</td>
</tr>
<tr>
<td>O</td>
<td>X</td>
<td>O</td>
<td>[Preset Freq 2]</td>
</tr>
<tr>
<td>O</td>
<td>X</td>
<td>X</td>
<td>[Preset Freq 3]</td>
</tr>
<tr>
<td>X</td>
<td>O</td>
<td>O</td>
<td>[Preset Freq 4]</td>
</tr>
<tr>
<td>X</td>
<td>O</td>
<td>X</td>
<td>[Preset Freq 5]</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>O</td>
<td>[Preset Freq 6]</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
<td>[Preset Freq 7]</td>
</tr>
</tbody>
</table>

O = Open  
X = Closed

**Human Interface Module (HIM)**

**Description**

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

**IMPORTANT:** The operation of HIM functions depends upon drive parameter settings. Default parameter values allow full HIM functionality.
Figure 1.5
Human Interface Module

Figure 1.6
Adapter Locations
Module Removal

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

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

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

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

HIM Operation

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

Figure 1.7
Status Display

Stopped
+0.00 Hz
Troubleshooting and Error Codes

Chapter Objectives

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

Troubleshooting

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

**IMPORTANT:** All printed circuit boards are referenced to “common” per the schematic diagrams.

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

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

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

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

- Set the Speed Reference to minimum.
- Select the proper motor-rotation direction.
- Disconnect the motor from its mechanical load.
ATTENTION: This assembly contains parts and sub-assemblies that are sensitive to electrostatic discharge. Static control precautions are required when servicing this assembly. Component damage may result if you ignore electrostatic discharge control procedures. If you are not familiar with static control procedures, reference Allen-Bradley Publication 8000–4.5.2, Guarding Against Electrostatic Discharge, or any other applicable ESD protection handbook.

Electrostatic Discharge Precautions

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

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

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

![Overvolt Fault F 5](image)

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

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

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

Contact Description

During normal operating conditions (no faults present, drive running) the CR3 fault contacts at TB2–13 & 14 are open, and the contacts at TB2–14 & 15 are closed. When a fault occurs, the state of these contacts changes.
## Table 2.A
1336 PLUS Fault Descriptions

<table>
<thead>
<tr>
<th>Name &amp; Fault #</th>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Adptr Freq Err</strong> 65</td>
<td>The SCANport adapter that was the selected frequency reference sent a frequency greater than 32767 to the drive.</td>
<td>Correct the problem that is causing the SCANport adapter to send the illegal frequency reference to the drive.</td>
</tr>
<tr>
<td><strong>Auxiliary Fault</strong> 02</td>
<td>The auxiliary input interlock is open.</td>
<td>If Control Interface option is installed, check connections at TB3-24. If option is not installed, set [Input Mode] to “1”.</td>
</tr>
<tr>
<td><strong>BGND 10ms Over</strong> 51</td>
<td>Microprocessor loop fault. Occurs if the 10ms background task hasn’t been run in 15 ms.</td>
<td>Replace Main Control Board or complete drive as required.</td>
</tr>
<tr>
<td><strong>Blwn Fuse Flt</strong> 58</td>
<td>If the difference between the commanded voltage and the measured voltage is greater than 1/8 of rated voltage for 0.5 seconds, then a fault will be issued indicating that the bus fuse in 30 kW (40 HP) and up drives has blown.</td>
<td>Locate cause, replace Fuse.</td>
</tr>
<tr>
<td><strong>Diag C Lim Flt</strong> 36</td>
<td>The drive output current has exceeded the hardware current limit and the [Cur Lim Trip En] parameter was enabled.</td>
<td>Check programming of [Cur Lim Trip En] parameter. Check for excess load, improper DC boost setting, DC brake volts set too high or other causes of excess current.</td>
</tr>
<tr>
<td><strong>Drive Fault Reset</strong> 22</td>
<td>Power-up has been attempted with an Open Stop contact or Closed Start contact.</td>
<td>Check/verify wiring and contact operation.</td>
</tr>
<tr>
<td><strong>Drive -&gt; HIM</strong></td>
<td>Error 1 – The checksum read from the EEPROM does not match the checksum calculated from the EEPROM data.</td>
<td>Repeat operation. Replace HIM.</td>
</tr>
<tr>
<td><strong>EE Init Read</strong> 53</td>
<td>1. Gate Driver Board replacement (requires re-initialization). 2. Trouble reading EEPROM during initialization.</td>
<td>1. Reset to factory defaults &amp; cycle input power. 2. Check all connections to the Power/Driver Board. Replace the board or complete drive as needed.</td>
</tr>
<tr>
<td><strong>EE Init Value</strong> 54</td>
<td>Stored parameter value is out of range on initialization.</td>
<td>1. Reset to factory defaults &amp; cycle input power. 2. Check all connections to the Power/Driver Board. Replace the board or complete drive as needed.</td>
</tr>
<tr>
<td><strong>EEprom Checksum</strong> 66</td>
<td>The checksum read from the EEPROM does not match the checksum calculated from the EEPROM data.</td>
<td>1. Reset to factory defaults &amp; cycle input power. 2. Check all wire and cable connections to the Power/Driver Board. Replace the Power/Driver Board or complete drive as required.</td>
</tr>
<tr>
<td><strong>EEprom Fault</strong> 32</td>
<td>EEPROM is being programmed and will not write a new value.</td>
<td>Check all wire and cable connections to the Main Control Board. Replace Main Control Board or complete drive as required.</td>
</tr>
<tr>
<td><strong>FGND 10ms Over</strong> 52</td>
<td>Microprocessor loop fault. Occurs if a 10ms interrupt is pending before the current interrupt is complete.</td>
<td>Replace Main Control Board or complete drive as required.</td>
</tr>
<tr>
<td><strong>Ground Fault</strong> 13</td>
<td>A current path to earth ground in excess of 100A has been detected at one or more of the drive output terminals. NOTE: If ground current exceeds 220% of drive rated current, “Overcurrent Flt” may occur instead of Ground Fault.</td>
<td>Check the motor and external wiring to the drive output terminals for a grounded condition.</td>
</tr>
<tr>
<td>Name &amp; Fault #</td>
<td>Description</td>
<td>Action</td>
</tr>
<tr>
<td>----------------</td>
<td>-------------</td>
<td>--------</td>
</tr>
<tr>
<td>Ground Warning 57</td>
<td>A current path to earth ground in excess of 2A has been detected at one or more of the drive output terminals. See [Ground Warning].</td>
<td>Check the motor and external wiring to the drive output terminals for a grounded condition.</td>
</tr>
<tr>
<td>Hertz Err Fault 29</td>
<td>This fault indicates that there is not a valid operating frequency. It can be caused by any of the following: 1. [Maximum Freq] is less than [Minimum Freq]. 2. Skip frequencies and skip bandwidth eliminate all operating frequencies. 3. 4–20mA input signal speed reference has been lost and [4–20mA Loss Sel] is set for “Stop-Fault.”</td>
<td>1. Check [Minimum Freq] and [Maximum Freq] parameters. 2. Check [Skip Freq 1], [Skip Freq 2], [Skip Freq 3] and [Skip Freq Band] parameters. 3. Check for broken wires, loose connections or transducer loss at 4–20mA input, TB2.</td>
</tr>
<tr>
<td>Hertz Sel Fault 30</td>
<td>A frequency select parameter has been programmed with an out of range value.</td>
<td>Reprogram [Freq Select 1] and/or [Freq Select 2] with a correct value. If problem persists, replace Main Control Board or complete drive.</td>
</tr>
</tbody>
</table>
| HIM → Drive | Error 1 – The checksum read from the EEPROM does not match the checksum calculated from the EEPROM data.  
Error 2 – Number of parameters in saved profile does not equal master.  
Error 3 – Download was attempted to a different type drive (i.e. 1336 → 1305).  
Error 4 – Saved data not correct for new drive.  
Error 5 – Drive is running while attempting download. | Retry download. Replace HIM.  
Retry download. Replace HIM.  
Download can only take place with same type drive.  
Capabilities of drive different than master drive.  
Reprogram param.  
Stop drive, then perform download. |
<p>| Loop Overrn Flt 23 | An overrun of the 2.5ms control loop has occurred. | Check all connections to the Power/Driver Board. Replace the board or complete drive as required. |
| Max Retries Fault 33 | Drive unsuccessfully attempted to reset a fault and resume running for the programmed number of [Reset/Run Tries]. | Check fault buffer for fault code requiring reset. Correct the cause of the fault and manually clear by pressing the local Stop key or cycling the TB3 Stop input. |
| Motor Mode Flt 24 | A fault has been detected originating from the Control Board. | Check all connections to the Control Board. Replace the board, Language Module, or complete drive as required. |
| Motor Stall Fault 06 | Current remained over 150% for more than 4 seconds. | If the motor is drawing excessive current (over 150%), the motor load is excessive and will not allow the drive to accelerate to set speed. A longer accel time or a reduced load may be required. |</p>
<table>
<thead>
<tr>
<th>Name &amp; Fault #</th>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Neg Slope Fault 35</strong></td>
<td>Drive software detected a portion of the volts/hertz curve with a negative slope.</td>
<td>Check drive programming: 1. [Maximum Voltage] parameter must be greater than [Base Voltage]. 2. [Maximum Freq] parameter must be greater than [Base Frequency]. 3. [Base Voltage] parameter must be greater than [Start Boost]. 4. If the [DC Boost Select] parameter is set to “Custom” [Base Voltage] must be greater than [Break Voltage] and [Break Voltage] must be greater than [Start Boost].</td>
</tr>
<tr>
<td><strong>Open Pot Fault 09</strong></td>
<td>An external pot is connected and the common side of the pot is open. The drive generates this fault when the voltage between TB2-2 and TB2-3 exceeds 3.9V DC.</td>
<td>Check the external potentiometer circuit at TB2, terminals 1, 2 and 3 for an open circuit.</td>
</tr>
<tr>
<td><strong>Op Error Fault 11</strong></td>
<td>A SCANport™ device requests a Read or Write of a data type not supported. This will also occur if: 1. [Motor Type] is set to “Sync PM” and [Stop Mode Used] is set to “DC Brake”, or 2. [Motor Type] is set to “Sync Reluc” or “Sync PM” and [Speed Control] is set to “Slip Comp”.</td>
<td>Check programming.</td>
</tr>
<tr>
<td><strong>Overcurrent Flt 12</strong></td>
<td>Overcurrent is detected in overcurrent hardware trip circuit.</td>
<td>Check for a short circuit at the drive output or excessive load conditions at the motor.</td>
</tr>
<tr>
<td><strong>Overload Fault 07</strong></td>
<td>Internal electronic overload trip.</td>
<td>An excessive motor load exists. It must be reduced such that drive output current does not exceed the current set by the [Overload Amps] parameter.</td>
</tr>
<tr>
<td><strong>Overtemp Fault 08</strong></td>
<td>Heat sink temperature exceeds a predefined value of 90°C (195°F).</td>
<td>Check for blocked or dirty heat sink fins. Check that the ambient temperature has not exceeded 40°C (104°F). Check fan. Check thermistor. Thermistor should register 100kΩ at room temperature.</td>
</tr>
<tr>
<td><strong>Overvolt Fault 05</strong></td>
<td>DC bus voltage exceeded maximum value.</td>
<td>Monitor the AC line for high line voltage or transient conditions. Bus overvoltage can also be caused by motor regeneration. Extend the decel time or install dynamic brake option.</td>
</tr>
<tr>
<td><strong>Phase U Fault 38</strong></td>
<td>A phase to ground fault has been detected between the drive and motor in this phase.</td>
<td>Check the wiring between the drive and motor. Check motor for grounded phase.</td>
</tr>
<tr>
<td><strong>Phase V Fault 39</strong></td>
<td>A phase to ground fault has been detected between the drive and motor in this phase.</td>
<td>Check the wiring between the drive and motor. Check motor for grounded phase.</td>
</tr>
<tr>
<td><strong>Phase W Fault 40</strong></td>
<td>A phase to ground fault has been detected between the drive and motor in this phase.</td>
<td>Check the wiring between the drive and motor. Check motor for grounded phase.</td>
</tr>
<tr>
<td><strong>P Jump Err Flt 37</strong></td>
<td>Reserved for future use.</td>
<td></td>
</tr>
</tbody>
</table>
## Table 2.A (continued)
### 1336 PLUS Fault Descriptions

<table>
<thead>
<tr>
<th>Name &amp; Fault #</th>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pole Calc Fault 50</td>
<td>Generated if the calculated value of [Motor Poles] is less than 2 or greater than 32.</td>
<td>Check [Motor NP RPM] and [Motor NP Hertz] programming.</td>
</tr>
<tr>
<td>Power Loss Fault 03</td>
<td>DC bus voltage remained below 85% of nominal for longer than 0.500ms. [Line Loss Fault] parameter is set to “enabled.”</td>
<td>Monitor the incoming AC line for low voltage or line power interruption.</td>
</tr>
<tr>
<td>Power Mode Fault 26</td>
<td>The internal power mode variable received an incorrect value.</td>
<td>Check all connections to the Control Board. Replace the board, Language Module, or complete drive as required.</td>
</tr>
<tr>
<td>Power Overload 64</td>
<td>The drive rating of 150% for 1 minute has been exceeded.</td>
<td>Reduce load.</td>
</tr>
<tr>
<td>Power Test Flt 46</td>
<td>The internal power mode variable received an incorrect value.</td>
<td>Check all connections to the Power/Driver Board. Replace the board or complete drive as required.</td>
</tr>
<tr>
<td>Precharge Fault 19</td>
<td>Occurs if precharge device is open 20ms after the end of a line loss condition or if the bus charging alarm remains on for 20 seconds (precharge did not complete).</td>
<td>All larger frames – Check the precharge circuit. Replace the input SCRs, SCR Firing Board, Power Driver Board or complete drive as needed.</td>
</tr>
<tr>
<td>Precharge Open 56</td>
<td>The precharge circuit was commanded to close, but was detected to be open.</td>
<td>All larger frames – Check the precharge circuit. Replace the input SCRs, SCR Firing Board, Power Driver Board or complete drive as needed.</td>
</tr>
<tr>
<td>Reprogram Fault 48</td>
<td>The drive was commanded to write default values to EEPROM.</td>
<td>1. Clear the fault or cycle power to the drive. 2. Program the drive parameters as needed. <strong>Important:</strong> If [Input Mode] has been changed from its original value, power must be cycled before the new value will take affect.</td>
</tr>
<tr>
<td>ROM or RAM Flt 68</td>
<td>Internal power-up ROM or RAM tests have not executed properly.</td>
<td>Check Language Module. Replace Control Board or complete drive as required.</td>
</tr>
<tr>
<td>Run Boost Fault 34</td>
<td>An attempt has been made to set the [Run Boost] parameter to a value greater than the [Start Boost] parameter.</td>
<td>Verify that parameter has been programmed correctly.</td>
</tr>
<tr>
<td>Serial Fault 10</td>
<td>A SCANport adapter has been disconnected and the [Logic Mask] bit for that adapter is set to “1.”</td>
<td>1. If no adapter was intentionally disconnected, check wiring to the SCANport adapters. Replace wiring, SCANport expander, SCANport adapters, Main Control Board or complete drive as required. 2. If an adapter was intentionally disconnected and the [Logic Mask] bit for that adapter is set to “1”, this fault will occur. To guard against this fault occurring, set the [Logic Mask] bit for the adapter to “0.”</td>
</tr>
<tr>
<td>Shear Pin Fault 63</td>
<td>Programmed [Current Limit] amps has been exceeded and [Shear Pin Fault] is enabled.</td>
<td>Check load requirements and [Current Limit] setting.</td>
</tr>
<tr>
<td>Name &amp; Fault #</td>
<td>Description</td>
<td>Action</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Temp Sense Open</td>
<td>Heat sink thermistor is open or malfunctioning.</td>
<td>Check thermistor and connections.</td>
</tr>
<tr>
<td>55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undervolt Fault</td>
<td>DC Bus voltage fell below the minimum value (388V DC at 460V AC input).  [Line Loss Fault] and [Low Bus Fault] set to “enabled.”</td>
<td>Monitor the incoming AC line for low voltage or line power interruption.</td>
</tr>
<tr>
<td>04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UV Short Fault</td>
<td>Excessive current has been detected between these two output terminals.</td>
<td>Check the motor and external wiring to the drive output terminals for a shorted condition.</td>
</tr>
<tr>
<td>41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UW Short Fault</td>
<td>Excessive current has been detected between these two output terminals.</td>
<td>Check the motor and external wiring to the drive output terminals for a shorted condition.</td>
</tr>
<tr>
<td>42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VW Short Fault</td>
<td>Excessive current has been detected between these two output terminals.</td>
<td>Check the motor and external wiring to the drive output terminals for a shorted condition.</td>
</tr>
<tr>
<td>43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xsistr Desat Flt</td>
<td>One or more of the output transistors were operating in the active region instead of desaturation. This can be caused by excessive transistor current or insufficient base drive voltage.</td>
<td>Check for damaged output transistors. Replace output transistors, Power Driver Board or complete drive as needed.</td>
</tr>
<tr>
<td>47</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 2.B
Fault Code Cross Reference

<table>
<thead>
<tr>
<th>Fault #</th>
<th>Display Name</th>
<th>Reset/Run</th>
</tr>
</thead>
<tbody>
<tr>
<td>02</td>
<td>Auxiliary Fault</td>
<td>Yes</td>
</tr>
<tr>
<td>03</td>
<td>Power Loss Fault</td>
<td>Yes</td>
</tr>
<tr>
<td>04</td>
<td>Undervolt Fault</td>
<td>Yes</td>
</tr>
<tr>
<td>05</td>
<td>Overtvolt Fault</td>
<td>Yes</td>
</tr>
<tr>
<td>06</td>
<td>Motor Stall Fault</td>
<td>Yes</td>
</tr>
<tr>
<td>07</td>
<td>Overload Fault</td>
<td>Yes</td>
</tr>
<tr>
<td>08</td>
<td>Overtemp Fault</td>
<td>Yes</td>
</tr>
<tr>
<td>09</td>
<td>Open Pot Fault</td>
<td>No</td>
</tr>
<tr>
<td>10</td>
<td>Serial Fault</td>
<td>No</td>
</tr>
<tr>
<td>11</td>
<td>Op Error Fault</td>
<td>No</td>
</tr>
<tr>
<td>12</td>
<td>Overcurrent Fit</td>
<td>Yes</td>
</tr>
<tr>
<td>13</td>
<td>Ground Fault</td>
<td>No</td>
</tr>
<tr>
<td>19</td>
<td>Precharge Fault</td>
<td>No</td>
</tr>
<tr>
<td>22</td>
<td>Drive Fault Reset</td>
<td>Yes</td>
</tr>
<tr>
<td>23</td>
<td>Loop Overrn Fit</td>
<td>Yes</td>
</tr>
<tr>
<td>24</td>
<td>Motor Mode Fit</td>
<td>Yes</td>
</tr>
<tr>
<td>26</td>
<td>Power Mode Fault</td>
<td>Yes</td>
</tr>
<tr>
<td>28</td>
<td>Timeout Fault</td>
<td>No</td>
</tr>
<tr>
<td>29</td>
<td>Hertz Err Fault</td>
<td>No</td>
</tr>
<tr>
<td>30</td>
<td>Hertz Set Fault</td>
<td>No</td>
</tr>
<tr>
<td>31</td>
<td>Timeout Fault</td>
<td>No</td>
</tr>
<tr>
<td>32</td>
<td>EEPROM Fault</td>
<td>No</td>
</tr>
<tr>
<td>33</td>
<td>Max Retries Fault</td>
<td>No</td>
</tr>
<tr>
<td>34</td>
<td>Run Boost Fault</td>
<td>No</td>
</tr>
<tr>
<td>35</td>
<td>Neg Slope Fault</td>
<td>No</td>
</tr>
<tr>
<td>Fault #</td>
<td>Display Name</td>
<td>Reset/Run</td>
</tr>
<tr>
<td>--------</td>
<td>----------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>36</td>
<td>Diag C Lim Flt</td>
<td>No</td>
</tr>
<tr>
<td>37</td>
<td>P Jump Err Flt</td>
<td>No</td>
</tr>
<tr>
<td>38</td>
<td>Phase U Fault</td>
<td>No</td>
</tr>
<tr>
<td>39</td>
<td>Phase V Fault</td>
<td>No</td>
</tr>
<tr>
<td>40</td>
<td>Phase W Fault</td>
<td>No</td>
</tr>
<tr>
<td>41</td>
<td>UV Short Fault</td>
<td>No</td>
</tr>
<tr>
<td>42</td>
<td>UW Short Fault</td>
<td>No</td>
</tr>
<tr>
<td>43</td>
<td>VW Short Fault</td>
<td>No</td>
</tr>
<tr>
<td>46</td>
<td>Power Test Flt</td>
<td>No</td>
</tr>
<tr>
<td>47</td>
<td>Xsistr Desat Flt</td>
<td>No</td>
</tr>
<tr>
<td>48</td>
<td>Reprogram Fault</td>
<td>No</td>
</tr>
<tr>
<td>50</td>
<td>Pole Calc Fault</td>
<td>No</td>
</tr>
<tr>
<td>51</td>
<td>BGND 10ms Over</td>
<td>Yes</td>
</tr>
<tr>
<td>52</td>
<td>FGND 10ms Over</td>
<td>Yes</td>
</tr>
<tr>
<td>53</td>
<td>EE Init Read</td>
<td>No</td>
</tr>
<tr>
<td>54</td>
<td>EE Init Value</td>
<td>No</td>
</tr>
<tr>
<td>55</td>
<td>Temp Sense Open</td>
<td>No</td>
</tr>
<tr>
<td>56</td>
<td>Precharge Open</td>
<td>No</td>
</tr>
<tr>
<td>57</td>
<td>Ground Warning</td>
<td>No</td>
</tr>
<tr>
<td>58</td>
<td>Blwn Fuse Flt</td>
<td>No</td>
</tr>
<tr>
<td>63</td>
<td>Shear Pin Fault</td>
<td>No</td>
</tr>
<tr>
<td>64</td>
<td>Power Overload</td>
<td>No</td>
</tr>
<tr>
<td>65</td>
<td>Adptr Freq Err</td>
<td>No</td>
</tr>
<tr>
<td>66</td>
<td>EEprom Checksum</td>
<td>No</td>
</tr>
<tr>
<td>68</td>
<td>ROM or RAM Flt</td>
<td>No</td>
</tr>
</tbody>
</table>
Diagnostic Procedures by Symptom

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

**Drive Will Not Start**

- **Drive will not start.**
  - **Display on HIM?**
    - **Yes**
      - **HIM displays “Auxiliary Fault”?**
        - **Yes**
          - Drive equipped with L Option?
            - **Yes**
              - Auxiliary Input True?
                - **Yes**
                  - Correct Auxiliary Circuit and clear fault.
                - **No**
                  - Replace L Option or Main Control Board.
            - **No**
              - Replace L Option or Main Control Board.
        - **No**
          - Drive equipped with L Option?
            - **Yes**
              - Auxiliary Input True?
                - **Yes**
                  - Correct Auxiliary Circuit and clear fault.
                - **No**
                  - Add a jumper to J7 between pins 3 and 4 or replace Main Control Board as needed.
            - **No**
              - Enable Input True?
                - **Yes**
                  - Correct Enable Circuit.
                - **No**
                  - Add a jumper to J7 between pins 3 and 4 or replace Main Control Board as needed.
      - **No**
        - HIM displays “Not Enabled”?
          - **Yes**
            - Drive equipped with L Option?
              - **Yes**
                - Enable Input True?
                  - **Yes**
                    - Correct Enable Circuit.
                  - **No**
                    - Add a jumper to J7 between pins 3 and 4 or replace Main Control Board as needed.
                - **No**
                  - Refer to: “Drive Stays at Zero Hertz When Started”.
          - **No**
            - Follow instructions given in Table 2.A.
      - **No**
        - HIM displays “Stopped”? 
          - **Yes**
            - Are any bits in [Stop Owner] set to “1”? 
              - **Yes**
                - Find and correct source of STOP command.
              - **No**
                - Correct Start Input circuit or replace Main Control Board as needed.
          - **No**
            - Does [Start Owner] show a bit set to “1” when START commanded?
              - **Yes**
                - Correct Start Input circuit or replace Main Control Board as needed.
              - **No**
                - Replace Main Control Board.

- **End of troubleshooting.**
Chapter 2
Troubleshooting and Error Codes

No Display

No HIM display.

Is the HIM backlight lit? Yes

Is the drive's fan running? Yes

HIM connected properly? Yes

Replace HIM, Main Control Board, or Gate Driver Board as needed.

No HIM display.

Is the HIM backlight lit? Yes

Is the drive's fan running? Yes

HIM connected properly? Yes

Replace HIM, Main Control Board, or Gate Driver Board as needed.

Voltage present at TB1-R, -S, -T? No

Is the fuse blown on the Gate Driver Board? Yes

Replace the fuse, Gate Driver Board, or complete drive as needed.

No

Is the fuse blown on the Gate Driver Board? No

DC bus voltage present? Yes

Replace Gate Driver Board.

No

Replace the Diode Bridge and any other damaged components.
**Drive Will Not Jog**

Local Human Interface Module used to control drive.

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

1. **Drive will not Jog.**
2. **Is drive running?**
   - Yes → **Drive must be stopped before attempting to Jog.**
   - No → **Will drive run if commanded to Start?**
     - Yes → **Is the [Jog Mask] bit for the adapter being used set to 1?**
       - Yes → **Is the Jog Input true when Jog is commanded?**
         - Yes → **Replace the Adapter, L Option, or Main Control Board.**
         - No → **External wiring problem.**
       - No → **Does a [Jog Owner] bit go to 1 when Jog is commanded?**
         - Yes → **Set the [Jog Mask] bit for the adapter being used to 1.**
         - No → **HIM displays “Stopped” when Jog is commanded?**
           - Yes → **Drive running at incorrect frequency?**
             - Yes → **Replace Main Control Board.**
             - No → **Replace Main Control Board.**
           - No → **Is a [Stop Owner] bit set to 1?**
             - Yes → **Find and correct the source of the Stop command.**
             - No → **Change Logic Mask bit to 1.**
           - No → **Replace Main Control Board.**
         - No → **Is Logic Mask bit set to 0?**
           - Yes → **Change Logic Mask bit to 1.**
           - No → **Replace Main Control Board.**
Drive Stays at Zero Hertz When Started

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

1. Drive stays at Zero Hertz when Started.
   - [Drive Status] Running Bit (Bit 1) = 1?
     - Yes
     - HIM displays “At Speed” or [Drive Status] At Speed Bit (Bit 8) = 1?
       - Yes
       - [Command Freq] greater than zero?
         - Yes
         - Replace Main Control Board, Gate Driver Board, or drive as needed.
         - No
         - [Drive Alarm] Motor Limit or Regen Limit Bits (Bits 2 & 3) = 1?
           - Yes
           - Correct excessive motor load condition.
           - No
           - No
         - Is [Freq Source] correct?
           - Yes
           - Is [Input Mode] set to a mode with L Option TB3 Speed Select inputs?
             - Yes
             - SCANport adapter has selected an incorrect reference. Correct the problem with, or replace, the SCANport adapter.
             - No
             - SCNo
           - No
           - Check state of Speed Select inputs on TB3. Check programming of [Reference Mask] and [Input Mode].
     - No
     - Refer to “Drive Will Not Start”.
   - No
   - [Drive Status] Running Bit (Bit 1) = 1?
     - No
     - [Command Freq] greater than zero?
       - Yes
       - Replace Main Control Board, Gate Driver Board, or drive as needed.
       - No
       - Is the frequency reference input to the drive at zero?
         - Yes
         - Correct problem with frequency reference.
         - No
         - Replace Main Control Board or complete drive as needed.
   - No
**Drive Goes to Max Frequency**

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

- Drive goes to [Maximum Freq].
  - Is [Command Freq] = [Maximum Freq]?
    - Yes: Drive is correctly following Freq Reference
      - Yes: Is Scanport Adapter or L Option set to select the correct reference?
        - No: Correct the Speed Select inputs.
        - Yes: Reprogram the Skip Frequency function.
    - No: [Freq Source] correct?
      - Yes: Skip Frequency function interfering with reference?
        - Yes: Reprogram the Skip Frequency function.
        - No: [Freq source] = Adapter 1–6?
          - Yes: Replace the Adapter providing the reference.
          - No: [Freq source] = Preset 1–7?
            - Yes: Is the Preset used programmed to [Maximum Freq]?
              - Yes: Reprogram to correct value.
              - No: Does the metering parameter for the frequency reference equal [Maximum Freq]?
                - Yes: Input signal at TB2 normal?
                  - Yes: [Analog Invert] correct?
                    - No: Reprogram [Analog Invert].
                    - Yes: Correct input signal problem.
                  - No: Correct input signal problem.
                  - Yes: Replace Main Control Board.
                - No: Input signal at TB2 normal?
                  - Yes: [Analog Invert] correct?
                    - No: Reprogram [Analog Invert].
                    - Yes: Correct input signal problem.
                - No: Replace Main Control Board.
        - No: Replace Main Control Board.
      - No: Replace Main Control Board.
  - No: Replace Main Control Board.

**Clearing Faults**

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

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

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Disassembly and Access Procedures

Chapter Objectives

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

Disassembly and Access Overview

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

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

Electrostatic Discharge Precautions

**ATTENTION:** This assembly contains parts and sub-assemblies that are sensitive to electrostatic discharge. Static control precautions are required when servicing this assembly. Component damage may result if you ignore electrostatic discharge control procedures. If you are not familiar with static control procedures, reference Allen-Bradley Publication 8000–4.5.2, Guarding Against Electrostatic Discharge, or any other applicable ESD protection handbook.
Electrostatic discharge generated by static electricity can damage the complimentary metallic oxide semiconductor devices on various drive boards. It is recommended that you perform these procedures to guard against this type of damage when circuit boards are removed or installed:

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

Tools

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

- Pliers
- Phillips screwdrivers (small, medium, and large)
- Standard screwdrivers (small, medium, and large)
- 25/64-inch or 10 mm socket
- 7/16-inch or 11 mm socket
- 33/64-inch or 13 mm deep-well socket
- 5/16-inch or 8 mm open-end wrench
- Torque wrench, metered in lb-in. or N-m
- Nylon tie wraps

Fastener Torque Specifications

Torque Sequence

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

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

The following illustrates temporary and final tightening sequences for components fastened to a heat sink using two, four, and six screws. Temporary torque is 1/3 (33%) of final torque, except six-point mountings, which require 0.5 N-m (4 lb-in.). The numeric illustration labels are for your assistance. Drive components do not carry these labels.
Figure 3.1  
Two-Point Mounting

Figure 3.2  
Four-Point Mounting

Figure 3.3  
Six-Point Mounting

Note: Do not exceed 0.5 Newton-meters (4 lb-in.) on initial torque of all six screws.

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, four-point and six-point components to the heat sink.
<table>
<thead>
<tr>
<th>Component</th>
<th>Fastener Application</th>
<th>Torque (lb-in.)</th>
<th>Torque (N-m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan Motor</td>
<td>Motor to Fan Cover Assembly</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>Fan Cover Assembly</td>
<td>Assembly to chassis</td>
<td>26</td>
<td>3</td>
</tr>
<tr>
<td>Fan Transformer</td>
<td>Transformer to chassis</td>
<td>26</td>
<td>3</td>
</tr>
<tr>
<td>Fan Capacitor</td>
<td>Capacitor to chassis</td>
<td></td>
<td>Hand-tighten</td>
</tr>
<tr>
<td>MOV Surge Suppressor</td>
<td>MOV to chassis</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>Snubber Resistor</td>
<td>Resistor to heat sink</td>
<td>26</td>
<td>3</td>
</tr>
<tr>
<td>Snubber Resistor</td>
<td>Wires to Capacitor Bus Bar Assembly</td>
<td>50</td>
<td>6</td>
</tr>
<tr>
<td>Snubber Bracket</td>
<td>Bracket to Power Module</td>
<td>80</td>
<td>9</td>
</tr>
<tr>
<td>Snubber Board</td>
<td>Board to Brackets</td>
<td>50</td>
<td>6</td>
</tr>
<tr>
<td>Snubber Board</td>
<td>Board to Input Rectifier</td>
<td>50</td>
<td>6</td>
</tr>
<tr>
<td>Volt Sharing Resistor</td>
<td>Resistor to heat sink</td>
<td>26</td>
<td>3</td>
</tr>
<tr>
<td>Volt Sharing Resistor</td>
<td>Wires to Capacitor Bus Bar Assembly</td>
<td>50</td>
<td>6</td>
</tr>
<tr>
<td>Thermistor</td>
<td>Thermistor to heatsink</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>Bus Capacitor Holder</td>
<td>Holder to Bus Capacitors</td>
<td>26</td>
<td>3</td>
</tr>
<tr>
<td>Capacitor Bus Bar Assembly</td>
<td>Assembly to Bus Capacitors</td>
<td>50</td>
<td>6</td>
</tr>
<tr>
<td>Power Module Gate Interface Board</td>
<td>Board to Power Modules</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>Power Module Bus Bar</td>
<td>Bus Bar to Power Modules</td>
<td>80</td>
<td>9</td>
</tr>
<tr>
<td>Power Module</td>
<td>Module to heat sink</td>
<td></td>
<td>Refer to Figure 3.3</td>
</tr>
<tr>
<td>DIN Rail (TB1)</td>
<td>Rail to chassis</td>
<td>50</td>
<td>6</td>
</tr>
<tr>
<td>PE Shortening Bar</td>
<td>Bar to TB1</td>
<td>80</td>
<td>9</td>
</tr>
<tr>
<td>Input Rectifier</td>
<td>Rectifier to heat sink</td>
<td>50</td>
<td>6</td>
</tr>
<tr>
<td>Transitional Bus Bar Assembly</td>
<td>Assembly to Power Module Bus Bar Assembly</td>
<td>80</td>
<td>9</td>
</tr>
<tr>
<td>Bus Fuse F1</td>
<td>Fuse to Transitional Bus Bar Assembly</td>
<td>80</td>
<td>9</td>
</tr>
<tr>
<td>DC Bus Inductor L1</td>
<td>Inductor to chassis</td>
<td>50</td>
<td>6</td>
</tr>
<tr>
<td>Bus Bar Cable Adaptor</td>
<td>Adaptor to Transitional Bus Bar Assembly and DC Bus Inductor</td>
<td>80</td>
<td>9</td>
</tr>
<tr>
<td>Converter Bus and Motor Bus Bars</td>
<td>Bus Bars to all connections</td>
<td>80</td>
<td>9</td>
</tr>
<tr>
<td>Wires (PE)</td>
<td>Wires to Ground Stud</td>
<td>80</td>
<td>9</td>
</tr>
<tr>
<td>Wires</td>
<td>Wires to TB1</td>
<td>80</td>
<td>9</td>
</tr>
<tr>
<td>Wire (TE)</td>
<td>Wire to TB1</td>
<td>50</td>
<td>6</td>
</tr>
<tr>
<td>Wires</td>
<td>Wires to TB2</td>
<td>7</td>
<td>0.8</td>
</tr>
<tr>
<td>Wires</td>
<td>Wires to TB3</td>
<td>8 – 10</td>
<td>0.9 – 1.1</td>
</tr>
<tr>
<td>LEM Mounting Plate</td>
<td>Mounting Plate to LEM Clamping Plate</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>LEM Clamping Plate</td>
<td>Clamping Plate to Bus Bar</td>
<td>26</td>
<td>3</td>
</tr>
<tr>
<td>Power Cables</td>
<td>Cables to terminals</td>
<td>80</td>
<td>9</td>
</tr>
<tr>
<td>Main Control, Gate Driver, Precharge Board Mounting Plates</td>
<td>Plates to chassis</td>
<td>26</td>
<td>3</td>
</tr>
<tr>
<td>High Voltage Guard</td>
<td>Guard to chassis</td>
<td>26</td>
<td>3</td>
</tr>
</tbody>
</table>
Disassembly and Access Procedures

Removing the Drive Enclosure

Figure 3.4
Drive Enclosure

- Latches
- 8-Pin HIM Connector (Behind Cover)
- Ground Stud (Behind Cover)
- Hinges
Removal

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

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

1. Remove power from the drive.
2. Turn the Enclosure Cover latches, located on the right side of the cover, 90 degrees clockwise.
3. Open the cover.
4. Check for zero volts at TB1 terminals +DC and –DC, and for absence of control voltage, before proceeding with tests or part replacement.
5. Remove the 8-pin HIM connector from the HIM holder and the ground wire from the ground stud on the inside cover. Disconnect the HIM cable and the ground wire from the clips inside the cover.
6. Pull the cover up toward the top of the drive to disengage the cover from the hinges.
7. Remove the Enclosure top and bottom panels.
8. Remove the Enclosure side panels.

**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 the High Voltage Guard

The High Voltage Guard is a clear plastic guard covering the LEMs, Bus Capacitor Bank, and DC Bus Inductor.

Figure 3.5
High Voltage Guard
Removal

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

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

1. Remove power from the drive.
2. Remove the Enclosure cover if the drive has an enclosure. Refer to Removing the Drive Enclosure in this chapter.
3. Check for zero volts at TB1 terminals +DC and –DC, and for absence of control voltage, before proceeding with tests or part replacement.
4. Remove the screws fastening the High Voltage Guard to the standoffs.
5. Lift the guard upward to disengage the tabs on the right side from the bus bar supports.
6. Pull the guard away from the drive.

Installation

Install the High Voltage Guard in reverse order of removal. Refer to Table 3.A – Fastener Torque Specifications.

**ATTENTION:** Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.
Removing Control Interface Board MOD–L4, –L5, or –L6

Figure 3.6
Control Interface Board

Main Control Board

Control Interface Board

Terminal Strip TB3
Removal

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

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

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

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

Installation

Install the Control Interface Board in reverse order of removal.

**ATTENTION:** Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.
Removing the Main Control Board Mounting Plate

**Figure 3.7**
Main Control Board Mounting Plate

**Removal**

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

**ATTENTION:** Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.
**IMPORTANT:** Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Remove the Enclosure cover if the drive has an enclosure. Refer to Removing the Drive Enclosure in this chapter.
3. Check for zero volts at TB1 terminals +DC and –DC and absence of control voltage.
4. Disconnect the following from the Main Control Board:
   - J1 connector
   - J2 ribbon cable connector
   - J8 connector
   - The 8-pin connector from the HIM Mounting Plate on the Main Control Board.
   - Ground wires from terminal strip TE.
   - Chassis ground wire at the top-right corner of the Main Control Board Mounting Plate.
5. Slide the LEM harness out of the clip located at the top-left of the Main Control Board.
6. Remove the two screws fastening the bottom of the Main Control Board Mounting Plate to the standoffs.
7. Remove the nuts fastening the top of the Main Control Board Mounting Plate to the Gate Driver Board Mounting Plate.
8. Lift the Main Control Board Mounting Plate out of the drive.

**Installation**

Install the Main Control Board Mounting Plate in reverse order of removal. Refer to Table 3.A – Fastener Torque Specifications.

---

**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

**Removal**

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

**ATTENTION:** Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.
**IMPORTANT:** Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the Drive.
2. Remove the Enclosure cover if the drive has an enclosure. Refer to Removing the Drive Enclosure in this chapter.
3. Check for zero volts at TB1 Terminals +DC and –DC, and for absence of control voltage.
4. Remove all wires from Terminal Strip TB3 if a Control Interface Board is used.
5. Disconnect the following from the Main Control Board:
   - J1 connector
   - J2 ribbon cable connector
   - J6 connector
   - J8 connector
   - The 8-pin connector from the HIM Mounting Plate on the Main Control Board.
   - Ground wire at stake-on connector J10
   - All wires from the terminals on TB2
6. Remove the five screws fastening the Main Control Board to the mounting plate.
7. Slide the Main Control Board toward the top of the drive to release it from the slide-mount stand-offs.
8. Lift the Main Control Board away from the mounting plate.

**Installation**
Install the Main Control Board in reverse order of removal.

**ATTENTION:** Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.
Removing The Gate Driver Board Mounting Plate

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

**ATTENTION:** Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.
IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.

2. Remove the Enclosure if the drive has an Enclosure. Refer to Removing the Drive Enclosure in this chapter.

3. Check for zero volts at TB1 terminals +DC and –DC, and for absence of control voltage.

4. Remove the Main Control Board Mounting Plate. Refer to Removing the Main Control Board Mounting Plate in this chapter.

5. Disconnect the following from the Gate Driver Board:
   - J2 connector
   - J6 connector
   - J7 connector
   - J8 connector
   - J9 connector
   - J10 connector
   - J13 connector
   - Ground wire from the top of the Gate Driver Board Mounting Plate.

6. Remove the screws fastening the bottom of the Gate Driver Board Mounting Plate to the chassis.

7. Slide the plate toward the top of the drive to disengage the mounting plate tabs from the slots on the chassis.

**Installation**

Install the Gate Driver Board Mounting Plate in reverse order of removal. Refer to Table 3.A – Fastener Torque Specifications.

---

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

---

**ATTENTION:** Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.
Removing the Gate Driver Board from the Mounting Plate

**Removal**

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

**ATTENTION:** Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.
**IMPORTANT:** Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.

2. Remove the Enclosure if the drive has an Enclosure. Refer to Removing the Drive Enclosure in this chapter.

3. Check for zero volts at TB1 terminals +DC and –DC, and for absence of control voltage.

4. Remove the Main Control Board Mounting Plate. Refer to Removing the Main Control Board Mounting Plate in this chapter.

5. Disconnect the following from the Gate Driver Board:
   - J2 connector
   - J6 connector
   - J7 connector
   - J8 connector
   - J9 connector
   - J10 connector
   - J13 connector
   - TB6 High Voltage Aux. Input
   - Ground wire from the top of the Gate Driver Board Mounting Plate.

6. Turn the eight standoff screws, fastening the Gate Driver Board to the Mounting Plate, 1/4 turn counterclockwise.

7. Pull the Gate Driver Board away from the Mounting Plate.

**Installation**

Install the Gate Driver Board in reverse order of removal.

---

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

---

**ATTENTION:** Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.
Removing the Precharge Board Mounting Plate

**Figure 3.11**
Precharge Board Mounting Plate

**Removal**

---

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

---

**ATTENTION:** Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.
**IMPORTANT:** Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Remove the Enclosure if the drive has an Enclosure. Refer to Removing the Drive Enclosure in this chapter.
3. Check for zero volts at TB1 terminals +DC and –DC, and for absence of control voltage.
4. Remove the High Voltage guard.
5. Disconnect the following from the Precharge Board:
   - J1 connector
   - J2 connector
   - J3 connector
   - J4 connector
   - Ground wire from the stud at the bottom left of the mounting plate.
6. Remove the screws fastening the top of the Mounting Plate to the chassis.
7. Slide the Mounting Plate toward the bottom of the drive to disengage the tabs from the slots in the chassis.
8. Pull the Precharge Board Mounting Plate out of the enclosure.

**Installation**

Install the Precharge Board Mounting Plate in reverse order of removal. Refer to Table 3.A – Fastener Torque Specifications.

---

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

**ATTENTION:** Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.
Removing the Precharge Board from the Mounting Plate

Figure 3.12
Precharge Board

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

ATTENTION: Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.
**IMPORTANT:** Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Remove the Enclosure if the drive has an Enclosure. Refer to Removing the Drive Enclosure in this chapter.
3. Check for zero volts at TB1 terminals +DC and –DC, and for absence of control voltage.
4. Remove the High Voltage Guard.
5. Disconnect the following from the Precharge Board:
   - J1 connector
   - J2 connector
   - J3 connector
   - J4 connector
6. Pull the Precharge Board guard away from the four guard supports.
7. Turn the six standoff screws, fastening the Precharge Board to the Mounting Plate, 1/4 turn counterclockwise.
8. Pull the Precharge Board away from the Mounting Plate.

**Installation**
Install the Precharge Board in reverse order of removal.

---

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

---

**ATTENTION:** Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.
Removing a Power Module Snubber Board

The Power Module Snubber Boards are located under the Motor Bus Bars and LEMs.

**Figure 3.13**
Power Module Snubber Board

**Removal**

**ATTENTION:** Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.
ATTENTION: Hazard of electric shock exists. Up to 1,600 VDC will be on J1 if the Snubber Resistor is open. Measure for zero (0) VDC from Snubber Board terminal TP3 to plus (+) bus before removing connector J1. Use a resistor greater than 1 ohm and less than 100 ohm, rated for 25 watts minimum, between TP3 and plus (+) bus to discharge any voltage.

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

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

1. Remove power from the drive.
2. Remove the Enclosure if the drive has an Enclosure. Refer to Removing the Drive Enclosure in this chapter.
3. Check for zero volts at TB1 terminals +DC and –DC, and for absence of control voltage.
4. Remove the High Voltage Guard. Refer to Removing the High Voltage Guard in this chapter.
5. Remove the Main Control Board Mounting Plate. Refer to Removing the Main Control Board Mounting Plate in this chapter.
6. Remove the Gate Driver Mounting Plate. Refer to Removing the Gate Driver Board Mounting Plate in this chapter.
7. Remove the Precharge Board Mounting Plate. Refer to Removing the Precharge Board Mounting Plate in this chapter.
8. Remove the wires from the connectors on the LEMs.
9. Remove the Motor Bus Bars. LEMs are attached to two of these bars.
11. Slide the notches in the Motor Bus Bars away from the slots in the Motor Bus Bar Support to remove the Motor Bus Bars from the Drive.
12. Remove the Snubber Resistor wire from the Power Module Snubber Board stake-on connector J1.
13. Remove the screws fastening the Power Module Snubber Board to the Snubber Bracket to remove the Snubber Boards.

14. Check Snubber Resistor with VOM. The reading should be 8 ohms. If open, replace Resistor.

**Installation**

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

Install the Snubber Board in reverse order of removal. Refer to Table 3.A – Fastener Torque Specifications.

**IMPORTANT:** Install washers on TB1 terminals with the serrated side up.

**ATTENTION:** Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.
Removing an Input Rectifier Snubber Board

The Input Rectifier Snubber Boards are located under the Gate Driver Board Mounting Plate.

**Figure 3.14**
Input Rectifier Snubber Board

**Removal**

---

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

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

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

1. Remove power from the drive.
2. Remove the Enclosure if the drive has an Enclosure. Refer to Removing the Drive Enclosure in this chapter.
3. Check for zero volts at TB1 terminals +DC and –DC, and for absence of control voltage.
4. Remove the Main Control Board Mounting Plate. Refer to Removing the Main Control Board Mounting Plate in this chapter.
5. Remove the Gate Driver Board Mounting Plate. Refer to Removing the Gate Driver Board Mounting Plate in this chapter.
6. Remove the wire from Input Rectifier Snubber Board stake-on connector J1.
7. Remove the two screws fastening the Snubber Board to the Converter Snubber “Z” bracket.

Installation
Install the Snubber Board in reverse order of removal. Refer to Table 3.A – Fastener Torque Specifications.

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

Accessing Power Plane Components
To access the power plane components located on the chassis, refer to Removing a Power Module Snubber Board in this chapter.
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Component Test Procedures

Chapter Objectives

The following tests help you troubleshoot B150–B250 and C150–C250, and CX300 drives.

Component Test Overview

In some cases, different tests troubleshoot components of the same name. These similar tests vary according to the rating of the drive being tested. Verify that the rating on the drive matches the rating for the test you are performing. The procedures in this chapter assume that the drive you are servicing either has no enclosure or that the enclosure is removed from the drive. For more information on removing the Drive Enclosure, refer to Chapter 3 – Disassembly and Access Procedures, Removing the Drive Enclosure.

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

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

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

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

Tools

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

- Pliers
- Phillips screwdrivers (medium and large)
- Standard screwdrivers (small, medium, and large)
- 25/64-inch or 10 mm socket
- 7/16-inch or 11 mm socket
- 33/64-inch or 13 mm deep-well socket
- 5/16-inch or 8 mm open-end wrench
- Torque wrench, metered in lb-in. or N-m
- Nylon tie wraps
Test 1
Testing the Gate Driver Board

The Gate Driver Board is located between the Main Control Board and the Main Chassis. If modules have been replaced, you must test the Gate Driver Board.

**Figure 4.1**
Gate Driver Board Test

**ATTENTION:** Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and −DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.
IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.

2. Check for zero volts at TB1 terminals +DC and –DC, and for absence of control voltage.

3. Remove the Main Control Board Mounting Plate. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Main Control Board Mounting Plate.

4. Unplug the connectors from the Gate Driver Board.

5. Set your meter to test resistance.

6. Test Fuses F1 and F3 for an open condition. Replace the Gate Driver Board if either fuse shows an open condition.

7. Set your meter to test diodes.

8. Test VR1 – VR6. The following table shows meter connections at the components and ideal meter readings for those connections. Refer to the former illustration for component locations.

<table>
<thead>
<tr>
<th>Component</th>
<th>Meter (+) Lead</th>
<th>Meter (–) Lead</th>
<th>Nominal Meter Reading*</th>
</tr>
</thead>
<tbody>
<tr>
<td>VR1</td>
<td>+</td>
<td>–</td>
<td>1.06</td>
</tr>
<tr>
<td></td>
<td>–</td>
<td>+</td>
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<tr>
<td>VR2</td>
<td>+</td>
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<td>1.8</td>
</tr>
<tr>
<td>VR3</td>
<td>+</td>
<td>–</td>
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</tr>
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<td></td>
<td>–</td>
<td>+</td>
<td>1.8</td>
</tr>
<tr>
<td>VR4</td>
<td>+</td>
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<tr>
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<tr>
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<td>1.06</td>
</tr>
<tr>
<td></td>
<td>–</td>
<td>+</td>
<td>1.8</td>
</tr>
</tbody>
</table>

Note: Typical malfunction is shorted in both directions.

* Meter Used: Fluke® Model 87, set to “Diode” range.

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

ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.
If modules have been replaced, you must check the Power Module Snubber Board and the Precharge Board. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board and Removing the Precharge Board Mounting Plate.

**Figure 4.2**
Precharge Board Test

**ATTENTION:** Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.
IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

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

ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.
The Power Modules are located near the top of the heat sink. If modules have been replaced, you must check the Power Module Snubber Board. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board.

**ATTENTION:** Hazard of electric shock exists. Up to 1,600 VDC will be on J1 if the Snubber Resistor is open. Measure for zero (0) VDC from Snubber Board terminal TP3 to plus (+) bus before removing connector J1. Use a resistor greater than 1 ohm and less than 100 ohm, rated for 25 watts minimum, between TP3 and plus (+) bus to discharge any voltage. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board.
ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

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

1. Remove power from the drive.
2. Check for zero volts at TB1 terminals +DC and –DC, and for absence of control voltage.
3. Remove the Main Control Board Mounting Plate. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Main Control Board Mounting Plate.
4. Remove the Gate Driver/Precharge Board Mounting Plate. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Gate Driver/Precharge Board Mounting Plate.
5. Remove the Power Module Snubber Boards. Refer to Chapter 3 Disassembly and Access Procedures, Removing a Power Module Snubber Board.
6. Test the Power Module Snubber Resistor. The Power Module Snubber Resistor will read 8.0 ohm with meter on resistance. Refer to Figure 4.4.
7. Set your meter to test diodes.

8. Test the Power Modules. The following table shows meter connections and ideal meter readings for those connections. Refer to Figure 4.3 for meter connection locations.

<table>
<thead>
<tr>
<th>Meter (+) Lead</th>
<th>Meter (–) Lead</th>
<th>Nominal Meter Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>C</td>
<td>0.318</td>
</tr>
<tr>
<td>E</td>
<td>G</td>
<td>Infinite</td>
</tr>
<tr>
<td>C</td>
<td>E</td>
<td>Infinite</td>
</tr>
<tr>
<td>C</td>
<td>G</td>
<td>Infinite</td>
</tr>
<tr>
<td>G</td>
<td>E</td>
<td>Infinite</td>
</tr>
<tr>
<td>G</td>
<td>C</td>
<td>Infinite</td>
</tr>
</tbody>
</table>

9. Replace a Power Module if meter readings are not as shown. Refer to Chapter 5 – Part Replacement Procedures, Power Modules.

10. If one or more Power Modules is replaced, test the Gate Driver Board. Refer to Testing the Gate Driver Board in this chapter.

**ATTENTION:** Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.
Test 4
Testing the Bus Capacitors

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

ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.
**IMPORTANT:** Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

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

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

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

<table>
<thead>
<tr>
<th>Drive Rating</th>
<th>Input Volts</th>
<th>Meter Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>200</td>
<td>280V DC ±10%</td>
</tr>
<tr>
<td></td>
<td>230</td>
<td>322V DC ±10%</td>
</tr>
<tr>
<td></td>
<td>240</td>
<td>336V DC ±10%</td>
</tr>
<tr>
<td>B</td>
<td>380</td>
<td>535V DC ±10%</td>
</tr>
<tr>
<td></td>
<td>415</td>
<td>580V DC ±10%</td>
</tr>
<tr>
<td></td>
<td>480</td>
<td>650V DC ±10%</td>
</tr>
<tr>
<td>C</td>
<td>500</td>
<td>700V DC ±10%</td>
</tr>
<tr>
<td></td>
<td>575</td>
<td>800V DC ±10%</td>
</tr>
<tr>
<td></td>
<td>600</td>
<td>850V DC ±10%</td>
</tr>
</tbody>
</table>
6. If the voltage is out of tolerance, check the following:
   • An open condition at an Input Rectifier.
   • A voltage drop due to Bus Inductor L1 resistance.
   • A voltage drop between an Input Rectifier and the bus capacitors due to loose or resistive wires or connections.
   • Precharge circuit problems.

7. If the above check does not reveal a problem, replace the Bus Capacitor Bank and Load-Sharing Resistors. Refer to Chapter 5 – Part Replacement Procedures, Bus Capacitor Bank.

---

ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.
Test 5
Testing the Input Rectifiers

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

ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.
IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.

2. Check for zero volts at TB1 terminals +DC and –DC, and for absence of control voltage.

3. Remove the Main Control Board and Mounting Plate. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Main Control Board Mounting Plate.

4. Remove the Gate Driver/Precharge Board Mounting Plate. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Gate Driver/Precharge Board Mounting Plate.

5. Remove the Input Rectifier Snubber Board. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Input Rectifier Snubber Board.

6. Set your meter to test diodes.

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

<table>
<thead>
<tr>
<th>Meter (+) Lead</th>
<th>Meter (–) Lead</th>
<th>Nominal Meter Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>AK</td>
<td>K</td>
<td>Infinite</td>
</tr>
<tr>
<td>AK</td>
<td>A</td>
<td>Infinite</td>
</tr>
<tr>
<td>K</td>
<td>A</td>
<td>Infinite</td>
</tr>
<tr>
<td>K</td>
<td>AK</td>
<td>Infinite</td>
</tr>
<tr>
<td>A</td>
<td>AK</td>
<td>Infinite</td>
</tr>
<tr>
<td>A</td>
<td>K</td>
<td>Infinite</td>
</tr>
<tr>
<td>G1</td>
<td>K1</td>
<td>0.011</td>
</tr>
<tr>
<td>K1</td>
<td>G1</td>
<td>0.011</td>
</tr>
<tr>
<td>G2</td>
<td>K2</td>
<td>0.011</td>
</tr>
<tr>
<td>K2</td>
<td>G2</td>
<td>0.011</td>
</tr>
</tbody>
</table>

8. Replace the Input Rectifier if any meter readings are not as shown. Refer to Chapter 5 – Part Replacement Procedures, Input Rectifiers.

9. If the Input Rectifier shorted, check the Power Modules for damage. Refer to Testing the Power Modules in this chapter.
Part Replacement Procedures

Chapter Objective

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

Part Replacement Overview

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

Safety Precautions

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

Electrostatic Discharge Precautions

ATTENTION: This assembly contains parts and sub-assemblies that are sensitive to electrostatic discharge. Static control precautions are required when servicing this assembly. Component damage may result if you ignore electrostatic discharge control procedures. If you are not familiar with static control procedures, reference Allen-Bradley Publication 8000–4.5.2, Guarding Against Electrostatic Discharge, or any other applicable ESD protection handbook.
Electrostatic discharge generated by static electricity can damage the complimentary metallic oxide semiconductor devices on various drive boards. It is recommended that you perform these procedures to guard against this type of damage when circuit boards are removed or installed:

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

**Tools**

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

- Pliers
- Phillips screwdrivers (small, medium, and large)
- Standard screwdrivers (small, medium, and large)
- 25/64-inch or 10 mm socket
- 7/16-inch or 11 mm socket
- 33/64-inch or 13 mm deep-well socket
- 5/16-inch or 8 mm open-end wrench
- Torque wrench, metered in lb-in. or N-m
- Nylon tie wraps
This section explains in detail how to replace the following drive components:

- Bus Capacitor Bank
- Thermistor
- Power Modules
- Input Rectifiers
- Fan and Transformer Assembly
- DC Bus Inductor L1
- Ground Sense CT
- Bus Fuse F1
- LEMs
- MOV Surge Suppressor

For Gate Driver/Precharge Board, Main Control Board, Snubber Boards, and Control Interface Board installation and removal procedures, refer to Chapter 3.
Allen-Bradley Adjustable Frequency AC Drives are modular by design to enhance troubleshooting and spare parts replacement, thereby helping reduce production down-time. The following illustration calls out the main components of a typical drive. Component designs vary slightly among the different drive ratings, but component locations are identical.
Bus Capacitor Bank

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

Figure 5.2
Bus Capacitor Bank
Removal

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

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

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

Access the Main Chassis:
1. Remove power from the drive.
2. Check for zero volts at TB1 terminals +DC and –DC, and for absence of control voltage.
3. Remove the High Voltage Guard from the drive. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the High Voltage Guard.
4. Remove the Main Control Board Mounting Plate. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Main Control Board Mounting Plate.
5. Remove the Gate Driver. Refer to Removing the Gate Driver Board Mounting Plate in this chapter.
6. Remove the Precharge Board Mounting Plates. Refer to Removing the Precharge Board Mounting Plate in this chapter.

Access the Bus Capacitor Bank:
1. Remove the screws fastening the Transitional Bus Bar Assembly to the Power Module Bus Bars, DC Bus Inductor, and Capacitor Bus Bar Assembly.
2. Remove the Bus Fuse. Refer to Bus Fuse F1 in this chapter.
3. Slide the Transitional Bus Bar Assembly to the left to remove it from the drive.
4. Remove the screws fastening the wires to the Capacitor Bus Bar Assembly.
5. Remove the nuts fastening the Capacitor Bus Bar Assembly to the Bus Capacitors.

6. Remove the Capacitor Bus Bar Assembly from the drive.

7. Remove the screws fastening the Bus Capacitor Holder to the chassis. Remove the Capacitor Holder and the two Cover Support Brackets at the top of the Bus Capacitor Holder from the drive.

8. Remove the Bus Capacitors from the Drive.

**Installation**


**IMPORTANT:** Orient the notch and vent hole on the Bus Capacitors to the top of the drive.

2. Connect the Load-Sharing Resistors to the Bus Capacitors according to the following diagram. Refer to the schematic diagrams in this manual for more information on component configurations.

**IMPORTANT:** Check the Load-Sharing Resistors for an open condition and replace any open resistors.

**IMPORTANT:** If the drive is equipped with PEM nuts on the Cap Bus bar, use them instead of capacitor studs to make the electrical connection.

---

**Figure 5.3**

Load-Sharing Resistor Connections to Bus Capacitors

---

**ATTENTION:** Capacitors not installed correctly will explode or vent and could cause injury and equipment damage. Observe correct polarities.
**Thermistor**

The Thermistor is located on the heat sink at the top-middle of the drive.

![Thermistor Diagram](AB0458A)

**Figure 5.4** Thermistor

**Removal**

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

**ATTENTION:** Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.
IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Check for zero volts at TB1 terminals +DC and –DC, and for absence of control voltage.
3. Remove the screws fastening the High Voltage Guard from the drive. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the High Voltage Guard.
4. Disconnect the Thermistor connector at J1 on the Main Control Board.
5. Unscrew the Thermistor from the heat sink.

Installation

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

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

The Power Modules are located near the top of the heat sink. If one or more Power Modules is replaced, you must check the Power Module Snubber Board and the Precharge Board. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Precharge Board Mounting Plate.

Figure 5.5
Power Modules

[Diagram of Power Modules with labels: Preform, Power Module, Power Module Interface Board, Screw (3), Screw (6), Snubber Standoffs, Power Module Bus Bar, Screw (4)]
Removal

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

**ATTENTION:** Hazard of electric shock exists. Up to 1,600 VDC will be on J1 if the Snubber Resistor is open. Measure for zero (0) VDC from Snubber Board terminal TP3 to plus (+) bus before removing connector J1. Use a resistor greater than 1 ohm and less than 100 ohm, rated for 25 watts minimum, between TP3 and plus (+) bus to discharge any voltage. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board.

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

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

1. Remove power from the drive.
2. Check for zero volts at TB1 terminals +DC and –DC, and for absence of control voltage.
3. Remove the High Voltage Guard from the drive. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the High Voltage Guard.
4. Remove the Main Control Board Mounting Plate. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Main Control Board Mounting Plate.
5. Remove the Gate Driver. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Gate Driver Board Mounting Plate.
6. Remove the Precharge Board Mounting Plates. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Precharge Board Mounting Plate.

8. Remove the screws fastening the Snubber Standoffs to the Power Module Bus Bar to remove the standoffs.

9. Remove the screws fastening the Power Module Bus Bar to the Power Modules and the Transitional Bus Bar Assembly. Slide the Power Module Bus Bar toward the right side of the drive to remove.

10. Remove the wiring harness from Power Module Gate Interface Board Connector J1. Remove the screws fastening the Power Module Gate Interface Boards to the Power Modules. Remove the Power Module Gate Interface Boards.

11. Remove the screws fastening the Power Modules to the heat sink.

**Installation**

1. Clean all surfaces between the Power Module and the heat sink using a soft, clean cloth.

2. Replace the Preform between the Power Module and the heat sink.


---

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

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

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

Figure 5.6
Input Rectifiers

Removal

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

**ATTENTION:** Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.
IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Check for zero volts at TB1 terminals +DC and –DC, and for absence of control voltage.
3. Remove the High Voltage Guard from the drive. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the High Voltage Guard.
4. Remove the Main Control Board Mounting Plate. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Main Control Board Mounting Plate.
5. Remove the Gate Driver Board Mounting Plate. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Gate Driver Board Mounting Plate.
7. Remove the screws fastening the Input Rectifier Standoffs to the rectifiers.
8. Remove the screws fastening the Positive and Negative Converter Bars to the DC Bus Inductor.
9. Remove the TB1 Input Bus Bars and the Precharge Board Wiring Harnesses from the Rectifiers.
10. Remove the screws fastening the Input Rectifiers to the heat sink.

**Installation**

1. Clean all surfaces between the Input Rectifier and the heat sink using a soft, clean cloth.
2. Replace the Preform between the Input Rectifier and the heat sink.

IMPORTANT: Install washers on TB1 terminals with the serrated side up.

---

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

The Fan is located in the chassis and under TB1 at the bottom of the heat sink. The Fan Transformer and Fan Capacitor are located in the bottom left corner of the chassis.

Removal

**ATTENTION:** Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.
ATTENTION: Hazard of electric shock exists. Up to 1,600 VDC will be on J1 if the Snubber Resistor is open. Measure for zero (0) VDC from Snubber Board terminal TP3 to plus (+) bus before removing connector J1. Use a resistor greater than 1 ohm and less than 100 ohm, rated for 25 watts minimum, between TP3 and plus (+) bus to discharge any voltage. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board.

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

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

Access the Main Chassis:

1. Remove power from the drive.
2. Check for zero volts at TB1 terminals +DC and –DC, and check for absence of control voltage.
3. Remove the High Voltage Guard from the drive. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the High Voltage Guard.
4. Remove the Main Control Board Mounting Plate. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Main Control Board Mounting Plate.
5. Remove the Gate Driver. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Gate Driver Board Mounting Plate.
6. Remove the Precharge Board Mounting Plates. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Precharge Board Mounting Plate.
8. Remove all wires from PE, TE, MOV and Fan Transformer at TB1.
9. Remove the TB1 Input Bus Bars from the Input Rectifiers.
10. Remove the Bus PE Bracket from TB1 PE partitions.
Remove TB1 and Mounting Rail:
1. Loosen the screws on the Terminal End Stops on each end of the TB1 Mounting Rail.
2. Slide the left End Stop off the TB1 Mounting Rail.
3. Remove the screw fastening the left side of the Mounting Rail to the chassis.
4. Slide the right End Stop off the TB1 Mounting Rail.
5. Slide the first partition toward the right end of the rail.
6. Remove the screw fastening the right side of the Mounting Rail to the chassis.
7. Slide the two PE partitions apart and toward opposite ends of the TB1 Mounting Rail.
8. Remove the screw fastening the Mounting Rail to the chassis.
9. Remove the TB1 Mounting Rail and the Label Plate.

Access the Fan:
1. Disconnect the Fan wiring harness.
2. Remove the screws fastening the Fan Cover to the chassis.
3. Pull the Fan Cover assembly away from the Drive.
4. Remove the screws fastening the Fan to the Fan Cover to remove the Fan.
5. Disconnect the Fan Capacitor from the Fan Wiring Harness.
6. Unscrew the Fan Capacitor from the chassis by hand.
7. Disconnect the Fan Transformer from the Fan Wiring Harness and from TB1.
8. Remove the screws fastening the Fan Transformer to the chassis.
Installation
Install the Fan Assembly in reverse order of removal, with the following exceptions:

- Thread the Fan wiring connector through the hole in the Fan Cover.
- Refer to Chapter 3 – Disassembly and Access Procedures, Fastener Torque Specifications.
- Install the Fan Capacitor to the chassis with M8 split washer and hand tighten.
- Connect the Fan Transformer red wire to TB1 terminal S-L2 and the black wire to TB1 terminal R-L1.

**IMPORTANT:** Install washers on TB1 terminals with the serrated side up.

---

**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 lower left corner of the drive.

Removal

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

**ATTENTION:** Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.
IMPORTANT: Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Check for zero volts at TB1 terminals +DC and –DC, and check for absence of control voltage.
3. Remove the screws fastening the High Voltage Guard from the drive. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the High Voltage Guard.
4. Remove the Gate Driver Board Mounting Plate. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the Gate Driver Board Mounting Plate.
5. Remove the Fuse and TB1 cables from the DC Bus Inductor.
6. Remove the screws fastening the DC Bus Inductor to the Transitional Bus Bar Assembly.
7. Remove the Positive and Negative Converter Bars. Refer to Input Rectifiers in this chapter.
8. Remove the screws fastening the Bus Bar Cable Adaptors to the DC Bus Inductor terminals.
9. Remove screws fastening the DC Bus Inductor to the chassis.

IMPORTANT: Note the position and orientation of the Ground Sense CT (CT3) around the (–)Bus terminal at the top of the Bus inductor. This CT will come off when the inductor is removed. Re-install the CT in the same position, and make sure the (+)Bus cable to the fuse passes through the Ground Sense CT during assembly.

10. Remove the Bus Inductor from the Drive.

Installation
Install DC Bus Inductor L1 in reverse order of removal. Refer to Chapter 3 – Disassembly and Access Procedures, Fastener Torque Specifications.

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

The Ground Sense CT is located between DC Bus Inductor L1 and the Transitional Bus Bar Assembly.

Figure 5.9
Ground Sense CT

Removal

**ATTENTION:** Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and −DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.
ATTENTION: Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.

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

1. Remove power from the drive.
2. Check for zero volts at TB1 terminals +DC and –DC, and check for absence of control voltage.
3. Remove the screws fastening the High Voltage Guard from the drive. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the High Voltage Guard.
4. Disconnect the Ground Sense CT from Gate Driver Board connector J2.
5. Remove the screws from the wire passing through Ground Sense CT. One screw is located at Bus Fuse F1, and one at the DC Bus Inductor.
6. Remove the screws fastening the bottom of Bus Fuse F1 to the Capacitor Bus Bar Assembly.
7. Remove the screws fastening the Transitional Bus Bar Assembly to the Power Module Bus Bars, DC Bus Inductor, and Capacitor Bus Bar Assembly.
8. Slide the Transitional Bus Bar Assembly to the left to remove it from the Drive.

Installation
Install the Ground Sense CT in reverse order of removal, inserting the wire, connecting Bus Fuse F1 to DC Bus Inductor, through the center of the Ground Sense CT. Refer to Chapter 3 – Disassembly and Access Procedures, Fastener Torque Specifications.

ATTENTION: A possible short-circuit hazard exists. Position the fuse-to-inductor wire with the shrink-wrapped end of the wire connected to the Bus Inductor. Failure to position the wire as illustrated may result in serious injury or equipment damage.

ATTENTION: Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.
Bus Fuse F1

The Bus Fuse is located on the Transitional 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. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.

**ATTENTION:** Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.
**IMPORTANT:** Before you remove connections and wires from the drive components, mark the connections and wires to correspond with their component connections and terminals to prevent incorrect wiring during assembly.

1. Remove power from the drive.
2. Check for zero volts at TB1 terminals +DC and –DC, and check for absence of control voltage.
3. Remove the screws fastening the High Voltage Guard from the drive. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the High Voltage Guard.
4. Remove the screws fastening the Bus Fuse to the drive.

**Installation**

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

---

**ATTENTION:** Replace all guards before applying power to the drive. Failure to replace guards may result in death or serious injury.
ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and –DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.
ATTENTION: Hazard of electric shock exists. Up to 1,600 VDC will be on J1 if the Snubber Resistor is open. Measure for zero (0) VDC from Snubber Board terminal TP3 to plus (+) bus before removing connector J1. Use a resistor greater than 1 ohm and less than 100 ohm, rated for 25 watts minimum, between TP3 and plus (+) bus to discharge any voltage. Refer to Chapter 3 – Disassembly and Access Procedures, Removing a Power Module Snubber Board.

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

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

1. Remove power from the drive.
2. Check for zero volts at TB1 terminals +DC and –DC, and check for absence of control voltage.
3. Remove the screws fastening the High Voltage Guard from the drive. Refer to Chapter 3 – Disassembly and Access Procedures, Removing the High Voltage Guard.
4. Remove the wires from the connectors on the LEMs.
5. Remove the screws fastening the LEM Motor Bus Bars to the Output Motor Bus Bars.
6. Remove the two screws and the Clamping Plate holding the LEM Mounting Clamp around the Motor Bus Bar.
7. Pull the LEMs away from the Mounting Plates.

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

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

The MOV Surge Suppressor is located in the bottom-left corner of the Drive near the Fan Transformer and Fan Capacitor. The MOV protects the drive from high voltage surges above approximately 1,000 volts. Replace it if it is burned, expanded, or ruptured after such events as a lightening strike, or inadvertent connection of the drive input to a voltage source substantially above nameplate voltage.

Figure 5.12
MOV Surge Suppressor

Removal

ATTENTION: Disconnect and lock out power from the drive before disassembling the drive. Failure to disconnect power may result in death or serious injury. Verify bus voltage by measuring the voltage between +DC and −DC on Terminal Block TB1. Do not attempt to service the drive until the bus voltage has discharged to zero volts.
ATTENTION: Wear a wrist-type grounding strap when servicing 1336 PLUS Drives. Failure to protect drive components against ESD may damage drive components. Refer to Electrostatic Discharge Precautions at the beginning of this chapter.

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

1. Remove power from the drive.
2. Check for zero volts at TB1 terminals +DC and –DC, and check for absence of control voltage.
3. Remove the nut fastening the MOV Surge Suppressor ground wire to the ground stud on the chassis.
4. Remove the MOV Surge Suppressor wires from TB1 terminals R-L1, S-L2, and T-L3.
5. Remove the screw fastening the MOV Surge Suppressor to the chassis.
6. Remove the MOV Surge Suppressor from the Drive.

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

IMPORTANT: Install washers on TB1 terminals with the serrated side up.

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

Chapter Objectives

This chapter illustrates and lists replacement parts for the 1336 PLUS Drives rated B150 – B250, C150 – C250, and CX300, and describes replacement parts ordering procedures.

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

Ordering Replacement Parts

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

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

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

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

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

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

Figure 6.1
Parts for B150 – B250, C150 – C250, and CX300 Drives
<table>
<thead>
<tr>
<th>Callout</th>
<th>Symbol</th>
<th>Description</th>
<th>Location</th>
<th>Replacement Procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Q1 – Q6</td>
<td>Transistor (Power Module)</td>
<td>Heat Sink</td>
<td>Chapter 5, Power Modules</td>
</tr>
<tr>
<td>2</td>
<td>A23 – A28</td>
<td>Power Module Gate Interface Board</td>
<td>Power Module</td>
<td>Chapter 5, Power Modules</td>
</tr>
<tr>
<td>3</td>
<td>R20 – R22</td>
<td>Power Module Snubber Resistor</td>
<td>Heat Sink</td>
<td>Chapter 3, Removing a Power Module Snubber Board</td>
</tr>
<tr>
<td>4</td>
<td>NTC1</td>
<td>Thermistor</td>
<td>Heat Sink</td>
<td>Chapter 5, Thermistor</td>
</tr>
<tr>
<td>5</td>
<td>SCR1 – SCR3</td>
<td>Input Rectifier</td>
<td>Heat Sink</td>
<td>Chapter 5, Input Rectifiers</td>
</tr>
<tr>
<td>6</td>
<td>A20 – A22</td>
<td>Power Module Bus Bar and Snubber Board</td>
<td>Power Module</td>
<td>Chapter 3, Removing a Power Module Snubber Board</td>
</tr>
<tr>
<td>7</td>
<td>R1 – R3</td>
<td>Load-Sharing Resistor</td>
<td>Heat Sink</td>
<td>Chapter 5, Bus Capacitor Bank</td>
</tr>
<tr>
<td>8</td>
<td>CT1, CT2</td>
<td>LEM</td>
<td>Bus Bar</td>
<td>Chapter 5, LEMs</td>
</tr>
<tr>
<td>9</td>
<td>A11 – A13</td>
<td>Input Rectifier Snubber Board</td>
<td>Input Rectifier</td>
<td>Chapter 3, Removing the Input Rectifier Snubber Board</td>
</tr>
<tr>
<td>10</td>
<td>A1</td>
<td>Gate Driver Board</td>
<td>Gate Driver/Precharge Board Mounting Plate</td>
<td>Chapter 3, Removing the Gate Driver Board</td>
</tr>
<tr>
<td>11</td>
<td>MAIN CONTROL BOARD</td>
<td>Main Control Board</td>
<td>Main Control Board Mounting Plate</td>
<td>Chapter 3, Removing the Main Control Board from the Mounting Plate</td>
</tr>
<tr>
<td>12</td>
<td>HIM</td>
<td>Human Interface Module</td>
<td>Enclosure Cover</td>
<td>Chapter 1, Module Removal</td>
</tr>
<tr>
<td>13</td>
<td>A10</td>
<td>Precharge Board</td>
<td>Gate Driver/Precharge Board Mounting Plate</td>
<td>Chapter 3, Removing the Precharge Board</td>
</tr>
<tr>
<td>14</td>
<td>FAN</td>
<td>Fan</td>
<td>Main Chassis</td>
<td>Chapter 5, Fan and Transformer</td>
</tr>
<tr>
<td>15</td>
<td>MOV1</td>
<td>MOV Surge Suppressor</td>
<td>Main Chassis</td>
<td>Chapter 5, Fan and Transformer</td>
</tr>
<tr>
<td>16</td>
<td>T1</td>
<td>Fan Transformer</td>
<td>Main Chassis</td>
<td>Chapter 3, Removing the Input Rectifier Snubber Board</td>
</tr>
<tr>
<td>17</td>
<td>C-HB1</td>
<td>Fan Capacitor</td>
<td>Main Chassis</td>
<td>Chapter 5, Fan and Transformer</td>
</tr>
<tr>
<td>18</td>
<td>L1</td>
<td>DC Bus Inductor</td>
<td>Main Chassis</td>
<td>Chapter 5, DC Bus Inductor L1</td>
</tr>
<tr>
<td>19</td>
<td>CT3</td>
<td>Ground Sense CT</td>
<td>—</td>
<td>Chapter 5, Ground Sense CT</td>
</tr>
<tr>
<td>20</td>
<td>F1</td>
<td>Bus Fuse</td>
<td>—</td>
<td>Chapter 5, Bus Fuse F1</td>
</tr>
<tr>
<td>21</td>
<td>C1 – C10</td>
<td>Bus Capacitors</td>
<td>Main Chassis</td>
<td>Chapter 5, Bus Capacitor Bank</td>
</tr>
</tbody>
</table>
1336 PLUS Spare Parts Information

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

• Allen-Bradley home page on the World Wide Web at:
  http://www.ab.com
  then select . . .
  “Drives” followed by . . .
  “Product Information” and . . .
  “Service Information . . .”
  Select document 1060.pdf

• Standard Drives “AutoFax” service — An automated system that you can call to request a “faxed” copy of the spare parts information (or other technical document).
  Simply call 440-646-6701 and follow the phone prompts to request document 1060.
150 – 300 HP 1336 PLUS Drives
UNIVERSAL INVERTER SYSTEM
SCHEMATIC DIAGRAM STAND ALONE UNIT
150 – 250 HP 380/460 VAC
150 – 300 HP 575 VAC, BULLETIN 1336

AB078A
S-3
1336 PLUS Schematics
B150 – B250
C150 – C250

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BASED ON MAXIMUM DRIVE RATING THE FOLLOWING FUSES OR
APPROVED EQUIVALENT MUST BE USED:

<table>
<thead>
<tr>
<th>HORSEPOWER</th>
<th>380/460VAC FUSE CURRENT/TY</th>
<th>575VAC FUSE CURRENT/TY</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>300A/UL CLASS CC, T OR J</td>
<td>250A/UL CLASS CC, T OR J</td>
</tr>
<tr>
<td>200</td>
<td>400A/UL CLASS CC, T OR J</td>
<td>300A/UL CLASS CC, T OR J</td>
</tr>
<tr>
<td>250</td>
<td>450A/UL CLASS CC, T OR J</td>
<td>400A/UL CLASS CC, T OR J</td>
</tr>
<tr>
<td>300</td>
<td>NOT APPLICABLE</td>
<td>400A/UL CLASS SPR/FWP OR A700</td>
</tr>
</tbody>
</table>

TABLE 2
THE INVERTER DC + BUS FUSE WILL REMAIN ONE AMP RATING.
FOR ALL UNITS IN THIS FRAME, THE TABLE BELOW DEFINES THE FUSE RATING.

<table>
<thead>
<tr>
<th>DRIVE HORSEPOWER, INPUT VOLTAGE</th>
<th>FUSE INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>150/200/250 HP – 380/460/575 VAC</td>
<td>600A A700600–4 25178–310–19</td>
</tr>
<tr>
<td>300HP – 575 VAC</td>
<td>600A A700600–4 25178–310–19</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>ITEM</th>
<th>B/M</th>
<th>SCHEMATIC DIAGRAM</th>
<th>DESIGNATOR</th>
<th>RATING</th>
<th>TYPE</th>
<th>P/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>74101–169–XX</td>
<td>74101–167</td>
<td>F1</td>
<td>1.5A/600V</td>
<td>KTK–R–1.5</td>
<td>25172–260–08</td>
</tr>
<tr>
<td>A10</td>
<td>74101–181–XX</td>
<td>74101–179</td>
<td>F3</td>
<td>1.5A/600V</td>
<td>KTK–R–1.5</td>
<td>25172–260–09</td>
</tr>
<tr>
<td>A20–22</td>
<td>74101–363–XX</td>
<td>74101–361</td>
<td>NONE</td>
<td>1.5A/600V</td>
<td>KTK–R–1.5</td>
<td>25172–260–09</td>
</tr>
</tbody>
</table>

Capacitor Detail

Fan Detail

Main Control Board Detail

From Gate Driver Board Connector J1

From NTC

150 – 250 HP 380/460 VAC
150 – 300 HP 575 VAC, BULLETIN 1336

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Glossary

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

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

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

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

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

BR: Refer to Bridge Rectifier.

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

1. DC-Injection braking (AC drives) — A method which produces electromagnetic braking forces in the motor by removing 2 AC motor (stator) phases and injecting DC current. The result is a linear braking characteristic (ramp) that does not diminish with motor speed. Application is normally limited to 10–20% of rated motor speed due to increased heating in the rotor.

2. Dynamic braking (AC drives) — A method which produces electromagnetic braking forces in the motor by dissipating generated power into the DC bus through a resistive load. Braking force remains constant and is only limited by the thermal capacity of the resistors. The result is a linear braking characteristic (ramp) that does not diminish with motor speed.

3. Regenerative braking — A method which produces electromagnetic braking forces in the motor by electronically controlling the return of generated power to the AC supply. The result is a controllable linear braking characteristic (ramp) that does not diminish with motor speed.
4. Motor-mounted or separately-mounted brake — A positive-action, mechanical friction device. Normal configuration is such that when the power is removed, the brake is set. This can be used as a holding brake. (Note: A separately mounted brake is not one which is located on some part of the mechanical drive train other than the motor.)

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

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

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

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

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

**BTU:** Refer to *British Thermal Unit*.

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

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

**CEMF:** Refer to *Counter Electromotive Force*.

**CMOS:** Complimentary Metallic Oxide Semiconductor. A semiconductor device in which an electric field controls the conductance of a channel under a metal electrode called a gate.
Cogging: A condition in which a motor does not rotate smoothly but steps or jerks from one position to another during shaft revolution. Cogging is most pronounced at low motor speeds and can cause objectionable vibrations in the driven machinery.

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

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

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

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

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

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

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

DC Boost: Compensates for the voltage drop across the resistance of an AC motor circuit and the resulting reduction in torque.
**DC Bus:** A drive’s power structure that transmits a rectified AC line power from the bridge rectifier to the output transistors.

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

**Diode:** A solid-state uni-directional conductor.

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

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

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

**Duty Cycle:**

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

**Dynamic Braking:** Refer to *Braking*.

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

**Electrostatic Discharge (ESD):** A static-electricity discharge that may damage drive components. Refer to the ESD precautions found in this manual to guard against damage to drive components.
Enable: To activate logic by the removal of a suppression signal.

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

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

ESD: Refer to Electrostatic Discharge.

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

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

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

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

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

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


IGBT: Refer to Insulated Gate Bipolar Transistor.

Induction Motor: An induction motor is an alternating-current motor in which the primary winding on one member is connected to the power source. A secondary winding on the other member carries the induced current. There is no physical electrical connection to the secondary winding; its current is induced.
Inertia: A measure of a body’s resistance to change in velocity, whether a body is at rest or moving at a constant velocity. The velocity can be either linear or rotational. The moment of inertia (WK²) is the product of the weight (W) of an object and the square of the radius of gyration (K²). The radius of gyration is a measure of how the mass of the object is distributed about the axis of rotation. WK² is usually expressed in units of lb-ft².

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

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

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

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

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

ISO: Refer to International Organization for Standards.

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

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

Kinetic Energy: The energy of motion of a moving body.
LAD: Refer to Linear Acceleration/Deceleration.

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

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

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

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

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

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

MOV: Refer to Surge Protection.

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

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

NEC: Refer to National Electrical Code.

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

NEMA: Refer to National Electrical Manufacturer’s Association.
Offset: The steady-state deviation of a controlled variable from a fixed setpoint.

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

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

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

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

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

Pot: A potentiometer, or variable resistor.

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

Power Factor (Displacement): A measurement of the time phase difference between the fundamental voltage and fundamental current in an AC circuit. It represents the cosine of the phase angle difference. 
Fp = cos(α– β)

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

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

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

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

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

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

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

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

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

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

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

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

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

Set Speed: The desired operating speed.

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

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

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

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

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

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

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

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

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

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

**Transistor:** An active solid-state semiconductor device.

**Work:** A force moving an object over a distance. \[ \text{work} = \text{force} \times \text{distance} \].
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