TABLE OF CONTENTS

1- INTRODUCTION

1-1 Application

Gradient Driver Tests are a new way of testing the Gradient Driver subsystem. The tests look like diagnostics that are invoked on the screen at the operator work space. They are more than that, however; they are a hybrid digital and analog diagnostic test. This group of tests exercise and test the entire Gradient Driver subsystem with the three non-proprietary Power-up Tests, and the proprietary Static and Dynamic Tests.

The Gradient Driver Tests are available on systems with SGD Hi-Slew cabinets and use the GIP (Gradient Interface Processor) to look at digital and analog signals within the Gradient Driver subsystem.

The Gradient Driver Tests are designed to isolate a problem in a FRU, or group of FRUs. The tests are easy to invoke, and they exercise the Gradient Driver subsystem. Errors are reported to the system error log. The system error log entries are limited in size, so in cases where additional information is required, an “extended error” may be available. System error messages with extended information will contain the symbols “->” at the end of the message. The extended error messages document is titled “Horizon 8x (LX) Extended Error Log” and is available on the Service Methods CD-ROM.

1-2 Purpose

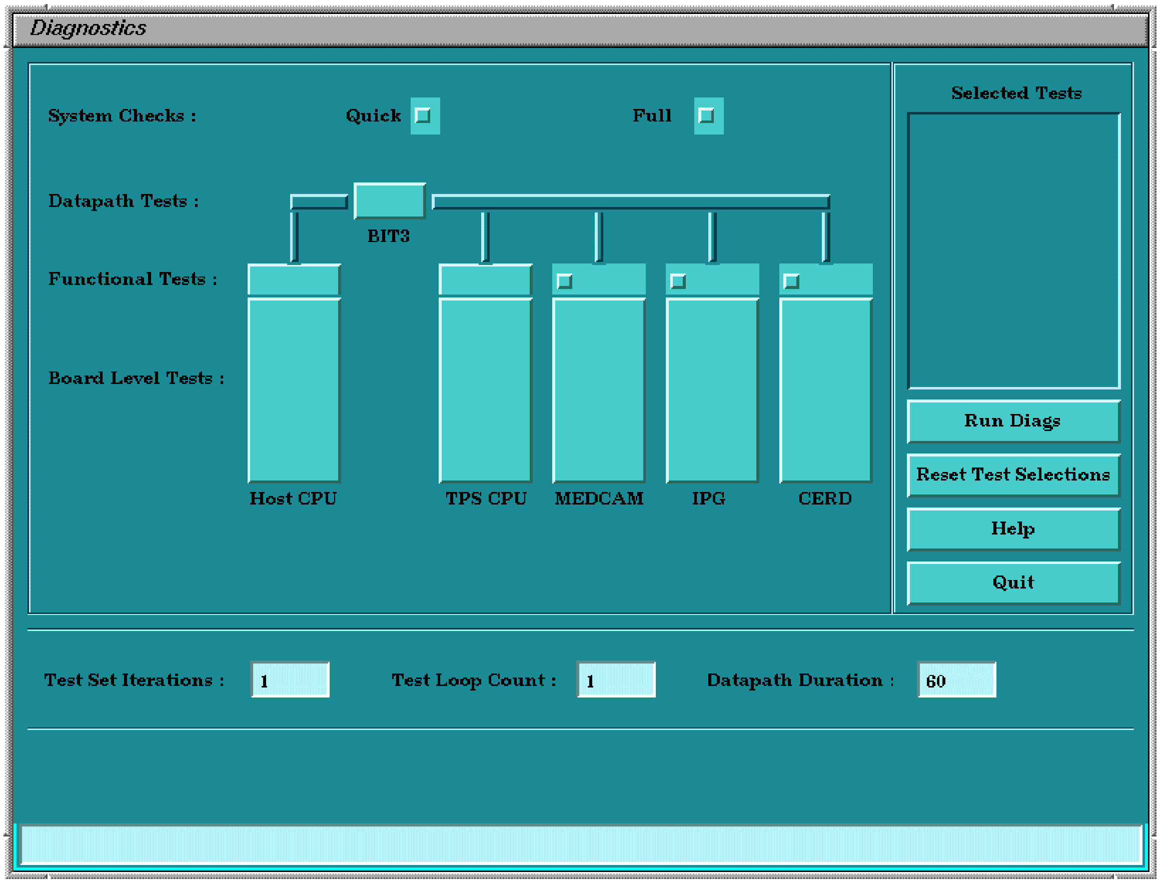
Note

A valid Service Key is required to run these Proprietary Class C Diagnostics.
A Service Key is required for Gradient Tests (Static and Dynamic Tests)
All other diagnostic tests are non-proprietary

1. Click on **[Diagnostics]** on the Service Desktop; then click **[Start]**.

2. Wait for the Diagnostics Main Menu to appear, as shown in Illustration 1-1.

1-2 Purpose (continued)



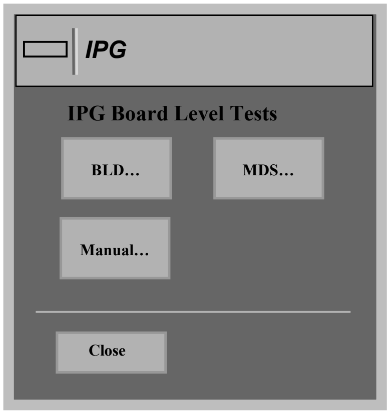
Test Set Iterations : 1
Test Loop Count : 1
Datapath Duration : 60

DIAGNOSTICS MAIN MENU SCREEN
ILLUSTRATION 1-1

3. On the Diagnostics Main Menu Screen, make sure Test Set Iterations is set to **[1]** (default).

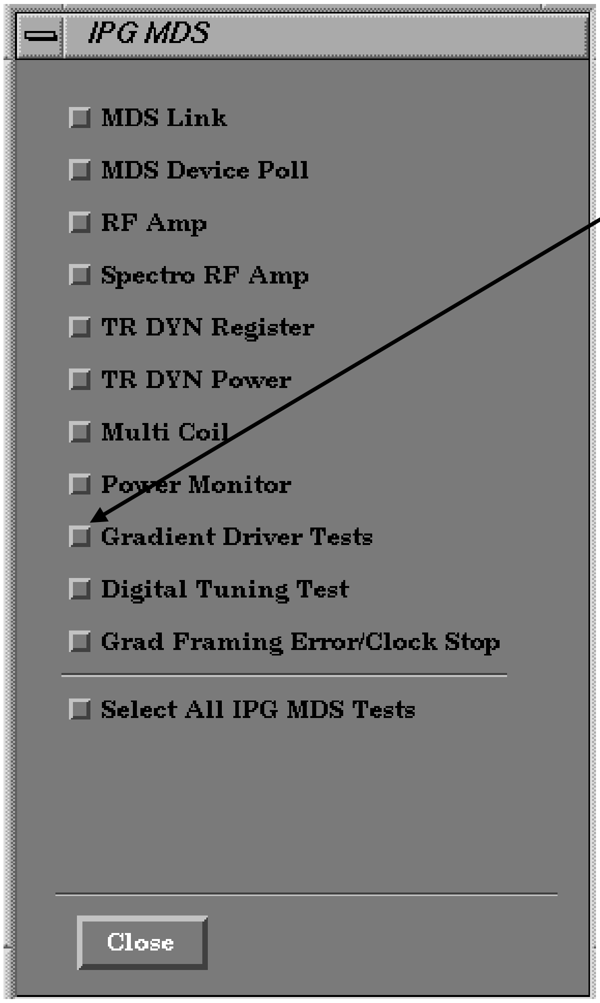
4. Click on **IPG**.

5. On the IPG screen (IPG Board Level Tests:), click on **[MDS...]**. See Illustration 1-2.



IPG SCREEN
ILLUSTRATION 1-2

6. On IPG MDS screen, Select **[Gradient Driver Tests]**. Then click on **[Close]**, then **[Close]** again. See Illustration 1-3.
7. On Diagnostics Main Menu screen, click on **[Run Diags]**. A *Results* window will appear along with a status message indicating the TPS is resetting. Once the TPS reset is complete, the selected diagnostic test will automatically commence. To halt the test, click on **[Stop Diags]**.



TEST SELECTION SCREEN
ILLUSTRATION 1-3

2- POWER-UP TESTS

Power-up Tests examine GIP board interrupts, memory, and register access. They run each time the system is brought up to the applications level, each time the TPS is reset, and the first time the Gradient Driver Tests are invoked from the Diagnostic menu on the Service Desktop.

When the IPG/SPI code is loaded the first time, TPS resets. All subsequent Run Diags sessions do not run Power-up Tests.

When Gradient Driver Tests are run the first time, the TPS is reset. That reset invokes the Power-up Tests. After that, the ASM/GASM Local Voltage Check, Static Tests, and Dynamic Tests occur. These are explained next.

For a complete description of the Power-up Tests, see the procedure for Gradient Driver Power-up Diags.

3- STATIC TESTS

These diagnostics test for three possible hardware configurations and operating modes. They exercise the Gradient Driver subsystem in the most comprehensive manner, and also in the same modes used in product. Together with the Power-up Tests, these Static Tests establish confidence in the following areas of the subsystem.

- Digital portions of the GIP Board
- The entire MDS Link
- The analog signals on the GPM.
- The analog signals on the GRAMs
- The analog signals on the GIP
- The entire power chain of the gradient subsystem.

Prior to starting the Static Tests, a comparison is made between the hardware configuration specified in the `MRconfig.cfg` file, and the actual hardware sensed by the GIP Board. If the two do not match, the Gradient Driver Tests are aborted. It is critical that the MR configuration file and the hardware present match exactly for these tests to operate. If they do not match, Gradient Driver Tests are not executed for any axis.

3-1 Static Fault Checking

Prior to beginning the Static Tests, all fault registers on the GIP are checked. Section 6 of this document lists the signals tested.

If any of the faults are set, an error is logged, and NO Tests are performed. Always use the “Horizon 8x (LX) Extended Error Log” for additional servicing information.

Faults are also monitored during the operation of the test. If a fault occurs, an error is logged and the test is aborted on that axis.

3-2 Static Tests Modes

There are three modes in which the Static Tests run:

- Standby/Voltage Controlled Mode
- Ready/Voltage Controlled Mode
- Ready/GRAM Current Controlled Mode

3-3 Static Data Collection

Each Static Test consists of forcing DAC values and measuring a set of signals. All tests sequence through two passes. The first uses a small range of DAC values to catch any overcurrent conditions before damaging hardware. The second pass uses the full scale range from -237.5A to 237.5A, with steps every 12.5A. If any signals are out of range in the first pass, an error is logged and the test is aborted.

3-4 Static Data Analysis

Throughout the Static Tests, signals are generated and data are collected. To determine the relative health of the hardware, transfer functions are calculated using the data collected to determine if those data are within range. This is the method that these tests use to predict where a problem is in the subsystem.

3-5 Static Tests Error Handling

Each axis of the Gradient Driver subsystem is tested independently. If an error occurs on one axis, the error is logged, the axis is taken to Standby, and the test on that axis aborts; however, all other axes, continue with the rest of the Static and Dynamic Tests.

3-6 Static Tests Error Reporting

Every error message that could be generated by the Static Tests has been reviewed for technical accuracy and service relevance. In all cases, if there were more information that could be added to the error message, an extended error message has been created. Use the "Horizon 8x (LX) Extended Error Log" utility on your laptop to gain access to the extended error information.

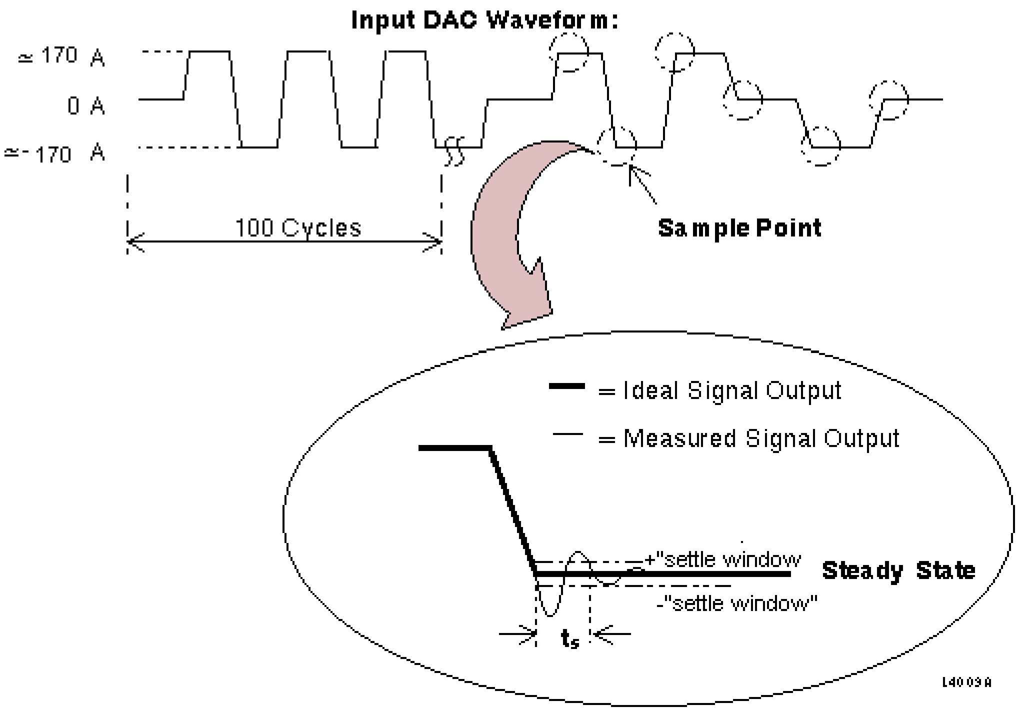
4- DYNAMIC TESTS

The Dynamic Tests are executed sequentially after a successful run of the Static Tests. This group of tests actually has IPG-generated waveforms. This means that voltages and currents are generated and played out using the Gradient Driver subsystem circuitry, and the epoxy-filled Gradient Coil. This digital and analog test uses a waveform that is played out to provide a unique look at analog information for diagnostic purposes.

The test that is run during the Dynamic Tests portion of the Gradient Driver Tests is called the *Settling Time Test*.

4-1 Settling Time Test

This Dynamic Test verifies that a measured gradient signal settles into its steady state value within a predefined settling time. Settling time is defined as *the time required for a signal to reach and remain in a "predefined" window of the ideal steady state voltage or current*.



SETTLING TIME TEST WAVEFORMS
ILLUSTRATION 4-1

Illustration 4-1 shows the Settling Time Test waveforms and sample times. The upper portion of the illustration shows the overall waveform used during the test. The DAC Input is cycled through several swings of current. After loading down the system with 100 cycles, the sample phase is entered. In this phase, the DAC signal is taken from 0A to approximately 170A to approximately –170A to approximately 170A to 0A to approximately –170A to 0A, to explore each of the major transition points of the waveform. Each transition point in the illustration is indicated by a dashed circle.

At a transition point, the resultant output signal exhibits an overshoot and damped oscillation to its steady-state value (as shown in the exploded view in the illustration). The Settling Time Test verifies that the output signal enters the "pre-defined" window within the defined settling time (t_S).

4-2 Dynamic Fault Checking

Prior to beginning the Settling Time Tests, all fault registers on the GIP are checked. Section 6 of this document lists the signals tested.

If any of the faults are set, an error is logged and no Dynamic Tests are performed. Refer to the "Horizon 8x (LX) Extended Error Log" for additional servicing information.

4-3 Dynamic Data Collection

The IPG generates the Input DAC Waveform for this test. At transition points, the IPG and GiP are synchronized so that the GIP begins collecting output signal samples every 32 µsec. Since the IPG has the ability to control the waveform with 4-µsec precision, the IPG actually plays out the dynamic waveform eight times, with a 4-µsec offset each cycle. The GIP, with a 32-µsec sampling ability, collects all eight offset waveforms and interleaves the collected data. This interleaving provides 4 µsec spaced signal data, and therefore, more precise collected data. Depending on the settling time, samples are collected until it is guaranteed that the output signal must be in the "predefined" window. If the output signal is not within the window, the test fails and an error is logged.

4-4 Dynamic Data Analysis

Throughout the Dynamic Tests, signals are generated, and data are collected. This is how these tests predict where a problem is in the subsystem. The entire process is automated, and is performed within the Dynamic Tests software. Service strategies are then determined and reported in the error log and the "Horizon 8x (LX) Extended Error Log".

4-5 Dynamic Tests Error Reporting

Every error message that could be generated by the Static Tests has been reviewed for technical accuracy and service relevance. In all cases, if there were more information that could be added to the error message, an extended error message is created. The extended error messages document is titled “Horizon 8x (LX) Extended Error Log” and is available on the Service Methods CD-ROM.

5- MDS LINK DEPENDENCY

The Gradient Driver Tests depend on the MDS Link being able to communicate between the Systems Cabinet and Gradient Cabinet. The GIP performs the Analog Service Module "ASM" functions of monitoring the gradient driver hardware for all axes.

6- FAULT REGISTERS TABLE

TABLE 6-1

FAULT REGISTERS TABLE

FAULT	Continue Scanning ?	Does Hardware Automatically go to Standby?	Method for Clearing Fault on Hardware Module	Method for Clearing Fault on GIP Board
Framing Error	Yes	All Unchanged	N/A	Framing Error Bit in the GIP Framing/Clock Stop Register
Clock Stop Error	No	All GPMs = Standby All mGRAMs = Standby Pwr Supplies = Ready	N/A	Clock Stop Error Bit in the GIP Framing/Clock Stop Register
GPM Cable Off	No	Axis GPM = Standby Axis mGRAM = Standby Other GPMs & mGRAMS = Unchanged Pwr Supplies = Ready	Restore Cable	X/Y/Z_FAULT_CLEAR Bit in the FAULT_CLEAR Register
GPM Short Overload	Yes	All Unchanged	Not Needed (Clears itself)	Clear Overload Bit in FAULT_CLEAR Register
GPM Long Overload	No	Axis GPM = Standby Axis mGRAM = Standby Other GPMs & mGRAMS = Unchanged Pwr Supplies = Ready	Enable to Standby Signal Transition	Clear Overload Bit in FAULT_CLEAR Register
GPM Transistor Junction Overtemp	Yes	All Unchanged	Cool Down	X/Y/Z_FAULT_CLEAR Bit in the FAULT_CLEAR Register
GPM Shelf Overtemp	No	Axis GPM = Standby Axis mGRAM = Standby Other GPMs & mGRAMS = Unchanged Pwr Supplies = Ready	Cool Down	FAULT_CLEAR Register
GPM Transistor Fault	No	Axis GPM = Standby Axis mGRAM = Standby Other GPMs & mGRAMS = Unchanged Pwr Supplies = Ready	Enable to Standby Signal Transition	FAULT_CLEAR Register
GPM Supply Fault (GPM-PS in Ready & No GPM Latched Supply Fault)	No	Axis GPM = Standby Axis mGRAM = Standby Other GPMs & mGRAMS = Unchanged Pwr Supplies = Ready	Self-Cleaning	FAULT_CLEAR Register
GPM Latched Supply Fault	No	All GPMs = Standby All mGRAMs = Standby Pwr Supplies = Ready	N/A	Must Clear GPM Supply Fault via X/Y/Z_FAULT_CLEAR Bit in the FAULT_CLEAR Register
GPM Power Off	No	Axis GPM = Standby Axis mGRAM = Standby Other GPMs & mGRAMS = Unchanged mGRAM-PS = Ready If all GPMs have Power Off, GPM-PS is set to Standby, else GPM-PS is set to Ready	Restore Power	X/Y/Z_FAULT_CLEAR Bit in the FAULT_CLEAR Register
mGRAM Cable Off / Wiring Fault	No	Axis GPM = Standby Axis mGRAM = Standby Other GPMs & mGRAMS = Unchanged Pwr Supplies = Ready	Restore Cable	X/Y/Z_FAULT_CLEAR Bit in the FAULT_CLEAR Register

TABLE 6-1 (Continued)

FAULT REGISTERS TABLE

FAULT	Continue Scanning ?	Does Hardware Automatically go to Standby?	Method for Clearing Fault on Hardware Module	Method for Clearing Fault on GIP Board
mGRAM Heatsink Overtemp	No	Axis GPM = Standby Axis mGRAM = Standby Other GPMs & mGRAMS = Unchanged Pwr Supplies = Ready	Cool Down	FAULT_CLEAR Register
mGRAM Low Voltage Power Supply UnderVoltage	No	Axis GPM = Standby Axis mGRAM = Standby Other GPMs & mGRAMS = Unchanged Pwr Supplies = Ready	SW Reset the mGRAM	FAULT_CLEAR Register
mGRAM OverCurrent	No	All GPMs = Standby All mGRAMs = Standby Pwr Supplies = Standby	SW Reset the mGRAM	FAULT_CLEAR Register
mGRAM OverVoltage	No	All GPMs = Standby All mGRAMs = Standby Pwr Supplies = Standby	SW Reset the mGRAM	FAULT_CLEAR Register
mGRAM UnderVoltage (mGRAM-PS in Ready)	No	Axis GPM = Standby Axis mGRAM = Standby Other GPMs & mGRAMS = Unchanged Pwr Supplies = Ready	SW Reset the mGRAM	FAULT_CLEAR Register
dI/dt Overrange	Yes	All Unchanged	Not Needed	Overrange Clear Bit in FAULT_CLEAR Register
mGRAM Current Distortion	No	Axis GPM = Standby Axis mGRAM = Standby Other GPMs & mGRAMS = Unchanged Pwr Supplies = Ready	Not Needed	FAULT_CLEAR Register
mGRAM Power Off	No	Axis GPM = Standby Axis mGRAM = Standby Other GPMs & mGRAMS = Unchanged mGRAM-PS = Ready If all GPMs have Power Off, GPM-PS is set to Standby, else GPM-PS is set to Ready	Restore Power	X/Y/Z_FAULT_CLEAR Bit in the FAULT_CLEAR Register
GPM-PS Cable Off	No	All GPMs = Standby All mGRAMs = Standby Pwr Supplies = Standby	Restore Cable	GPM-PS_FAULT CLEAR Bit in FAULT_CLEAR Register
mGRAM-PS Cable Off	No	All GPMs = Standby All mGRAMs = Standby Pwr Supplies = Standby	Restore Cable	mGRAM-PS_FAULT CLEAR Bit in FAULT_CLEAR Register
GPM-PS Fault	No	All GPMs = Standby All mGRAMs = Standby Pwr Supplies = Standby	Enable to Standby Signal Transition	GPM-PS_FAULT CLEAR Bit in FAULT_CLEAR Register
mGRAM-PS Fault	No	All GPMs = Standby All mGRAMs = Standby Pwr Supplies = Standby	Enable to Standby Signal Transition	mGRAM-PS_FAULT CLEAR Bit in FAULT_CLEAR Register
GPM-PS Power Off	No	All GPMs = Standby All mGRAMs = Standby Pwr Supplies = Standby	Restore Power	GPM-PS_FAULT CLEAR Bit i FAULT_CLEAR Register
mGRAM-PS Power Off	No	All GPMs = Standby All mGRAMs = Standby Pwr Supplies = Standby	Restore Power	mGRAM-PS_FAULT CLEAR Bit in FAULT_CLEAR Register

REVISION HISTORY

REV	DATE	AUTHOR	PRIMARY REASONS FOR CHANGE
0	Feb 19, 1998	R. Hawthorne	Initial conversion from ToolBook to Word format
1	Jun 22, 1998	J. Wolak	Updated reference to new Ext Error Log
2	Feb 18, 1999	F. Fiore	Edits based on 8.3 Tools Validation
3	Jun 30, 1999	G. Boerner	Edits based on 8.3 Tools Validation
4	Oct 8, 1999	M. Keber	Updated Diag Menu illustration for Release 8.3; added correct proprietary header.
5	Oct. 25, 2000	M. Jones	Fixed illustration 1-2 position problem.