Allen-Bradley

Regenerative DC Bus Supply Unit (RGU)

Bulletin 2364F

Troubleshooting Guide

Important User Information

Because of the variety of uses for the products described in this publication, those responsible for the application and use of this control equipment must satisfy themselves that all necessary steps have been taken to assure that each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes and standards.

The illustrations, charts, sample programs and layout examples shown in this guide are intended solely for purposes of example. Since there are many variables and requirements associated with any particular installation, Allen-Bradley does not assume responsibility or liability (to include intellectual property liability) for actual use based upon the examples shown in this publication.

Allen-Bradley publication SGI-1.1, *Safety Guidelines for the Application, Installation and Maintenance of Solid-State Control* (available from your local Allen-Bradley office), describes some important differences between solid-state equipment and electromechanical devices that should be taken into consideration when applying products such as those described in this publication.

Throughout this manual we use notes to make you aware of safety considerations:

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

Attention statements help you to:

- identify a hazard
- avoid a hazard
- recognize the consequences

Important: Identifies information that is critical for successful application and understanding of the product.

Chapter 4 Testing Components

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Preface

Contents

The Regenerative DC Bus Supply Unit (RGU™) is a regenerative front end unit used to supply a common DC bus drive system.

This manual includes information for troubleshooting RGU failure conditions, troubleshooting components, and handling fault and warning conditions.

This preface supplies information on the following topics:

- who should use this manual
- safety precautions
- contents of this manual
- related documentation
- Rockwell Automation support

Who Should Use This Manual

This manual is intended for qualified personnel who are responsible for servicing the Bulletin 2364F Regenerative DC Bus Supply Unit (RGU).

If you do not have a basic understanding of this unit, please refer to the applicable documentation and system schematics, or contact your local Rockwell Automation Drive Systems representative for more information before using this product.

Be sure to read through this manual and through publication 2364F-5.01, *Regenerative DC Bus Supply Unit (RGU)–User Manual*, before servicing the RGU.

Safety Precautions

The following general precautions apply to Bulletin 2364F RGUs and to drive systems lineups.

ATTENTION: Only those familiar with the drive system, the products used in the system, and the associated machinery should plan or implement the installation, startup, and future maintenance of the system. Failure to comply can result in personal injury and/or equipment damage.

ATTENTION: Only connect Rockwell Automation common DC bus AC drives to the RGU common DC bus output.

ATTENTION: Do not connect any drives to the RGU common DC bus which have input voltage specifications greater than the maximum input voltages listed below.

Nominal Input Voltage of RGU (V AC)	Maximum DC Input of Drive (V DC)
380	632
460	746
575	933

ATTENTION: Verify that all sources of AC and DC power are deenergized and locked out or tagged out in accordance with the requirements of ANSI/NFPA 70E, Part II.

ATTENTION: The system may contain stored energy devices. To avoid the hazard of electrical shock, verify that all voltage on capacitors has been discharged before attempting to service, repair, or remove a drive system or its components. You should only attempt the procedures in this manual if you are qualified to do so and are familiar with solid-state control equipment and the safety procedures in publication NFPA 70E.

ATTENTION: An incorrectly applied or installed drive system can result in component damage and/or a reduction in product life. Wiring or application errors–such as undersizing the motor, incorrect or inadequate AC supply, and excessive ambient temperatures– can result in the malfunction of the drive equipment.

ATTENTION: The drive system contains ESD (electrostatic discharge) sensitive parts and assemblies. Static control precautions are required when installing, testing, or repairing the RGU. Component damage can result in ESD control procedures are not followed. If you are not familiar with static control procedures, refer to Allen-Bradley publication 8000-4.5.2, *Guarding Against Electrostatic Damage* or any other applicable ESD protection handbook.

To reduce the risk of ESD damage to circuit boards, wear a grounding wrist strap when handling circuit boards. Store circuit boards in conductive packets.

Contents of this Manual

Chapter	Title	Contents
	Preface	Information concerning safety, support, and reference documentation.
1	Introduction	Introduction to manual content, information for data nameplates, and startup/ operating procedures.
2	Troubleshooting the RGU	Procedures for troubleshooting and handling conditions in the RGU.
3	Troubleshooting Faults and Warnings	Introduction to faults and warnings on the RGU, plus troubleshooting action to correct fault situations.
4	Testing Components	Troubleshooting procedures for the main control board, gate driver board, isolation board, and other components of the RGU.
A	Reference Information	Specifications, board diagrams, test point information, board-to-board schematics, and firmware block diagrams.
	Glossary	Listing of terms that are used in this manual.
	Index	Index of key topics in this manual.

Related Documentation

For	Read This Document	Document Number
Layout diagrams, specifications, setup instructions, and schematics of the RGU	Regenerative DC Bus Supply Unit (RGU)–User Manual	2364F-5.01
Information for operating and understanding the Graphic Programming Terminal	Bulletin 1201 Graphic Programming Terminal–User Manual	1201-5.0
Information for installing and configuring the Remote I/O (RIO) Communications Module.	Bulletin 1203 Remote I/O Communications Module–Getting Started Manual	1203-5.1
Information for installing and configuring the DeviceNet Communications Module	Bulletin 1203 DeviceNet Communications Module–User Manual	1203-5.3
Information for installing and configuring the Serial Communications Module	Bulletin 1203 Serial Communications Module–User Manual	1203-5.5
Information for installing, configuring, programming, and troubleshooting the 1336 FORCE adjustable frequency AC drive	1336 FORCE Adjustable Frequency AC Drive–User Manual	1336 FORCE-5.12
Information for installing, configuring, programming, and troubleshooting the 1336 PLUS adjustable frequency AC drive	1336 PLUS Adjustable Frequency AC Drive–User Manual	1336 PLUS-5.0
Instructions for properly handling and moving motor control centers (MCCs)	Receiving, Handling, and Storing Motor Control Centers–Instructions	2100-5.5
Instructions for installing Bulletin 2300 motor control centers (MCCs), splicing busbars, and removing roll-out units	Bulletin 2300 Family of Drive Systems–Installation Manual	2300-5.1
Information for installing, configuring, and programming the SA3000 AC drive	SA3000 Binder	S-3001
Information for installing, configuring, and programming the SA3100 AC drive	SA3100 Binder	S-3053
Instructions for testing and replacing components in the RGU power structure	1336 FORCE Adjustable Frequency AC Drive–Service Manuals	1336 FORCE-6.12 to 6.15
Information for wire sizes, grounding, and other electrical topics	National Electrical Code	ANSI/NFPA70
A list of all the documentation available through Allen-Bradley	Allen-Bradley Publication Index	SD499
A glossary of industrial automation terms and abbreviations	Industrial Automation Glossary	AG-7.1

Rockwell Automation Support

Rockwell Automation offers support services worldwide, with Sales/ Support offices, authorized distributors, and authorized Systems Integrators located throughout the United States, plus Rockwell Automation representatives in every major country in the world.

Local Product Support

Please contact your local Rockwell Automation representative for:

- sales and order support
- product technical training
- warranty support
- support service agreements

Technical Product Assistance

If you need to contact us for technical assistance, please review the appropriate product manuals and the troubleshooting information in this manual first.

For the quickest possible response, please have the catalog numbers of your products ready when you call.

Introduction

Using This Manual

This manual provides information to help service personnel troubleshoot and correct the most common RGU conditions.

This troubleshooting guide is laid out with the following topics:

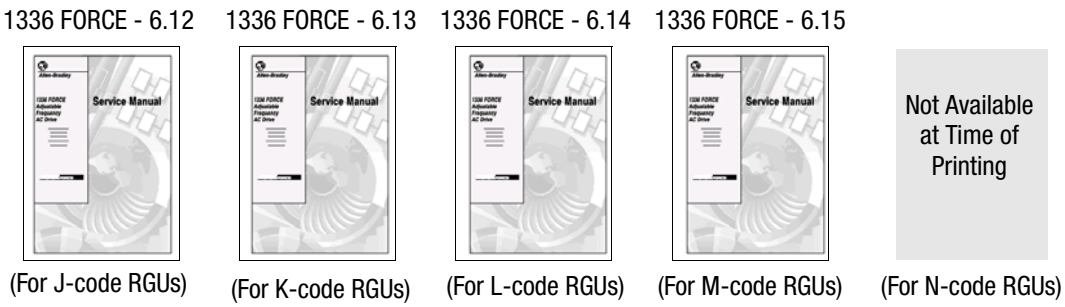
- Troubleshooting RGU Conditions
- Troubleshooting Warnings and Faults
- Testing Components
- Reference Information

This manual is to be used in conjunction with publication 2364F-5.01, *Regenerative DC Bus Supply Unit (RGU)–User Manual*, which provides component information, schematics, installation instructions, specifications, and a parameter list.

1336 FORCE Service Manuals

In addition to RGU publications, the 1336 FORCE service manuals (shown in Figure 1.1) provide information for testing and replacing components within the RGU power structure. See chapter 4 for more information.

Figure 1.1
1336 FORCE Service Manuals



Note: *Most of the construction and components of the N-code power structure are equivalent to the M-code power structure. Publication 1336 FORCE - 6.15 has sufficient information for servicing the N-code power structure.*

Basic Troubleshooting Techniques

When troubleshooting, refer to the system schematics and determine the components that are critical to the process. Test each of the critical components to determine the problem. Also, consider how the RGU's programming parameters may be affecting the situation. Consider upgrading to the latest version of firmware available.

When a damaged component has been found, always try to determine the cause of the problem, rather than just replacing the component. Verify that equipment is connected and being used properly; verify that the parameters are properly set for the particular application; and so on. Try to determine and resolve all underlying problems to avoid future component failures.

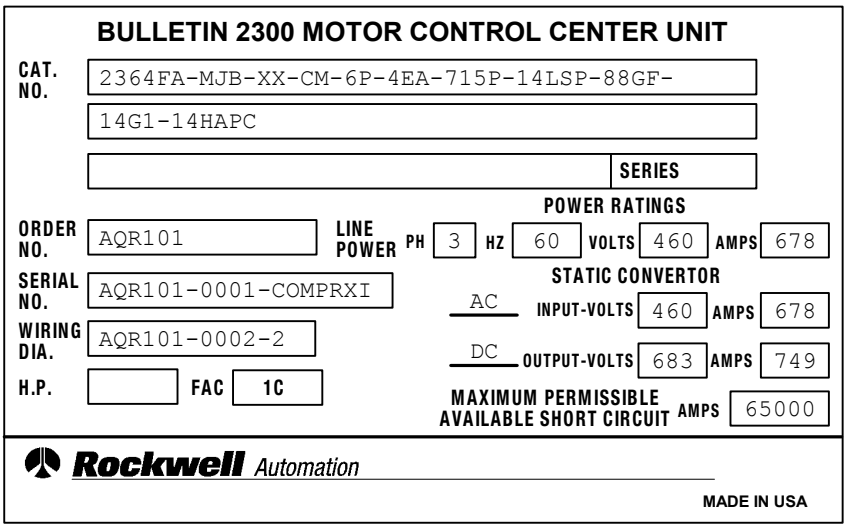
For significant or recurring problems, contact your local Rockwell Automation office for support. Rockwell Automation support personnel can provide technical assistance and can offer information about hardware and software updates as they are made available.

Data Nameplates

The data nameplate provides the electrical ratings for the RGU, signifies the type of RGU, and identifies the options that have been included in the unit.

The data nameplate shown in Figure 1.2 is located in the input bay of the RGU and signifies the unit ratings, catalog string, and unique reference identifiers for the RGU.

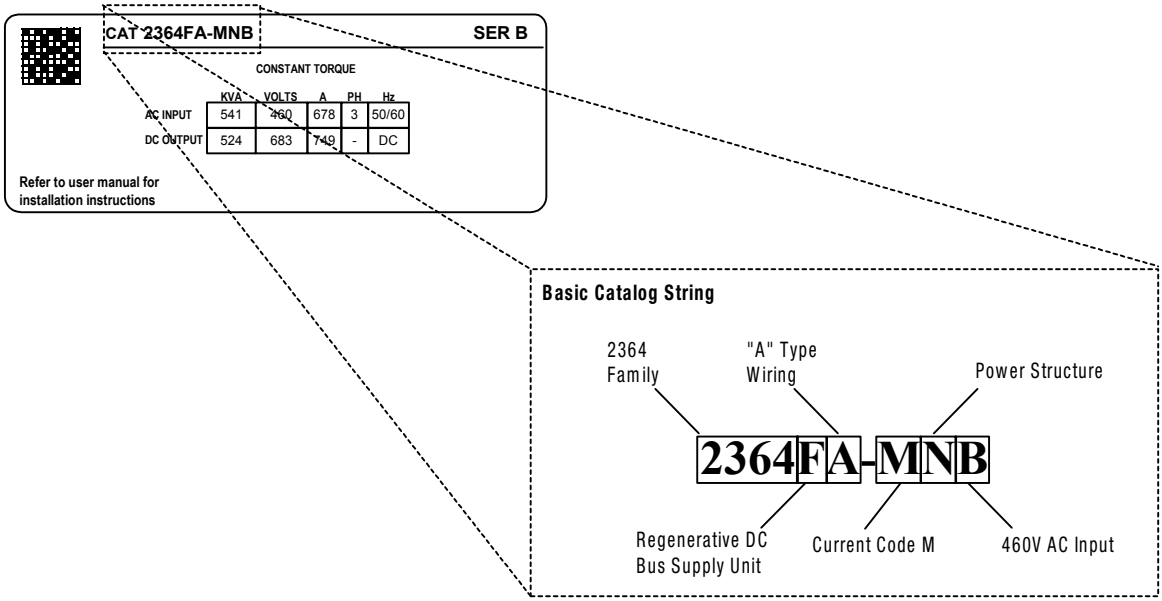
Figure 1.2
Data Nameplate–RGU



The data nameplate shown in Figure 1.3 is located on the power structure and signifies the ratings and the catalog string for the power structure. Figure 1.3 also shows the basic catalog string format.

Note: *For more catalog string information, refer to publication 2364F-5.01, Regenerative DC Bus Supply (RGU)–User Manual.*

Figure 1.3
Data Nameplate–Power Structure



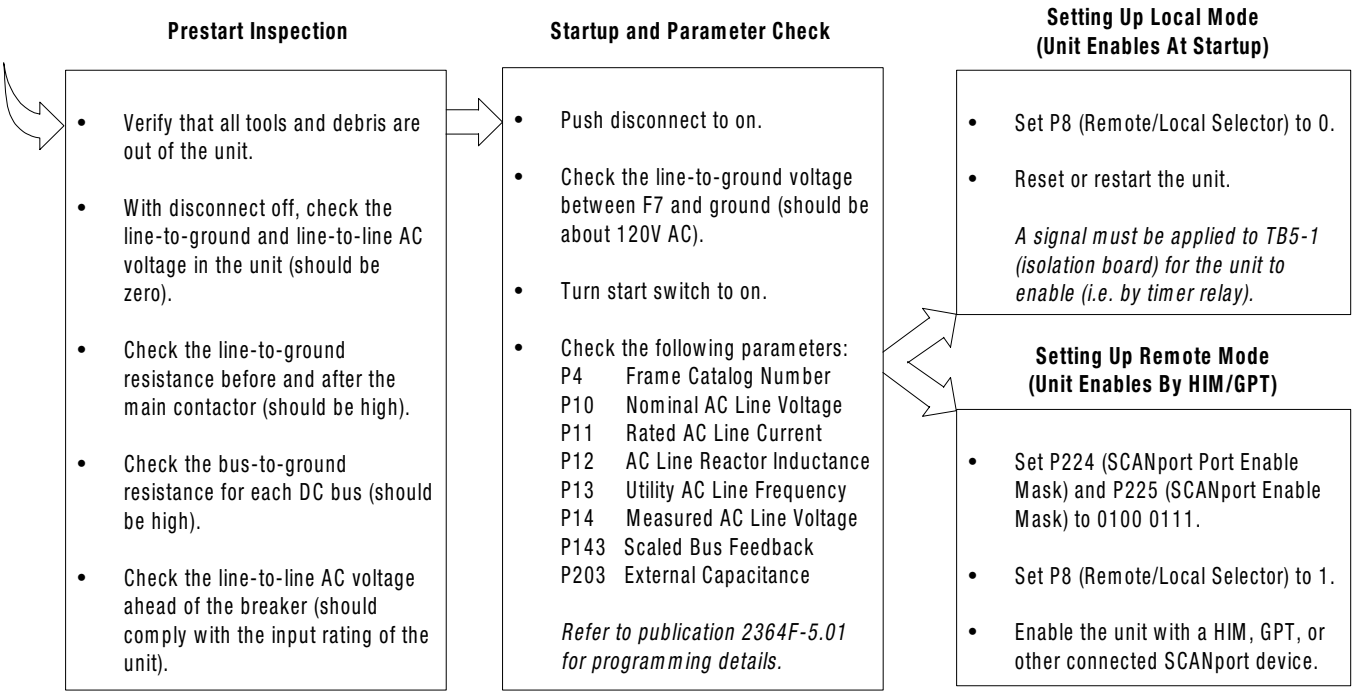
Basic Catalog Strings

2364FA-JNN	J-code RGU, 380V AC	2364FA-MNN	M-code RGU, 380V AC
2364FA-JNB	J-code RGU, 460V AC	2364FA-MNB	M-code RGU, 460V AC
2364FA-JNC	J-code RGU, 575V AC	2364FA-MNC	M-code RGU, 575V AC
2364FA-KNN	K-code RGU, 380V AC	2364FA-NNN	N-code RGU, 380V AC
2364FA-KNB	K-code RGU, 460V AC	2364FA-NNB	N-code RGU, 460V AC
2364FA-KNC	K-code RGU, 575V AC	2364FA-NNC	N-code RGU, 575V AC
2364FA-LNN	L-code RGU, 380V AC		
2364FA-LNB	L-code RGU, 460V AC		
2364FA-LNC	L-code RGU, 575V AC		

Starting and Operating the RGU

Figure 1.4 shows the process that should be used to start a unit which has been serviced. If the unit is set for local mode, the unit will automatically enable when started.

Figure 1.4
Starting and Operating the RGU



Troubleshooting The RGU

RGU Conditions

This chapter provides troubleshooting instructions for the most common RGU conditions. Choose the topic that most closely represents the condition of your unit.

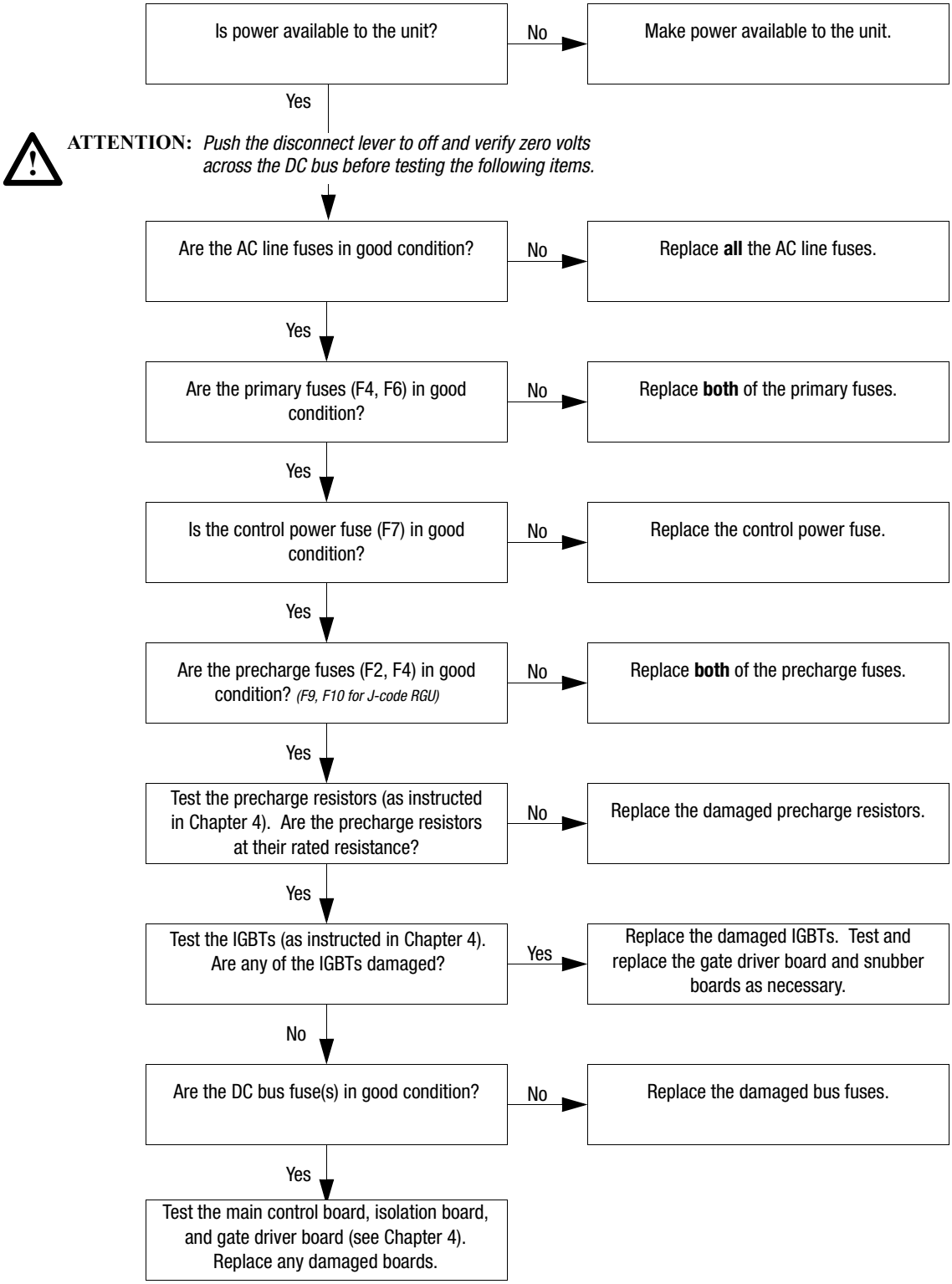
Conditions Handled in This Chapter
Unit Will Not Start
Unit Will Not Enable
Unit Overvoltage/Overcurrent Trips
Damaged Components

Handling Unresolved Conditions

If a condition cannot be resolved by the troubleshooting instructions in this manual, contact your local Rockwell Automation office for additional support.

Unit Will Not Start

After the disconnect lever and start switch have been turned on, the RGU should power any connected HIM or GPT devices and perform its precharge routine to raise the voltage of the capacitors on the DC bus. Check the following items if the unit will not operate.

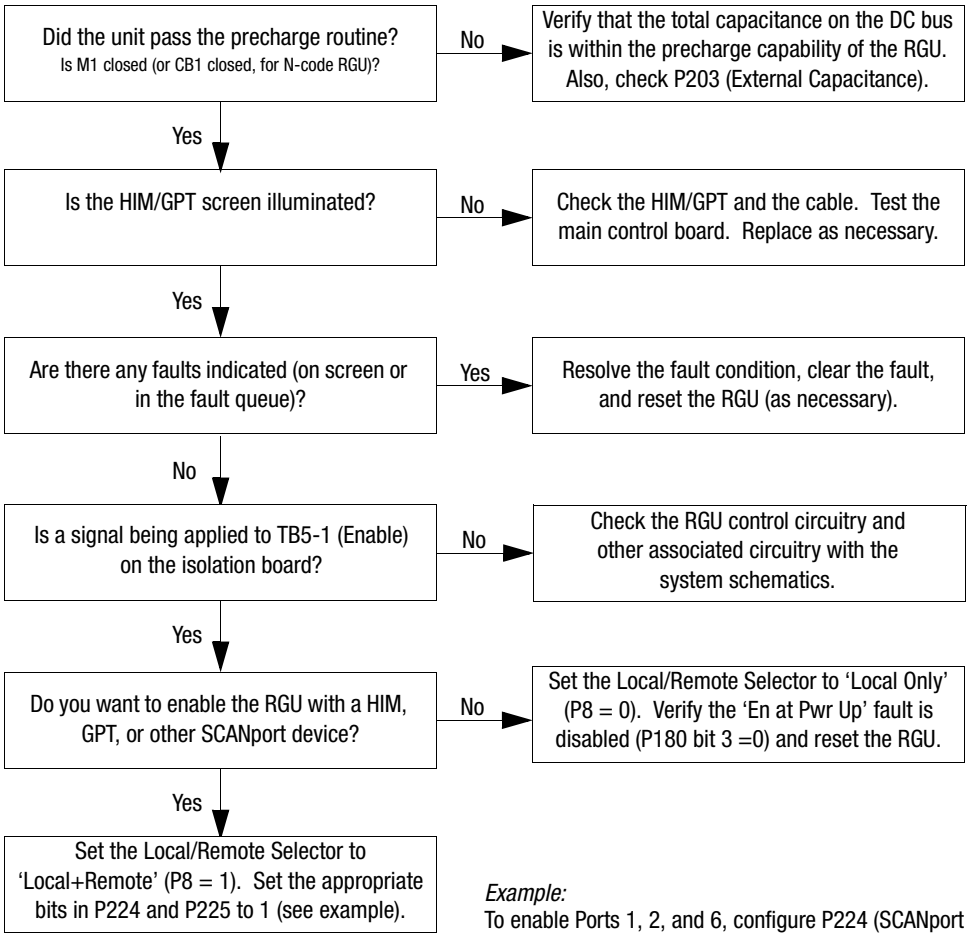


Unit Will Not Enable

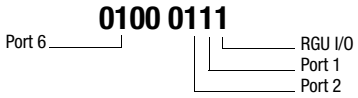
After the disconnect lever and start switch have been turned on, the RGU should power any connected HIM or GPT devices and perform its precharge routine to raise the voltage of the capacitors on the DC bus.

If the Remote/Local Selector (P8) is set to 'Local Only', the RGU should automatically enable when the precharge routine finishes. If the Remote/Local Selector is set to 'Local+Remote', the RGU should enable when an enable command is sent by a connected SCANport device (HIM, GPT, etc.).

Check the following items if the unit will not enable.



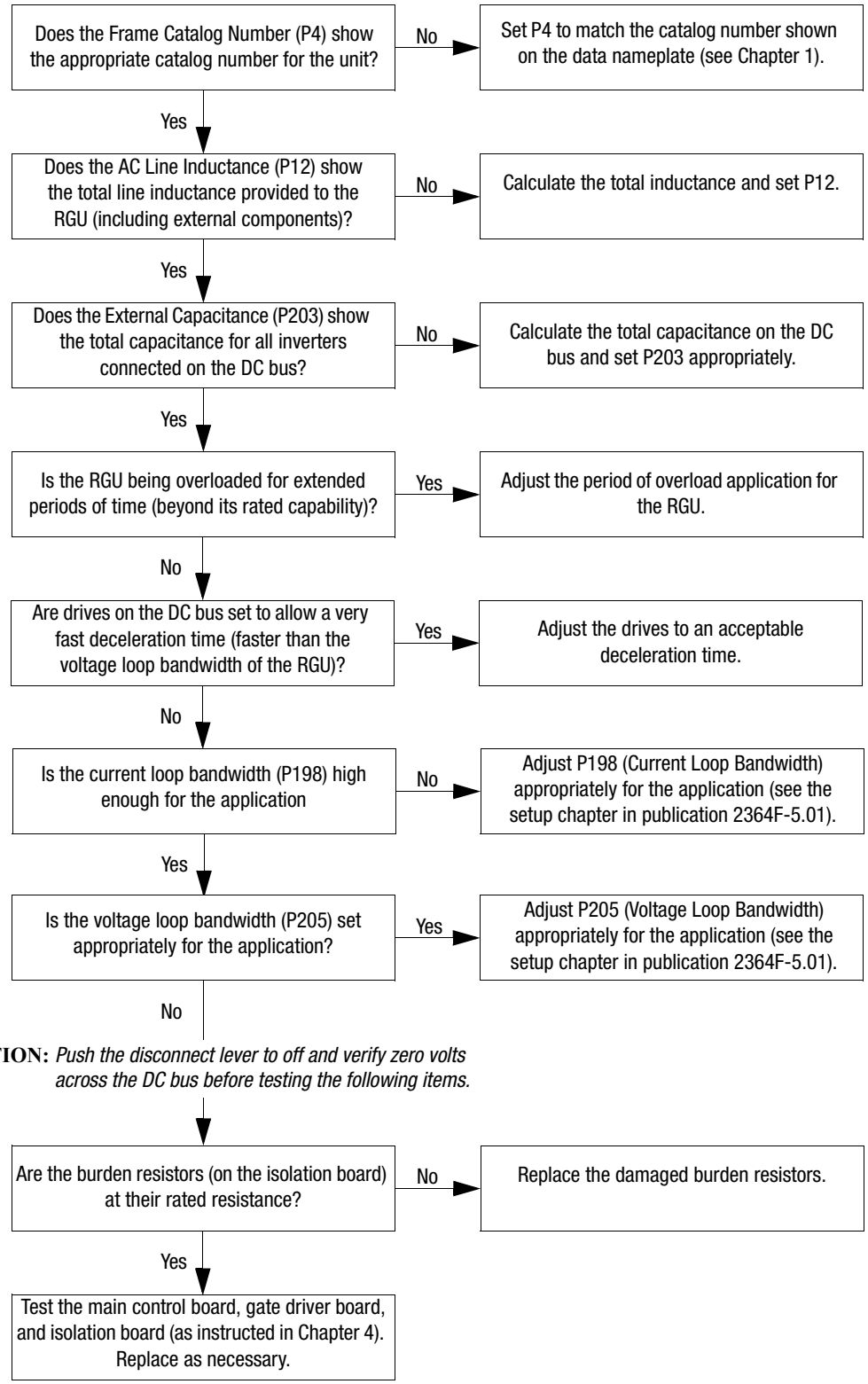
Example:
To enable Ports 1, 2, and 6, configure P224 (SCANport Port Enable Mask) and P225 (SCANport Enable Mask) as shown.



Note: *The RGU can also be enabled by setting the 'Enable Cmd' bit to 1 in the Host Command Word (P32).*

Unit Overvoltage/Overcurrent Trips

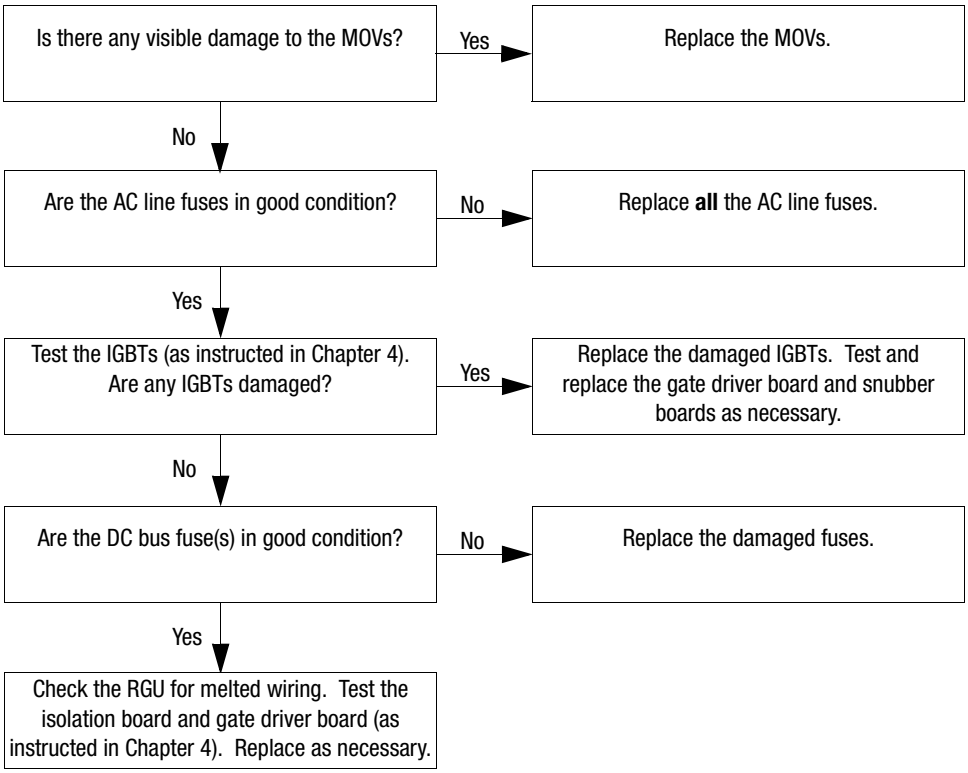
Check the following items if the unit frequently has an overvoltage or overcurrent trip.



Damaged Components

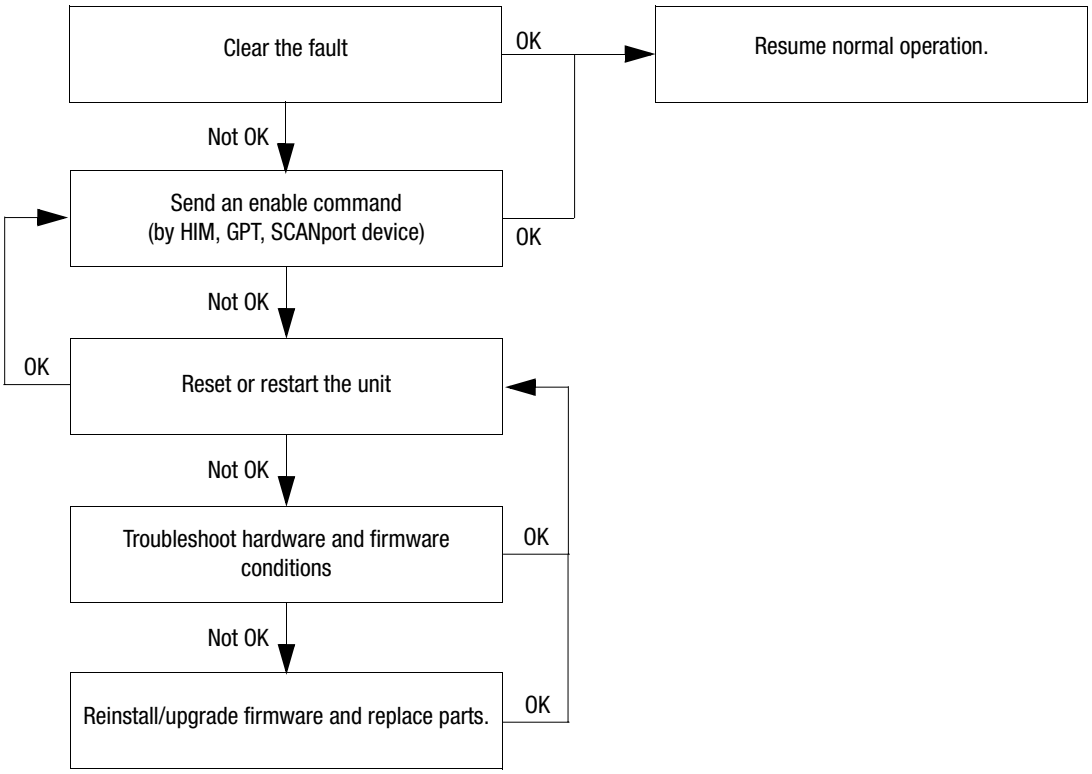
Damaged components may be suspected if a loud discharge or melting smell has come from the RGU. Check the following items to find damaged components.

ATTENTION: *Push the disconnect lever to off and verify zero volts across the DC bus before testing the following items.*



Handling Fault Conditions

Typically, a fault condition can be resolved through the process shown in flowchart below. See chapter 3 for details on handling specific faults and warnings.



Troubleshooting Faults and Warnings

Contents

This chapter covers the faults and warnings which may indicate troubled conditions in the RGU. When the RGU indicates a warning, fault, or status condition, you may need to take remedial action as stated in this chapter.

Topics in this chapter
Faults and Warnings
How to Check the Warning and Fault Queues
Resetting the RGU
Troubleshooting Faults and Warnings

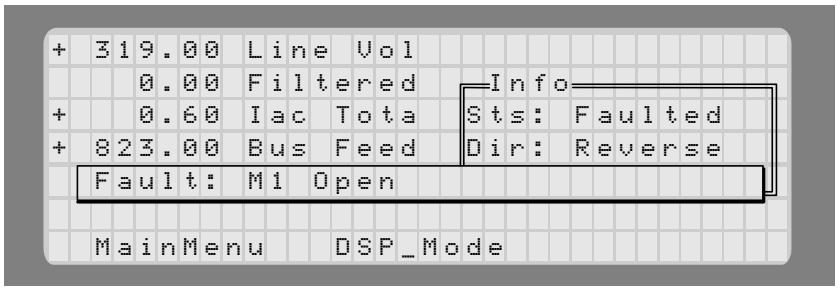
Faults and Warnings

A fault situation will typically cause the RGU to report the condition and disable. A warning situation will cause the RGU to report the condition, but the RGU will continue normal operation (with regard to the condition). The RGU will indicate a situation as either a fault or warning according to the configuration of the fault/warning select parameters.

When the RGU faults, the HIM or GPT will immediately report the fault on screen.

Figure 3.1
Fault Announcement–HIM

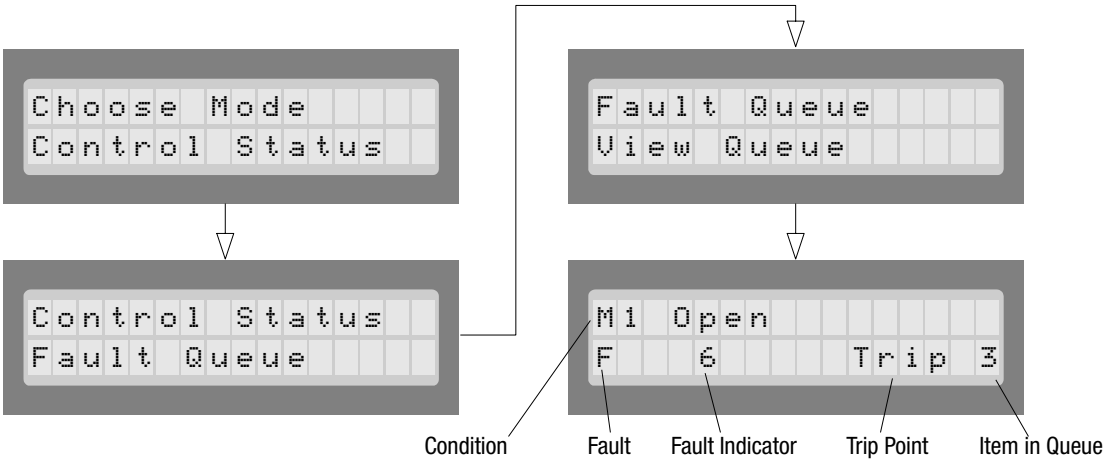
Figure 3.2
Fault Announcement–GPT



How to Check the Warning and Fault Queues

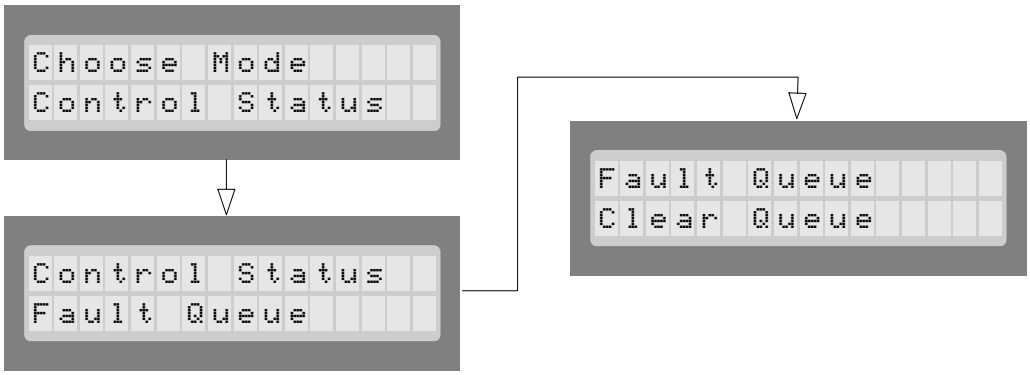
When a fault condition occurs, the RGU will store the fault information in the fault queue. The fault queue will indicate the fault condition, the sequence number of the fault, and will display 'Trip' if the fault caused the RGU to trip. To view the warning or fault queue with a HIM, choose *Control Status*, then choose either *Fault Queue* or *Warning Queue*, then choose *View Queue* to open the queue (as shown in Figure 3.3).

Figure 3.3
Checking the Fault Queue–HIM



Typically, the fault (or fault queue) will need to be cleared before the RGU can be enabled again. To clear the fault queue, choose *Control Status*, then choose *Fault Queue*, then choose *Clear Queue* (as shown in Figure 3.4). The fault queue will clear, and the unit can be enabled again (a reset may be required to rectify any hardware or software conditions).

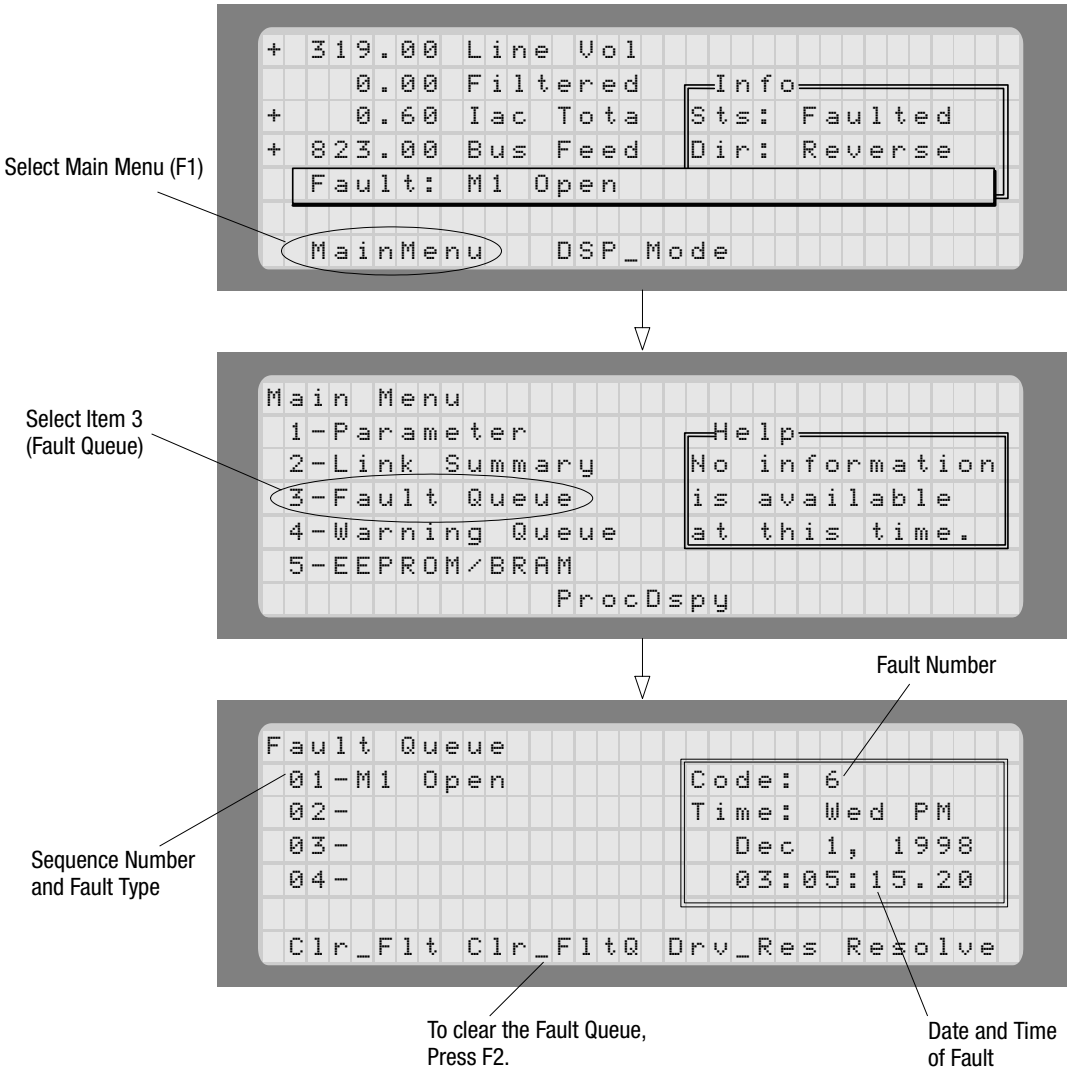
Figure 3.4
Clearing the Fault Queue–HIM



To view the warning or fault queue with a GPT, go to the main menu by pushing F1, then choose either *Fault Queue* or *Warning Queue*. The fault queue should appear as shown in Figure 3.5.

The fault queue can be cleared by entering the fault queue and pressing F1 to clear the fault or F2 to clear the queue. An individual fault can be cleared on a GPT by pressing the stop button (on any screen).

Figure 3.5
Checking the Fault Queue–GPT



Resetting the RGU

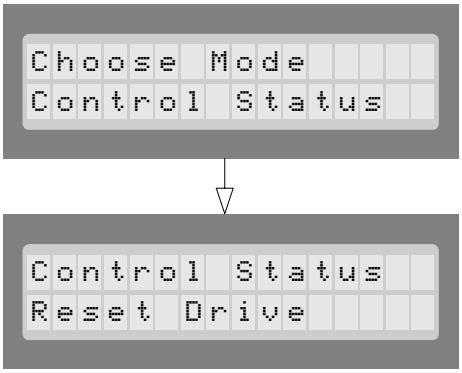
If a fault is the result of a hardware or software failure, the unit may need to be reset to reinitialize the hardware and software before the unit can be enabled.

The RGU can be reset by:

- Cycling power to the RGU.
- Sending a reset command through a HIM, GPT, or other SCANport device.

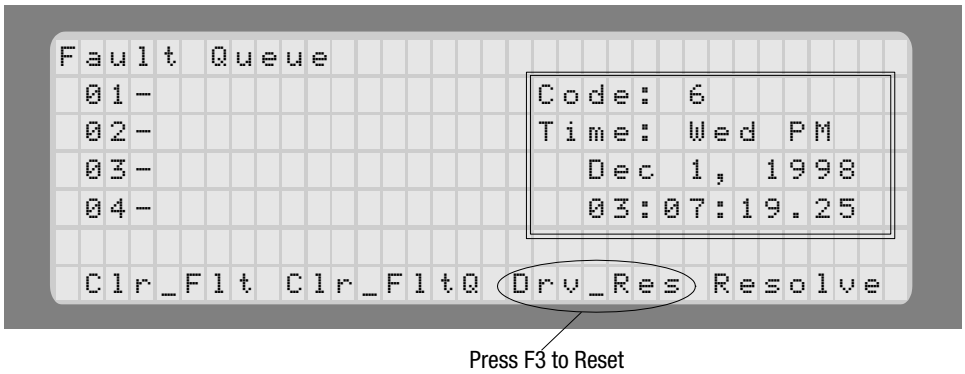
To reset the RGU with a HIM, choose *Control Status*, then choose *Reset Drive*.

Figure 3.6
Resetting the RGU–HIM



To reset the RGU with a GPT, press F3 (while in the fault queue).

Figure 3.7
Resetting the RGU–GPT



To reset the RGU with other SCANport devices, send a reset command through the Host Command Word (P32 bit 7).

Troubleshooting Faults and Warnings

The following list provides information for understanding and troubleshooting each fault or warning condition in the RGU.

Parameters can be stored in the internal memory of a GPT or Series B HIM, or can be stored and printed out using DriveTools software.

Important: Always record or store parameters before upgrading firmware or replacing the main control board.

ATTENTION: Do not attempt to alter or modify any printed circuit boards. Any attempt to alter or modify boards may result in personal injury or property damage.

Number	Fault	Indicates	Action
0 P174 bit 0	ROM Bad CRC	Program memory error detected.	Try restarting the RGU, verify that all connections to the main control board are in place, and check the main control board for any obvious damage or any debris which may be shorting circuitry. If necessary, try reinstalling the firmware (or upgrade to the latest available firmware). Replace the board and/or send the board in for repair if the problem cannot be resolved.
1 P174 bit 1	RAM Error	RAM error detected.	Try restarting the RGU, verify that all connections to the main control board are in place, and check the main control board for any obvious damage or any debris which may be shorting circuitry. If necessary, try reinstalling the firmware (or upgrade to the latest available firmware). Replace the board and/or send the board in for repair if the problem cannot be resolved.
2 P174 bit 2	BatRAM Err	Battery-backed RAM error detected.	Try restarting the RGU, verify that all connections to the main control board are in place, and check the main control board for any obvious damage or any debris which may be shorting circuitry. If necessary, try reinstalling the firmware (or upgrade to the latest available firmware). Replace the board and/or send the board in for repair if the problem cannot be resolved.
3 P174 bit 3	DSP Load	Error detected while loading DSP program memory at startup.	Try restarting the RGU, verify that all connections to the main control board are in place, and check the main control board for any obvious damage or any debris which may be shorting circuitry. If necessary, try reinstalling the firmware (or upgrade to the latest available firmware). Replace the board and/or send the board in for repair if the problem cannot be resolved.
4 P174 bit 4	FPGA Load	Error detected while loading FPGA firmware at startup.	Try restarting the RGU, verify that all connections to the main control board are in place, and check the main control board for any obvious damage or any debris which may be shorting circuitry. If necessary, try reinstalling the firmware (or upgrade to the latest available firmware). Replace the board and/or send the board in for repair if the problem cannot be resolved.
5 P174 bit 5	Iq Foldback *W*	The current is being limited due to high heatsink temperatures.	The internal wiring may be at risk of overheating. Check that the door fans are operating properly, and verify that the RGU is operating at the appropriately derated current (see the specifications appendix in 2364F-5.01). Verify that the RGU is not operating in overload for an extended period of time.

Note: *'W'* indicates that the condition is normally reported as a warning, rather than a fault.

Number	Fault		Indicates	Action
6 P174 bit 6	M1 Open		M1 contactor opened while the RGU is in ready or running state.	Clear the fault and try resetting/restarting the RGU. Check all feedback wiring. Verify that the door-mounted start switch is turned on. Check that timer relay (TR1) is set to 3 seconds. Check for any other fault activity that may be causing the M1 Open fault.
7 P174 bit 7	SCANport Err	*W*	Error detected in SCANport controlling device (or device missing).	Verify that the SCANport device is connected properly. Pull the plug out and reconnect. If necessary, try resetting or restarting the RGU.
8 P174 bit 8	R2R HW Error		Error detected in the R2R hardware by the CAN chip (which is responsible for R2R communications).	Clear the fault and try resetting/restarting the RGU. Check the R2R board(s) and wiring connections. Troubleshoot the board(s) and replace as necessary.
9 P174 bit 9	Control Volt	*W*	The voltage supplied to the main control board is too low for reliable operation.	The boards receive power from the DC bus. Check the wiring from the gate driver board (J10) to the DC bus. Check the ribbon cable connection between the gate driver board (J1) and the main control board (J3). Check the TE connection on main control board (J11) and the gate driver board (TB7-2). Troubleshoot the gate driver board and main control board and replace as necessary.
10 P174 bit 10	H/S Overtemp		The heatsink temperature has exceeded the prescribed temperature limit (100ºC for J-L codes, 110ºC for M and N-codes).	Check that the door fans are operating properly, and verify that the RGU is operating at the appropriately derated current (see the specifications appendix in 2364F-5.01). Verify that the RGU is not operating in overload for an extended period of time. Check internal wiring and components for heat damage (melted wiring or burn marks).
11 P174 bit 11	Bus Low	*W*	The DC bus voltage is under the DC Bus Low Setting (P28, default 71% of nominal).	Verify the parameter setup. Check the Frame Catalog Number (P4), the Scaled Bus Feedback (P143), the Bus Voltage Feedback Calibration (P144), and the DC Bus Low Setting (P28). Check the bus for shorts to ground (PE).
12 P174 bit 12	Bus High	*W*	The DC bus voltage has exceeded the DC Bus High Setting (P29, default 114% of nominal).	Verify the parameter setup. Check the Frame Catalog Number (P4), the Scaled Bus Feedback (P143), the Bus Voltage Feedback Calibration (P144), and the DC Bus High Setting (P29).
13 P174 bit 13	BRAM Chksum	*W*	The checksum of data in battery-backed RAM was bad. The data is deemed as unreliable.	Try restarting the RGU, verify that all connections to the main control board are in place, and check the main control board for any obvious damage or any debris which may be shorting circuitry. If necessary, try reinstalling the firmware (or upgrade to the latest available firmware). Replace the board and/or send the board in for repair if the problem cannot be resolved.
14 P174 bit 14	Prchrg Fail		The DC bus voltage was high enough to power the control boards (200V DC), but did not rise to the RMS value of the AC line to allow the main contactor (M1) to close.	There may be too many inverters attached to the DC bus (the precharge routine can only accommodate a certain amount of external capacitance). If necessary, disconnect some of the inverters until the RGU has completed its precharge, or contact Rockwell Automation for other solutions. Check the precharge resistors, the precharge fuses, and the precharge contactor (M2). Also, check for shorts between the DC bus and ground (PE).
15 P174 bit 15	DSP Timeout		The host processor did not receive data from the DSP. The host assumes that the DSP is not running.	Try restarting the RGU, verify that all connections to the main control board are in place, and check the main control board for any obvious damage or any debris which may be shorting circuitry. If necessary, try reinstalling the firmware (or upgrade to the latest available firmware). Replace the board and/or send the board in for repair if the problem cannot be resolved.
16 P177 bit 0	Desaturizatn		A power module was overloaded so severely that the power module was forced out of full 'turn on' condition.	Check the power modules as indicated in chapter 4. Check the line fuses and DC bus fuse (if equipped). If the components are good, clear the fault and reset/restart the RGU.

Number	Fault	Indicates	Action
17 P177 bit 1	Board Intlk	The voltage feedback connector (J1) or the current feedback connector (J7) is not plugged into the isolation board.	Verify that the J1 and J7 connections on the isolation board are secure and that the wiring is in good condition. Check the AC line sensor fuses (F17 - 19). In an N-code RGU, check the LEM power supply located on the upper front of the power structure roll out unit.
18 P177 bit 2	HW Bus OverV	The hardware has detected a DC bus voltage over 810V DC (380/460V AC) or 1000V DC (575V AC).	Verify that the setup parameters are programmed appropriately (see the setup chapter of 2364F-5.01). Also, check the burden resistors on the isolation board. Check the operation of other drives in the system.
19 P177 bit 3	HW Line I	The hardware has detected an AC line overcurrent.	Verify that the setup parameters are programmed appropriately (see the setup chapter of 2364F-5.01). Check for any shorts to ground. Also, check the burden resistors on the isolation board. Clear the fault and try resetting/restarting the RGU.
20 P177 bit 4	Zero Seq Err	The 3-phase input to the unit is out of balance. The current vector sum is not near zero.	Clear the fault and try resetting/restarting the RGU. Verify that all connections to the main control board are in place, and check the main control board for any obvious damage or any debris which may be shorting circuitry. If necessary, try reinstalling the firmware (or upgrade to the latest available firmware). If the problem cannot be resolved, contact Rockwell Automation for hardware updates. If necessary, replace the main control board and/or send the board to Rockwell Automation for testing.
21 P177 bit 5	Phase Lock L	One or more phases from the AC line have lost power or have browned out.	The RGU can continue to operate until power is lost from two phases, or until power becomes too low for the RGU to compensate to load. If the phase(s) do not return, verify that the circuit breaker is closed, check the power source, check all AC connections, check the incoming AC line fuses (F1, F2, F3), and check for shorts to ground (PE). If there is no actual phase loss, check the AC line sensor fuses and the J1 connection to the isolation board.
22 P177 bit 6	Phase Loss	A phase from the AC line has lost power.	The RGU can continue to operate on single-phase power, but may trip if the load becomes too great, or may trip if the RGU is forced to regenerate. If the phase does not return, check the power source, check the incoming AC line fuses (F1, F2, F3), and check for shorts from the lost phase to ground (PE). If there is no actual phase loss, check the AC line sensor fuses and the J1 connection to the isolation board.
23 P177 bit 7	Not Used		
24 P177 bit 8	Not Used		
25 P177 bit 9	Not Used		
26 P177 bit 10	SW Line I	The software has detected an AC line overcurrent.	Verify that the setup parameters are programmed appropriately (see the setup chapter of 2364F-5.01). Check for any shorts to ground. Also, check the burden resistors on the isolation board.
27 P177 bit 11	I Offset Err	An excessive line current has been detected during initial power up.	Check the parameters for any unusual current settings. Check for any shorts to ground. Verify that the correct burden resistors are installed on the isolation board.

Note: *'W'* indicates that the condition is normally reported as a warning, rather than a fault.

Number	Fault		Indicates	Action
28 P177 bit 12	DualPort TO		The DSP did not receive any data from the host processor. The DSP assumes that the host is not running.	Clear the fault and try resetting/restarting the RGU. Verify that all connections to the main control board are in place, and check the main control board for any obvious damage or any debris which may be shorting circuitry. If necessary, try reinstalling the firmware (or upgrade to the latest available firmware). Replace the board and/or send the board in for repair if the problem cannot be resolved.
29 P177 bit 13	Not Used			
30 P177 bit 14	Not Used			
31 P177 bit 15	DSP Fault		DSP is in faulted state (reason unknown).	Clear the fault and try resetting/restarting the RGU. Verify that all connections to the main control board are in place, and check the main control board for any obvious damage or any debris which may be shorting circuitry. If necessary, try reinstalling the firmware (or upgrade to the latest available firmware). Replace the board and/or send the board in for repair if the problem cannot be resolved.
32 P180 bit 0	Clock Loss	*W*	The host processor was reset due to a clock loss.	Try resetting/restarting the RGU when possible. Verify that all connections to the main control board are in place, and check the main control board for any obvious damage or any debris which may be shorting circuitry. If necessary, try reinstalling the firmware (or upgrade to the latest available firmware). Replace the board and/or send the board in for repair if the problem cannot be resolved.
33 P180 bit 1	Double Bus	*W*	The host processor was reset due to a memory access error. The memory device was not responding in cycle.	Try resetting/restarting the RGU when possible. Verify that all connections to the main control board are in place, and check the main control board for any obvious damage or any debris which may be shorting circuitry. If necessary, try reinstalling the firmware (or upgrade to the latest available firmware). Replace the board and/or send the board in for repair if the problem cannot be resolved.
34 P180 bit 2	Watchdog	*W*	The host processor was reset due to a watchdog situation.	Try resetting/restarting the RGU when possible. Verify that all connections to the main control board are in place, and check the main control board for any obvious damage or any debris which may be shorting circuitry. If necessary, try reinstalling the firmware (or upgrade to the latest available firmware). Replace the board and/or send the board in for repair if the problem cannot be resolved.
35 P180 bit 3	En at Pwr Up		The RGU enabled immediately at power up.	Verify that the parameters are programmed appropriately. If the RGU is set to 'Local Mode Only' (P8 = 0), then this fault can be suppressed or can be reported as a warning by reprogramming P181 and/or P182.
36 P180 bit 4	Battery Low	*W*	The lithium battery in the battery-backed RAM is low. If the RGU is powered down, all setup parameters will be lost.	Replace the battery on the U11 RAM chip as indicated in chapter 4 (or send the main control board in for repair).
37 P180 bit 5	TIO Loss		The slave RGU could not synchronize with the master RGU on power up since the TIO signal could not be found.	Verify that the master unit is operating properly. Check the R2R boards and fiber optic connections. Secure all terminals. If an R2R hub board is equipped, verify the wiring arrangement. Reset the RGUs.
38 P180 bit 6	R2R Dup Addr		The CAN chip detected two nodes trying to use a duplicate address.	Verify that only one unit is set as a master unit (P5). Check the R2R boards and fiber optic connections. Secure all terminals. If an R2R hub board is equipped, verify the wiring arrangement. Reset the RGUs. If necessary, reinstall or upgrade the firmware.
39 P180 bit 7	Lost Master		The slave RGU is not receiving data from the master unit (seen only on a slave RGU in a master-slave configuration).	Check the R2R boards and fiber optic connections. Secure all terminals. If an R2R hub board is equipped, verify the wiring arrangement. Verify that the master RGU is operating properly. Reset the RGUs.

Number	Fault		Indicates	Action
40 P180 bit 8	DPRAM Error		An error has been detected in the dual port RAM between the host processor and the DSP.	Clear the fault and try resetting/restarting the RGU. Verify that all connections to the main control board are in place, and check the main control board for any obvious damage or any debris which may be shorting circuitry. If necessary, try reinstalling the firmware (or upgrade to the latest available firmware). Replace the board and/or send the board in for repair if the problem cannot be resolved.
41 P180 bit 9	No Vloop Tic	*W*	The primary clock for the host processor (which is used to synchronize with the DSP) is missing.	The unit switches to the internal timer, but synchonization between the host processor and the DSP is lost. Try restarting the RGU, verify that all connections to the main control board are in place, and check the main control board for any obvious damage or any debris which may be shorting circuitry. If necessary, try reinstalling the firmware. Replace the board and/or send the board in for repair if the problem cannot be resolved.
42 P180 bit 10	No Fast Task		A watchdog error has been detected in the main control loop task of the host processor.	Clear the fault and try resetting/restarting the RGU. Verify that all connections to the main control board are in place, and check the main control board for any obvious damage or any debris which may be shorting circuitry. If necessary, try reinstalling the firmware (or upgrade to the latest available firmware). Replace the board and/or send the board in for repair if the problem cannot be resolved.
43 P180 bit 11	No Bgnd Task		A watchdog error has been detected in a background task of the host processor.	Clear the fault and try resetting/restarting the RGU. Verify that all connections to the main control board are in place, and check the main control board for any obvious damage or any debris which may be shorting circuitry. If necessary, try reinstalling the firmware (or upgrade to the latest available firmware). Replace the board and/or send the board in for repair if the problem cannot be resolved.
44 P180 bit 12	Addr Bus Err		An address bus error has been detected on the main control board.	Clear the fault and try resetting/restarting the RGU, verify that all connections to the main control board are in place, and check the main control board for any obvious damage or any debris which may be shorting circuitry. If necessary, try reinstalling the firmware (or upgrade to the latest available firmware). Replace the board and/or send the board in for repair if the problem cannot be resolved.
45 P180 bit 13	Data Bus Err		A data bus error has been detected on the main control board.	Clear the fault and try resetting/restarting the RGU, verify that all connections to the main control board are in place, and check the main control board for any obvious damage or any debris which may be shorting circuitry. If necessary, try reinstalling the firmware. Replace the board and/or send the board in for repair if the problem cannot be resolved.
46 P180 bit 14	Line Low	*W*	The input line voltage has fallen below the minimum threshold (as defined in P26).	Verify the parameter setup. Check the Frame Catalog Number (P4), the Rated AC Line Current (P11), and the AC Line Low Setting (P26). Verify that the current feedback burden resistors (on the isolation board) are appropriately sized.
47 P180 bit 15	Line High	*W*	The input line voltage has exceeded the maximum threshold (as defined in P27).	Verify the parameter setup. Check the Frame Catalog Number (P4), the Rated AC Line Current (P11), and the AC Line High Setting (P27). Check that the current feedback burden resistors (on the isolation board) are appropriately sized.
48 P183 bit 0	I2t Warnings	*W*	The I2t wire protection has evaluated the heatsink to power module junction temperatures, and is indicating that the temperature is at half of the trip point.	The internal wiring may be at risk of overheating. Check that all the door fans are operating properly, and verify that the RGU is operating at the appropriately derated current (see the specification appendix of 2364F-5.01). Verify that the RGU is not operating in overload for an extended period of time.

Note: *'W'* indicates that the condition is normally reported as a warning, rather than a fault.

Number	Fault		Indicates	Action
49 P183 bit 1	I2t Overload	*W*	The I2t wire protection has tripped the unit since the heatsink to power module junction temperature has exceeded the maximum allowed.	The internal wiring may be at risk of overheating. Check that the door fans are operating properly, and verify that the RGU is operating at the appropriately derated current (see the specifications appendix in 2364F-5.01). Verify that the RGU is not operating in overload for an extended period of time. Check internal wiring and components for heat damage (melted wiring or burn marks).
50 P183 bit 2	H/S Hightemp	*W*	The heatsink temperature has exceeded 80ºC.	Check that the door fans are operating properly. Verify that the RGU is operating at the appropriately derated current (see the specifications appendix in 2364F-5.01). Verify that the RGU is not operating in overload for an extended period of time.
51 P183 bit 3	Reset Req'd	*W*	The RGU recognizes that a reset is required.	Reset the RGU. Either shut down the RGU and restart, or reset the RGU through a HIM or GPT.
52 P183 bit 4	NTC Open	*W*	The RGU has detected that the circuit for the NTC bridge thermal sensor is open.	Verify that the NTC wiring is in good condition. Check the connection on the main control board (J2). If necessary, replace the NTC sensor.
53 P183 bit 5	NTC Short	*W*	The RGU has detected that the NTC bridge thermal sensor wires are shorted together.	Verify that the NTC wiring is in good condition. Check the connection on the main control board (J2). If necessary, replace the NTC sensor.
54 P183 bit 6	MSTR Faulted	*W*	The slave RGU has received a faulted status from the master RGU through the R2R network.	Check the master RGU fault queue and correct the situation. Shut down the RGUs in the system. Restart all the RGUs after all the power has been discharged from the DC bus (restart the master RGU first).
55 P183 bit 7	1 Phase Warn	*W*	The RGU has detected a single phase condition on the incoming AC power. The threshold for detecting this condition is set by 1 Phase Threshold (P147).	If the phase does not return, check the power source, check the incoming AC line fuses (F1, F2, F3), and check for shorts from the lost phase to ground (PE). If there is no actual phase loss, check the AC line sensor fuses and the J1 connection to the isolation board.
56 P183 bit 8	1 Phase Err		The detected single phase condition has persisted beyond the time limit specified by 1 Phase Err Delay (P148).	If the phase does not return, check the power source, check the incoming AC line fuses (F1, F2, F3), and check for shorts from the lost phase to ground (PE). If there is no actual phase loss, check the AC line sensor fuses and the J1 connection to the isolation board.

Note: *'W'* indicates that the condition is normally reported as a warning, rather than a fault.

Testing Components

Components

This chapter provides instructions for testing RGU components. The topics listed below are covered in this chapter.

Topics in this Chapter
Testing and Replacing Parts in the Power Structure
Testing the Main Control Board
Testing the Gate Driver Board
Testing the Isolation Board
Testing the Control Power Filter
Testing the Line RC Suppressor
Testing the DC Bus Suppressor
Testing MOVs
Testing Precharge Resistors
Testing IGBTs
Terminal Blocks

ATTENTION: Do not attempt to alter or modify any printed circuit boards in the RGU. Any attempt to alter or modify boards may result in personal injury or property damage.

Testing and Replacing Parts in the Power Structure

The RGU power structure design is based on the 1336 FORCE drive. To test or replace parts in the power structure, refer to the instructions in this publication, and refer to the appropriate 1336 FORCE service manual, listed in Table 4.A, for additional details.

Table 4.A: 1336 FORCE Service Manuals

RGU Current Code	Reference Publication
J	1336 FORCE - 6.12
K	1336 FORCE - 6.13
L	1336 FORCE - 6.14
M	1336 FORCE - 6.15
N	*Not available at time of publishing.*

Note: *Most of the construction and components of the N-code power structure are equivalent to the M-code power structure. Publication 1336 FORCE - 6.15 can be used to service N-code power structures.*

How the RGU Power Structure Differs From the 1336 FORCE

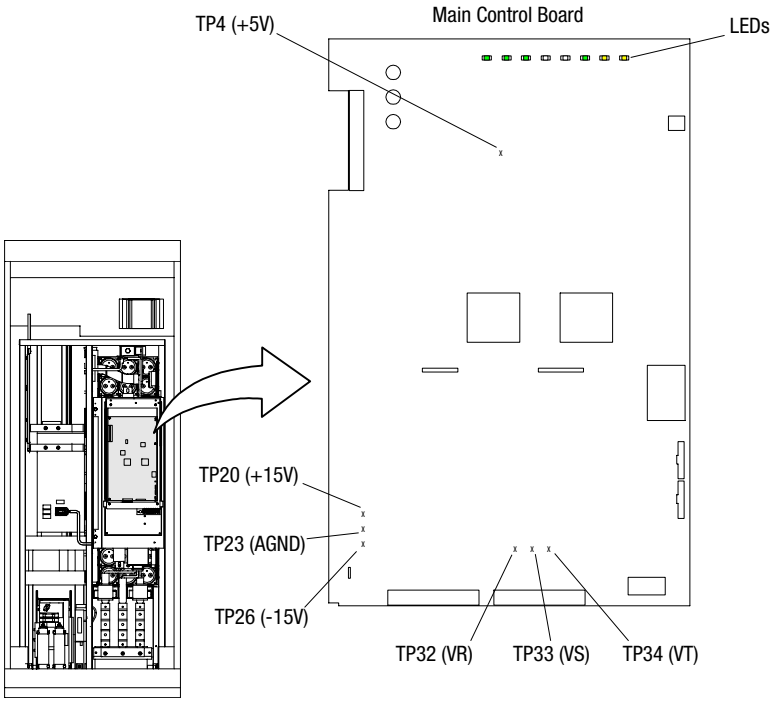
When using the 1336 FORCE service manuals, take note that the RGU power structure differs from the 1336 FORCE in the following regards:

- The power structure has an isolation board in place of the 1336 FORCE precharge board.
- The power structure has an RGU main control board in place of the 1336T main control board, standard adapter board, and HIM mounting bracket.
- The power structure does not include SCRs, SCR heatsinks, SCR snubber boards, or the SCR cooling fan.
- The power structure does not include a ground sense current transducer.
- The power structure does not include a DC bus inductor.
- The power structure can include an optional R2R communication board, R2R hub board, and/or SCANport interface board.
- The power structure may include a third current transducer on phase L2.
- The power structure may have a power supply filter board mounted below the gate driver board.

Testing the Main Control Board

The main control board regulates the power structure operation, and is capable of communication with external devices through SCANport and analog I/O.

Figure 4.1
Main Control Board



Note: *A full listing of test points and a detailed drawing of the main control board can be found in Appendix A.*

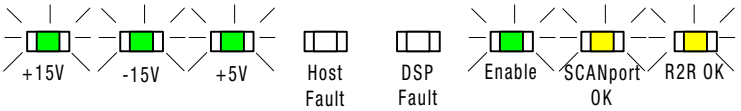
Important: Always record or store parameters before replacing the main control board, upgrading firmware, or replacing the battery for the battery-backed memory (parameters can be stored in the internal memory of a GPT or Series B HIM, or can be stored on a PC using DriveTools).

1. With power applied to the unit, check the LED indicators on the main control board (see Figure 4.2).

Figure 4.2
LED Indicators

Normal Operation

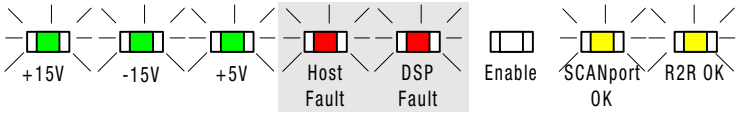
The LEDs should be illuminated as shown when the unit is enabled.



Fault LED(s) are Illuminated

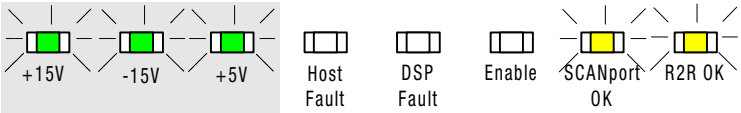
Check the fault queue if either of the fault LEDs are illuminated (see chapter 3 to troubleshoot).

Reinstall firmware if the host fault LED is flashing.



Power LEDs are not Illuminated (or are weak)

Check the wiring connections on the main control board and test the gate driver board if the power LEDs are not illuminated or are weak.



2. Set meter for DC voltage. Check the power supply to the main control board by testing the voltage across the test points shown in Table 4.B.

Table 4.B: Power Supply Test Points–Main Control Board

Test Points	Typical Voltage
TP4 to AGND	4.7 to 5.3V DC
TP20 to AGND	14.4 to 15.4V DC
TP26 to AGND	-14.4 to -15.4V DC

Note: *If a low voltage is seen, the ribbon cable (at J3) may need to be connected/replaced, or the gate driver board may need to be tested (the gate driver board supplies power for the main control board and isolation board).*

3. Set meter for AC voltage. Check the AC line feedback by testing the voltage of TP32, TP33, and TP34 with respect to AGND. Table 4.C shows the typical voltages that should be seen for these test points.

Table 4.C: AC Line Feedback Test Points–Main Control Board

Rated Line Voltage	Typical Voltage at Test Points
380V AC	1.08 to 1.21V AC
460V AC	1.28 to 1.42V AC
575V AC	1.62 to 1.76V AC

Note: *If a low voltage is seen, the ribbon cable (at J12) may need to be connected/replaced, or the isolation board may need to be tested.*

Consider checking the gate driver board and isolation board, as necessary. If there are firmware or SCANport problems, try reinstalling or upgrading to the latest available firmware.

If the board has failed any of these tests, or if the unit continually faults with the items shown in Table 4.D, the board may be damaged. Consider replacing the board and/or sending the board to Rockwell Automation for repair.

Table 4.D: AC Line Feedback Test Points–Main Control Board

Fault Number	Fault Name	Fault Number	Fault Name
0	ROM Bad CRC	32	Clock Loss
1	RAM Error	33	Double Bus
2	BatRAM Err	34	Watchdog
3	DSP Load	36	Battery Low
4	FPGA Load	40	DPRAM Err
7	SCANport Err	41	No Vloop Tic
13	BRAM Chksum	42	No Fast Task
15	DSP Timeout	43	No Bgnd Task
28	DualPort TO	44	Addr Bus Err
31	DSP Fault	45	Data Bus Err

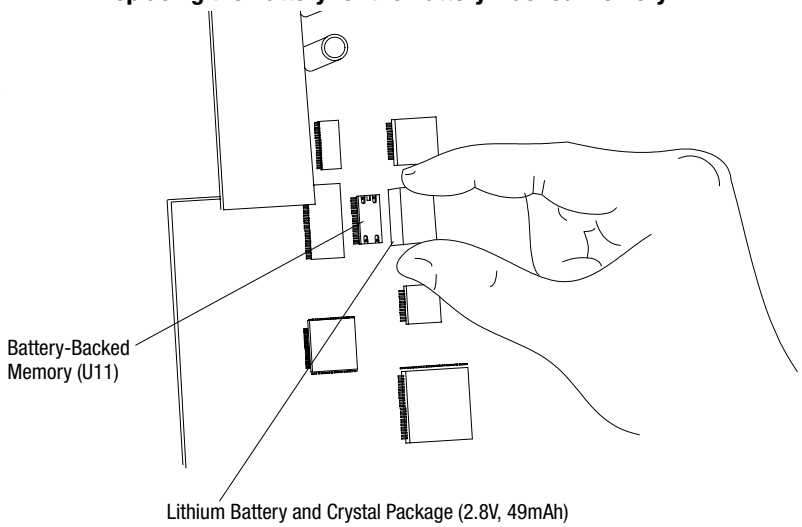
Replacing the Battery for the Battery-Backed Memory on the Main Control Board

Replacing the battery on the main control board (U11) will erase all modified parameters. Record parameters before replacing the battery.

1. Push the disconnect lever to off and wait for all voltage to discharge from the unit. Do not continue until all voltage has dissipated from the DC bus.
2. Verify that there is no voltage across the DC bus (see Figure 4.12 and Figure 4.13 for check points).
3. Verify that there is no voltage across the terminals and subcomponents of the main control board.
4. Put on an electrostatic discharge (ESD) protective strap and connect the strap to one of the door latches.
5. Grasp the battery, from the top and bottom, and gently pull the battery off of U11 as shown in Figure 4.3 (note the orientation of the battery).
6. Gently press the new battery into place (the battery can only be installed in one orientation).
7. Properly dispose of the lithium battery according to your local ordinances and company procedures.

See publication 1756-5.68 for guidelines concerning lithium battery disposal.

Figure 4.3
Replacing the Battery for the Battery-Backed Memory



Testing the Gate Driver Board

The gate driver board turns the IGBT gates on and off and supplies power to the main control board and isolation board.

Figure 4.4
Accessing the Gate Driver Board

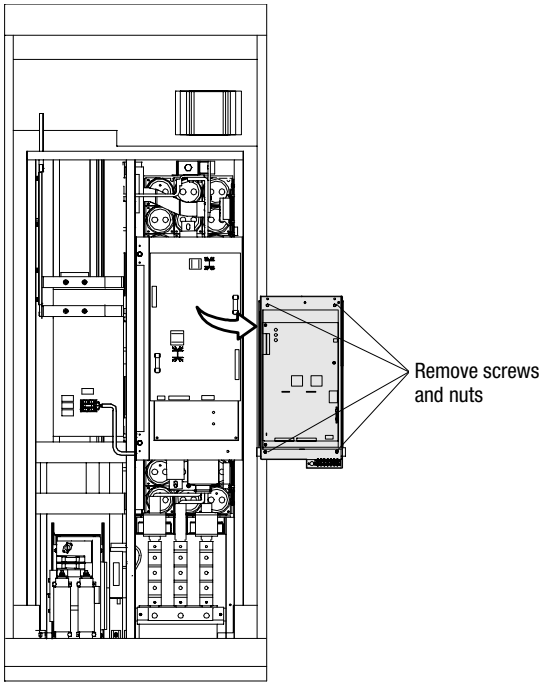
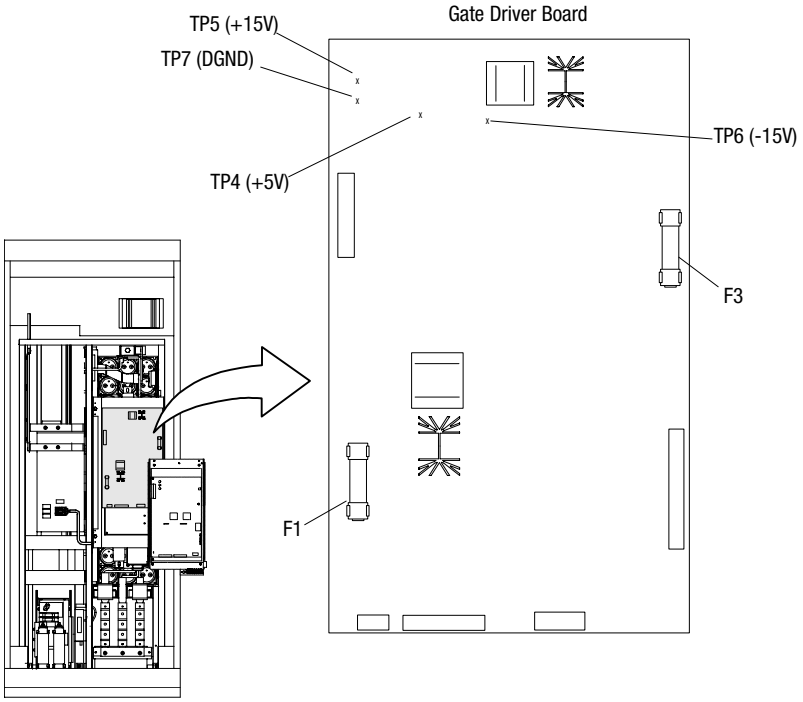


Figure 4.5
Gate Driver Board



Note: *A full listing of test points and a detailed illustration of the gate driver board can be found in Appendix A.*

1. Push the disconnect lever to off and wait for all voltage to discharge from the unit. Do not continue until all voltage has dissipated from the DC bus.

2. Verify that there is no voltage across the DC bus (see Figure 4.12 and Figure 4.13 for check points.

3. Disconnect all wiring from the main control board (J2, J3, J9, J10, J11, J12, and TB1).

4. Remove the mounting panel for the main control board (see Figure 4.4).

5. Test fuses F1 and F3 on the gate driver board. If a fuse is damaged, replace the board (the damaged board can be sent to Rockwell Automation for repair).

6. Secure all wiring to the gate driver board (J1, J7, J8, J10, and TB7).

7. Set meter(s) to test for DC voltage.

8. Connect meter leads to the test points indicated in Table 4.E (if necessary, test only one set of test points at a time).

Table 4.E: Power Supply Test Points–Gate Driver Board

Test Points	Typical Voltage
TP4 to DGND	4.7 to 5.3V DC
TP5 to DGND	14.4 to 15.4V DC
TB6 to DGND	-14.4 to -15.4V DC

9. With the meter leads connected, reattach the mounting panel for the main control board.

10. Reconnect all wiring to the main control board (J2, J3, J9, J10, J11, J12, and TB1).

11. Push the disconnect lever to on and turn the start switch to on.

12. Check the voltage readings. If the readings do not comply with Table 4.E, replace the gate driver board.

    Note: *If the gate driver board is damaged, IGBTs and snubber boards may also need to be tested.*

If the board has failed any of these tests, or if the unit continually faults with the items shown in Table 4.F, the board may be damaged. Consider replacing the board and/or sending the board to Rockwell Automation for further testing and repair.

Table 4.F: Typical Faults–Possibly Involving the Gate Driver Board

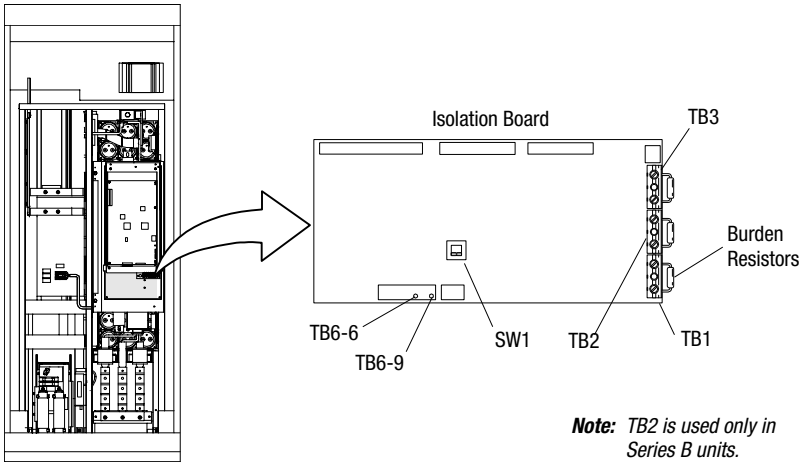
Fault Number	Fault Name
9	Control Volt
16	Desaturization

For additional test procedures, see the appropriate 1336 FORCE service manual (see Table 4.A).

Testing the Isolation Board

The isolation board receives feedback from the AC line, DC bus, current transducers, main contactor (M1), and reset button. This feedback is passed to the main control board for processing.

Figure 4.6
Isolation Board



Note: *A detailed illustration of the isolation board can be found in Appendix A.*

1. Push the disconnect lever to off and wait for all voltage to discharge from the unit. Do not continue until all voltage has dissipated from the DC bus.

2. Verify that there is no voltage across the DC bus (see Figure 4.12 and Figure 4.13 for check points).

3. Verify that there is no voltage across the terminals and subcomponents of the isolation board.

4. Set meter to test resistance.

5. Check the resistance of each burden resistor. Replace any burden resistors that do not comply with the specifications give in Table 4.G.

Table 4.G: Burden Resistor Specifications

Current Code	Rated Input Voltage	Rated Resistance (Acceptable Readings)	
J	380/460	8.87 ohm	(8.84-9.31 ohm)
J	575	11.0 ohm	(10.45-11.55 ohm)
K	380/460/575	7.5 ohm	(7.12-7.88 ohm)
L	380/460	6.19 ohm	(5.88-6.50 ohm)
L	575	7.15 ohm	(6.79-7.51 ohm)
M	380/460	4.02 ohm	(3.82-4.22 ohm)
M	575	4.53 ohm	(4.30-4.76 ohm)
N	380/460	3.01 ohm	(2.86-3.16 ohm)
N	575	3.40 ohm	(3.23-3.57 ohm)

6. Check all wiring connections on the isolation board and verify that SW1 is set appropriately (115V AC).

7. Set meter to test AC voltage. While applying power to the unit, check the voltage across the bus control relay (TB6-6 to TB6-9). The voltage should rise to 115V AC during precharge, then drop to zero after precharge.

If the board has failed any of these tests, or if the unit continually faults with the items shown in Table 4.H, the board may be damaged. Consider replacing the board and/or sending the board to Rockwell Automation for repair.

Table 4.H: Typical Faults–Possibly Involving Isolation Board

Fault Number	Fault Name
17	Board Intlk
20	Zero Seq Err
21	Phase Lock Loop
22	Phase Loss
27	I Offset Err

Testing the Control Power Filter

The control power filter reduces the noise in the control power. The effectiveness of the filter can be checked by viewing the waveforms before and after the filter (there should be less noise seen after the filter, as shown in Figure 4.7).

Push the disconnect lever to off and wait for all voltage to discharge from the unit. Do not continue until all voltage has dissipated from the DC bus.

Verify that there is no voltage across the DC bus (see Figure 4.12 and Figure 4.13 for check points).

Verify that there is no voltage across the subcomponents of the control power filter.

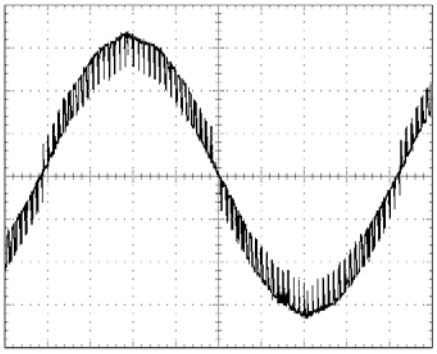
Set meter for resistance and check the resistor. For 4 kHz filters, the resistance should be 0.8-1.4 ohms (1 ohm rating). For 2 kHz filters, the resistance should be 1.3-1.9 ohms (1.5 ohm rating).

Check the continuity between C1-1 and the connection point for the control power transformer (PT1).

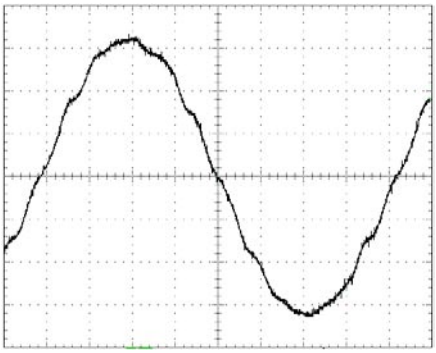
If the filter has failed any of these tests, it may be damaged. Replace the filter and consider replacing any associated wiring or fuses, as necessary.

Figure 4.7
Voltage Waveforms Ahead and After the Control Power Filter

Typical Control Power–Ahead of Filter



Typical Control Power–After Filter



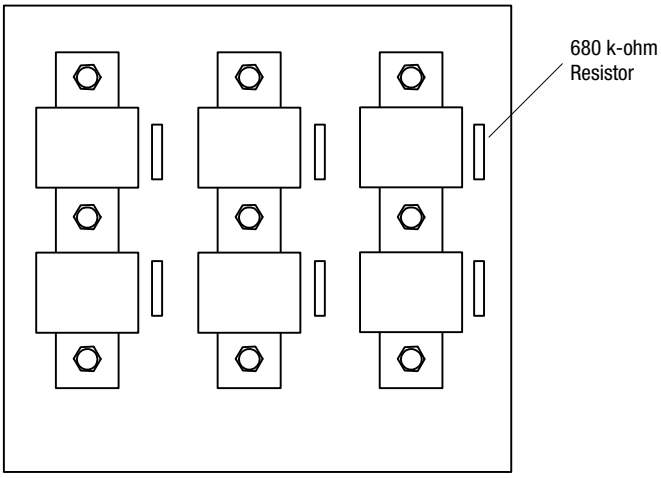
Testing the Line RC Suppressor

The line RC suppressor discharges excess voltage from the AC lines.

1. Push the disconnect lever to off and wait for all voltage to discharge from the unit. Do not continue until all voltage has dissipated from the DC bus.
2. Verify that there is no voltage across the DC bus (see Figure 4.12 and Figure 4.13 for check points).
3. Verify that there is no voltage across the subcomponents of the suppressor.
4. Check the board, fuses, and any associated wiring for visible damage (burn marks, or damaged subcomponents).
5. Remove fuses F14, F15, and F16.
6. Set meter for resistance and test each resistor on the board. Each resistor should read 670-700 k-ohm (680 k-ohm rating).
7. Reinstall fuses F14, F15, and F16. Check the fuses with a meter.

If the board has failed any of these tests, the board may be damaged. Replace the board and consider replacing any associated wiring or fuses, as necessary.

Figure 4.8
Line RC Suppressor



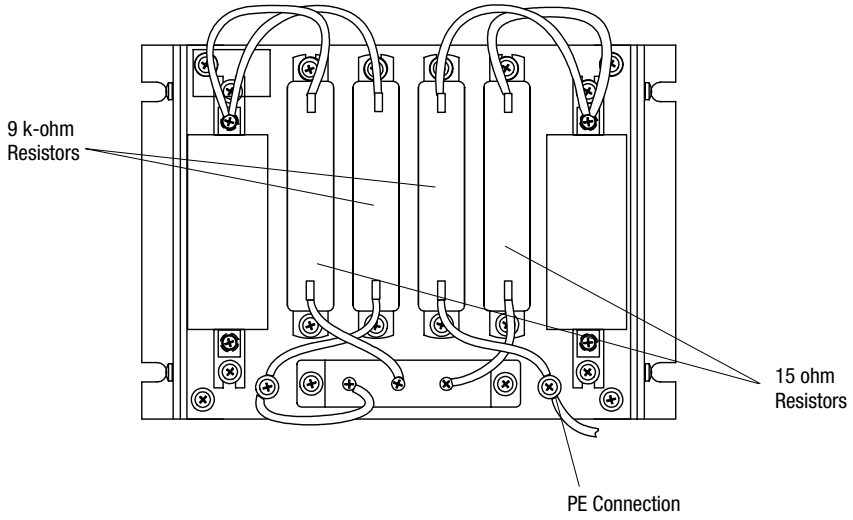
Testing the DC Bus Suppressor

The DC bus suppressor discharges excess voltage from the DC bus.

1. Push the disconnect lever to off and wait for all voltage to discharge from the unit. Do not continue until all voltage has dissipated from the DC bus.
2. Verify that there is no voltage across the DC bus (see Figure 4.12 and Figure 4.13 for check points).
3. Verify that there is no voltage across the subcomponents of the suppressor.
4. Check the suppressor and any associated wiring for visible damage (burn marks or damaged subcomponents).
5. Check the resistance between the top of each capacitor with respect to the PE terminal. The meter should show 8-10 ohms.
6. Set meter for resistance and test each resistor. The two middle resistors should read 8.5-9.5 k-ohms (9 k-ohm rating). The two outer resistors should read 14.7-15.8 ohms (15 ohm rating).

If the suppressor has failed any of the above tests, it may be damaged. Replace the suppressor and consider replacing any associated wiring, as necessary.

Figure 4.9
DC Bus Suppressor



Testing MOVs

MOVs provide surge, line-to-line, and line-to-ground protection for the RGU.

1. Push the disconnect lever to off and wait for all voltage to discharge from the unit. Do not continue until all voltage has dissipated from the DC bus.
2. Verify that there is no voltage across the DC bus (see Figure 4.12 and Figure 4.13 for check points).
3. Observe the MOVs (typically located near the circuit breaker). Replace any MOVs that are visibly damaged.

Testing Precharge Resistors

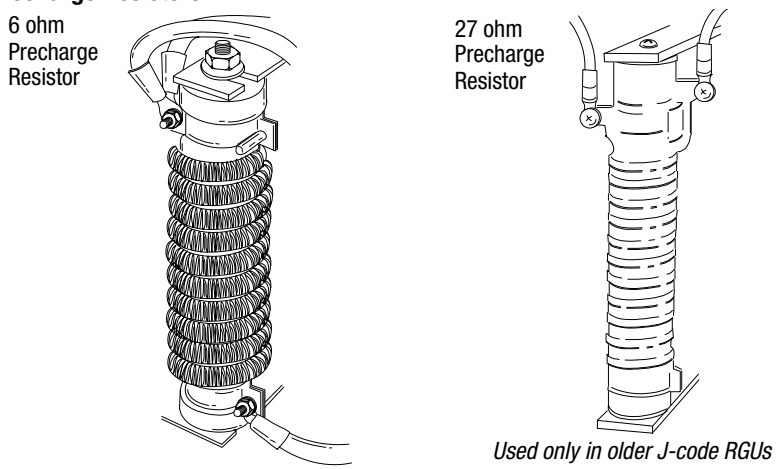
The precharge resistors help the RGU supply appropriate voltage to the internal capacitors during the precharge routine.

1. Push the disconnect lever to off and wait for all voltage to discharge from the unit. Do not continue until all voltage has dissipated from the DC bus.
2. Verify that there is no voltage across the DC bus (see Figure 4.12 and Figure 4.13 for check points).
3. Check the precharge fuses.
4. Set meter to check resistance. Disconnect and check each of the precharge resistors. Resistors should indicate a resistance of 5.6-6.8 ohms (6 ohm rating).

   Note: *Older J-code RGU resistors should have a resistance of 26.5-28.0 ohms (27 ohm rating). This resistor is shown in Figure 4.10.*

Replace any damaged components and associated wiring, as necessary.

Figure 4.10
Precharge Resistors



Testing IGBTs

IGBTs can be checked by testing the resistance of the AC terminals with respect to the DC busbars.

1. Push the disconnect lever to off and wait for all voltage to discharge from the unit. Do not continue until all voltage has dissipated from the DC bus.

2. Verify that there is no voltage across the DC bus (see Figure 4.12 and Figure 4.13 for check points).

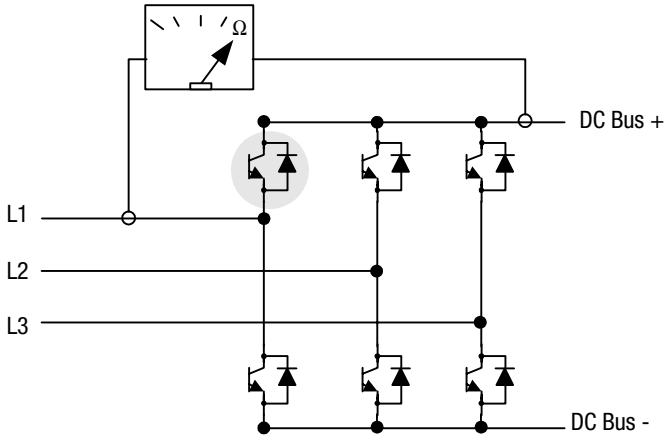
3. Test the resistance between L1 and DC Bus+. J, K, and L-code RGUs should show a high resistance (over 500 k-ohms), M and N-code RGUs should indicate a resistance of 5 to 10 k-ohms (since two IGBTs are installed in parallel). Test the other two lines (L2 and L3) with respect to DC Bus+.

4. Test the resistance of L1, L2, and L3 with respect to DC Bus-. Again, J, K, and L-code RGUs should read over 500 k-ohms, while M and N-code RGUs should read 5 to 10 k-ohms.

5. Set meter to check diodes. Take a reading of L1 to DC Bus+ (with negative lead on the DC bus). A reading of 0.2 to 0.4 volts should be seen. Test the other two lines with respect to DC Bus+.

6. Take a reading of L1 to DC Bus- (with positive lead on DC bus). Again a reading of 0.2 to 0.4 volts should be seen. Test the other two lines with respect to DC Bus-.

Figure 4.11
Testing IGBTs



If any of these tests have failed, the particular IGBTs may be damaged (opened or shorted). Replace any damaged IGBTs and consider testing the gate driver board and snubber boards.

Additional test instructions for the IGBTs (power modules) can be seen in the 1336 FORCE service manuals (see Table 4.A).

Figure 4.12
Check Points on AC Line and DC Bus (J, K, and L-code RGUs)

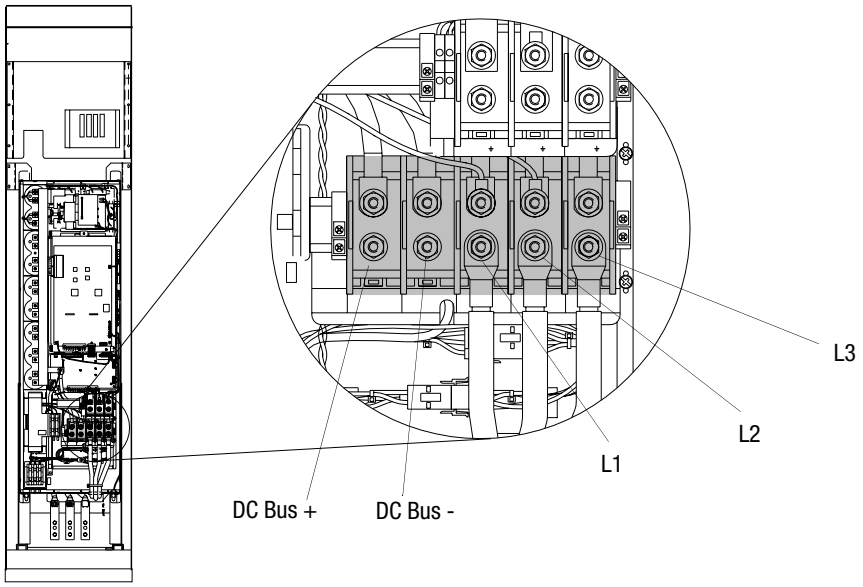
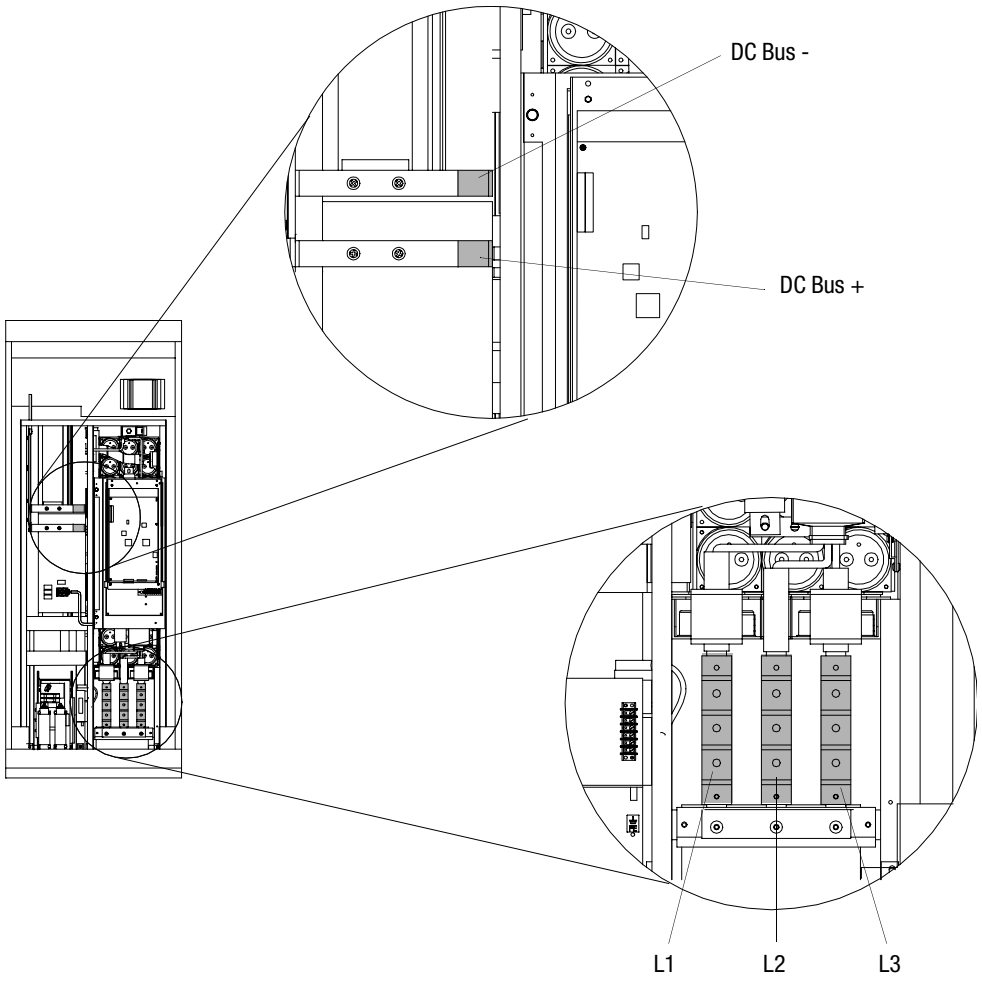


Figure 4.13
Check Points on AC Line and DC Bus (M and N-code RGUs)



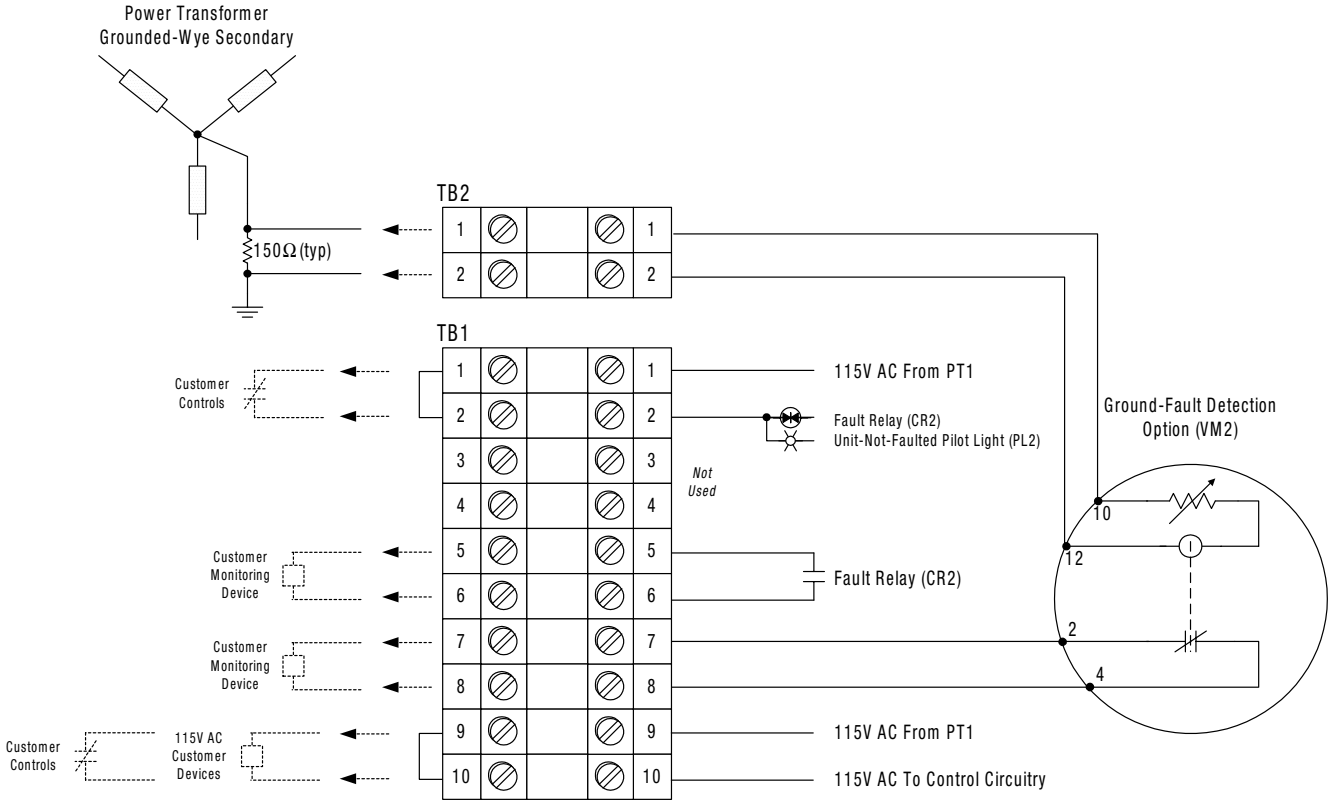
Terminal Blocks

The RGU includes two terminal blocks which are available for customer connections (TB1 and TB2, shown in Figure 4.14). These terminal blocks are located in the leftmost bay of the unit.

The RGU also has an analog I/O terminal block available for customer connections (TB1, on the main control board). Details for connecting, programming, and using analog I/O can be found in publication 2364F-5.01.

N-code RGUs also include an additional terminal block (TB3). This terminal block is dedicated for motor-operated circuit breaker wiring.

Figure 4.14
Terminal Blocks–TB1 and TB2



Reference Information

Contents

This appendix includes reference information for the RGU, as indicated below.

Reference Information in This Chapter
Specifications
Printed Circuit Boards
Test Points
Board-to-Board Schematics
Firmware Diagrams

Specifications

Table A: Functional Specifications

Efficiency	97%
AC Input Frequency Tolerance	45 to 65 Hz
AC Input Voltage Tolerance	±10%
Motoring Output Current Overload	150% of rated current for 60 seconds
Regenerating Output Current Overload	150% of rated current for 60 seconds 150% of rated current for 30 seconds (380/460V AC N-code RGUs at 40°C, or 575V AC N-code RGUs at 30°C)
Output Voltage Variation	10% maximum for a ±100% DC output current step load change
Resolution of Output Voltage Selection	1.0V
Voltage Regulator Bandwidth	200 radians/sec maximum
Current Regulator Bandwidth	800 radians/sec (for 2 kHz units) 1200 radians/sec (for 4 kHz units)

Table B: Electrical Specifications–Part 1

RGU Current Code	Nominal Input Voltage (V AC)	① Continuous AC Line Current (A AC)	Input Power (kVA)	Nominal DC Bus Voltage (V DC)	Maximum Continuous DC Bus Current (A DC)	② Rated DC Bus (kW)	Control Transformer Ratings	
							Basic Capacity (kVA)	Standard Capacity (kVA)
J	380	77	51	564	85	49	2.0	5.0
K	380	182	120	564	200	116	2.0	5.0
L	380	330	217	564	363	211	2.0	5.0
M	380	678	447	564	746	433	5.0	5.0
N	380	906	596	564	997	578	5.0	10.0
J	460	77	61	683	85	59	2.0	5.0
K	460	182	145	683	201	141	2.0	5.0
L	460	330	263	683	364	255	2.0	5.0
M	460	678	541	683	749	524	5.0	5.0
N	460	906	722	683	1000	700	5.0	10.0
J	575	77	62	848	88	74	2.0	5.0
K	575	182	181	848	201	170	2.0	5.0
L	575	286	285	848	326	276	2.0	5.0
M	575	602	600	848	686	582	5.0	5.0
N	575	802	799	848	914	775	5.0	10.0

① The continuous AC line current values apply to both motoring and regenerating operations.

② Rated DC bus kW is the power available on the DC thru bus at rated voltage and current.

Electrical Specifications–Part 2

RGU Current Code	Input Voltage (V AC)	Internal Capacitance (uF)	Line Inductance (uH)	Overcurrent Trip (Arms)	Overcurrent Trip Reference (TP20 Volts)	Overvoltage Trip (V DC)	Overvoltage Trip Reference (TP22 Volts)	Burden Resistor (Ohms)	Warning Temperature (ºC)	Trip Temperature (ºC)
J	380	6450	1193	173	4.55	820	3.75	8.87	80	100
K	380	12000	510	409	4.55	820	3.75	7.50	80	100
L	380	15000	317	743	4.55	820	3.75	6.19	80	100
M	380	24000	137	1526	4.55	820	3.75	4.02	80	110
N	380	24000	102	2039	4.55	820	3.75	3.01	80	110
J	460	6450	1193	173	4.55	820	3.75	8.87	80	100
K	460	12000	510	409	4.55	820	3.75	7.50	80	100
L	460	15000	317	743	4.55	820	3.75	6.19	80	100
M	460	24000	137	1526	4.55	820	3.75	4.02	80	110
N	460	24000	102	2039	4.55	820	3.75	3.01	80	110
J	575	2860	1853	140	4.55	1025	4.69	11.0	80	100
K	575	6000	832	409	4.55	1025	4.69	7.50	80	100
L	575	15000	404	644	4.55	1025	4.69	7.15	80	100
M	575	24000	191	1354	4.55	1025	4.69	4.53	80	110
N	575	24000	144	1805	4.55	1025	4.69	3.40	80	110

Table C: Typical Capacitor Bank Values per Drive in uf/10 (For 380/460V AC Lineups)

Frame Size ⇨	A							B					C	D			E		F		G		H
HP ⇨	0.5-1	1.5	2	3	5	7.5-10	15-20	1	3	7.5-10	15	20-30	40-60	60	75-100	125-150	150-200	250	250	300-450	250	300-600	700-800
1336 FORCE/SA3100	-	-	-	-	-	-	-	16	33	135	215	430	645	645	900	1200	1200	1500	-	2070	1500	2400	2400
1336 IMPACT	16	22	33	47	68	135	-	-	-	-	215	430	645	645	900	1200	1200	1500	-	2070	1500	2400	2400
1336 PLUS/1336 PLUS II	16	22	33	47	68	135	135	-	-	-	215	430	645	645	900	1200	1200	1500	2070	2070	1500	2400	-

Table D: Typical Capacitor Bank Values per Drive in uf/10 (For 575V AC Lineups)

Frame Size ⇨	A		B		C	D		E		F	G	H
HP ⇨	1-10	15-20	1-10	15-20	25-60	75-100	125	150	200-300	350-400	300-600	700-800
1336 FORCE/SA3100	-	-	90	140	290	400	600	900	1500	1800	2400	2400
1336 IMPACT	75	-	-	140	290	400	600	900	1500	1800	2400	2400
1336 PLUS/1336 PLUS II	75	75	-	-	290	400	600	900	1500	1800	2400	-

Table E: Typical Capacitor Bank Values for each SA3000 Inverter (in uf/10)

Inverter	56A	70A	112A	140A	192A	240A	534A	972A	1457A
Capacitance	380	470	760	940	1330	1645	3200	6400	12800

Printed Circuit Boards

Figure 1
Main Control Board

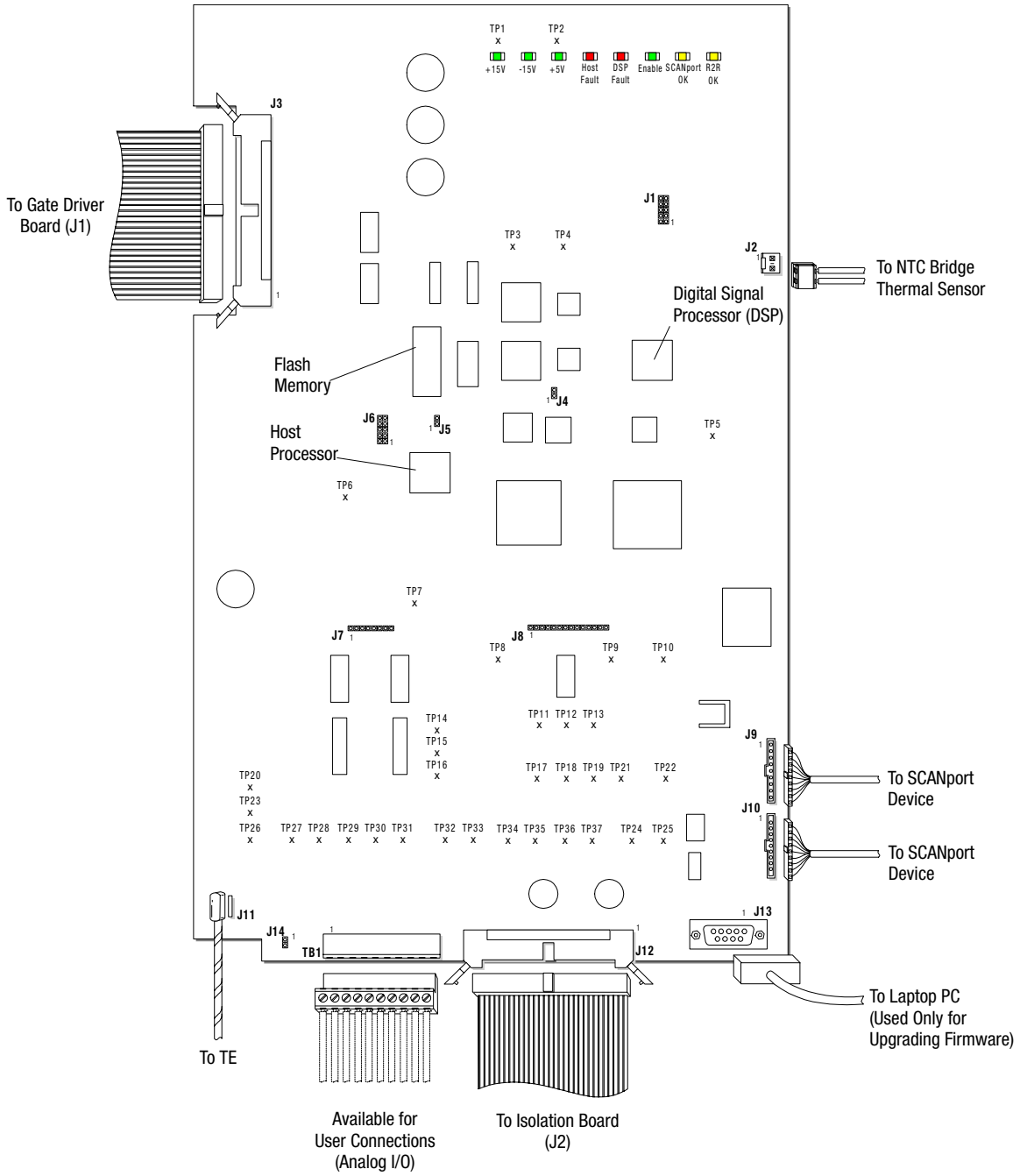


Figure 2
Gate Driver Board

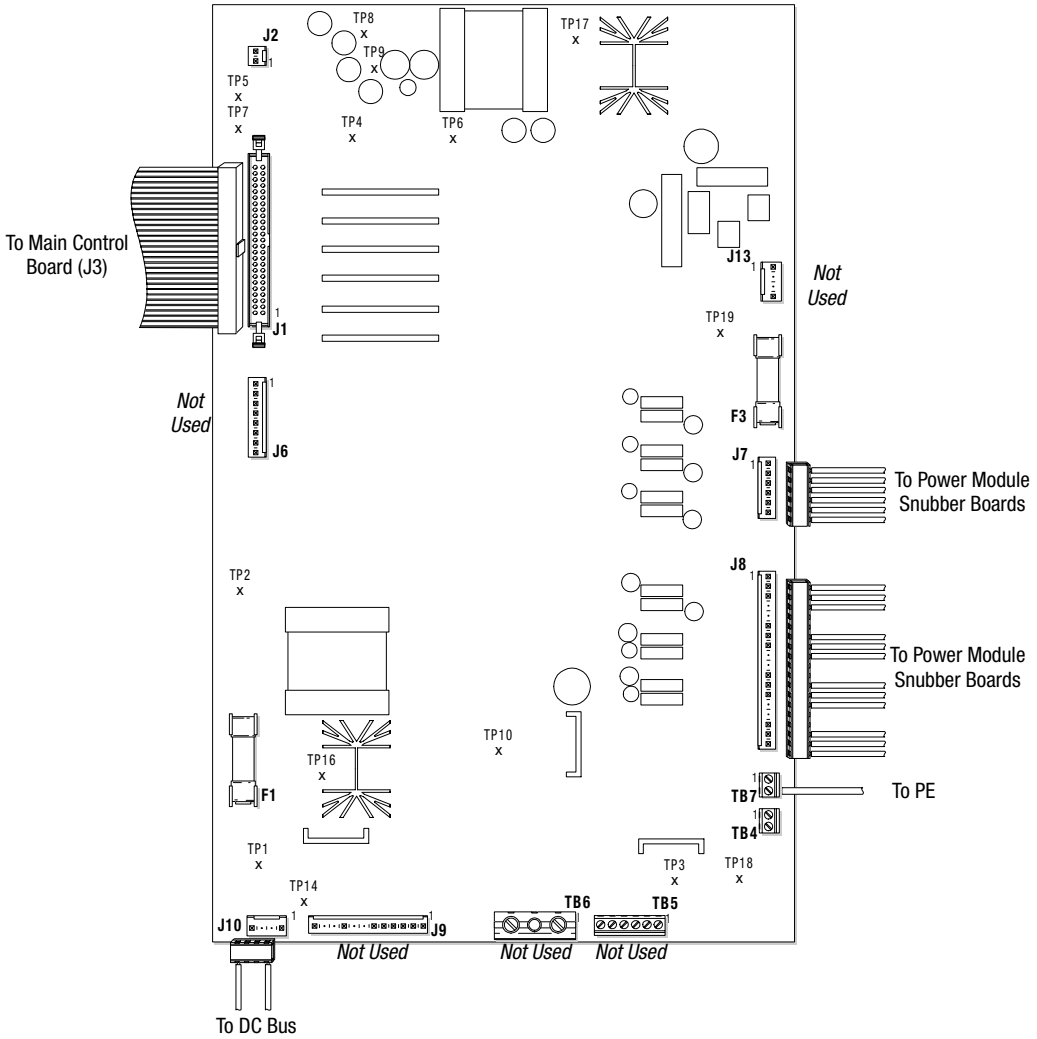
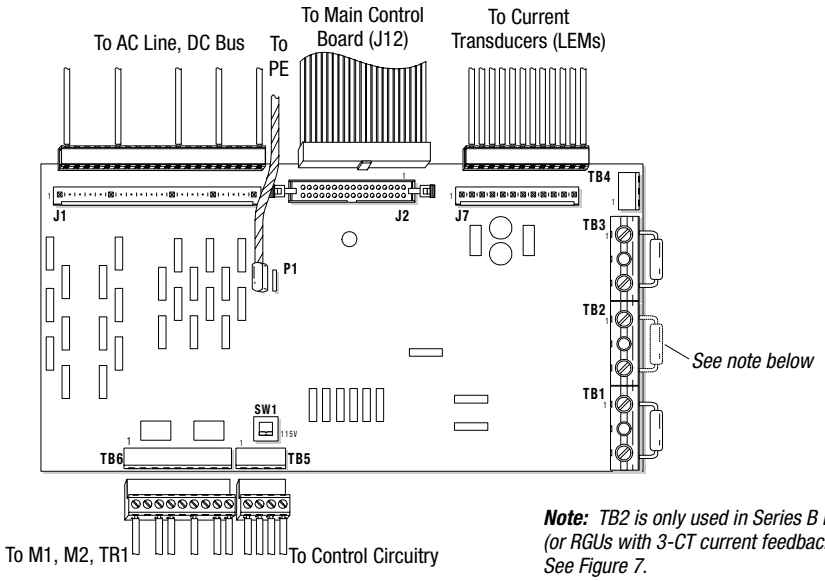


Figure 3
Isolation Board



Note: *TB2 is only used in Series B RGUs (or RGUs with 3-CT current feedback). See Figure 7.*

Test Points

Table F: Test Points–Main Control Board

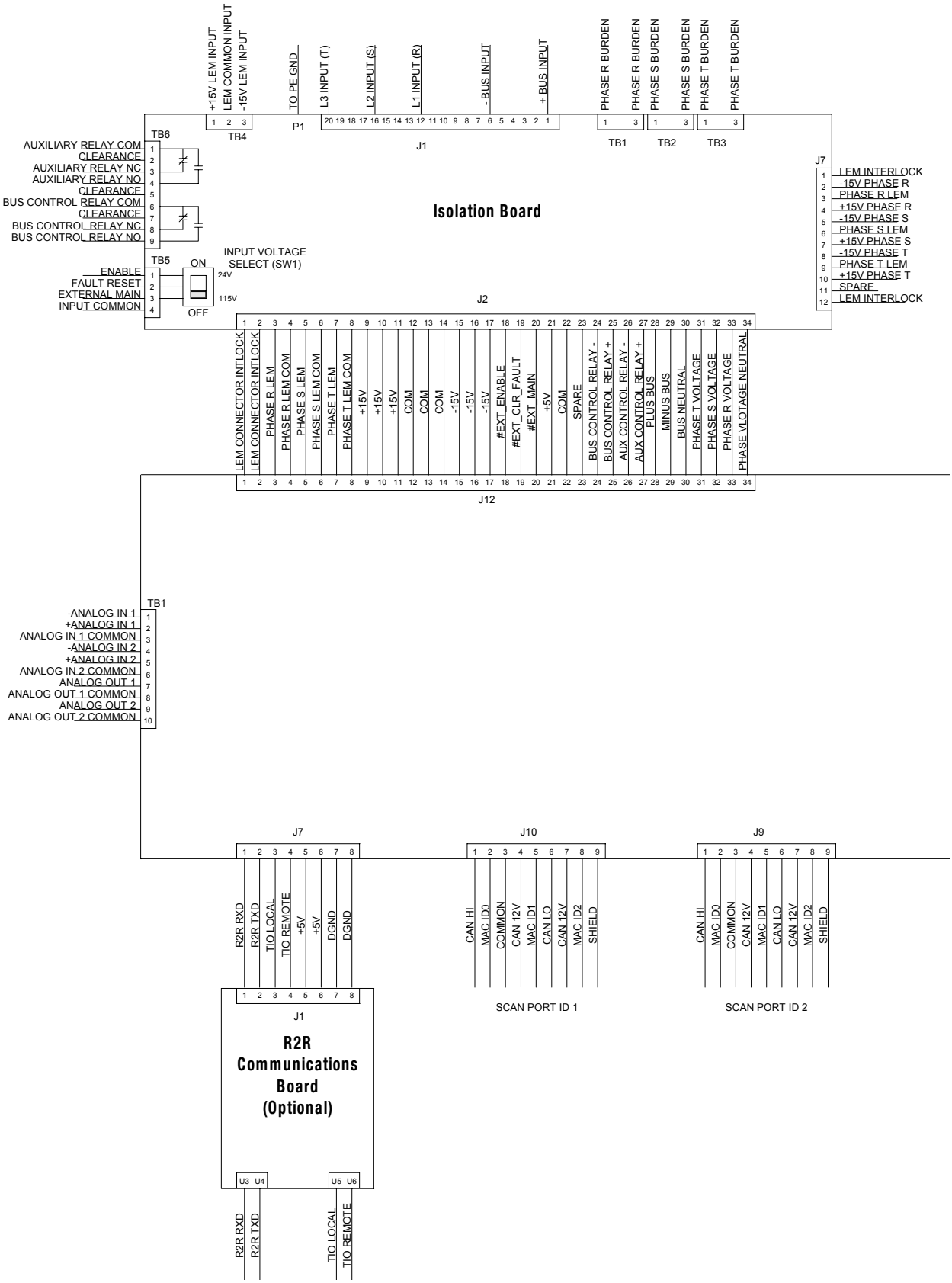
Test Points	Name	Description	Scale	Typical Range
TP1	AGND	Analog Ground	-	-
TP2	DGND	Digital Ground	-	-
TP3	DGND	Digital Ground	-	-
TP4	+5V	+5V Power Supply	1:1	4.8 to 5.5V DC
TP5	DGND	Digital Ground	-	-
TP6	RESET	Ground for Reset	-	-
TP7	DGND	Digital Ground	-	-
TP8	ANIN8	Analog In 8 Reference	-	-10 to +10V DC (see parameter P44 in pub 2364F-5.01)
TP9	DESAT	Power Desaturization Trip	Factory Use Only	-
TP10	ABS I	Absolute Value of Line Current	1.95V AC=Rated Currnt	1.75 to 2.15V AC (at full load)
TP11	DSP DAC3	DSP DAC 3 Output	Factory Use Only	-
TP12	AGND	Analog Ground	-	-
TP13	DSP DAC2	DSP DAC 2 Output	Factory Use Only	-
TP14	+5VREF	+5V Reference	1:1	4.8 to 5.3V DC
TP15	-5VREF	-5V Reference	1:1	-5.3 to -4.8V DC
TP16	+10VREF	+10V Reference	1:1	9.6 to 10.4V DC
TP17	OCT REF	Overcurrent Trip	4.04V = 200%	(225% of rated current)
TP18	EDC	DC Bus/Line Voltage	5V DC= 713V DC	2.50/3.02/3.78V DC (depending on rated line voltage)
TP19	OVT REF	Overvoltage Trip	5V DC= 1125V DC	3.08/3.73/4.66V DC (depending on rated line voltage
TP20	+15V	+15V Power Supply	1:1	14.4 to 15.4V DC
TP21	ISS	Simulated S-Phase Current	1.95V AC=Rated Currnt	1.75 to 2.15V AC (at full load)
TP22	IR	Line Current (R)	1.95V AC=Rated Currnt	1.75 to 2.15V AC (at full load)
TP23	AGND	Analog Ground	-	-
TP24	IT	Line Current (T)	1.95V AC=Rated Currnt	1.75 to 2.15V AC (at full load)
TP25	IS	Line Current (S)	1.95V AC=Rated Currnt	1.75 to 2.15V AC (at full load)
TP26	-15V	-15V Power Supply	1:1	-14.4 to -15.4V DC
TP27	ANIN1	Analog In 1	10V DC = Full Scale	-10 to 10V DC (see parameter P36 in pub 2364F-5.01)
TP28	ANIN2	Analog In 2	10V DC = Full Scale	-10 to 10V DC (see parameter P37 in pub 2364F-5.01)
TP29	AGND	Analog Ground	-	-
TP30	ANOUT1	Analog Out 1	10V DC = Full Scale	-10 to 10V DC (see parameter P47 in pub 2364F-5.01)
TP31	ANOUT2	Analog Out 2	10V DC = Full Scale	-10 to 10V DC (see parameter P48 in pub 2364F-5.01)
TP32	VR	Voltage (R)	1.435V AC = 277V AC	1.14/1.38/1.71V AC (depending on rated line voltage)
TP33	VS	Voltage (S)	1.435V AC = 277V AC	1.14/1.38/1.71V AC (depending on rated line voltage)
TP34	VT	Voltage (T)	1.435V AC = 277V AC	1.14/1.38/1.71V AC (depending on rated line voltage)
TP35	+BUS	+Bus Voltage to Ground	5V DC = 1125V DC	1.25/1.51/1.89V AC (depending on rated line voltage)
TP36	-BUS	-Bus Voltage to Ground	5V DC = 1125V DC	1.25/1.51/1.89V AC (depending on rated line voltage)
TP37	BUS	Bus Voltage	5V DC = 1125V DC	1.25/1.51/1.89V AC (depending on rated line voltage)

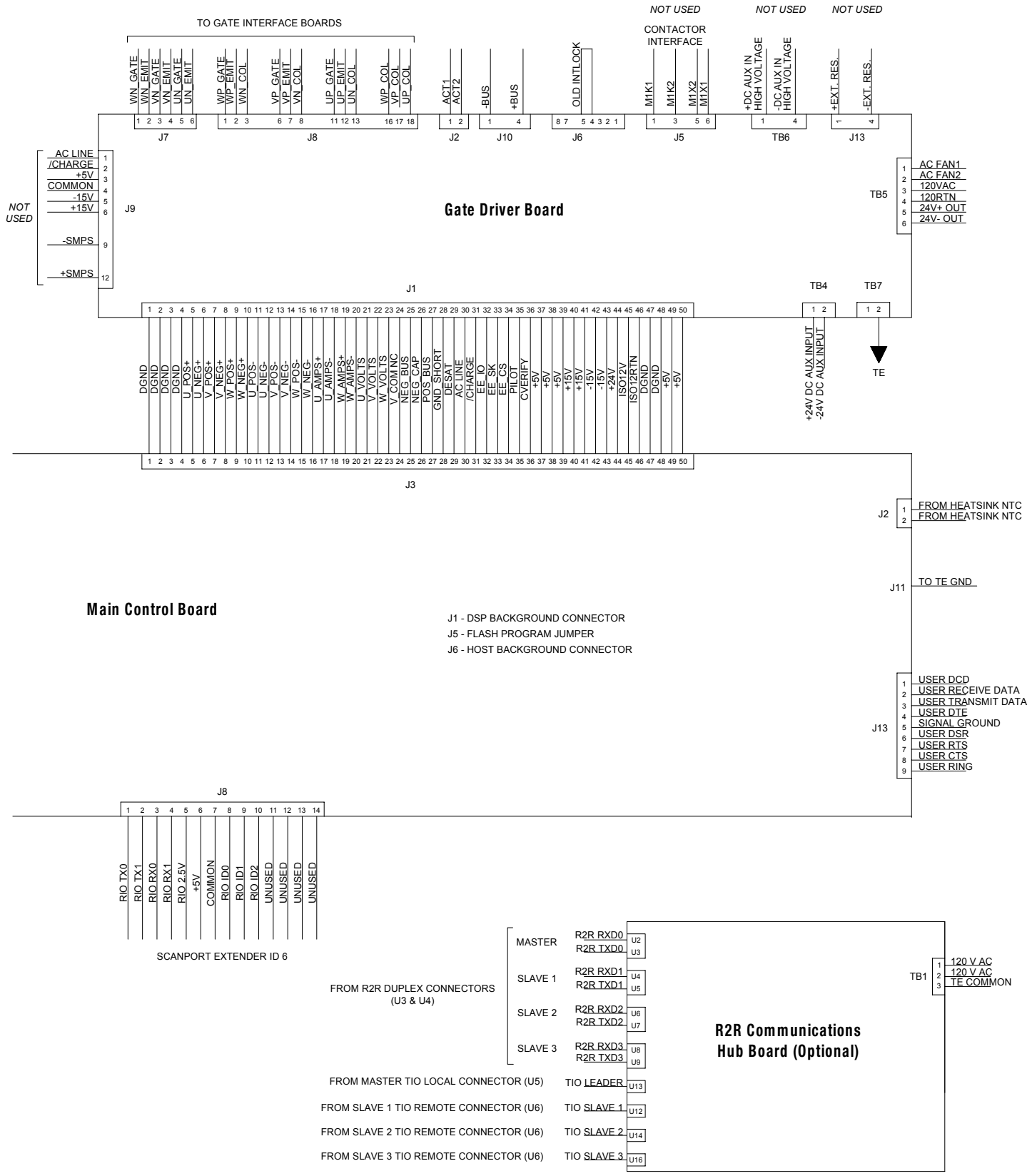
Table G: Test Points–Gate Driver Board

Test Points	Name	Description	Scale	Typical Range
TP1	+BUS	Positive Bus Input	1:1	½ rated DC bus voltage
TP2	-BUS	Negative Bus Input	1:1	½ rated DC bus voltage
TP3	+24V	+24V Power Supply	1:1	23.7 to 24.3V DC
TP4	+5V	+5V Reference	1:1	4.8 to 5.4V DC
TP5	+15V	+15V Reference	1:1	14.4 to 15.4V DC
TP6	-15V	-15V Reference	1:1	-14.4 to -15.4V DC
TP7	DGND	Digital Ground	-	-
TP8	ISO12	Tachometer/Encoder	Not Used	-
TP9	ISO12RTN	Tachometer/Encoder	Not Used	-
TP10	PS IN-	Power Supply In-	1:1	½ rated DC bus voltage
TP14	+EXT	External Resistor Discharge+	Not Used	-
TP16	PS IN+	Power Supply In+	1:1	½ rated DC bus voltage
TP17	-24V	-24V Power Supply	1:1	-23.7 to -24.4V DC
TP18	DGND	Digital Ground	-	-
TP19	-EXT	External Resistor Discharge-	Not Used	-

Board-to-Board Schematics

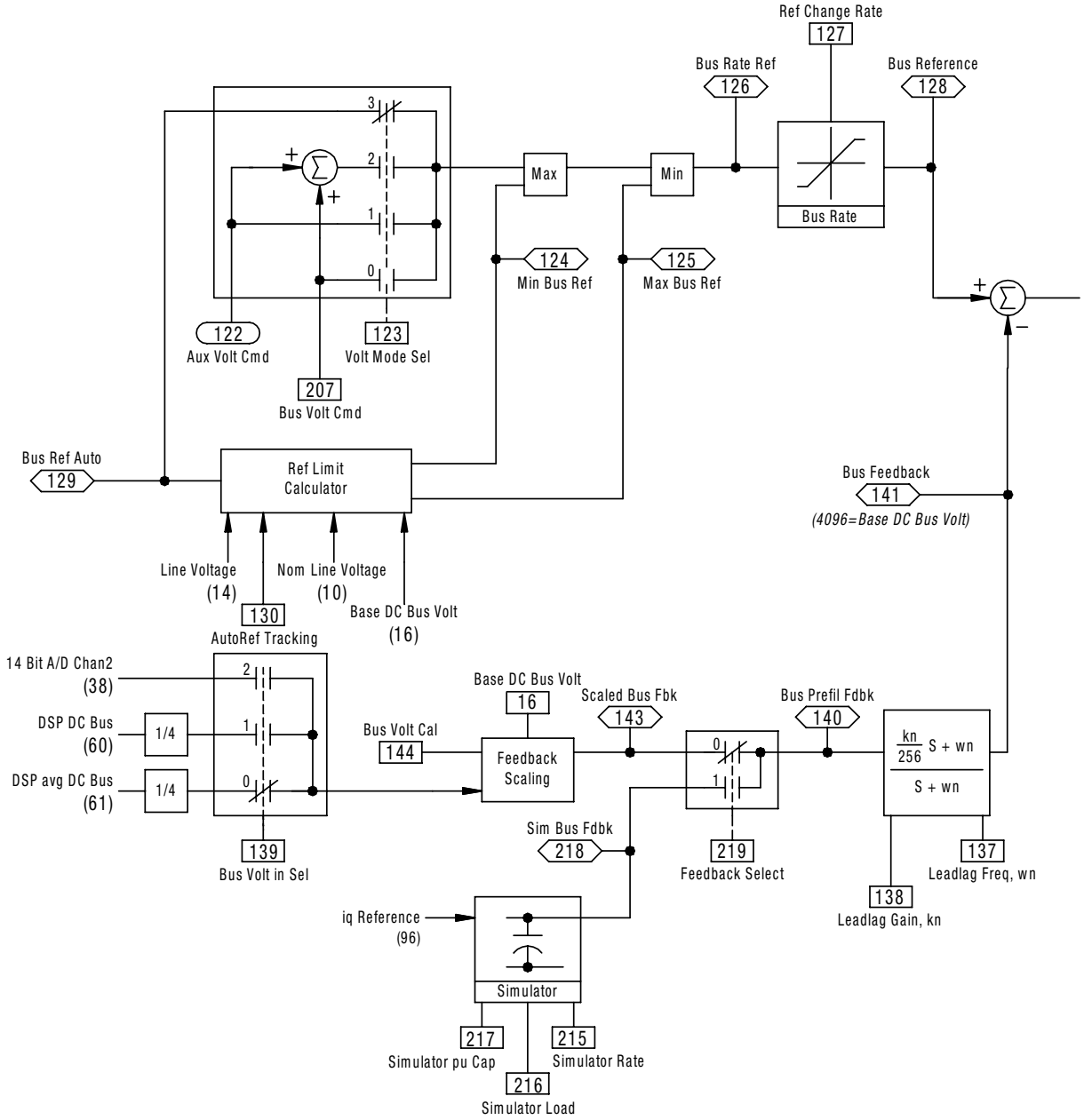
Figure 4
Board-to-Board Schematics

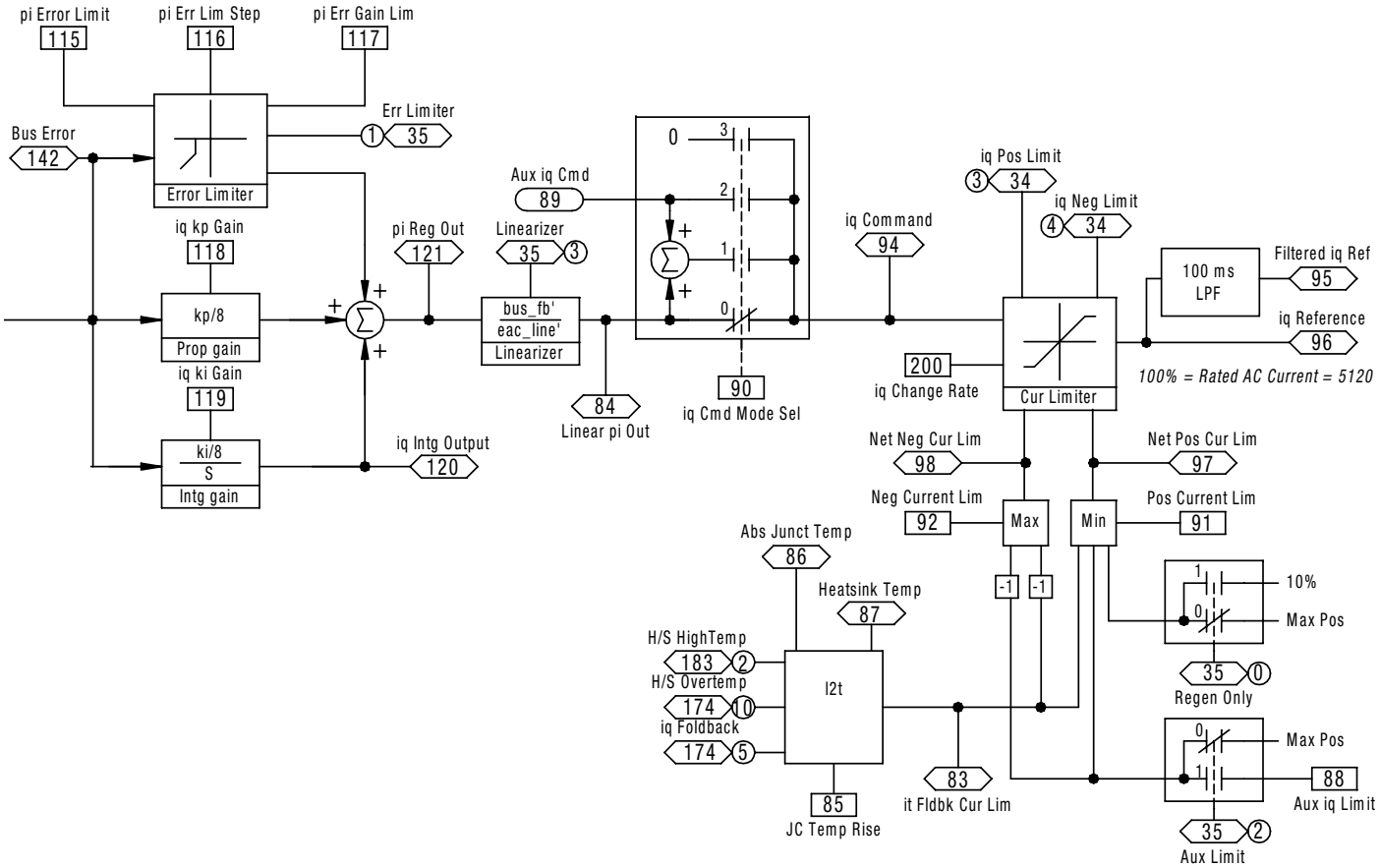



TO GATE INTERFACE BOARDS
WN_GATE
WN_EMIT
VN_GATE
VN_EMIT
UN_GATE
UN_EMIT
WP_GATE
WP_EMIT
WN_COL
VP_GATE
VP_EMIT
VN_COL
UP_GATE
UP_EMIT
UN_COL
WP_COL
VP_COL
UP_COL
ACT1
ACT2
-BUS
+BUS
OLD INTLOCK
NOT USED
CONTACTOR INTERFACE
M1K1
M1K2
M1X2
M1X1
NOT USED
+DC AUX IN HIGH VOLTAGE
-DC AUX IN HIGH VOLTAGE
NOT USED
+EXT. RES.
-EXT. RES.
J7
J8
J2
J10
J6
J5
TB6
J13
AC LINE /CHARGE
+5V
COMMON
-15V
+15V
NOT USED
J9
-SMPS
+SMPS
Gate Driver Board
TB5
AC FAN1
AC FAN2
120VAC
120RTN
24V+ OUT
24V- OUT
J1
TB4
TB7
+24V DC AUX INPUT
-24V DC AUX INPUT
TE
J3
J2
FROM HEATSINK NTC
FROM HEATSINK NTC
J11
TO TE GND
Main Control Board
J1 - DSP BACKGROUND CONNECTOR
J5 - FLASH PROGRAM JUMPER
J6 - HOST BACKGROUND CONNECTOR
J13
USER DCD
USER RECEIVE DATA
USER TRANSMIT DATA
USER DTE
SIGNAL GROUND
USER DSR
USER RTS
USER CTS
USER RING
J8
RIO TX0
RIO TX1
RIO RX0
RIO RX1
RIO 2.5V
+5V
COMMON
RIO ID0
RIO ID1
RIO ID2
UNUSED
SCANPORT EXTENDER ID 6
FROM R2R DUPLEX CONNECTORS (U3 & U4)
MASTER
R2R RXD0
R2R TXD0
SLAVE 1
R2R RXD1
R2R TXD1
SLAVE 2
R2R RXD2
R2R TXD2
SLAVE 3
R2R RXD3
R2R TXD3
FROM MASTER TIO LOCAL CONNECTOR (U5)
TIO LEADER
FROM SLAVE 1 TIO REMOTE CONNECTOR (U6)
TIO SLAVE 1
FROM SLAVE 2 TIO REMOTE CONNECTOR (U6)
TIO SLAVE 2
FROM SLAVE 3 TIO REMOTE CONNECTOR (U6)
TIO SLAVE 3
R2R Communications Hub Board (Optional)
TB1
120 V AC
120 V AC
TE COMMON

Firmware Diagrams

Figure 5
Firmware Block Diagram–Regulation




pi Error Limit
115
pi Err Lim Step
116
pi Err Gain Lim
117
Bus Error
142
Error Limiter
Err Limiter
1
35
iq kp Gain
118
kp/8
Prop gain
iq ki Gain
119
ki/8
S
Intg gain
pi Reg Out
121
iq Intg Output
120
Aux iq Cmd
89
Linearizer
35
3
bus_fb'
eac_line'
Linearizer
84
Linear pi Out
90
iq Cmd Mode Sel
iq Command
94
iq Pos Limit
3
34
iq Neg Limit
4
34
200
iq Change Rate
Cur Limiter
100 ms
LPF
Filtered iq Ref
95
iq Reference
96
100% = Rated AC Current = 5120
Net Neg Cur Lim
98
Net Pos Cur Lim
97
Neg Current Lim
92
Max
Min
Pos Current Lim
91
Abs Junct Temp
86
Heatsink Temp
87
-1
-1
10%
Max Pos
35
0
Regen Only
H/S HighTemp
183
2
H/S Overtemp
174
1
iq Foldback
174
5
I2t
83
it Fldbk Cur Lim
85
JC Temp Rise
Max Pos
88
Aux iq Limit
35
2
Aux Limit

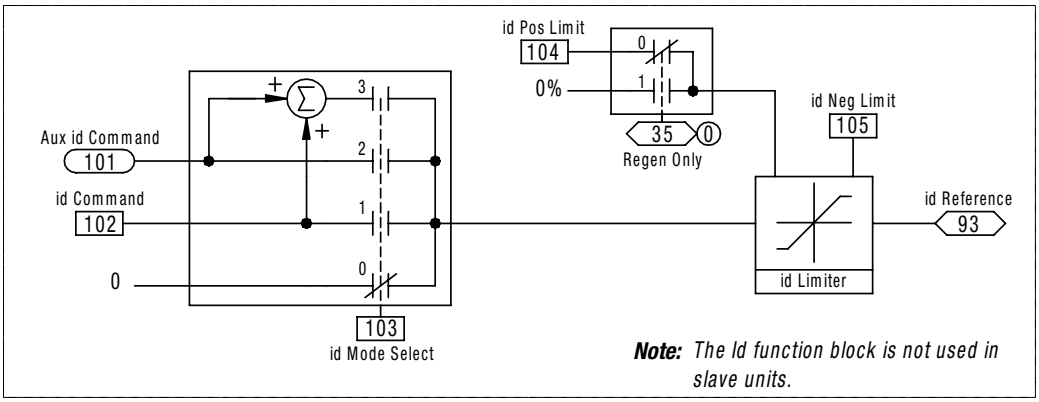

id Pos Limit
104
0%
35
0
Regen Only
id Neg Limit
105
Aux id Command
101
id Command
102
0
103
id Mode Select
id Limiter
id Reference
93
Note: The Id function block is not used in slave units.

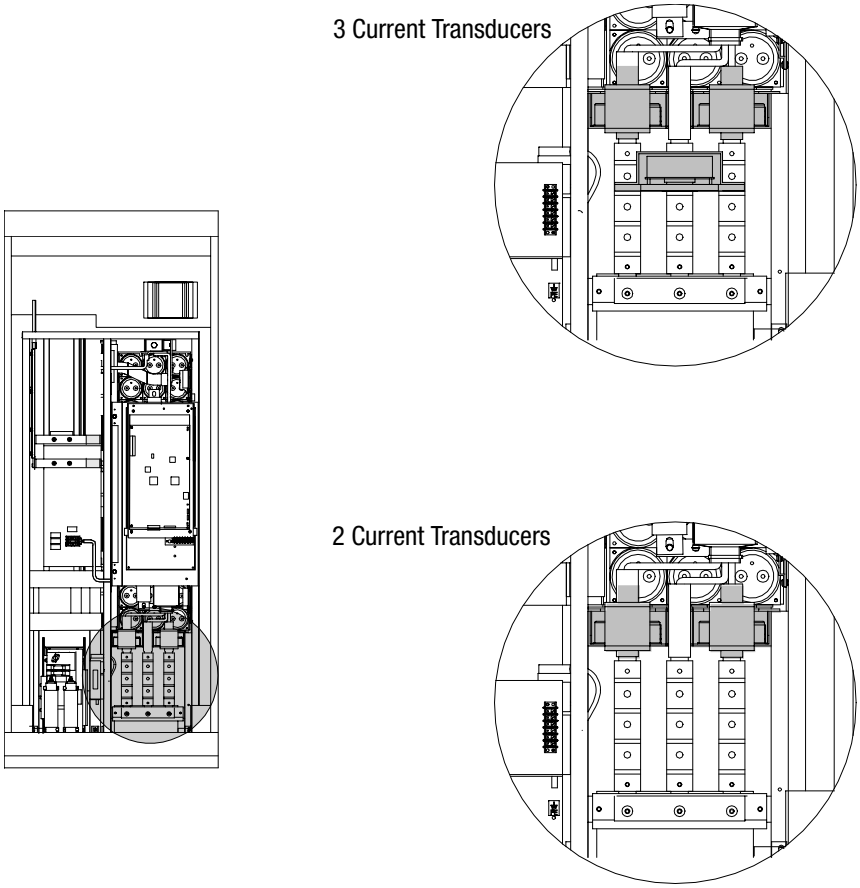
Figure 6 shows the parameter settings that are made in response to a control mode selection.

Figure 6
RGU Control Mode Selection

RGU Mode
5

P#	Parameter Name	Master	Slave	Stand alone	Notes
5	RGU Control Mode	0	1	2	-
90	Iq Mode Select	0	2	0	Slave set to Aux Iq Command
198	Current Loop Bandwidth	1000	1000	1200	-
267	RGU-to-RGU Transmit Address	1	0	0	Master set to transmit
268	RGU-to-RGU Receive 1 Address	0	1	0	Slave set to receive
271	RGU-to-RGU Transmit Indirect 1	96	0	0	Master set to transmit P96 (Iq Reference)
272	RGU-to-RGU Transmit Indirect 2	20	0	0	Master set to transmit P20 (Master Status)
273	RGU-to-RGU Receive1, Indirect 1	0	89	0	Slave set to receive to P89 (Aux Iq Command)
274	RGU-to RGU Receive1, Indirect 2	0	20	0	Slave set to receive to P20 (Master Status)

Figure 7
Line Sensing Current Transducers



1336 FORCE Adjustable Frequency AC Drive

An adjustable frequency AC drive produced by Rockwell Automation. Most of the construction and components of the RGU power structure are equivalent to the 1336 FORCE drive.

Control Power Filter

A filter used to reduce harmonics and noise in the 115V AC control power.

Digital Signal Processor (DSP)

The digital signal processor which is located on the main control board of the RGU. This component processes current commands for the RGU.

Disable

When a unit is disabled, the control logic is not directing current flow operations. A unit is typically disabled by a disable command or by a fault condition.

Disconnect

A circuit breaking device.

Enable

When a unit is enabled, the control logic is directing the motoring or regenerative current by modulating its hardware (IGBTs).

Feedback

Signals from the hardware which indicate the hardware status to the control logic.

Gate Driver Board

The RGU gate driver board is responsible for modulating the power modules and supplying power to the control boards. The gate driver board is interfaced with the main control board.

Graphic Programming Terminal (GPT)

A programming terminal with a graphical LED display and a pushbutton keyboard which is used to program, control, and view the status of a unit. The GPT is also able to load and store parameters in its local memory.

Host Processor

The main processor on the main control board of the RGU. This component processes feedback and controls most of the activities in the RGU.

Human Interface Module (HIM)

A programming terminal used to program, control, and view the status of a unit.

Insulated Gate Bipolar Transistor (IGBT)

A transistor which can be used to allow current to flow in two opposite directions. Also known as *power module*.

Isolation Board

The RGU isolation board receives direct feedback from the AC line, DC bus, and current transducers. This board supplies scaled feedback to the main control board.

Main Control Board

The RGU main control board regulates the voltage and current, oversees activities in the unit, and processes I/O. This board is isolated from the power circuitry.

Metal-Oxide Varistor (MOV)

A component used to protect against voltage surges and excessively high line-to-line/line-to-ground voltages.

Motoring Current

Current which is being supplied to the inverters (through the DC bus) for motoring.

Non-Regenerative DC Bus Supply Unit (NRU)

A six-pulse DC power supply produced by Rockwell Automation The NRU is typically used as a front end power supply on a drive system lineup.

Overload

A condition where the unit is supplying current above its rated current. For example, operating a unit at 150% overload would indicate that the unit is supplying 150% of its rated current. Most units can operate with an overload condition for a short period of time.

Power Factor (pf)

A measurement of the time phase difference between the voltage and current in an AC circuit.

Power Module

A transistor used in the RGU and 1336 products to convert regulated power between AC and DC. See also insulated gate bipolar transistor (IGBT).

Power Structure

A 3-phase power bridge built in the RGU which converts AC to DC (motoring current) and DC to PWM AC (regenerative current). The power structure includes control boards, a precharge circuit, a power bridge, and a capacitor bank.

Regenerative DC Bus Supply Unit (RGU)

A regenerative DC power supply unit produced by Rockwell Automation. The RGU is typically used as a front end power supply to provide motoring and regenerative current for a drive system lineup.

Regenerating Current

Current which is being driven back from the motors (from motoring induction) to the DC bus. RGUs are able to place regenerating current back onto the AC line.

RGU-to-RGU (R2R) Communications

A communication link used between master and slave RGUs. In R2R communications, the master RGU passes current commands, status information, and synchronization signals to the slave RGUs.

SCANport

Communications technology which is used by many Rockwell Automation products. HIMs, PLCs, and many drive systems products can communicate with one another through SCANport.

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