TABLE OF CONTENTS

Description - This document combines the various gradient driver function checks that are used on Signa Horizon Lx systems with Scaleable Gradient Driver (SGD) hardware.

1- GPM GRADIENT DRIVER CHECKS

Description - This document relates to Signa Horizon products. This material describes the status indicators on the SGD subsystem, and the function checks that may be used for troubleshooting.

1-1- Introduction

The SGD gradient driver subsystem contains both fault indicators and a dedicated service tool to help you diagnose problems. LEDs on the main board of a Gradient Power Module (GPM) indicate certain fault conditions; these are described in the next section. The Gradient Interface Processor (GIP) is specifically designed to help solve troubleshooting problems. The GIP reports to the system error log If gradient driver voltage, current, or temperature parameters are out of specification.

In addition to these built-in tools, a check list describes symptoms and possible causes. The order of each list begins with possible causes most likely to occur, possible causes easiest to check, or possible causes least costly in terms of time and equipment. For items requiring the replacement of FRUs (field-replaceable unit), refer to the Replacement / Maintenance section of the documentation.

DANGER!!

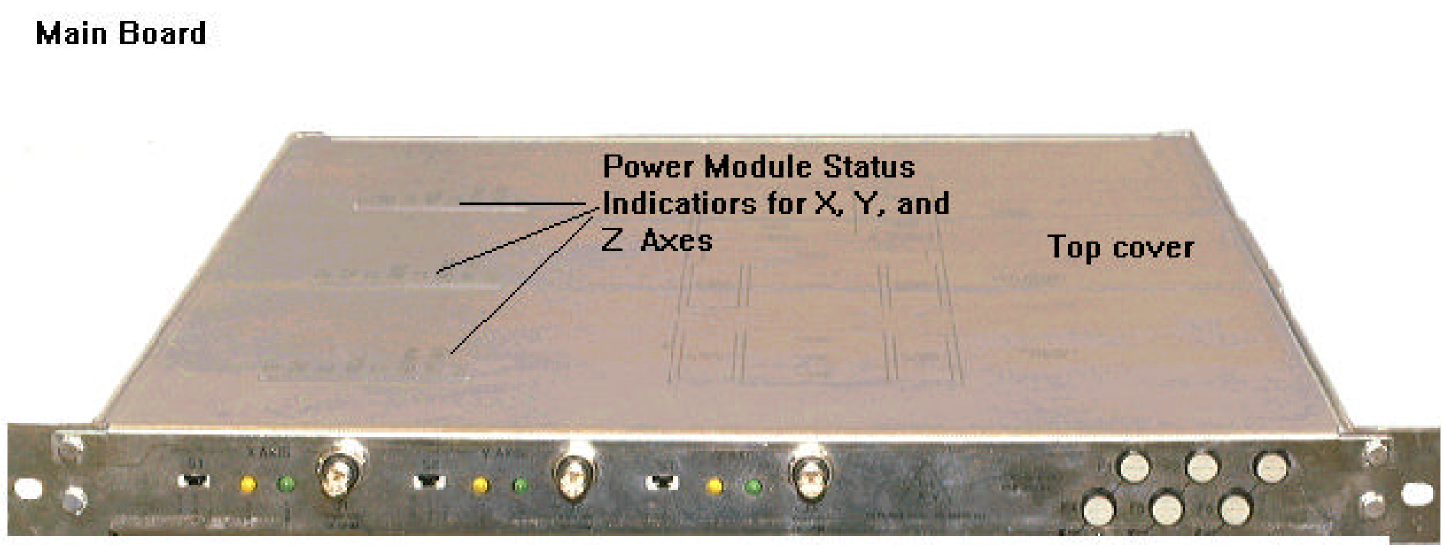
FATAL ELECTRIC SHOCK HAZARD!! THE SGD ACTS AS A CONSTANT LOAD SOURCE, AND WILL SEND MAXIMUM CURRENT TO ANY LOAD (INCLUDING YOU!). TO PREVENT FATAL ELECTRIC SHOCK, USE EXTREME CARE WHEN TROUBLESHOOTING HIGH POWER COMPONENTS. ENSURE THAT POWER IS OFF TO THE SGD BEFORE ANY COMPONENT REMOVAL, OR CONNECTOR ITEGRITY VERIFICATION.

CAUTION

Equipment damage possibility. The various modules may have static-sensitive components, such as boards, that can be damaged if not handled in a static-free environment. Take appropriate care (e.g., wear wrist grounding strap) when handling these modules.

1-2- Power Module Status Indicators

LEDs on the main board, mounted on top of the GPM, report the power module status (see Illustration L6020). The Ready LED is green; all others are yellow (see table 1).



MAIN BOARD TRAY/LED STATUS INDICATORS
ILLUSTRATION L6020

TABLE1
POWER MODULE STATUS INDICATORS

LED name	LED Color	Function
Standby	Yellow	Indicates that voltage is available to the power module, but the power module is not presently supplying current or voltage to the load.
Ready	Green	Indicates that power module is in normal operating mode.
Overload	Yellow	This condition exists when the output waveform does not match the input waveform for periods longer than 0.05 milliseconds. The LED remains on as long as the overload condition exists.
Long Overload	Yellow	This condition exists when the output waveform does not match the input waveform for periods longer than 35 milliseconds.
Transistor Overtemp	Yellow	This condition exists when the output transistor junctions become too hot. Current in the output stages is reduced until the temperature returns to a safe level.
Shelf Overtemp	Yellow	When one of the High side output heat sinks overheats, this LED lights. The power module is placed in Standby until the temperature returns to a safe level.
Transistor Fault	Yellow	This condition exists when a short circuit occurs in the output stage transistors. The power module is latched in Standby. Limited software resets are permitted. Then a TPS reset or GPM Power Supply power cycle is required.

Some of these conditions can be self-correcting, such as overtemp and overload. Other conditions might be corrected by cycling the circuit breaker located on the bottom panel on the front of the GPM Power Supply. Transistor faults and long overloads are reset by the GIP.

1-3- Using the GPM's Analog Signals

The GIP monitors the following current, voltage, and temperature variables:

- Temperature signals from four sensors in the transistor heat sinks
- Power supply voltage (Vcc)
- Output voltage.

1-4- Power Outage Checklist

During troubleshooting, determining if power is applied in an effective way to isolate power as a source of the problem. There are many modules in the SGD cabinet that are powered. Subsystem problems are detailed in the following sections.

1-4-1 No Power at All

If there is no power to the SGD, check the following:

1. Check the circuit breakers at the ac source of the SGD Power Supplies. The circuit breakers are located at the PDU.

2. Check the circuit breakers on the Mini-GRAM and GPM power supplies on the front of the SGD.

3. Check the wiring on the inside of the SGD cabinet. Use the Gradient Driver Block Diagram located in *Direction 2153389, Signa Horizon (Release 8.x) Block Diagrams & Supplemental Schematics*.

1-4-2 No Power at GIP

The "Power" LED on the front panel of the GIP chassis will not light if power is OFF to the GIP module. If there is no power to the GIP, check the following:

1. Check to see if the auxiliary circuit breaker on the Mini-GRAM Power Supply is ON.

2. Check the cable from the Mini-GRAM Power Supply to the GIP.

1-4-3 No 208 Vac to GPM

There are LEDs on the front of the GPM for each main board. If these are not lit, check the following:

1. Check the GPM Power Supply Auxiliary Circuit Breakers.

2. Check all power cables.

1-4-4 No LED From Individual Axes on GPM

1. See section 1-4-3 No 208 Vac to GPM.

2. Check the 0.250-amp time delay fuses (F1 through F6) on the front of the GPM Main Board.

1-4-5 Circuit Breaker Trips

1. Check for short circuits.

2. Check circuit breaker functionality.

3. Inspect for arcing damage inside power supply.

4. If there is no damage, turn on the breaker.

5. If damage is seen, replace the supply.

1-5- GPM Error Checklist

1-5-1 One Axis Remains in Standby and Won't Go to Ready

1. Check that the GPM slide switch is in left position.

2. Check the small red Standby Command LED on the GPM Main Board. Remove the GPM top cover to see the LED. The LED lights when the main board is receiving the standby command signal.

   a. See Section 1-4-2 No Power at the GIP

   b. Check the cables and the connections between the GIP and GPM.

   c. If the LED is not lit (i.e., not receiving the standby command from the GIP), and the power module remains in standby mode, the problem is in the GPM.

   d. Check the jumpers on the main board.

   e. Replace the main board.

1-5-2 All GPM axes remain in Standby and Won't Go to Ready

1. See section 1-6-1 Faulty Communication – All Axes.

2. See section 1-5-1 One Axis Remains in Standby and Won't Go to Ready.

1-5-3 Long Overload (GPM Keeps Latching)

1. Check the output connections and the cables to the load.

2. Replace the Main Board.

3. Replace the PPBM.

4. Swap axes connection to isolate the output shelf.

1-5-4 Transistor Fault After Cycling Breaker

1. Swap the Main Board.

2. Swap axes connection to isolate the output shelf.

1-5-5 PPBM Supply Error After Cycling Breaker

WARNING!

HIGH VOLTAGE EXISTS IN THE INNER AREAS SURROUNDING THE PPBM. WHILE THE SGD HAS POWER, DO NOT ATTACH TEST CLIPS IN THESE AREAS, OR PUT A SCREWDRIVER TIP THROUGH THE FRONT COVER OF THE POWER MODULE!

1. Check for input voltage on the rear of the GPM. (Nominal voltage 190Vdc, Maximum voltage 210Vdc).

2. Swap the main board.

3. Swap the PPBM.

4. See section 1-7-1 PPBM Overheat.

1-6- Status and Control Problem Checklist

1-6-1 Faulty Communication – All Axes

1. Check the integrity and the connections of the fiber optic connections. Use the fiber optic light meter during the Class A IPG-Manual-Fiber Optics Diagnostics. See the procedure for Fiber Optic Checks.

2. See section 1-4-2 No Power at GIP.

3. After the GIP is switched on, allow about 15 seconds for its self-test to complete.

1-6-2 Faulty Communication – One Axis

1. Check the slide switch on the GPM. It must be in the left position.

2. See section 1-4-3 No 208 VAC to GPM

3. Check the cables and the connections between the GIP and GPM.

4. Check the integrity and the connections of the fiber optic cables leading to the GIP. Use the fiber optic light meter during the Class A IPG-Manual-Fiber Optics Diagnostics. See the procedure for Fiber Optic Checks.

5. Check the jumper settings on the main board in the power module.

6. Swap the main board of the faulty axis with the main board of another axis. If the problem moves, replace main board.

7. Replace the GIP.

1-7- Cooling Problem Checklist

1-7-1 Power Modules Overheat

1. Check that the fan is running correctly.

2. Check that rear doors are closed. The door should pull closed due to the vacuum created by the fan.

3. Check for clogged air filters.

4. Check for blockage of the vents.

5. Check that output power and load are within specification.

6. Replace the overheated assembly (PPBM or transistor shelf).

1-7-2 Fan Does Not Run

1. Check the circuit breakers on the front of both the GPM Power Supply and MiniGRAM Power Supply.

2. Replace the fan.

1-7-3 Fan Runs Backward

If the fan runs backward, air flow is reduced. Correct the incorrectly wired ac phases. The GPM-PS power input phase may be reversed. The best indication of a mis-wired fan is if the doors to the cabinets are not pulled in by the vacuum created by the fan.

2- DYNAMIC SETTLING TIME TEST

Description - This document relates to Signa Horizon products.

2-1- Introduction

The purpose of this test is to generate waveforms that are useful in checking the functionality of each gradient axis. The output of the SGD (ICOIL) is compared to the command to the SGD (DAC_I).
A Grafidy scan prescription was used to generate these waveforms.

2-2- Description of Signals Tested

- ICOIL is the actual trapezoidal current that the MiniGRAM produces. It is the output of the SGD.
- VOut can be obtained from the BNC female connection J1 on the GPM Main Board that is labeled "VOut/20."
- DAC_I is a digitized signal that originates at the Systems Cabinet. It is a current command signal from the GIP to the SGD.
- DAC_DI is the first derrivative of DAC_I.
- VFilt is the voltage output of the MiniGRAM. 1 Volt on scope = 200 Volts.
- LCoil is the gain needed to match the amplifiers to the inductance of the Gradient Coil.

2-3- Initial Conditions

- Software fully operational
- Quad head coil removed from cradle

2-4- Tools Required

- Two-channel 400 MHz oscilloscope with two scopes lead and 2 BNC cables.

2-5- Hardware Set-up

1. Remove the front cover of the SGD cabinet.

2. Turn on the power to the scope. Set each scope channel to dc coupling, and position each trace at the zero-reference graticule.

3. Attach BNC to GIP BNC (ICOIL) and X10 Scope Probe to DAC_I on the GIP Sub D. Attach scope ground to GIP ground.

4. Using the scope calibration signal, verify that probes are properly compensated and have the correct gain.

5. Connect both scope leads to a ground test point.

6. Connect the ground lead of both scope probe to a ground test point.

7. Adjust the vertical trace of each channel so that it is on the zero-reference graticule.

2-6- Scan Setup

CAUTION

Do not perform any scan in this procedure without first disabling RF Output to the screen room. This procedure is performed without transmitting RF to the screen room. There are no phantoms. Make sure that RF to the scan room has been disabled before proceeding with this procedure.

1. Disable RF to the screen room. For Signa Horizon 5.X systems, remove jumper J-11 (labeled "To RF Amp") on the Systems Cabinet exciter board. For Signa Horizon 8.X Systems, Locate the RF Out Disable switch just below J108 on the Systems Cabinet CERD board. Toggle the switch to the RF OUT DISABLE position.

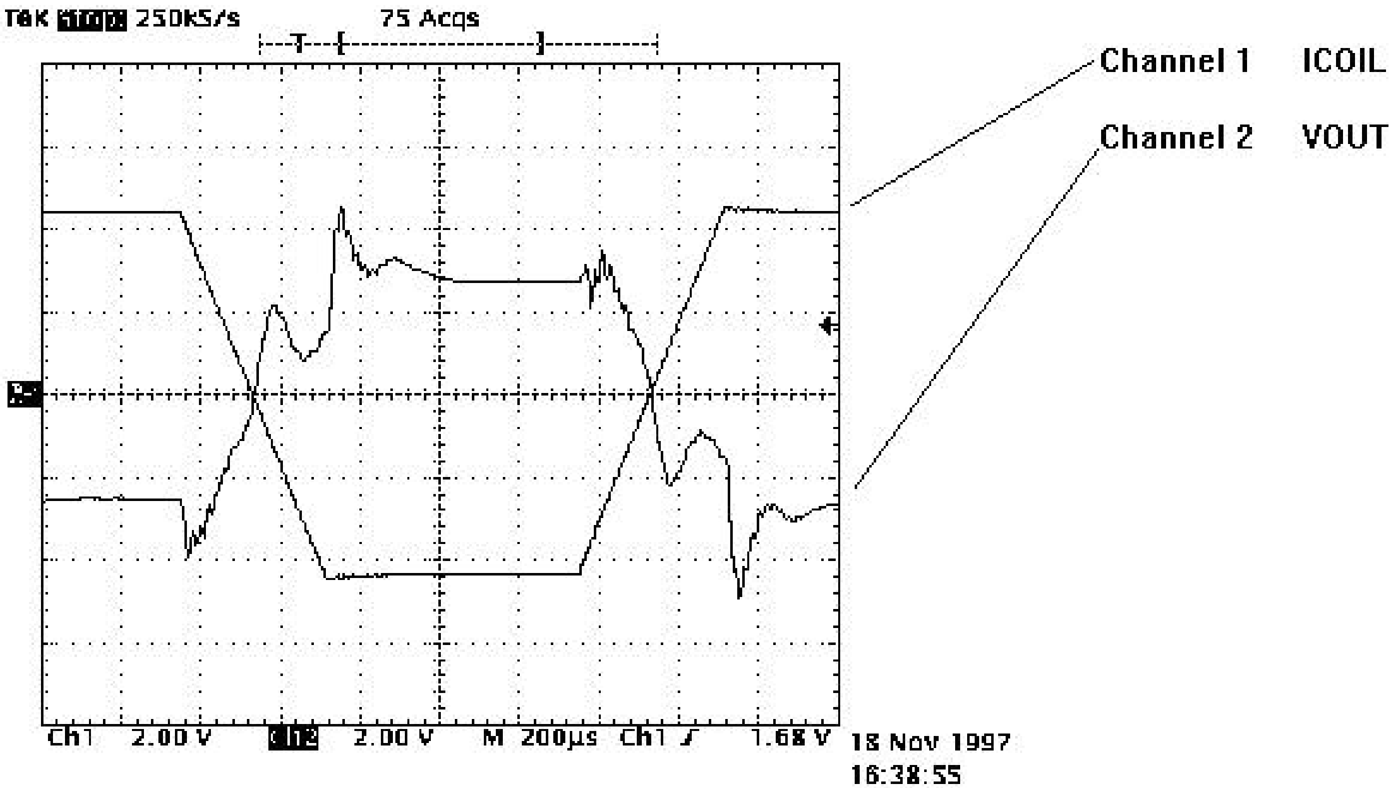
2. Enter the **Grafidy** scan prescription.

3. Set the vertical control to 2V/division. Set the horizontal control to 200 microseconds per division. Select DC coupling.

4. Click on **[Manual Prescan]**.

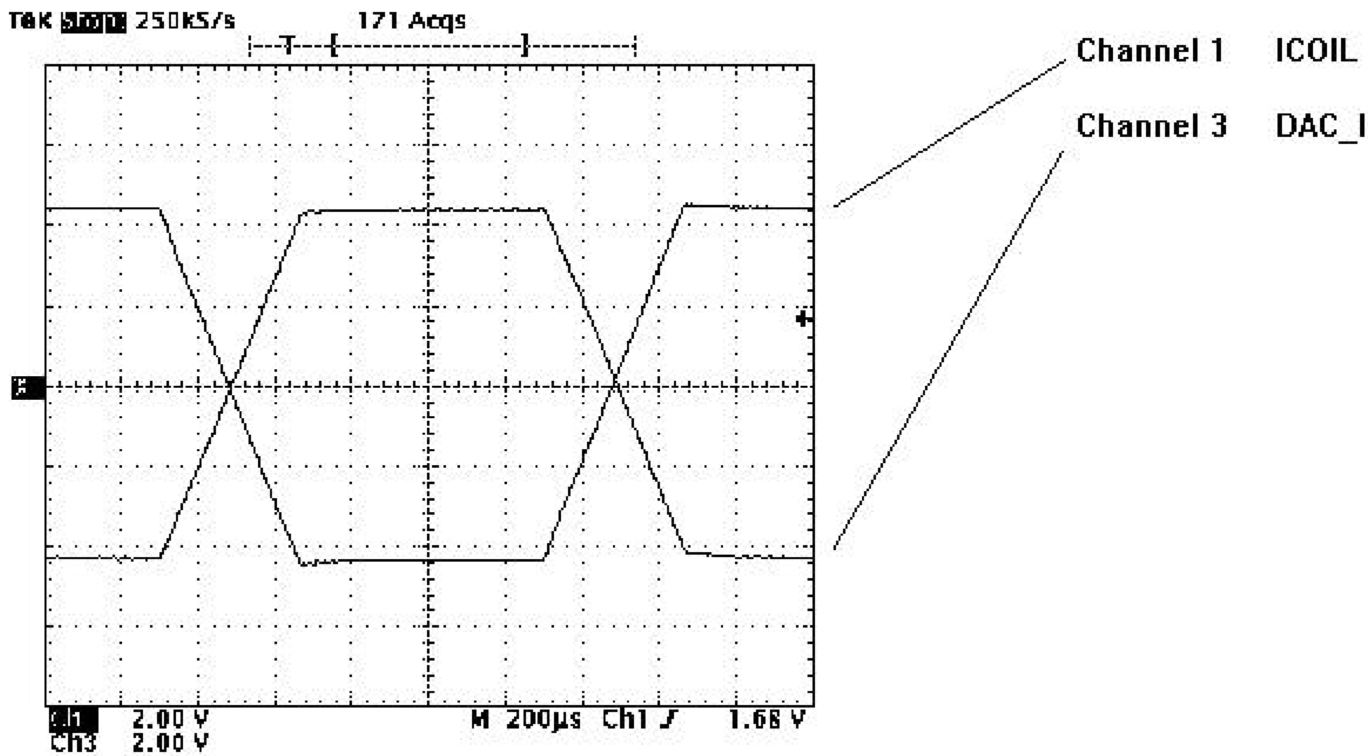
5. Examples of typical waveforms:

Illustration L10 shows a typical representation of ICOIL and VOUT waveforms.



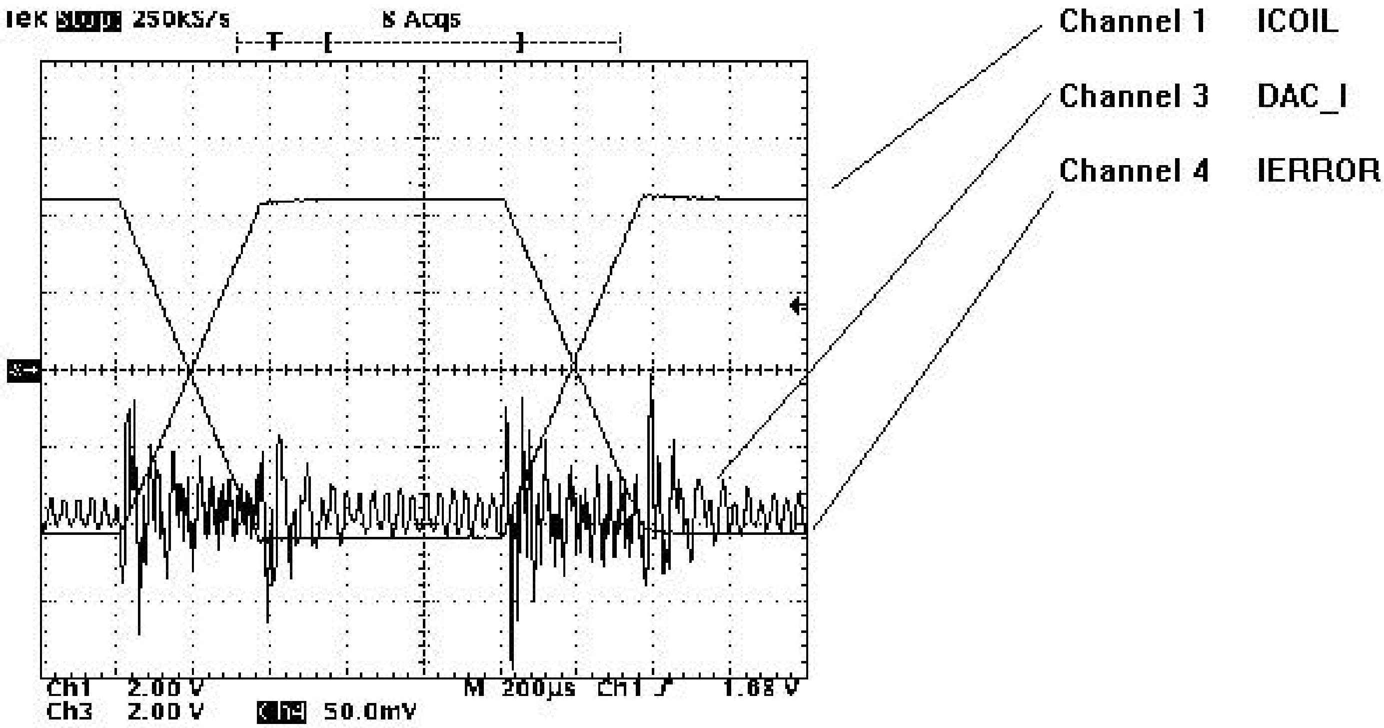
COMPARISON OF ICOIL TO VOUT
ILLUSTRATION L10

Illustration L11 shows ICOIL and DAC_I.



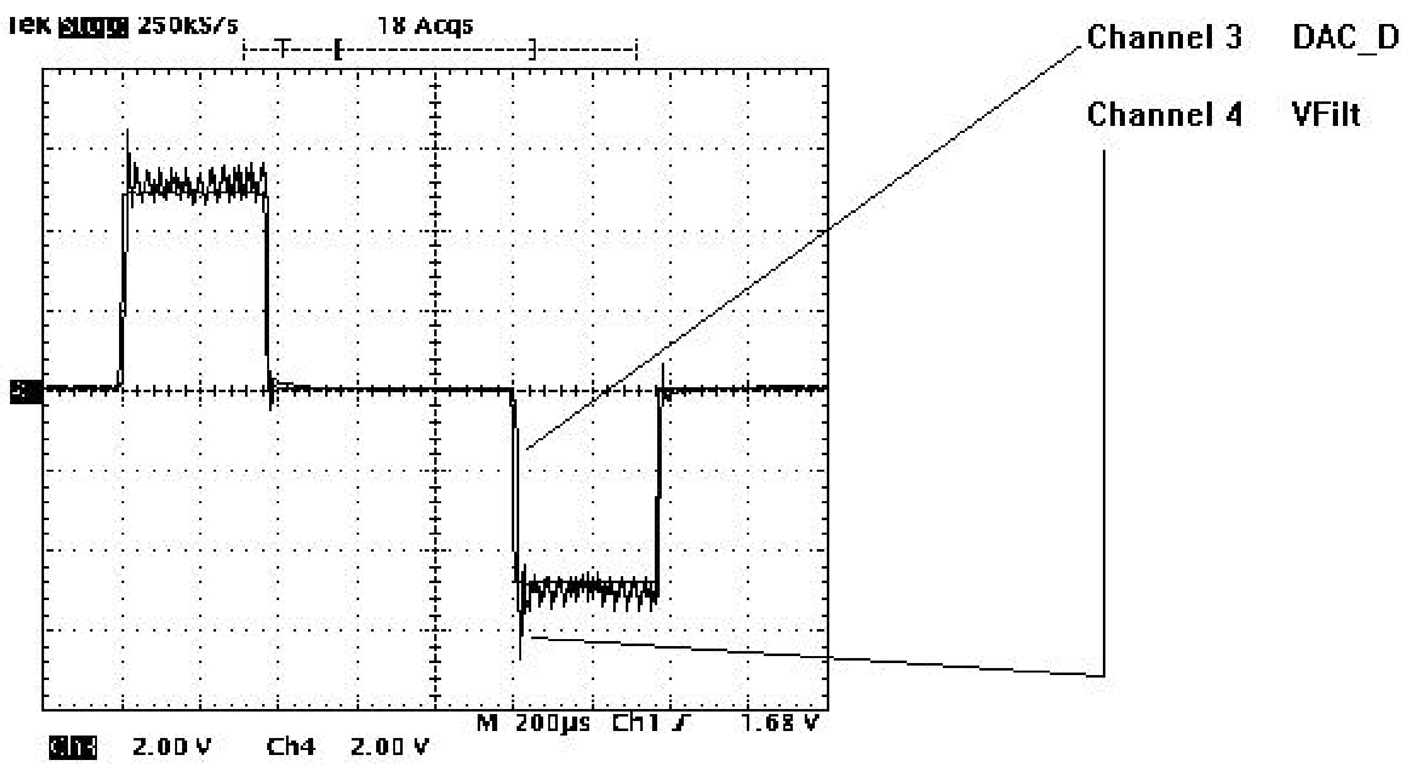
COMPARISON OF ICOIL DAC_I
ILLUSTRATION L11

Illustration L12 shows ICOIL, DAC_I, and IERROR.



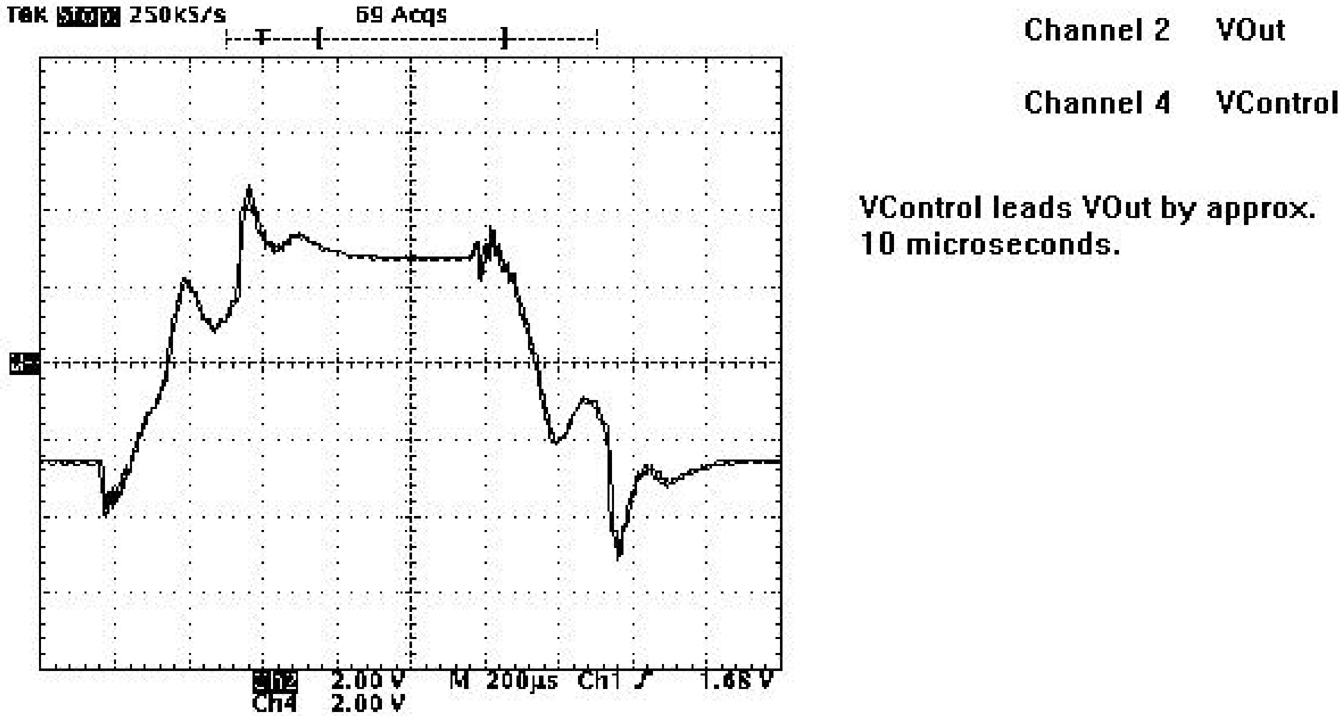
COMPARISON OF ICOIL, DAC_I, AND IERROR
ILLUSTRATION L12

Illustration L13 shows DAC_DI and VFilt.



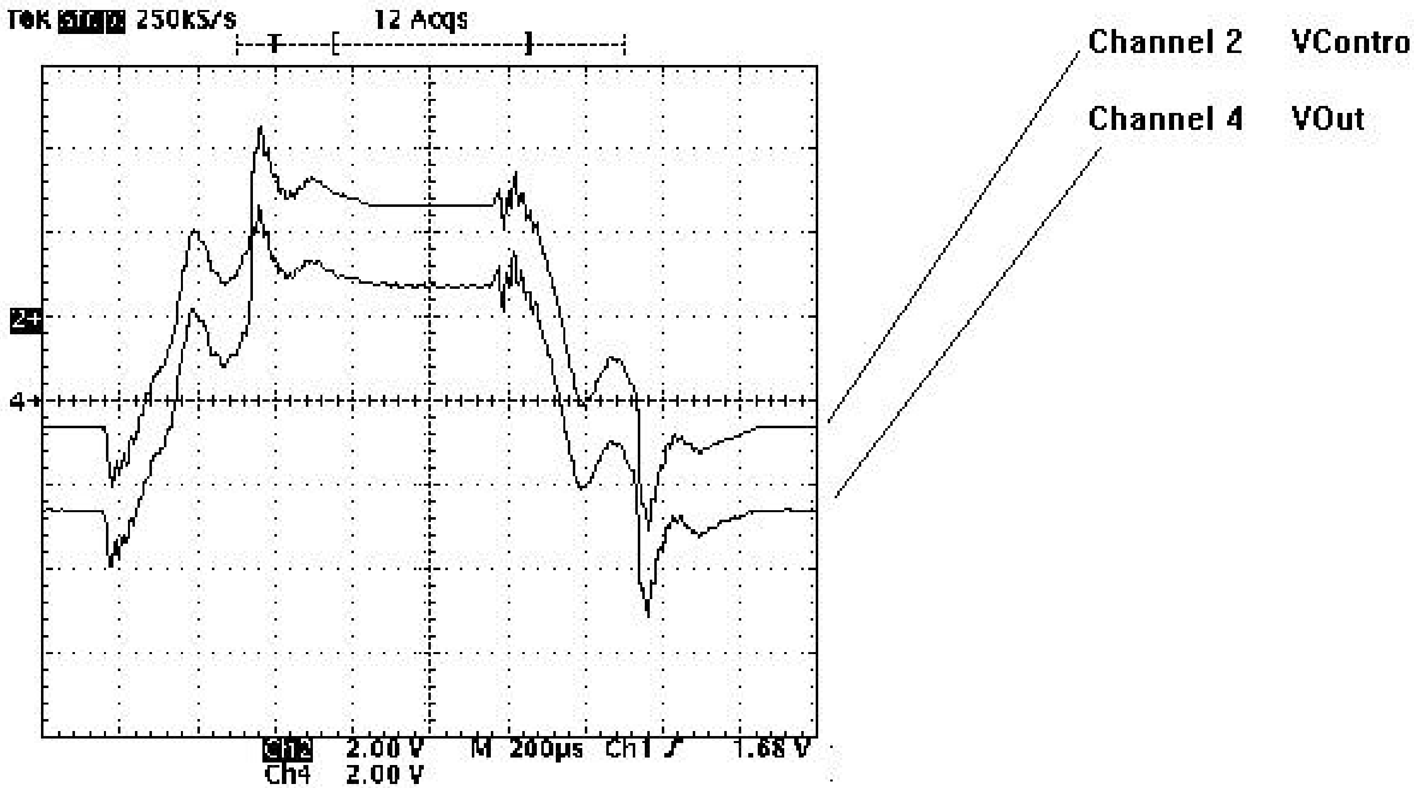
COMPARISON OF DAC_DI AND VFILT
ILLUSTRATION L13

Illustration L14 shows VOut and VControl.



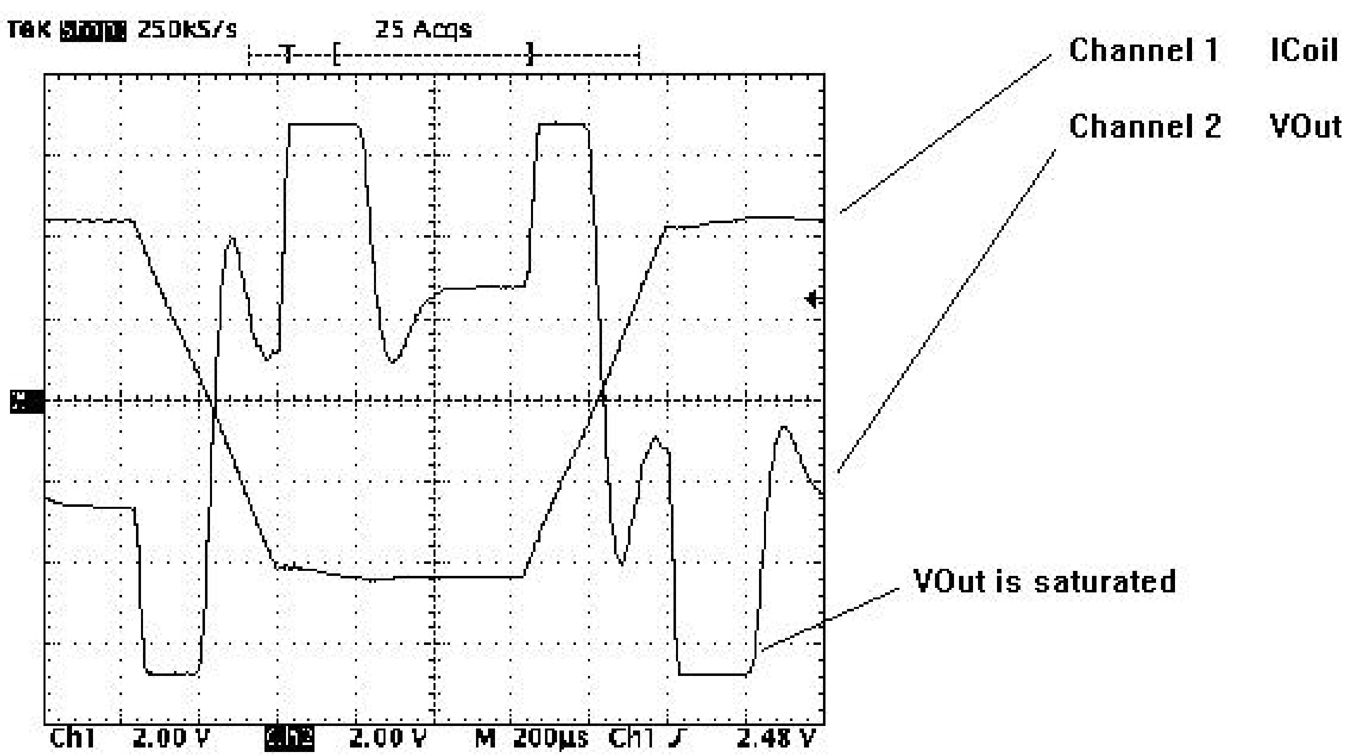
COMPARISON OF VOUT TO VCONTROL
ILLUSTRATION L14

Illustration L15 shows LCOIL and VOut with nulled Z Axis Short Time Constants.



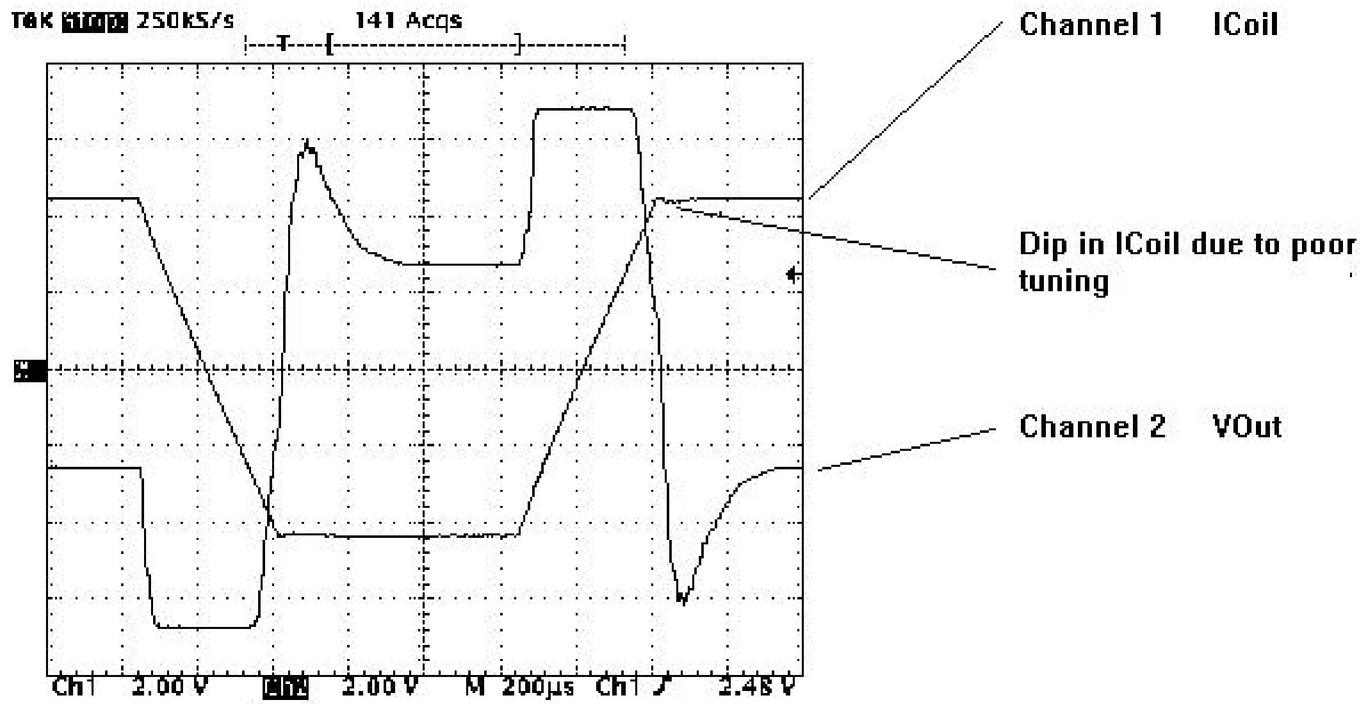
LCOIL AND VOUT WITH Z AXIS SHORT TIME CONSTANTS
ILLUSTRATION L15

Illustration L16 shows ICoil and VOut with LCoil set 300 counts too high.



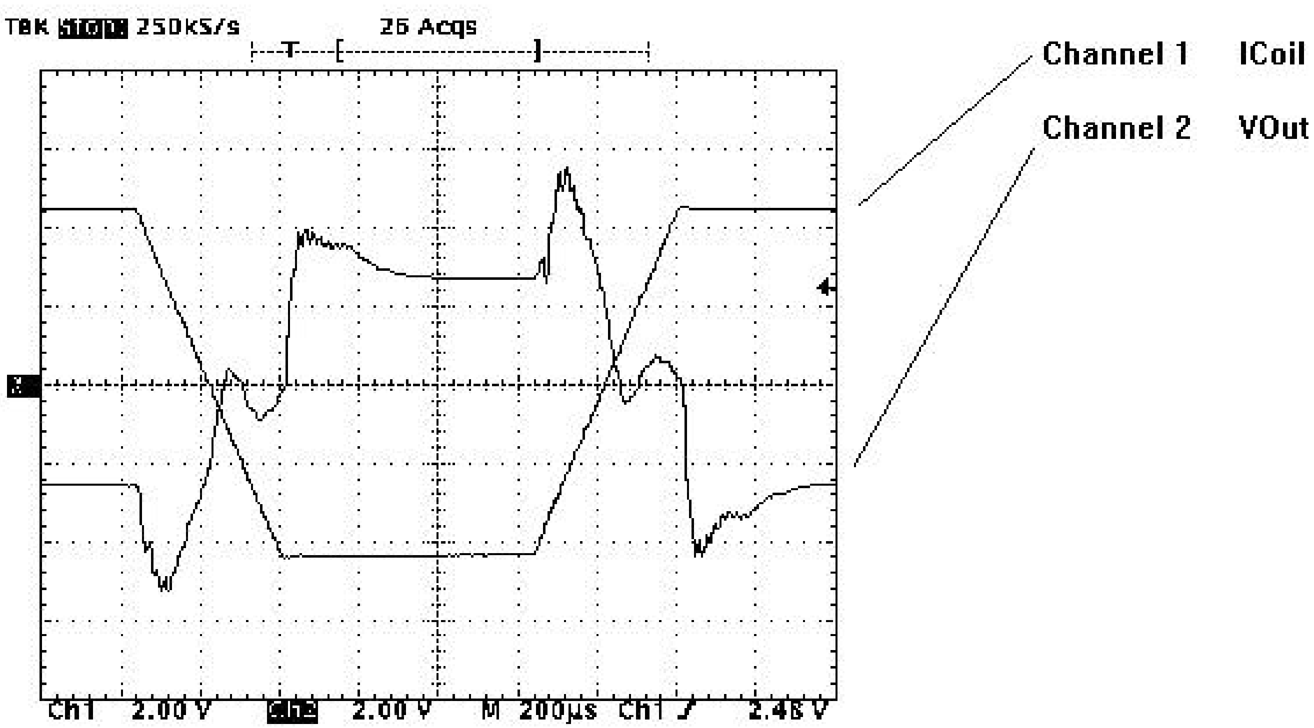
ICOIL AND VOUT WITH LCOIL SET 300 COUNTS TOO HIGH
ILLUSTRATION L16

Illustration L17 shows ICoil and VOut with LCoil set 100 counts too high.



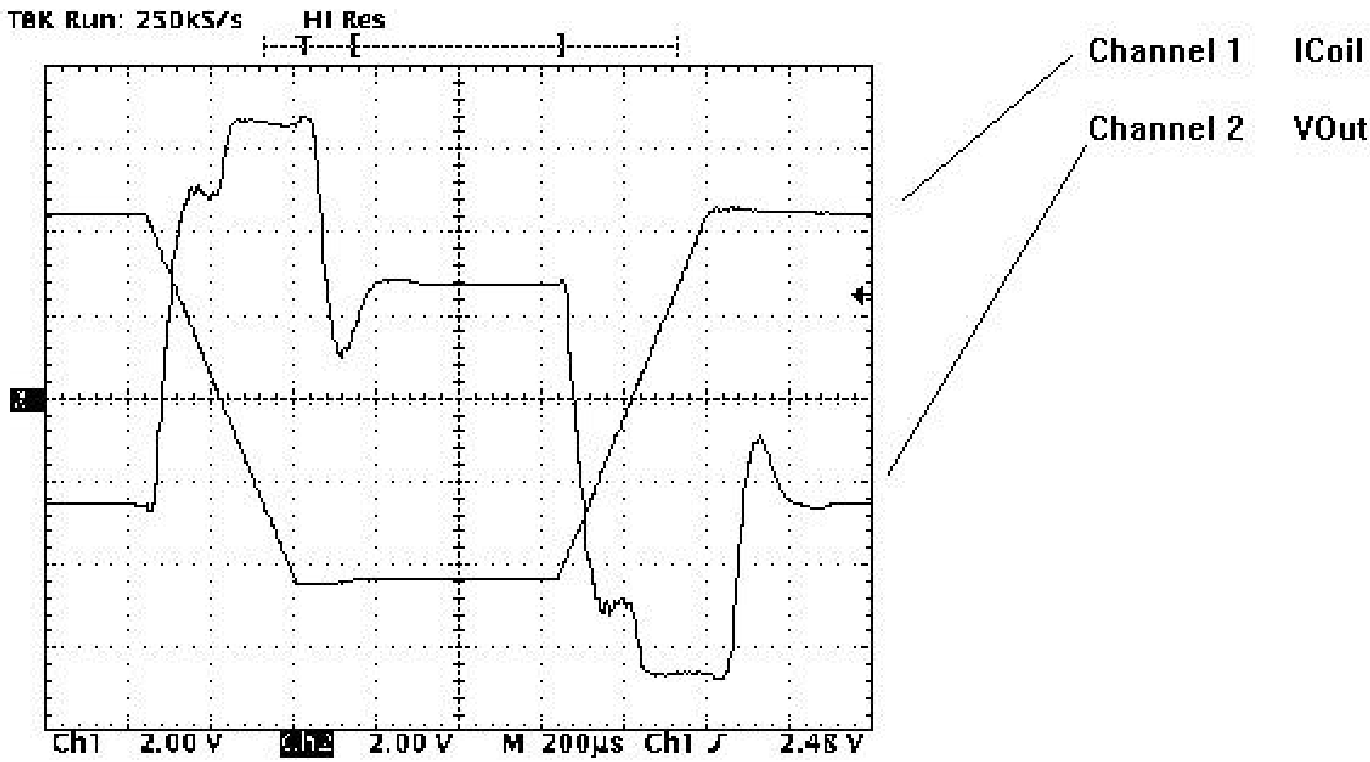
ICOIL AND VOUT WITH LCOIL SET 100 COUNTS TOO HIGH
ILLUSTRATION L17

Illustration L18 shows ICoil and VOut with LCoil set 100 counts too low.



ICOIL AND VOUT WITH LCOIL SET 100 COUNTS TOO LOW
ILLUSTRATION L18

Illustration L19 shows ICoil and VOut with LCoil set 300 counts too low.



ICOIL AND VOUT WITH LCOIL SET 300 COUNTS TOO LOW
ILLUSTRATION L19

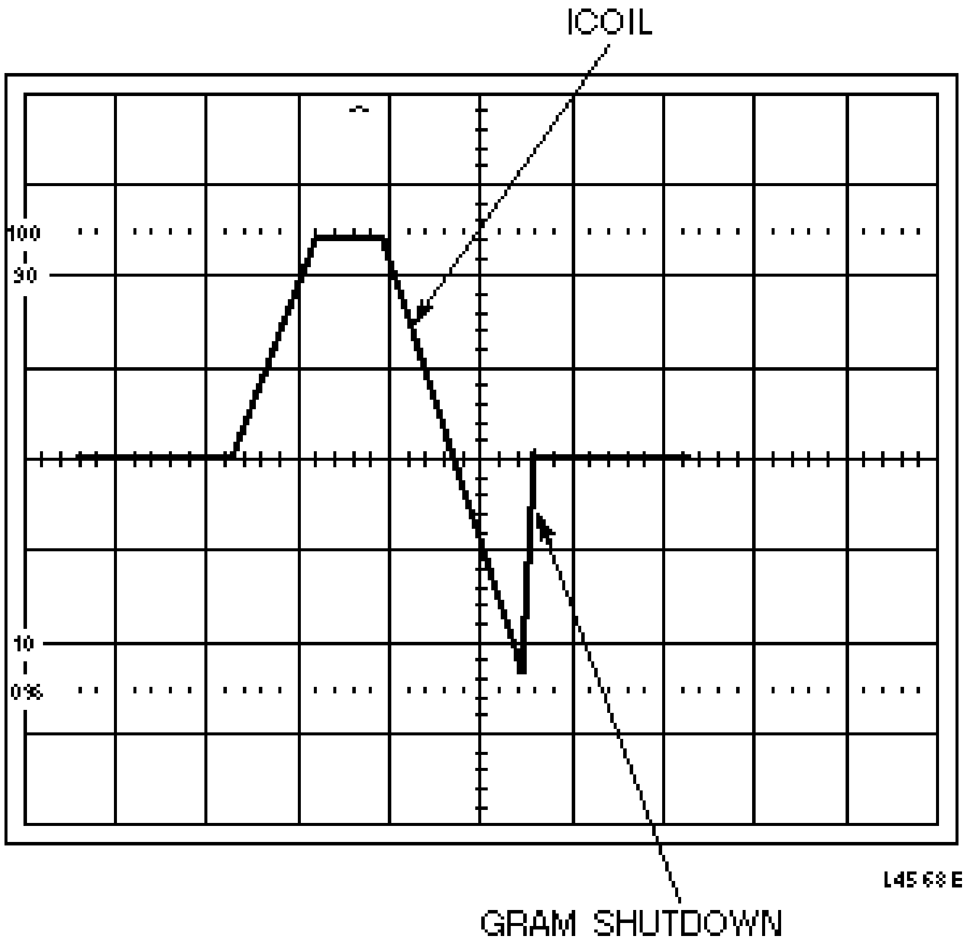
2-8- Troubleshooting Tips

If your waveforms do not appear to represent those detailed in this test, there is probably something out of adjustment. For example, MINI-GRAM tuning may need to be performed, or dc offsets may need to be checked.

The DAC_I and ICOIL waveforms can be difficult to interpret; however, during troubleshooting, they may be a good indicator of whether something is wrong. If the waveforms do not approximate those in this test, there is a problem somewhere in the gradient driver subsystem.

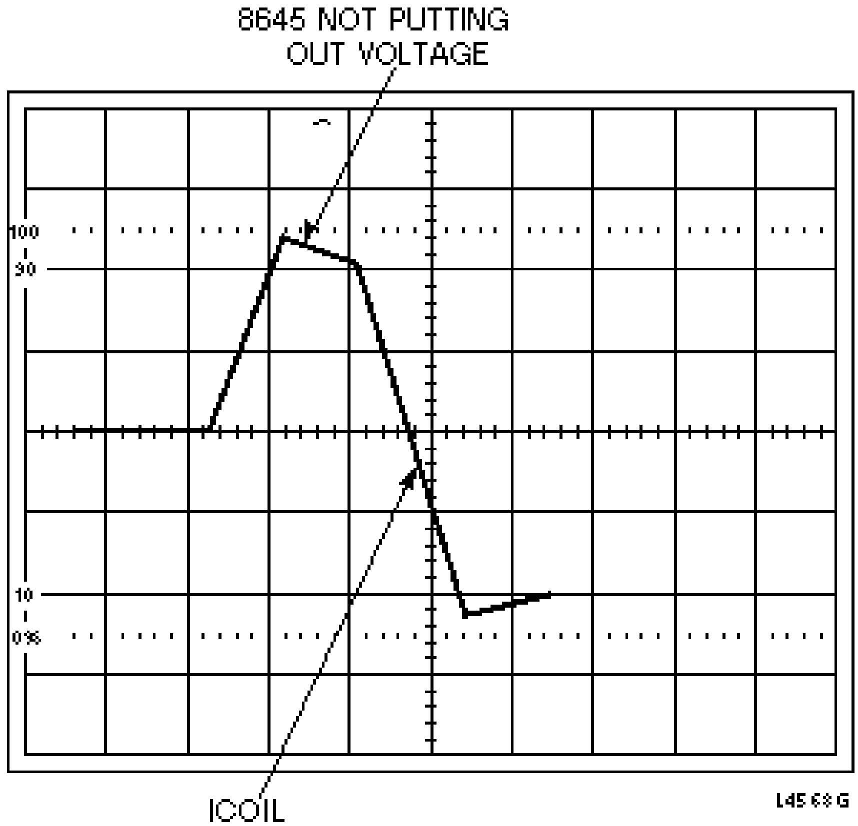
Other problems that may occur during this test include waveform oscillation. ICOIL may be oscillating during the ramps, or on the plateau, or flat top portion, of the waveform. Undershooting at the ramps may also occur on the ICOIL waveforms: parts of the waveform may be missing. For example, there may be only positive portions of ICOIL; or, there may be only negative portions of ICOIL present.

Illustration L4568E shows how ICOIL might look as a result of the Mini-GRAM shutting down for a portion of the pulse.



ICOIL DEMONSTRATING MINIGRAM SHUTDOWN
ILLUSTRATION L4568E

Illustration L4568G shows how ICOIL might look as a result of the GPM not putting out voltage.



ICOIL WITH GPM NOT PUTTING OUT VOLTAGE
ILLUSTRATION L4568G

2-9. System Restoration

At the completion of this procedure, remember to enable RF OUT to the screen room.

3- TRANSISTOR JUNCTION TEMPERATURE TEST

Description - This document relates to Signa Horizon products. This test provides a means of measuring the transistor junction temperature of the transistors on the transistor shelf in the power module.

3-1- Transistor Junction Parameters

Two transistor junction parameters are monitored for each power module during run time monitoring. The GIP monitors transistor junction temperatures. Transistor junction temperatures that exceed specifications can lead to premature transistor junction breakdown.

The transistor junction parameters that are monitored are +LTj and –LTj.

3-2- Power Module Block Diagram

There are four transistor shelves used in each power module transistor shelf. Each transistor shelf has a unique function and name.

- Hi-NPN Output Assembly
- Lo-NPN Output Assembly
- Hi-PNP Output Assembly
- Lo-PNP Output Assembly

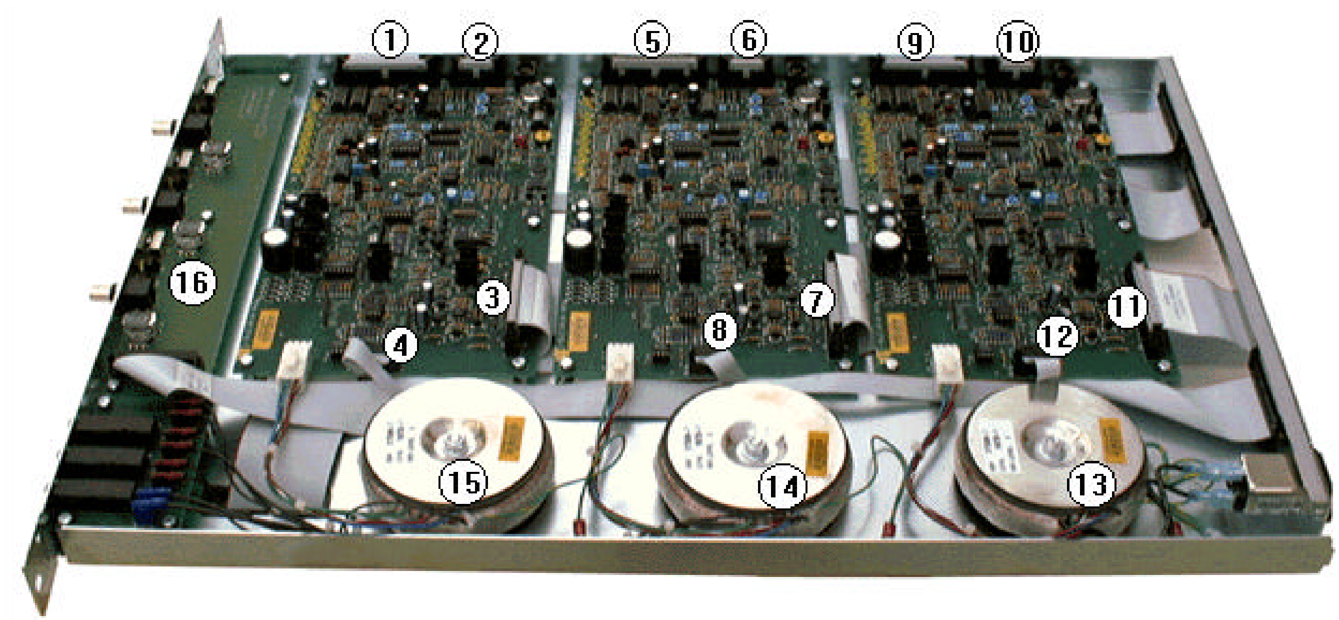
3-3- Main Board LED Indicators

Yellow LED E306, on the GPM main board, lights when the high side output sinks overheat. The power module is placed in standby mode until the temperature returns to a safe level. Error messages in the error log describe the nature of the fault.

3-4- Test Point and Transistor Shelf Locations

3-4-1 Temperature Test Point Location

The transistor junction test points and the output shelf temperature test points are on the GPM main board. See Illustration L6022.



1. J200 cable, X-axis	5. J200 cable, Y-axis	9. J200 cable, Z-axis	13. Xfmr., Z-axis
2. J301 cable, X-axis	6. J301 cable, Y-axis	10. J301 cable, Z-axis	14. Xfmr., Y-axis
3. J400 cable, X-axis	7. J400 cable, Y-axis	11. J400 cable, Z-axis	15. Xfmr., X-axis
4. J300 cable, X-axis	8. J300 cable, Y-axis	12. J300 cable, Z-axis	16. Display Board

MAIN BOARD TRAY
ILLUSTRATION L6022

- TJ201 +LTj is the test junction, or test point, for transistor junction temperature on the positive output shelf.

- TJ201 –LTj is the test junction, or test point, for transistor junction temperature on the negative output shelf.

3-5- Transistor Junction Temperature Measurement

1. Using a DVM, on the dc voltage range, measure the junction temperature voltage on TJ201 +LTj with respect to ground. Record the value in table 7.

TABLE 7
TRANSISTOR JUNCTION TEMPERATURE MEASUREMENTS

	HIGH POWER MODULE			LOW POWER MODULE		
	X	Y	Z	X	Y	Z
+LTj-H				__ ___ _	__ ___ _	__ ___ _
-LTj-H				__ ___ _	__ ___ _	__ ___ _
+LTj-L	__ ___ _	__ ___ _	__ ___ _			
-LTj-L	__ ___ _	__ ___ _	__ ___ _			

2. Measure the junction temperature voltage, on TJ201 –LTj with respect to ground. Record the value in table 7.

3. Plot the voltages on the graphs provided, in table 8 and table 9. If the voltage converts to a temperature greater than 150º C, then the transistor junction temperature for that junction, is way too high.

TABLE 8
+LTJ PLOT

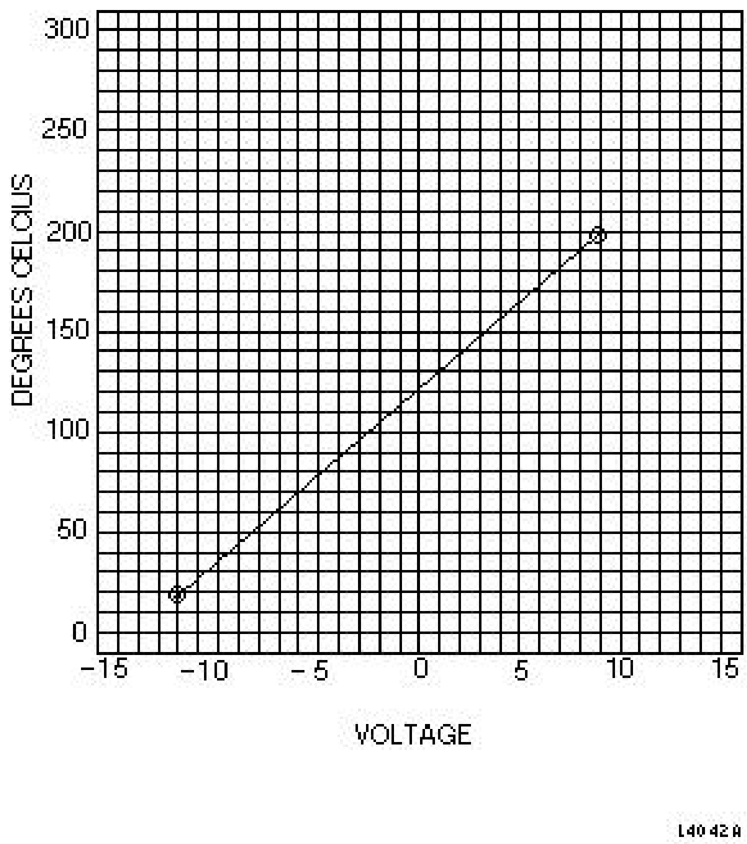
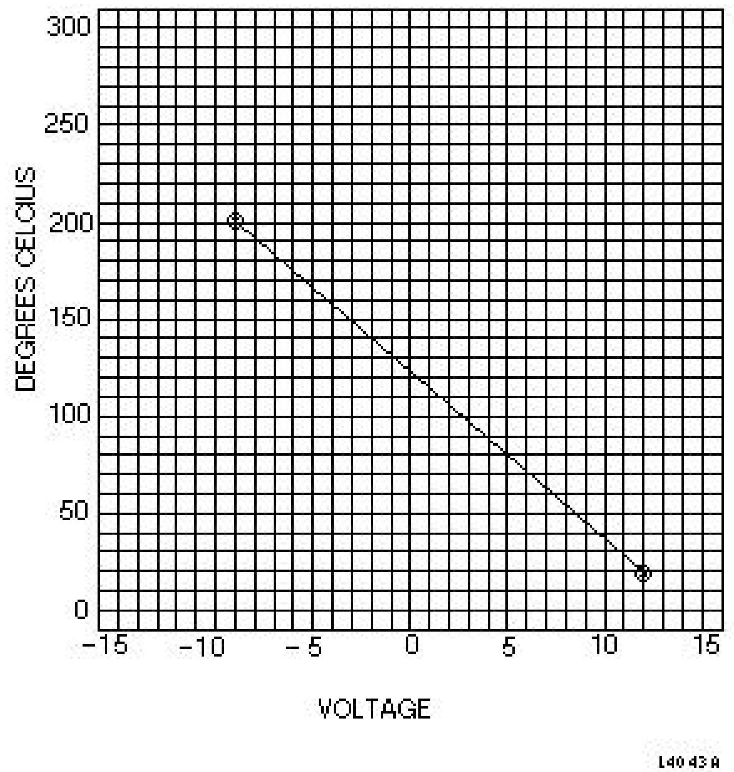


TABLE 9
TABLE 9: –LTJ PLOT



Refer to Section 3-7 - Troubleshooting tips.

3-6- Transistor Junction Transfer Function Calculation

The voltage values for +LTj will plot with a positive slope, while the voltage values for –LTj will plot with a negative slope.

3-6-1 +LTj Parameters

The positive transistor's junction temperatures should be plotted on the graph in table 8 in Section 3-5. The specification for +LTJ is <150º C, while the temperature range is from –12V at 25º C to +9V at 200º C.

3-6-2 –LTj Parameters

The negative transistor's junction temperatures should be plotted on the graph in table 9 in Section 3-5. The specification for –LTj is > –150º C, while the temperature range is –9V at 200º C to +12V at 25º C.

3-7- Troubleshooting Tips

Note

Error messages - +LTj-L and -LTj-L error messages do not appear on systems with only one power module per axis

Run time monitoring may produce +LTj-H, -LTj-H, +LTj-L and –LTj-L error messages, depending on the temperature sensed during a scan. Accurate measurement and comparison of the transistor junction, using the test points, cannot be made, since the GIP receives the temperature information about every 17 milliseconds. Therefore, make your measurements after the scan has completed. Five minutes after a scan is enough time for a normal transistor junction to cool down to approximately room temperature. If this is not the case, however, there is a problem with the Main Board or Output Shelf.

3-8- System Restoration

1. It is critical that all the covers be fastened back to the appropriate module, and that the covers be replaced on all cabinets.

2. Perform a body or head scan to ensure system functionality.

4- SHORTED TRANSISTOR SHELF TEST

Description - This document relates to Signa Horizon products. This material deals with the Long Overload Test.

If there is a shorted transistor, swap the Main Board versus the Output Shelf. No measurements are needed.

5- MANUAL GRADIENT DRIVER TESTS

Description - This document relates to Signa Horizon products. The material deals with Manual Gradient Driver Tests.

5-1- Introduction

With the complexity of the gradient driver subsystem and its closed loop analog circuit, it is useful to be able to measure and view key test points and signals in order to help isolate a problem to a FRU, or a logical group of FRUs. Because of this, the Manual Gradient Driver Tests were created to provide a visual means of viewing these key signals and test points.

5-2- Gradient Driver Test Modes

Each product configuration is tested for the hardware that is present. There are two modes that are tested: voltage control mode and GRAM mode.

5-3- Static Fault Checking

Prior to beginning the manual static tests, all fault registers in the SGD System are checked. Table 13 is a complete list of all of the fault registers that are polled before manual static tests are started. In addition, a comparison is made between the hardware configuration specified in the `MRconfig.cfg` file and the hardware sensed by the GIP board. If a mismatch is found, an error is logged and no manual static tests are performed.

TABLE 13
STATIC FAULTS

Fault	Continue Scanning?	Does hardware Automatically go to Standby?	Method for Clearing Fault on Hardware Module	Method for Clearing on GIP Board
Framing Error	Yes	All unchanged	N/A	Framing Error Bit in the GIP Framing/Clock Stop Register
Clock Stop Error	No	All GPMs = Standby All mGRAMs =Standby Pwr Supplies = Ready	N/A	Clock Stop Error bit in the GIP Framing/clock Stop Register
GPM Cable Off	No	Axis GPM = Standby Axis mGRAMs = Standby Other GPMs & mGRAMs = unchanged Pwr Supplies = Ready	Restore Cable	X/Y/Z_FAULT_ CLEAR bit in FAULT_CLEAR register
GPM Short Overload	Yes	All unchanged	Not needed (clears itself)	Clear Overload bit in FAULT_CLEAR Register
GPM Long Overload	No	Axis GPM = Standby Axis mGRAMs = Standby Other mGRAMs = Standby Other GPMs & mGRAMs = unchanged Pwr Supplies = Ready	Enable to Standby Signal Transition	Clear Overload bit in FAULT_CLEAR register
GPM Transistor Junction Overtemp	Yes	All unchanged	Cool Down	X/Y/Z_FAULT_ CLEAR bit in FAULT_CLEAR register
GPM Shelf Overtemp	No	Axis GPM = Standby Axis mGRAMs = Standby Other GPMs & mGRAMs = unchanged Pwr supplies = Ready	Cool Down	FAULT_CLEAR Register
GPM Transistor Fault	No	Axis GPM = Standby Axis mGRAMs = Standby Other GPMs & mGRAMs = unchanged Pwr supplies = Ready	Enable to Standby Signal Transition	FAULT_CLEAR Register
GPM Supply Fault (GPM-PS in Ready and	No	Axis GPM = Standby Axis mGRAMs = Standby Other GPMs & mGRAMs =	Self Clearing	FAULT_CLEAR Register

No GPM Latched Supply Fault		unchanged Pwr supplies = Ready		
GPM Latched Supply Fault	No	All GPMs = Standby All mGRAMs = Standby Pwr Supplies = Standby	N/A	Must clear GPM Supply Fault via X/Y/Z_FAULT_CLEAR bit in FAULT_CLEAR register
GPM Power Off	No	Axis GPM = Standby Axis mGRAM = Standby Other GPMs & mGRAMs unchanged mGRAM-PS Ready If all GPMs have Power Off, GPM-PS is set to Standby , Else: GPM-PS is set to Ready	Restore Power	X/Y/Z_FAULT_ CLEAR bit in FAULT_CLEAR register
mGRAM Cable Off / Wiring Fault	No	Axis GPM = Standby Axis mGRAMs = Standby Other GPMs & mGRAMs = unchanged Pwr supplies = Ready	Restore Cable	X/Y/Z_FAULT_ CLEAR bit in FAULT_CLEAR register
mGRAM Heatsink Overtemp	No	Axis GPM = Standby Axis mGRAMs = Standby Other GPMs & mGRAMs = unchanged Pwr supplies = Ready	Cool Down	FAULT_CLEAR Register
mGRAM Low Voltage Power Supply Undervoltage	No	Axis GPM = Standby Axis mGRAMs = Standby Other GPMs & mGRAMs = unchanged Pwr supplies = Ready	SW Reset the mGRAM	FAULT_CLEAR Register
mGRAM Overcurrent	No	All GPMs = Standby All mGRAMs = Standby Pwr Supplies = Standby	SW Reset the mGRAM	FAULT_CLEAR Register
mGRAM Overvoltage	No	All GPMs = Standby All mGRAMs = Standby Pwr Supplies = Standby	SW Reset the mGRAM	FAULT_CLEAR Register
mGRAM Undervoltage (mGRAM-PS in Ready)	No	Axis GPM = Standby Axis mGRAMs = Standby Other GPMs & mGRAMs = unchanged Pwr supplies = Ready	SW Reset the mGRAM	FAULT_CLEAR Register
dI/dt Overrange	Yes	All unchanged	Not Needed	Overrange clear bit in FAULT_CLEAR Register
Axis GPM = Standby Axis mGRAMs = Standby Other GPMs & mGRAMs = unchanged Pwr supplies =	No	Axis GPM = Standby Axis mGRAMs = Standby Other GPMs & mGRAMs = unchanged Pwr supplies = Ready	Not Needed	FAULT_CLEAR Register

Ready				
mGRAM Power Off	No	Axis GPM = Standby Axis mGRAM = Standby Other GPMs & mGRAMs unchanged mGRAM-PS Ready If all GPMs have Power Off, GPM-PS is set to Standby , Else: GPM-PS is set to Ready	Restore Power	X/Y/Z_FAULT_ CLEAR bit in FAULT_CLEAR register

If any of the above faults are set, an error is logged, no test signal is generated, and the axis remains in standby mode. To view the errors, turn the test off; the errors are then written to the error log.

5-4- Summary of Manual Static Tests

The manual static tests run five test signals in two operational modes. From the operator work space there are two test selections available, one for each operational mode: **[VCONTROL Mode]** and **[GRAM Mode]**.

5-4-1 Voltage Control Mode Signal Test

Clicking on **[VCONTROL Mode]** plays out a constant voltage signal throughout the gradient driver subsystem. This test sets the power modules to *local* mode, and puts out a constant value to the power modules. This output is based on the signal number entered in the data entry field at the operator work space, and on the hardware configuration. Table 14 shows the expected output voltage at the ICOIL BNC connector and VOut.

TABLE 14
VCONTROL MODE HARDWARE CONFIG, SIGNAL #, AND RESULTING DAC VALUE

Hardware Configuration	Signal LM=1	Signal LM=2	Signal LM=3	Signal LM=4	Signal LM=5
SGD-HiSlew	Vout=20V	10V	0V	-10V	-20V
	ICOIL (BNC)-0.5V	-0.25V	0V	-0.25V	-0.5V

5-4-2 Voltage Control Mode Test

This test causes the system to play out a constant voltage with the gradient drivers set to Ready/Voltage Control Mode. There are five possible voltage levels that can be select by entering the numbers 1 through 5 in the test parameter field (syntax: lm=1). You can then measure voltages at select test points to localize hardware problems.

If this is the first manual diagnostic test requested, the IPG diagnostic code is downloaded. Then, the MDS link is reset, the SPI diagnostic code is downloaded if necessary, and the test request with the signal number is sent to the SPI via the dual port ram. The SPI then sends a packet to the GIP requesting the voltage control mode test with the selected signal number.

To stop the test, click on **[VCONTROL Mode]** again. This sends another packet via the SPI to the GIP and stops the test. Once the test has been stopped, the error queue on the GIP is flushed, and error messages are displayed in the error log.

5-4-3 GRAM Control Mode Signal Test

Clicking on **[GRAM Mode]** plays out a constant current signal throughout the gradient driver subsystem. This test sets the power modules to local mode, and puts out a constant value to the power modules. The constant value output is based on the signal number entered in the data entry field at the operator work space and on the hardware configuration. Table 16 shows the expected output voltage at the ICOIL BNC connection and VOut.

TABLE 16
MGRAM MODE HARDWR. CONFIG, SIGNAL#, AND RESULTING DAC VALUE

Hardware Configuration	Signal LM=1	Signal LM=2	Signal LM=3	Signal LM=4	Signal LM=5
SR-77 and SR-120	Vout=50A	25A	0A	-25A	-50A
	ICOIL(BNC)=-1.25V	-0.625V	0V	0.625V	1.25V

5-4-4 GRAM Control Mode Test

This test causes the system to play out a constant voltage with the gradient drivers set to Ready/GRAM Control Mode. There are five possible voltage levels that can be selected by entering the numbers 1 through 5 in the test parameter field. You can then measure voltages at select test points to localize hardware problems.

At the first run of the manual diagnostic test, the IPG diagnostic code is downloaded. Then, the MDS link is reset, the SPI diagnostic code is downloaded if necessary, and the test request with the signal number is sent to the SPI via the dual port ram. The SPI then sends a packet to the GIP requesting the current control mode test with the selected signal number.

To stop the test, click on **[GRAM Mode]** again. This sends another packet via the SPI to the GIP and stops the test. Once the test has been stopped, the error queue on the GIP is flushed, and messages are displayed in the error log.

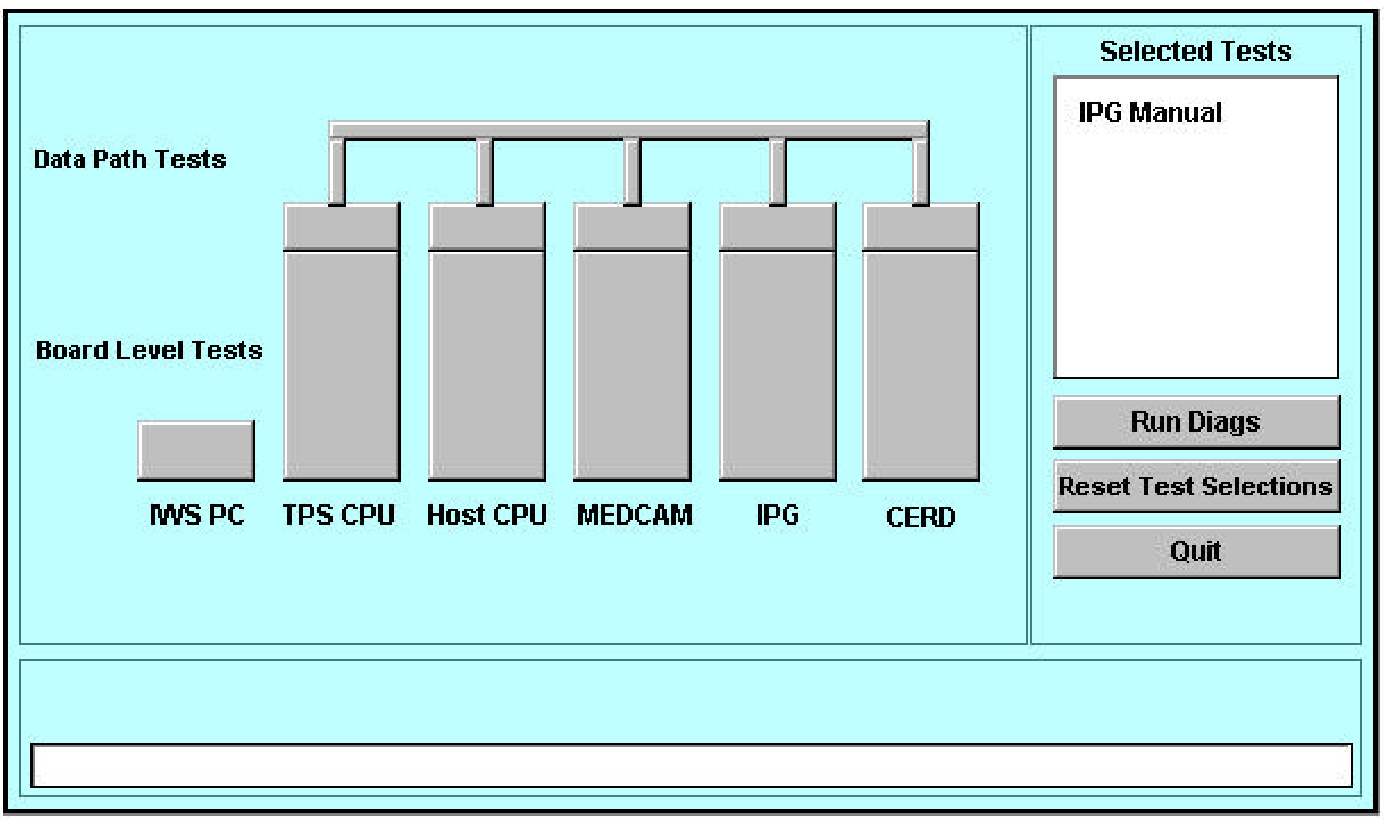
5-5- Executing Gradient Driver Tests

WARNING!

POSSIBLE EQUIPMENT DAMAGE OR PERSONAL INJURY! THIS TEST GENERATES CURRENTS AND VOLTAGES. TAKE MEASUREMENTS FOR THE DESIGNATED SIGNALS AND SIGNAL LOCATIONS ONLY. DO NOT TOUCH THE OUTPUTS OF THE GRADIENT DRIVER AT ANY TIME DURING THIS TEST. DO NOT TOUCH THE INPUTS TO THE EPOXY-FILLED GRADIENT COIL AT ANY TIME DURING THIS TEST.

1. Select the **Diags Main Menu** from the **[Diagnostics]** menu on the Service Desktop, then click **[Start]**.

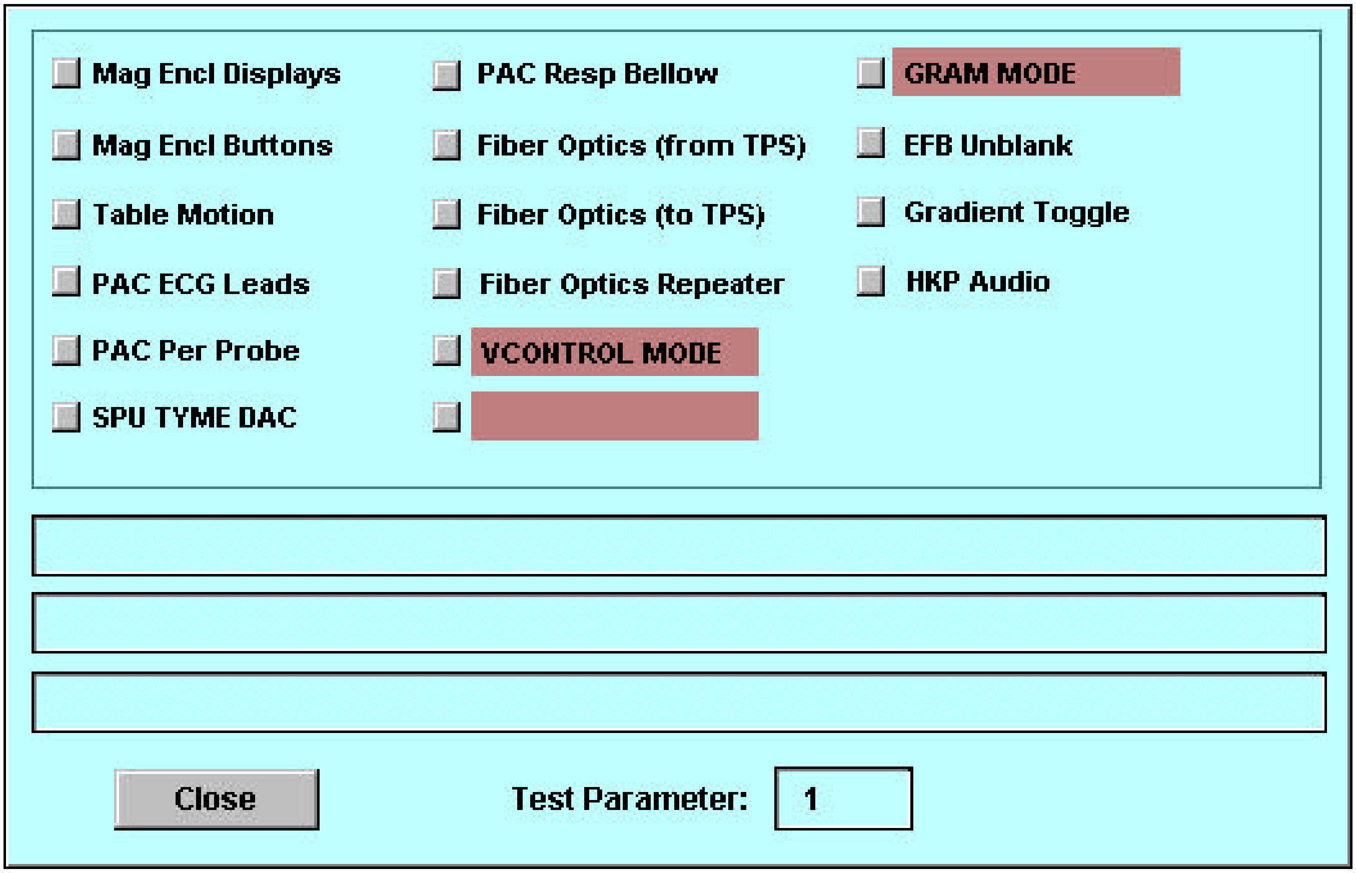
2. Wait for the Diagnostics Main Menu to appear, as shown in Illustration L1611C.



DIAGNOSTIC MAIN MENU
ILLUSTRATION L1611C

3. Click on **IPG**, then **[Manual...]**.

4. Select the Manual Gradient Driver Tests: **[VCONTROL MODE]** or **[GRAM MODE]**. See Illustration L1612C.



MANUAL TEST MENU
ILLUSTRATION L1612C

5. Set **Test Parameter** value between 1 and 5 (e.g., **1<Enter>)**. Click on **[Close]**, then **[Close]** again.

Note

levels of amplitude - These diagnostics were designed to invoke a signal at five different levels. Starting at the highest power helps isolate only those signals that are out of tolerance. If the main input and output are correct, it is not necessary to proceed further; however, if a signal is out of tolerance, further testing will localize to the FRU

6. Click on **[Run Diags]**. A *Results* window appears, along with a status message indicating that the TPS is resetting. Once the TPS reset is complete, the selected diagnostic test automatically commences. To halt the test, click on **[Stop Diags]**.

Note

If the signal disappears - This diagnostic is designed to play out a signal for fifteen minutes at a time. If the signals suddenly go away during a measurement, see if the hardware has gone from Ready to Standby. This is an indication that the Manual Gradient Driver Tests have timed out. Execute the level command to restart the diagnostic

Note

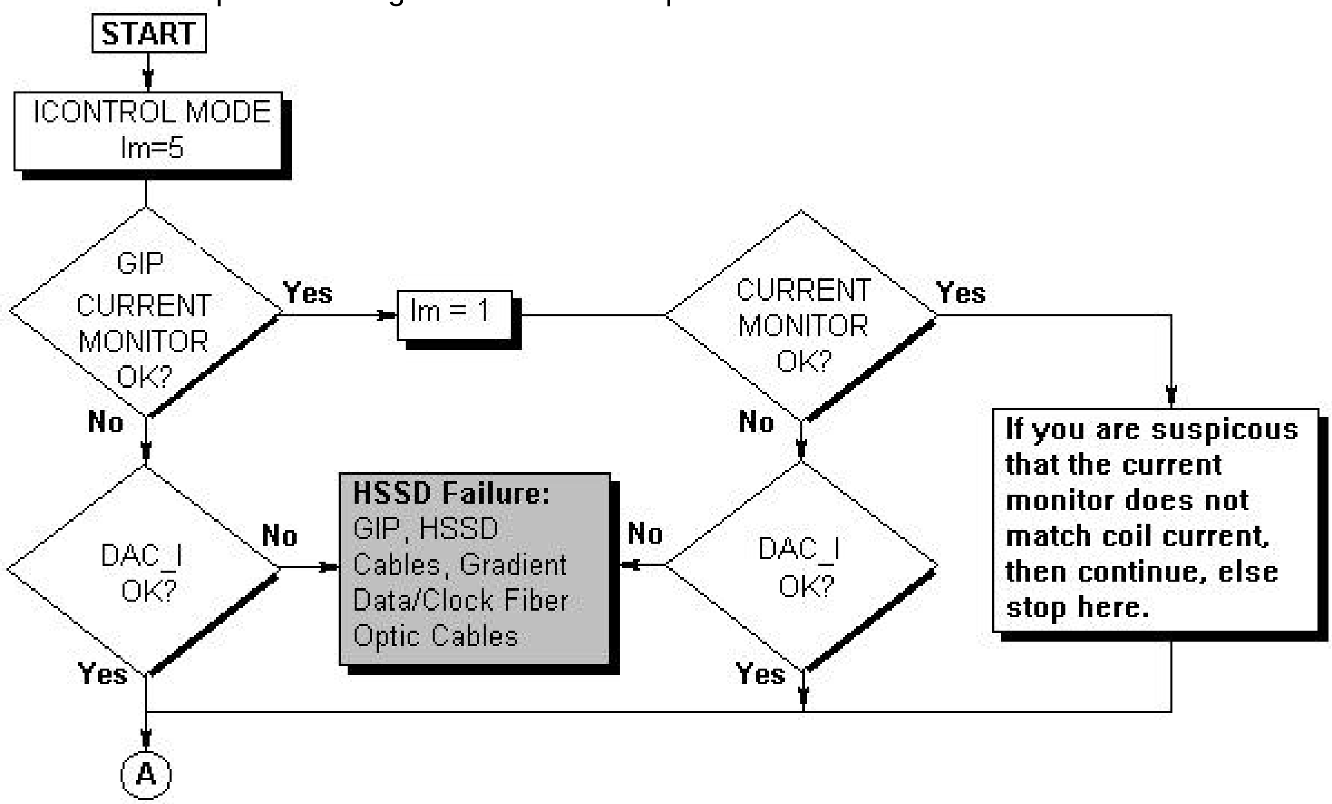
Measuring test points - It is important to measure all test points with respect to analog ground unless stated otherwise.

CAUTION

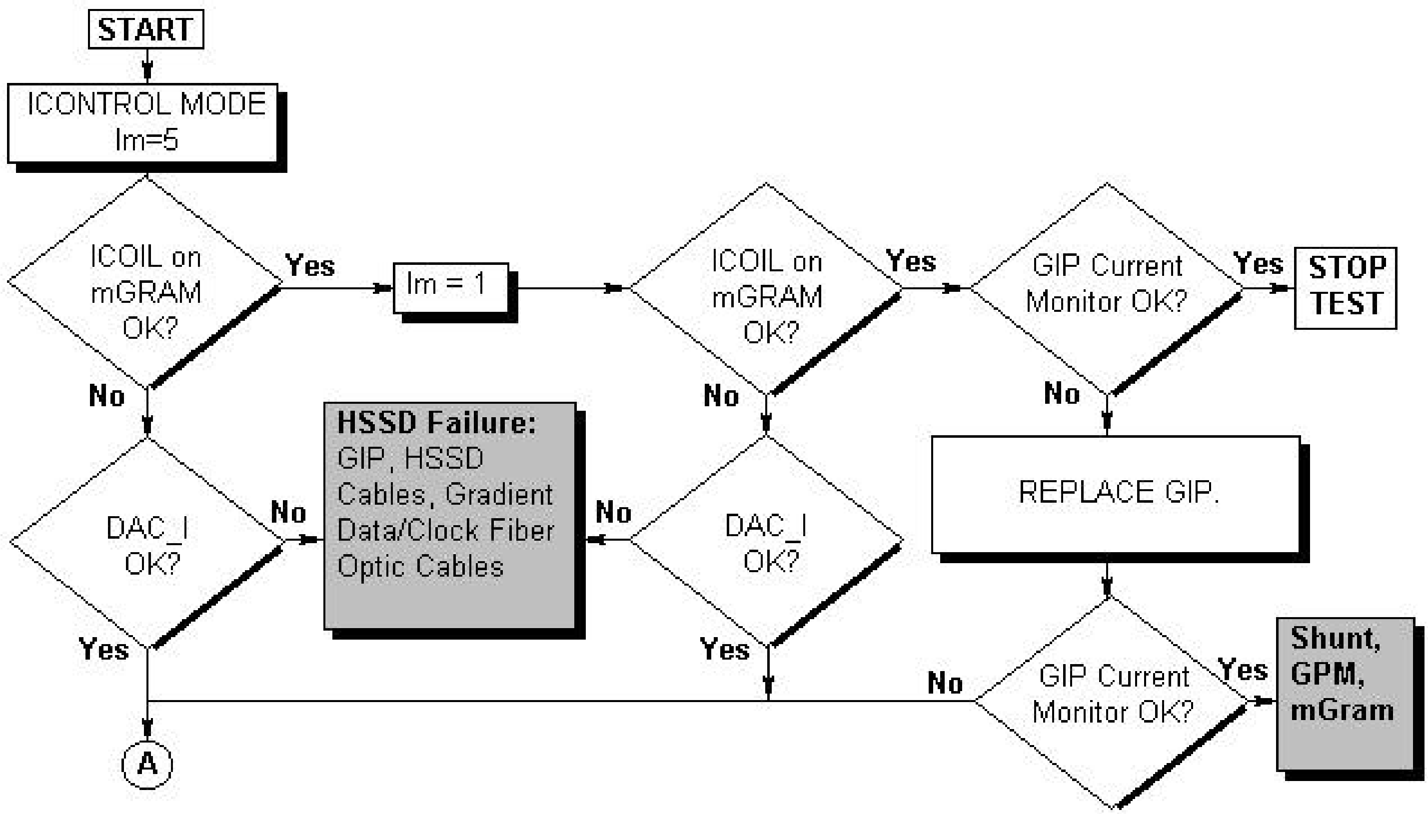
Possible equipment damage. Turn off power to the MIF module before unplugging the ASM. Failure to do so will damage the ASM.

5-5-1 Gradient Driver Troubleshooting Flowchart

1. Follow the flowcharts in Illustration L1 for Signa Horizon, or in Illustration L2 for Signa Horizon HiSpeed and Signa Horizon EchoSpeed.



SIGNA HORIZON MANUAL GRADIENT DRIVER TESTS FLOWCHART
ILLUSTRATION L1



SIGNA HORIZON HISPEED & ECHOSPEED MANUAL GRADIENT DRIVER TESTS FLOWCHART
ILLUSTRATION L2

5-5-2 Exiting Diagnostics

Click on **[Quit]** to exit the Diags Main Menu; the TPS resets.

6- LOAD CONTINUITY TEST

Description - This document relates to Signa Horizon products. The material covers load continuity testing and the gradient driver subsystem.

6-1- Introduction

This procedure measures the continuity, or impedance, of the load, or the output of the gradient driver subsystem components. The epoxy-filled gradient coil is the load for the gradient driver subsystem. However, between the output of that subsystem and the epoxy-filled gradient coil are interface panels, a gradient filter on the penetration panel, and a terminal strip at the rear of the magnet.

This procedure can be used with all of the Signa Horizon product options. However, since hardware configuration varies from product to product, verify that the system is the same as the reference section to ensure that the correct procedure is being referred to.

It is useful to reference the Signa Horizon block diagrams for complete signal path information.

6-2- Preliminary Setup

DANGER!!

FATAL ELECTRIC SHOCK HAZARD!! THE SGD AMPLIFIERS ACT AS CONSTANT LOAD SOURCES AND WILL SEND MAXIMUM CURRENT TO ANY LOAD (INCLUDING YOU!). TO PREVENT FATAL ELECTRIC SHOCK, ENSURE THAT THE POWER IS OFF BEFORE CONTINUING WITH THIS PROCEDURE.

1. Perform lock out tag out by securing the PDU circuit breaker for the SGD cabinet with the lock out tag out devices. Verify that all energy has been disabled by measuring incoming power to the MiniGRAM Power Supply at J-10, and incoming power to the GPM Power Supply at J-10.

2. Verify that power is off by connecting a DVM across the input leads (J1, J2) and output leads (J3, J4) at rear of each Mini-GRAM module. Make sure that the DVM reads 0V.

6-3- Gradient Driver Subsystem Load Continuity Test

Measurements for load continuity are made at three locations for the gradient driver subsystem: the SGD cabinet, both sides of the penetration panel, and the terminal strip at the rear of the magnet.

6-3-1 Signa Horizon HiSlew

1. Using a DVM set to *ohms*, measure the resistance across the + and – input studs, and then across the + and – output studs of each Mini-GRAM module.

2. OPEN LOAD TEST: The resistance measured across the + and – GRAM IN should be greater than 1 kΩ. The resistance measured across the + and – GRAM OUT should be less than 1 Ω. If greater than 1 Ω, then the load may be an open circuit.

3. Measure the resistance from the + and – input studs to ground, and then the + and – output studs to ground of the GRAM module. The –IN to ground measurement should be less than one Ω. All other studs to ground must measure greater than 1k Ω.

Note

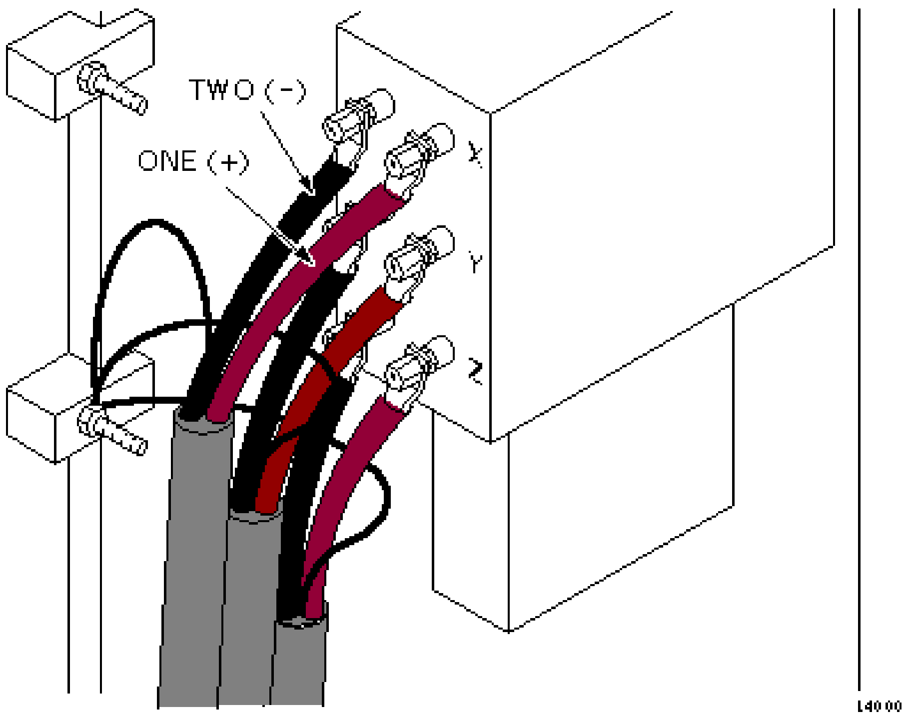
GRAM IN to GRAM OUT measurement - Measuring resistance from GRAM IN to GRAM OUT at the rear of the GRAM measures the coil resistance.

4. An open load to ground should measure as follows: + to –GRAM out will measure greater than 1 Ω. From + or – to ground should measure less than 1 kΩ.

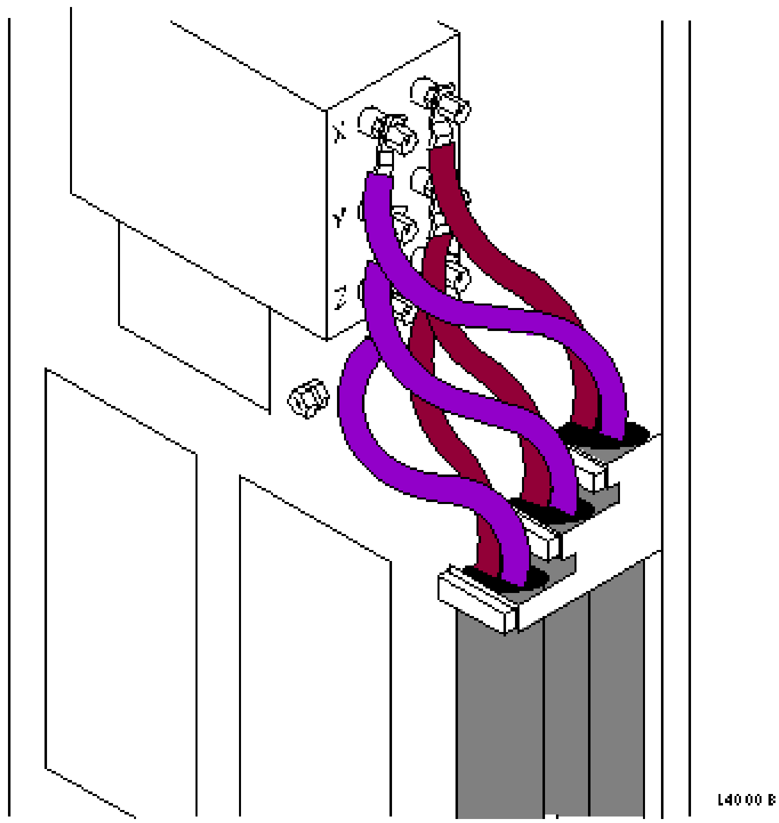
Continue with measurements at the penetration panel, Section 6-3-2 Penetration Panel/Gradient Filter Box Measurements.

6-3-2 Penetration Panel/Gradient Filter Box Measurements

The gradient cables are attached to a new gradient filter, on both sides of the penetration panel. See Illustration L4000A and Illustration L4000B.



EQUIPMENT ROOM VIEW OF THE GRADIENT FILTER BOX
ILLUSTRATION L4000A



SCAN ROOM SIDE VIEW OF THE GRADIENT FILTER BOX
ILLUSTRATION L4000B

1. Using a DVM set to *ohms*, measure the resistance across the +*X* and –*X* load.

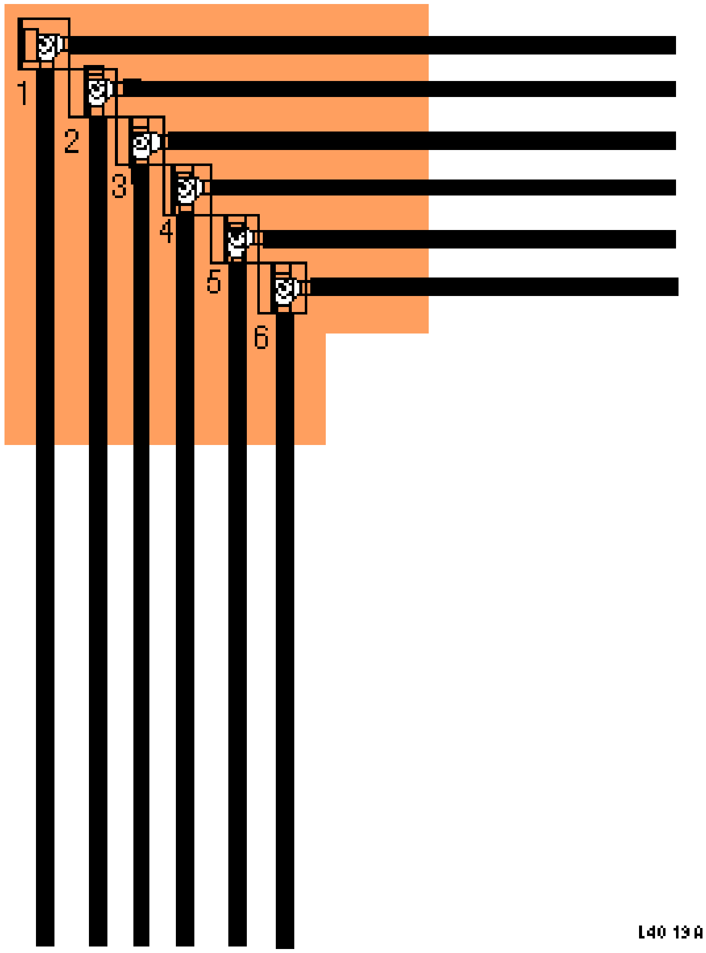
2. The resistance measured at this point should not exceed 1 Ω.

3. Continue measuring the resistance across the *Y* load and then the *Z* load.

4. Repeat steps 1, 2, and 3 for the scan room side of the penetration panel. See Illustration L4000B.

6-3-5 Gradient Cable Terminal Strip Measurements

The gradient cables are attached to a new terminal strip, at the rear of the magnet. Terminal number 1 is +*X* and terminal number 2 is –*X*. Terminal number 3 is +*Y* and terminal 4 is –*Y*. Terminal 5 is +*Z* and terminal 6 is –*Z* (see Illustration L4019A).



GRADIENT CABLE TERMINAL STRIP
ILLUSTRATION L4019A

1. Using a DVM set to *ohms*, measure the resistance across the +*X* and –*X* load.

2. The resistance measured at this point should not exceed 1 Ω.

3. Continue measuring the resistance across the *Y* load and the *Z* load.

4. Measure the resistance from *X* to *Y*, *X* to *Z*, and *Y* to *Z* for both polarities. In all of these cases, the resistance should be greater than 1 kΩ.

6-4- System Restoration

If any of the measurements were not in spec, then replace that component or module. To restore the system to specifications.

1. Ensure that all connections are tight.

2. Measure for open circuit load and short to ground. The Field Engineer will disconnect load cables at measurement points as he continues to isolate opens and shorts.

3. Enable power at the PDU by removing the lock out tag out devices.

4. Apply power to the SGD.

5. Replace all the covers on the cabinets.

6. Perform a body or head scan to ensure system functionality.

REVISION HISTORY

REV	DATE	AUTHOR	PRIMARY REASONS FOR CHANGE
0	May 28, 1998	J. Saperstein	Initial Conversion from Toolbook to Word.