Service Manual

Tektronix

HDST1
HD-SDI Stress Test Module

070-A881-51

Warning
The servicing instructions are for use by qualified personnel only. To avoid personal injury, do not perform any servicing unless you are qualified to do so. Refer to all safety summaries prior to performing service.

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General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. To avoid potential hazards, use this product only as specified.

Only qualified personnel should perform service procedures.

While using this product, you may need to access other parts of the system. Read the *General Safety Summary* in other system manuals for warnings and cautions related to operating the system.

To Avoid Fire or Personal Injury

Connect and Disconnect Properly. Do not connect or disconnect probes or test leads while they are connected to a voltage source.

Ground the Product. This product is indirectly grounded through the grounding conductor of the mainframe power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded.

Observe All Terminal Ratings. To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product.

Do not apply a potential to any terminal, including the common terminal, that exceeds the maximum rating of that terminal.

Do Not Operate Without Covers. Do not operate this product with covers or panels removed.

Use Proper Fuse. Use only the fuse type and rating specified for this product.

Avoid Exposed Circuitry. Do not touch exposed connections and components when power is present.

Wear Eye Protection. Wear eye protection if exposure to high-intensity rays or laser radiation exists.

Do Not Operate With Suspected Failures. If you suspect there is damage to this product, have it inspected by qualified service personnel.

Do Not Operate in Wet/Damp Conditions.

Do Not Operate in an Explosive Atmosphere.

Keep Product Surfaces Clean and Dry.

Provide Proper Ventilation. Refer to the manual's installation instructions for details on installing the product so it has proper ventilation.

Symbols and Terms

Terms in this Manual. These terms may appear in this manual:

WARNING. *Warning statements identify conditions or practices that could result in injury or loss of life.*

CAUTION. *Caution statements identify conditions or practices that could result in damage to this product or other property.*

Terms on the Product. These terms may appear on the product:

DANGER indicates an injury hazard immediately accessible as you read the marking.

WARNING indicates an injury hazard not immediately accessible as you read the marking.

CAUTION indicates a hazard to property including the product.

Symbols on the Product. The following symbols may appear on the product:

WARNING
High Voltage

Protective Ground
(Earth) Terminal

CAUTION
Refer to Manual

Double
Insulated

Service Safety Summary

Only qualified personnel should perform service procedures. Read this *Service Safety Summary* and the *General Safety Summary* before performing any service procedures.

Do Not Service Alone. Do not perform internal service or adjustments of this product unless another person capable of rendering first aid and resuscitation is present.

Disconnect Power. To avoid electric shock, disconnect the mains power by means of the power cord or, if provided, the power switch.

Use Care When Servicing With Power On. Dangerous voltages or currents may exist in this product. Disconnect power, remove battery (if applicable), and disconnect test leads before removing protective panels, soldering, or replacing components.

To avoid electric shock, do not touch exposed connections.

Preface

You have purchased this optional service manual for the HDST1 HD-SDI Stress Test module. To optimize troubleshooting capability, you should also purchase the service manual for the TG 2000 Platform mainframe.

About This Manual

This manual contains information for servicing the HDST1 HD-SDI Stress Test module to a module level. The information is designed only for qualified service technicians, with moderate experience in analog circuits, digital circuits, and television technology.

This manual is composed of the following sections:

- *Specifications* provides instrument specifications tables.
- *Operating Information* provides basic operating information.
- *Theory of Operation* is an overview of the module's design.
- *Performance Verification* contains procedures to perform the operation tests.
- *Adjustment Procedures* contains procedures for adjusting an HDST1 Stress Test module to meet warranted characteristics.
- *Maintenance* contains installation, removal and replacement, and trouble-shooting instructions.
- *Options* contains a description of available options for the HDST1 Stress Test module.
- *Replaceable Electrical Parts* for the module level are included in the Replaceable Mechanical Parts list.
- *Diagrams* contains interconnect diagrams showing the connections between the HDST1 Stress Test module, the mainframe, and other modules.
- *Replaceable Mechanical Parts* lists the part numbers for replacement parts that you can order. Exploded view illustrations help you to identify the parts.

Related Manuals

The following documents are related to the HDST1 Stress Test module.

- The *TG 2000 Signal Generation Platform Service Manual* describes how to service the mainframe to the module level, and includes a troubleshooting disk that is required for all module and mainframe troubleshooting. This optional manual must be ordered separately, and is recommended before beginning any troubleshooting.
- The *TG 2000 Signal Generation Platform User Manual* describes how to use the TG 2000 Platform. It also contains information about SCPI commands, programming structure, and status and events for the TG 2000 Signal Generation Platform. Some of this information applies to all generator modules, including the HDST1 Stress Test module.
- The *HDST1 HD-SDI Stress Test Module User Manual* contains operating information and information about SCPI commands for the HDST1 Stress Test module.

Contacting Tektronix

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Technical support	Email: techsupport@tektronix.com 1-800-833-9200, select option 3* 6:00 a.m. – 5:00 p.m. Pacific time

*** This phone number is toll free in North America. After office hours, please leave a voice mail message.**
Outside North America, contact a Tektronix sales office or distributor; see the Tektronix web site for a list of offices.

Specifications

Specifications

This section contains a general product description of the HDST1 Stress Test module followed by the operating specifications of the module.

Product Description

The HDST1 HD-SDI Stress Test module is designed to be installed in the TG2000 Signal Generation Platform. The TG2000 Platform must be running version 2.2 or later firmware.

The module is an HD stress test module which provides HDTV interface stressing functions. The module contains the following features:

- Amplitude and duty cycle of the output signal, jitter amplitude and frequency, and error rate are adjustable in real-time from the front panel.
- Cable simulator of 20 m and 100 m
- Error insertion
- Calibration signal output
- Full remote control using GPIB or RS-232C interface

Characteristics

This section contains the specifications for the HDST1 Stress Test module.

Specifications are only valid when the module is installed in a TG 2000 Platform mainframe. For installation instructions, refer to *Module Installation* on page 2–2.

For a list of environmental specifications, refer to the *TG 2000 Signal Generation Platform Service Manual*.

Table 1–1: Electrical specifications

Characteristic	Performance requirements	Reference information
Input		
Number of outputs	1	BNC
Signal	HD-SDI (serial digital interface)*	1.485 Gbps or 1.485/1.001 Gbps, 800 mVp-p ± 10%
Return Loss	< –15 dB	≤ 742.5 MHz
	< –10 dB	≤ 1.485 GHz
Stress output		
Number of outputs	1	BNC
Amplitude range	80 mV to 1040 mV	10% to 130% of 800 mV
Amplitude resolution	1%	
Amplitude error	< 5%	Measured at 800 mV, 4.64 MHz square wave
Duty cycle variable range	40% to 60%	
Duty cycle resolution	1%	
Rise and fall time	< 270 ps	20% to 80%
Overshoot, typical	< 10%	Measured from 90% to 110% of 800 mV amplitudes (measured with Tektronix CSA8000, 80E03, and Anritsu 12N75B)
Return loss	< –15 dB	≤ 1.485 GHz

* **A color bars signal is recommended for the HD-SDI signal. If using special test signals such as a check field (pathological) signal for input, you may not perform appropriate stress testing.**

Table 1–1: Electrical specifications (cont.)

Characteristic	Performance requirements	Reference information
High frequency jitter		
Amplitude	0 UI to 1 UI	
Resolution	0.01 UI	
Amplitude error, typical	< 0.1 UI	Measured at 1 UI, ≤ 1 MHz
	< 0.1 UI + 5%	Measured at 1 UI, ≤ 5 MHz
	< 0.1 UI + 10%	Measured at 1 UI, ≤ 10 MHz
Frequency	0.1 Hz to 10 MHz	
Waveform		Sine wave 2 nd harmonic: ≤ –15 dB 3 rd harmonic: ≤ –15 dB
Low frequency jitter		
Amplitude	0 UI to 20 UI	
Resolution	0.01 UI	
Amplitude error, typical	< 0.1 UI + 1%	Measured at 8 UI, ≤ 1 kHz
	< 0.1 UI + 5%	Measured at 8 UI, ≤ 5 kHz
	< 0.1 UI + 10%	Measured at 8 UI, ≤ 10 kHz
Frequency	0.1 Hz to 10 kHz	
Waveform		Sine wave 2 nd harmonic: ≤ –20 dB 3 rd harmonic: ≤ –20 dB
Error insertion		
Error rate	0 to 120 errors/s	Errors are generated by inverting one bit of the original SDI signal data.
Error rate resolution	0.1 error/s	
Cable simulator 1		
Number of connectors	2 (IN and OUT)	BNC
Cable type		L-5CFB
Cable length		20 m
Attenuation error	± 1 dB	–1.9 dB @ 220 MHz
	± 1 dB	–2.9 dB @ 470 MHz
	± 1 dB	–3.8 dB @ 770 MHz
	± 2 dB	–5.1 dB @ 1300 MHz
Return loss	< –15 dB	≤ 1.485 GHz

Table 1–1: Electrical specifications (cont.)

Characteristic	Performance requirements	Reference information
Cable simulator 2		
Number of connectors	2 (IN and OUT)	BNC
Cable type		L-5CFB
Cable length		100 m
Attenuation error	± 1 dB	–9.6 dB @ 220 MHz
	± 1 dB	–14.7 dB @ 470 MHz
	± 1 dB	–19.1 dB @ 770 MHz
	± 2 dB	–26.0 dB @ 1300 MHz
Return loss	< –15 dB	≤ 1.485 GHz

Table 1–2: Certifications and compliances

Category	Standard or description
EC Declaration of Conformity – EMC	EC Council EMC Directive 89/336/EEC, amended by 93/68/EEC; EN55103-1/2: EMC Product Family Standard for Audio, Video, Audio-Visual, and Entertainment Lighting Control Apparatus for Professional Use Environment: E4 EN 55103-1 Emissions: EN 55103-1, Annex A — Radiated Magnetic Field Emissions EN 55022, Class A[1] — Radiated and Conducted EN 61000-3-2 — Power Line Harmonics EN 55103-2 Immunity: EN 55103-2, Annex A — Radiated Magnetic Field Immunity IEC 61000-4-2 — Electrostatic Discharge Immunity IEC 61000-4-3 — Radiated RF Electromagnetic Field Immunity IEC 61000-4-4 — Electrical Fast Transient/Burst Immunity IEC 61000-4-5 — Surge Immunity IEC 61000-4-6 — Conducted Disturbance Induced by RF Field Immunity IEC 61000-4-11 — Voltage Dips, Short Interruptions and Voltage Variations Immunity
Australia/New Zealand Declaration of Conformity – EMC	Conforms with the following standards in accordance with the Electromagnetic Compatibility Framework: AS/NZS 3548 — Information Technology Equipment
FCC	FCC 47 CFR Part 15, Subpart B, Class A

1 The performance of the TG2000 is degraded to the E4 environment for radiated emissions only when operating with the combinations of HDVG1 and HDST1 in an HD-SDI stress test application.

Operating Information

Installation

This section contains instructions for installing the HDST1 Stress Test module into the TG 2000 Platform mainframe and instructions for operating the module. Listed below are the major topics in this section.

- Preventing component damage
- Module installation
- Module removal

Preventing Component Damage

CAUTION. *Electrostatic discharge (ESD) can damage components on this module and mainframe. To prevent ESD or other component damage, follow the steps below when installing, removing, or handling modules:*

1. Wear a grounded antistatic wrist strap to discharge the static voltage from your body while installing or removing modules from the TG 2000 Platform mainframe.
2. Transport and store modules in a static-protected bag or container.
3. Do not slide the module over any surface.
4. Handle modules as little as possible.
5. Do not touch module components or connector pins.
6. Do not use any devices capable of generating or holding a static charge in the work area where you remove, install, or handle modules.
7. Avoid handling modules in areas that have a floor or work-surface covering capable of generating a static charge.
8. Do not remove the module circuit board assembly from the shield. The shield is an important stiffener which prevents damage to surface-mount components.

Module Installation

A T-10 torx tip screwdriver is the only tool you need to install the module. A T-10 torx tip is supplied with the module.

Hardware Installation

To install the module into the TG 2000 Platform mainframe, perform these steps:

1. Set the TG 2000 Platform mainframe rear-panel power switch to off.
2. Unplug the power cord.
3. Select the slot you will use to install the module. Table 2–1 lists the slot restrictions. Figure 2–1 shows a sample configuration with slot numbers.

Table 2–1: Module slot assignments

Module	Slots in which the module can be installed
AGL1 Genlock module	Slot 2 or 3
AVG1 Generator module	Slots 2 through 10
AWVG1 Generator module	Slots 2 through 10
BG1 Generator module	Slots 2 through 10
Clock module	Slot 1
CPU module	Slot 11
DVG1 Generator module	Slots 2 through 10
GP1 GPIB Interface module	Slot 10
HDST1 Stress Test module	Slots 2 through 10
HDVG1 Generator module	Slots 2 through 10

CAUTION. *The TG2000 Platform mainframe can handle a maximum of one HDST1 module. Exceeding this quantity could cause excessive heat which could damage the product and could result in fire.*

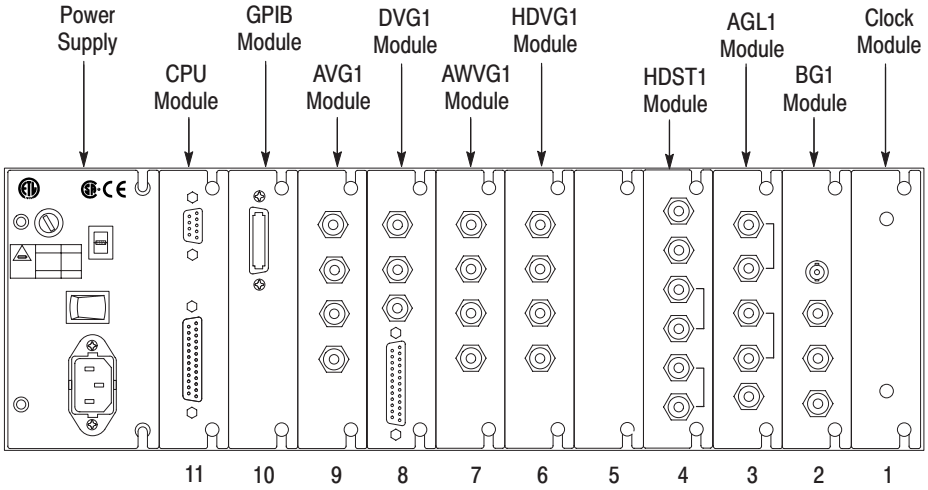


Figure 2–1: TG 2000 Platform mainframe rear panel, showing slot numbering

WARNING. *To avoid a shock hazard, always remove the power cord before removing the top cover. Failure to remove the power cord can result in serious injury or death.*

4. Refer to Figure 2–2 and remove or loosen all screws to remove the top cover.

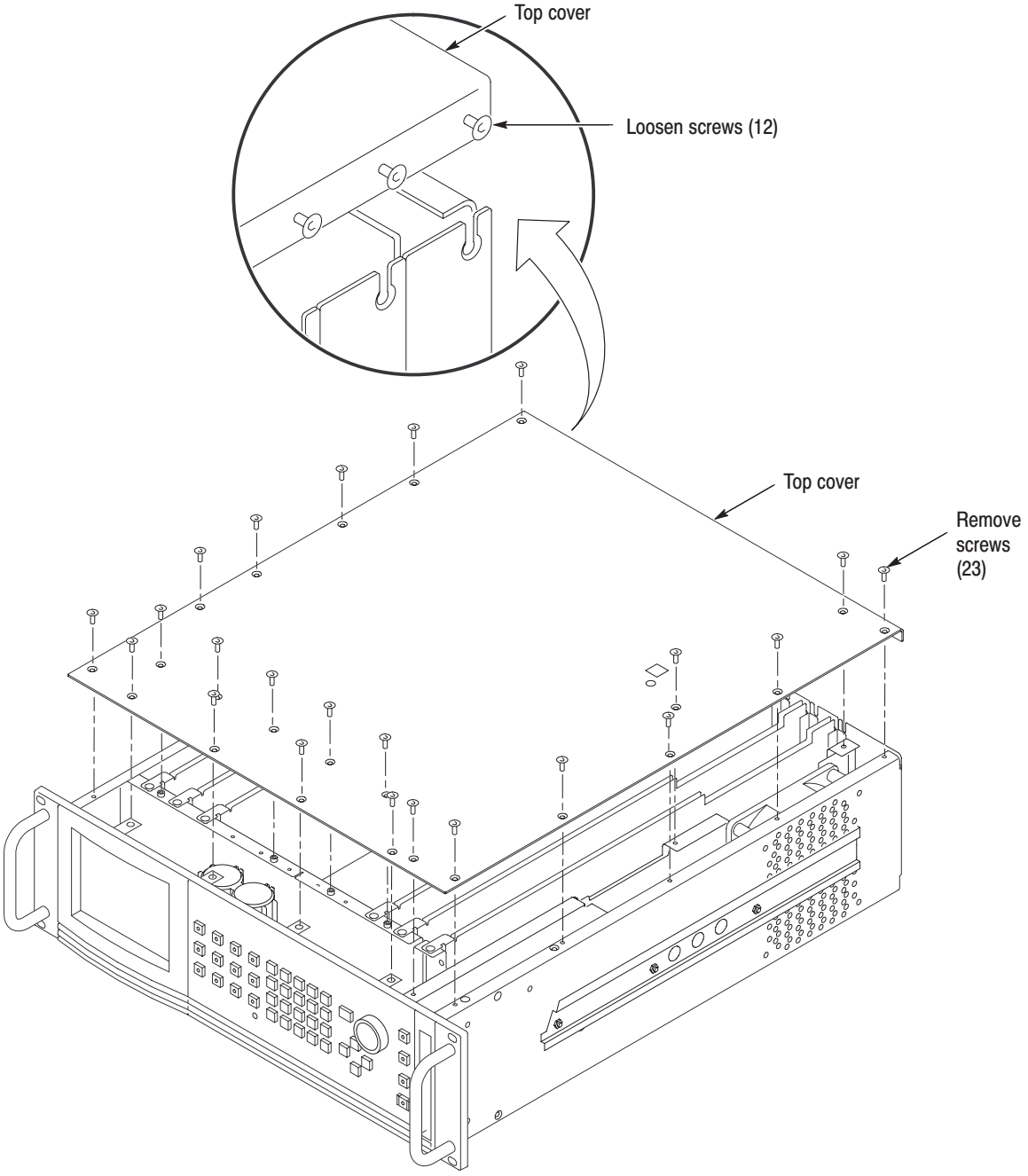


Figure 2–2: Top cover removal

5. Remove the appropriate rear panel as shown in Figure 2–3. Loosen, but do not remove the bottom screw. You will use it later to secure the module.

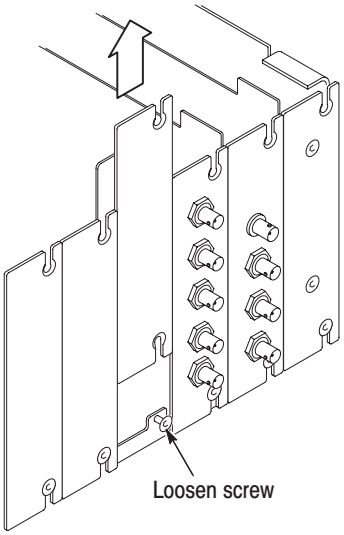


Figure 2–3: Removing the rear panel

6. While ensuring correct alignment of the module flange as shown in Figure 2–4, lower the module into the desired slot as shown in Figure 2–5.

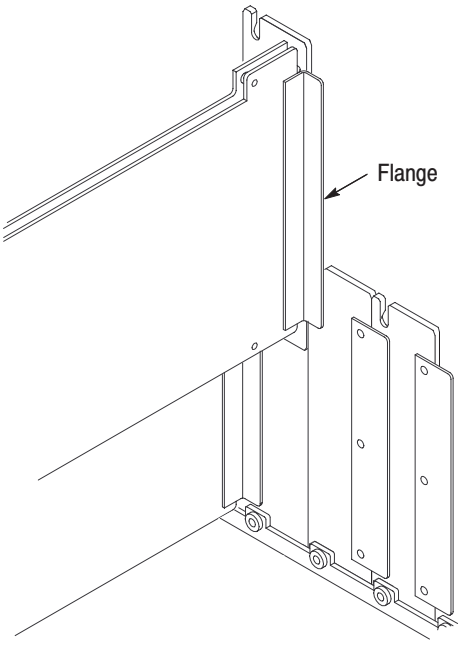


Figure 2–4: Module flange

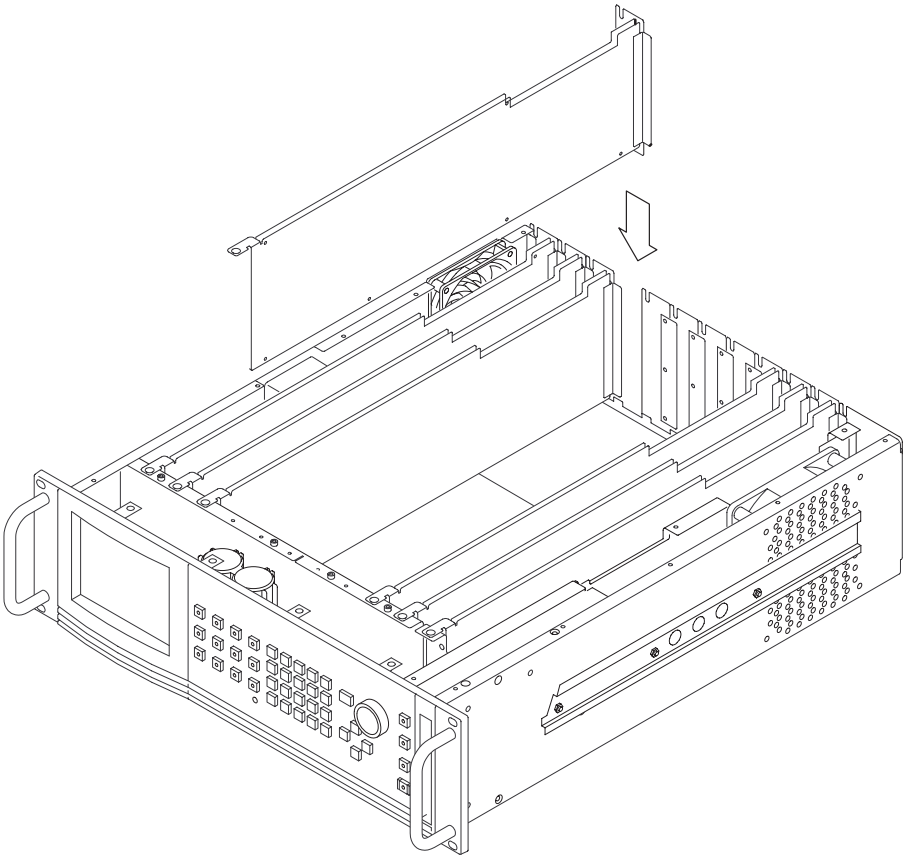


Figure 2–5: Installing the module

7. Ensure that the connectors on the Backplane board and the module exactly match before seating the module.

CAUTION. *The connectors must exactly match before you attempt to press the module firmly in place. If the connectors do not match you could bend a pin that could damage the module, mainframe, or both when power is applied.*

8. Press down evenly on the module until it is firmly in place.
9. Refer to Figure 2–6 and insert and tighten the top screw, which comes with your module, and tighten the rear panel screw.

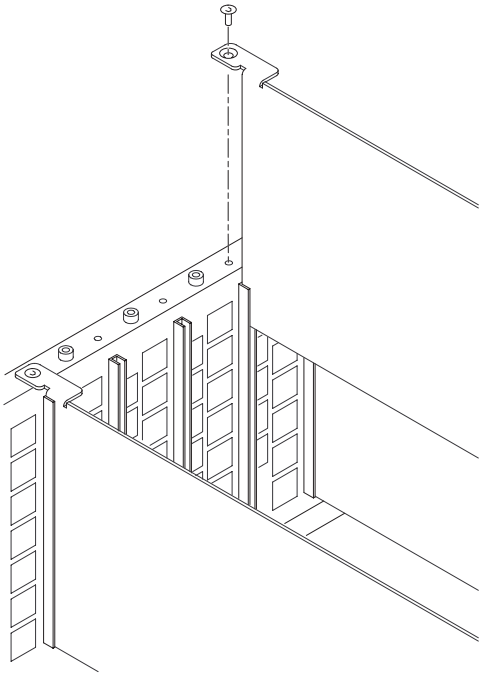


Figure 2–6: Top screw

10. Reinstall the top cover and insert and tighten all top cover screws.
11. Plug in the instrument power cord. Power on the mainframe by setting the rear-panel power switch to ON and pressing the front-panel power switch. Wait for the instrument to perform self tests.

Module Removal

A T-10 torx tip screwdriver is the only tool you need to remove the module.

Module Removal

To remove the module, follow these steps:

1. Turn off the platform by pressing the front-panel **On/Standby** switch and switching the rear panel power switch to off.
2. Unplug the power cord.

WARNING. *To avoid a shock hazard always unplug the power cord before removing the top cover. Failure to unplug the power cord can result in serious injury or death.*

3. Remove all top-cover screws and remove the top cover. See Figure 2–2 on page 2–4.
4. Remove the appropriate rear panel as shown in Figure 2–3 on page 2–5. Loosen, but do not remove the bottom screw. You will use it later to secure the rear panel.
5. Refer to Figure 2–6 on page 2–7 and remove the top screw.
6. Remove the module. To leave the slot empty, proceed to step 8 of this procedure.
7. To install a module in the empty slot, proceed to *Module Installation* on page 2–2.
8. To ensure proper cooling and adherence to EMI shielding requirements, install a blank panel to cover any empty slots in the rear panel. A spare blank panel is included in the TG 2000 Platform mainframe accessories kit.
9. Tighten the screws on the blank rear panel.
10. Reinstall the top cover and insert and tighten all top cover screws.

Functional Overview

This section provides an overview of the HDST1 module. If you are not familiar with the operation of the TG 2000 Signal Generation Platform, refer to the *TG 2000 Signal Generation Platform User Manual* before reading this section.

Figure 2–7 shows the menu structure for basic module operations.

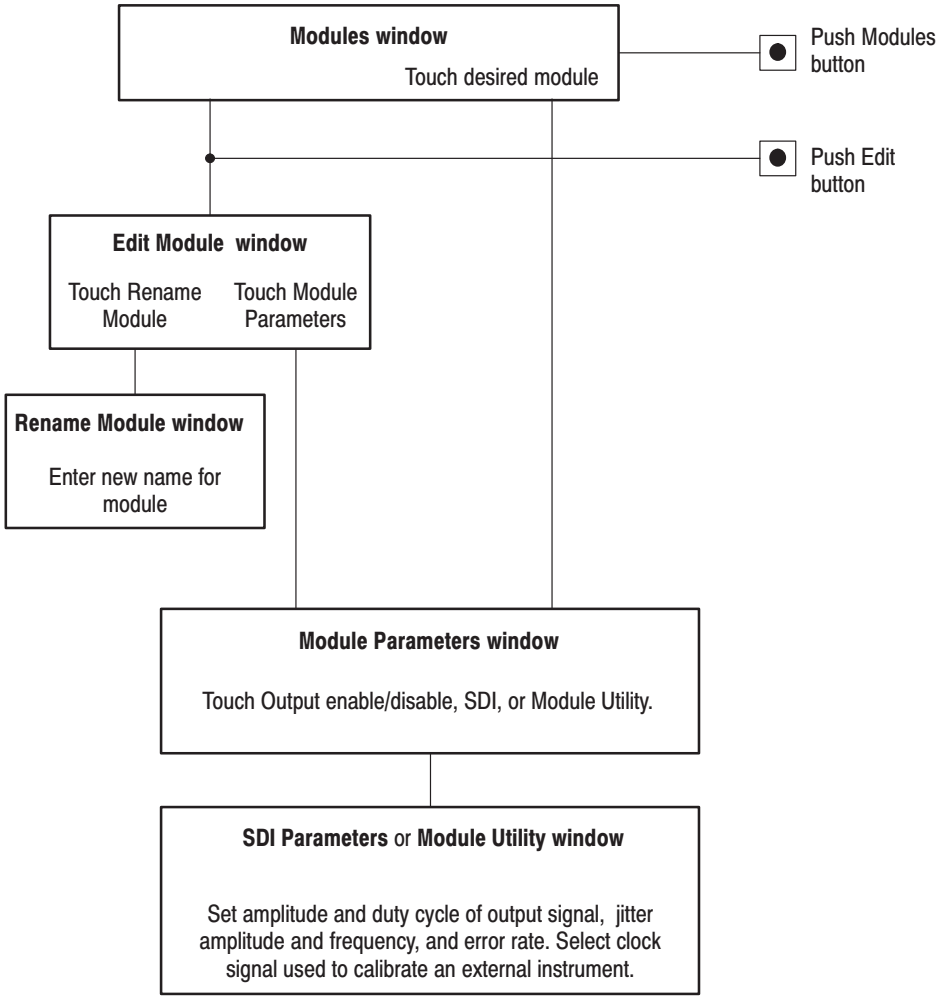


Figure 2–7: Menu structure for the HDST1 module

Rear-panel Connectors

The HDST1 module has these six connectors:

- **INPUT**: Use this connector to input a 1.485 Gbps (or 1.485/1.001 Gbps) serial digital signal.

NOTE. *A color bars signal is recommended for the serial digital signal. If using special test signals such as a check field (pathological) signal for input, you may not perform appropriate stress testing.*

- **STRESS OUT**: Use this connector to output a serial digital signal for stress tests. The signal parameters can be changed from a window menu and the front panel controls. In addition, this connector can be used to output a clock signal for calibrating an external equipment.
- **20m IN**: Input connector for cable extension stress testing of 20 m.
- **20m OUT**: Output connector for cable extension stress testing of 20 m.
- **100m IN**: Input connector for cable extension stress testing of 100 m.
- **100m OUT**: Output connector for cable extension stress testing of 100 m.

Online Help

Push the front-panel **HELP** button to display a help window. The help window describes the window you were using when you pushed HELP.

Operating Procedures

This section is organized into the following main topics:

- Power on the mainframe and select the module
- Module parameters

Refer to Figure 2–7 on page 2–9 for the menu structure.

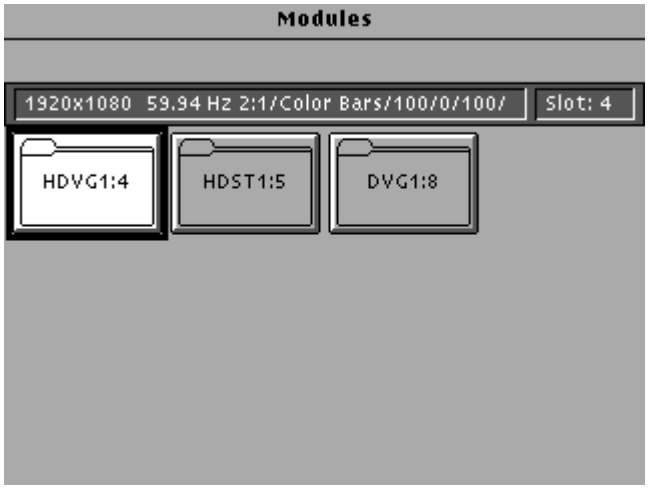
Power On and Select the Module

After the module is installed in the mainframe, and the mainframe is installed in the rack or other location where it will be used, power on the mainframe, and select the module by following these steps:

1. Set the rear-panel power switch to the **ON** position.
2. Press the front-panel **POWER** switch if necessary.
3. Wait for a few seconds as the mainframe executes confidence tests on the mainframe and modules. Check for any error messages that might appear.
4. When self tests are complete, the instrument displays icons representing the generator modules. If an installed module is not represented, refer to *Troubleshooting* in the *HDST1 HD-SDI Stress Test Module Service Manual*.

***NOTE**. The illustrations in these procedures show the factory default name (HDST1:X where X represents the slot number in which the module is installed). However, because you can rename the module, your icons may display a different name. Refer to the* TG 2000 Signal Generation Platform User Manual *for information about editing the module name.*

5. Since you have just powered on the platform, the Modules window is displayed. To open this window at other times, push the **Modules** button.



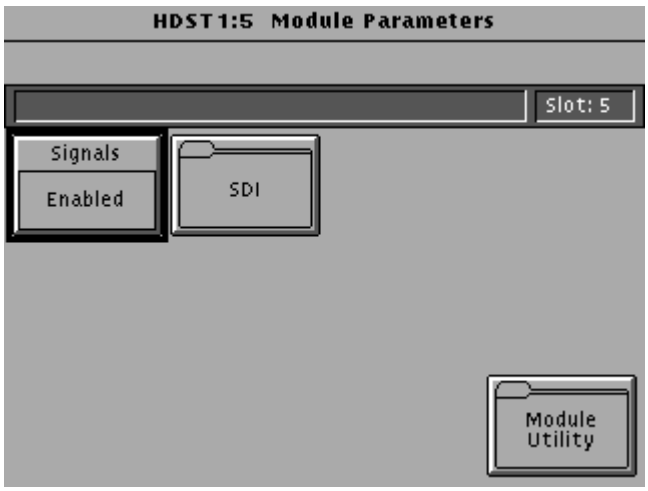
6. Touch the module icon on the display. The Module Parameters window appear.

Module Parameters

The following procedures discuss windows that are accessed through the Module Parameters window, shown below.

To enter the Module Parameters window for the HDST1 module, follow these steps:

1. Select the HDST1 module, if not already selected. The Module Parameters window appears, as shown below.



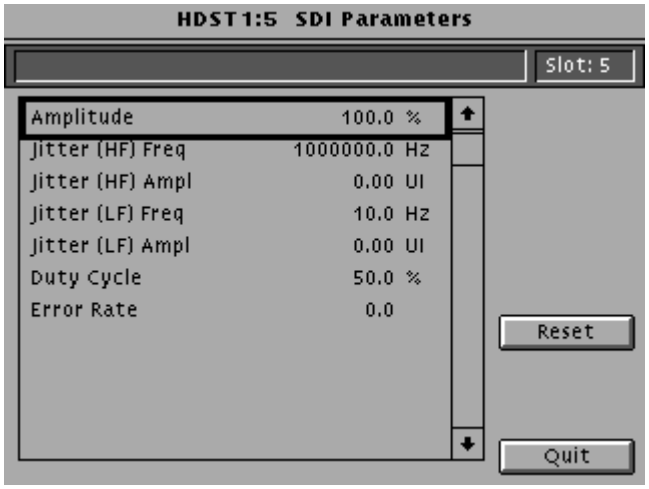
2. Another way to access this window is as follows:
   a. Push the **Modules** button.
   b. Ensure that the module is highlighted.
   c. Push the **Edit** button.
   d. Touch **Module Parameters**.

SDI Parameters

You can adjust the SDI parameters such as signal amplitude, duty cycle, jitter amplitude and frequency, and error rate.

To change the SDI parameters, follow these steps:

1. In the Module Parameters window, shown on page 2–13, touch **SDI**.
2. The SDI Parameters window opens, as shown below.



3. Use the Navigation arrow keys to select the parameter you want to change.
4. Enter a value using the knob or keypad.
5. If you want to reset all the parameters to the default value, touch **Reset**.
6. Touch **Quit** to exit the window.

Enable/Disable the Output Signal

To enable or disable the module output, follow these steps:

1. Select the module, if not already selected. The Module Parameters window (shown on page 2–13) appears.
2. Touch the **Output** icon to toggle the state of the module's output signal.
3. Touch **Quit** to exit.

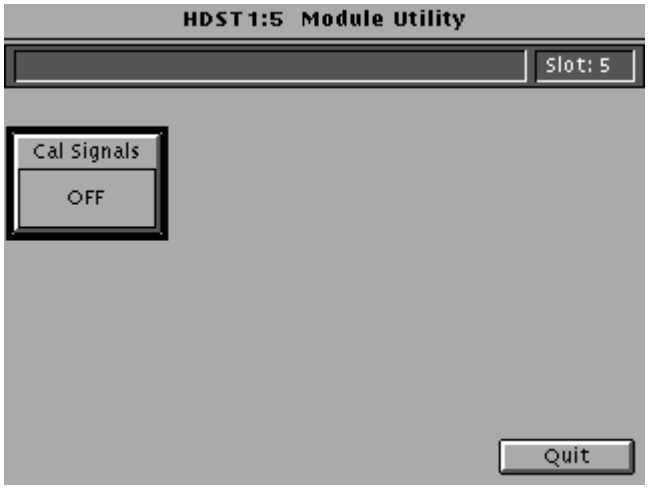
Module Utility

You can output a clock signal that can be used to calibrate an external equipment.

***NOTE**. The calibration signal can be output when the error rate setting in the SDI parameters window is set to more than or equal to 0.1.*

To output the calibration signal, follow these steps:

1. In the Module Parameters window, shown on page 2–13, touch **Module Utility**.
2. The Module Utility window opens, as shown below.



3. Touch the **Cal Signals** icon to select **4.6MHz Clock**.
4. Touch **Quit** to exit the window.

Theory of Operation

Theory of Operation

This section describes the basic operation of the major circuit blocks in the HDST1 Stress Test module.

For information about the TG 2000 Platform mainframe, refer to the *TG 2000 Signal Generation Platform Service Manual*.

Serial to Parallel Converter The serial to parallel converter converts the HD-SDI signal from the INPUT connector into 20-bit parallel data. It also generates the 74.25 MHz or 74.185 MHz clock signal for the parallel data.

FIFO The FIFO synchronizes the data from the serial-to-parallel converter with the 74 MHz clock signal added to low frequency jitter.

Direct Digital Synthesizer 1 The direct digital synthesizer creates a sinusoidal signal used to generate low frequency jitter. It has also a multiplier to vary the amplitude of the signal.

D/A Converter 1 The D/A converter converts the digital sinusoidal signal from Direct Digital Synthesizer 1 to a analog sinusoidal signal used to control low frequency jitter.

Direct Digital Synthesizer 2 The direct digital synthesizer creates a sinusoidal signal used to generate high frequency jitter. It has also a multiplier to vary the amplitude of the signal.

D/A Converter 2 The D/A converter converts the digital sinusoidal signal from the Direct Digital Synthesizer 2 to a analog sinusoidal signal used to control high frequency jitter.

D/A Converter 3 The D/A convertor controls the amount of the current in Driver. When it generates a high voltage signal, the driver outputs a high amplitude pulse.

D/A Converter 4 The D/A converter controls the duty cycle of the output signal.

Duty Cycle Changer The duty cycle changer varies the duty cycle by the analog signal from D/A Converter 4 that is applied to one of the differential input.

Parallel to Serial Converter The parallel-to-serial converter converts the 20-bit 74 MHz data with low frequency jitter to a 1.485 GHz SDI signal.

ECL Delay Lines & Mux The ECL delay lines & Mux generate high frequency jitter using the eight ECL delay lines (MC100E 196). It depends on the amount of jitter how many delay lines are used: 1 delay line for 0 UI to 0.125 UI, 2 delay lines for 0.125 UI to 0.25 UI, 4 delay lines for 0.25 UI to 0.5 UI, and 8 delay lines for 0.5 UI to 1.0 UI. When both of the low frequency jitter and error insertion features are not used, this circuit directly selects the SDI signal from the INPUT connector.

Delay Line (E728) The delay line generates low frequency jitter using an ECL delay line (E728). It can generate jitter from 0 UI to 20 UI.

Driver The driver generates the pulse from 0.08 Vp-p to 1.04 Vp-p at 75 Ω.

A/D Converter The A/D converter is used for the self calibrate of the output voltage. It measure the output voltage by setting the pulse output from Driver to DC.

μP Interface The μP interface communicates with the CPU of the TG2000 Platform mainframe.

Flash The flash stores the F/W and calibration data for the duty cycle.

NVRAM The NVRAM stores the calibration data; output amplitude, low frequency jitter, and high frequency jitter. The data is volatilized when the HDST1 Stress Test module is removed from the TG2000 Platform mainframe.

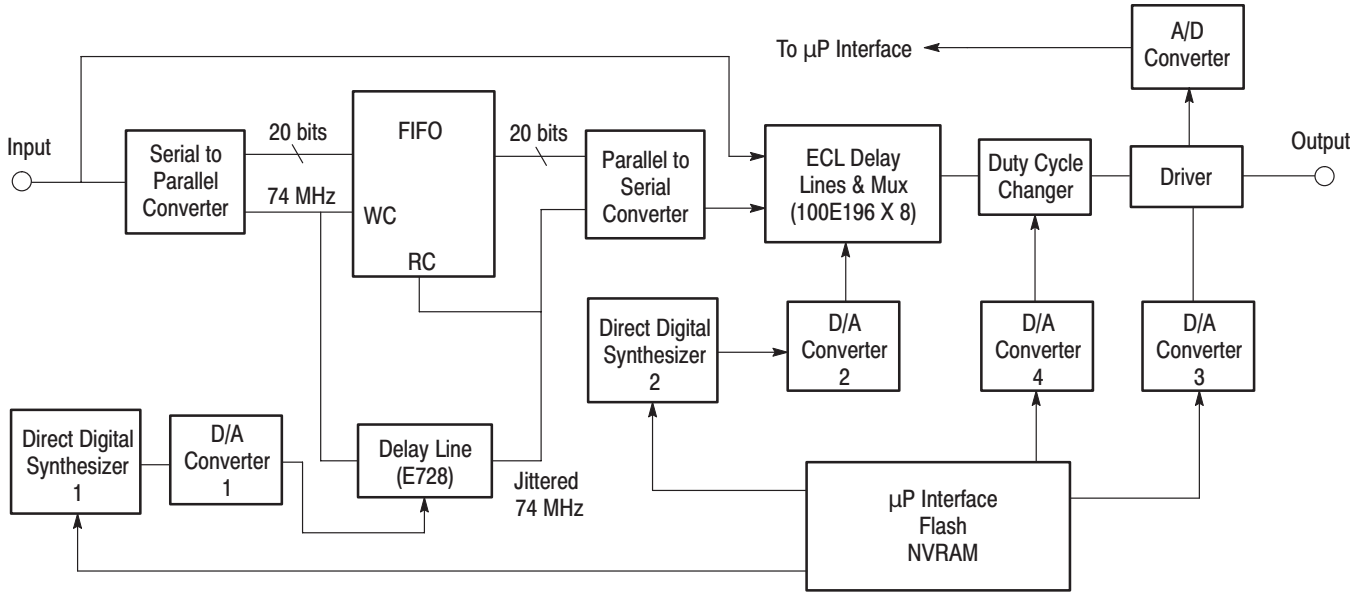


Figure 3–1: Simplified block diagram of the HDST1 Stress Test module

Performance Verification

Performance Verification

Perform the following procedure to verify that your HDST1 Stress Test module is meeting the requirements listed in the *Specifications* section.

Required Equipment

Test Equipment

Table 4–1 lists the equipment required for this procedure.

Table 4–1: Equipment required for Performance Verification

Item	No.	Minimum requirement	Recommended equipment
Oscilloscope	1	Bandwidth: 1 GHz or higher	Tektronix TDS784D
Sampling oscilloscope with head	1	Bandwidth: 6 GHz or higher	Tektronix CSA8000 and 80E03
Network analyzer	1		HP 8752C
Digital Multimeter	1	5 1/2 digits	Fluke 8842A
HDTV digital video generator	1		Tektronix HDVG1
HD-SDI stress test module	1		Tektronix HDST1 (for reference use)
TV signal generator platform	1		Tektronix TG700
Analog wideband video generator	1		Tektronix AWVG7
75 Ω BNC cable	2	Length: 42 inches	Tektronix part no. 012-0074-00
75 Ω BNC cable	1	Length: 72 inches	Tektronix part no. 012-0159-01
50 Ω SMA cable	1	Length: 2m	Tektronix part no. 174-0679-00
75 Ω coax terminator	1		Tektronix part no. 011-0102-03
75 Ω signal adapter	1	Bandwidth: 1 GHz Amplitude precision: –3 dB	Tektronix AMT75
BNC T connector	1		Tektronix part no. 103-0030-00
BNC female-to-dual banana adapter	1		Tektronix part no. 103-0090-00
50 Ω N-to-SMA adapter	1		Stack BA045
75 Ω BNC-to-NC adapter	2		Stack BA059
75 Ω transformer	2		Anritsu 12N75B
75 Ω female-to-female connector	3		Canare BCJ-J
SMA male-to-BNC female adapter	1		Tektronix part no. 015-0554-00
TG700 Signal Generator Platform Software Library CD-ROM	1	Firmware version 3.2 or later	Tektronix part no. 062-A249-XX

Calibration Data Report

Photocopy this form and use it to record the performance test results.

Table 4–2: HDST1 Calibration Data Report

Serial Number:	Cal Date:	Temperature:	Humidity:

Step	Function Tested	Minimum	Cal Data	Maximum
1.	STRESS OUT Amplitude (Measured at 800 mV, 4.64 MHz Square Wave)	760.0 mV	mV	840.0 mV
2.	STRESS OUT Rise/Fall Time			
	Rise Time	------		270 ps
	Fall Time	------		270 ps

Preparation for Performance Verification

Do the following before starting the performance verification procedures:

Power On and Warm Up

Power on and warm up the TG2000 Platform mainframe as follows:

1. Connect the TG 2000 Platform mainframe to an AC power source that is appropriate for your system.
2. Set the rear-panel power switch to the ON position.
3. Press the front-panel POWER switch if necessary.
4. Wait for a few seconds as the mainframe executes confidence tests on the mainframe and modules. Check to see if any error messages appear.
5. When the self tests are complete, the instrument will display icons representing each of the installed modules. If an installed module is not represented on the display, proceed to *Troubleshooting* on page 6–9.
6. Allow 20 minutes of warm-up time before starting the performance verification procedures.
7. During warm-up time, you can perform the remaining preparation steps.

Creating a Preset

Before beginning the Performance Verification procedures, create a preset to save your instrument settings as follows:

1. Push the **Presets** button.
2. Touch **Presets** on the display.
3. Touch **Create** on the display.
4. Touch letters on the display to spell out a name for the new preset, and then touch **OK**.
5. Use the **Navigation** arrows to move the cursor to the new preset. Press the **Select** key.
6. Touch **Save To**. Your current instrument settings are saved to the new preset.

Recalling the Factory Preset

Recall the Factory Preset as follows:

1. Push the **Presets** button.
2. Touch **Presets** on the display.
3. Use the **Navigation** arrows to move the cursor to the **Factory** preset. Press the **Select** button.
4. Touch **Recall**. The instrument is set to factory presets.

Download the Calibration Signal file to the TG700

Before starting the performance verification procedures, you need to download the oscilloscope calibration signal file (**HDST1_CAL.DNL**) to the TG700. The calibration signal file is included in the TG700 Signal Generator Platform Software Library CD-ROM.

To download the calibration signal file to the TG700, you must install the TG7 Comm application program into your PC. The following procedures supposes that TG7 Comm is already installed in your PC.

Download the calibration signal file to the TG700 as follows:

1. Use a Ethernet cable to connect between the 10 BASE-T port on the TG700 and Ethernet port on the PC.
2. Insert the TG700 Signal Generator Platform Software Library CD-ROM into a CD-ROM drive on the PC.
3. Select the AWVG7 folder in the TG7 Comm application window.
4. Select **PC to TG** from the **File** pull-down menu to open the PC to TG Download dialog box.
5. In the PC to TG Download dialog box, select the **HDST1_CAL.DNL** file. This file is included in the \Signal Library\AWVG7\Dnls_GBR\HDST1 folder.
6. In the dialog box, confirm the file and then click the **OK** button to download the file.

Assigning the Signal to the OTHER Test Signal Button.

After downloading the calibration signal file to the TG700, you need to assign the file to the OTHER test signal button for output.

7. Press the **MODULE** button to display the AWVG7 module main menu.
8. Press the **FORMAT** button.
9. Use the left (◀) or right (▶) arrow button to select **1080 59i GBR**, and then press the **ENTER** button.
10. Press the **COLOR BAR** button to load the signal set.
11. Press the **MODULE** button to display the TG700 main menu.
12. Use the up (▲) or down (▼) arrow button to select **UTILITY**, and then press the **ENTER** button.
13. Use the up (▲) or down (▼) arrow button to select **SIGNAL KEY ASSIGN**, and then press the **ENTER** button.

14. Use the up (▲) or down (▼) arrow button to select **TEST SIGNAL KEY ASSIGN**.
15. Use the left (◀) or right (▶) arrow button to select **AWVG7**, and then press the **ENTER** button.
16. Use the up (▲) or down (▼) arrow button to select **OTHER KEY**.
17. Use the left (◀) or right (▶) arrow button to select the **HDST1_CAL**.
18. Press the **ENTER** button to implement the assignment.

Oscilloscope/Signal Adapter Measurement System Compensation

Perform the following procedure to compensate for the oscilloscope and signal adapter measurement system used to check the output amplitude. The following equipment is required for the procedure:

- Oscilloscope
- AWVG7 generator module
- TG700 mainframe
- Digital multimeter
- BNC female-to-dual banana adapter
- BNC T connector
- 75 Ω coax terminator
- 75 Ω BNC cable
- 75 Ω signal adapter

Procedure.

1. Use the 75 Ω BNC cable, BNC T connector, 75 Ω coax terminator, and BNC female-to-dual banana adapter to connect the upper CH 1 connector on the AWVG7 Generator module to the INPUT connector on the digital multimeter as shown in Figure 4–1.

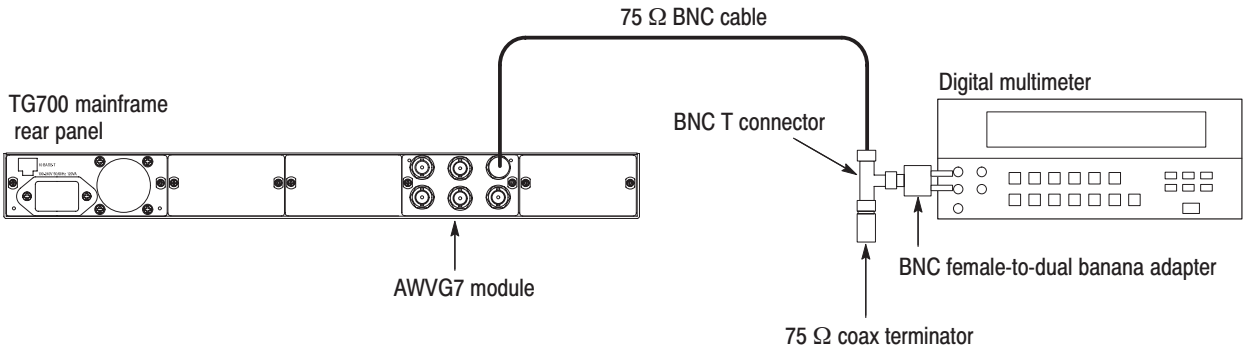


Figure 4–1: Initial equipment connection for compensating the measurement system

2. Press the **MODULE**, **FORMAT**, and **FRONT PANEL ENABLE** buttons simultaneously, and then release the **MODULE** and **FORMAT** buttons to re-start the TG700 mainframe in Factory mode.
3. Select the **DAC Gain (GBR) : 0 mV** calibration signal as follows:
   a. Press the **MODULE** button to display the **AWVG7** main menu.
   b. Press the up (▲) or down (▼) arrow button to select **CALIBRATION**.
   c. Press the left (◀) or right (▶) arrow button to select **DAC Gain (GBR)**, and then press the **ENTER** button.
   d. Press the left (◀) or right (▶) arrow button to select **0mV**, and then press the **ENTER** button.
4. Read the value on the digital multimeter, and then note this value as **DC0**.
5. Press the left (◀) or right (▶) arrow button to select **700.397mV**, and then press the **ENTER** button.
6. Read the value on the digital multimeter, and then note this value as **DC7**.
7. Disconnect the BNC cable from the BNC T connector.
8. Use the 75 Ω BNC cable and the 75 Ω signal adapter to connect the upper CH 1 connector on the AWVG7 Generator module to the CH 1 input on the oscilloscope as shown in Figure 4–2.

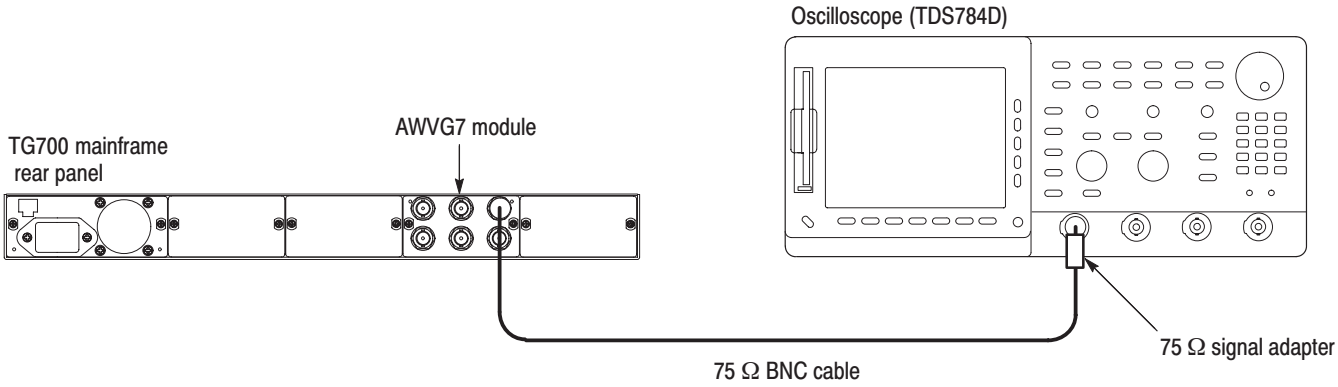


Figure 4–2: Second equipment connection for compensating the measurement system

9. Set the oscilloscope settings as indicated below:

Vertical
- Scale . . . . . CH 1: 100 mV/div
- Offset . . . . . 400 mV
- Position . . . . . 0 V

Horizontal
- Scale . . . . . 5.00 μs/div
- Delay time . . . . . 25 ns/div
- Delayed runs time . . 4.312 μs (Delayed Only)

Trigger
- Position 50%
- Level . . . . . 400 mV
- Source . . . . . CH 1
- Type . . . . . Edge
- Slope . . . . . Positive
- Mode . . . . . Normal

Acquire . . . . . Average 64

Measure . . . . . Amplitude

10. Select the **HDST1_CAL** signal as follows:

a. Press the **MODULE** button on the TG700 mainframe to display the AWVG7 main menu.

b. Press the **FORMAT** button to select **1080 59i GBR**, and then press the **ENTER** button.

c. Press the **OTHER** test signal button to select **HDST1_CAL**.

11. Use the oscilloscope to measure the amplitude of the 4.64 MHz signal in the video signal area, and then note this value **Vref**.

12. Calculate the compensation coefficient by the following formula:

Compensation coefficient: K = 800/700.397 × (DC7–DC0)/Vref

Performance Verification Procedures

Be sure you have performed the *Preparation for Performance Verification* before proceeding.

Performance verification procedures can be performed individually if desired.

WARNING. *Dangerous electric shock hazards exist inside the TG 2000 mainframe. Only qualified service personnel should perform these procedures.*

Output Amplitude Check

This test verifies the signal amplitude of the STRESS OUT output. The following equipment is required for the test:

- HDTV digital video generator (HDVG1 module)
- Oscilloscope
- Two 75 Ω BNC cables
- 75 Ω signal adapter

Perform the following procedure to verify the output amplitude error of the STRESS output:

1. Use the 75 Ω BNC cable to connect the OUT 1 connector on the HDVG1 module to the INPUT connector on the HDST1 Stress Test module as shown in Figure 4–3.

2. Use the 75 Ω BNC cable and the 75 Ω signal adapter to connect the STRESS OUT connector on the HDST1 Stress Test module to the CH 1 input on the oscilloscope as shown in Figure 4–3.

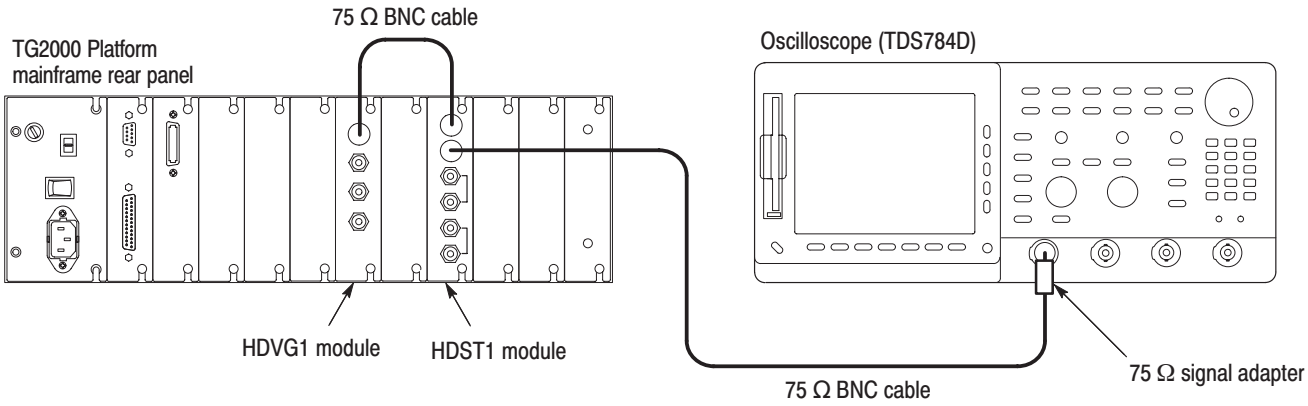


Figure 4–3: Equipment connections for verifying the output amplitude

3. Set the oscilloscope settings as indicated below:

Vertical scale . . . . . CH 1: 100 mV/div
Horizontal scale . . . . . 25 ns/div
Trigger source . . . . . CH 1
Trigger slope . . . . . Positive
Trigger mode . . . . . Normal
Acquire menu . . . . . Average 64
Measure . . . . . Amplitude

4. Set the HDVG1 module to output the following signal:

1920 × 1080 60i (or 59.94i) 2:1 75% SMPTE Color Bars

5. Set the error rate value of the HDST1 Stress Test module to 0.1 as follows:

a. Press the **Modules** button on the TG2000 Signal Platform mainframe.

b. Touch **HDST1** on the display.

c. Touch **SDI**.

d. Use the Navigation arrow keys to select **Error Rate**.

e. Use the knob or keypad to set the value to 0.1.

f. Touch **Quit** to close the window.

6. Output the 4.6 MHz clock signal as follows:

a. Touch **Module Utility** on the display.

b. Touch **Cal Signals** to select **4.6 MHz Clock**.

c. Touch **Quit** to close the window.

7. Use the oscilloscope to measure the amplitude of the 4.6 MHz clock signal, and then note this value as **Vhdst**.
8. Use the following formula to calculate the output amplitude:

   Output amplitude = K × Vhdst
   (Where K is the compensation coefficient calculated on page 4–8)
9. Verify that the calculated value is within the range of 768 mV to 832 mV.
10. Set the output amplitude value of the HDST1 Stress Test module to 50 % as follows:
    a. Touch **SDI** on the display.
    b. Use the Navigation arrow keys to select **Amplitude**.
    c. Use the knob or keypad to set the value to 50.0%.
11. Change the vertical scale setting of the oscilloscope to 50 mV/div.
12. Verify that the output amplitude is within the range of 384 mV to 416 mV.
13. Set the output amplitude value of the HDST1 Stress Test module to 130%.
14. Change the vertical scale setting of the oscilloscope to 200 mV/div.
15. Verify that the output amplitude is within the range of 998.4 mV to 1081.6 mV.

Duty Cycle Check

This test verifies the duty cycle of the output signal. The following equipment is required for the test:

- Sampling oscilloscope with sampling head
- HDTV digital video generator (HDVG1 module)
- HDST1 HD-SDI Stress Test module (for reference use)
- Three 75 Ω BNC cables
- 50 Ω SMA cable
- 50 Ω N-to-SMA adapter
- 75 Ω BNC-to-NC adapter
- SMA male-to-BNC female adapter

Perform the following procedure to verify the duty cycle of the output signal.

CAUTION. *Before connecting a cable to the sampling head, be sure to wear a grounded antistatic wrist strap to discharge the static voltage from your body.*

1. Use the 75 Ω BNC cable to connect the OUT 1 connector on the HDVG1 module to the INPUT connector on the HDST1 Stress Test module as shown in Figure 4–4.
2. Use the 75 Ω BNC cable to connect the OUT 2 connector on the HDVG1 module to the INPUT connector on the reference HDST1 module as shown in Figure 4–4.
3. Use the 50 Ω SMA cable, 50 Ω N-to-SMA adapter, 75 Ω transformer, and 75 Ω BNC-to-NC adapter to connect the STRESS OUT connector on the HDST1 Stress Test module to the CH 1 input on the sampling oscilloscope as shown in Figure 4–4.
4. Use the 75 Ω BNC cable and SMA male-to-BNC female adapter to connect the STRESS OUT connector on the reference HDST1 module to the TRIGGER DIRECT input on the sampling oscilloscope as shown in Figure 4–4.

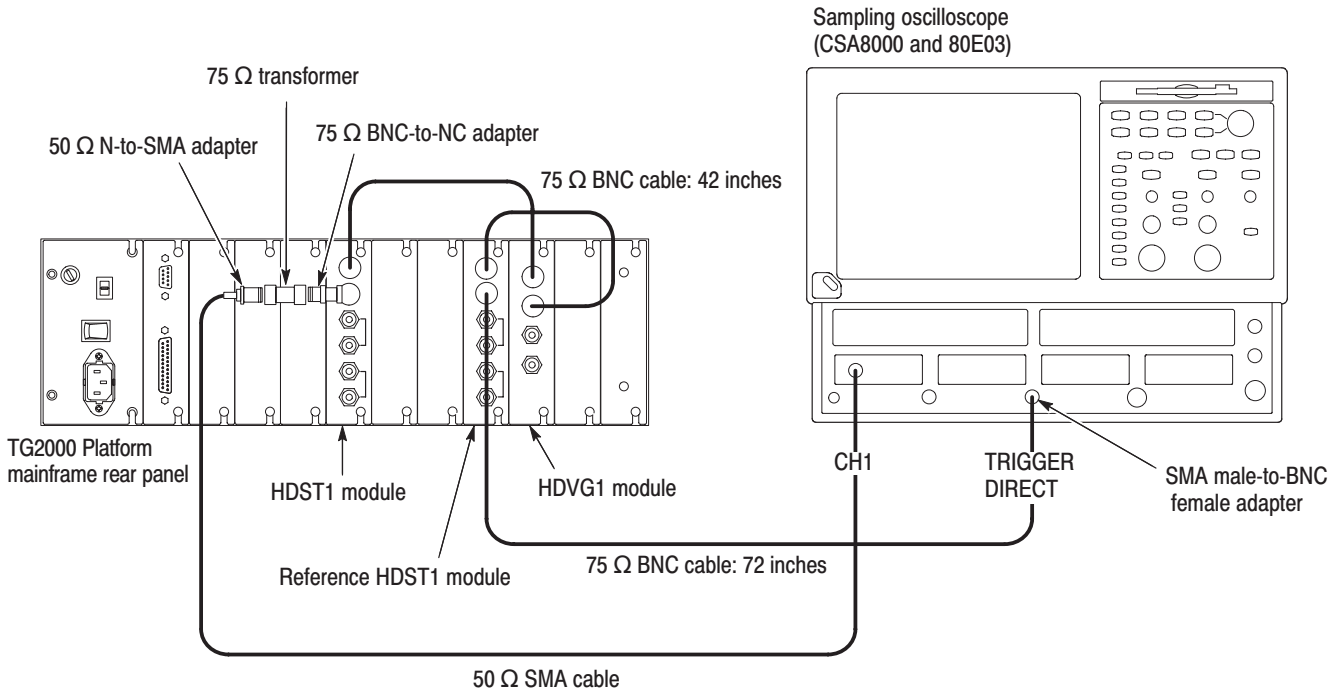


Figure 4–4: Equipment connections for verifying the duty cycle

5. Set the sampling oscilloscope settings as indicated below:

Vertical
- Scale . . . . . 60 mV/div
- Position/Offset . . . . . 0 V

Horizontal
- Scale . . . . . 100 ps/div
- Position . . . . . properly
- Record length 2000

Trigger
- Source . . . . . External Direct
- Slope . . . . . Positive
- Level . . . . . 0.0 V
- Mode . . . . . Normal

Display
- Style . . . . . Variable Persistence 1.000 s

Histogram
- Main C1 . . . . . Horizontal
- Enable Histogram . . Check
- Display Option . . . . . Histogram/Linear/Size 2
- Limit Controls . . . . . Top: 6.487 mV, Bot: –6.487 mV, Left: 21.95 ns, Right: 22.95 ns

6. Set the HDVG1 module to output the following signal:

1920 × 1080 60i (or 59.94i) 2:1 75% SMPTE Color Bars

7. Set the reference HDST1 module settings as indicated below:

Error Rate 0.1
Cal Signals . . . . . 4.6 MHz Clock

8. Reset all the SDI parameters of the HDST1 Stress Test module to their default values as follows:

a. Press the **Modules** button on the TG2000 Platform mainframe.

b. Touch **HDST1:7** on the display. (in this procedure, the HDST1 Stress Test module is installed into the seventh slot of the TG2000 Platform mainframe.)

c. Touch **SDI**.

d. Touch **Reset**.

9. Adjust the horizontal position control on the sampling oscilloscope so that an eye opening is positioned at the center of the screen.

10. Verify that the time difference from the zero-crossing point of the rising edge to the zero-crossing point of the next falling edge is within the range of 639.4 ps to 706.6 ps.

11. Set the duty cycle value of the HDST1 Stress Test module to 40 % as follows:

a. Press the Navigation arrow keys to select **Duty Cycle**.

b. Use the knob or keypad to set the value to 40.0%.

12. Verify that the time difference from the zero-crossing point of the rising edge to the zero-crossing point of the next falling edge is within the range of 504.8 ps to 572 ps. See Figure 4–5.

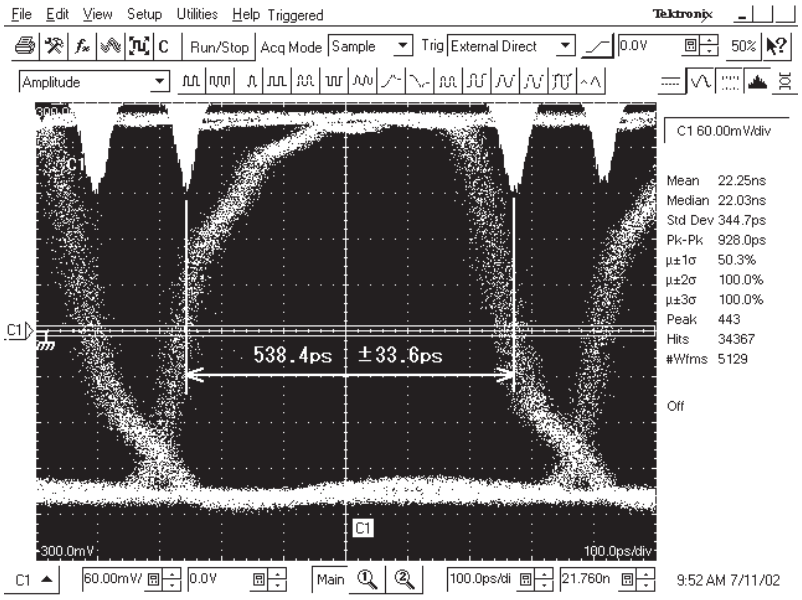


Figure 4–5: Time difference between the zero-crossing points (duty cycle: 40.0%)

13. Use the knob or keypad to change the duty cycle value to 60.0%.

14. Verify that the time difference from the zero-crossing point of the rising edge to the zero-crossing point of the next falling edge is within the range of 774 ps to 841.2 ps. See Figure 4–6.

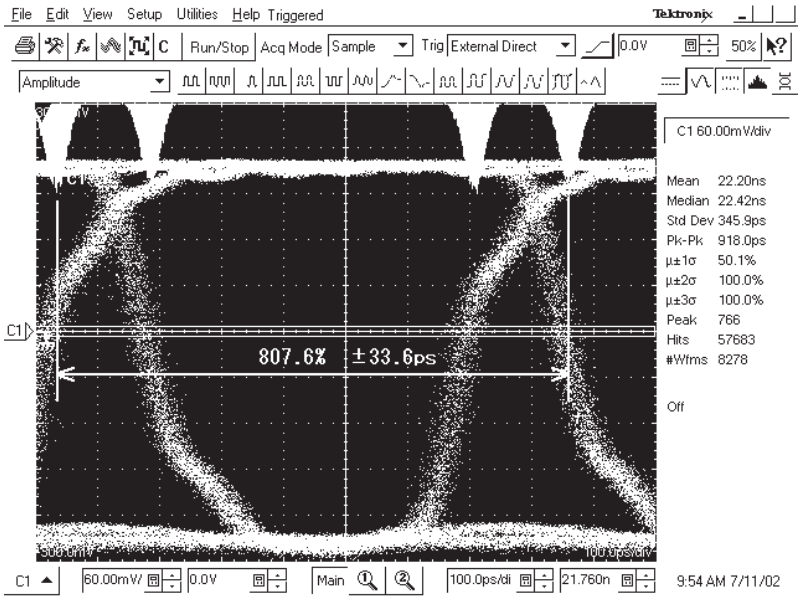


Figure 4–6: Time difference between the zero-crossing points (duty cycle: 60.0%)

15. Return the duty cycle value to 50.0%.

Rise/Fall Time and Overshoot Check

This test verifies the rise time, fall time, and overshoot of the output signal. The following equipment is required for the test:

- Sampling oscilloscope with sampling head
- HDTV digital video generator (HDVG1 module)
- HDST1 HD-SDI Stress Test module (for reference use)
- Three 75 Ω BNC cables
- 50 Ω SMA cable
- 50 Ω N-to-SMA adapter
- 75 Ω BNC-to-NC adapter
- SMA male-to-BNC female adapter

Perform the following procedure to verify the rise time, fall time, and overshoot of the output signal:

Use the equipment connection from the previous test.

1. Set the sampling oscilloscope settings as indicated below:

   Vertical
   - Scale . . . . . 60 mV/div
   - Position/Offset . . . . . 0 V

   Horizontal
   - Scale . . . . . 100 ps/div
   - Position . . . . . properly
   - Record length 2000

   Trigger
   - Source . . . . . External Direct
   - Slope . . . . . Positive
   - Level . . . . . 0.0 V
   - Mode . . . . . Normal

   Display
   - Style . . . . . Variable Persistence 1.000 s

   Histogram . . . . . Off

   Acquisition
   - Average . . . . . 64 Samples

   Measure
   - Meas1 . . . . . Select Meas: Timing– C1 Rise
Ref Level: Relative Hi 80%/Low 20%
   - Meas2 . . . . . Select Meas: Amplitude– C1+Overshoot
   - Meas3 . . . . . Select Meas: Timing– C1 Fall
Ref Level: Relative Hi 80%/Low 20%
   - Meas4 . . . . . Select Meas: Amplitude– C1–Overshoot

2. Set the HDVG1 module to output the following signal:

   1920 × 1080 60i (or 59.94i) 2:1 75% SMPTE Color Bars

3. Set the reference HDST1 module settings as indicated below:

   Error Rate 0.1
   Cal Signals . . . . . 4.6 MHz Clock

4. Set the error rate value of the HDST1 Stress Test module to 0.1 as follows:

   a. Press the **Modules** button on the TG2000 Platform mainframe.

   b. Touch **HDST1:7** on the display. (in this procedure, the HDST1 Stress Test module is installed into the seventh slot of the TG2000 Platform mainframe.)

   c. Touch **SDI**.

   d. Use the Navigation arrow keys to select **Error Rate**.

   e. Use the knob or keypad to set the value to 0.1.

   f. Touch **Quit** to close the window.

5. Output the 4.6 MHz clock signal from the HDST1 Stress Test module as follows:
   a. Touch **Module Utility** on the display.
   b. Touch **Cal Signals** to select **4.6 MHz Clock**.
   c. Touch **Quit** to close the window.
6. Adjust the horizontal position control on the sampling oscilloscope so that the rising edge of the clock signal is positioned at 2 division from the left side of the screen.
7. Verify that the rise time (Tr) is less than 270 ps.
8. Verify that the positive overshoot is less than 76 mV(10%).
9. Change the trigger slope setting of the sampling oscilloscope to **Negative**.
10. Verify that the fall time (Tf) is less than 270 ps
11. Verify that the negative overshoot is less than 76 mV (10%).
12. Verify that the time difference between the rise time and fall time (Tr–Tf) is less than 100 ps.

Jitter Amplitude Check

This test verifies the high and low frequency jitter amplitude of the output signal. The following equipment is required for the test:

- Sampling oscilloscope with sampling head
- HDTV digital video generator (HDVG1 module)
- HDST1 HD-SDI Stress Test module (for reference use)
- Three 75 Ω BNC cables
- 50 Ω SMA cable
- 50 Ω N-to-SMA adapter
- 75 Ω BNC-to-NC adapter
- SMA male-to-BNC female adapter

Perform the following procedure to verify the high and low frequency jitter amplitude of the output signal:

Use the equipment connection from the previous test.

High Frequency Jitter Amplitude.

1. Set the sampling oscilloscope settings as indicated below:

   Vertical
   - Scale . . . . . 60 mV/div
   - Position/Offset . . . . . 0 V

   Horizontal
   - Scale . . . . . 20 ps/div
   - Position . . . . . properly
   - Record length 2000

   Trigger
   - Source . . . . . External Direct
   - Slope . . . . . Positive
   - Level . . . . . 0.0 V
   - Mode . . . . . Normal

   Display
   - Style . . . . . Variable Persistence 1.000 s

   Histogram . . . . . On
   Acquisition mode . . . . . Sample
   Measure . . . . . Off

2. Set the HDVG1 module to output the following signal:

   1920 × 1080 60i (or 59.94i) 2:1 75% SMPTE Color Bars

3. Set the reference HDST1 module settings as indicated below:

   Error Rate 0.1
   Cal Signals . . . . . 4.6 MHz Clock

4. Set the error rate value of the HDST1 Stress Test module to 0.1 as follows:

   a. Press the **Modules** button on the TG2000 Platform mainframe.

   b. Touch **HDST1:7** on the display. (in this procedure, the HDST1 Stress Test module is installed into the seventh slot of the TG2000 Platform mainframe.)

   c. Touch **SDI**.

   d. Use the Navigation arrow keys to select **Error Rate**.

   e. Use the knob or keypad to set the value to 0.1.

   f. Touch **Quit** to close the window.

5. Output the 4.6 MHz clock signal from the HDST1 Stress Test module as follows:

   a. Touch **Module Utility** on the display.

   b. Touch **Cal Signals** to select **4.6 MHz Clock**.

   c. Touch **Quit** to close the window.

6. Adjust the horizontal position control on the sampling oscilloscope so that the rising edge of the clock signal is positioned at the center of the screen.

7. Change the vertical scale setting of the sampling oscilloscope to 10 mV/div.

8. After the **#Wfms** value of the histogram exceeds 3000, measure the **Pk-Pk** value and then note this value as **Trem**.

9. Set **Jitter [HF] Freq** to **1,000,000 Hz** and **Jitter [HF] Ampl** to **1.00 UI** of the HDST1 Stress Test module as follows:

   a. Touch **SDI** on the display.

   b. Press the Navigation arrow keys to select **Jitter [HF] Freq**.

   c. Use the knob or keypad to set the value to 1,000,000 Hz.

   d. Press the Navigation arrow keys to select **Jitter [HF] Ampl**.

   e. Use the knob or keypad to set the value to 1.00 UI.

10. Change the sampling oscilloscope settings as indicated below:

    Vertical scale . . . . . 60 mV/div
    Horizontal scale . . . . . 200 ps/div

11. Adjust the horizontal position control so that the whole of the rising edge is positioned at the center of the screen. See Figure 4–7.

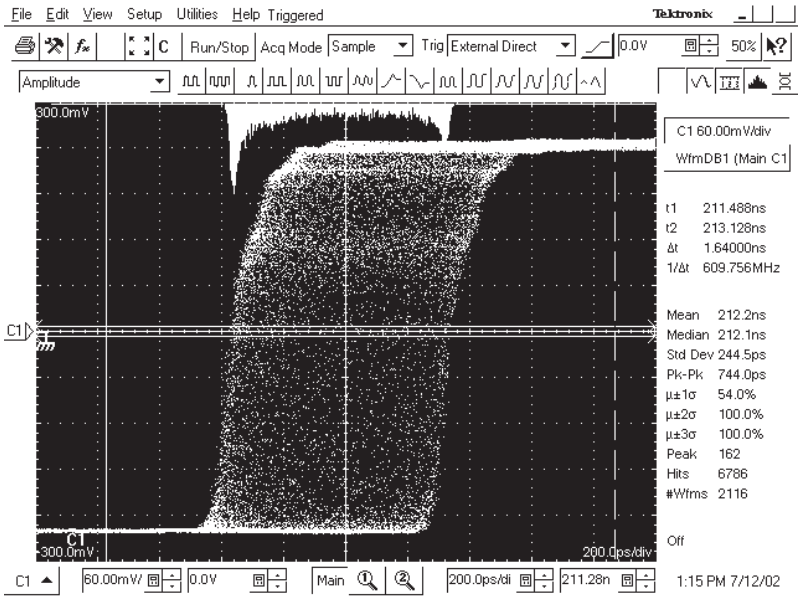


Figure 4–7: Centering the rising edge

12. After the **#Wfms** value of the histogram exceeds 2000, measure the **Pk-Pk** value and then note this value as **Tjit1M**.
13. Verify that the high frequency jitter amplitude of 1 MHz meets the following relationship:

    1 MHz jitter amplitude: Tjit1M–Trem= 673 ps ± 67 ps
14. Change **Jitter [HF] Freq** to **5,000,000 Hz** of the HDST1 Stress Test module.
15. Measure the **Pk-Pk** value, and then note this value as **Tjit5M**.
16. Verify that the high frequency jitter amplitude of 5 MHz meets the following relationship:

    5 MHz jitter amplitude: Tjit5M–Trem= 673 ps ± 100 ps
17. Change **Jitter [HF] Freq** to **10,000,000 Hz** of the HDST1 Stress Test module.
18. Measure the **Pk-Pk** value, and then note this value as **Tjit10M**.
19. Verify that the high frequency jitter amplitude of 10 MHz meets the following relationship:

    10 MHz jitter amplitude: Tjit10M–Trem= 673 ps ± 134 ps
20. Return **Jitter [HF] Ampl** to **0.00 UI**.

Low Frequency Jitter Amplitude.

21. Set **Jitter [LF] Freq** to **1,000 Hz** and **Jitter [LF] Ampl** to **8.00 UI** of the HDST1 Stress Test module as follows:

a. Press the Navigation arrow keys to select **Jitter [LF] Freq**.

b. Use the knob or keypad to set the value to 1,000 Hz.

c. Press the Navigation arrow keys to select **Jitter [LF] Ampl**.

d. Use the knob or keypad to set the value to 8.00 UI.

22. Change the sampling oscilloscope horizontal scale setting to 1.000 ns/div.

23. Adjust the horizontal position control so that the whole of the rising edge is positioned at the center of the screen.

24. After the **#Wfms** value of the histogram exceeds 2000, measure the **Pk-Pk** value and then note this value as **Tjit1k**.

25. Verify that the low frequency jitter amplitude of 1 kHz meets the following relationship:

1 kHz jitter amplitude: Tjit1k–Trem= 5.384 ns ± 0.726 ns

26. Change **Jitter [LF] Freq** to **5,000 Hz** of the HDST1 Stress Test module.

27. Measure the **Pk-Pk** value, and then note this value as **Tjit5k**.

28. Verify that the low frequency jitter amplitude of 5 kHz meets the following relationship:

5 kHz jitter amplitude: Tjit5k–Trem= 5.384 ns ± 0.942 ns

29. Change **Jitter [LF] Freq** to **10,000 Hz** of the HDST1 Stress Test module.

30. Measure the **Pk-Pk** value, and then note this value as **Tjit10k**.

31. Verify that the low frequency jitter amplitude of 10 kHz meets the following relationship:

10 kHz jitter amplitude: Tjit10k–Trem= 5.384 ns ± 1.211 ns

32. Touch **Reset** in the SDI Parameters window to reset all of the parameters to their default values.

Cable Simulator Check

This test verifies the attenuation characteristics of the cable simulator. The following equipment is required for the test:

- Network analyzer
- Two 75 Ω BNC cables
- Two 75 Ω transformers
- Two 75 Ω BNC-to-NC adapters
- Three 75 Ω Female-to-Female connectors

Perform the following procedure to verify the attenuation error of the cable simulator.

1. Use the 75 Ω BNC cables, 75 Ω female-to-female connectors, 75 Ω BNC-to-NC adapters, and 75 Ω transformers to connect Reflection Test port and Transmission Test Port on the network analyzer as shown in Figure 4–8.

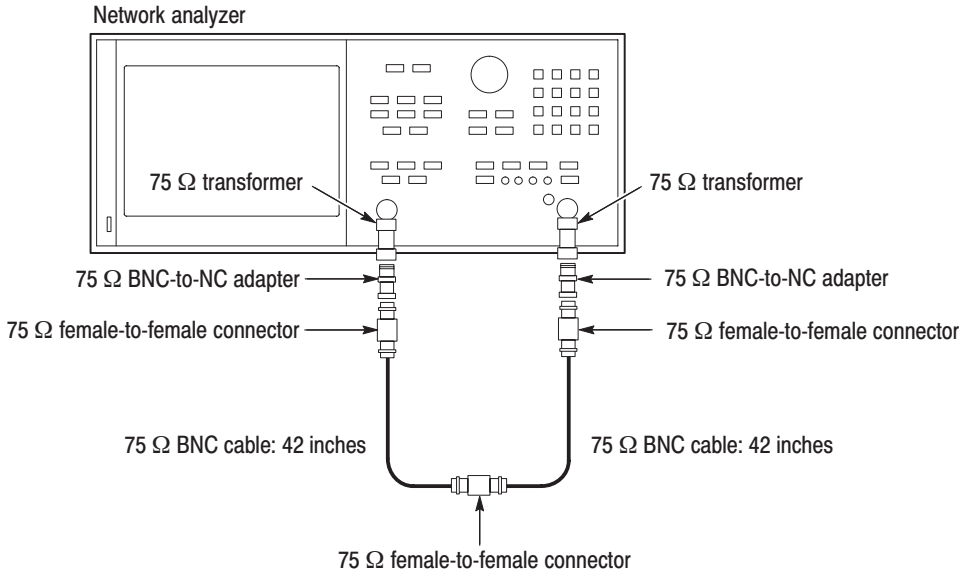


Figure 4–8: Initial equipment connections for verifying the attenuation characteristics of the cable simulator

2. Press the **MEAS** button to select TRANSMISSION.
3. Press the **CAL** button to select CALIBRATE MENU → RESPONSE → THRU to calibrate the measurement system.
4. After the calibration is normally completed, press **DONE: RESPONSE** to enable the calibration data.

5. Disconnect the 75 Ω BNC cables from the 75 Ω female-to-female connector.

6. Connect the 75 Ω BNC cable from Reflection Test Port on the network analyzer to the 20 m IN connector on the HDST1 Stress Test module. See Figure 4–9.

7. Connect the 75 Ω BNC cable from Transmission Test Port on the network analyzer to the 20 m OUT connector on the HDST1 Stress Test module. See Figure 4–9.

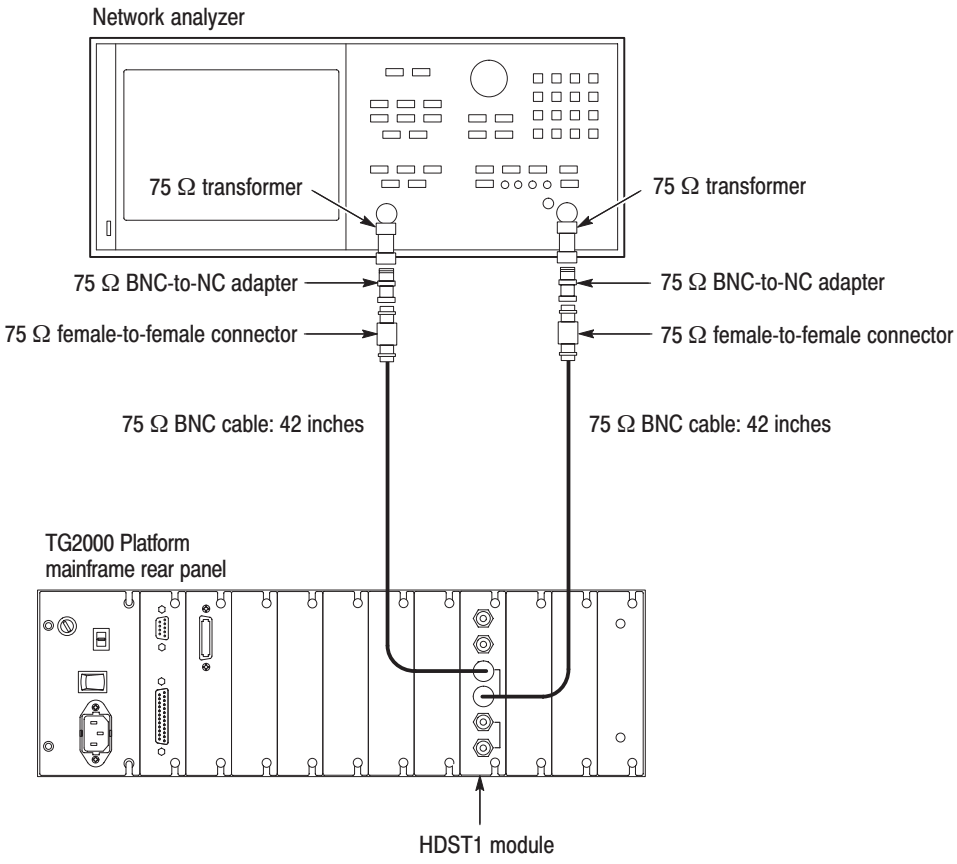


Figure 4–9: Second equipment connections for verifying the attenuation characteristics of the cable simulator

8. Press the **SCALE REF** button on the network analyzer and set the analyzer settings as indicated below:

   SCALE/DIV . . . . . 1 dB/div
   REFERENCE POSITION . . . 7 DIV

9. Press the **MKR** button on the network analyzer to set the frequency of each marker as indicated below:

MARKER 1: 300 kHz
MARKER 2: 220 MHz
MARKER 3: 470 MHz
MARKER 4: 770 MHz

10. Select MARKER 1, and then verify that other markers value to MARKER 1 are within the following ranges:

MARKER 2: –1.9 dB ± 1 dB
MARKER 3: –2.9 dB ± 1 dB
MARKER 4: –3.8 dB ± 1 dB

11. Change the frequency of MARKER 4 to 1.3 GHz.

12. Select MARKER 1, and then verify the MARKER 4 value is within the following ranges:

MARKER 4: –5.1 dB ± 2 dB

13. Move the BNC cable from the 20 m IN connector to 100 m IN connector on the HDST1 Stress Test module.

14. Move the BNC cable from the 20 m OUT connector to 100 m OUT connector on the HDST1 Stress Test module.

15. Press the **SCALE REF** button on the network analyzer to set the SCALE/DIV setting to 5 dB/div.

16. Press the **MKR** button on the network analyzer to set the frequency of each marker as indicated below:

MARKER 1: 300 kHz
MARKER 2: 220 MHz
MARKER 3: 470 MHz
MARKER 4: 770 MHz

17. Select MARKER 1, and then verify that other markers value to MARKER 1 are within the following ranges:

MARKER 2: –9.6 dB ± 1 dB
MARKER 3: –14.7 dB ± 1 dB
MARKER 4: –19.1 dB ± 1 dB

18. Change the frequency of MARKER 4 to 1.3 GHz.

19. Select MARKER 1, and then verify the MARKER 4 value is within the following ranges:

MARKER 4: –26.0 dB ± 2 dB

Recall Preset

Recall the preset you created as follows:

1. Push the **Presets** button.
2. Touch **Presets** on the display.
3. Use the **Navigation** arrows to move the cursor to the preset that you created before beginning the *Performance Verification* procedure. Press the **Select** key.
4. Touch **Recall**. Your instrument settings are recalled.

This completes the *Performance Verification* procedure. If you require further assistance, contact your nearest Tektronix Service Center.

Adjustment Procedures

Adjustment Procedures

This section contains information needed to adjust the HDST1 Stress Test module.

The only adjustment in the HDST1 Stress Test module is for the 50% duty cycle.

Requirements for Adjustment

Before doing the adjustment, note the following requirements.

Personnel This procedure is only to be performed by trained service technicians.

Warm-Up Period The HDST1 Stress Test module requires a 20 minute warm-up time in a +20° C to +30° C environment before it is adjusted. Adjustment done before the operating temperature has stabilized may cause errors in performance.

Equipment Required

Table 5–1 lists the equipment required to adjust the 50% duty cycle.

Table 5–1: Equipment required

Item	No.	Minimum requirement	Recommended equipment
Sampling oscilloscope with head	1	Bandwidth: 6 GHz or higher	Tektronix CSA8000 and 80E03
HDTV digital video generator	1		Tektronix HDVG1
HD-SDI stress test module	1		Tektronix HDST1 (for reference use)
75 Ω BNC cable	2	Length: 42 inches	Tektronix part no. 012-0074-00
75 Ω BNC cable	1	Length: 72 inches	Tektronix part no. 012-0159-01
50 Ω SMA cable	1	Length: 2 m	Tektronix part no. 174-0679-00
50 Ω N-to-SMA adapter	1		Stack BA045
75 Ω BNC-to-NC adapter	1		Stack BA059
75 Ω transformer	1		Anritsu 12N75B
SMA male-to-BNC female adapter	1		Tektronix part no. 015-0554-00
HDST1 module firmware disk	1		Tektronix part no. 062-A299-XX

Firmware Installation

Before performing the 50% duty cycle adjustment, you must first reinstall the HDST1 module firmware to save the adjustment data to the module's flash ROM.

Procedure

1. Install the HDST1 Stress Test module in the TG2000 Platform mainframe. Both the HDVG1 module and the reference HDST1 module need to be installed in the TG2000 Platform mainframe prior to performing this adjustment. See Figure 5–1.

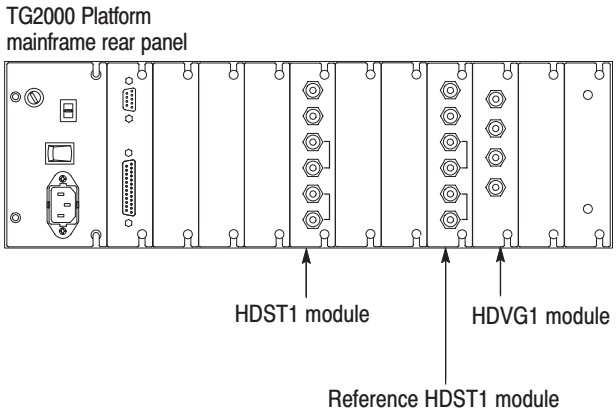


Figure 5–1: Module configuration for reinstalling the firmware

2. While holding down the **Modules** button, power on the TG2000 Platform mainframe.
3. The following message appears:

   Interactive reconfigulation in progress
   [1] Cancel Reconfiguration
   [2] Reconfigure all modules
   Select:

4. Press **2** on the numeric keypad.
5. The TG2000 Platform mainframe recognizes the HDST1 Stress Test module in the slot 7 (in this procedure, the HDST1 Stress Test module is installed into the seventh slot of the TG2000 Platform mainframe), and then display the following message:

Firmware configuration menu for HDST1 module in slot 7:
[1] Ignore module
[2] Program Flash Disk from floppy
[3] Use existing module firmware
[4] Erase module firmware, ignore module
Select:

6. Press **2** on the numeric keypad. For the HDVG1 module and the reference HDST1 module, select [3] (press **3** on the numeric keypad). The following message appears:

   Signal configuration menu for HDST1 module in slot 7:
   [1] Not a generator module, no signals
   [2] Use module–resident signals
   [3] Replace signals from floppy
   [4] Add signals from floppy
   [5] Delete all module–resident signals
   Select:

7. Press **1** on the numeric keypad. For the HDVG1 module, select [2] (press **2** on the numeric keypad). The following message appears:

   Place floppy containing module firmware
   for HDST1 module in slot 7 in floppy drive.
   Press “Select” to begin
   or “Escape” to abort.

8. Insert the **HDST1 Firmware Disk** into the floppy disk drive on the TG2000 Platform mainframe, and then press the **Select** button.

9. While the firmware is installing, the following message appears:

   Executing SLOT 7 HDST1 Confidence Test
   Begin HDST1 board ConfTest 12
   End of HDST1 Conftest
   Diagnostic Passed
   Executing HDST1 SLOT 7: SELFCAL
   Self Cal Finished

10. Verify that there are no error messages. After the installation is completed, the TG2000 Platform mainframe starts up automatically.

11. Verify that the TG2000 Platform mainframe power up successfully and the module icon of the HDST1 Stress Test module is displayed on the Modules window.

50% Duty Cycle Adjustment

Procedures

1. Use the 75 Ω BNC cable to connect the OUT 1 connector on the HDVG1 module to the INPUT connector on the HDST1 Stress Test module as shown in Figure 5–2.
2. Use the 75 Ω BNC cable to connect the OUT 2 connector on the HDVG1 module to the INPUT connector on the reference HDST1 module as shown in Figure 5–2.
3. Use the 50 Ω SMA cable, 50 Ω N-to-SMA adapter, 75 Ω transformer, and 75 Ω BNC-to-NC adapter to connect the STRESS OUT connector on the HDST1 Stress Test module to the CH 1 input on the sampling oscilloscope as shown in Figure 5–2.
4. Use the 75 Ω BNC cable and SMA male-to-BNC female adapter to connect the STRESS OUT connector on the reference HDST1 module to the TRIGGER DIRECT input on the sampling oscilloscope as shown in Figure 5–2.

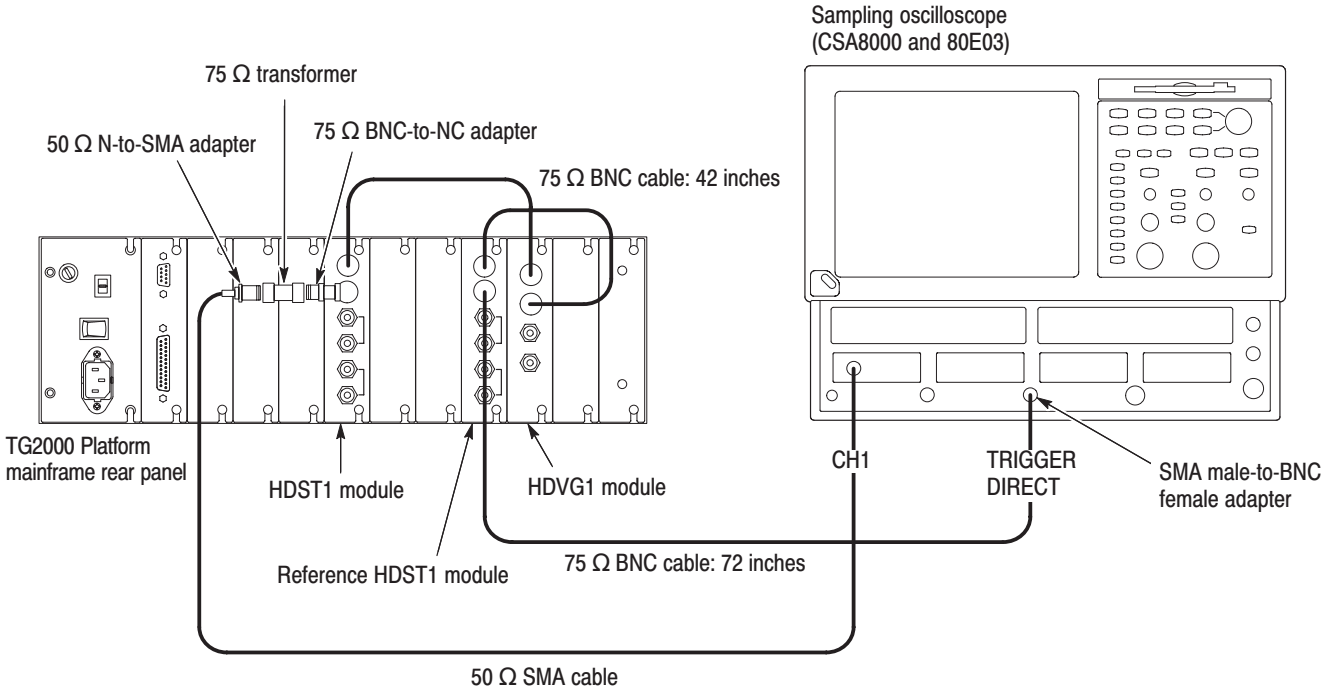


Figure 5–2: Equipment connections for adjusting the 50% duty cycle

5. Set the sampling oscilloscope settings as indicated below:

Vertical
- Scale . . . . . 60 mV/div
- Position/Offset . . . . . 0 V

Horizontal
- Scale . . . . . 100 ps/div
- Position . . . . . properly
- Record length 2000

Trigger
- Source . . . . . External Direct
- Slope . . . . . Positive
- Level . . . . . 0.0 V
- Mode . . . . . Normal

Display
- Style . . . . . Variable Persistence 1.000 s

Histogram
- Main C1 . . . . . Horizontal
- Enable Histogram . . Check
- Display Option . . . . . Histogram/Linear/Size 2
- Limit Controls . . . . . Top: 6.487 mV, Bot: –6.487 mV, Left: 21.95 ns, Right: 22.95 ns

6. Set the HDVG1 module to output the following signal:

1920 × 1080 60i (or 59.94i) 2:1 75% SMPTE Color Bars

7. Set the reference HDST1 module settings as indicated below:

Error Rate 0.1
Cal Signals . . . . . 4.6 MHz Clock

8. Reset all the SDI parameters of the HDST1 Stress Test module to their default values as follows:

a. Press the **Modules** button on the TG2000 Platform mainframe.

b. Touch **HDST1:7** on the display. (in this procedure, the HDST1 Stress Test module is installed into the seventh slot of the TG2000 Platform mainframe.)

c. Touch **SDI** on the display.

d. Touch **Reset** to reset all the parameters to there default value.

9. Adjust the horizontal position control on the sampling oscilloscope so that an eye opening is positioned at the center of the screen.

10. Press the Navigation arrow keys on the TG2000 Platform mainframe to select **Duty Cycle**.

11. Set the duty cycle value in 0.5% step so that the eye-crossing point is aligned on the 0 V level.

12. Reset the histogram display of the sampling oscilloscope.

13. Verify that histograms are displayed just above each eye-crossing point and those histograms are an isosceles triangle. See Figure 5–3.

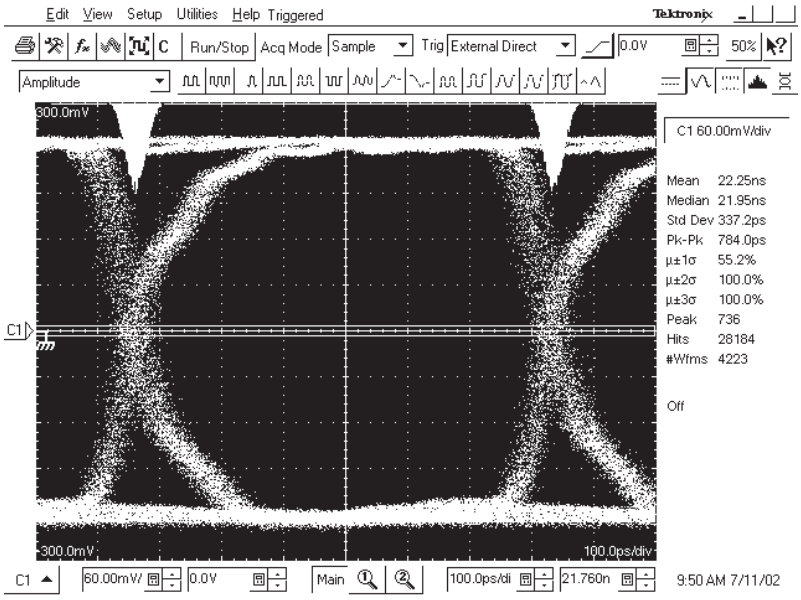


Figure 5–3: Eye pattern for adjusting the 50 % duty cycle

14. Touch **Set Duty** in the SDI Parameters window to write the duty cycle value to the module flash ROM.

***NOTE**. You can write the duty cycle value to the flash ROM only once after installing the firmware. If you fail in setting the value, you must reinstall the firmware and repeat the procedure again.*

Maintenance

Maintenance

This section contains instructions and procedures for maintaining the HDST1 Stress Test module. For information on servicing the mainframe, refer to the *TG 2000 Signal Generation Platform Service Manual*.

The following information can be found in this section:

If the instrument does not function properly, troubleshooting and corrective measures should be taken immediately to prevent additional problems.

***NOTE**. Contact your local Tektronix representative for information on where to return your instrument if it requires repair during the warranty period.*

Preparation

Please read and follow these preparation instructions before attempting to perform any maintenance or service to the instrument.

Servicing Prerequisites

Make sure of the following before beginning any instrument service:

- The maintenance or service of this instrument must be performed by qualified service personnel only.
- Read the *Service Safety Summary* located at the beginning of this manual before attempting to perform any maintenance or service to the instrument.
- Read the *Operating Information* section of this manual before attempting to perform any maintenance or service to the instrument.

Electrostatic Damage Prevention

This instrument contains electrical components that are susceptible to damage from electrostatic discharge. Static voltages of 1 kV to 30 kV are common in unprotected environments.

CAUTION. *Static discharge can damage any semiconductor component in this instrument.*

Observe the following precautions to avoid static damage:

- Minimize handling of static-sensitive components.
- Transport and store static-sensitive components or assemblies in their original containers, on a metal rail, or on conductive foam. Label any package that contains static-sensitive assemblies or components.
- Discharge the static voltage from your body by wearing a wrist strap while handling these components. Servicing static-sensitive assemblies or components should only be performed at a static-free workstation by qualified personnel.
- Nothing capable of generating or holding a static charge should be allowed on the workstation surface.
- Keep the component leads shorted together whenever possible.
- Pick up components by the body, never by the leads.
- Do not slide the components over any surface.
- Avoid handling components in areas that have a floor or work surface covering capable of generating a static charge.
- Use a soldering iron that is connected to earth ground.
- Use only special antistatic, suction-type or wick-type desoldering tools.

NOTE*. A 2% RMA flux content solder is recommended for making repairs in this instrument. Cleaning of rosin residue is not recommended. Most cleaning solvents tend to reactivate the rosin and spread it under components where it may cause corrosion under humid conditions. The rosin residue, if left alone, does not exhibit these corrosive properties.*

Inspection and Cleaning

Preventive maintenance consists of cleaning, visual inspection, performance checking, and, if needed, readjustment. The preventive maintenance schedule established for the instrument should be based on the environment in which it is operated and the amount of use. Under average conditions, scheduled preventive maintenance should be performed every 2000 hours of operation.

General Care

Protect the module from adverse weather conditions. The module is not waterproof.

CAUTION. *To avoid damage to this module, do not expose it to sprays, liquids, or solvents. Do not flex the circuit board if you remove the board from its mounting shield. The circuit board can be damaged by flexing. The shield provides necessary structural support to the circuit board.*

Cleaning and Visual Inspection

Clean the mainframe and modules often enough to prevent dust or dirt from accumulating. Refer to *Cleaning* and *Visual Inspection* in the *TG 2000 Signal Generation Platform Service Manual*.

Performance Verification

Check module performance after each 2000 hours of operation or every 12 months. This will help to ensure maximum performance and assist in locating defects that may not be apparent during regular operation. Performance verification procedures are included in this manual.

Repackaging Instructions

Use the following instructions to prepare your instrument for shipment to a Tektronix, Inc., Service Center:

1. Attach a tag to the instrument showing: the owner, complete address and phone number of someone at your firm who can be contacted, the instrument serial number, and a description of the required service.
2. Package the instrument in the original packaging materials. Figures 6–1 and 6–2 illustrate how to repackage the module in the original packaging materials. If the original packaging materials are not available, follow these directions:
   a. Obtain a carton of corrugated cardboard having inside dimensions six or more inches greater than the dimensions of the instrument. Use a shipping carton that has a test strength of at least 250 pounds (113.5 kg).
   b. Surround the module with a protective (anti-static) bag.

c. Pack dunnage or urethane foam between the instrument and the carton. If using Styrofoam kernels, overfill the box and compress the kernels by closing the lid. There should be three inches of tightly packed cushioning on all sides of the instrument.

3. Seal the carton with shipping tape, industrial stapler, or both.

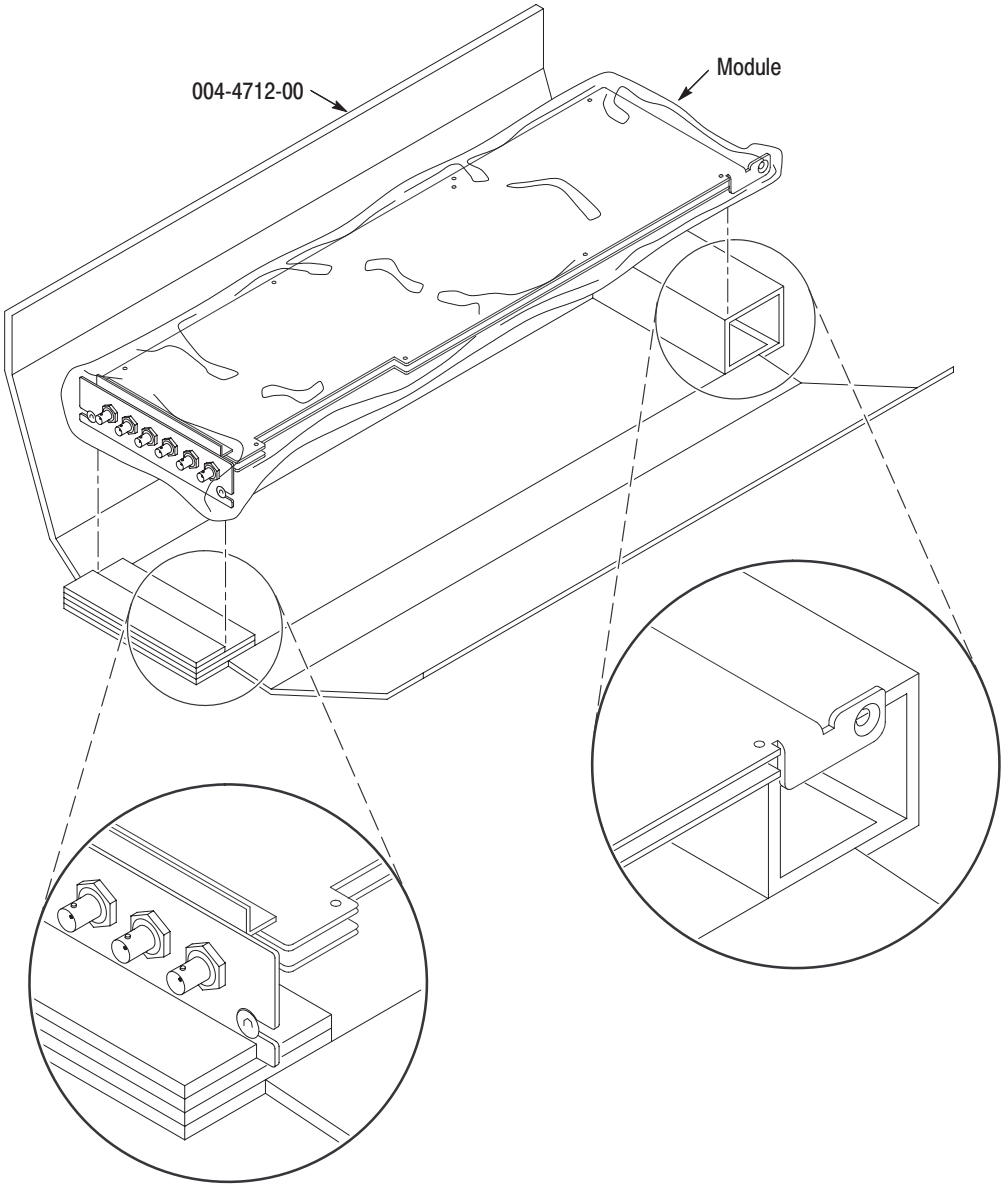


Figure 6–1: Placing the module in the protective wrapping

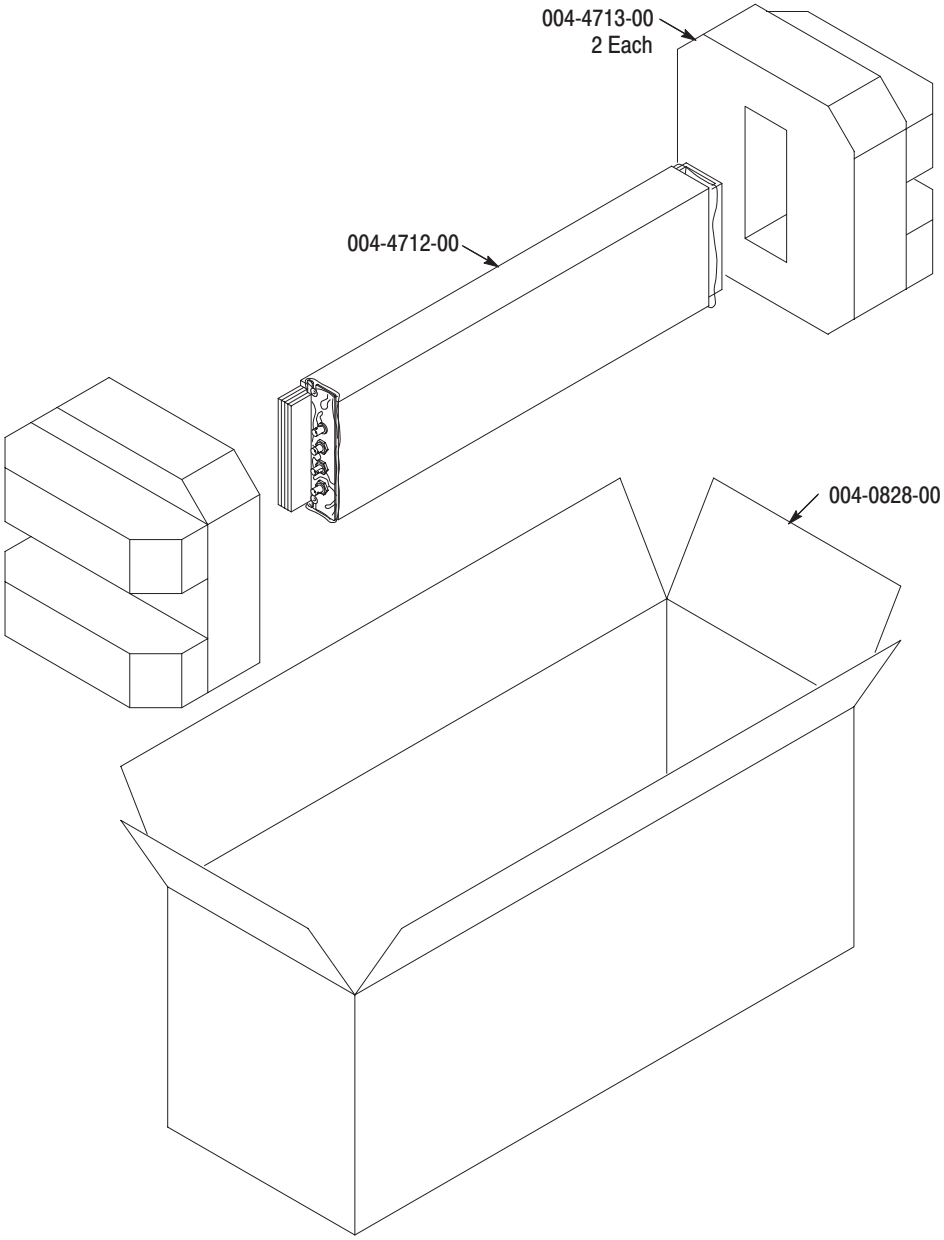


Figure 6–2: Placing the module in the shipping carton

Removal and Replacement

This section contains the instructions on how you can remove and replace the customer replaceable parts of the HDST1 Stress Test module.

Tools Required

The following tools are required to perform the removal and replacement procedures:

Table 6–1: Required tools

Tool	Use
Torx screwdriver handle	Removing the module from the mainframe
T-10 Torx tip	Removing the module from the mainframe
9/16 inch box wrench	Removing the rear panel

Removing the Rear Panel

To remove the rear panel from a module, perform the following steps:

1. Use the *Module Removal* procedure on page 2–7 to remove the HDST1 Stress Test module from the mainframe.
2. Remove the nuts and washers from each of the rear panel BNC connectors.
3. Lift the rear panel away from the module.
4. To replace the rear panel, position it on the module, install the lock washers and then the nuts.
5. Tighten the nuts.

Replacing the Rear Panel Connector (INPUT Connector Only)

It is usually not necessary to replace the rear panel connector (shown in the *Mechanical Parts List*, Figure 10–1–3). However, if the connector becomes damaged, you can replace it by performing the following steps:

1. Disconnect the connector cables from J300 on the A10 circuit board.
2. Unscrew the nut securing the BNC connector to the rear panel.
3. Remove the damaged connector from the real panel.
4. To replace the connector, reverse the procedure.

Troubleshooting Procedures

This section contains instructions and procedures for troubleshooting the HDST1 Stress Test module. These procedures will help you decide whether it is necessary to replace your module.

If the TG 2000 Platform mainframe does not boot up or if the display is not working, refer to *Troubleshooting* in the *TG 2000 Signal Generation Platform Service Manual*.

Equipment Required

The equipment listed in Table 6–2 is required for troubleshooting.

Table 6–2: Equipment required for troubleshooting

Equipment description	Minimum requirements/example
Torx screwdriver handle	Accepts Torx-driver bits
T-10 Torx tip	Torx-driver bit for T-10 screw head
Blank disks	MS–DOS preformatted, 3.5 inch. For instrument backup, you will need approximately one disk for each installed generator module. To write the console ring file, you will need two disks.
Troubleshooting disk	Supplied with the *TG 2000 Signal Generation Platform Service Manual*
Voltmeter with probes	Accurate to two decimal places, able to measure AC voltage of 900 $V_{RMS.}$ For example, Tektronix DM2510 Digital Multimeter

General Troubleshooting

This section contains general troubleshooting instructions and procedures to use when you begin to troubleshoot suspected faults with the HDST1 Stress Test module.

CAUTION. *To prevent data loss, back up the instrument before you begin any troubleshooting procedures.*

Saving the Console Ring File to Disk

The TG 2000 Platform mainframe displays module diagnostic information during instrument power up. Any error messages are written to an internal file called the console ring file. Tektronix technicians can use the information in the console ring file to help troubleshoot a malfunctioning module.

NOTE*. Write the console ring file to disk before performing troubleshooting to prevent the troubleshooting routines from overwriting the console ring file.*

Write the file as follows:

1. Load the Troubleshooting disk (supplied with the *TG 2000 Signal Generation Platform Service Manual*) into the floppy drive. Press the front-panel **Sequences** button.
2. Touch **File Utilities**, and then touch **Add Sequences from Disk**.
3. Select the **consbak.seq** sequence file and then touch **Start Load**.
4. Touch **OK, Quit**, and then **Quit** again.
5. Touch **Sequences** and then select the **consbak.seq** file to run (use the **Select** key).
6. Touch **Run**. Insert a blank disk when prompted, and touch **Quit**. Label this disk #1.
7. Turn the instrument off and then back on from the front panel. Wait until the instrument has completed its power up process.
8. Write the console ring file to disk again, using a different disk. Label this disk #2.
9. Read the console ring file power up messages. If there are HDST1 Stress Test module errors, refer to the *Fault Symptom Table* on page 6–11.

10. If the TG 2000 Platform does not display any power-up confidence test messages, or the CPU module fails the confidence test, refer to *Troubleshooting* in the *TG 2000 Signal Generation Platform Service Manual*.

Returning Modules to Tektronix

When you return a mainframe or module to Tektronix for repair or replacement, be sure to include the following:

- The disks containing the console ring files
- Whether or not the module passed diagnostics, the highest number reached for that module, and any error messages
- Description of the problem, including which troubleshooting flow chart you used

Fault Symptom Table

Use this fault symptom table after you have performed the preceding *General Troubleshooting*. Before proceeding, it is important to save the console ring file as indicated in *General Troubleshooting* on page 6–10.

Locate your fault symptom in Table 6–3 and go to the flowchart indicated.

Table 6–3: Fault symptom table

Symptom	Flowchart
Major difficulties with module	page 6–12
with module installed in current slot	page 6–13
with module moved to different slot	page 6–14
Mainframe fails to power up	page 6–15
Calibration data lost after power down	page 6–16

Troubleshooting Flowcharts

The troubleshooting flowcharts provide a series of steps to help you determine whether the HDST1 Stress Test module is faulty. Each chart relates to an entry in Table 6–3.

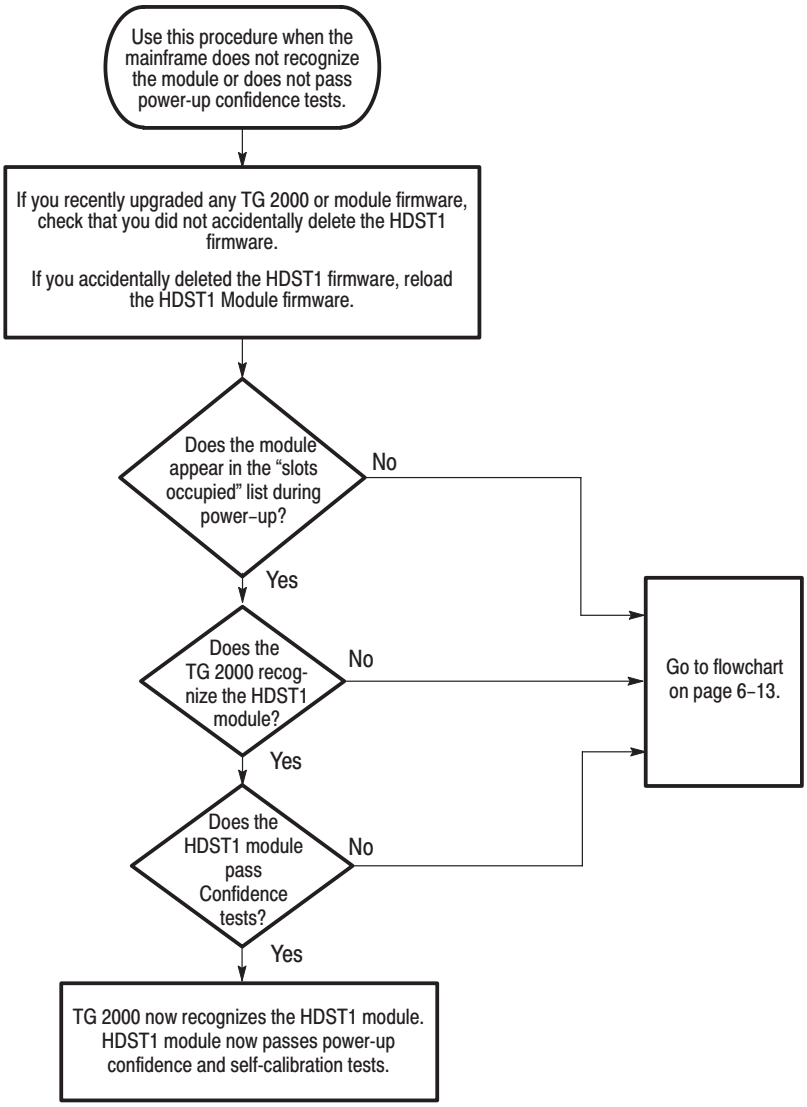


Figure 6–3: Flowchart for major difficulties with module

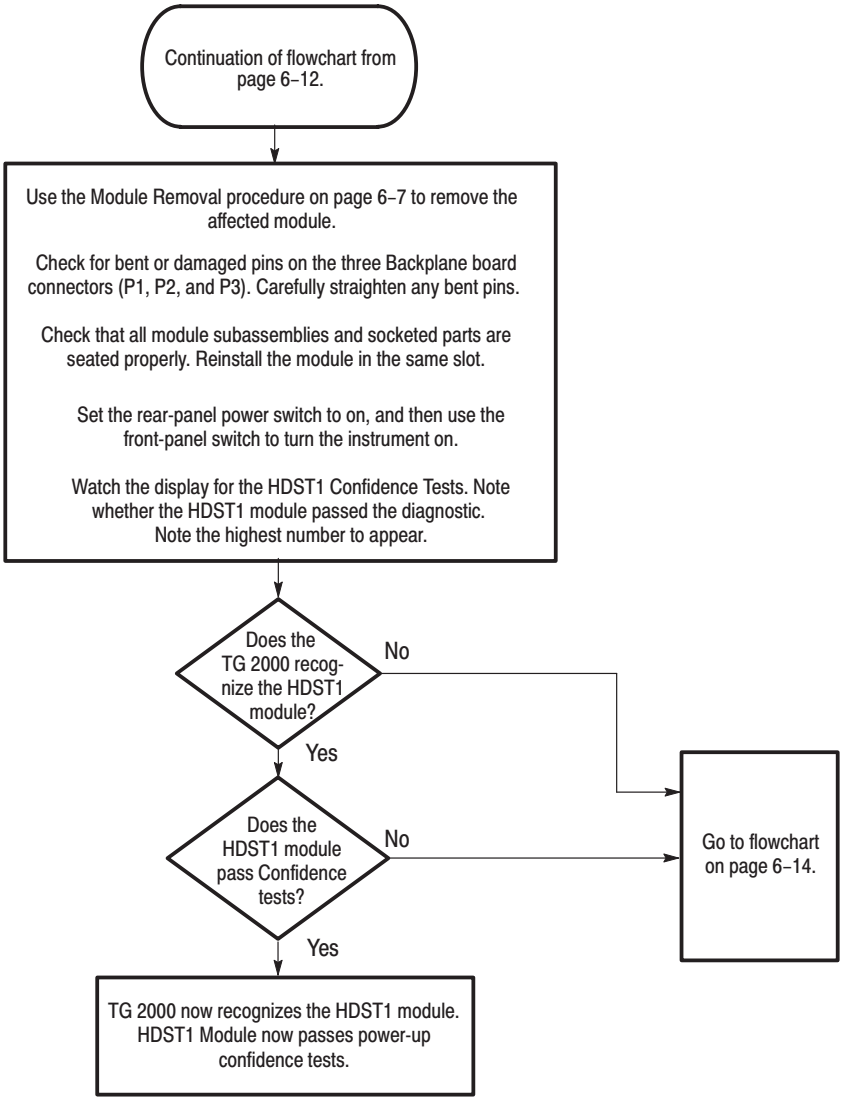


Figure 6–4: Flowchart for checking the current module installation slot

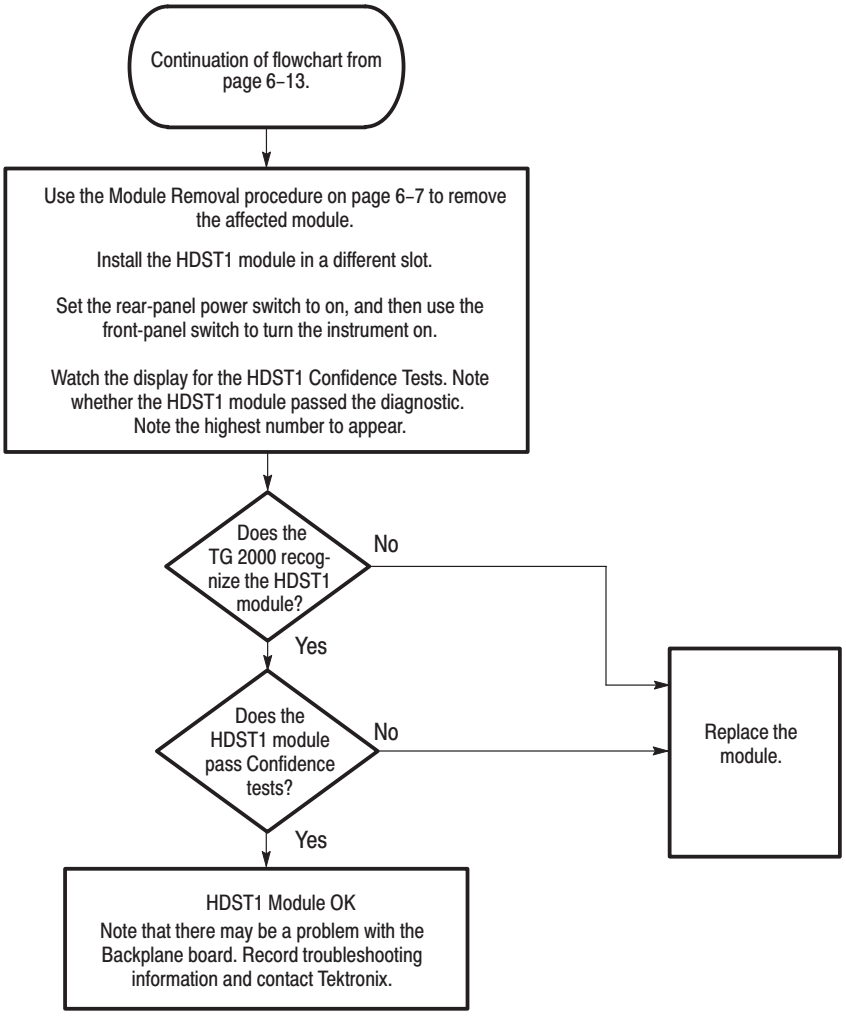


Figure 6–5: Flowchart for checking the module in a different slot

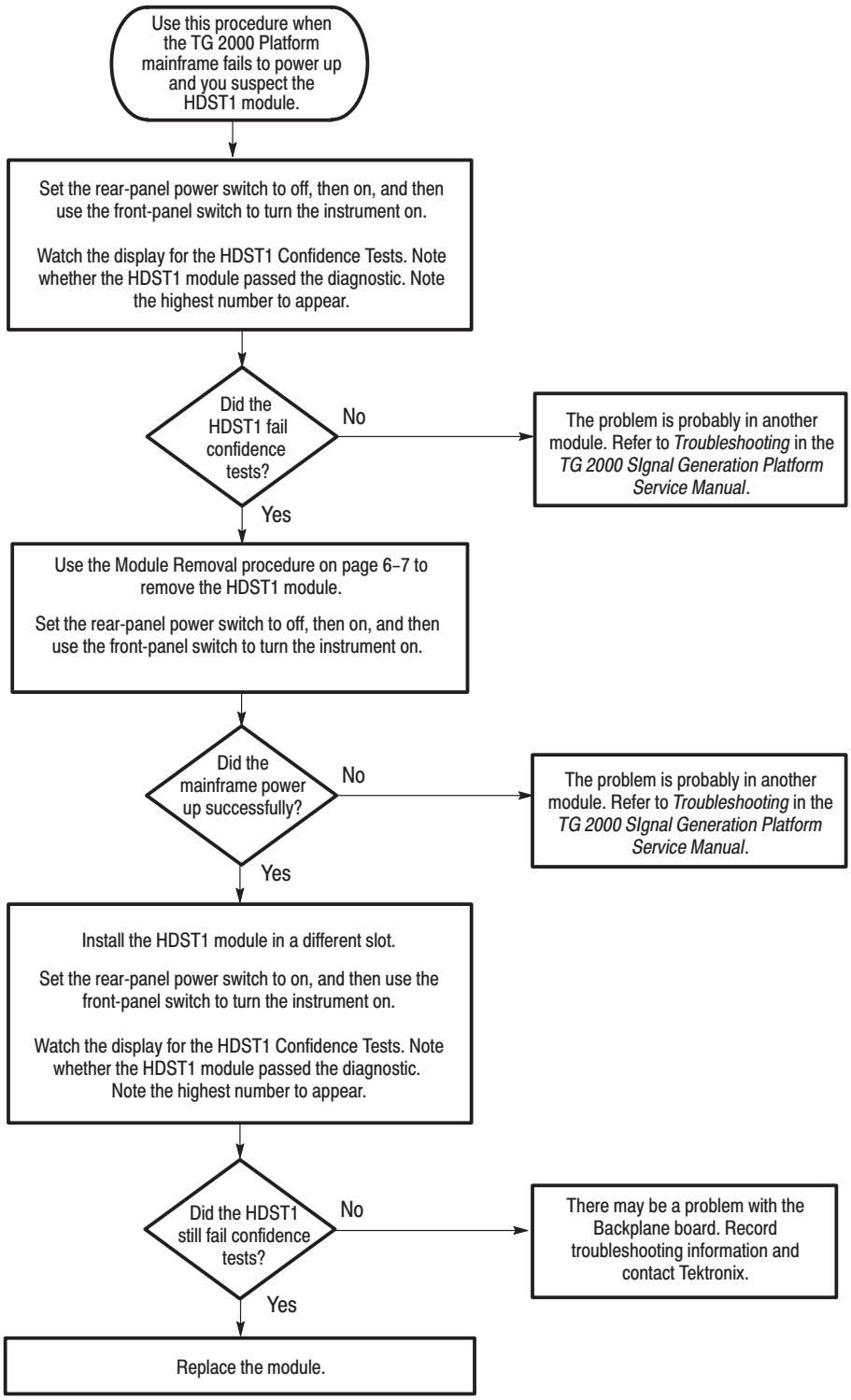


Figure 6–6: Flowchart for failure to power up

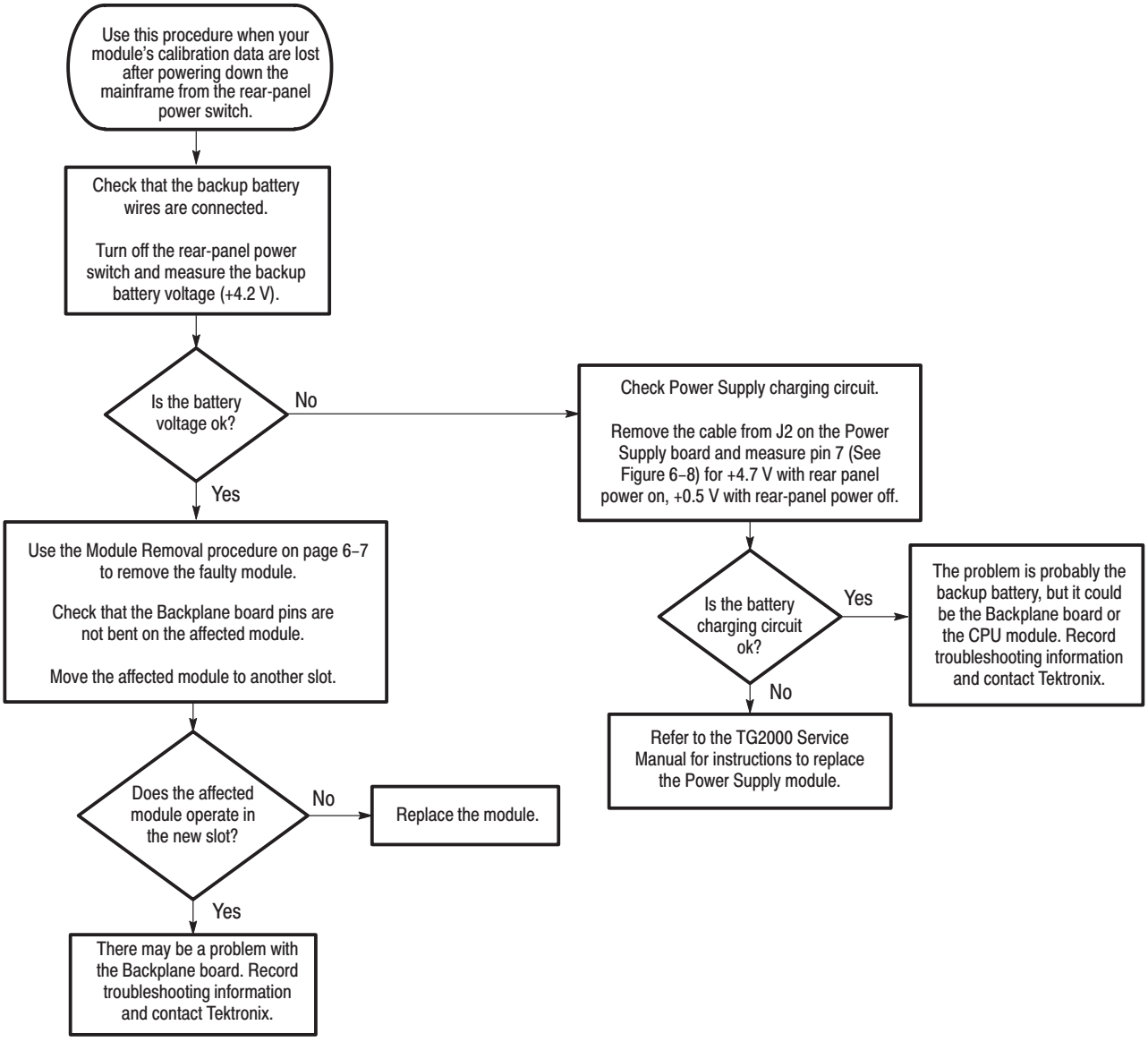


Figure 6–7: Flowchart for calibration data lost after power down

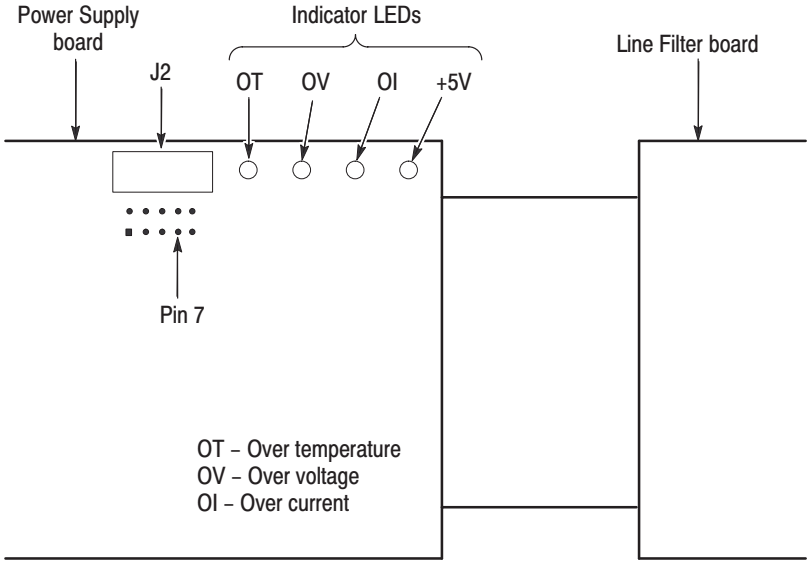


Figure 6–8: Measuring the battery charging circuit

Options

Options

This section describes options that are available for the HDST1 Stress Test module.

The following option is available.

- Option D1 ships with test result report.

Option D1 Description

A calibration data test result report will be provided with the HDST1 Stress Test module when this option is specified.

Replaceable Electrical Parts

Replaceable Electrical Parts

The module-level replaceable electrical parts are included in the *Replaceable Mechanical Parts* list. Since component-level repair is not supported, individual electrical components are not listed.

Diagrams

Diagrams

Figure 9–1 shows the HDST1 Stress Test module and how it interconnects with the TG 2000 Signal Generation Platform.

Diagrams showing mainframe component interconnections, such as power supply and clock, can be found in the *TG 2000 Signal Generation Platform Service Manual*.

A block diagram of the HDST1 Stress Test module is located in the *Theory of Operation* section, beginning on page 3–1.

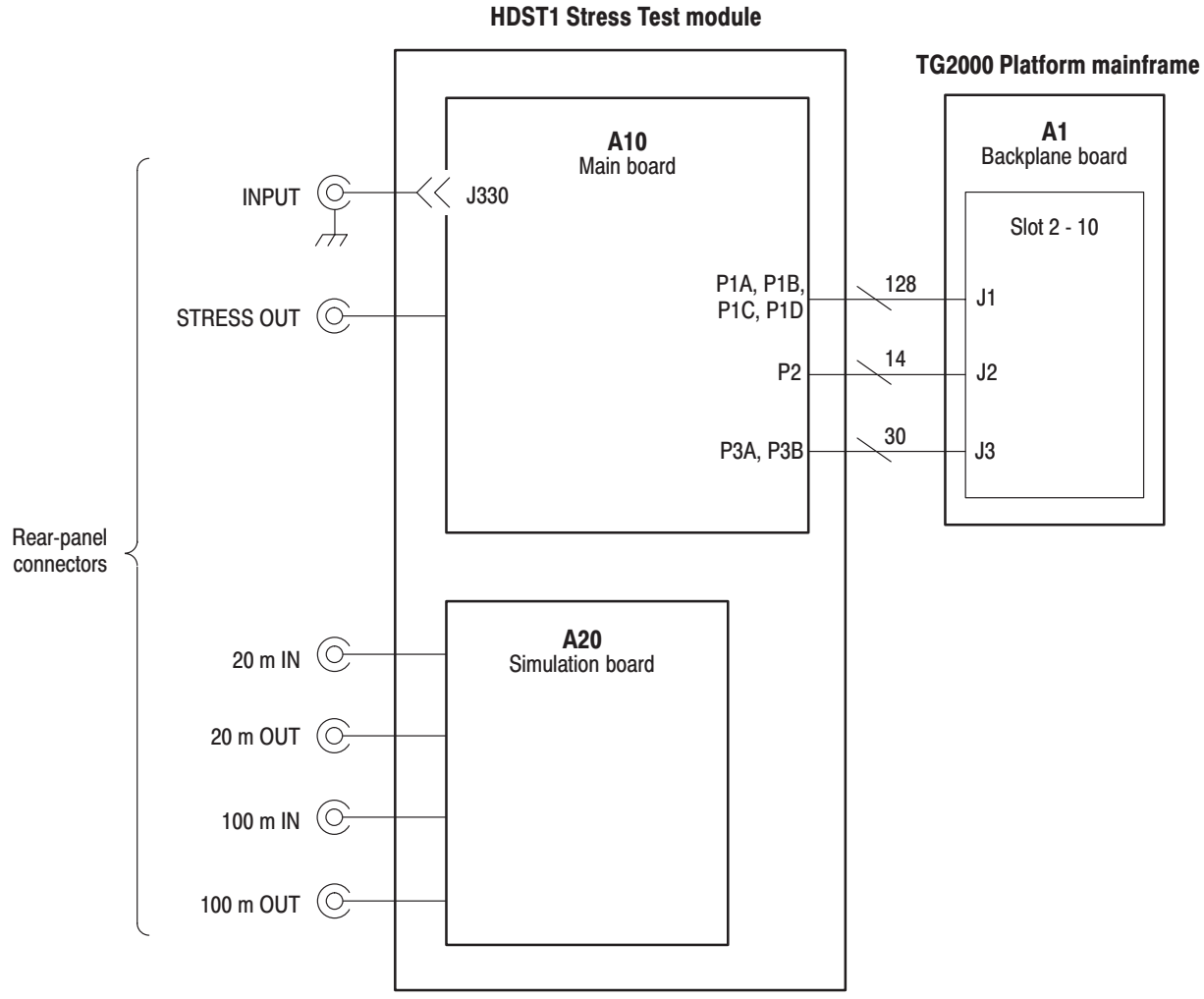


Figure 9–1: HDST1 Stress Test module connections

Mechanical Parts List

Mechanical Parts List

This section contains a list of the replaceable modules for the HDST1 Stress Test module. Use this list to identify and order replacement parts.

Parts Ordering Information

Replacement parts are available through your local Tektronix field office or representative.

Changes to Tektronix products are sometimes made to accommodate improved components as they become available and to give you the benefit of the latest improvements. Therefore, when ordering parts, it is important to include the following information in your order.

- Part number
- Instrument type or model number
- Instrument serial number
- Instrument modification number, if applicable

If you order a part that has been replaced with a different or improved part, your local Tektronix field office or representative will contact you concerning any change in part number.

Module Servicing

Modules can be serviced by selecting one of the following three options. Contact your local Tektronix service center or representative for repair assistance.

Module Exchange. In some cases you may exchange your module for a remanufactured module. These modules cost significantly less than new modules and meet the same factory specifications. For more information about the module exchange program, call 1-800-TEK-WIDE.

Module Repair and Return. You may ship your module to us for repair, after which we will return it to you.

New Modules. You may purchase replacement modules in the same way as other replacement parts.

Using the Replaceable Parts List

The following table describes each column in the parts list.

Parts List Column Descriptions

Column	Column name	Description
1	Figure & index number	Items in this section are referenced by figure and index numbers to the exploded view illustrations that follow.
2	Tektronix part number	Use this part number when ordering replacement parts from Tektronix.
3 and 4	Serial number	Column three indicates the serial number at which the part was first effective. Column four indicates the serial number at which the part was discontinued. No entries indicates the part is good for all serial numbers.
5	Qty	This indicates the quantity of parts used.
6	Name & description	An item name is separated from the description by a colon (:). Because of space limitations, an item name may sometimes appear as incomplete. Use the U.S. Federal Catalog handbook H6-1 for further item name identification.
7	Mfr. code	This indicates the code of the actual manufacturer of the part.
8	Mfr. part number	This indicates the actual manufacturer's or vendor's part number.

Abbreviations

Abbreviations conform to American National Standard ANSI Y1.1–1972.

Mfr. Code to Manufacturer Cross Index

The table titled *Manufacturers Cross Index* shows codes, names, and addresses of manufacturers or vendors of components listed in the parts list.

Manufacturers cross index

Mfr. code	Manufacturer	Address	City, state, zip code
0KB01	STAUFFER SUPPLY CO	810 SE SHERMAN	PORTLAND, OR 97214–4657
32997	BOURNS INC	TRIMPOT DIVISION 1200 COLUMBIA AVE	RIVERSIDE, CA 92507–2114
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON, OR 97077–0001
TK0191	TEKTRONIX JAPAN	PO BOX 5209 TOKYO INTERNATIONAL	TOKYO JAPAN 100–31

Replaceable parts list

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discont'd	Qty	Name & description	Mfr. code	Mfr. part number
10–1–1	211–0718–XX			2	SCREW,MACHINE:6–32 X 0.312,FLH,100 DEG,T–10 TORX	0KB01	ORDER BY DESC
10–1–2	174–C035–XX			1	CABLE ASSY,RF,75 OHM,COAX(RG179),19CM L,BNC TO PL71–LP–1.5C	TK0191	
10–1–3	333–A455–XX			1	PANEL,REAR:AL,HDST1	TK0191	
------	116–A019–XX			1	EXCHANGE MODULE:HDST1	80009	
					STANDARD ACCESSORIES		
	070–A880–XX			1	MANUAL,TECH:USER,HDST1	TK0191	
	020–A051–XX			1	TG2000 FIRMWARE UPGRADE KIT	TK0191	
	003–1604–XX			1	T–10 TORX TIP	TK0191	
	211–0718–XX			2	SCREW	0KB01	ORDER BY DESC
					OPTIONAL ACCESSORIES		
	070–A881–XX			1	MANUAL,TECH:SERVICE,HDST1	TK0191	

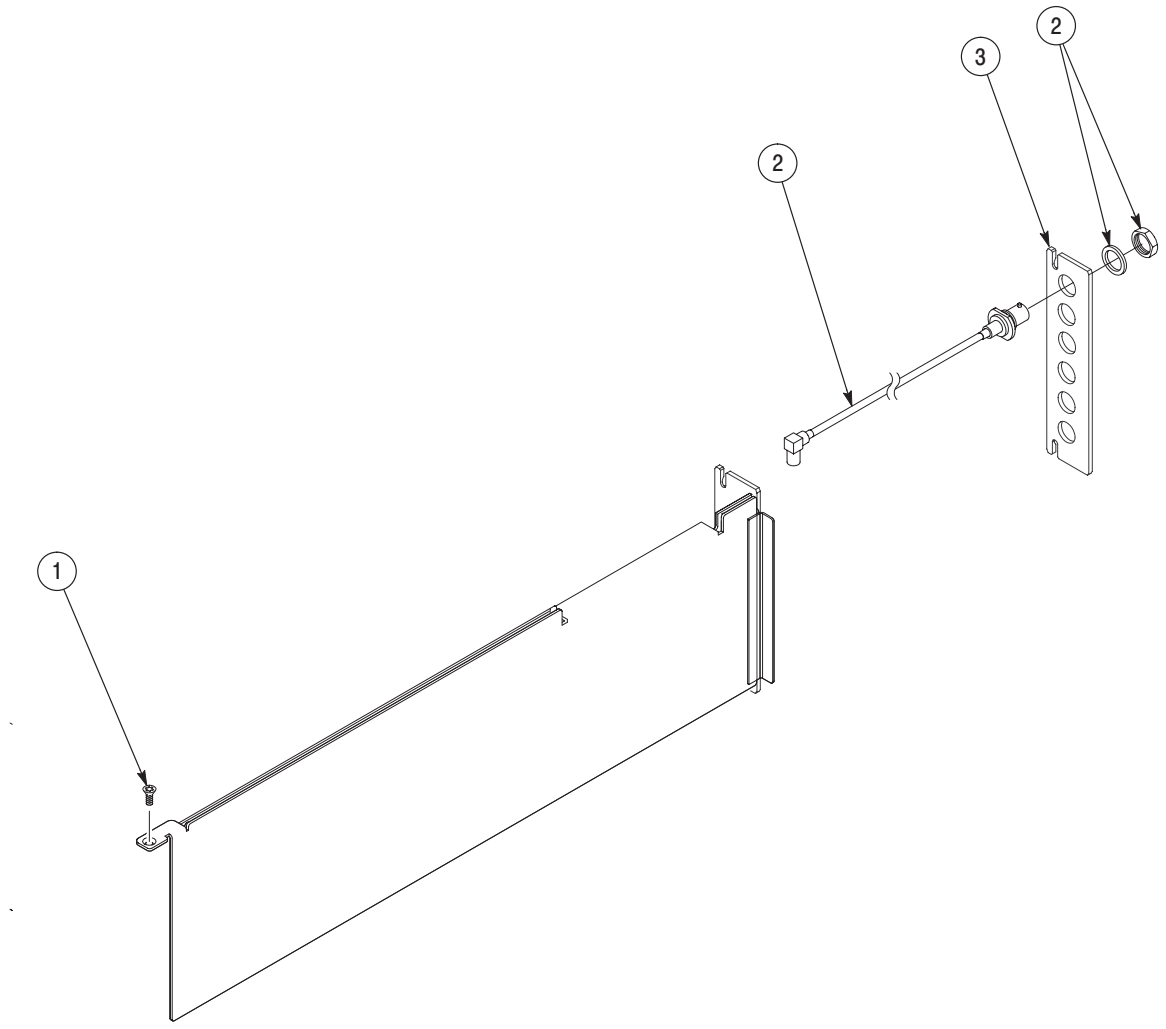


Figure 10–1: Exploded view