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Description - This document combines the various gradient driver function checks that are used on Signa Horizon Lx systems with 8645/GRAM hardware.

1- 8645 GRADIENT DRIVER CHECKS

Description - This document relates to Signa Horizon products. This material describes the status indicators on the 8645 gradient driver subsystem, and the function checks that may be used for troubleshooting.

1-1- Introduction

The 8645 gradient driver subsystem contains both fault indicators and a dedicated service tool to help you diagnose problems. LEDs on the main board of a power module indicate certain fault conditions; these are described in the next section. The analog service module (ASM) is specifically designed to help solve troubleshooting problems. The 8645 contains three ASMs, one per axis. The ASM reports to the system error log; gradient driver voltage, current, and temperature parameters that are out of specifications.

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 GRADIENT AMPLIFIERS (AND GRAM, IF PRESENT) ACT AS CONSTANT LOAD SOURCES, 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 BOTH CABINETS BEFORE ANY COMPONENT REMOVAL, OR CONNECTOR INTEGRITY VERIFICATION.

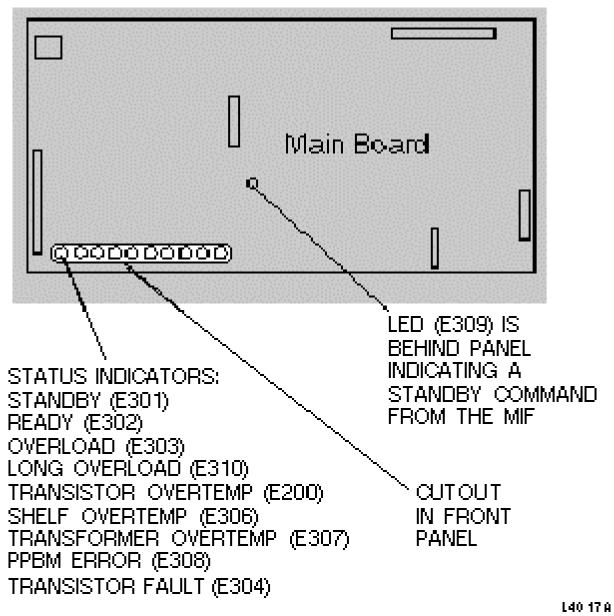
CAUTION

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 in a front panel cutout, report the power module status (see Illustration L4017A). The Ready LED is green; all others are yellow (see table 1).

Some of these conditions can be self-correcting. A *ready* signal replaces the *overtemp* signal when the power module temperature has returned to a safe level. Other conditions, such as long overload, might be corrected by cycling the circuit breaker located on the bottom panel on the front of the 8645 gradient cabinet.



POWER MODULE STATUS INDICATORS
ILLUSTRATION L4017A

TABLE 1
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. The power module is latched into Standby. The circuit breaker must be cycled (turned off and on) to reset the power module.
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.
Transformer	Yellow	This condition exists when one of the toroid transformers

Overtemp		overheats. The power module is placed in Standby until the temperature returns to a safe level.
PPBM Error	Yellow	This condition exists when the polyphase buck module overheats, or a voltage error occurs. The power module is placed in Standby until the condition is corrected. The signal also indicates a faulty free-wheeling diode. (These diodes protect the power transistors.) If a faulty diode is the problem, the power module is latched in Standby, and the circuit breaker must be cycled (turned off and on) to reset the power module.
Transistor Fault	Yellow	This condition exists when a short circuit occurs in the output stage transistors. The power module is latched in Standby. The circuit breaker must be cycled (turned off and on) to reset the power module.
Standby Command from the MIF	Yellow	

1-3- Using the Analog Service Module (ASM)

The ASM is an optional plug-in board inside the MIF (master interface). The ASM provides digitized information of important analog signals for one axis of the 8645. The ASM detects errors, helps service systems in the field, helps diagnose circuits to the FRU level, helps debug new systems, and aids in new engineering research and development. It also serves as a passive ear to monitor various functions inside the 8645. It transmits information to the GAP (gradient amplifier processor), whenever the GAP polls the ASM. The GAP polls the ASM every ten milliseconds. The ASM is controlled by the GAP through the MIF.

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

- Temperature signals from four sensors in the positive and negative current wells of the high and low power modules.
- Temperature signals from sensors in the 3-phase toroid transformers of the high and low power modules.
- Output current of the high and low power modules.
- Total output current. If the power modules are connected in parallel, the individual currents are summed by the MIF. If the power modules are connected in series, the current is sampled from the high side of the power module. (Normal product configuration has the power modules connected in series.)
- Power supply voltage (Vcc) in the high and low power modules.
- Output voltage of the high and low power modules.
- Output voltage from the MIF to the power modules.

- DAC voltage in the MIF. The DAC converts the digital input from the GAP HSSD connection to an analog signal. The analog voltage is sampled for use as a control signal to compare with the voltage across the power modules shunt resistor, and to produce the error signal. If the MIF is in analog mode, the ASM reads the input from the ANALOG Vin/GRAM CTRL Vout connector instead of the DAC voltage.

- DAC error signal. The difference between what the power module current should be and what it actually is. This error signal is for ASM monitoring only, and is not involved in correcting the power output.

- ASM board precision voltage. This 1.235 V source is used as a reference value to adjust other values if necessary.

- Calibration status. A register records whether the ASM is properly calibrated with the MIF. This calibration is done at the factory, and is not intended to be done in the field.

There are four LEDs on the ASM board that can provide hints about internal MIF/ASM problems. If lit, they indicate the conditions listed in table 2.

TABLE 2
ANALOG SERVICE MODULE (ASM) LEDS

LED Name	LED Color	Function
E101	Green	If the LED is lit, the ASM has been calibrated. If the LED is not lit, the ASM requires calibration. If this is the case, return it to the factory for calibration.
E1	Green	This LED is for the +12V supply at an unregulated digital ground. If there are no faults related to this voltage, the LED remains lit. When not lit, it indicates that the MIF has a voltage problem.
E2	Green	This LED is for the +24V supply at an unregulated digital ground. If there are no faults related to this voltage, the LED remains lit. When not lit, it indicates that the MIF has a voltage problem.
E3	Green	This LED is for the –24V supply at an unregulated digital ground. If there are no faults related to this voltage, the LED remains lit. When not lit, it indicates that the MIF has a voltage problem.

1-4- Power Outage Checklist

During troubleshooting, determining if power is applied is an effective way to isolate power as a source of the problem. There are many modules in the 8645 gradient 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 8645 gradient cabinet, check the following:

1. Check the circuit breakers at the ac source of the 8645 gradient cabinet. The circuit breakers are located at the PDU.

2. Check the circuit breakers on the lower panel on the front of the 8645 gradient cabinet.

3. Check the wiring on the inside of the 8645 gradient 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 GAP or MIFs

The LED on the front panel of each MIF chassis will not light if power is off to the MIF module. In addition, the two LEDs on the GAP board will not light if power is off to the GAP module. If there is no power to the GAP or MIFs, check the following:

1. Check the 15-amp circuit breaker (CB5) to the ac voltage outlet box (AC-1) inside the 8645 gradient cabinet.

2. Check the ac voltage outlet box (AC-1) inside the 8645 gradient cabinet for ac volts out.

1-4-3 No Power in the GAP Only (but MIFs have power)

The two LEDs on the GAP board will not light if the power is off to the GAP module. If there is no power to the GAP, check the following:

1. Be sure that the front panel on/off switch (S1) is on.

2. Check the power cord going to outlet box (AC-1) inside the 8645 gradient cabinet.

3. Replace the GAP module because the GAP power supply is probably bad.

1-4-4 No Power in an Individual MIF

If the LED on the front panel of a particular MIF is not lit, there is probably no power to that individual MIF. Check the following:

1. Be sure that the front power slide switch (S5) is on.

2. Check the power cord leading to the outlet box is plugged in.

3. Check the 0.375-amp time-delay fuse (F1) on the rear of the circuit board. You will need to slide the MIF unit out of the cabinet, and remove the cover.

4. Check the MIF main board connectors J201 (AC in) and J200 (connection to the transformer), and the MIF front panel board connector J203 (connection to the power switch).

5. Replace the MIF.

1-4-5 ASM Voltage Indicator LEDs Not Lit

The ASM has LEDs that are visible from the front of the 8645 gradient cabinet. The ASMs get their power from the MIFs. If these LEDs do not light, check the following:

CAUTION

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

1. See section 4-4 No Power in an Individual MIF.
2. Check that the ASM board is securely installed in the connector.
3. Swap the ASM with another axis. If the problem stays the same, it may be in the MIF, or on the main board. If the problem moves with the ASM, replace the ASM.

1-4-6 No 208 Vac to Individual Power Modules (but others have input power)

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

1. Check the 50A circuit breakers (CB1, CB2, CB3, CB6, CB7, or CB8), depending on the system configuration.
2. Check all power cables.

1-4-7 No Output From Individual Power Module

1. See section 4-6 No 208 Vac to Individual Power Modules.
2. Check the 0.125-amp time delay fuses (F1 and F2) on the back of the power module.
3. Replace the polyphase buck module (PPBM).
4. Replace toroid power supply.

1-4-8 Circuit Breaker Keeps Tripping

1. Check for shorts circuits.
2. Check circuit breaker functionality.
3. Swap power cables between axes to isolate the problem to a module or circuit breaker.
4. Replace toroid power supply.

5. Replace PPBM.

1-5- Power Module Error Checklist

1-5-1 No Main Board Status Indicators are Lit

1. See Section 4-6 No 208 Vac to Individual Power Modules.

2. Check the 0.125-amp time delay fuses (F1 and F2) on the back of the power module.

3. Check all the board connectors.

4. Check the in-line connector from the small toroid transformer to main board.

5. If TJ400 test points on main board do not have the proper voltages, replace the board.

Note

Voltage readings - Voltage readings are specified on the main board silk screening

6. Replace the small toroid power transformer.

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

1. Check status LEDs on the front panel of the main board. If one of the error signals is on, correct that problem. See section 2 - Power Module Status Indicators, and Illustration L4017A. If no other LEDs are on, check the following possibilities:

2. Check the status indicators on the other series-connected power module. This applies to Signa Horizon and Signa Horizon EchoSpeed products only.

3. Cycle (turn the power off and on) the circuit breakers.

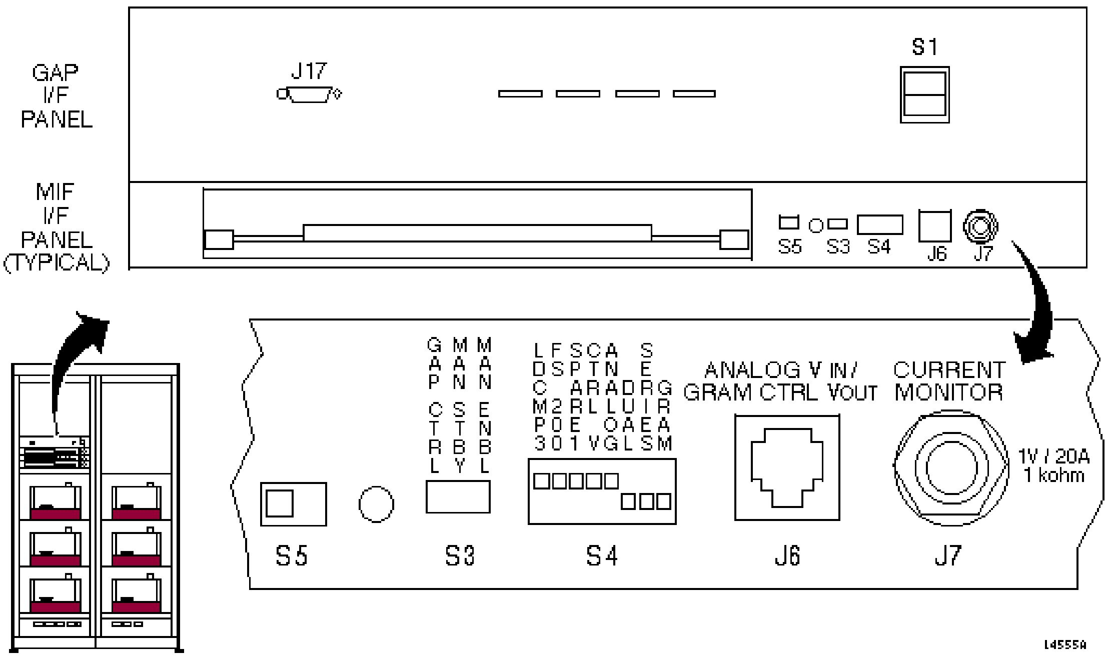
4. Check that the respective MIFs are turned on (front slide switch S5 on).

5. Check slide switch S3 on the front of the MIF for the appropriate settings. The switch has three positions: GAP Control, Manual Standby, and Manual Enable. If the power module enters into ready mode with the MIF switch in Manual Enable, the fault probably lies with the power module, or the connection between the MIF and the power module.

6. Check the small red MIF Standby Command LED (309) on the power module main board. Remove the power module front cover to see the LED. The LED lights when the main board is receiving the standby command signal from the MIF.

   a. See section 4-4 No Power in an Individual MIF above.

b. Check that the MIFs DIP switches (S4) match the desired configuration. See Illustration L4555A and table 3.



FRONT GAP/MIF PANELS
ILLUSTRATION L4555A

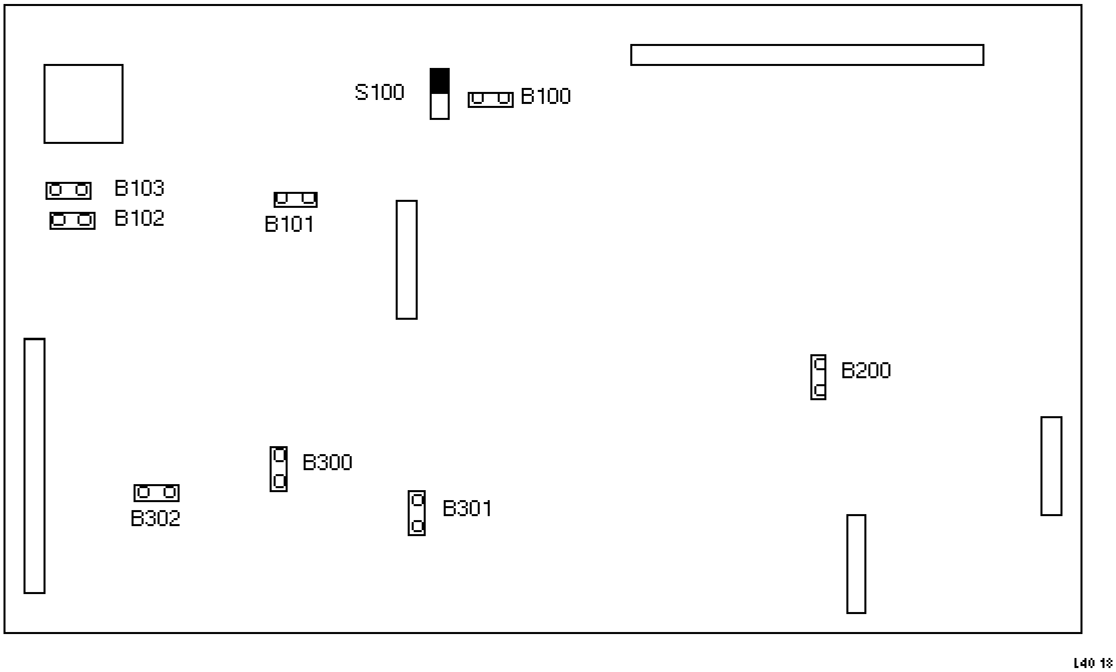
TABLE 3
FRONT GAP/MIF PANELS (S4)

Switch Number	1	2	3	4	5	6	7	8
Signa Horizon Product Configuration	off	off	off	off	off	on	on	off
Signa Horizon HiSpeed Product Configuration	off	off	off	off	off	off	on	on
Signa Horizon EchoSpeed Product Configuration	off	off	off	off	off	on	on	on

c. Check the cables and the connections between the GAP, MIF, and power module.

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

e. Check the jumpers on the main board. See Illustration L4018A and table 4



MAIN BOARD JUMPER LOCATIONS
ILLUSTRATION L4018A

TABLE 4
MAIN BOARD JUMPER DEFINITIONS

Jumper #	Description	Options	Normal Setting
B100	X1 Input Polarity	Horizontal (Both) Inverted Vertical (Both) Non-inverted	Horizontal (Both)
B101	Active Ballast	Left = On Right = Off	Right
B102	J5 –Input	Installed = Connected with MIF Signal Removed = Disconnected from MIF Signal	Installed
B103	J5 +Input	Installed = Connected with MIF Signal Removed = Disconnected from MIF Signal	Installed
B200	Transistor Junction Overtemp Latch	Installed = Enabled Removed = Disabled	Removed
B300	Transistor Junction Overtemp Latch	Installed = Enabled Removed = Disabled	Removed
B301	Standby	Up = External Standby Command Down = Manual Standby	Up
B302	Long Overload Standby	Installed = Standby on Long Overload Removed = No Standby on Long Overload	Installed
S100	Input Source Selector	Up = X10 Input Down = X1 Input	Up

f. Replace the main board.

1-5-3 All Power Modules remain in Standby and Won't Go to Ready

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

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

1-5-5 Long Overload After Cycling Breaker (Power Module Keeps Latching)

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

2. Replace the PPBM.

3. Replace the output shelf.

4. Replace the main board.

5. Replace the toroid power supply.

1-5-6 Transistor Fault After Cycling Breaker

1. Replace the output shelf.

2. Replace the main board.

3. Replace the toroid power supply.

1-5-7 PPBM Error After Cycling Breaker

WARNING!

HIGH VOLTAGE EXISTS ON THE INNER SCREEN SURROUNDING THE PPBM. WHILE THE 8645 HAS POWER, DO NOT ATTACH TEST CLIPS TO THE OUTER SCREEN, OR PUT A SCREWDRIVER TIP THROUGH THE OUTER SCREEN OF THE POWER MODULE!

1. Check for high line voltage.

2. Replace the PPBM.

3. Replace the main board.

4. Replace the toroid power supply.

5. See section 7-1 Power Modules 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 4-2 No Power at GAP or MIFs.

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

1-6-2 Faulty Communication – One Axis

1. Check slide switch S3 on the MIF for the appropriate setting. The switch has three positions: GAP control, manual standby, and manual enable (See Illustration L4555A in Section 1-5-2).

2. See section 4-4 No Power in an Individual MIF.

3. Check the cables and the connections between the GAP, MIF, ASM, and power modules.

4. Check the integrity and the connections of the fiber optic cables leading to the GAP. 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. See Illustration L4018A and table 4 in Section 1-5-2.

6. Swap the MIF cables with another MIF to see if the problem moves; if so, replace the MIF. It is important to swap all the cables on one MIF with all cables on the second MIF.

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

8. Swap the ASM of the faulty axis with an ASM of another axis. If the problem moves, replace the ASM.

9. Replace the GAP.

1-6-3 ASM Calibration LED Not Lit (but Voltage LEDs are Lit)

1. Replace the ASM.

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.
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 (toroid, PPBM, or transistor shelf).

1-7-2 Fan Does Not Run

1. Check the circuit breaker (CB4).
2. Check the 0.5-amp fuse (F1) on fan control board.
3. Check the cable connections to the fan control board.
4. Replace the fan control board.
5. Replace the fan.

1-7-3 Fan Does Not Switch Speed

1. Check that the GAP is on.
2. Check the cable connections to the fan controller board.
3. Replace the fan controller board.
4. Replace the GAP.
5. Replace the fan.

1-7-4 Fan Runs Backward

If the fan runs backward, air is sucked in through the top of the 8645 gradient cabinet and expelled out the front. Correct the incorrectly wired ac phases.

2- DYNAMIC SETTLING TIME TEST

Description - This document relates to Signa Horizon products. The Dynamic Settling Time Test is applicable only to systems with the EPI option.

2-1- Introduction

The purpose of this test is to check the functionality of the settling time for each gradient axis. The waveforms that are generated indicate a relative settling time for each axis for a given scan protocol. An EPI scan protocol is used for this test. Settling time is a function of slew rate.

2-2- Signals Tested

Signals that are tested are DAC_I, and IERROR. *DAC_I* is the digitized signal that is amplified by the GRAM tuning board, thus producing IGRAD. *IGRAD* is the current that the power modules request from the GRAM. *ICOIL* is the current that the GRAM produces. *IERROR* is ten times the difference between IGRAD and ICOIL.

Ideally, IGRAD and ICOIL should match, and IERROR should be zero; however, an error between these two signals does occur. The hardware control loop causes ICOIL to follow IGRAD. The time that it takes ICOIL to become equal to IGRAD is the *settling time*. The settling time is the parameter to look at in this test; however, since the resolution of IERROR is better, it is used to determine the settling time. IERROR will be viewed with DAC_I.

2-3- Initial Conditions

- Software fully operational
- Quad head coil removed from cradle

CAUTION

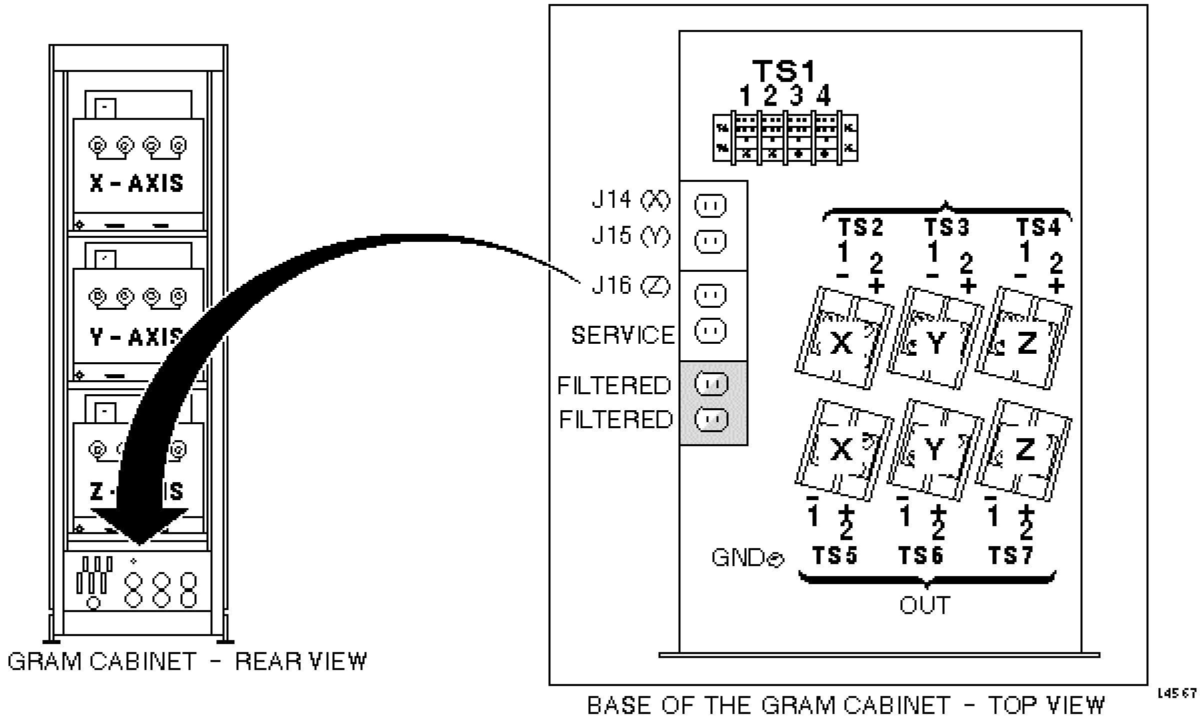
Equipment damage possibility. Remove the quad head coil from the cradle before performing any body scans. Failure to do so may damage the head coil T/R network.

2-4- Tools Required

- Body Sphere Phantom, 2135650, with Small Body Loader Shell, 2125244
- Two-channel 400 MHz oscilloscope with scope leads

2-5- Hardware Set-up

Use the filtered service outlet in the base of the GRAM cabinet to power the scope (see Illustration L4567A). Failure to do so will invalidate all measurements.



FILTERED SERVICE OUTLET IN THE BASE OF THE GRAM CABINET
ILLUSTRATION L4567A

To accurately perform the Dynamic Settling Time Test, calibrate the scope to the ground potential of the GRAM control board. Use the scope magnetic shield, associated with the RF measurements kit, for all scope measurements.

1. Remove the front cover of the GRAM cabinet.

2. Remove the cover on the GRAM module for each axis being tested.

3. Turn on the power to the scope. Place each scope channel to dc, and position each trace at the zero-reference graticule.

CAUTION

Possible instabilities and errors. It is critical that power from the filtered service outlet, which is supplied with the GRAM, be used for these calibrations. The oscilloscope must be powered from the same source as the GRAM control boards. If power from the service outlet is NOT used, there will be noise on the waveform that is displayed on the scope This will cause phase instabilities that will seriously impair this measurement. This outlet is located below the Z GRAM in the base of the GRAM cabinet, next to the GRAM output terminals. Use extreme care when plugging the scope into the filtered service outlet. The outlet provides 110 Vac. See Illustration L4567A. Product versions of this cabinet should have an extension cord plugged into this filtered service outlet, bringing power up and away from the exposed terminal strips.

4. Using the scope calibration signal, verify that there is no attenuation from the scope probes. Calibrate the scope probes as necessary so that the calibration waveforms have square corners.

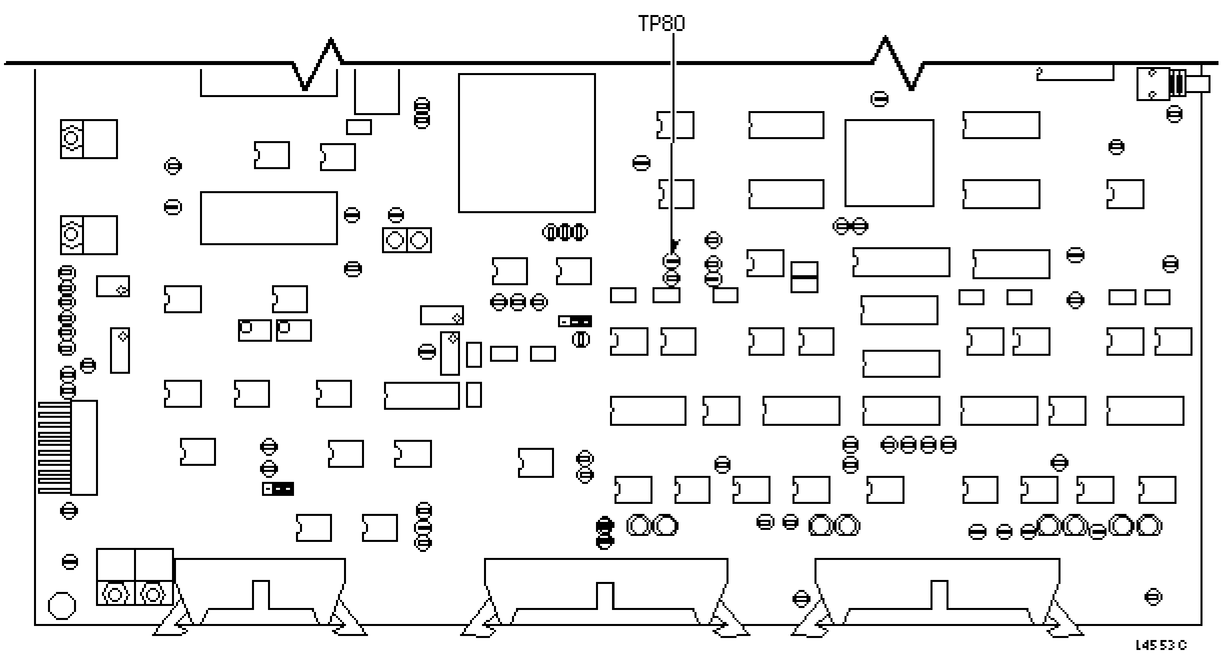
5. Connect both scope leads to a ground test point on the GRAM control board. (The black test points are ground).

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.

8. With the calibrated scope leads, set Channel 1 to 50 mV/div with dc coupling, and Channel 2 to 2 Volts/Div with ac coupling. The time sweep should be set at 200 msec/div. Select Channel 2 as the scope trigger.

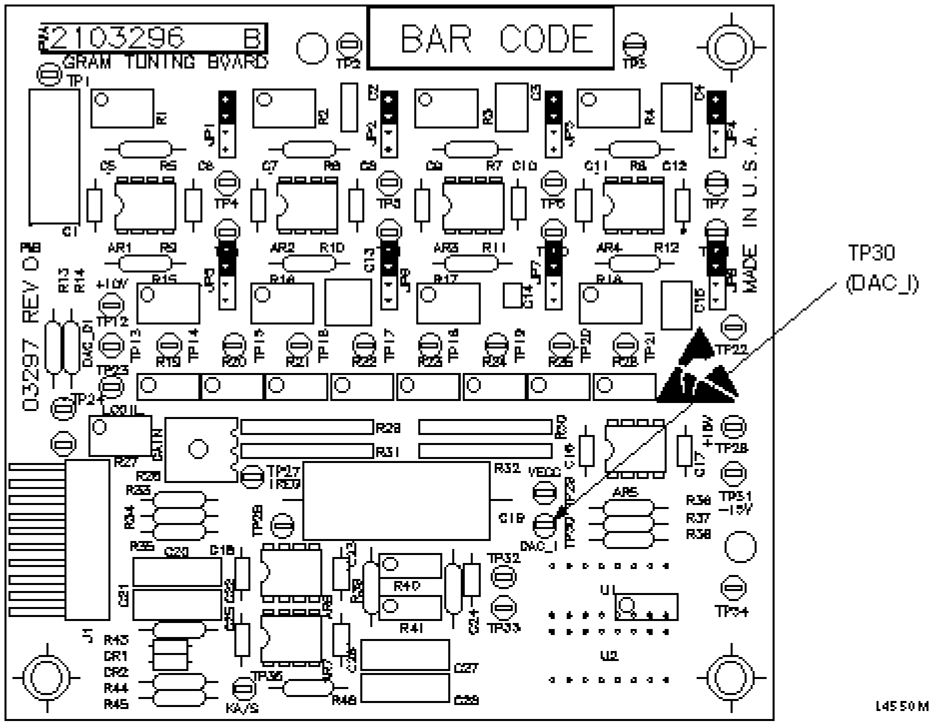
a. Channel 1 displays IERROR. Connect Channel 1 to TP80 on the GRAM control board (see Illustration L4553C).



TP80 (IERROR) LOCATED ON LOWER HALF OF THE GRAM CONTROL BOARD
ILLUSTRATION L4553C

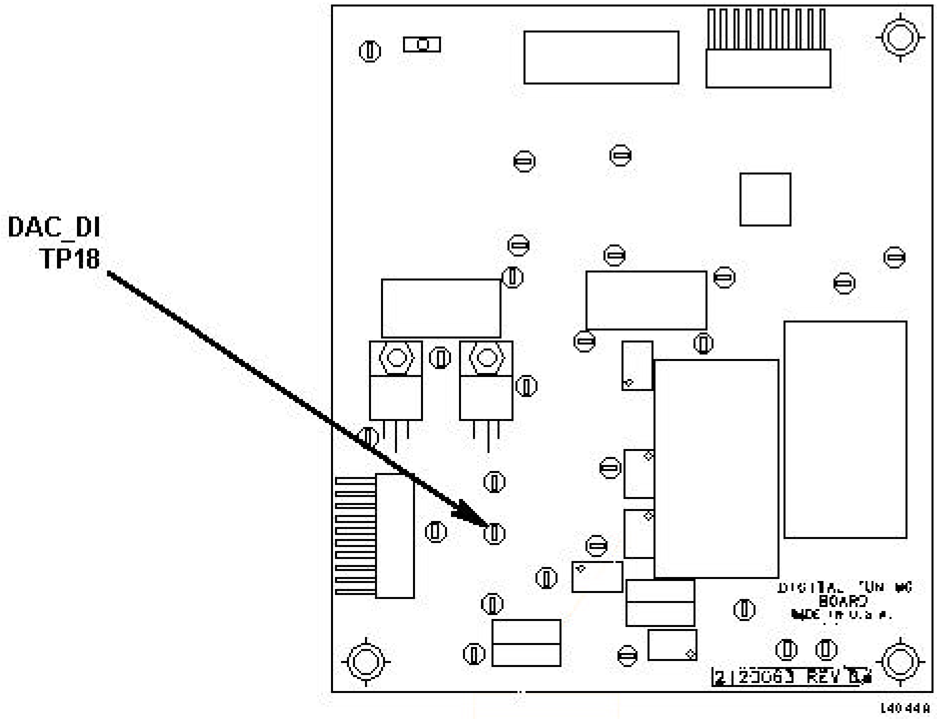
b. Channel 2 displays DAC_I. Locate the appropriate TP, depending on which type of GRAM tuning board is on the system:

For analog GRAM tuning boards, connect Channel 2 to the DAC_I TP (see Illustration L4550M).



DAC_I TEST POINT LOCATION ON ANALOG GRAM TUNING BOARD
ILLUSTRATION L4550M

For digital GRAM tuning boards, connect Channel 2 to DAC_DI TP18 (see Illustration L4044A).



TP18 (DAC_DI) LOCATION ON DIGITAL GRAM TUNING BOARD
ILLUSTRATION L4044A

c. Connect both ground leads to a ground test point on the GRAM control board.

2-6- Scan Setup

1. Place the body sphere phantom and the small body loader shell at the head end of the cradle. Landmark on the center line of the sphere, and prepare the system to scan. Refer to Table 1.

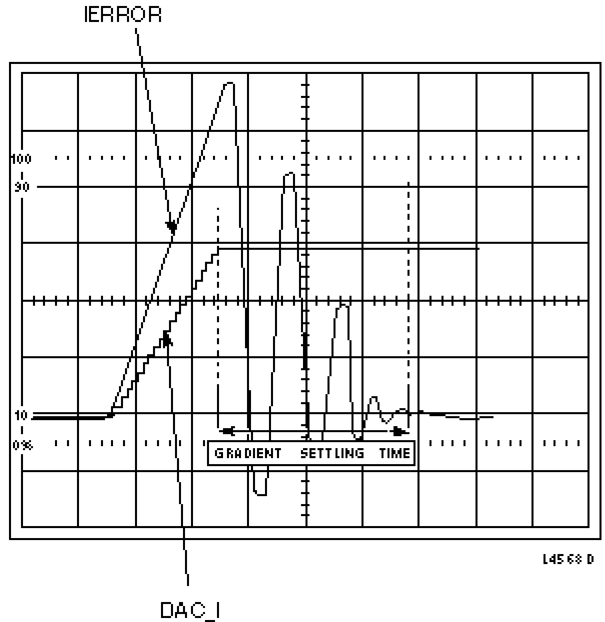
Note
No alternative procedure - There is no alternate proprietary procedure available for GE use, or to sites with a valid Advanced Service Package Limited License at this time.

2. Click on **[Scan]**.

Note
Scope measurements - Scope measurements should not be performed while the system is prescanning. Wait until the system starts to scan, then make scope measurements.

2-7- Gradient Settling Time Waveforms: IERROR

1. When the system starts to scan, view the waveforms for each axis, see Illustration L4568D



IERROR AND DAC_I
ILLUSTRATION L4568D

2-8- Troubleshooting Tips

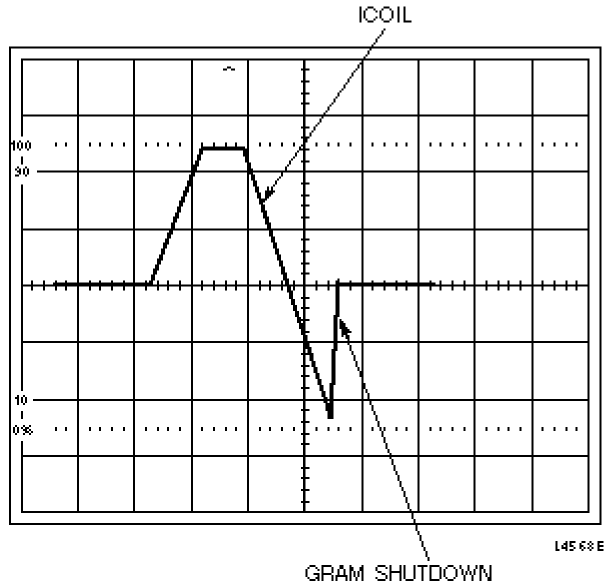
This test is relatively sensitive. If the waveforms do not appear to represent those detailed in this test, there is probably something out of adjustment. For example, GRAM tuning may need to be performed, or dc offsets may need to be checked.

The IGRAD 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.

VCTRL is monitored by the GRAM control board during this test, which checks for analog saturation. Analog saturation may occur if there is a hardware problem during this test. If that occurs, an error message details what course to follow.

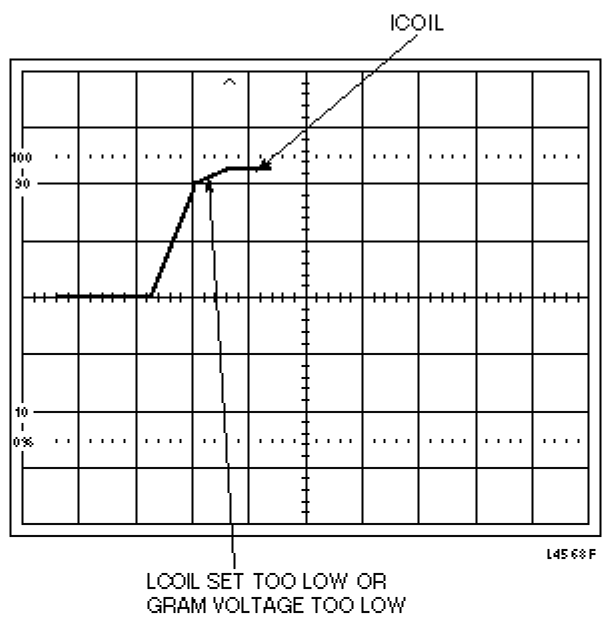
Other problems that may occur during this test include waveform oscillation. ICOIL may be oscillating during the ramps, or on the plateau, or flat top portion, of the waveform. Undershooting at the ramps may also occur on the ICOIL waveforms: parts of the waveform may be missing. For example, there may 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 GRAM shutting down for a portion of the pulse.



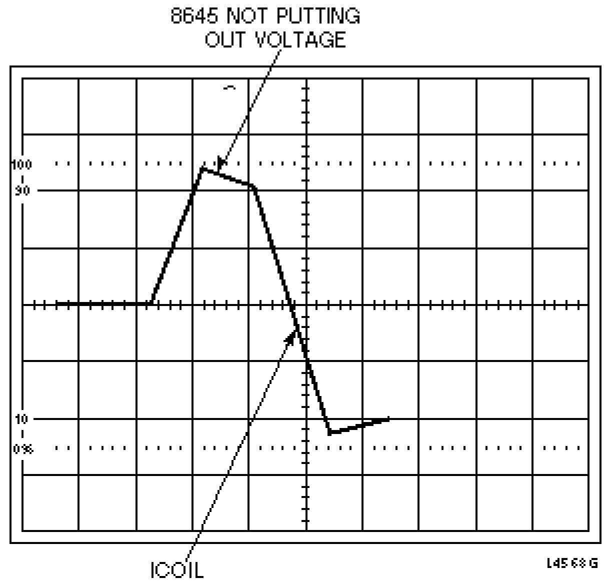
ICOIL DEMONSTRATING GRAM SHUTDOWN
ILLUSTRATION L4568E

Illustration L4568F shows how ICOIL might look as a result of ICOIL being set too low, or the GRAM voltage being too low.



ICOIL: LCOIL OR GRAM VOLTAGE TOO LOW
ILLUSTRATION L4568F

Illustration L4568G shows how ICOIL might look as a result of the 8645 power modules not putting out voltage.



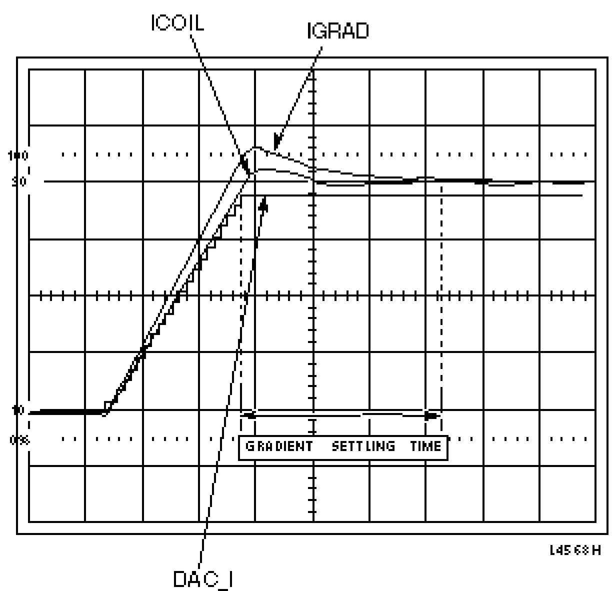
ICOIL WITH 8645 NOT PUTTING OUT VOLTAGE
ILLUSTRATION L4568G

2-9- Gradient Settling Time Waveforms: ICOIL and IGRAD

Note

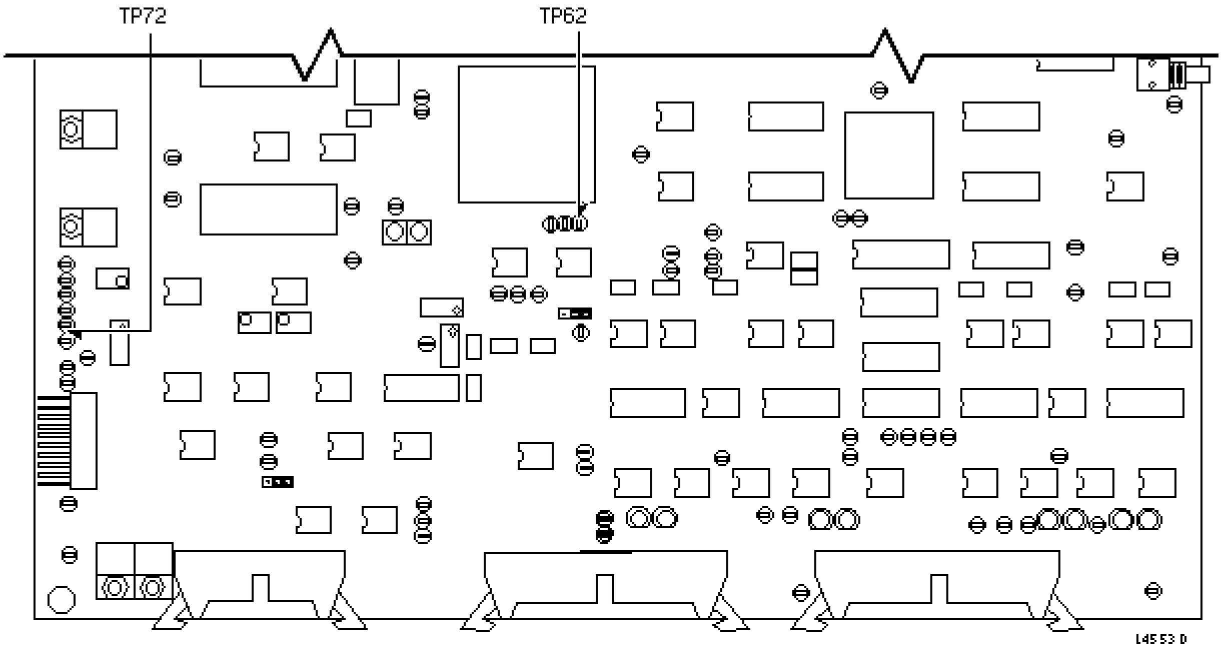
Three channel scope - It is helpful to use a scope with three channels in order to display all three waveforms for comparison

1. For reference purposes, it is possible to view ICOIL and IGRAD (see Illustration L4568H). Some of the waveform problems described in the previous section illustrate what can happen to these two signals.



ICOIL, IGRAD, AND DAC_DI
ILLUSTRATION L4568H

a. Channel 1 displays ICOIL. Connect Channel 1 to TP62 on the GRAM control board (see Illustration L4553D).



TP62 (ICOIL) & TP72 (IGRAD) Locations on Lower Half of GRAM Control Board
ILLUSTRATION 4553D

b. Channel 2 displays IGRAD. Connect Channel 2 to TP72 on the GRAM control board (see Illustration L4553D).

c. Channel 3 displays DAC_I. Depending on system configuration, use the appropriate TP as follows:

For analog GRAM tuning boards, connect Channel 3 to the DAC_I TP (see Illustration L4550M in Section 2-5).

For digital GRAM tuning boards, connect Channel 3 to DAC_DI TP18 (see Illustration L4044A in Section 2-5).

3- TRANSFORMER CORE TEMPERATURE TEST

Description - This document relates to Signa Horizon products. This material discusses measuring toroid power supply core temperatures.

3-1- Introduction

Each power module within the 8645 gradient amplifier cabinet contains three toroid power supplies. Each toroid has a temperature sensor located in or near its core. The temperature sensor sends data to the analog service module (ASM) board. The ASM reports an error condition to the gradient amplifier processor (GAP) board. This error is then reported to the error log. The ASM refers to these signals as XFTEMP-H and XFTEMP-L, where XFTEMP refers to transformer temperature, H refers to the high power module, and L refers to the low power module.

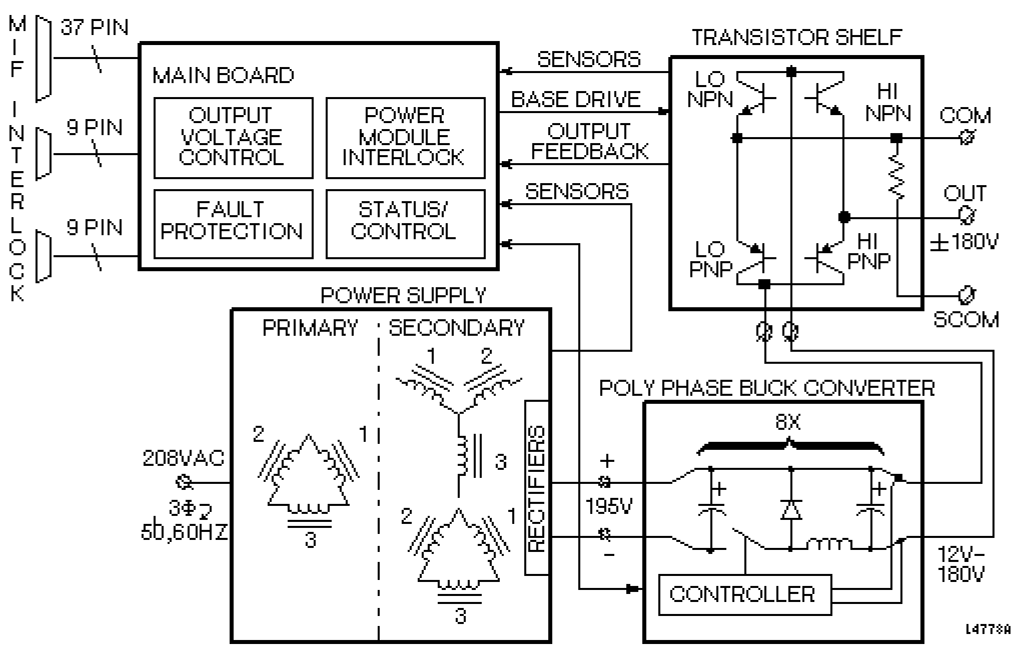
When an error condition is reported, you can use the Transformer Core Temperature Test to measure the core temperatures of each toroid via test points on the 8645 main board. This information is helpful when troubleshooting XFTEMP-H and XFTEMP-L faults.

The temperature limits of the toroid are:

- At 177º C, the power module goes to standby mode.
- The temperature must be below 168º C before the power module can be enabled again.

3-2- Power Module Block Diagram

Illustration L4778A functionally shows the three toroid power supplies used in each power module. Notice that the primary transformer accommodates 3-phase incoming power. The toroid power supply, also known as a *buck DC power supply*, converts 3-phase 208 Vac to 200 Vdc (nominal) at up to 200A peak or 140A RMS. Three toroidal power transformers tap each of the three ac power lines (phases A, B, and C) in a wye configuration. The transformers are protected by a 50-amp, 3-phase circuit breaker between the power supply input and the ac line.

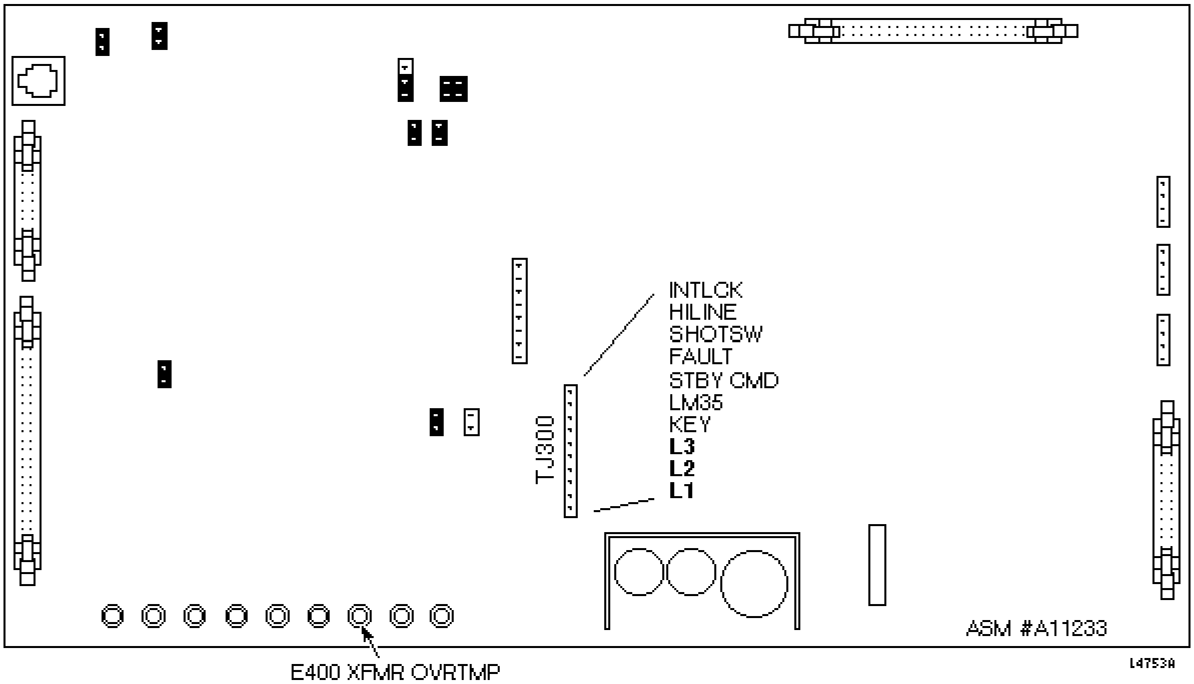


8645 POWER MODULE WIRING DIAGRAM
ILLUSTRATION L4778A

3-3- Main Board LED Indicator

Note

Note that E400 on the 8645 main board is a yellow LED that lights when a transformer overtemp condition exists (see Illustration L4753A). Error messages in the error log describe the nature of the fault.



8645 MAIN BOARD: E400 LED AND TEMPERATURE TEST POINT LOCATIONS
ILLUSTRATION L4753A

3-4- Test Point and Toroid Locations

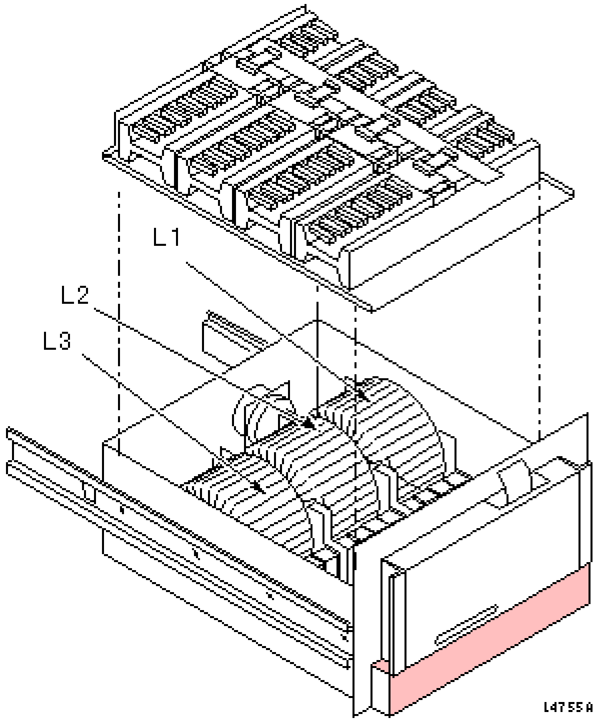
3-4-1 Temperature Test Point Location

Each of the three toroids has a test point on the 8645 main board. See Illustration L4753A in Section 3-3 for test point locations.

- TJ300 L1 is the test junction, or test point for toroid L1.
- TJ300 L2 is the test junction, or test point for toroid L2.
- TJ300 L3 is the test junction, or test point for toroid L3.

3-4-2 Toroid Location

Each test point refers to a unique toroid location. See Illustration L4755A for toroid locations.



TOROID TRANSFORMER LOCATIONS
ILLUSTRATION 4755A

3-5- Toroid Temperature Measurement

1. Using a DVM on the dc voltage range, measure L1 with respect to ground. Record the value in table 7.

2. Measure L2 with respect to ground. Record the value in table 7.

3. Measure L3 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	— — —	— — —	— — —			

3-6- Temperature Transfer Function Calculation

Each measurement uses the formula in table 7 (see Section 3-5), and should not exceed 150º C.

3-7- Troubleshooting Tips

Run time monitoring may produce +TEMP or –TEMP error messages, depending on the temperature sensed during a scan. This may also lead to a transformer overtemp. In this event, you may need to wait for up to fifteen minutes for the transformer to cool down. (The thermal time constant of the transformer is about eight minutes.) During a scan, the temperature of each toroid should go up. After the scan, the temperatures should drop gradually until they are just above ambient room temperature. If both low and high power modules are present, then all transformer temperatures for a single axis should be approximately the same. If one transformer temperature either stays at room temperature, or goes very high compared to others on the same axis, that toroid may be miswired, or need replacement. This condition could also lead to the circuit breaker tripping.

If all the toroid temperatures in a single power module seem elevated, this can be caused by the polyphase buck module, (PPBM) not stepping down the voltage properly. You may want to look at the voltage across +Vcc and –Vcc on that power module main board. Normally, the voltage difference is approximately equal to 13 V, when the axis is ready but not when scanning, A shorted device in the PPBM could cause it to go as high as 195 Vdc. During scanning, the voltage changes dynamically in response to the output voltage. $Vcc \cong |Vout| + 13$ V. To monitor this on a scope requires using two probes connected differentially to both +Vcc and –Vcc.

3-8- System Restoration

1. It is critical that all the covers be fastened 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- 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.

4-1- Transistor Junction Parameters

Two transistor junction parameters are monitored for each power module during run time monitoring. The analog service module (ASM) monitors these signals and routes the data via the master interface (MIF) to the gradient amplifier processor (GAP) board. Transistor junction temperatures that exceed specifications can lead to premature transistor junction breakdown.

The transistor junction parameters that are monitored are +LTj and –LTj. The high power module parameters are +LTj-H and –LTj-H. The low power module parameters are +LTj-L and –LTj-L. The parameter –LTj is associated with the negative transistor well junction die temperature, and the +LTj signal is associated with the positive transistor well junction die temperature.

4-2- Power Module Block Diagram

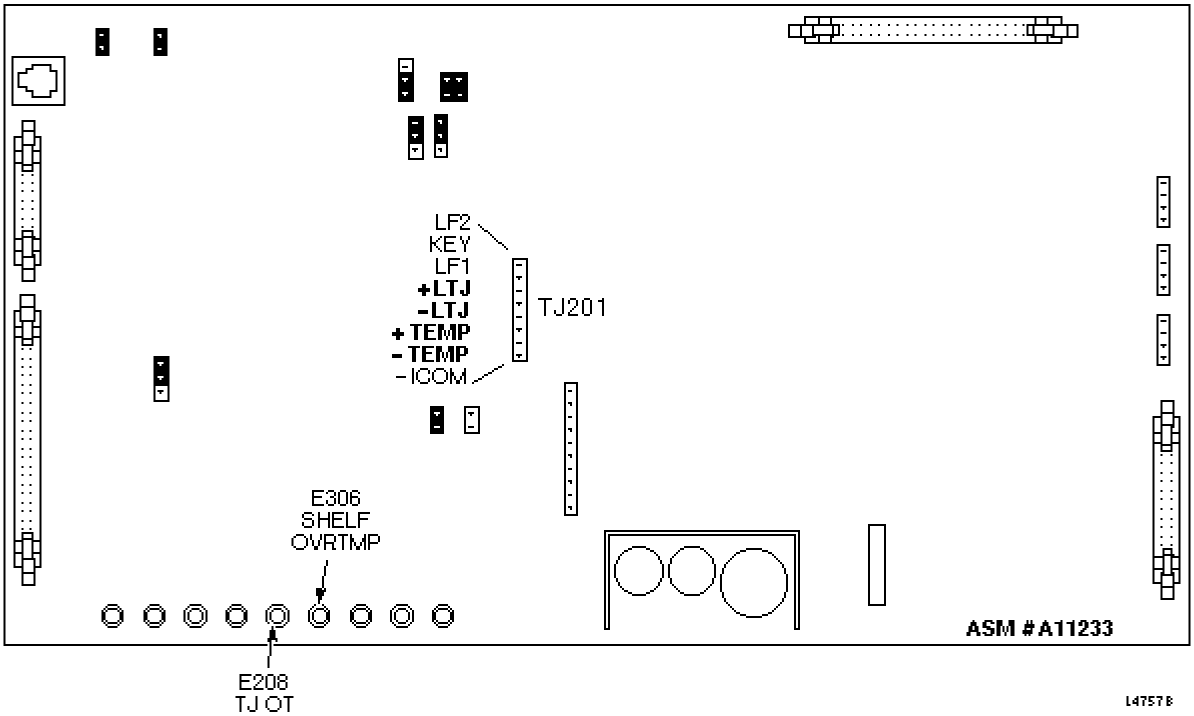
Illustration L4778A in Section 3-2 functionally shows the four transistor shelves used in each power module. Notice that there are four transistors indicated on the block diagram. Each transistor in the block diagram represents a transistor shelf. Each transistor shelf has a unique function and name.

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

One high power module contains all four transistor shelves, and one low power module contains all four transistor shelves. Do not confuse the transistor shelf nomenclature with the power module nomenclature.

4-3- Main Board LED Indicators

Yellow LED E306, on the 8645 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 (see Illustration L4757B).



8645 BOARD: TRANSISTOR JUNCTION AND SHELF OVERTEMP LEDS & TEST POINTS
ILLUSTRATION L4757B

4-4- Test Point and Transistor Shelf Locations

4-4-1 Temperature Test Point Location

The transistor junction test points and the output shelf temperature test points are on the 8645 main board. See Illustration L4757B in Section 4-3 for test point locations.

- 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.

4-5- 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 in Section 3-5.

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

Note

Note that there are two measurements for the high power modules, and two for the low power modules.

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

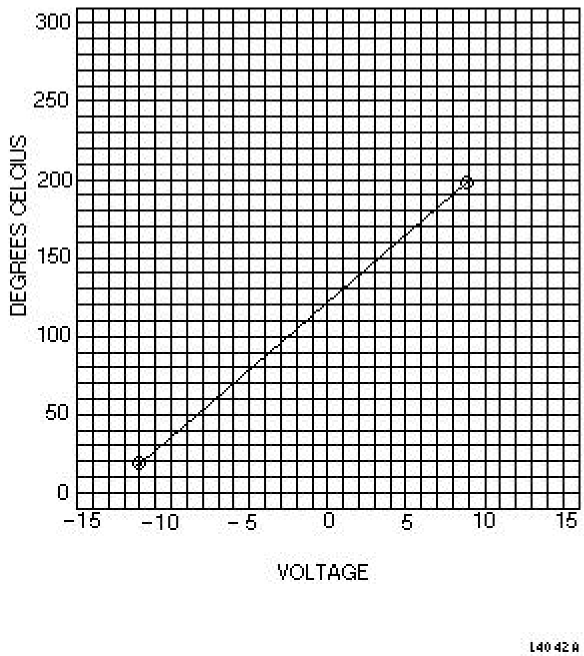
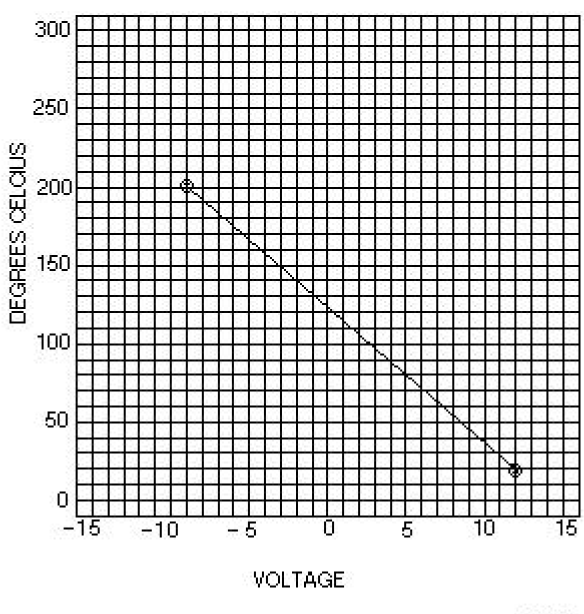


TABLE 9
TABLE 9: –LTJ PLOT



Refer to Section 7- Troubleshooting tips.

4-6- 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.

4-6-1 +LTj Parameters

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

4-6-2 –LTj Parameters

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

4-7- 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 GAP receives the temperature information about every 32 seconds. 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 one of the transistor junctions. If this occurs, replace the corresponding output shelf.

4-8- 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.

5- OUTPUT SHELL TEMPERATURE TEST

Description - This document relates to Signa Horizon products. This test provides a method of measuring the output shelf temperature in the power module.

5-1- Output Shelf Parameters

Two output shelf parameters are monitored for each power module during run time monitoring. The analog service module (ASM) monitors these signals and routes the data via the master interface (MIF) to the gradient amplifier processor (GAP) board. Output shelf temperatures that exceed specifications can lead to output shelf problems.

The output shelf parameters that are monitored are +TEMP and –TEMP. The high power module parameters are +TEMP-H and –TEMP-H. The low power module parameters are +TEMP-L and –TEMP-L. The –TEMP parameter is associated with the negative transistor well junction die temperature, and +TEMP is associated with the positive transistor well junction die temperature. The overtemp condition is set at 150º C.

5-2- Power Module Block Diagram

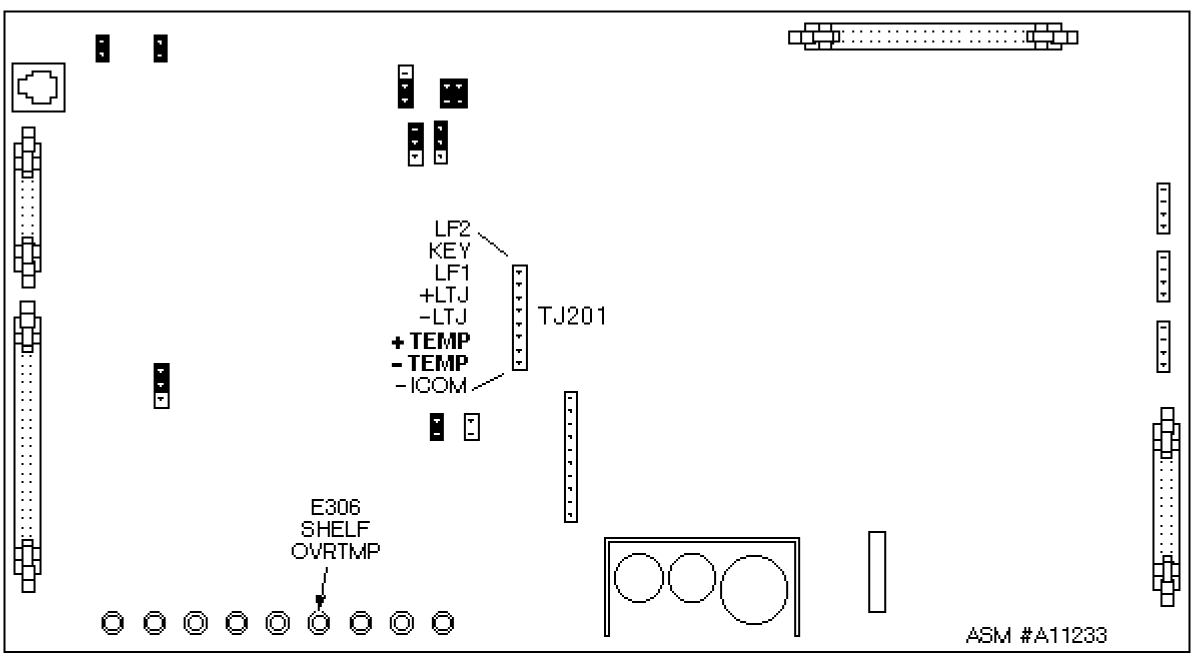
Illustration L4778A in Section 3-2 functionally shows the four transistor shelves used in each power module. Notice that there are four transistors indicated. Each transistor in the diagram represents a transistor shelf. Each transistor shelf has a unique function and name.

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

One high power module contains all four transistor shelves, and one low power module contains all four transistor shelves. Do not confuse the transistor shelf nomenclature with that of the power module.

5-3- Main Board LED Indicators

Yellow LED E306, on the 8645 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 (see Illustration L4757C).



L4757C

8645 MAIN BOARD: OUTPUT SHELF TEMP TEST POINTS, AND OVERTEMP LED
ILLUSTRATION L4757C

5-4- Test Point and Transistor Shelf Locations

5-4-1 Output Shelf Temp TP Location

The Output Shelf Temperature Test points are located on the 8645 main board. See Illustration L4757C in Section 5-3 for test point locations.

- TJ201 +TEMP is the test junction, or test point for the positive output shelf temperature.
- TJ201 –TEMP is the test junction, or test point for the negative output shelf temperature.

5-5- Output Shelf Temp Measurement

1. Using a DVM, measure the output shelf temperature on TJ201 +TEMP with respect to ground. Record the value in table 10.
2. Measure the output shelf temperature on TJ201 –TEMP with respect to ground. Record the value in table 10.

TABLE 10
OUTPUT SHELF TEMPERATURE MEASUREMENTS

	HIGH POWER MODULE			LOW POWER MODULE		
	X	Y	Z	X	Y	Z
+TEMP-H				— —— –	— —— —	— —— —
-TEMP-H				— —— —	— —— —	— —— —
+TEMP-L	— —— –	— —— —	— —— —			
-TEMP-L	— —— —	— —— —	— —— —			

Note
Note that there are two measurements for high power modules, and two for low power modules.

3. Plot that voltage on the graphs provided in table 11 and table 12. If the voltage converts to a temperature greater than 150º C, the output shelf temperature for that component is too high. Refer to section 7- Troubleshooting Tips.

TABLE 11
+TEMP PLOT

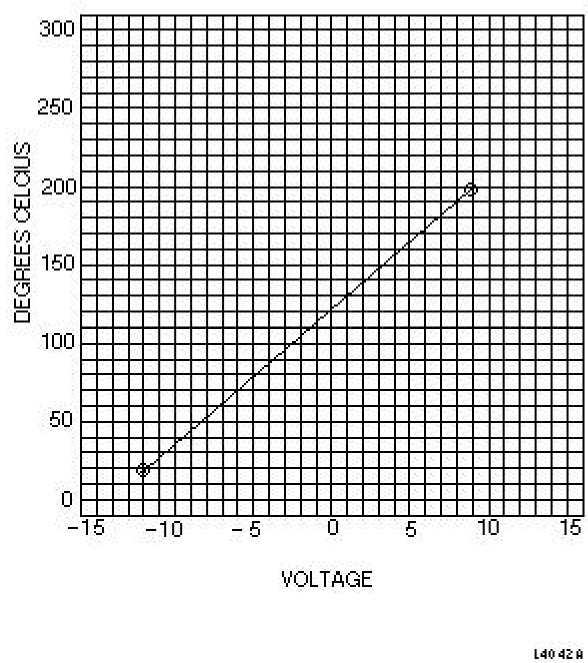
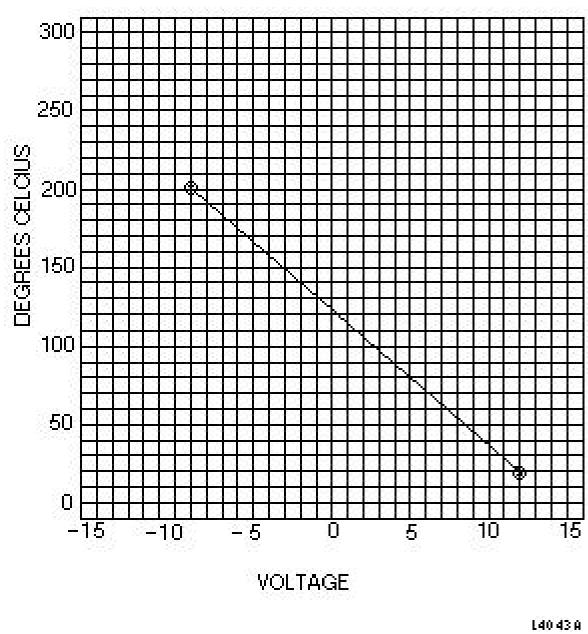


TABLE 12
–TEMP PLOT



5-6- Output shelf Temp Calculation

Values for +TEMP plot with a positive slope while values for –TEMP plot with a negative slope.

5-6-1 +TEMP Parameters

Positive output shelf temperatures should be plotted on the graph in table 11. The specification for +TEMP is <150º C, where the temperature range is –12V at 25º C to +9V at 200º C.

5-6-2 –TEMP Parameters

Negative output shelf temperatures should be plotted on the graph in table 12. The specification for –TEMP is > –150º C, where the temperature range is –9V at 200º C to +12V at 25º C.

5-7- Troubleshooting Tips

Run time monitoring may produce +TEMP-H, +TEMP-L, -TEMP-H and –TEMP-L error messages, depending on the temperature sensed during a scan. An accurate measurement and comparison of the output shelf, using the test points on the main board, cannot be made since the GAP receives temperature information about every 32 seconds; therefore, make your measurements after the scan has completed. Waiting five minutes after a scan is enough time for a normal output shelf to cool down to approximately room temperature. If, however, this is not the case, there is a problem with one of the output shelves. If this occurs, replace the corresponding output shelf.

5-8- System Restoration

1. It is critical that all 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.

6- DAC_DI VOLTAGE OFFSET TEST

Description - This document relates to Signa Horizon products. This adjustment is performed as part of GRAM tuning; here, however, it is a check to see if DAC_DI is out of adjustment.

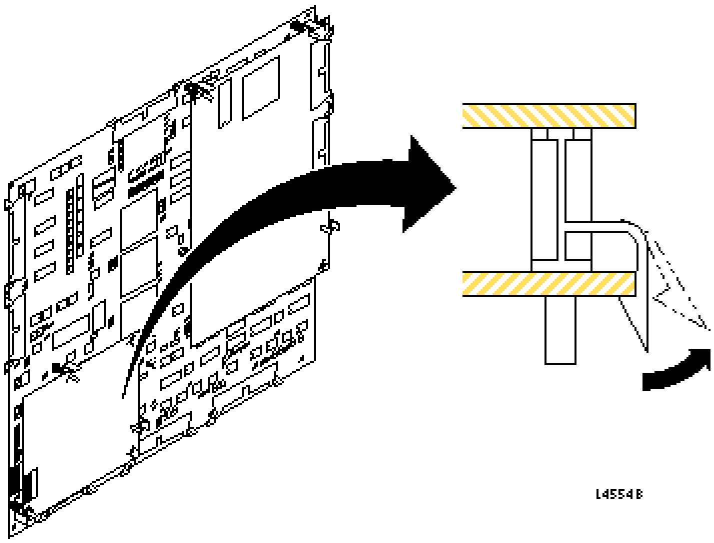
6-1- Preliminary Set-up

1. Turn off the power for all three GRAM modules in the GRAM cabinet, using the circuit breakers located at the lower-front of the GRAM cabinet.

CAUTION

Equipment damage possibility. Do not pull the circuit board off. The nylon standoffs are quite brittle and will break. Push the top of the standoff away from the circuit board one by one. If they do not push off of the circuit board at first, work on the other standoffs iteratively.

2. Carefully push back the white nylon circuit board stand-offs on the GRAM analog or digital tuning board, one by one in an iterative fashion until all stand-offs are released. See Illustration L4554B. Do not disconnect the cables on the GRAM tuning board at this time.

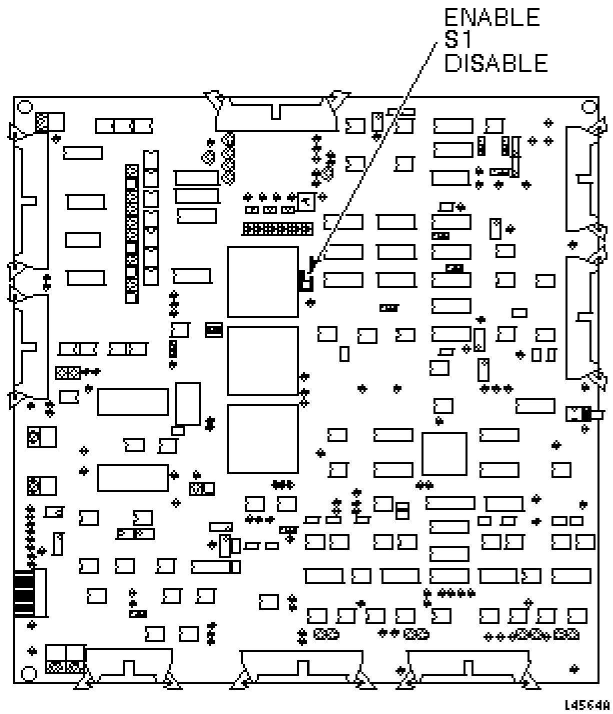


WHITE NYLON CIRCUIT BOARD STAND-OFFS
ILLUSTRATION L4554B

3. Use the nylon standoffs as a circuit board holder by turning the GRAM tuning board perpendicular to the GRAM control board. Push the tuning board in between the clip and the post of one of the nylon standoff. This should hold the GRAM tuning board in place.

4. Turn on the power for all three GRAM modules in the GRAM cabinet, using the circuit breakers located at the lower-front of the GRAM cabinet.

5. On the GRAM control board, verify that switch S1 is in the up/enable position (see Illustration L4564A).

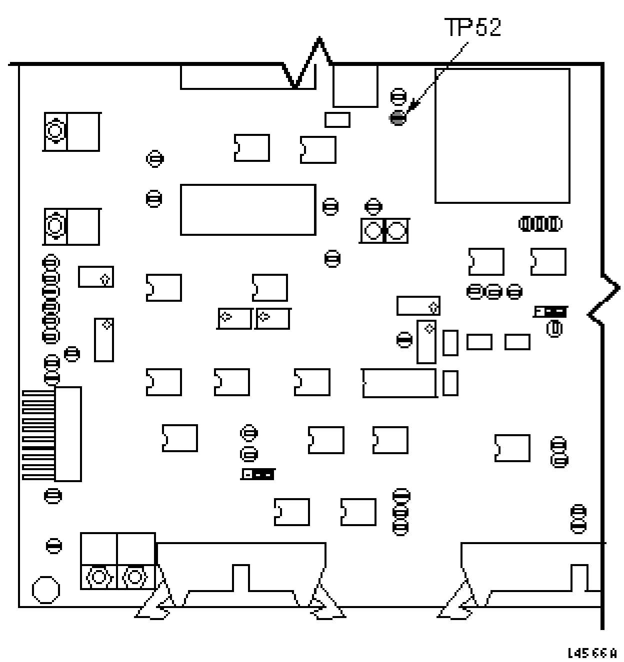


GRAM CONTROL BOARD: S1 LOCATION AND POSITION
ILLUSTRATION L4564A

6-2- Voltage Offset Adjustment

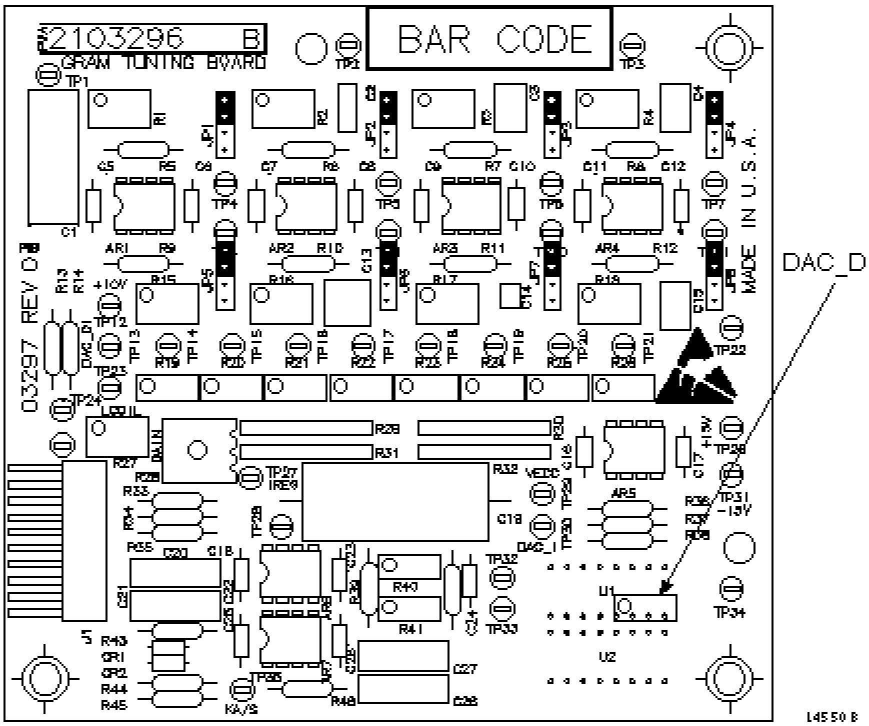
1. Ensure that the status of the system is *ready*, i.e., ready to prescan. Since there is no special scan prescription performed for this procedure, any protocol will be adequate. The message `Scanner Ready` will appear in the scan status window when the system is ready.

2. At the GRAM control board, connect the positive DVM lead to TP52. Connect the negative DVM lead to a ground test point. The black test points are ground. See Illustration L4566A.



GRAM CONTROL BOARD: DAC_DI TEST POINT (TP52)
ILLUSTRATION L4566A

3. For systems with an **analog tuning board**: Adjust the 1 mΩ DAC_DI offset pot located on the GRAM analog tuning board until the DMV reads 0 mVdc ±3 mVdc. See Illustration L4550B. The DAC_DI 1 mΩ pot (U1) is located in the lower-right quadrant of the Rev B GRAM analog tuning board.



DAC_DI POTENTIOMETER LOCATION ON GRAM ANALOG TUNING BOARD
ILLUSTRATION L4550B

4. For systems with a **digital tuning board**: Adjust the 1 mΩ DAC_DI offset pot (R37) located on the GRAM digital tuning board until the DMV reads 0 mVdc ±3 mVdc. See Illustration L4044A in Section 2-5. The DAC_DI 1 mΩ pot is located in the lower-middle of the GRAM digital tuning board.

6-3- System Restoration

1. Turn off the power for all three GRAM modules in the GRAM cabinet, using the circuit breakers located at the lower-front of the GRAM cabinet.

2. Replace the GRAM tuning board.

CAUTION

Equipment damage possibility. The nylon standoffs are quite brittle and will break. Push the GRAM tuning board on top of the standoffs one by one. It must be push onto the standoffs carefully, working it onto the standoffs iteratively.

3. Replace the covers on each GRAM.

4. Replace the cover on the GRAM cabinet.

5. Turn on the power for all three GRAM modules in the GRAM cabinet, using the circuit breakers located at the lower-front of the GRAM cabinet.

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

7- SHORTED TRANSISTOR SHELF TEST

Description - This document relates to Signa Horizon products. This material deals with the Shorted Transistor Shelf Test.

7-1- Introduction

Long overloads are difficult to diagnose and troubleshoot because they can be caused by almost anything in the gradient driver subsystem. Long overloads must be cleared by cycling the power (turning the power off and then back on) on the 8645 gradient amplifier cabinet and the GRAM cabinet.

Note

Note - GRAM cabinet availability - The GRAM cabinet is present only on Signa Horizon HiSpeed and Signa Horizon EchoSpeed systems.

The polyphase buck module (PPBM) tries to provide 12 volts when the system is ready. If the transistor shelf is shorted, the PPBM senses a higher than expected current. Since the PPBM waits ten milliseconds before shutting down when it senses an overcurrent condition, it tries to provide the 12 Vdc for a short time every ten milliseconds. This is what generates a "spiked" dc waveform.

To help isolate a shorted transistor shelf, perform the following test.

7-2- Transistor Shelf Test

1. Command the system to ready. This can be done by prescribing any scan prescription and getting the system ready to prescan.

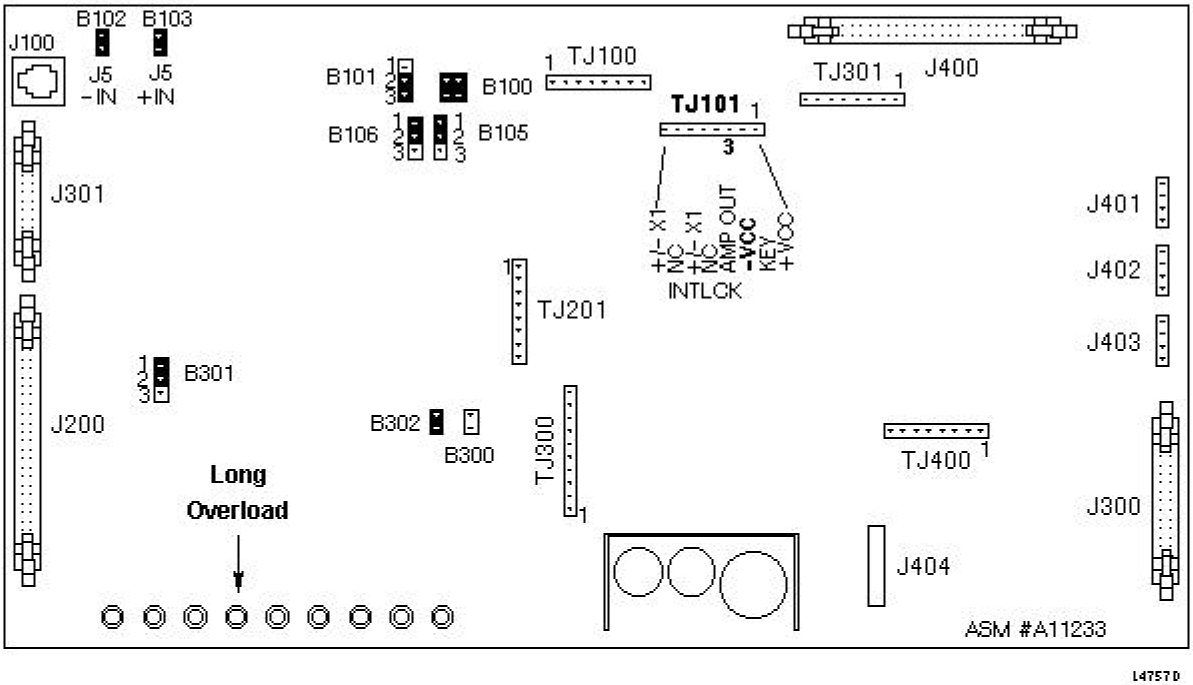
CAUTION

Potential equipment damage, or personal injury. When the system is in the *ready* state, there is voltage and current present at the outputs of the gradient driver subsystem. It is NOT necessary to be scanning in order to have this potential present. Use caution when removing the covers from the 8645 gradient cabinet and power modules.

2. Remove the covers from the 8645 gradient cabinet.

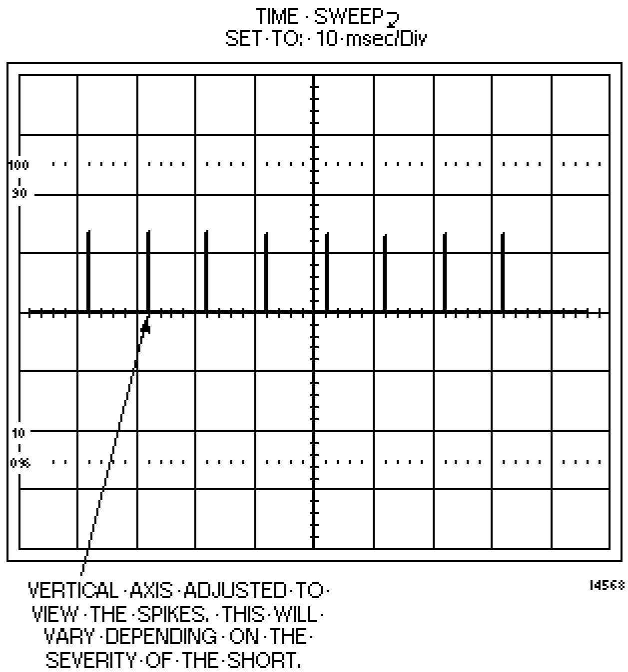
3. Remove the front cover of the power module in question.

4. Using an oscilloscope to make a differential measurement, connect a scope probe to +Vcc, TJ101 Pin 1 on the main board. Connect the ground lead for that probe to –Vcc, TJ101 Pin 3. See Illustration L4757D.



8645 MAIN BOARD: SHOWING TJ101, PINS 1 & 3, +VCC & –VCC
ILLUSTRATION L4757D

5. Adjust the oscilloscope until the Vcc waveform is in view. This waveform should be at 12 Vdc. If the waveform has spikes every ten milliseconds, and greater than or equal to 10 V amplitude, there is a shorted transistor shelf for that power module. Refer to Illustration L4568J. Replace that output shelf.



POLYPHASE BUCK MODULE DELAYED SHUTDOWN
ILLUSTRATION L4568J

CAUTION

Equipment damage possibility. Equipment damage may occur if you remove the transistor that is shorted and run the system. While it may appear that there is no impact on image quality, there is damage occurring inside the remaining transistors as they are now accommodating the current that had gone through the removed transistor. Do NOT remove the transistor and run the system. Doing so will diminish the life of the remaining transistors on the output shelf. If there is a shorted transistor, replace the entire output shelf.

7-3- System Restoration

1. Ensure that both covers are replaced.

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

8- MANUAL GRADIENT DRIVER TESTS

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

8-1- 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.

8-2- Gradient Driver Test Modes

Each product configuration is tested for the hardware that is present. There are three modes that are tested: voltage control mode, current control mode and GRAM mode. Only those systems with a GRAM can be tested in the GRAM mode. The product configurations and the applicable test modes are listed below.

8-2-1 Signa Horizon (SR-20) Test Modes

- Ready/Voltage Controlled Mode: six power modules & No GRAM
- Ready/Current Controlled Mode: six power modules & No GRAM

8-2-2 Signa Horizon HiSpeed (SR-77) Test Modes

- Ready/Voltage Controlled Mode: three power modules & three GRAMs
- Ready/Current Controlled Mode: three power modules & three GRAMs
- Ready/GRAM Mode: three power modules & three GRAMs

8-2-3 Signa Horizon EchoSpeed (SR-120) Test Modes

- Ready/Voltage Controlled Mode: six power modules & three GRAMs
- Ready/Current Controlled Mode: six power modules & three GRAMs
- Ready/GRAM Mode: six power modules & three GRAMs

8-3- Static Fault Checking

Prior to beginning the manual static tests, all fault registers on the MIF and GRAM 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 GAP board. If a mismatch is found, an error is logged and no manual static tests are performed.

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.

TABLE 13
FAULT REGISTERS POLLED BEFORE MANUAL STATIC TEST BEGINS

MIF	GRAM
Shelf Overtemp-H	I-AMP (amplifier overcurrent)
Shelf Overtemp-L	I-COIL (output overcurrent)
Transformer Overtemp-H	SHOOT THRU (ST)
Transformer Overtemp-L	DC Overcurrent
Transistor Fault-H	Over voltage
Transistor Fault-L	Under voltage
PPBM Fault-H	Wiring fault
PPBM Fault-L	IGBT overtemperature
DIE Overtemp No Latch-H	Current distorted
DIE Overtemp No Latch-L	Power Supply failure
- -	AVG_OC (Average current above limit)
- -	GND loss

8-4- Summary of Manual Static Tests

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

8-4-1 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 DAC values output in full scale based on the 20-bit signed data register for each hardware configuration.

TABLE 14
LOCAL MODE INPUTS & OUTPUTS FOR VOLTAGE CONTROL MODE SIGNAL TEST

Hardware Configuration	Signal IM=1	Signal IM=2	Signal IM=3	Signal IM=4	Signal IM=5
Signa Horizon EchoSpeed	26214	13107	0	–13107	–26214
Signa Horizon HiSpeed	52429	26214	0	–26214	–52429
Signa Horizon	13212	6606	0	–6606	–13212

8-4-2 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 data entry 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 GAP 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 GAP and stops the test. Once the test has been stopped, the error queue on the GAP is flushed, and error messages are displayed in the error log.

8-4-3 Current Control Mode Signal Test

Clicking on **[ICONTROL Mode]** plays out a constant current signal throughout the gradient driver subsystem. This test sets the power modules to local mode and outputs 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 15 shows the DAC values output in full scale based on the 20-bit signed data register.

TABLE 15
LOCAL MODE INPUTS & OUTPUTS FOR CURRENT CONTROL MODE SIGNAL TEST

Hardware Configuration	Signal IM=1	Signal IM=2	Signal IM=3	Signal IM=4	Signal IM=5
Signa Horizon EchoSpeed	131072	65536	0	–65536	–131072
Signa Horizon HiSpeed	131072	65536	0	–65536	–131072
Signa Horizon	131072	65536	0	–65536	–131072

8-4-4 Current Control Mode Test

This test causes the system to play out a constant voltage with the gradient drivers set to Ready/Current Control Mode. There are five possible voltage levels that can be selected by entering the numbers 1 through 5 in data entry field (syntax: lm=1). 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 GAP requesting the current control mode test with the selected signal number.

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

8-4-5 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 DAC values output in full scale based on the 20-bit signed data register

TABLE 16
LOCAL MODE INPUTS & OUTPUTS FOR GRAM CONTROL MODE SIGNAL TEST

Hardware Configuration	Signal IM=1	Signal IM=2	Signal IM=3	Signal IM=4	Signal IM=5
Signa Horizon EchoSpeed	131072	65536	0	–65536	–131072
Signa Horizon HiSpeed	131072	65536	0	–65536	–131072

8-4-6 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 data entry field (syntax: Im=1). 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 GAP 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 GAP and stops the test. Once the test has been stopped, the error queue on the GAP is flushed, and messages are displayed in the error log.

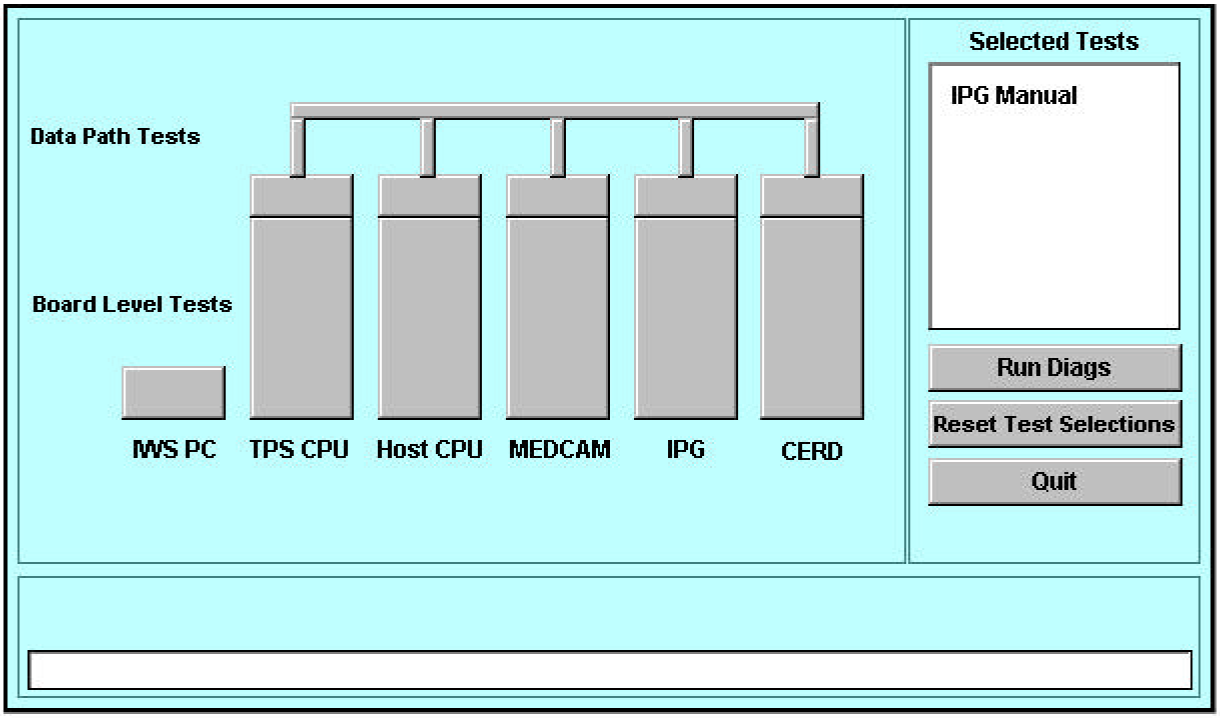
8-5- Executing Gradient Driver Tests

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]**.

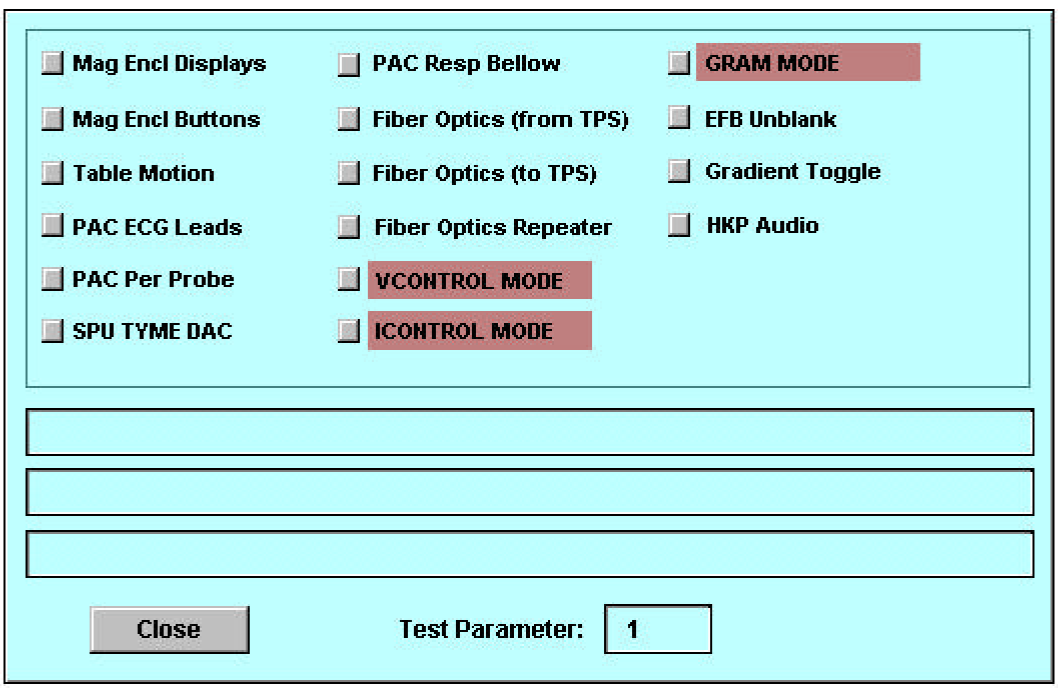
2. Wait for the Diagnostics Main Menu to appear, as shown in Illustration L1611C.



DIAGNOSTIC MAIN MENU
ILLUSTRATION L1611C

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

4. Select the Manual Gradient Driver Tests: **[VCONTROL MODE]**, **[ICONTROL 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

5 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

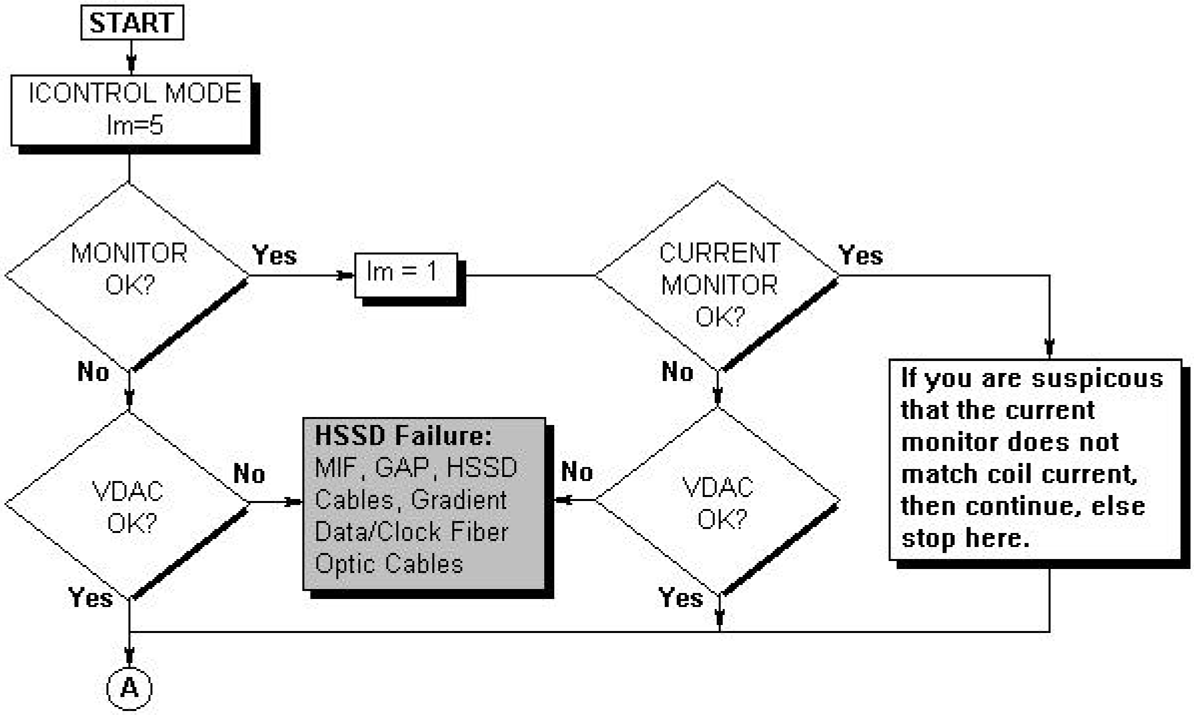
Measuring test points - it is important to measure all test points with respect to analog ground unless stated otherwise .

CAUTION

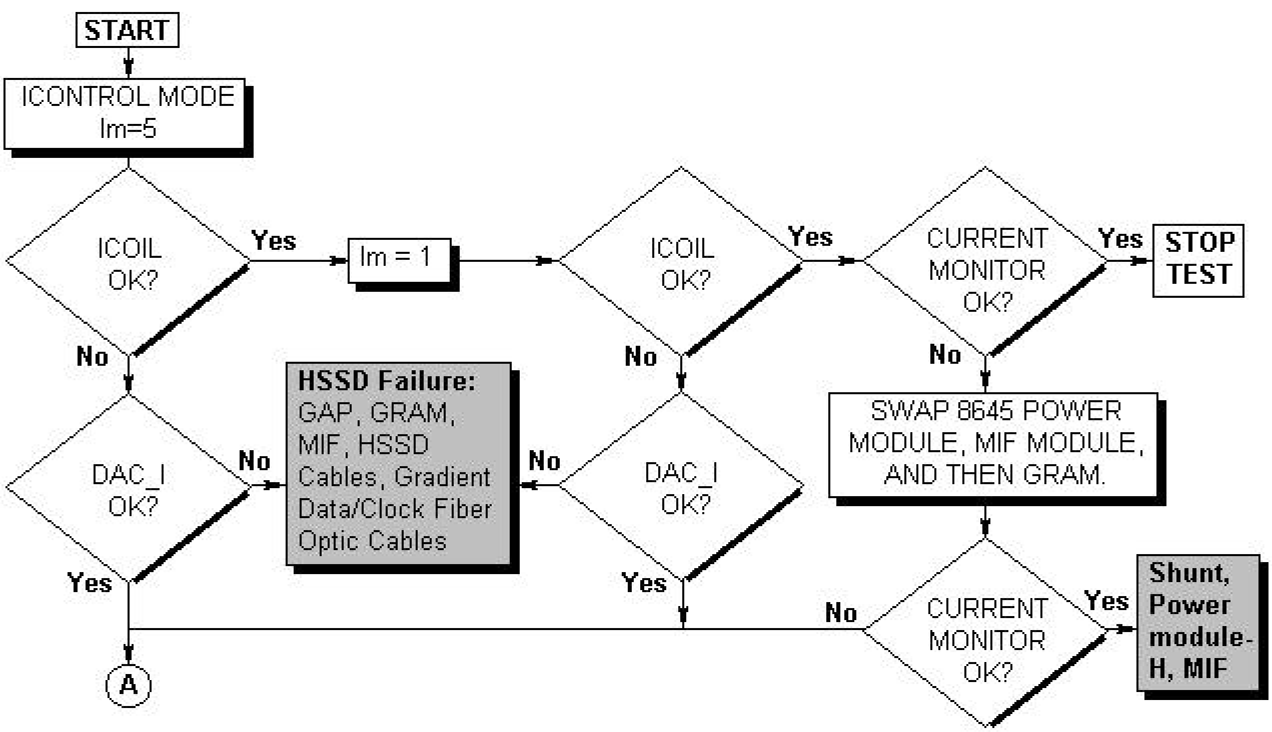
Possible equipment damage. Turn off power to the MIF module before unplugging the ASM. Failure to do so will damage the ASM.

8-5-1 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

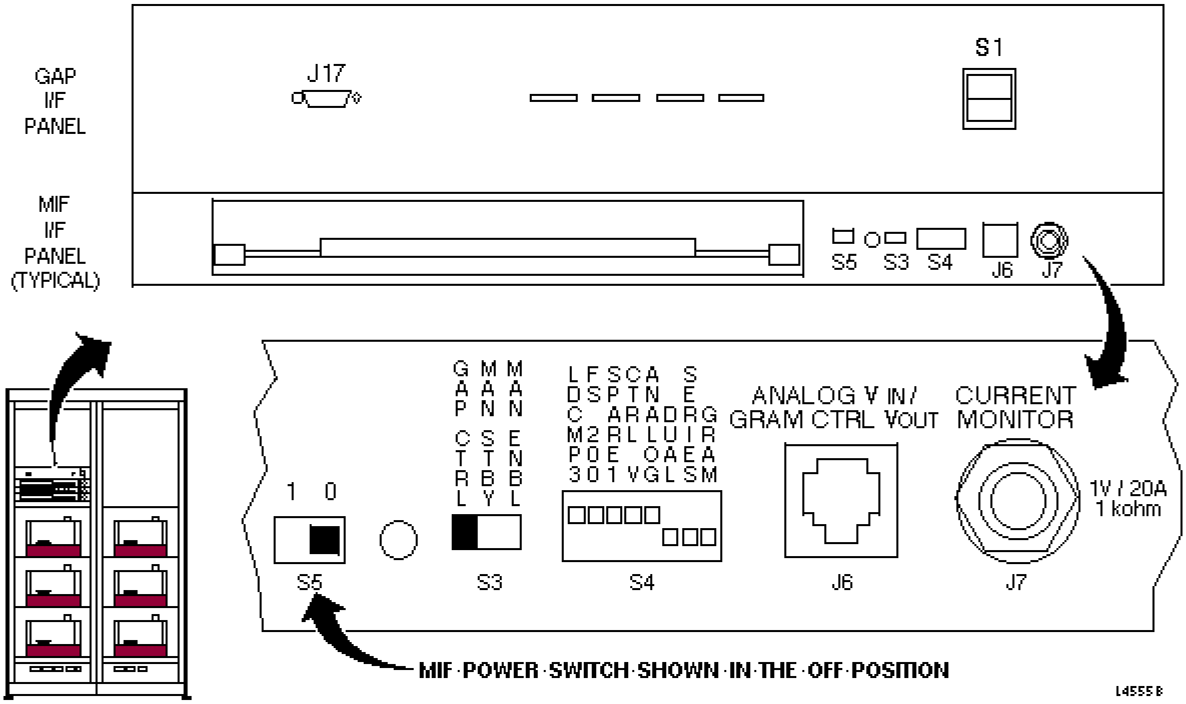
a. Use table 17 for exact steps to measure each of the signals referenced in the Signa Horizon flowchart.

TABLE 17
MANUAL GRADIENT DRIVER PROCEDURE FOR SIGNA HORIZON

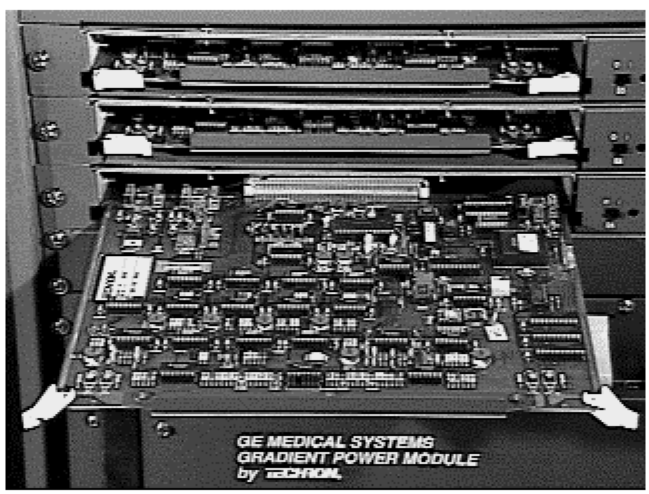
Signal Name	Main	MIF	ASM	GRAM	Procedure
VDAC			√		This measurement is taken on the ASM. 1. Turn off power to MIF module. See Illustration L4555B below for location of MIF module power switch. 2. Unplug the ASM. See Illustration L4576A below. 3. Connect the positive lead from a DVM to TJ200 pin 3 (VDAC) and the negative lead from the DVM to TJ400 pin 1 (which is ground). See Illustration L4757A below. 4. Record VDAC on the data sheet.
VMIF-H	√				This measurement is a <u>differential</u> measurement taken on the main board of the high power module. J5 B102 –IN to J5 B103 +IN. 1. Connect the positive lead of the DVM to J5 B103 +IN and the negative lead of the DVM to J5 B102 –IN. See Illustration L4757A below. 2. Record VMIF-H on the data sheet.
VMIF-L	√				This measurement is a <u>differential</u> measurement taken on the main board of the low power module, J5 B102 –IN to J5 B103 +IN. 1. Connect the positive lead of the DVM to J5 B103 +IN and the negative lead of the DVM to J5 B102 –IN. See Illustration L4757A below. 2. Record VMIF-L on the data sheet.
AMP OUT-H	√				This measurement is taken on the main board of the high power module at a terminal strip labeled *TJ101*. Pin 4 of this terminal jumper is AmpOut. See Illustration L4757A below. 1. Connect positive lead of the DVM to TJ101 pin 4 and negative lead of the DVM to TJ100 pin 1 (AGND). 2. Record AMP OUT-H on the data sheet.
AMP OUT-L	√				This measurement is taken on the main board of the low power module at a terminal strip labeled *TJ101*. Pin 4 of this terminal jumper is AmpOut. See Illustration L4757A below. 1. Connect positive lead of the DVM to TJ101 pin 4 and negative lead of the DVM to TJ100 pin 1 (AGND). 2. Record AMP OUT-L on the data sheet.
IOUT-H	√				This measurement is taken on the main board of the high power module with respect to analog ground. 1. Connect positive lead of the DVM to terminal junction TJ101 pin 7, which is labeled *Cur Mon*, and the negative lead of the DVM to TJ100 pin 1 (AGND). This is where IOUT-H is. See Illustration L4757A below. 2. Record IOUT-H on the data sheet.
Current monitor		√			This measurement is made on the front panel of the MIF module at J7. This is a BNC connector. Multiply the value that is read on the DVM by 20 to convert the measurement to actual current. 1. Connect the BNC lead of the DVM to J7 on the front of the MIF module. See Illustration L4555B below. 2. Record CURRENT MONITOR on the data sheet.
+TEMP-H	√				This measurement is taken on the main board of the high power module on the terminal strip labeled *TJ201*. See Illustration L4757A below. 1. Connect the positive lead of the DVM to terminal junction TJ201 +TEMP with respect to analog ground. 2. Record +TEMP on the data sheet.

-TEMP-H	√				This measurement is taken on the main board of the high power module on the terminal strip labeled *TJ201*. See Illustration L4757A below. 1. Connect the positive lead of the DVM to terminal junction TJ201 –TEMP with respect to analog ground. 2. Record –TEMP on the data sheet.
+TEMP-L	√				This measurement is taken on the main board of the low power module at the terminal strip labeled *TJ201*. See Illustration L4757A below. 1. Connect the positive lead of the DVM to terminal junction TJ201 +TEMP with respect to analog ground. 2. Record +TEMP on the data sheet.
-TEMP-L	√				This measurement is taken on the main board of the low power module on the terminal strip labeled *TJ201*. See Illustration L4757A below. 1. Connect the positive lead of the DVM to terminal junction TJ201 –TEMP with respect to analog ground. 2. Record –TEMP on the data sheet.
+LTj-H	√				This measurement is taken on the main board of the high power module on terminal junction TJ201 +LTj-H. See Illustration L4757A below. 1. Connect the positive lead of the DVM to terminal junction TJ201 +LTj with respect to analog ground. 2. Record +LTj on the data sheet.
-LTj-H	√				This measurement is taken on the main board of the high power module on terminal junction TJ201 –LTj. See Illustration L4757A below. 1. Connect the positive lead of the DVM to terminal junction TJ201 –LTj with respect to analog ground. 2. Record –LTj on the data sheet.
+LTj-L	√				This measurement is taken on the main board of the low power module on terminal junction TJ201 +LTj. See Illustration L4757A below. 1. Connect the positive lead of the DVM to terminal junction TJ201 +LTj with respect to analog ground. 2. Record +LTj on the data sheet.
-LTj-L	√				This measurement is taken on the main board of the low power module on terminal junction TJ201 –LTj. See Illustration L4757A below. 1. Connect the positive lead of the DVM to terminal junction TJ201 –LTj with respect to analog ground. 2. Record –LTj on the data sheet
XFTEMP-L1-H	√				This measurement is taken on the main board of the high power module on terminal junction TJ300 L1. See Illustration L4757A below. 1. Connect the positive lead of the DVM to terminal junction TJ300 L1 with respect to analog ground. 2. Record L1 on the data sheet.
XFTEMP-L2-H	√				This measurement is taken on the main board of the high power module on terminal junction TJ300 L2. See Illustration L4757A below. 1. Connect the positive lead of the DVM to terminal junction TJ300 L2 with respect to analog ground. 2. Record L2 on the data sheet.
XFTEMP-L3-H	√				This measurement is taken on the main board of the high power module on terminal junction TJ300 L3. See Illustration L4757A below.

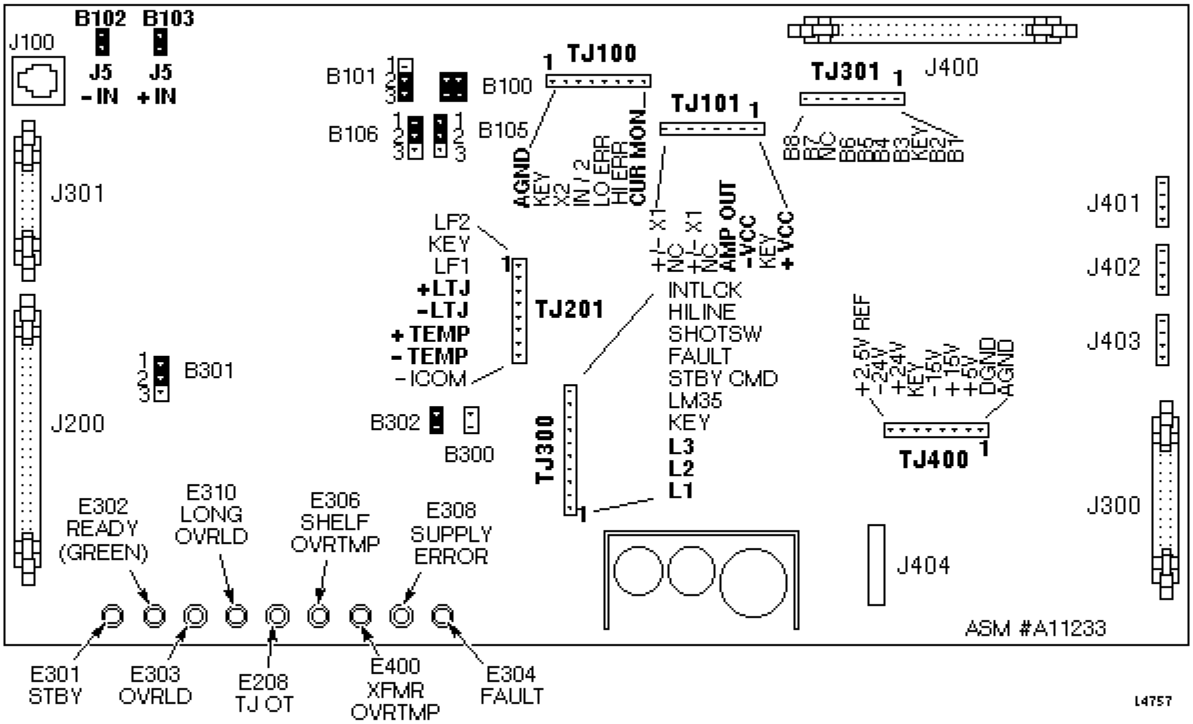
					1. Connect the positive lead of the DVM to terminal junction TJ300 L3 with respect to analog ground. 2. Record L3 on the data sheet.
XFTEMP-L1-L	√				This measurement is taken on the main board of the low power module on terminal junction TJ300 L1. See Illustration L4757A below. 1. Connect the positive lead of the DVM to terminal junction TJ300 L1 with respect to analog ground. 2. Record L1 on the data sheet.
XFTEMP-L2-L	√				This measurement is taken on the main board of the low power module on terminal junction TJ300 L2. See Illustration L4757A below. 1. Connect the positive lead of the DVM to terminal junction TJ300 L2 with respect to analog ground. 2. Record L2 on the data sheet.
XFTEMP-L3-L	√				This measurement is taken on the main board of the low power module on terminal junction TJ300 L3. See Illustration L4757A below. 1. Connect the positive lead of the DVM to terminal junction TJ300 L3 with respect to analog ground. 2. Record L3 on the data sheet.
+/– Vcc-H	√				This measurement is a <u>differential</u> measurement taken on the main board of the high power module on terminal junction TJ101 pin 1 to pin 3 (+Vcc to –Vcc). 1. Connect the positive lead of the DVM to terminal junction TJ101 +Vcc and the negative lead of the DVM to terminal junction TJ101 –Vcc. See Illustration L4757A below. 2. Record +/– Vcc on the data sheet.
+/– Vcc-L	√				This measurement is a <u>differential</u> measurement taken on the main board of the high power module on terminal junction TJ101 pin 1 to pin 3 (+Vcc to –Vcc). 1. Connect the positive lead of the DVM to terminal junction TJ101 +Vcc and the negative lead of the DVM to terminal junction TJ101 –Vcc. See Illustration L4757A below. 2. Record +/– Vcc on the data sheet.



FRONT MIF/GAP PANELS: SHOWING MIF POWER SWITCH S5
ILLUSTRATION L4555B



ASM UNPLUGGED
ILLUSTRATION L4576A



8645 MAIN BOARD: PINS FOR B102, 103, TJ100, 101, 201, 300, 301, 400, & LEDS
ILLUSTRATION 4757A

b. Use table 18 for exact steps to measure each of the signals referenced in the Signa Horizon HiSpeed flowchart.

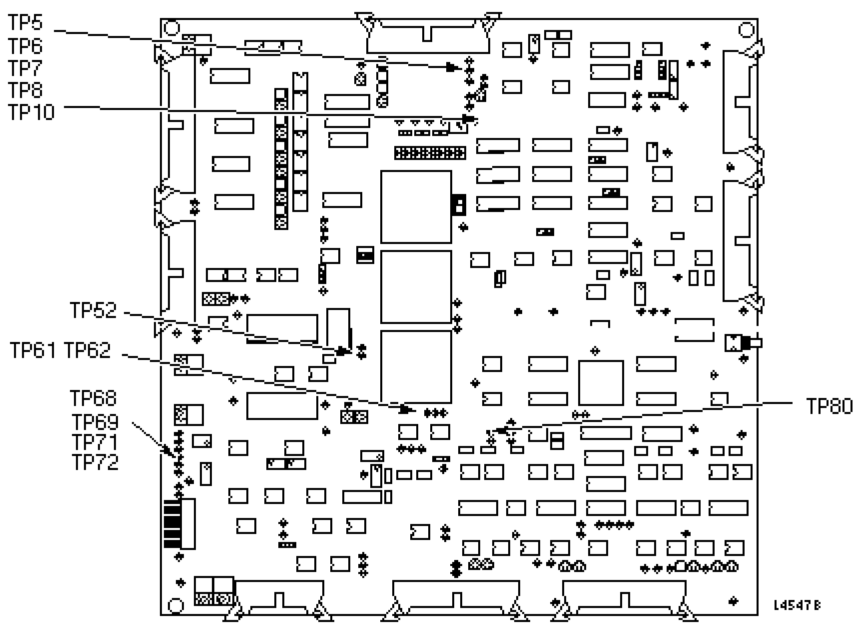
TABLE 18
MANUAL GRADIENT DRIVER PROCEDURE FOR SIGNA HORIZON HISPEED

Signal Name	Main	MIF	ASM	GRAM	Procedure
VDAC			√		This measurement is taken on the ASM. 1. Turn off power to MIF module. See Illustration L4555B for location of MIF module power switch. 2. Unplug the ASM. See Illustration L4576A above. 3. Connect the positive lead from a DVM to TJ200 pin 3 (VDAC) and the negative lead from the DVM to TJ400 pin 5 (which is ground). See Illustration L4757A. 4. Record VDAC on the data sheet.
VMIF-H	√				This measurement is a differential measurement taken on the main board of the high power module. J5 B102 –IN to J5 B103 +IN. 1. Connect the positive lead of the DVM to J5 B103 +IN and the negative lead of the DVM to J5 B102 –IN. See Illustration L4757A. 2. Record VMIF-H on the data sheet.
AMP OUT-H	√				This measurement is taken on the main board of the high power module with respect to ground. There is a terminal strip labeled TJ101. Pin 4 of this terminal jumper is AmpOut. See Illustration L4757A. 1. Connect positive lead of the DVM to TJ101 pin 4 and negative lead of the DVM to TJ100 pin 1 (AGND). 2. Record AMP OUT-H on the data sheet.
IOUT-H	√				This measurement is taken on the main board of the high power module with respect to analog ground.

					1. Connect positive lead of the DVM to terminal junction TJ101 pin 6, which is labeled *Cur Mon*, and the negative lead of the DVM to TJ100 pin 1 (AGND). This is where IOUT-H is. See Illustration L4757A. 2. Record IOUT-H on the data sheet.
Current monitor		√			This measurement is made on the front panel of the MIF module at J7. This is a BNC connector. The value that is read on the DVM should be multiplied by 20 to convert the measurement to actual current. 1. Connect the BNC lead of the DVM to J7 on the front of the MIF module. See Illustration L4555B. 2. Record CURRENT MONITOR on the data sheet.
+TEMP-H	√				This measurement is taken on the main board of the high power module on the terminal strip labeled *TJ201*. See Illustration L4757A. 1. Connect the positive lead of the DVM to terminal junction TJ201 +TEMP with respect to analog ground. 2. Record +TEMP on the data sheet.
-TEMP-H	√				This measurement is taken on the main board of the high power module on the terminal strip labeled *TJ201*. See Illustration L4757A. 1. Connect the positive lead of the DVM to terminal junction TJ201 –TEMP with respect to analog ground. 2. Record –TEMP on the data sheet.
+LTj-H	√				This measurement is taken on the main board of the high power module on terminal junction TJ201. See Illustration L4757A. 1. Connect the positive lead of the DVM to terminal junction TJ201 +LTj with respect to analog ground. 2. Record +LTj on the data sheet.
-LTj-H	√				This measurement is taken on the main board of the high power module on terminal junction TJ201. See Illustration L4757A. 1. Connect the positive lead of the DVM to terminal junction TJ201 –LTj with respect to analog ground. 2. Record –LTj on the data sheet.
XFTEMP-L1-H	√				This measurement is taken on the main board of the high power module on terminal junction TJ300. See Illustration L4757A. 1. Connect the positive lead of the DVM to terminal junction TJ300 L1 with respect to analog ground. 2. Record L1 on the data sheet.
XFTEMP-L2-H	√				This measurement is taken on the main board of the high power module on terminal junction TJ300. See Illustration L4757A. 1. Connect the positive lead of the DVM to terminal junction TJ300 L2 with respect to analog ground. 2. Record L2 on the data sheet.
XFTEMP-L3-H	√				This measurement is taken on the main board of the high power module on terminal junction TJ300. See Illustration L4757A. 1. Connect the positive lead of the DVM to terminal junction TJ300 L3 with respect to analog ground. 2. Record L3 on the data sheet.
+/– Vcc-H	√				This measurement is a <u>differential</u> measurement taken on the main board of the high power module on terminal junction TJ101 pin 1 to pin 3 (+Vcc to –Vcc). 1. Connect the positive lead of the DVM to terminal junction TJ101 +Vcc and the negative lead of the DVM to terminal junction TJ101 –Vcc. See Illustration L4757A. 2. Record +/– Vcc on the data sheet.

DAC_I				√	This measurement is taken on the GRAM control board with respect to ground. (Black test points are ground.) See Illustration L4757B below. 1. Connect positive lead of the DVM to test point TP68 and the negative lead of the DVM to a black test point. 2. Record DAC_I on the data sheet. This signal has also been referred to as IDAC and DACI.
DAC_DI				√	This measurement is taken on the GRAM control board with respect to ground. (Black test points are ground.) See Illustration L4757B below. 1. Connect positive lead of the DVM to test point TP52 and the negative lead of the DVM to a black test point. 2. Record DAC_DI on the data sheet.
IGRAD				√	This measurement is taken on the GRAM control board with respect to ground. (Black test points are ground.) See Illustration L4757B below. 1. Connect positive lead of the DVM to test point TP72 and the negative lead of the DVM to a black test point. 2. Record IGRAD on the data sheet.
IREG				√	This measurement is taken on the GRAM control board with respect to ground. (Black test points are ground.) See Illustration L4757B below. 1. Connect positive lead of the DVM to test point TP71 and the negative lead of the DVM to a black test point. 2. Record IREG on the data sheet.
VC (VCONTROL)				√	This measurement is taken on the GRAM control board with respect to ground. (Black test points are ground.) See Illustration L4757B below. 1. Connect positive lead of the DVM to test point TP69 and the negative lead of the DVM to a black test point. 2. Record VC on the data sheet.
ICOIL				√	This measurement is taken on the GRAM control board with respect to ground. (Black test points are ground.) See Illustration L4757B below. 1. Connect positive lead of the DVM to test point TP62 and the negative lead of the DVM to a black test point. 2. Record ICOIL on the data sheet.
IERROR				√	This measurement is taken on the GRAM control board with respect to ground. (Black test points are ground.) See Illustration L4757B below. 1. Connect positive lead of the DVM to test point TP80 and the negative lead of the DVM to a black test point. 2. Record IERROR on the data sheet.
VBUS-0				√	This measurement is taken on the GRAM control board with respect to ground. (Black test points are ground.) See Illustration L4757B below. 1. Connect positive lead of the DVM to test point TP5 and the negative lead of the DVM to a black test point. 2. Record VBUS - 0 on the data sheet.
VBUS-1				√	This measurement is taken on the GRAM control board with respect to ground. (Black test points are ground.) See Illustration L4757B below. 1. Connect positive lead of the DVM to test point TP6 and the negative lead of the DVM to a black test point. 2. Record VBUS-1 on the data sheet.
VBUS-2				√	This measurement is taken on the GRAM control board with respect to ground. (Black test points are ground.) See Illustration L4757B below.

					1. Connect positive lead of the DVM to test point TP7 and the negative lead of the DVM to a black test point. 2. Record VBUS-2 on the data sheet.
VBUS-3				√	This measurement is taken on the GRAM control board with respect to ground. (Black test points are ground.) See Illustration L4757B below. 1. Connect positive lead of the DVM to test point TP8 and the negative lead of the DVM to a black test point. 2. Record VBUS-3 on the data sheet.
VBUS DIAG				√	This measurement is taken on the GRAM control board with respect to ground. (Black test points are ground.) See Illustration L4757B below. 1. Connect positive lead of the DVM to test point TP10 and the negative lead of the DVM to a black test point. 2. Record VBUS DIAG on the data sheet
VFILT				√	This measurement is taken on the GRAM control board with respect to ground. (Black test points are ground.) See Illustration L4757A below. 1. Connect positive lead of the DVM to test point TP61 and the negative lead of the DVM to a black test point. 2. Record VFILT on the data sheet.



GRAM CONTROL BOARD
ILLUSTRATION L4757B

c. Use table 19 for exact steps to measure each of the signals referenced in the Signa Horizon EchoSpeed flowchart.

TABLE 19
MANUAL GRADIENT DRIVER PROCEDURE FOR SIGNA HORIZON ECHOSPEED

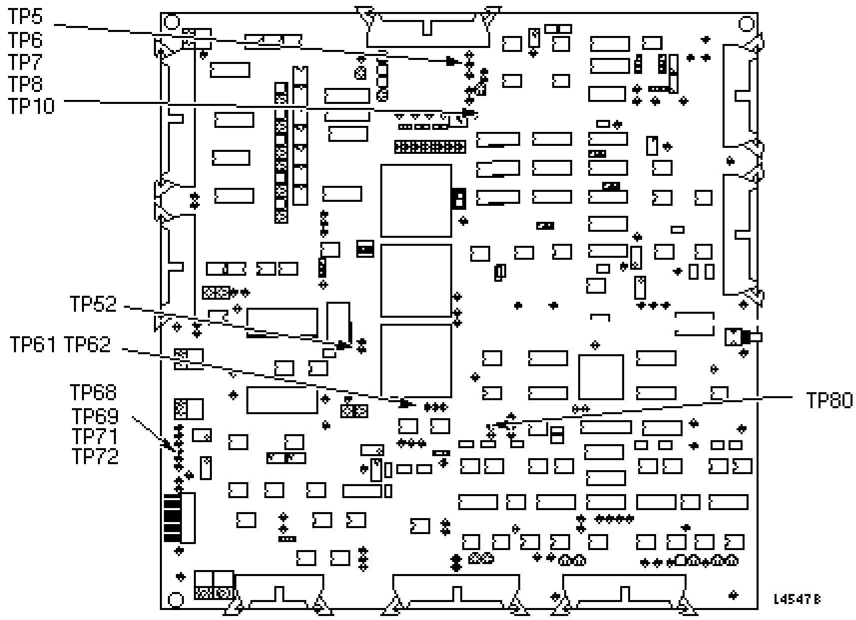
Signal Name	Main	MIF	ASM	GRAM	Procedure
VDAC				√	This measurement is taken on the ASM. 1. Turn off power to MIF module. See Illustration L4555B above for location of MIF module power switch. 2. Unplug the ASM. See Illustration L4576A above.

					3. Connect the positive lead from a DVM to TJ200 pin 3 (VDAC) and the negative lead from the DVM to TJ400 pin 5 (which is ground). See Illustration L4757A above. 4. Record VDAC on the data sheet.
VMIF-H	√				This measurement is a <u>differential</u> measurement taken on the main board of the high power module. J5 B102 –IN to J5 B103 +IN. 1. Connect the positive lead of the DVM to J5 B103 +IN and the negative lead of the DVM to J5 B102 –IN. See Illustration L4757A above. 2. Record VMIF-H on the data sheet.
VMIF-L	√				This measurement is a <u>differential</u> measurement taken on the main board of the low power module. J5 B102 –IN to J5 B103 +IN. 1. Connect the positive lead of the DVM to J5 B103 +IN and the negative lead of the DVM to J5 B102 –IN. See Illustration L4757A above. 2. Record VMIF-L on the data sheet.
AMP OUT-H	√				This measurement is taken on the main board of the high power module with on a terminal strip labeled *TJ101*. Pin 4 of this terminal jumper is AmpOut. See Illustration L4757A above. 1. Connect positive lead of the DVM to TJ101 pin 4 and negative lead of the DVM to TJ100 pin 1 (AGND). 2. Record AMP OUT-H on the data sheet.
AMP OUT-L	√				This measurement is taken on the main board of the low power module on a terminal strip labeled *TJ101*. Pin 4 of this terminal jumper is AmpOut. See Illustration L4757A above. 1. Connect positive lead of the DVM to TJ101 pin 4 and negative lead of the DVM to TJ100 pin 1 (AGND). 2. Record AMP OUT-L on the data sheet.
IOUT-H	√				This measurement is taken on the main board of the high power module. 1. Connect positive lead of the DVM to terminal junction TJ101 pin 7, which is labeled *Cur Mon*, and the negative lead of the DVM to TJ100 pin 1 (AGND). This is where IOUT-H is. See Illustration L4757A above. 2. Record IOUT-H on the data sheet.
Current monitor		√			This measurement is made on the front panel of the MIF module at J7. This is a BNC connector. Multiply the value that is read on the DVM by 20 to convert the measurement to actual current. 1. Connect the BNC lead of the DVM to J7 on the front of the MIF module. See Illustration L4555B above. 2. Record CURRENT MONITOR on the data sheet
+TEMP-H	√				This measurement is taken on the main board of the high power module on the terminal strip labeled *TJ201*. See Illustration L4757A above. 1. Connect the positive lead of the DVM to terminal junction TJ201 +TEMP with respect to analog ground. 2. Record +TEMP on the data sheet.
-TEMP-H	√				This measurement is taken on the main board of the high power module on the terminal strip labeled *TJ201*. See Illustration L4757A above. 1. Connect the positive lead of the DVM to terminal junction TJ201 –TEMP with respect to analog ground. 2. Record –TEMP on the data sheet.
+TEMP-L	√				This measurement is taken on the main board of the low power

					module at the terminal strip labeled *TJ201*. See Illustration L4757A above. 1. Connect the positive lead of the DVM to terminal junction TJ201 +TEMP with respect to analog ground. 2. Record +TEMP on the data sheet.
-TEMP-L	√				This measurement is taken on the main board of the low power module on the terminal strip labeled *TJ201*. See Illustration L4757A above. 1. Connect the positive lead of the DVM to terminal junction TJ201 –TEMP with respect to analog ground. 2. Record –TEMP on the data sheet.
+LTj-H	√				This measurement is taken on the main board of the high power module on terminal junction TJ201 +LTj-H. See Illustration L4757A above. 1. Connect the positive lead of the DVM to terminal junction TJ201 +LTj with respect to analog ground. 2. Record +LTj on the data sheet.
-LTj-H	√				This measurement is taken on the main board of the high power module on terminal junction TJ201 –LTj. See Illustration L4757A above. 1. Connect the positive lead of the DVM to terminal junction TJ201 –LTj with respect to analog ground. 2. Record –LTj on the data sheet.
+LTj-L	√				This measurement is taken on the main board of the low power module on terminal junction TJ201 +LTj. See Illustration L4757A above. 1. Connect the positive lead of the DVM to terminal junction TJ201 +LTj with respect to analog ground. 2. Record +LTj on the data sheet.
-LTj-L	√				This measurement is taken on the main board of the low power module on terminal junction TJ201 –LTj. See Illustration L4757A above. 1. Connect the positive lead of the DVM to terminal junction TJ201 –LTj with respect to analog ground. 2. Record –LTj on the data sheet
XFTEMP-L1-H	√				This measurement is taken on the main board of the high power module on terminal junction TJ300 L1. See Illustration L4757A above. 1. Connect the positive lead of the DVM to terminal junction TJ300 L1 with respect to analog ground. 2. Record L1 on the data sheet.
XFTEMP-L2-H	√				This measurement is taken on the main board of the high power module on terminal junction TJ300 L2. See Illustration L4757A above. 1. Connect the positive lead of the DVM to terminal junction TJ300 L2 with respect to analog ground. 2. Record L2 on the data sheet.
XFTEMP-L3-H	√				This measurement is taken on the main board of the high power module on terminal junction TJ300 L3. See Illustration L4757A above. 1. Connect the positive lead of the DVM to terminal junction TJ300 L3 with respect to analog ground. 2. Record L3 on the data sheet.
XFTEMP-L1-L	√				This measurement is taken on the main board of the low power module on terminal junction TJ300 L1. See Illustration L4757A above. 1. Connect the positive lead of the DVM to terminal junction

					TJ300 L1 with respect to analog ground. 2. Record L1 on the data sheet.
XFTEMP-L2-L	√				This measurement is taken on the main board of the low power module on terminal junction TJ300 L2. See Illustration L4757A above. 1. Connect the positive lead of the DVM to terminal junction TJ300 L2 with respect to analog ground. 2. Record L2 on the data sheet.
XFTEMP-L3-L	√				This measurement is taken on the main board of the low power module on terminal junction TJ300 L3. See Illustration L4757A above. 1. Connect the positive lead of the DVM to terminal junction TJ300 L3 with respect to analog ground. 2. Record L3 on the data sheet.
+/– Vcc-H	√				This measurement is a differential measurement taken on the main board of the high power module on terminal junction TJ101 pin 1 to pin 3 (+Vcc to –Vcc). 1. Connect the positive lead of the DVM to terminal junction TJ101 +Vcc and the negative lead of the DVM to terminal junction TJ101 –Vcc. See Illustration L4757A above. 2. Record +/– Vcc on the data sheet.
+/– Vcc-L	√				This measurement is a differential measurement taken on the main board of the low power module on terminal junction TJ101 pin 1 to pin 3 (+Vcc to –Vcc). 1. Connect the positive lead of the DVM to terminal junction TJ101 +Vcc and the negative lead of the DVM to terminal junction TJ101 –Vcc. See Illustration L4757A above. 2. Record +/– Vcc on the data sheet.
DAC_I				√	This measurement is taken on the GRAM control board with respect to ground. (Black test points are ground.) See Illustration L4757B below. 1. Connect positive lead of the DVM to test point TP68 and the negative lead of the DVM to a black test point. 2. Record DAC_I on the data sheet. This parameter has also been referred to as IDAC and DACI.
DAC_DI				√	This measurement is taken on the GRAM control board with respect to ground. (Black test points are ground.) See Illustration L4757B below. 1. Connect positive lead of the DVM to test point TP52 and the negative lead of the DVM to a black test point. 2. Record DAC_DI on the data sheet.
IGRAD				√	This measurement is taken on the GRAM control board with respect to ground. (Black test points are ground.) See Illustration L4757B below. 1. Connect positive lead of the DVM to test point TP72 and the negative lead of the DVM to a black test point. 2. Record IGRAD on the data sheet.
IREG				√	This measurement is taken on the GRAM control board with respect to ground. (Black test points are ground.) See Illustration L4757B below. 1. Connect positive lead of the DVM to test point TP71 and the negative lead of the DVM to a black test point. 2. Record IREG on the data sheet.
VC (VCONTROL				√	This measurement is taken on the GRAM control board with respect to ground. (Black test points are ground.) See Illustration L4757B below.

					1. Connect positive lead of the DVM to test point TP69 and the negative lead of the DVM to a black test point. 2. Record VC on the data sheet.
ICOIL				√	This measurement is taken on the GRAM control board with respect to ground. (Black test points are ground.) See Illustration L4757B below. 1. Connect positive lead of the DVM to test point TP62 and the negative lead of the DVM to a black test point. 2. Record ICOIL on the data sheet.
IERROR				√	This measurement is taken on the GRAM control board with respect to ground. (Black test points are ground.) See Illustration L4757B below. 1. Connect positive lead of the DVM to test point TP80 and the negative lead of the DVM to a black test point. 2. Record IERROR on the data sheet.
VBUS-0				√	This measurement is taken on the GRAM control board with respect to ground. (Black test points are ground.) See Illustration L4757B below. 1. Connect positive lead of the DVM to test point TP5 and the negative lead of the DVM to a black test point. 2. Record VBUS - 0 on the data sheet.
VBUS-1				√	This measurement is taken on the GRAM control board with respect to ground. (Black test points are ground.) See Illustration L4757B below. 1. Connect positive lead of the DVM to test point TP6 and the negative lead of the DVM to a black test point. 2. Record VBUS-1 on the data sheet.
VBUS-2				√	This measurement is taken on the GRAM control board with respect to ground. (Black test points are ground.) See Illustration L4757B below. 1. Connect positive lead of the DVM to test point TP7 and the negative lead of the DVM to a black test point. 2. Record VBUS-2 on the data sheet.
VBUS-3				√	This measurement is taken on the GRAM control board with respect to ground. (Black test points are ground.) See Illustration L4757B below. 1. Connect positive lead of the DVM to test point TP8 and the negative lead of the DVM to a black test point. 2. Record VBUS-3 on the data sheet.
VBUS DIAG				√	This measurement is taken on the GRAM control board with respect to ground. (Black test points are ground.) See Illustration L4757B below. 1. Connect positive lead of the DVM to test point TP10 and the negative lead of the DVM to a black test point. 2. Record VBUS DIAG on the data sheet.
VFILT				√	This measurement is taken on the GRAM control board with respect to ground. (Black test points are ground.) See Illustration L4757B below. 1. Connect positive lead of the DVM to test point TP61 and the negative lead of the DVM to a black test point. 2. Record VFILT on the data sheet.



GRAM CONTROL BOARD
ILLUSTRATION L4547B

8-5-2 Exiting Diagnostics

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

9- LOAD CONTINUITY TEST

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

9-1- 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.

9-2- Preliminary Setup

DANGER!!

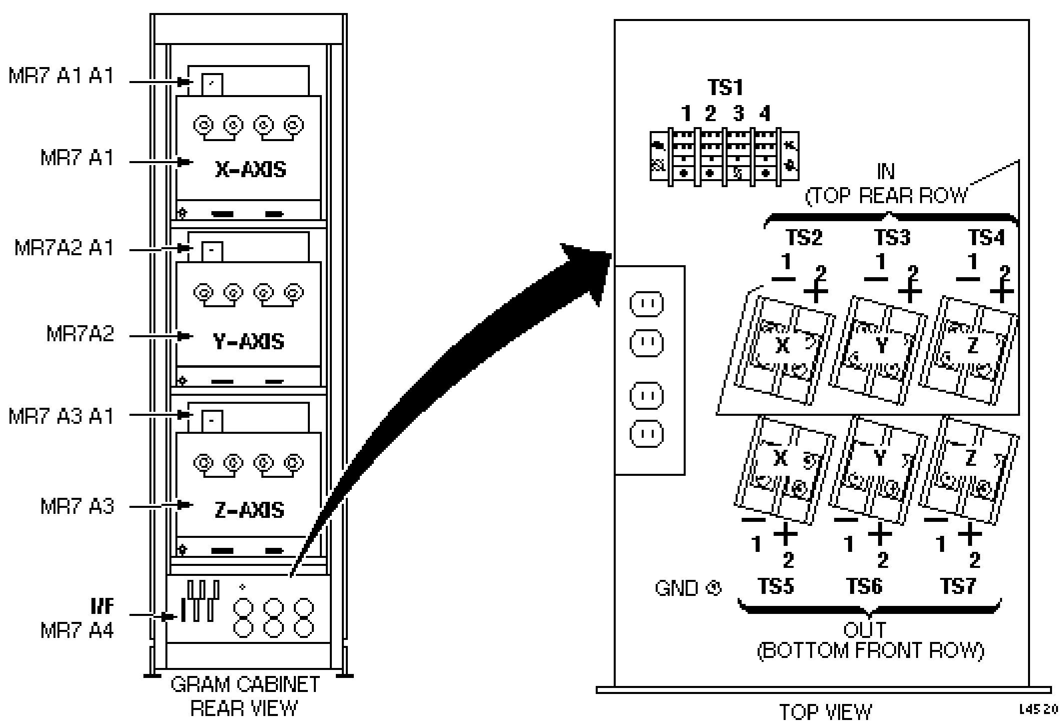
FATAL ELECTRIC SHOCK HAZARD!! THE GRAM AND THE GRADIENT AMPLIFIERS ACT AS CONSTANT LOAD SOURCES AND WILL SEND MAXIMUM CURRENT TO ANY LOAD (INCLUDING YOU!). TO PREVENT FATAL ELECTRIC SHOCK, ENSURE THAT THE POWER IS OFF TO BOTH CABINETS BEFORE CONTINUING WITH THIS PROCEDURE.

1. Lock out and tag out the PDU circuit breaker for the GRAM cabinet and the 8645 gradient amplifier cabinet using appropriate OSHA procedure. (Refer to *Procedure For Safety: Section 6*.)

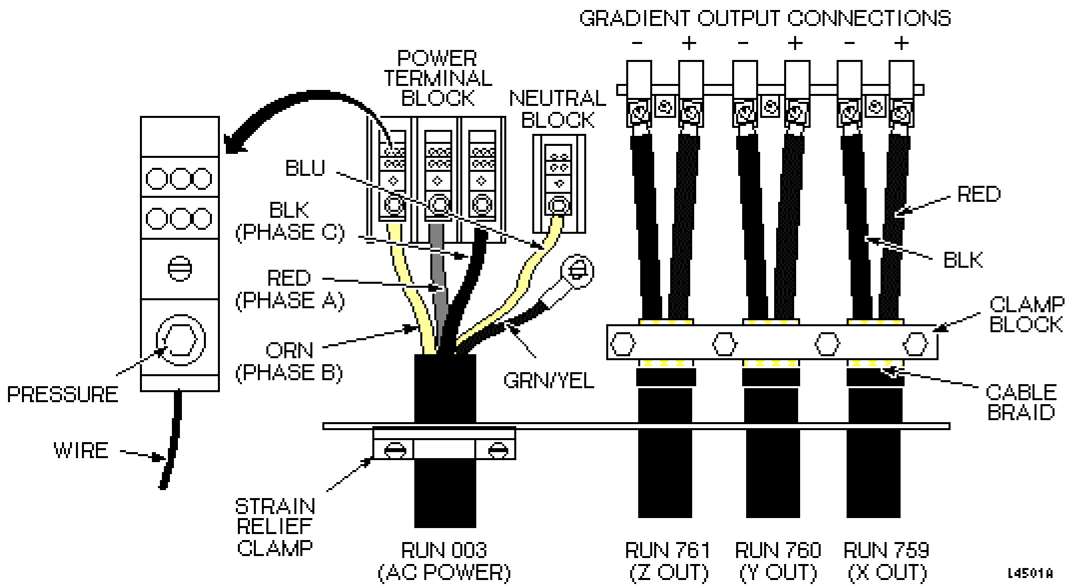
Note

Access to TS1 - Gain access to TS1 by sliding the bottom GRAM assembly (Z-axis) forward. Ensure the stability of GRAM cabinet by first extending the stabilizer feet.

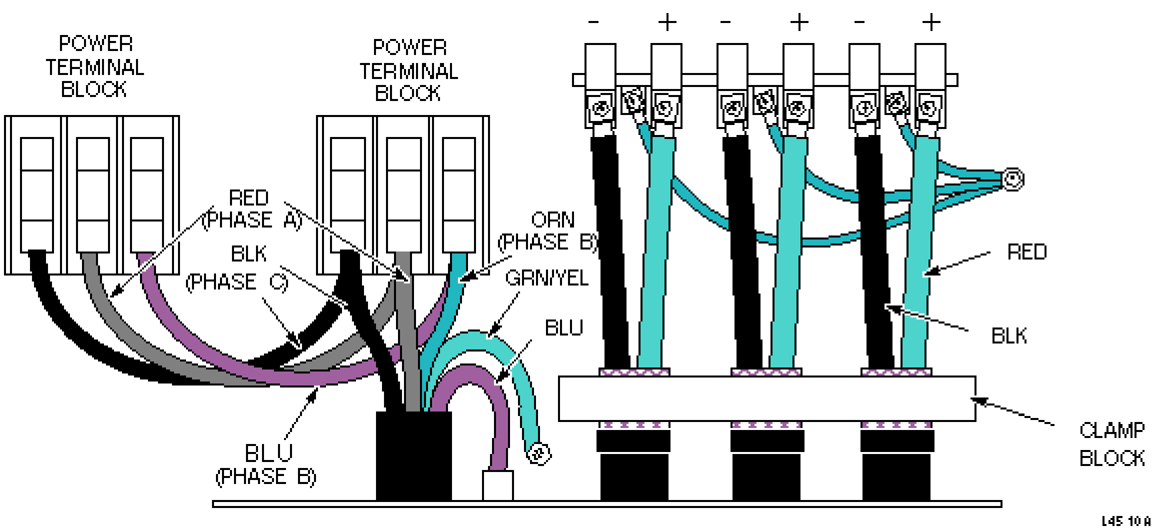
2. Verify that all energy has been disabled by measuring incoming power to the GRAM cabinet at TS1 (see Illustration L4520B). Verify that all energy has been disabled to the 8645 gradient cabinet by measuring the power at TS1. Also see Illustration L4501A for the Signa Horizon HiSpeed system, or Illustration L4510A for Signa Horizon or Horizon EchoSpeed systems.



GRAM CABINET, REAR VIEW – BOTTOM PANEL AND TS1
ILLUSTRATION L4520B

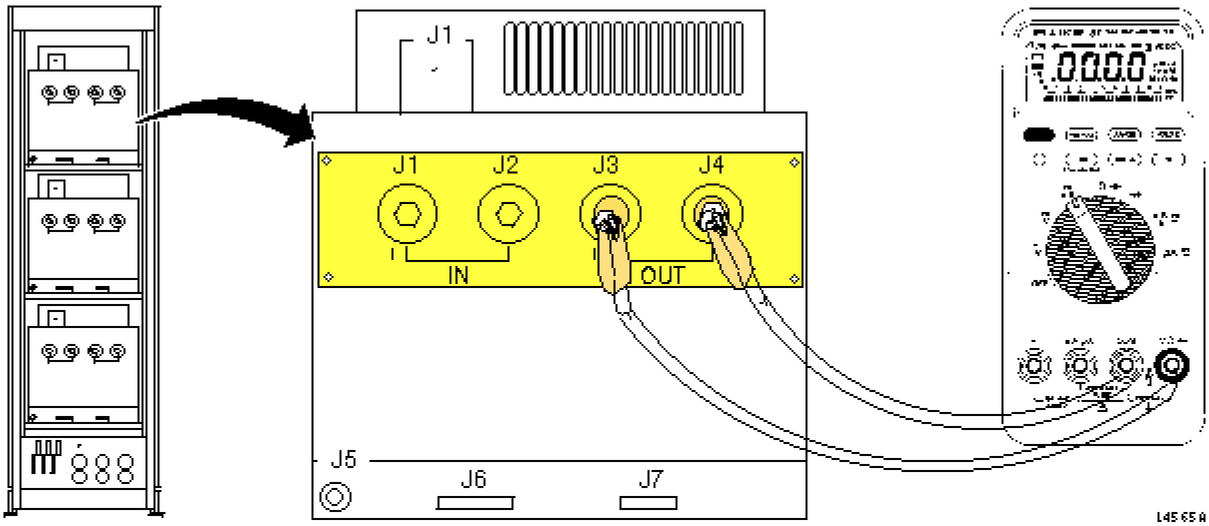


8645 CABINET POWER AND OUTPUT CABLE CONNECTIONS
ILLUSTRATION L4501A



INCOMING POWER TO A DOUBLE-BAY 8645 GRADIENT CABINET
ILLUSTRATION L4510A

3. Verify that power is off by connecting a DVM across the input leads (J1, J2) and output leads (J3, J4) at rear of GRAM, as shown in Illustration L4565A. Make sure that the DVM reads 0V.



GRAM CHASSIS: REAR VIEW WITH VOLTMETER ACROSS THE OUTPUT
ILLUSTRATION L4565A

9-3- Gradient Driver Subsystem Load Continuity Test

Measurements for load continuity are made at four locations for the gradient driver subsystem: the 8645 gradient amplifier cabinet, the GRAM cabinet (if present), both sides of the penetration panel, and the terminal strip at the rear of the magnet.

9-3-1 Signa Horizon

Since the Signa Horizon base product has a double bay (P4) 8645 gradient cabinet with no GRAM, the Load Continuity Test is from J1 at the rear of the high power module to J1 at the rear of the low power module.

1. Using a DVM set to *ohms*, measure the resistance across the output of the high and low power modules.

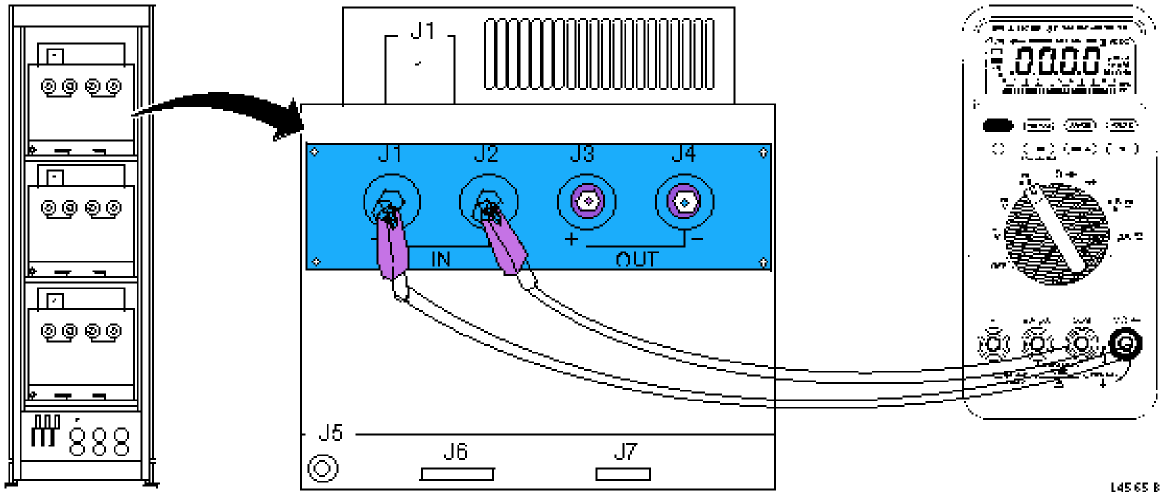
2. The resistance measured at this point should not exceed 1 Ω.

3. Continue with the measurements at the penetration panel, section 3-4 Penetration Panel/Gradient Filter Box Measurements.

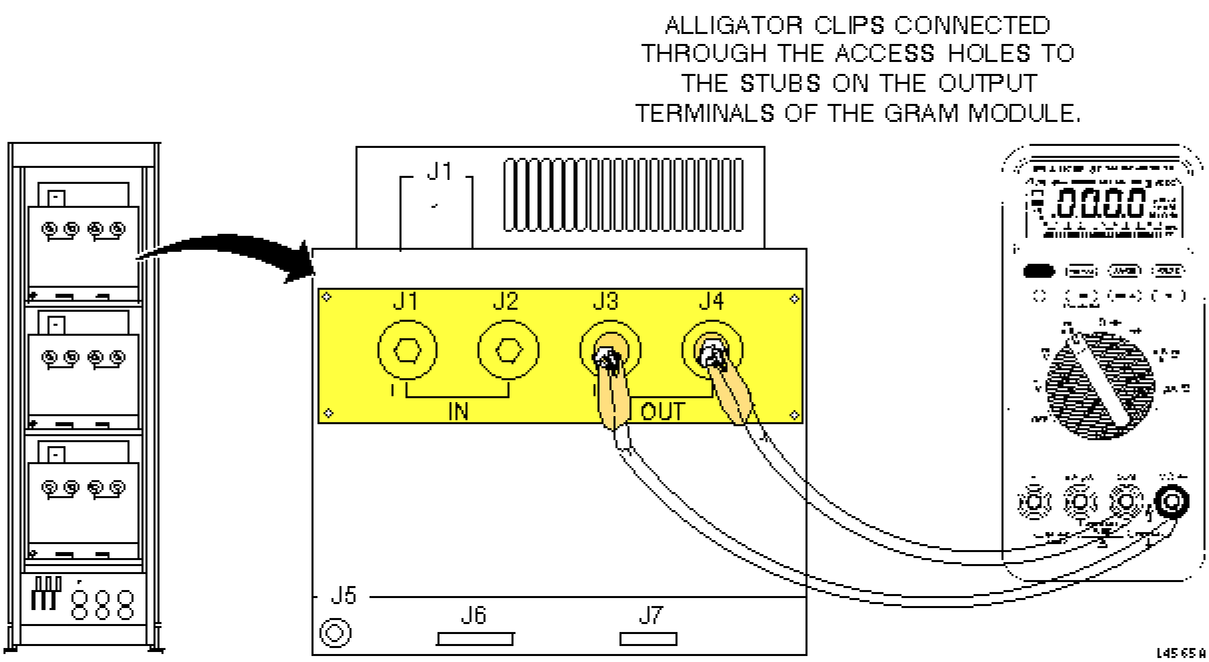
9-3-2 Signa Horizon HiSpeed

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

See Illustration L4565C for GRAM IN and Illustration L4565D for GRAM OUT measurement points.



GRAM CHASSIS: REAR VIEW WITH OHMMETER ACROSS THE INPUT
ILLUSTRATION L4565C



GRAM CHASSIS: REAR VIEW WITH OHMMETER ACROSS THE OUTPUT
ILLUSTRATION L4565D

2. The resistance measured across the + and – GRAM IN should be less than 1 Ω. The resistance measured across the + and – GRAM OUT should be less than 1 Ω.

3. Measure the resistance from the + and – input studs to ground, and then the + and – output studs to ground of the GRAM module.

4. The resistance measured from either GRAM IN to ground should be greater than 1 kΩ. The resistance measured from either GRAM OUT to ground should also be greater than 1 kΩ.

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.

5. If the GRAM output resistance measured is greater than 1 Ω, or the GRAM resistance to ground is less than 1 kΩ, continue with measurements at the penetration panel, Section 3-4 Penetration Panel/Gradient Filter Box Measurements.

9-3-3 Signa Horizon EchoSpeed

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

See Illustration L4565C for GRAM IN and Illustration L4565D for GRAM OUT measurement points.

2. The resistance measured across the + and – GRAM IN should be less than 1 Ω. The resistance measured across the + and – GRAM OUT should be less than 1 Ω.

3. Measure the resistance from the + and – input studs to ground and then the + and – output studs to ground of the GRAM module.

4. The resistance measured from either GRAM IN to ground should be greater than 1 kΩ. The resistance measured from either GRAM OUT to ground should also be greater than 1 kΩ.

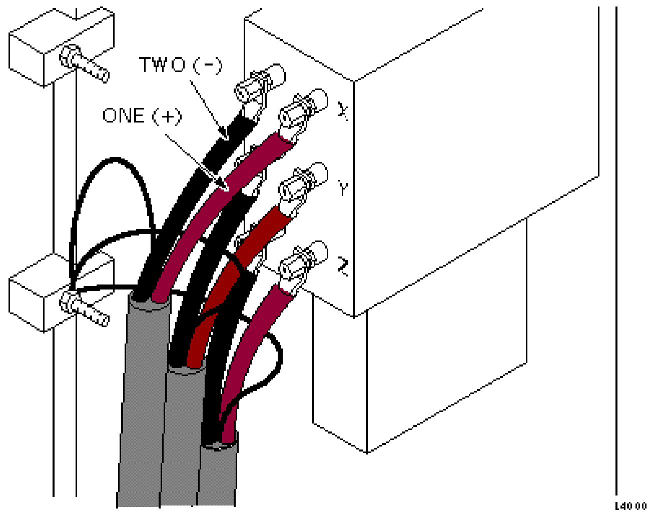
Note

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

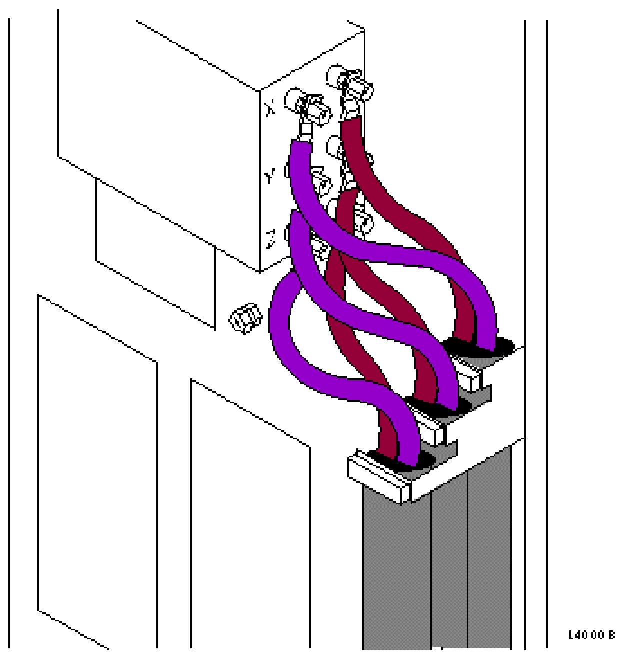
5. If the GRAM output resistance measured is greater than 1 Ω, or the GRAM resistance to ground is less than 1 kΩ, continue with measurements at the penetration panel in the next section.

9-3-4 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.

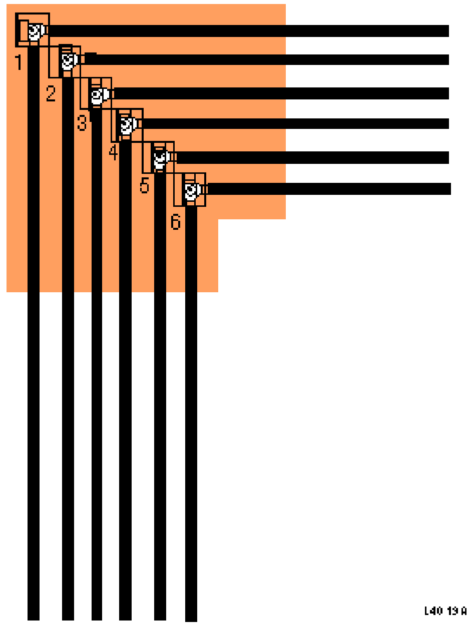
2. The resistance measured at this point should not exceed 1 Ω.

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.

9-3-5 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.

9-4- 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. Enable power at the PDU by removing the lock out tag out devices.

3. Apply power to the 8645 gradient cabinet and the GRAM cabinet (if present).

4. If the GRAM has been replaced, on Signa Horizon HiSpeed and Signa Horizon EchoSpeed, GRAM tuning must be performed.

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 21, 1998	J. Saperstein	Initial conversion from Toolbook to Word format
1	5/21/99	sma	updated procedure references for new GUI