



SPG8000
Master Sync / Clock Reference Generator
Service Manual

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Important safety information

This manual contains information and warnings that must be followed by the user for safe operation and to keep the product in a safe condition.

To safely perform service on this product, additional information is provided at the end of this section. (See page vi, *Service safety summary*.)

General safety summary

Use the product only as specified. Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. Carefully read all instructions. Retain these instructions for future reference.

Comply with local and national safety codes.

For correct and safe operation of the product, it is essential that you follow generally accepted safety procedures in addition to the safety precautions specified in this manual.

The product is designed to be used by trained personnel only.

Only qualified personnel who are aware of the hazards involved should remove the cover for repair, maintenance, or adjustment.

Before use, always check the product with a known source to be sure it is operating correctly.

This product is not intended for detection of hazardous voltages.

While using this product, you may need to access other parts of a larger system. Read the safety sections of the other component manuals for warnings and cautions related to operating the system.

When incorporating this equipment into a system, the safety of that system is the responsibility of the assembler of the system.

To avoid fire or personal injury

Use proper power cord. Use only the power cord specified for this product and certified for the country of use.

Ground the product. This product is grounded through the grounding conductor of the 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, make sure that the product is properly grounded.

Do not disable the power cord grounding connection.

Power disconnect. The power cord disconnects the product from the power source. See instructions for the location. Do not position the equipment so that it is difficult to operate the power cord; it must remain accessible to the user at all times to allow for quick disconnection if needed.

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, or with the case open. Hazardous voltage exposure is possible.

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

Do not operate with suspected failures. If you suspect that there is damage to this product, have it inspected by qualified service personnel.

Disable the product if it is damaged. Do not use the product if it is damaged or operates incorrectly. If in doubt about safety of the product, turn it off and disconnect the power cord. Clearly mark the product to prevent its further operation.

Before use, inspect voltage probes, test leads, and accessories for mechanical damage and replace when damaged. Do not use probes or test leads if they are damaged, if there is exposed metal, or if a wear indicator shows.

Examine the exterior of the product before you use it. Look for cracks or missing pieces.

Use only specified replacement parts.

Do not operate in wet/damp conditions. Be aware that condensation may occur if a unit is moved from a cold to a warm environment.

Do not operate in an explosive atmosphere.

Keep product surfaces clean and dry. Remove the input signals before you clean the product.

Provide proper ventilation. Refer to the installation instructions in the manual for details on installing the product so it has proper ventilation.

Slots and openings are provided for ventilation and should never be covered or otherwise obstructed. Do not push objects into any of the openings.

Provide a safe working environment. Always place the product in a location convenient for viewing the display and indicators.

Be sure your work area meets applicable ergonomic standards. Consult with an ergonomics professional to avoid stress injuries.

Use only the Tektronix rackmount hardware specified for this product.

Service safety summary

The *Service safety summary* section contains additional information required to safely perform service on the product. Only qualified personnel should perform service procedures. Read this *Service safety summary* and the *General safety summary* before performing any service procedures.

To avoid electric shock. Do not touch exposed connections.

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, switch off the product power and disconnect the power cord from the mains power before removing any covers or panels, or opening the case for servicing.

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.

Verify safety after repair. Always recheck ground continuity and mains dielectric strength after performing a repair.

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.*

Symbols and 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.



When this symbol is marked on the product, be sure to consult the manual to find out the nature of the potential hazards and any actions that must be taken to avoid them. (This symbol may also be used to refer the user to ratings in the manual.)

The following symbol(s) may appear on the product:



CAUTION
Refer to Manual



Protective Ground
(Earth) Terminal

Preface

This manual contains information needed to service an SPG8000 Master Sync / Clock Reference Generator to the module level.

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.*

To prevent personal injury or damage to the SPG8000, consider the following before beginning service:

- The procedures in this manual should be performed only by a qualified service person.
- Read the *General safety summary*. (See page iv.)
- Read the *Service safety summary*. (See page vi.)

When using this manual for servicing, be sure to follow all warnings, cautions, and notes.

Manual structure

This manual is divided into the following sections:

- *Theory of operation* contains circuit descriptions that support service to the module level.
- *Adjustment procedures* contains procedures for adjusting an SPG8000 generator to meet warranted characteristics.
- *Maintenance* contains information and procedures for performing preventive and corrective maintenance for the SPG8000 generator. These instructions include cleaning and fault isolation to the module level.
- *Remove and replace procedures* contains procedures to safely remove replaceable modules from the instrument.
- *Troubleshooting procedures* contains information and procedures to help you isolate and fix various problems.
- *Replaceable parts* includes a table of all replaceable modules, their descriptions, and their Tektronix part numbers.

Manual conventions

This manual uses certain conventions with which you should become familiar.

Some sections of the manual contain procedures for you to perform. To keep those instructions clear and consistent, this manual uses the following conventions:

- Names of front panel controls and menus appear in the same case (initial capitals, all uppercase, etc.) in the manual as is used on the SPG8000 front panel and menus.
- Instruction steps are numbered unless there is only one step.
- **Bold** text refers to specific interface elements that you are instructed to select, click, or clear.
 - Example: Press the **ENTER** button to access the PRESET submenu.
- *Italic* text refers to document names or sections. Italics are also used in NOTES, CAUTIONS, and WARNINGS.
 - Example: The *Theory of operation* section includes a block diagram.

Modules Throughout this manual, the term module appears. A module is composed of electrical and mechanical assemblies, circuit cards, and interconnecting cables.

Safety Symbols and terms related to safety appear in the *General safety summary*.

Product documentation

The following table lists the user documents for the SPG8000 generator:

Table i: Product documentation

Document	Tektronix Part Number	Description	Availability		
			Print	Web	CD
Quick Start User Manual	071-3080-xx (English)	Describes how to install the instrument and provides basic operating information	✓	✓	✓
	077-0745-xx (Japanese)			✓	✓
	077-0746-xx (Russian)			✓	✓
Technical Reference	077-0747-xx	Provides detailed operating information		✓	✓
Specifications and Performance Verification	077-0748-xx	Lists the product specifications and provides procedures for verifying the performance of the instrument		✓	✓
Service Manual	077-0749-xx	Describes how to service the instrument to the module level (such as circuit boards and fuses)		✓	
Declassification and Security Instructions	077-0750-xx	Describes how to clear or sanitize the data storage (memory) devices in the product for customers with data security concerns.		✓	
Release Notes	077-0751-xx	Describes the new features, improvements, and limitations of the instrument firmware		✓	
Video Sync Pulse Generator and Electronic Changeover Unit System Integration Technical Reference	077-0563-xx (ECO422D) 077-0877-xx (ECO8000, ECO8020)	Provides information for system integrators who are designing systems for high-definition (HD) and standard-definition (SD) digital video content where Tektronix electronic changeover units and video sync pulse generators are to be deployed.		✓	✓

Theory of operation

Base instrument theory of operation

This section describes the basic operation of the major circuit blocks or modules in the SPG8000 generator. The block diagram shows the modules and functional blocks in the instrument. (See Figure 1.)

Information about the circuit blocks, including a detailed block diagram of the Genlock/Black board, follows the SPG8000 block diagram.

Main board The Main board consists of the following seven blocks.

Processor core. The processor core consists of the CPU and all of its support circuits such as flash memory, DDR memory, clocks, buffers, reset circuit, configuration memory, and decoder PLD.

The CPU controls the front panel, LCD display, USB port, network interface, GPI interface, and installed generator boards. The CPU also controls execution of remote commands and downloading and uploading of signal files through the Ethernet interface.

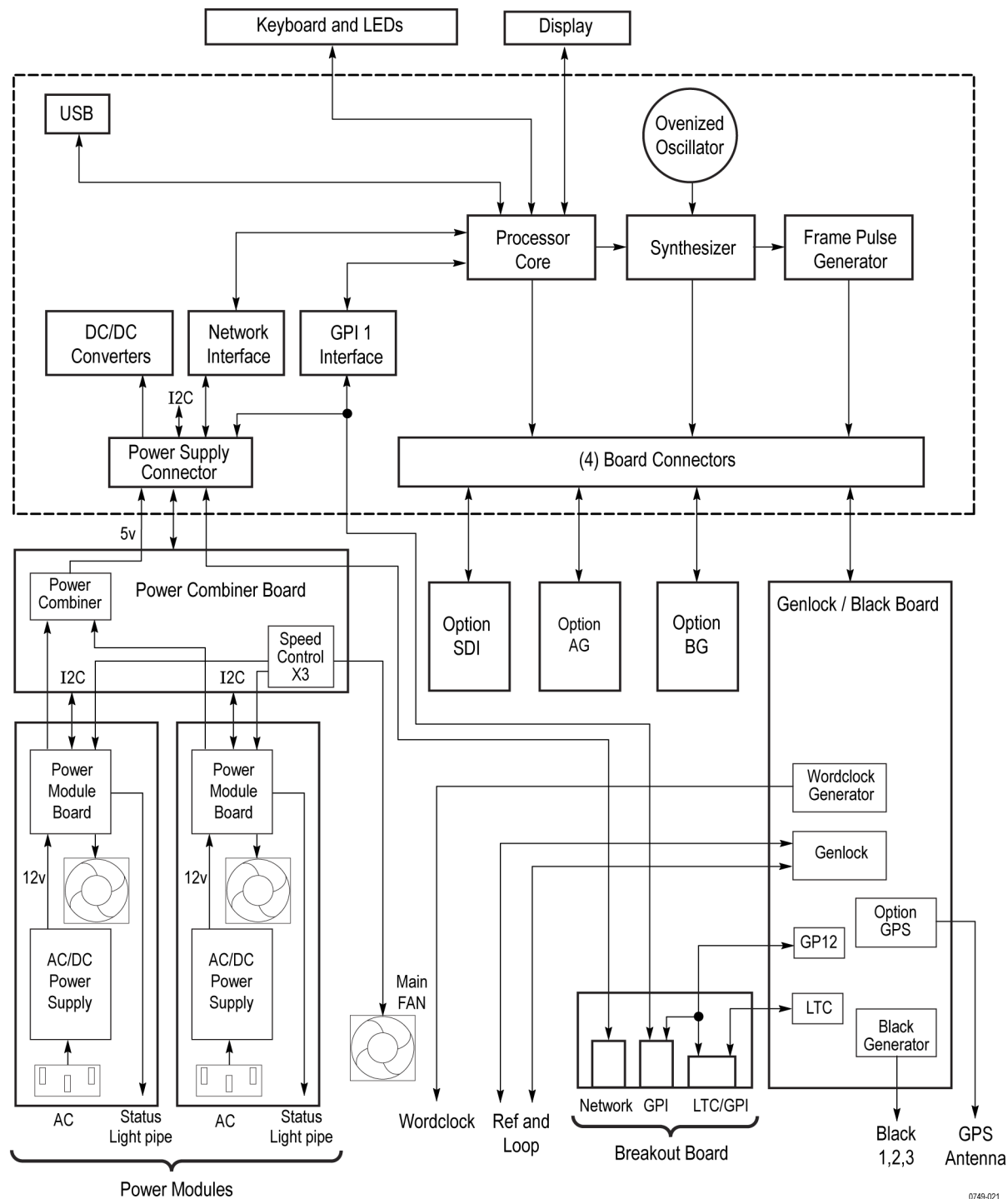
The flash memory holds the firmware data and signal data used to generate outputs from some modules. During Genlock, GPS or GLONASS referenced operation, the CPU reads data from the input module, and controls the frequency of the secondary clocks.

Ovenized oscillator. The ovenized oscillator provides the stable time base for generating signals. This is a fixed 20 MHz and is not adjustable.

Video / audio clocks. The synthesizer creates the video and audio clocks from the oven output. The video clocks are a 54 MHz master clock signal and HD rate clocks of 74.25 MHz and a 74.25/1.001 MHz. The audio clock is 12.288 MHz. The CPU can control the ratio between the oven and these clocks. By controlling this ratio, the system can lock to external signals for Genlock, GPS or GLONASS reference. The ratio is also adjusted to achieve calibration, with the resulting value stored in flash memory.

The 54 MHz and the 12.288 MHz are delivered to each generator card. For the HD rate clocks, the CPU controls four multiplexers that independently allow each generator card to get either the 74.25 MHz or 74.25/1.001 MHz clock. The diagnostics monitor that each clock is correctly locked to the oven or master 54 MHz clock.

Frame pulse generator. The frame pulse generator uses the 54 MHz clock to generate the three frame pulses at 2.997 Hz, 6.25 Hz, and 3.00 Hz that are used to synchronize the signal formats generated by the installed options.



0749-021

Figure 1: SPG8000 block diagram

DC/DC converters. This block converts the +5 V supplied by the Power Combiner board to -5 V, 3.3 V, 8 V, and 5 V analog for use by the circuit boards. Various voltages needed only on the Main board, such as to drive the DDR and processor core, are also provided.

The high current 5 V and 3.3 V voltages supplied to the slots are fused at the connector to each generator board. All of the major voltages, including both sides of each fuse, are monitored by the voltage diagnostic.

Control network interface. This block controls the Ethernet interface for the Control Ethernet Port.

The Ethernet port is located on the GPIO board at the instrument rear panel.

GPI interface. The GPI interface allows the CPU block to access the user inputs and outputs through the GPI ports located on the instrument rear panel.

There are two GPI circuit blocks, GPI 1 and GPI 2. GPI 1 is located on the Main board. GPI 2 is located on the Genlock/Black board. Both sets of GPI signals route through the cable to the Breakout board. The Breakout board houses the rear panel GPI, GPI/LTC, and Ethernet connections. The signals from GPI 1 are connected to pins 6,7,8 and 9 of the 9-pin rear panel GPI connector. The signals from GPI 2 are available on pins 2,3,4 and 5 of the 9-pin rear panel GPI connector, and on pins 1,2,3 and 11 of the 15-pin rear panel GPI/LTC connector. All of the GPI connections are available on the GPI port, but only the ones from block GPI 2 are on the GPI/LTC port.

Power supply

The SPG8000 has a redundant power subsystem, which contains three major components: the two power supply modules and the Power Combiner board. Operation with one power supply module is also supported, but there is no redundancy.

The power supply modules contain the line filter, the 100-240 VAC to 12 V supply, a fan, and the power module board, which adapts the cables to a board-to-board header. The power module board also has LEDs to drive the light pipe that shows power status on the rear panel of the power supply module.

The power module board has an EEPROM to log hours of operation. Since the power module board tracks the use time on the other supply components, replacing components within the supply module is not allowed.

The Power Combiner board takes in the 12 V from the one or two supplies, and converts to 5 V for the rest of the instrument. If there are two good supplies, the embedded microcontroller in the combiner chooses the preferred one. If either supply has an issue, the microcontroller chooses the best one. 12 V storage capacitors allow time for the system to switch supplies without any disruption of the 5 V output. During the boot up of the combiner microcontroller, the combiner functions in diode mode and uses the supply with the higher voltage, or a mix of the two.

The Power Combiner board also has the fan controllers, so the speed of all three fans can be set and sensed by the instrument processor over the I2C interface. The network interface signals pass through the combiner but only connect to the two connectors.

An I2C interface is used to allow the processor to access the micro-controller on the power combiner, the fan speed control, and the EEPROMS in the power supply modules.

Optional modules theory of operation

The instrument has a standard Genlock/Black generator board, plus orderable option boards. The options are: GPS Receiver board, AG board, BG board, and SDI board. This section describes the functions associated with those boards.

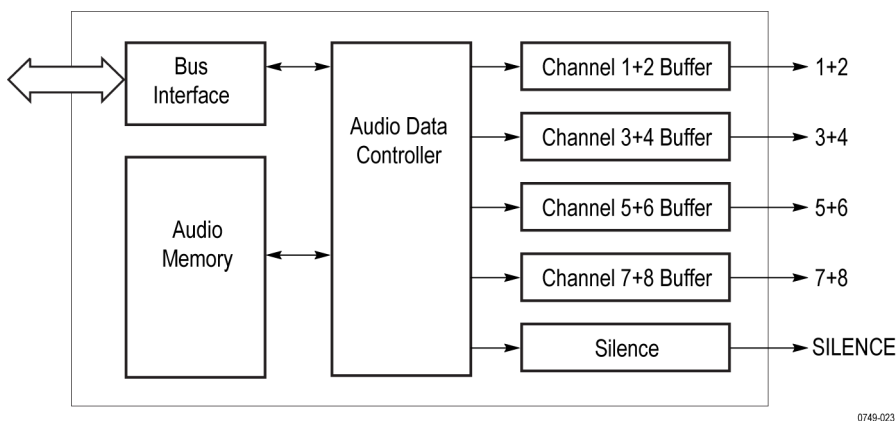
Option AG This section describes the basic operation of the major circuit blocks in the Option AG Audio Generator.

Bus interface. This block provides the communication between the Option AG circuitry and the instrument Main board.

Audio memory. This block contains 20/24 bits audio data for all of the serial audio outputs.

Audio data controller. The block is a part of the FPGA. It receives audio data from the Audio Memory and encodes these data to serial audio data stream that comply with the AES/EBU standard.

Channel buffers (1+2, 3+4, 5+6, 7+8, and silence). These blocks receive the digital audio data from the FPGA and set the output amplitude to the specified level.



0749-023

Figure 2: Simplified block diagram of the Option AG

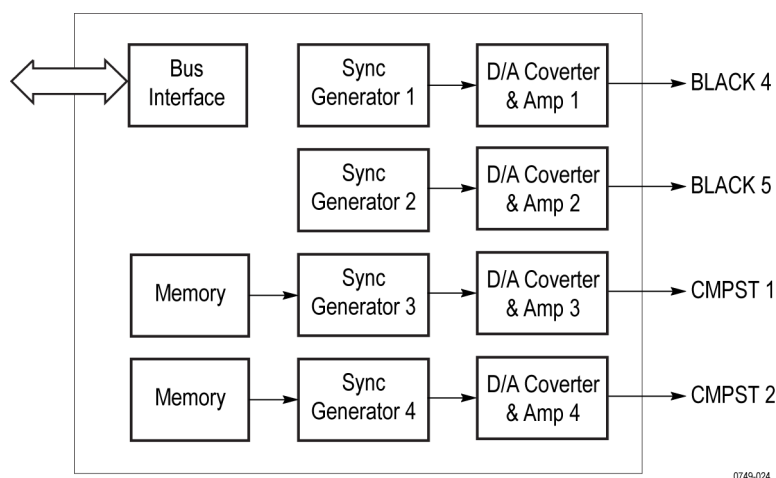
Option BG theory of operation

This section describes the basic operation of the major blocks in the Option BG circuitry.

Bus interface. This block provides the communication between the Option BG circuitry and the instrument Main board.

Sync generator. The block creates the digital data of NTSC/PAL black burst signal or HDTV trilevel sync signal. When optional memories are added, sync generator 3 and 4 can also generate 10 field ID and NTSC/PAL color bar signals.

D/A converter and amp. The block consists of a D/A converter, two amplifiers, and two filters (one is for NTSC/PAL and another is for HD). The D/A converter converts the digital data from the Sync Generator to an analog signal and reconstructs the signal for output.



0749-024

Figure 3: Simplified block diagram of the Option BG

Genlock/Black board theory of operation

The standard Genlock/Black board provides black, LTC and wordclock generation, as well as genlock and VITC/LTC time code input. This subsection describes the basic operation of the major circuit blocks on the standard Genlock/Black board. The next subsection describes the Option GPS Receiver board circuitry. (See Figure 4.)

Genlock control loop. The rear-panel REF and passive LOOP connectors accept reference video input. The reference video is then buffered, and drives a sync separator and an Analog to Digital Converter (ADC). The sync signals allow the Genlock logic to roughly align the internal sync to the incoming video. The sync signal also allows the genlock logic to window on the ADC samples from the sync edge or the burst. The samples are read by the SW which then "closes the loop" by writing to the DAC that controls the OCXO. This sets the phase and frequency of all the internal clocks.

All access to this circuitry occurs through the address and data busses, shown as the CPU I/O bus. The interface is a PLD on the GPS board, which is the central control interface for MCU data transactions to and from the GPS circuitry.

MTOD clock. The Master Time of Day (MTOD) clock contains the precise current time, which is phase locked to the selected time source. The MTOD is used for all time code generation and positioning of the frame reset pulses.

Outputs. The three Black Generation Engines and the four LTC engines each receive one of three frame reset pulses from the mainframe, which lock the video frames in all engines to exact references based on MTOD.

So that multiple units can have the same phase when locked to GPS, GLONASS or PTP the instrument times the frame pulses to an "Epoch." This means that all the signals are timed as if they started at a common time in the past, the "Epoch." The epoch may be selected as GMT midnight (00:00:00) on Jan 1st of either 1958 or 1970. The PTP standards specify the 1970 value. The video sequences generated by Option GPS are set to the correct time by calculating the total time from the selected epoch to the present, and adjusting the frame reset pulses accordingly. The frame reset pulses are used to reset the video generation outputs start position in time.

Option GPS provides 1 GPI (General Purpose Interface) input and 2 GPI outputs that you can set up for event triggering or detection. These are under SW control through the FPGA registers.

48 kHz word clock generator. The base black generator generates a 48 kHz clock (word clock) signal. You can configure this clock through the user interface for 1 V or 5 V.

VITC time code reader. The VITC time code reader operates on the same ADC data as the genlock. This data is processed to extract the VITC bits and check for valid CRC and continuity. When valid time code is detected, the SW reads the time values from the reader circuits.

LTC time code reader. LTC1 can be configured as an input. An ADC digitizes the LTC input and FPGA logic decodes the time data. The CPU reads the time data and sets the MTOD.

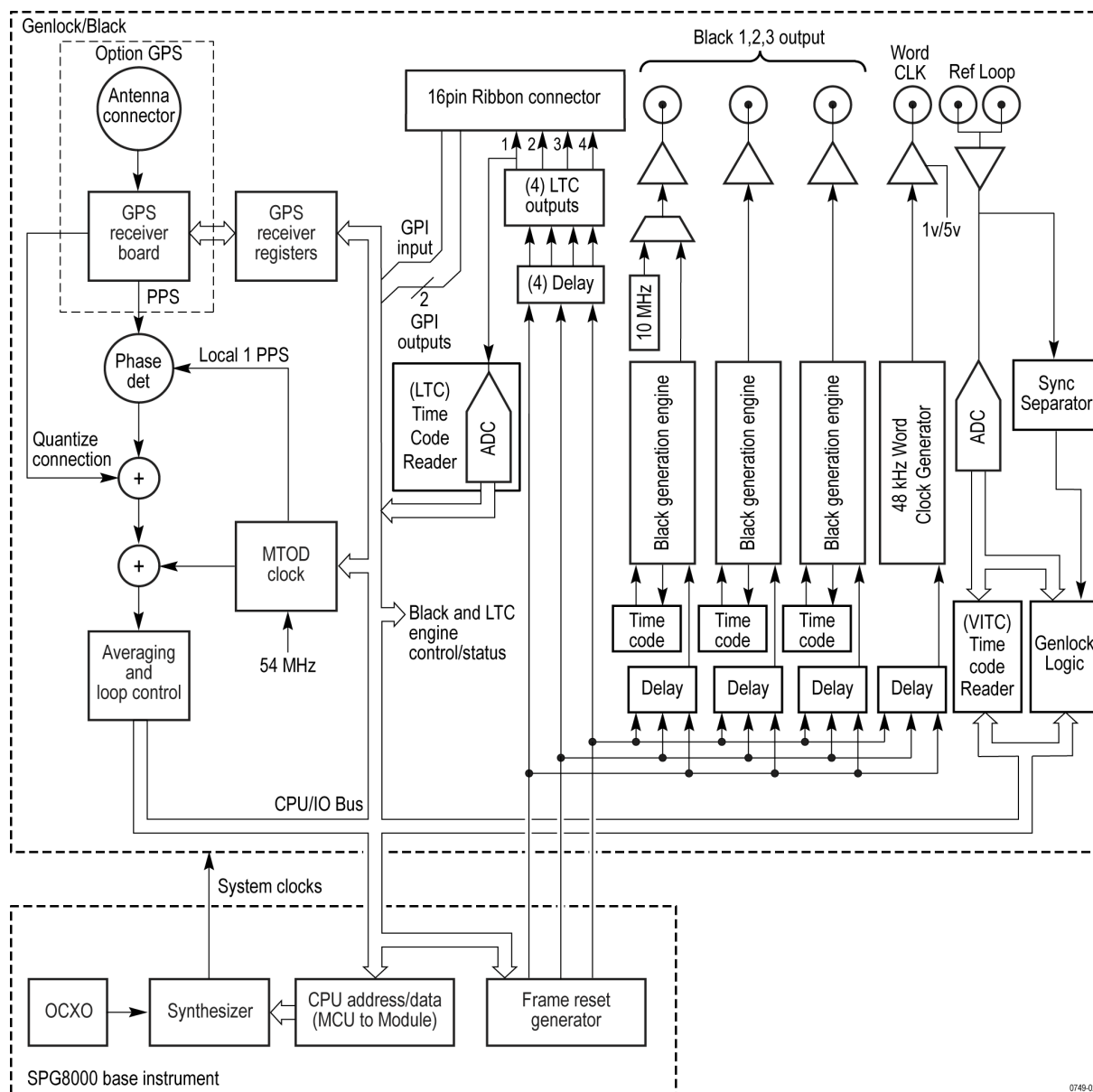


Figure 4: Simplified block diagram of the Genlock/Black and Option GPS circuitry

Option GPS theory of operation

Option GPS is a receiver board, which is mounted on the standard Genlock/Black board. The option adds GPS and GLONASS input capability. Refer to the Genlock/Black block diagram to view the Option GPS interconnections. (See Figure 4.)

GPS receiver types

Earlier versions of the GPS module can receive only GPS signals. Later versions of the GPS module can receive both GPS and GLONASS signals. If your module has the GPS/GLONASS receiver, use the REFERENCE menu to configure the module for the type of signal you are using.

How to determine which GPS receiver is installed in your instrument. Firmware version 1.5 or above must be installed in the instrument in order to view the GPS receiver type readout.

1. Press the **SYSTEM** button to access the SYSTEM menu.
2. Use the up (▲) or down (▼) arrow button to select **SYSTEM : VERSION INFO (H/W)**.
3. Use the left (◀) or right (▶) arrow button to select the version display with the **ID** field on the second line of the display as shown below.

SYSTEM : VERSION INFO (H/W)
V1.7 DO:36 BB:50 ID:3015

3080-066

- If the ID value is **3015**, then the later GPS receiver is installed that can receive both GPS and GLONASS signals.
- If the ID value is **3002**, then the earlier GPS receiver is installed that can receive only GPS signals.
- If the ID value is **3023**, then the later GPS receiver is installed that can receive both GPS and GLONASS signals.

Option GPS receiver loop. The Option GPS Receiver board block is a Trimble module, which can track up to 21 satellites, depending on constellation mode, and extract and average the time information from them.

The GPS/GLONASS receiver produces a pulse at the rate of 1 pulse per second (PPS) which is compared to a locally generated pulse per second (Local 1 PPS) in the Phase Detector block. The output from the Phase Detector contains a Quantization Error due to the time sampling method used in the GPS Receiver board. The GPS/GLONASS receiver also produces a serial data stream detailing the error (which can be up to 20 ns) that is arithmetically removed from the phase detector output (the Quantize Correction path). This corrected phase detector output can be seen on the diagnostic display.

The corrected phase is first filtered in the averaging and loop control block, and then read by software. The software then writes this to a synthesizer on the SPG8000 Main board to control the frequency of the mainframe master 54 MHz clock. This frequency control value can also be seen on the diagnostic display.

The mainframe 54 MHz oscillator clocks the Master Time of Day (MTOD) counter. This completes the loop, spread over the two boards, locking the mainframe synthesizer and MTOD counter to the incoming GPS or GLONASS signal.

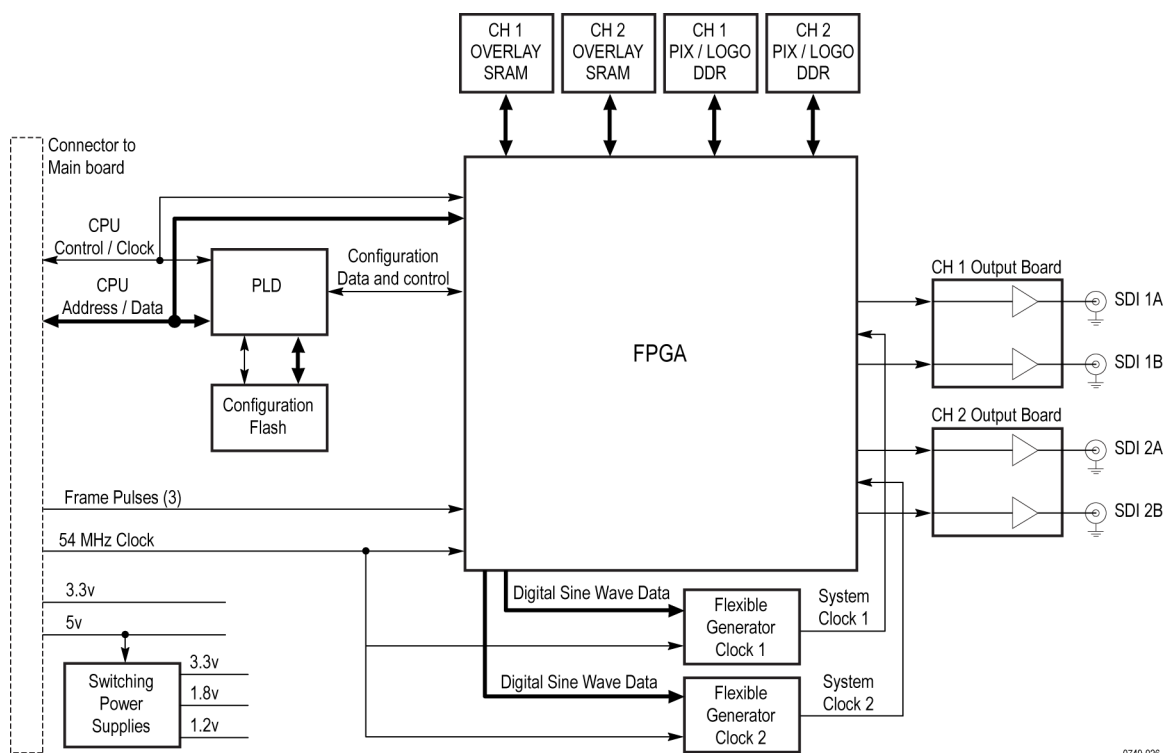
Antenna connector. Option GPS requires an external antenna to receive the GPS or GLONASS time signals. A GPS-only receiver can receive signals from up to 12 satellites; a GPS/GLONASS receiver has 32 channels and can receive signals from up to 21 satellites. (See page 8, *How to determine which GPS receiver is installed in your instrument.*)

The antenna connector applies these signals to the GPS Receiver board. For information about antenna requirements and installation, refer to the SPG8000 Quick Start User Manual, which is listed in the Product documentation table. (See Table i.)

Option SDI theory of operation

This section describes the basic operation of the major circuit blocks in the Option SDI. The discussions relate to the Block Diagram. (See Figure 5.)

There is some circuitry on the Option SDI Main circuit board that is not used. Unused circuitry is not represented in the block diagram, nor is it discussed in this theory of operation.



0749-026

Figure 5: Simplified block diagram of Option SDI

Overview. The Option SDI has three circuit boards: the Option SDI board, which mounts horizontally and contains the bulk of the circuitry, and two small output boards. These output boards plug into the SDI board vertically and provide the rear BNC connections and the circuits required to buffer the high-speed output signals.

The heart of the Option SDI generator is an FPGA, with other circuits that provide support and ancillary functions. For signal generation, the FPGA creates the output signal such as color bars or a ramp. For some signals, the information to create the signals is completely contained within the FPGA. For other signals, data from the memories is used as well. Serialization and scrambling is also done in the FPGA.

FPGA and associated circuits. A Programmable Logic Device (PLD) configures the FPGA by loading a file from the Flash at power up. This configures the FPGA for normal operation; there is a separate file for calibration.

The CPU interface connects to both the PLD and FPGA. During SW upgrade, the Flash files are loaded from the mainframe through the PLD. The FPGA uses the CPU connection to access the control registers.

Signal generation. The FPGA contains horizontal and vertical counters, which create the raster structure for the selected signal. For most test signals, these counters drive the FPGA elements that create the actual video signals such as color bars or flat field, along with the EAV and SAV info and CRCs, if appropriate. The video signals are then scrambled, serialized, and sent at 270 Mb/s, 1.5 Gb/s or 3 Gb/s from the FPGA to the output boards.

When generating frame picture signals, similar horizontal and vertical counters access the DDR memory for the given channel. In this mode, the data from the user's picture file is used to create the test signal. This data stream is combined with the standard test signal stream to add the other required elements, and the result is then serialized.

For logo overlay, the frame picture system is used, but only for a portion of the image. The user logo information is read from the DDR memory, and blended with the test signal information.

The circle and text overlay functions are generated from the SRAM for each channel. This data is blended with the active portion of the test signal or frame picture information to produce the combined signal information.

Clocks and frames. The SPG8000 circuitry provides three frame pulse signals. The actual frame signal used is the appropriate one for the rate of the signal being generated. The selected input frame resets the counters in the FPGA, establishing the correct video timing.

The SPG8000 circuitry also provides a 54 MHz clock for generator mode. This 54 MHz clock drives a DDS in the FPGA to create a digitized sine wave, which is then applied to the flexible generator clock circuit. Depending on the output format the flexible clock output is at either 148.5 MHz or 148.35 MHz. This clock is fed back to the FPGA to drive the generator core functions, and sent to the FPGA serializer clock inputs and the trigger output multiplexer.

The 54 MHz input clock also registers the input frame pulse. After it is registered at 54 MHz, it must cross to the 148.5 MHz domain. For this to work deterministically the phase of the two clocks is automatically controlled. The status of this automatic control system is shown in the diagnostic menu as DDS0 phase (channel 1) and DDS1 phase (channel 2).

SDI output boards. The two SDI Output boards (one for each output channel) take two channels from the FPGA serializers and buffers them to drive 75 Ω cable. The output level is set by nonvolatile electronic potentiometers on the output board, so the calibration is captured in the board.

Power supplies. This option has three switching supplies, and several linear supplies. Most of the power comes in as 5 V and is converted to the voltage needed by the switching supplies. The SPG8000 circuitry provides a small amount of 3.3 V for the processor interface, but the bulk of the 3.3 V used on the board is produced by the switching supply.

There are also 1.8 V and 1.2 V supplies, which are used for the memory and FPGA cores.

Adjustment procedures

This section provides procedures for the adjustments that can be performed by trained service technicians.



CAUTION. *All Adjustment procedures are to be performed only by trained service technicians.*

NOTE. Master clock. *There are two methods for adjusting the frequency of the master clock. You can use a frequency signal generator, or if Option GPS is installed, you can lock the master clock to a GPS or GLONASS signal. Procedures for both methods are included in this section.*

If your SPG8000 generator has Option GPS installed, you need to use GPS or GLONASS to adjust the master clock frequency. In this case, you can adjust the clock while the instrument is in operation, which avoids any system downtime or any warm-up period.

If your instrument does not have Option GPS installed, you must remove the instrument from service in order to adjust the master clock using a frequency generator.

Earlier versions of the GPS module can receive only GPS signals. Later versions of the GPS module can receive both GPS and GLONASS signals. (See page 8, How to determine which GPS receiver is installed in your instrument.)

Adjust master clock using a frequency signal generator

Use this procedure to adjust the frequency of the master clock if you do not have Option GPS installed in the instrument under test. This will require a reference SPG8000 with Option GPS installed (or equivalent test equipment).

Warm-up period. Allow a 20 minute warm-up time in a +20 °C to +30 °C environment before making this adjustment. The reference SPG8000 unit must be hooked to an external antenna, GPS or GLONASS signal during the warm-up period.

Adjustments done before the operating temperature has stabilized may cause errors in performance. In addition, the signal generators require appropriate warm-up time to meet the frequency accuracy.

Required equipment. The following table lists the equipment required to adjust the master clock frequency using a frequency signal generator.

Table 1: Equipment required to adjust the master clock using a signal generator

Item	No.	Minimum requirement	Recommended equipment
Frequency standard	1	Frequency: 10 MHz $\pm 1 \times 10^{-9}$ Amplitude: 8 dBm	A reference Tektronix SPG8000, with Option GPS installed and locked to GPS, GLONASS or equivalent Spectracom/Pendulum 6689
75 Ω BNC cable	1	Length: 42 inches	Tektronix part number 012-0074-00

Procedure Perform the following procedure to adjust the master clock frequency using a frequency standard.

1. Set the output of the frequency standard as follows:

Frequency: 10.000000 MHz

Output level: 8 dBm

2. Use the 75 Ω BNC cable to connect the rear-panel REF connector to the output of the frequency standard as shown in the following figure, and attach a 75 Ω terminator to the REF loop-through connector.

NOTE. You can use a second SPG8000, with Option GPS installed, to produce the 10 MHz frequency standard.

In this case, check that the Option GPS is locked to a GPS or GLONASS signal in fine mode. Configure the Black 3 output to supply a 10 MHz sine wave. Connect the Black 3 output to the rear-panel REF connector on the second SPG8000.

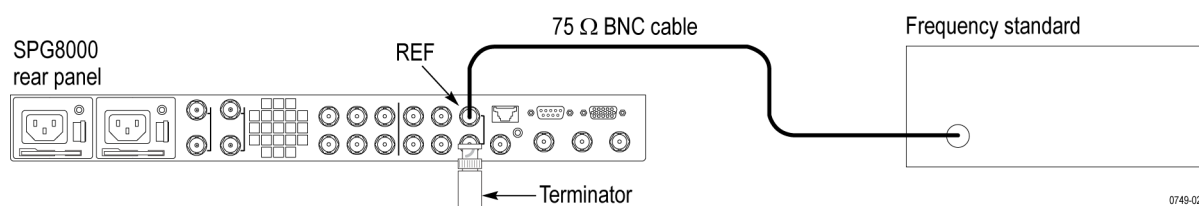


Figure 6: Adjusting the master clock frequency using a frequency standard

3. Restart the instrument in Factory mode. (See page 105, *To power up in factory mode.*)
4. Let the instrument warm up for 20 minutes before proceeding.

5. Set the reference source to CW as follows:
 - a. Press the **REF** button to display the REFERENCE menu.
 - b. Press the left (◀) or right (▶) arrow button to select **CW**, and then press the **ENTER** button.
6. Calibrate the oven system:
 - a. Press the **SYSTEM** button.
 - b. Press the up (▲) or down (▼) arrow button to select **CALIBRATE : OVEN**.
 - c. Press the **ENTER** button.
 - d. A message will be displayed asking you to verify that you want to execute the calibration. Press the **ENTER** button to proceed with the calibration.
 - e. Verify that the message **CALIBRATION result = xxxxxxxx** is displayed. The result should be seven characters near the value of **2,097,152**. Press the **ENTER** button to exit the calibration mode.
7. Verify the calibration:
 - a. Press the **SYSTEM** button.
 - b. Press the up (▲) or down (▼) arrow button to select **DIAGNOSTICS**.
 - c. Press the **ENTER** button.
 - d. Press the up (▲) or down (▼) arrow button to select **DIAGNOSTICS : CALIBRATION**.
 - e. Check that the **CAL** value is less than **2.5 e-6**.

NOTE. *If the CAL value is greater than 2.6 e-6, the oscillator oven may need to be serviced.*

Adjust master clock while locked to GPS

Use this procedure, you can adjust the clock while the instrument is in operation, which avoids any system downtime.

NOTE. Earlier versions of the GPS module can receive only GPS signals. Later versions of the GPS module can receive both GPS and GLONASS signals. (See page 8, How to determine which GPS receiver is installed in your instrument.)

Warm-up period. Allow a 20 minute warm-up time in a +20 °C to +30 °C environment before making this adjustment. The instrument must be hooked to an external antenna or GPS signal during the warm-up period.

Table 2: Equipment required to adjust the master clock while locked to GPS

Item	No.	Minimum requirement	Recommended equipment
GPS or GLONASS antenna feed with good signal level	1	Less than 5 dB attenuation since last amplifier	Trimble Bullet III, 5V, 35 dB gain, antenna with F-connector, or equivalent. Cable: up to 200 ft Belden 1694A, or equivalent, with an F connector on one end and a BNC connector on the other end.

Procedure. Perform the following procedure to set the internal frequency of the internal oscillator. This adjustment stores the current frequency of the oscillator while it is locked to a GPS, GLONASS or a reference signal, to be used when in **Internal** mode. It can be done without any disruption to operation and is best done in the operating environment of the instrument.

1. Verify that the GPS Constellation type is set to **GPS & GLONASS**:

NOTE. You need to perform this step only if your Option GPS module has a GPS/GLONASS receiver. (See page 8, How to determine which GPS receiver is installed in your instrument.)

- a. Press the **REF** button to access the REFERENCE menu.
 - b. Use the up (▲) or down (▼) arrow button to select **GPS CONSTELLATION**.
 - c. Use the left (◀) or right (▶) arrow button to select **GPS & GLONASS**.
 - d. Press the **ENTER** button to make the selection.
2. Verify that the instrument has warmed up for at least 20 minutes, with the external antenna GPS and/or GLONASS signal connected.
 3. Press the **STATUS** button.

4. Press the up (▲) or down (▼) arrow button to select **STATUS : GPS**.
5. Check that the signal status shows **Locked**.
6. Calibrate the oven system:
 - a. Press the **SYSTEM** button.
 - b. Press the up (▲) or down (▼) arrow button to select **CALIBRATE : OVEN**.
 - c. Press the **ENTER** button.
 - d. A message will be displayed asking you to verify that you want to execute the calibration. Press the **ENTER** button to proceed with the calibration.
 - e. Verify that the message **CALIBRATION result = xxxxxxx** is displayed. The result should be seven characters near the value of **2,097,152**. Press the **ENTER** button to exit the calibration mode.
7. Verify the calibration:
 - a. Press the **SYSTEM** button.
 - b. Press the up (▲) or down (▼) arrow button to select **DIAGNOSTICS**.
 - c. Press the **ENTER** button.
 - d. Press the up (▲) or down (▼) arrow button to select **DIAGNOSTICS : CALIBRATION**.
 - e. Check that the **CAL** value is less than **2.5 e⁻⁶**.

NOTE. *If the CAL value is greater than 2.6 e⁻⁶, the oscillator oven may need to be serviced.*

Adjust Option BG

Adjustments in the Option BG are for the output offset, output gain, and chroma gain.

Warm-up period. Allow a 20 minute warm-up time in a +20 °C to +30 °C environment before making these adjustments. Adjustments done before the operating temperature has stabilized may cause errors in performance.

Required equipment. The following table lists the equipment required to adjust the output offset, output gain, and chroma gain.

Table 3: Adjusting Option BG

Item	No.	Minimum requirement	Recommended equipment
TV signal generator platform	1		Tektronix SPG8000 with Option BG installed
Digital multimeter	1	5 1/2 digits	FLUKE 8842A
Oscilloscope	1	Bandwidth: 1 GHz or higher 75 Ω input	Tektronix DPO70404C with TekConnect TCA-75 adapter
75 Ω BNC cable	1	Length: 42 inches	Tektronix part number 012-0074-00
75 Ω coaxial terminator	1	75 Ω $\pm 0.1\%$	Tektronix part number 011-0102-03
BNC T connector	1		Tektronix part number 103-0030-00
BNC female to dual banana adapter	1		Tektronix part number 103-0090-00

Adjust the Option BG output offset and gain



WARNING. To avoid serious injury, do not touch exposed connectors or components when operating the SPG8000 with the top cover removed. Dangerous potentials exist at several points within the instrument.

1. Remove the top cover of the SPG8000. (See page 46, *Top cover*.)
2. Locate the variable resistors on the BG circuit board. (See Figure 7.)

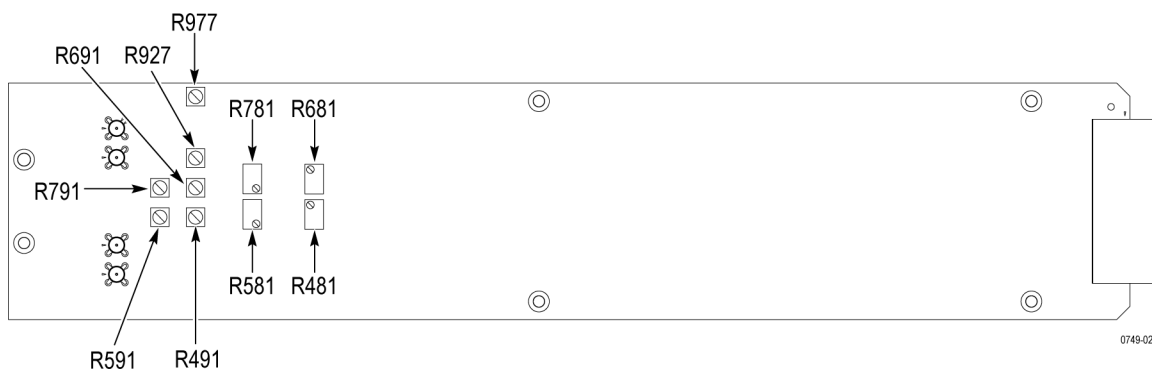


Figure 7: Variable resistors on the Option BG board

3. Use the 75 Ω BNC cable, BNC T connector, 75 Ω coaxial terminator, and BNC female-to-dual banana adapter to connect the BLACK 4 connector to the input connector on the digital multimeter. (See Figure 8.)

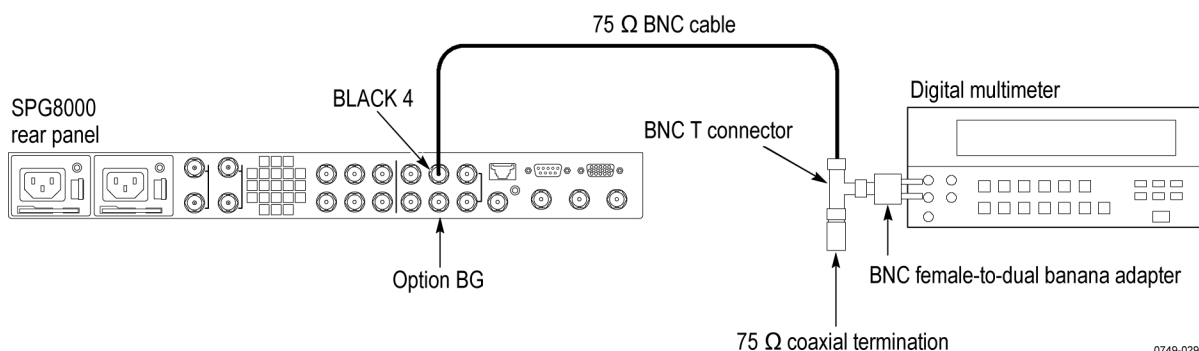


Figure 8: Adjusting the Option BG output offset and gain

4. Restart the instrument in Factory mode. (See page 105, *To power up in factory mode*.)

5. Select the DAC Offset (0 V DC) calibration signal for the Option BG outputs as follows:
 - a. Press the **BLACK** button until you see **BLACK 4 : FORMAT** on the display.
 - b. Use the left (◀) or right (▶) arrow button to select **NTSC**.
 - c. Press the **ENTER** button.
 - d. Use the up (▲) arrow button to select **CALIBRATION**.
 - e. Use the left (◀) or right (▶) arrow button to select **OFFSET CALIBRATION**.
 - f. Press the **ENTER** button.
 - g. Use the left (◀) or right (▶) arrow button to select **CALIBRATION : Offset DAC 715 (0 V)**.
 - h. Press the **ENTER** button.
 - i. Press the **BACK** button.
 - j. Repeat this step until you have selected the calibration signal for the **BLACK 4**, **BLACK 5**, **CMPST 1**, and **CMPST 2** outputs, using the **CMPST** button to view the Composite signal menus.
6. Locate variable resistor R491 on the BG circuit board. (See Figure 7.)
7. Adjust R491 so that the output offset is 0 V \pm 1 mV.
8. Change the BNC cable connection from the **BLACK 4** connector to the **BLACK 5** connector.
9. Locate variable resistor R591 on the BG circuit board. (See Figure 7.)
10. Adjust R591 so that the output offset is 0 V \pm 1 mV.
11. Change the BNC cable connection from **BLACK 5** connector to the **CMPST 1** connector.
12. Locate variable resistor R691 on the BG circuit board.
13. Adjust R691 so that the output offset is 0 V \pm 1 mV.
14. Change the BNC cable connection from the **CMPST 1** to the **CMPST 2** connector.
15. Locate variable resistor R791 on the BG circuit board.
16. Adjust R791 so that the output offset is 0 V \pm 1 mV.

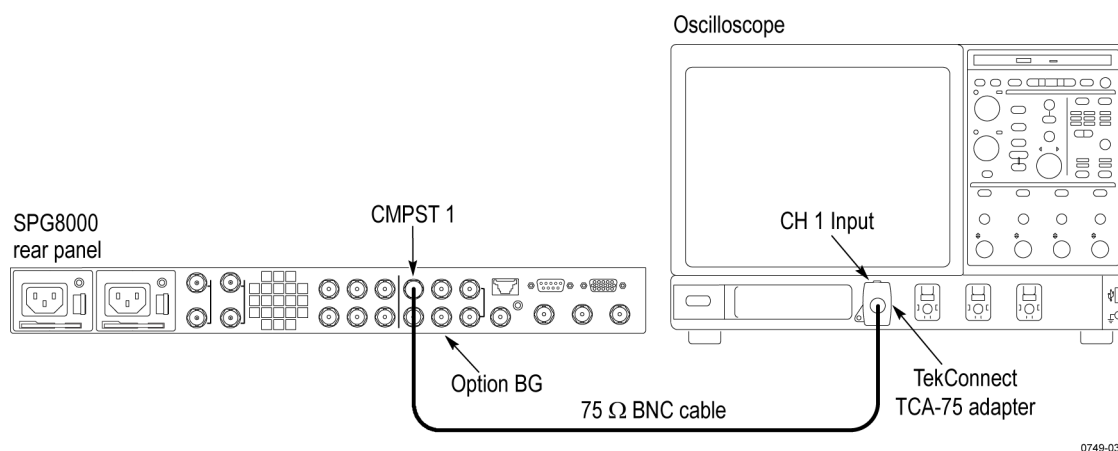
17. Select the DAC Gain (700 mV DC) calibration signal for the Option BG outputs as follows:
 - a. Press the **BLACK** button until you see **BLACK 4 : FORMAT** on the display.
 - b. Use the left (◀) or right (▶) arrow button to select **NTSC**.
 - c. Repeat for the **BLACK 5** output.
 - d. Press the up (▲) arrow button to select **CALIBRATION**.
 - e. Press the left (◀) or right (▶) arrow button to select **Amplitude Calibration**.
 - f. Press the **ENTER** button.
 - g. Press the left (◀) or right (▶) arrow button to select **DAC Gain (700 mV DC)**.
 - h. Press the **BACK** button.
 - i. Repeat parts a through h of this step to select the calibration signal for the **BLACK 5**, **CMPST 1**, and **CMPST 2** outputs, using the **CMPST** button to select the Composite outputs.
18. Locate variable resistor R481 on the BG circuit board. (See Figure 7.)
19. Adjust R481 so that the output level is 700 mV \pm 1 mV.
20. Change the BNC cable connection from the **BLACK 4** connector to the **BLACK 5** connector.
21. Locate variable resistor R581 on the Option BG circuit board. (See Figure 7.)
22. Adjust R581 so that the output level is 700 mV \pm 1 mV.
23. Change the BNC cable connection from the **BLACK 5** connector to the **CMPST 1** connector.
24. Locate variable resistor R681 on the BG circuit board. (See Figure 7.)
25. Adjust R681 so that the output level is 700 mV \pm 1 mV.
26. Change the BNC cable connection from the **CMPST 1** connector to the **CMPST 2** connector.
27. Locate variable resistor R781 on the BG circuit board. (See Figure 7.)
28. Adjust R781 so that the output level is 700 mV \pm 1 mV.

Adjust the Option BG chroma gain



WARNING. To avoid serious injury, do not touch exposed connectors or components when operating the SPG8000 with the top cover removed. Dangerous potentials exist at several points within the instrument.

1. Remove the top cover of the SPG8000. (See page 46, *Top cover*.)
2. Locate the variable resistors on the BG circuit board. (See Figure 7.)
3. Use the 75 Ω BNC cable to connect the CMPST 1 connector on the SPG8000 to the CH 1 connector on the oscilloscope, as shown. (See Figure 9.)



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Figure 9: Adjusting chroma gain

4. Select the **PAL 75% Color Bars (100% White)** signal for CMPST 1 and CMPST 2 as follows:
 - a. Press the **CMPST** button until you see **CMPST 1 : Format** in the display.
 - b. Press the right (►) arrow button to select **PAL**
 - c. Press the **ENTER** button.
 - d. Press the down (▼) arrow button to view the **CMPST 1 : TEST SIGNAL** menu.
 - e. Press the right (►) arrow button to select **75% Color Bars (100% White)**.
 - f. Press the **ENTER** button.
 - g. Repeat for the **CMPST 2** output.

5. Set the oscilloscope controls as follows:
 - Vertical: 100 mV / div
 - Sample depth: 100 K
 - Horizontal: 2.5 μ s / div
 - Trigger position: 50%
 - Vert offset: 700 mV
 - Trigger: 720 mV, rising edge
 - Hold-off: 63 μ s
6. After you see a stable trace on the oscilloscope, change the **Vertical** setting to **5 mV / div**.
7. Locate the flat bar followed by the burst packets for yellow and cyan as shown in the following figure.

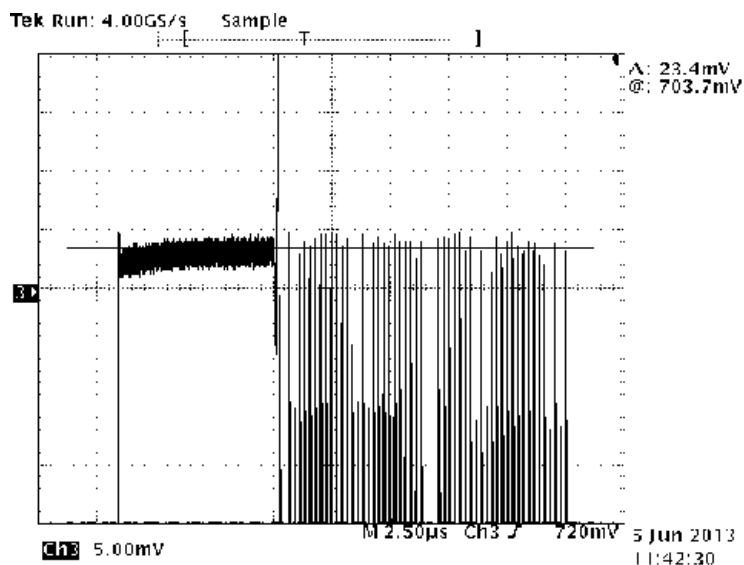


Figure 10: Triggered display for adjusting the Option BG chroma gain

8. Locate variable resistor R927 on the BG circuit board. (See Figure 7.)
9. Adjust R927 to match the level of the first chroma packet to the preceding 75% flat bar.
10. Change the BNC cable connection from the CMPST 1 connector to the CMPST 2 connector.
11. Locate variable resistor R977 on the BG circuit board. (See Figure 7.)
12. Adjust R977 to match the first chroma packet to the level of the preceding 75% flat bar.

Adjust Genlock/Black board

The adjustments on this module are Black burst level and Black burst offset. The procedures to adjust black burst level and offset are provided in this section.

Warm-up period. Allow a 20 minute warm-up time in a +20 °C to +30 °C environment before making these adjustments. Adjustments done before the operating temperature has stabilized may cause errors in performance.

Required equipment. The following table lists the equipment required to make the adjustments.

Table 4: Equipment required for the Genlock/Black board adjustment procedures

Item	No.	Minimum requirement	Recommended equipment
Digital multimeter	1	5 1/2 digits	FLUKE 8842A
75 Ω BNC cable	1	Length: 42 inches	Tektronix part number 012-0074-00
75 Ω coaxial precision terminator	1	75 Ω $\pm 0.1\%$	Tektronix part number 011-0102-03
BNC T connector	1		Tektronix part number 103-0030-00
BNC female to dual banana adapter	1		Tektronix part number 103-0090-00

Adjust the black burst level and offset

Perform the following procedure to adjust the black burst level and offset.

1. Restart the instrument in Factory mode. (See page 105, *To power up in factory mode.*)
2. Connect the BLACK 1 output to the multimeter as shown in the following figure. (See Figure 11.)

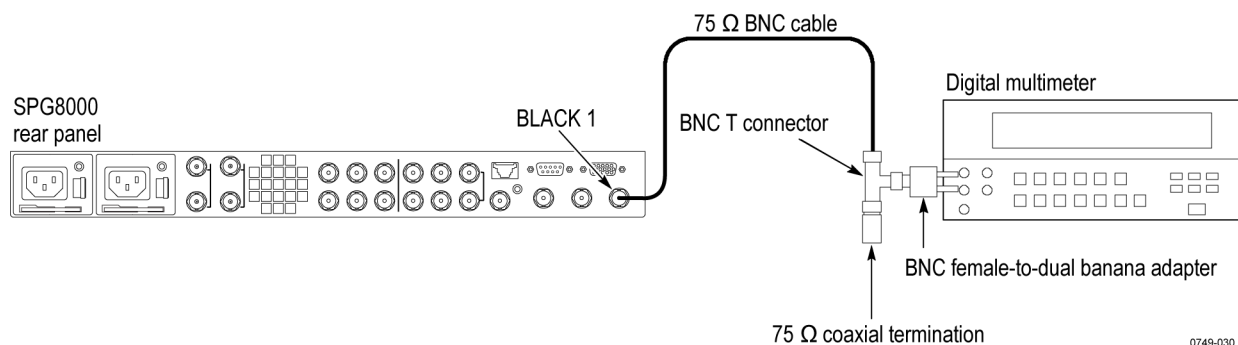


Figure 11: Equipment connections for Genlock/Black adjustments

3. Press the **BLACK** button until you see **BLACK 1** on the display.
4. **Set the Black level:**
 - a. Press the up (▲) or down (▼) arrow button to select **CALIBRATION**.
 - b. Press the left (◀) or right (▶) arrow button to select **CALIBRATION : AMPLITUDE**.
 - c. Press the **ENTER** button.
 - d. Press the left (◀) or right (▶) arrow button to select the **0 V** signal.
 - e. Make a note of the voltmeter reading.
 - f. Press the left (◀) or right (▶) arrow button to select the **700 mV** signal.
 - g. Make a note of the voltmeter reading.
 - h. Subtract the voltage measured in part e of this step (0 mV setting) from the voltage measured in part f of this step (700 mV setting).
 - i. If the result is <698 mV or >702 mV, use the up (▲) or down (▼) arrow buttons to adjust the gain.
 - j. Repeat parts d through i of this step until the difference between the two signals is $700 \text{ mV} \pm 2 \text{ mV}$.
 - k. Press the **ENTER** button to save the setting and exit the amplitude calibration menu.
5. **Set Black offset:**
 - a. Proceeding from the previous step, use the left (◀) or right (▶) arrow button to select **CALIBRATION : OFFSET**.
 - b. Press the **ENTER** button.
 - c. Use the left (◀) or right (▶) arrow button to select the **0 V** signal.
 - d. Measure the offset voltage.
 - e. If necessary, use the up (▲) or down (▼) arrow buttons to adjust the offset voltage to $0 \text{ V} \pm 5 \text{ mV}$.
 - f. Press the **ENTER** button to save the setting and exit the offset calibration menu.
6. Move the cable to the next output and repeat steps 3 through 5 for the **BLACK 2** and **BLACK 3** outputs.

Adjust Option SDI

There is only one adjustment for Option SDI. This adjustment sets the SDI output amplitude. Perform this adjustment for each channel if the instrument fails the SDI Output Amplitude portion of the performance verification procedure. This procedure replicates part of that procedure.

Warm-up period. Allow a 20 minute warm-up time in a +20 °C to +30 °C environment before making these adjustments. Adjustments done before the operating temperature has stabilized may cause errors in performance.

Required equipment. The following table lists the equipment required to make the adjustments.

Table 5: Equipment required for the Option SDI adjustment procedures

Item	No.	Minimum requirement	Recommended equipment
TV signal generator platform	1		Tektronix SPG8000 with Option SDI installed
Digital signal analyzer	1	Digital signal analyzer with a 20 GHz electrical sampling module and a probe interface module	Tektronix DSA8200 with an 80E04 electrical sampling module and an 80A03 Tek Connect Probe Interface module
Stable 10 kHz sine wave generator	1	CW sine wave with 800 mV _{p-p} ±5% into 75 Ω, THD < 60 dBc, 10 kHz, and <50 mV DC offset	Tektronix AFG3101
Tekconnect 75 Ω to 50 Ω adapter with BNC input connector	1		Tektronix TCA75
Precision RMS voltmeter	1		Keithley 2700 DMM
6 dB SMA attenuator	1		Tektronix part number 015-1001-01
SMA (male) to BNC (female) adapter			Tektronix part number 015-0554-00
1 m (3 ft.) BNC to BNC high-bandwidth cable	1		Belden 1694, MarkerTek 1694-B-B-3
1 m (3 ft.) BNC to BNC 50 Ω cable	1		Tektronix part number 012-0057-01
75 Ω precision terminator	1	75 Ω ±0.1%	Tektronix part number 011-0102-03
BNC T connector	1		Tektronix part number 103-0030-00
BNC female to dual banana adapter	1		Tektronix part number 103-0090-00

SDI output amplitude adjustment table

Print this table for use during the adjustment procedure.

Table 6: SDI output amplitude

	Minimum	Value	Maximum	
Characterization				
DMM Measurement (typically 0.2880 V)	—	—	—	
Oscilloscope Cycle RMS (typically 116 mV)	—	—	—	
Oscilloscope Cycle Mean (typically 1 mV)	—	—	—	
Sine wave RMS amplitude (typically 116 mV)	$\sqrt{(Cycle\ RMS)^2 - (Cycle\ Mean)^2}$		—	
Attenuation Factor	2.35		2.55	
Adjustment Record				
	Minimum	Value		Maximum
		Before adjustment	After adjustment	
SDI 1A amplitude				
Measured value (μ) with attenuation	776 mV			824 mV
SDI 1B amplitude				
Measured value (μ) with attenuation	776 mV			824 mV
SDI 2A amplitude				
Measured value (μ) with attenuation	776 mV			824 mV
SDI 2B amplitude				
Measured value (μ) with attenuation	776 mV			824 mV

Characterize the test system amplitude

Before adjusting the SDI Output Amplitude, you must first characterize the test system amplitude.

There are three parts to the amplitude characterization:

- Part A: Sets up a characterization reference to the DMM.
- Part B: Set up the DSA oscilloscope.
- Part C: Characterizes the test system.

Part A: characterize the reference against the DMM.

1. Connect the equipment as follows:
 - a. Connect one end of a 1 m high bandwidth cable to the AFG3101 output.
 - b. Connect the other end of the 1 m cable to the BNC T.
 - c. Connect the BNC T to a BNC to banana adapter.
 - d. Connect the other end of the BNC T to a precision terminator.
 - e. Connect the end of the banana adapter to the input of the DMM.
2. Set the AFG3101 to output a sine wave into a load impedance of $75\ \Omega$.
3. Set the AFG3101 to a 10 kHz output into a load impedance of $75\ \Omega$.
4. Set the AFG3101 to a 800 mVp-p output into a load impedance of $75\ \Omega$.
5. Check that the output of the AFG3101 is On.
6. Set the DMM to measure AC voltage using a medium filter setting. Set the range to allow for four digits of RMS amplitude.
7. Record the DMM measurement in the SDI output amplitude table. (See Table 6 on page 27.)

Part B: Set up the digital signal analyzer.

CAUTION. *Electrostatic discharge can damage the oscilloscope modules. To prevent damage, always work in a static free environment and discharge the static voltage from your body by wearing a grounded antistatic wrist strap while handling these modules.*

1. Install the 80A03 output cable into the Channel 1/2 slot of the oscilloscope.
2. Install the 80E04 sampling head into the 80A03 adapter and connect the two using the SMA cables.
3. Install the TCA-75 into the left port of the 80A03.
4. Install the TCA-BNC into the right port of the 80A03.
5. If needed, press the Default Settings button on the oscilloscope.
6. Press the Channel 1 button on the 80E04 sampling head to activate Channel 1.

Part C: Characterize the test system.

1. Connect the equipment as follows:
 - a. Connect the AFG3101 output to 1 m high bandwidth cable.
 - b. Connect the other end of the cable to a TCA-75.
 - c. Connect the TCA-75 to the 80A03 in the oscilloscope and plug-in.
 - d. Connect a 50 Ω cable from the AFG3101 trigger output.
 - e. Connect the other end of the 50 Ω cable to the BNC to SMA adapter.
 - f. Connect the SMA adapter to the 6 dB pad.
 - g. Connect the 6 dB pad to the trigger direct input on the oscilloscope.
2. Keep the AFG3101 at the same output as in Part A of this test.
3. Set the oscilloscope as follows:

Time/Div: 20 μ s
Volts/Div: 50 mV
Averaging: 16
Record Length: 4000 points
4. On the oscilloscope, select measurement 1 and then pulse amplitude and set it to measure Cycle RMS.
5. On the oscilloscope, select measurement 2 and then pulse amplitude and set it to measure Cycle Mean.

6. Record the Cycle RMS and Cycle Mean values in the SDI output amplitude table.
7. Calculate the corrected RMS amplitude of the sine wave: $\sqrt{(cycle\ RMS)^2 - (cycle\ mean)^2}$
8. Record the result in the test record.
9. Calculate the total attenuation factor for the system. This is the DMM measurement divided by the corrected RMS sine wave amplitude.
10. Record the attenuation factor value in the SDI output amplitude table.
11. Enter the attenuation factor value into the oscilloscope:
 - a. On the oscilloscope, press the SETUP DIALOG button.
 - b. Select the “Vert” tab from the top of the setup page.
 - c. Select the “External Attenuation” box, and enter the attenuation factor calculated in step 9 above.

Adjust the SDI output amplitude

1. Restart the instrument in Factory mode. (See page 105, *To power up in factory mode.*)
2. Press the **SDI** button until **SDI 1** appears.
3. Connect a 1 m high-bandwidth cable from the **SDI 1A** output of the module to the TCA75 BNC on the oscilloscope adapter.
4. Connect a 50 Ω cable from the **SDI 1B output** (through the BNC to SMA adapter, with or without the 6 dB pad) to the trigger direct input on a sampling oscilloscope.
5. Press the **SDI** button until **SDI7[x-1]: STATUS** appears.
6. Use the up (**▲**) or down (**▼**) arrow button to select **CALIBRATION**.
7. Press the **ENTER** button.
8. Press the right (**►**) arrow button to select **20 Bits Square**.
9. Press the **ENTER** button.
10. If necessary, set the oscilloscope as follows:

Time/Div: 2 ns
Volts/Div: 100 mV
Averaging: 16
Record Length: 4000 points

11. On the oscilloscope, select Measurement 3, Pulse-Amplitude, and then Amplitude to measure the amplitude on the flat part of the long pulse.
12. Right click on the measurement readout, and select **Show Statistics** and **Show Annotations** from the pop-up menu.
13. Note the expected average value, which is indicated by the letter μ , displayed on the oscilloscope.
14. Press the **Clear Data** button on the oscilloscope and wait about 5 seconds before proceeding to the next step.
15. Record the average value, which is indicated by the letter μ , in the *Signal 1A amplitude* row *Before adjustment value* column of the SDI output amplitude table.

NOTE. *If you entered the attenuation factor into the oscilloscope at the end of the amplitude characterization procedure, the oscilloscope will display the multiplication result.*

16. If adjustment is necessary, press the up (\blacktriangle) or down (\blacktriangledown) arrow button, and then press the **ENTER** button, to activate the adjustment mode.
17. Press the **Clear Data** button on the oscilloscope and wait about 5 seconds before proceeding to the next step.
18. Press the up (\blacktriangle) or down (\blacktriangledown) arrow button to change the amplitude to the expected average value noted in step 13.
19. Repeat steps 17 and 18 until the average measured value (μ) is within 1 mV of 800 mV, and then press the **ENTER** button to save the new amplitude calibration value.
20. Record the new measured attenuation corrected value in the *Signal 1A amplitude* row *After adjustment value* column of the SDI output amplitude table.
21. Press the **Back** button to exit the Channel 1: Top Calibration mode.
22. Connect the **SDI 1A** output to the trigger input of the DSA using the 1 meter 50 Ω cable. Connect the SDI 1B output to the TCA-75 using the high-bandwidth 75 Ω cable.
23. Use the left (\blacktriangleleft) or right (\blacktriangleright) arrow buttons to select **Channel 1: Bottom** to adjust the SDI 1B output.
24. Press the **ENTER** button.
25. Press the right (\blacktriangleright) arrow button to select **20 Bits Square**.
26. Press the **ENTER** button.
27. Repeat steps 15 through 21 for the SDI 1B output.

28. Move the 1 m high-bandwidth cable from the **SDI 1B** output to the **SDI 2A** output.
29. Move the 50 Ω cable from the SDI 1 A output to SDI 2 B.
30. Press the left (◀) or right (▶) arrow buttons to select **Channel 2: Top** to adjust the Signal 2A output.
31. Press the **ENTER** button.
32. Press the right (▶) arrow button to select **20 Bits Square**.
33. Repeat steps 15 through 21 for the Signal 2A output.
34. Move the 1 m high-bandwidth cable from the **SDI 2A** output to the **SDI 2B** output and swap the trigger input to connect to SDI 2A
35. Use the left (◀) or right (▶) arrow buttons to select **Channel 2: Bottom**.
36. Press the **ENTER** button.
37. Press the right (▶) arrow button to select **20 Bits Square**.
38. Press the **ENTER** button.
39. Repeat steps 15 through 21 for the SDI 2B output.
40. Cycle the power on the SPG8000 to return the generator to normal operating mode.

Maintenance

If your 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.*

This section contains information needed to safely and effectively service the SPG8000 generator to the module level.

To isolate a failure, use the fault isolation procedures found in the troubleshooting section. To remove and replace any failed module, follow the instructions in the removal procedure section. Use the replaceable parts list section for part numbers and ordering information for all replaceable modules.

General service information

Service prerequisites

To prevent personal injury or damage to the instrument, ensure the following before servicing this instrument:

- The procedures in this manual should be performed only by a qualified service person.
- Read the *General safety summary* and the *Service safety summary* at the beginning of this manual.
- When using this manual for servicing, be sure to follow all warnings, cautions, and notes.
- *Inspection and cleaning* describes how to inspect for dirt and damage and how to clean the exterior and interior of the instrument. (See page 36.)
- The *Remove and replace procedures* describe how to install or remove a replaceable module. (See page 39.)

Performance check interval

Generally, the performance check described in the *SPG8000 Specifications and Performance Verification Technical Reference* manual should be done every 12 months. In addition, a performance check is recommended after repair.

If the SPG8000 generator does not meet performance criteria, repair is necessary.

Terms in the manual

Throughout this manual, the term module appears, referring to any field-replaceable component or assembly.

Tektronix service offerings	<p>Tektronix provides service to cover repair under warranty and other services that may provide a cost-effective answer to your service needs.</p> <p>Whether providing warranty repair service or any of the other services listed below, Tektronix service technicians are well trained to service the SPG8000 generator. They have access to the latest information on improvements to the SPG8000 and the latest new options.</p>
Warranty repair service	<p>Tektronix warrants this product for one year from date of purchase. The warranty appears after the title page in this manual. Tektronix technicians provide warranty service at most Tektronix service locations. The Tektronix product catalog lists all worldwide service locations. You can also visit our Web site for service information: www.tektronix.com.</p>
Self service	<p>Tektronix supports repair to the module level by providing module exchange.</p> <p>Module exchange. This service reduces downtime for repair by allowing you to exchange most modules for remanufactured ones. Each module comes with a 90-day service warranty.</p> <p>For more information. Contact your local Tektronix service center or sales engineer for more information on any of the repair or adjustment services just described.</p>

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.

Before servicing this product, read the General Safety Summary and the Service Safety Summary at the front of the manual, as well as the following ESD information.



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

When performing any service that requires internal access to the instrument, adhere to the following precautions to avoid damaging internal modules and their components due to electrostatic discharge (ESD):

- Minimize handling of static-sensitive circuit boards and components.
- Transport and store static-sensitive modules in their static protected containers or on a metal rail. Label any package that contains static-sensitive boards.
- Discharge the static voltage from your body by wearing a grounded antistatic wrist strap while handling these modules. Service static-sensitive modules only at a static-free work station.
- Nothing capable of generating or holding a static charge should be allowed on the work station surface.
- Handle circuit boards by the edges when possible.
- Do not slide the circuit boards over any surface.
- Avoid handling circuit boards in areas that have a floor or work-surface covering capable of generating a static charge.

Inspection and cleaning

Inspection and Cleaning describes how to inspect for dirt and damage. It also describes how to clean the exterior and interior of the instrument. Inspection and cleaning are done as preventive maintenance. Preventive maintenance, when done regularly, may prevent malfunction and enhance reliability.

Preventive maintenance consists of visually inspecting and cleaning the instrument and using general care when operating it.

How often maintenance should be performed depends on the severity of the environment in which the instrument is used. A proper time to perform preventive maintenance is just before any instrument adjustment.

General care The cabinet helps keep dust out and should normally be in place during operation.



WARNING. *To prevent injury or death, power off the instrument and disconnect it from line voltage before performing any procedure that follows.*

Interior cleaning Use a dry, low-velocity stream of air to clean the interior of the chassis. Use a soft-bristle, nonstatic-producing brush for cleaning around components. If you must use a liquid for minor interior cleaning, use a 75% isopropyl alcohol solution and rinse with deionized water.

Exterior cleaning Clean the exterior surfaces of the chassis with a dry lint-free cloth or a soft-bristle brush. If any dirt remains, use a cloth or swab dipped in a 75% isopropyl alcohol solution. Use a swab to clean narrow spaces around controls and connectors. Do not use abrasive compounds on any part of the instrument that may be damaged by it.



CAUTION. *Avoid the use of chemical cleaning agents that might damage the plastics used in the instrument. Use only deionized water when cleaning the front-panel buttons. Use a glass cleaner to clean the LCD. For the rest of the instrument, use a 75% isopropyl alcohol solution as a cleaner and rinse with deionized water. Before using any other type of cleaner, consult your Tektronix Service Center or representative.*

Inspection – exterior. Inspect the outside of the instrument for damage, wear, and missing parts, using the following table as a guide. Immediately repair defects that could cause personal injury or lead to further damage to the instrument.

Table 7: External inspection checklist

Item	Inspect for	Repair action
Cabinet, front panel, and cover	Cracks, scratches, deformations, damaged hardware	Repair or replace defective module
Front-panel knobs	Missing, damaged, or loose knobs	Repair or replace missing or defective knobs
Connectors	Broken shells, cracked insulation, and deformed contacts. Dirt in connectors	Repair or replace defective modules. Clear or wash out dirt
Carrying handle and cabinet feet	Correct operation	Repair or replace defective part
Accessories	Missing items or parts of items, bent pins, broken or frayed cables, and damaged connectors	Repair or replace damaged or missing items, frayed cables, and defective modules
LCD	Cracks	Replace the LCD assembly
	Dirty	Clean with glass cleaner

Inspection – interior. To access the inside of the instrument for inspection and cleaning, you will need to remove the top cover.

Inspect the internal portions of the instrument for damage and wear, using Table 4-2 as a guide. Defects found should be repaired immediately.

If any circuit board is repaired or replaced, see if it is necessary to adjust the instrument. (See Table 8 on page 37.)



CAUTION. To prevent damage from electrical arcing, make sure that circuit boards and components are dry before applying power to the instrument.

Table 8: Internal inspection checklist

Item	Inspect for	Repair action
Circuit boards	Loose, broken, or corroded solder connections. Burned circuit boards. Burned, broken, or cracked circuit-run plating.	Remove and replace damaged circuit board.
Resistors	Burned, cracked, broken, blistered condition.	Remove and replace damaged circuit board.

Table 8: Internal inspection checklist (cont.)

Item	Inspect for	Repair action
Solder connections	Cold solder or rosin joints.	Resolder joint and clean with isopropyl alcohol.
Capacitors	Damaged or leaking cases. Corroded solder on leads or terminals.	Remove and replace damaged circuit board.
Wiring and cables	Loose plugs or connectors. Burned, broken, or frayed wiring.	Firmly seat connectors. Repair or replace modules with defective wires or cables.
Chassis	Dents, deformations, and damaged hardware.	Straighten, repair, or replace defective hardware.

Cleaning procedure – interior. To clean the instrument interior, perform the following steps:

1. Blow off dust with dry, low-pressure, deionized air (approximately 9 psi).
2. Remove any remaining dust with a lint-free cloth dampened in isopropyl alcohol (75% solution) and rinse with warm deionized water. (A cotton-tipped applicator is useful for cleaning in narrow spaces and on circuit boards.)

STOP. *If, after doing steps 1 and 2, a module is clean upon inspection, skip the remaining steps.*

3. If steps 1 and 2 do not remove all the dust or dirt, the instrument may be spray washed using a solution of 75% isopropyl alcohol by doing steps 4 through 6.
4. Gain access to the parts to be cleaned by removing easily accessible shields and panels.
5. Spray wash dirty parts with the isopropyl alcohol and wait 60 seconds for the majority of the alcohol to evaporate.
6. Dry all parts with low-pressure, deionized air.

Lubrication. There is no periodic lubrication required for the instrument.

Remove and replace procedures

This section contains procedures for removal and installation of customer-replaceable modules in the SPG8000. Any electrical or mechanical module, assembly, or part listed in the *Replaceable parts list* section of this manual is a module.

Preparation.



WARNING. Before performing this or any other procedure in this manual, read the General safety summary and the Service safety summary found at the beginning of this manual. Also, to prevent possible damage to the SPG8000 components, read the information on preventing ESD in this section. (See page 35, *Electrostatic damage prevention*.)

This subsection contains the following items:

- List of equipment required to remove and disassemble all modules.
- A module locator diagram for finding the replaceable modules in the SPG8000. (See Figure 13.)
- Interconnect illustrations and tables, showing where to reconnect cables after removal. (See page 42, *Interconnect illustrations*.)
- Procedures for removal and reinstallation of the electrical and mechanical modules.



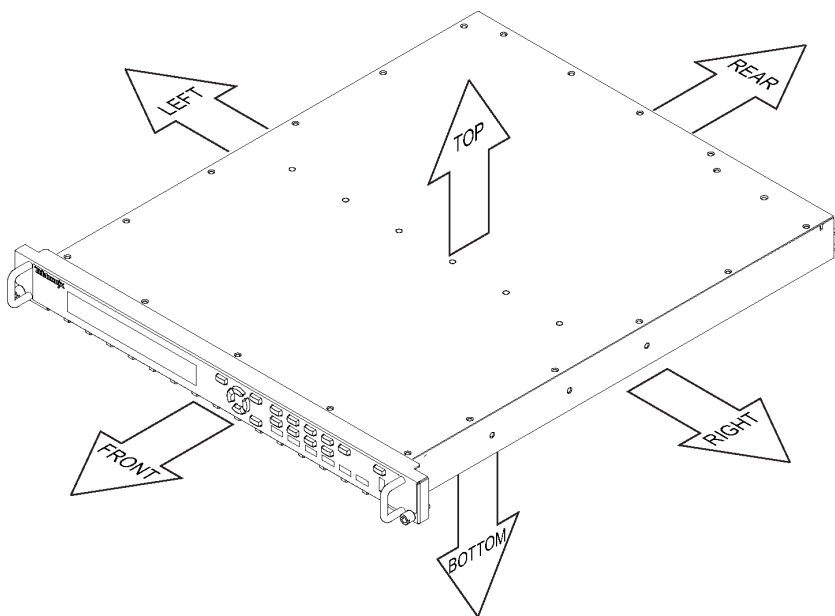
WARNING. Before performing any procedure in this subsection, disconnect the power cord from the line voltage source. Failure to do so could cause serious injury or death.

Required equipment. Many of the modules in the SPG8000 can be removed with a screwdriver handle mounted with a #2 Phillips tip. Use this tool whenever a procedure step instructs you to remove or install a screw unless a different size screwdriver is specified in that step.

Table 9: Required tools for removal and replacement of modules

Name	Description
Screwdriver handle	Accepts Phillips-driver bits
#1 and #2 Phillips tips	Phillips-driver bits for #1 and #2 size screw heads
Torque driver	Accepts 1/4 inch screwdriver bits. Torque range of 5 to 14 in/lb.
T10 TORX tip	TORX driver bit for T10 size screw heads.
T15 TORX tip	TORX driver bit for T15 size screw heads.
3/16" socket	Socket or nut driver to remove jackscrews from DSUB connector.
Nut driver, 9/16"	Wrench or deep nut driver, to remove nuts from BNC connectors
Nut driver, 7/32"	Wrench or deep nut driver, to remove nuts from bracket securing the SDI output modules.
Flat-blade screwdriver	Blade should be at approximately 1/4" wide. For disconnecting circuit boards from the Main board.
Terminator, BNC, closed	Used for pulling the Genlock/Black generator board from the instrument

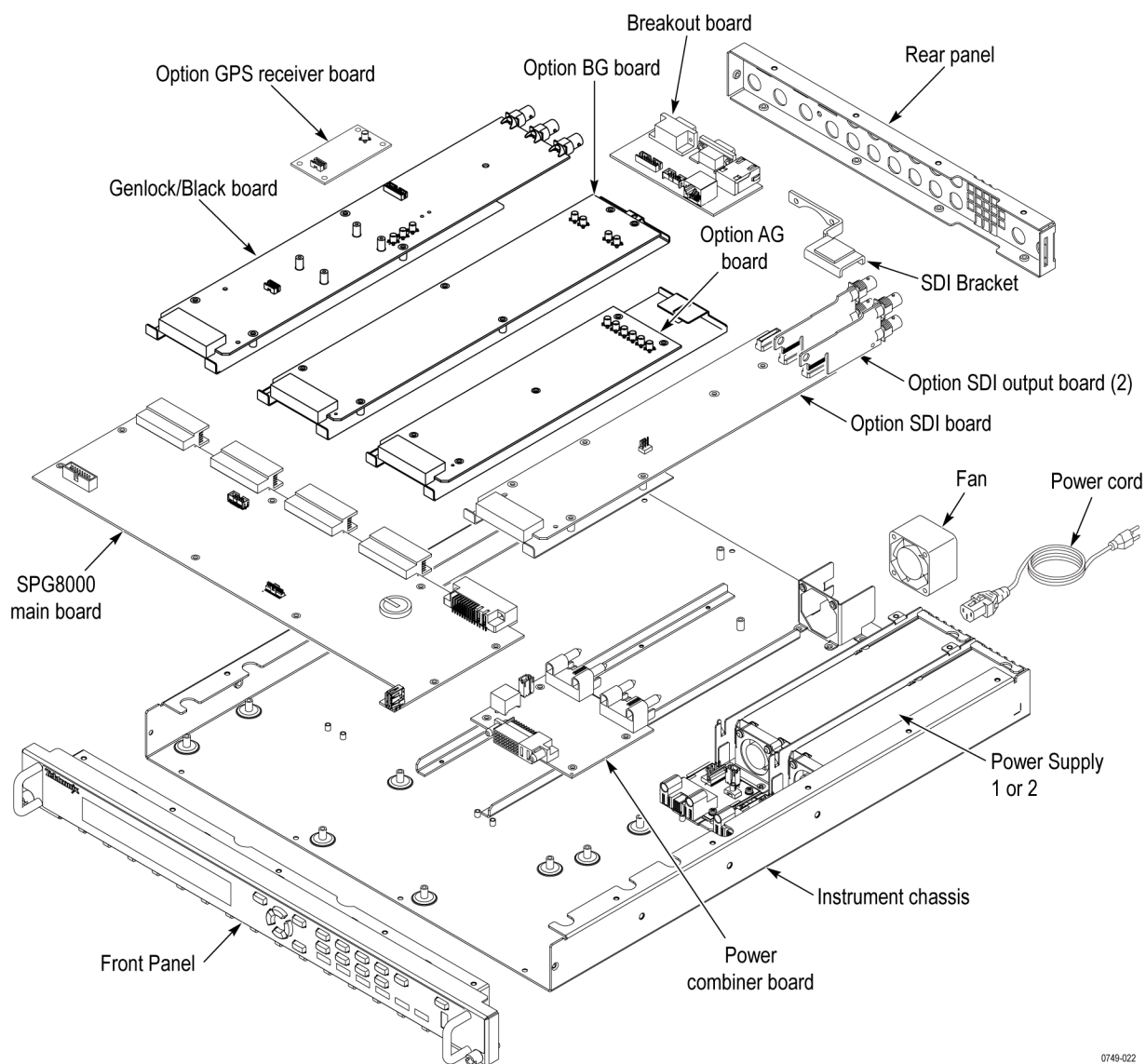
Instrument orientation. In this manual, procedures refer to "front," "rear," "top," etc. of the instrument. The following figure shows how the sides are referenced.



0749-011

Figure 12: Instrument orientation

Module locations. The following figure shows the location of the replaceable modules in the SPG8000.



0749-022

Figure 13: Module locator diagram

Interconnect illustrations The following illustrations and tables show where to reconnect cables.

Table 10: Cable connections table 1 of 3

Figure number	Rear-panel connector	Connects to
14- 1	SILENCE	J440 on AG board
14-2	WORD CLK	J9 on Genlock/Black board
14-3	AES 5 & 6	J420 on AG board
14-4	AES 7 & 8	J430 on AG board
14-5	AES 1 & 2	J400 on AG board
14-6	AES 3 & 4	J410 on AG board
14-7	CMPST 1	J930 on BG board
14-8	CMPST 2	J980 on BG board
14-9	BLACK 4	J830 on BG board
14-10	BLACK 5	J880 on BG board
14-11	REF	J7 on Genlock/Black board
14-12	LOOP	J3 on Genlock/Black board

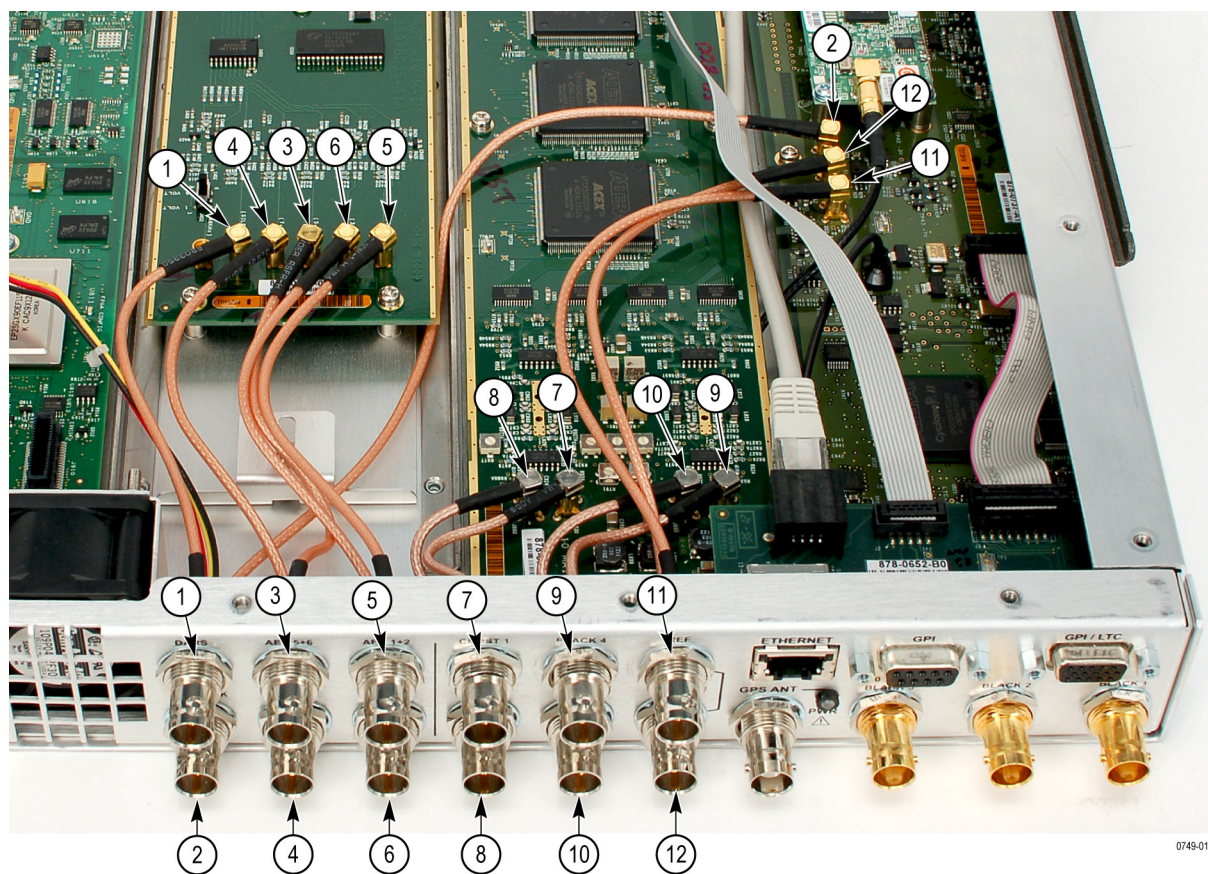


Figure 14: Cable connections 1 of 3

Table 11: Cable connections table 2 of 3

From		To	
Figure number	Description	Figure number	Description
15-1	Breakout board J1	16-2	Power combiner board JR101
15-2	Breakout board J2	16-4	Main board J703
15-3	Breakout board J3	16-4	Genlock/Black board J10
15-5	Light pipe header for the Antenna power indicator	Rear-panel	GPS ANT PWR rear-panel indicator
15-6	Option GPS Receiver board J1	Rear-panel	GPS ANT rear-panel connector
15-7	Option GPS Receiver board J4	15-8	Genlock/Black board J12

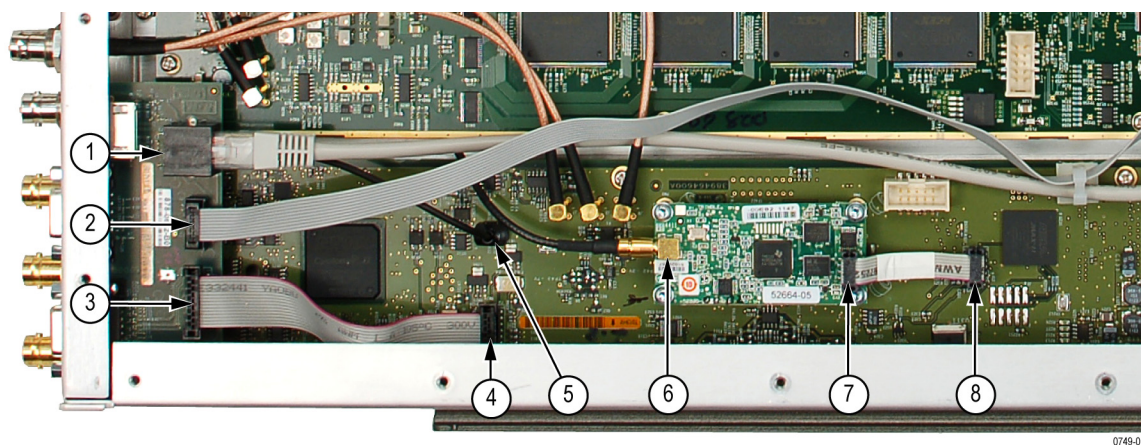
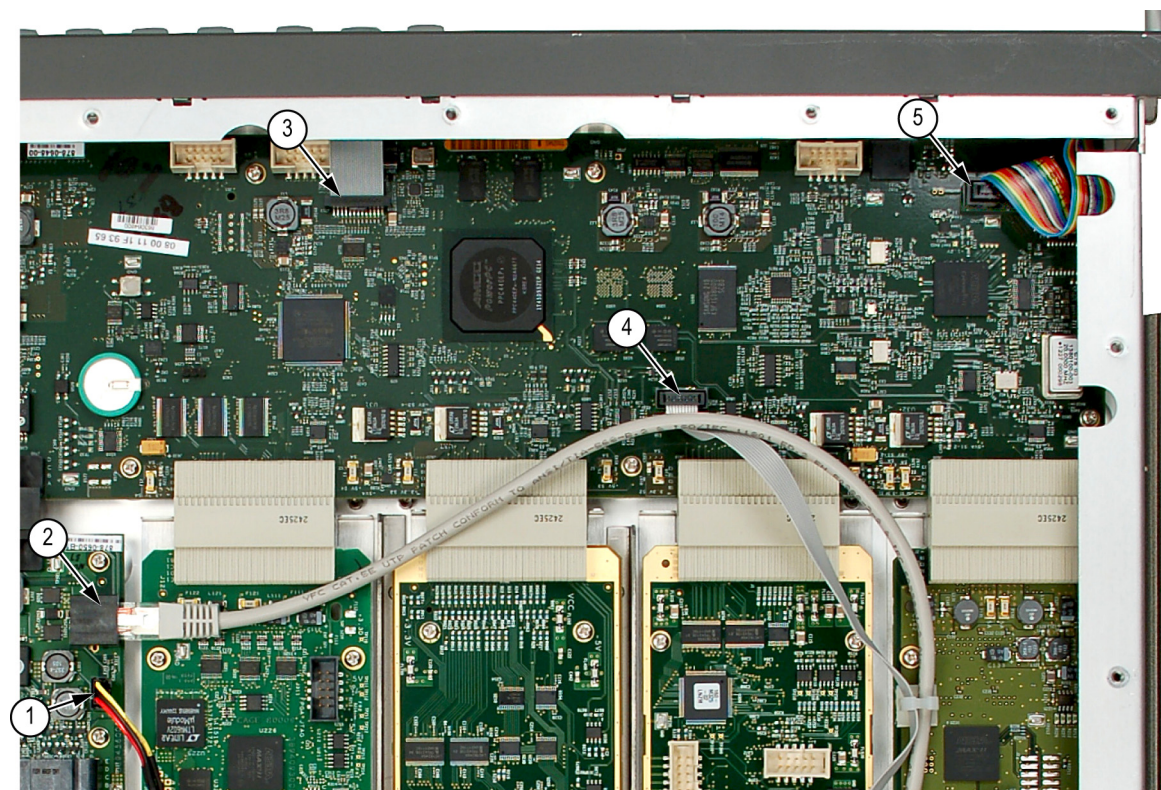


Figure 15: Cable connections 2 of 3

Table 12: Cable connections table 3 of 3

From		To	
Figure number	Description	Figure number	Description
16-1	Power combiner board J101	14-1	Fan cable from fan
16-2	Power combiner board JR101	15-1	Breakout board J1
16-3	Main board J711	(See Figure 18.)	Front panel board
16-4	Main board J703	15-2	Breakout board J2
16-5	Main board J725	(See Figure 18.)	Front panel board

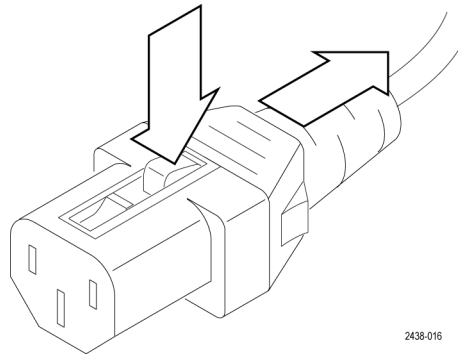


0749-018

Figure 16: Cable connections 3 of 3

Locking line cord

1. You need no equipment to perform this removal procedure. Locate the line cord in the locator diagram. (See Figure 13.)
2. Set the SPG8000 so the instrument bottom is down on the work surface and the rear is facing you.
3. Find the line cord on the rear panel. The locking cord has a release latch on the top that must be pressed to remove the cord. Grasp the plug, press the release latch, and pull the line cord and clamp away from the instrument.
4. To reinstall, insert the line cord into the power receptacle on the SPG8000 rear panel until it latches into place.



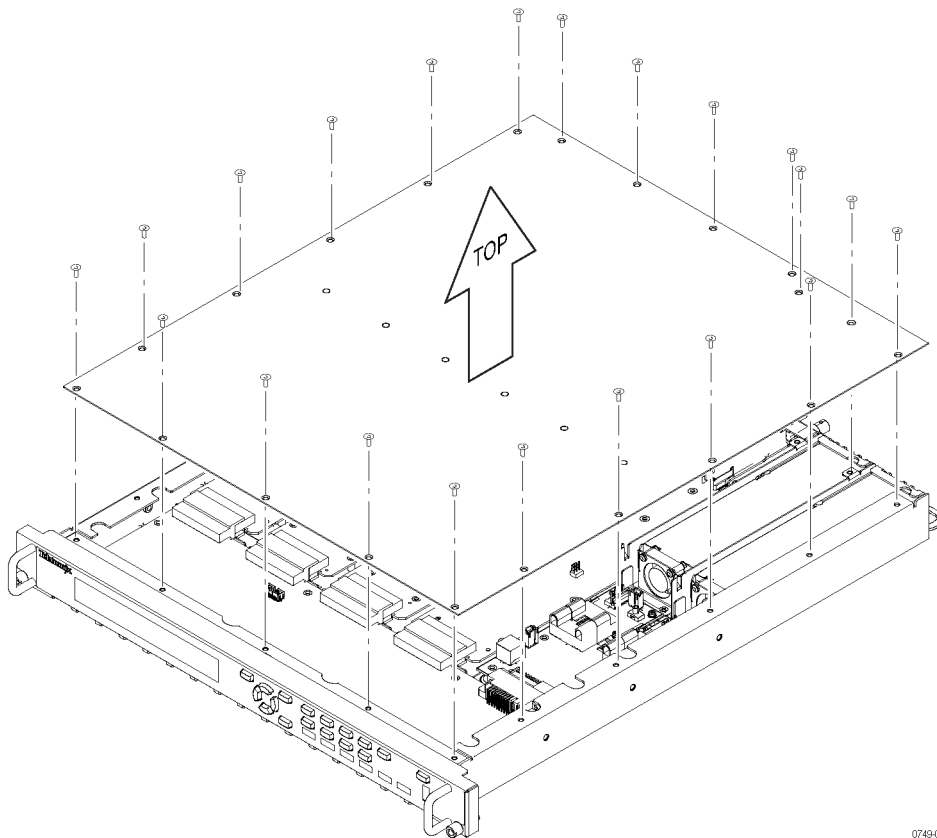
2438-016

Top cover



CAUTION. When handling circuit boards, follow the ESD instructions. (See page 35, *Electrostatic damage prevention.*)

1. Set the SPG8000 so that the bottom is down on the work surface and the rear is facing you.
2. Remove the top cover as follows:
 - a. Use a screwdriver with a #1 Phillips tip or #2 Phillips tip (depending on your unit) to remove the 22 screws securing the top over to the instrument.
 - b. Lift the top cover off the chassis. (See Figure 17.)
3. To reinstall the top cover, reverse the steps. Torque all screws to 5.5 in/lbs.



0749-013

Figure 17: Removing the top cover

Rear panel

The following steps identify which cables need to be disconnected and which nuts, washers, and screws need to be removed before removing the rear panel. Some of the rear-panel connectors will remain installed in the rear panel.

1. Position the instrument so that the top cover is on the work surface and the rear panel is facing you.
2. Use a screwdriver with a #1 or #2 Phillips tip to remove the four screws attaching the rear panel to the chassis.
3. Turn the instrument over so the bottom is on the work surface.
4. Remove the top cover. (See page 46, *Top cover*.)
5. Disconnect the following:
 - Locate all of the cables that connect to the rear panel and disconnect all of these cables where they attach to the boards (the cables are permanently attached to the BNCs). Refer to *Interconnect illustrations*. (See page 42, *Interconnect illustrations*.)
 - Do not remove the light pipe from the rear-panel antenna power indicator. Instead, pull the light pipe from the header on the Genlock/Black generator board. When you remove the rear panel, the light pipe will come with it. When you reinstall the rear panel, reattach the light pipe to the header on the Genlock/Black generator board.
 - Remove the jackscrews that hold the GPI and the GPI/LTC multi-pin connectors to the rear panel.
 - Use a 9/16" socket to remove the nuts and lock-washers from the gold rear-panel connectors labeled: BLACK 1, BLACK 2, BLACK 3, SDI 1A, SDI 2A, SDI 1B, and SDI 2B. This will allow the rear-panel to slide off the chassis. These BNCs will remain attached to the circuit boards, while the remaining BNCs will remain attached to the rear panel.
6. Pull the rear panel straight out from the chassis, carefully sliding the rear panel over the gold and multi-pin connectors that remain attached to the instrument.
7. To reinstall, reverse the procedure. Tighten the nuts on the BNCs to 14 in/lbs. Tighten the screws that attach the rear panel to the chassis, to 4 in/lbs.

- Main fan** To remove and replace the chassis fan, follow these instructions:
1. Locate the chassis fan in the locator diagram. (See Figure 13 on page 41.)
 2. Remove the instrument rear panel. (See page 47, *Rear panel*.)
 3. Remove the two screws that attach the fan to the fan bracket and slide the fan out of the bracket.
 4. To replace the fan, disconnect the cable from the Power Combiner board and reverse the procedure.

- Front panel assembly**
1. Locate the Front Panel assembly in the locator diagram. (See Figure 13 on page 41.)
 2. Remove the top cover. (See page 46, *Top cover*.)



CAUTION. *To prevent damage to the USB connector, use care when removing the Front Panel assembly. It is recommended that you remove the screws from the bottom of the instrument before you turn the instrument over to remove the side screws. This will prevent the Front Panel assembly from moving and damaging the USB connector.*

3. Remove the Front Panel assembly as follows: (See Figure 18.)
 - a. Set the instrument top down on the work surface with the front facing you.
 - b. Use a screwdriver with a #2 Phillips tip to remove the four screws securing the Front Panel assembly to the bottom of the instrument chassis.
 - c. Turn the instrument bottom down on the work surface with the front facing you.
 - d. Use a screwdriver with a #2 Phillips tip to remove the two screws securing the Front Panel assembly to the side of the chassis (one screw on each side).
 - e. Disconnect the cables at J711 and J725 on the Main board.
 - f. Grasp the Front Panel assembly and carefully pull it forward over the USB connector so that you do not damage the connector.
4. To reinstall the Front Panel assembly, perform steps 2 through 3 in reverse order. Torque all screws to 5.5 in/lbs.

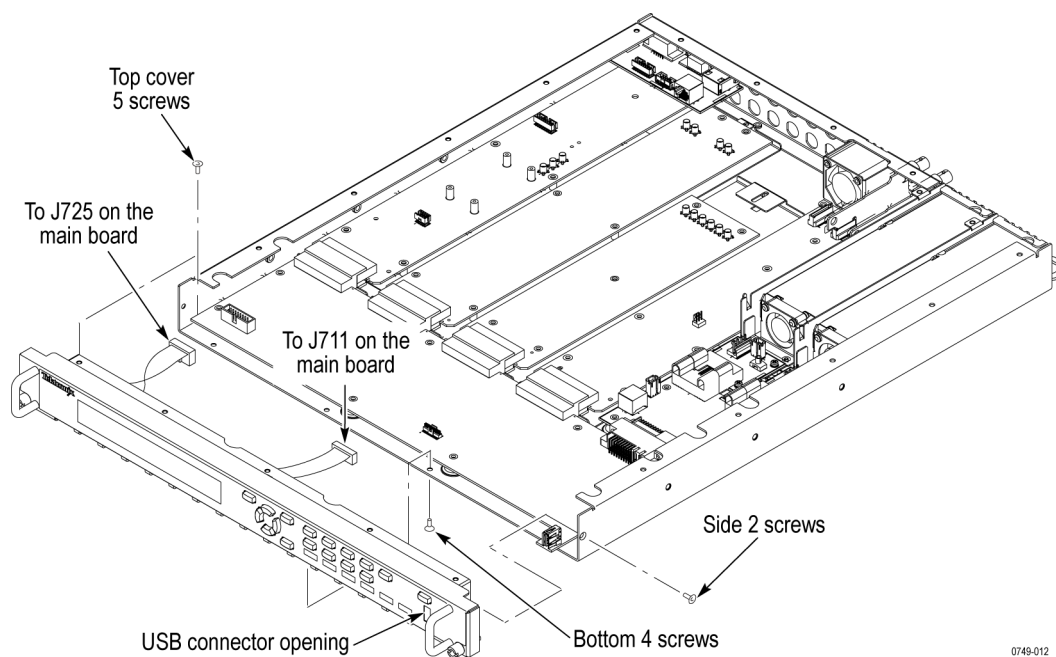


Figure 18: Removing the front panel assembly

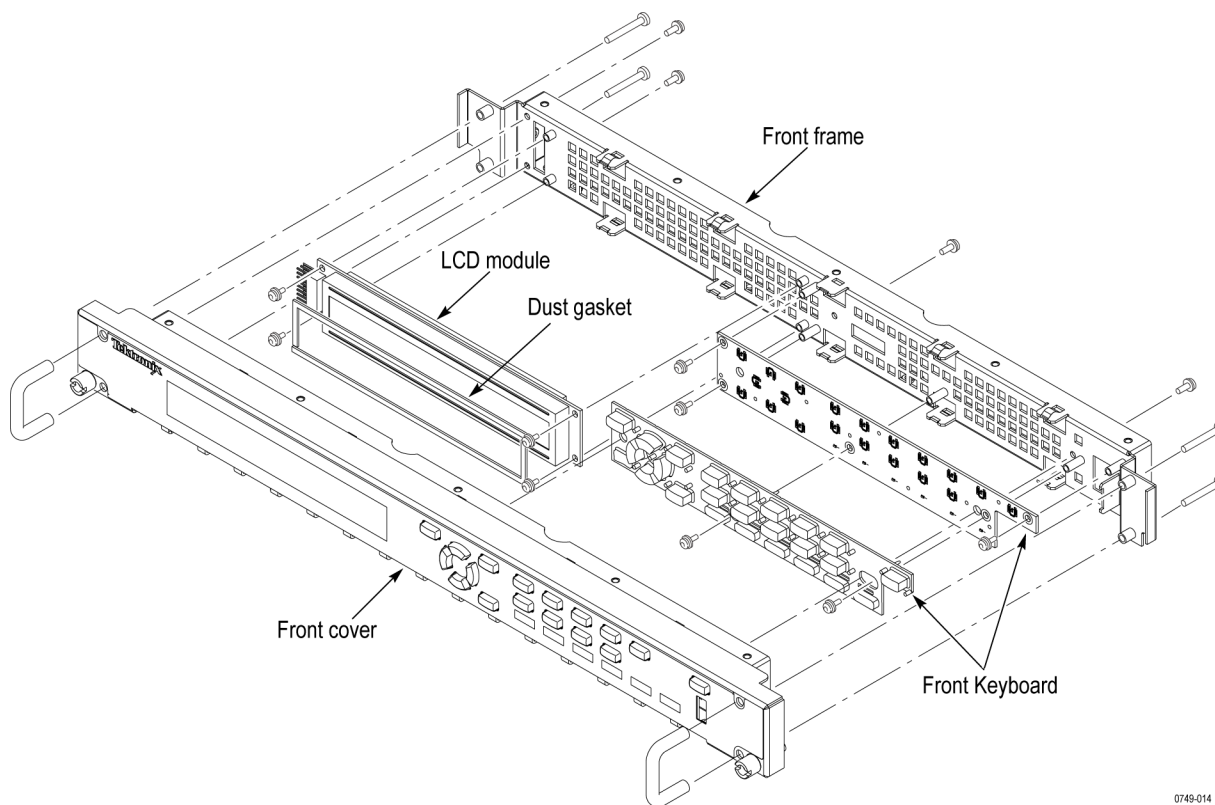
Front panel subassemblies

1. Remove the Front Panel assembly. (See page 48, *Front panel assembly*.)
2. Set the Front Panel assembly so that you can access the screws on the back side of the assembly.



CAUTION. To prevent dirt from being trapped between the LCD display and the front cover, keep the back of the Lexan cover clean while you are disassembling the Front Panel assembly.

3. Remove the front cover as follows. (See Figure 19.)
 - a. Use a screwdriver with a TORX T15 tip to remove the four screws securing the U-shaped handles to the front cover (two screws on each side).
 - b. Use a screwdriver with a #2 Phillips tip to remove the four screws securing the front cover to the front frame.
 - c. Grasp the front cover and pull it forward.



0749-014

Figure 19: Disassembling the front panel assembly

4. Remove the Front Panel Keyboard as follows.(See Figure 19.)
 - a. Use a screwdriver with a #2 Phillips tip to remove the four screws securing the keyboard to the front frame.
 - b. Lift the board away.
 - c. To remove the keypad from the board, carefully pull up on the keypad. There are eight tails from the keypad that extend through to the back side of the board.



CAUTION. *To prevent dirt from being trapped between the LCD display and the front cover, keep the LCD display clean while you are disassembling the Front Panel assembly.*

5. Remove the LCD module as follows. (See Figure 19.)
 - a. Use a screwdriver with a #2 Phillips tip to remove the four screws securing the LCD module to the front frame.
 - b. Lift the board away.
6. If necessary, hand disassemble any remaining components of the Front Panel assembly.
7. To reinstall the Front Panel assembly:

NOTE. *The connector on the display is not polarized, so be careful to attach it as described.*

- a. Attach the cable to the LCD by connecting pin 1 to the brown wire at the edge of the cable. This must be at the bottom of the instrument. If necessary, swap ends on the cable so that you can route it back toward the Main board, while keeping pin 1 down.

NOTE. *If you are replacing the LCD, you must add the dust gasket. Refer to the exploded view. (See Figure 32.)*

- c. Perform steps 1 through 6 in reverse order.
- d. Torque all screws to 5.5 in/lbs.
8. The connector on the display is not polarized so you must be careful how it connected. Pin 1 is connected to the brown wire at the edge of the cable. This must be at the bottom of the instrument. If necessary, swap ends on the cable to make it route back toward the Main board, while keeping pin 1 down.

Power supply There can be one or two power supplies installed in the SPG8000. If only one is installed, it should be in slot one. The power module blank cover should be installed in the other slot.

The power supply modules are replaced as a unit. There are no replaceable subassemblies.



WARNING. *Disconnect the power cord before removing the rear panel.*

Disconnect the power cord when the power supply module is not installed. High voltage inside.

No tools are needed to remove the power supply. You do not need to remove the instrument cover. The power supply module slides out the rear of the instrument as a module. (See Figure 20.)

1. Disconnect the locking power cord.
2. Turn the power supply handle to the left.
3. Push the metal tab under the STATUS light to the left.
4. While holding that tab to the left, use the handle to pull the power supply module out of the instrument.
5. To replace the power supply, reverse the procedure.

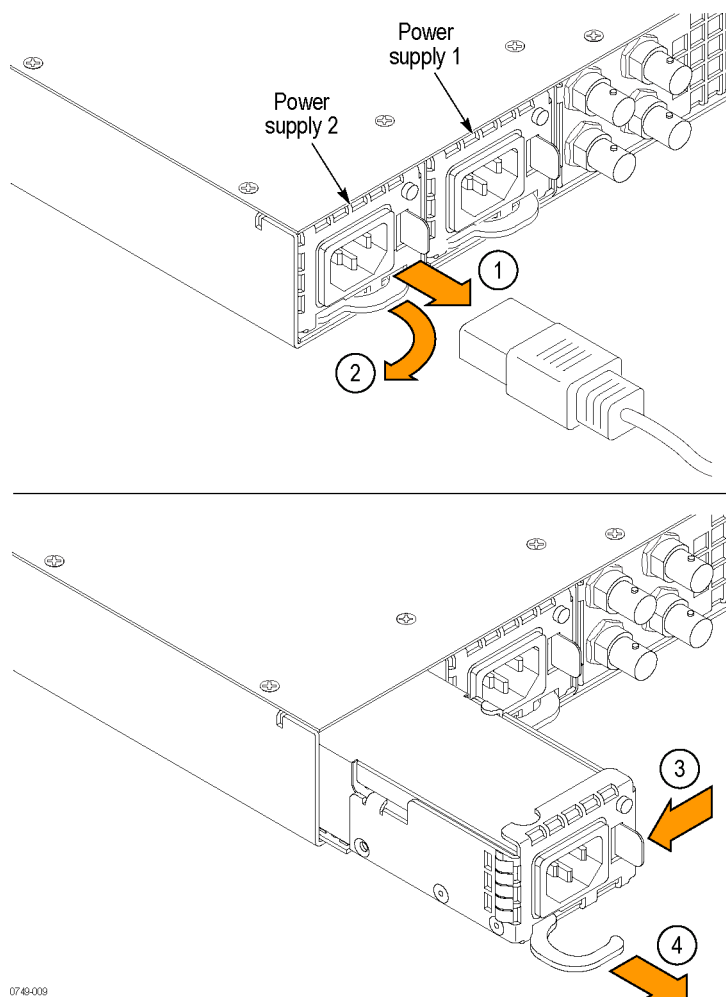


Figure 20: Removing the power supply

Power Combiner board

The power combiner board combines the power from the two power supplies and provides connections for the fan and Ethernet.

1. Remove all power supply modules from the instrument. (See page 52, *Power supply*.) The power supply modules will disconnect from the Power Combiner board. (See Figure 21.)
2. Remove the instrument top cover. (See page 46, *Top cover*.)
3. Disconnect the two cables from the Power Combiner board.
4. Remove the four screws that attach the Power Combiner board to the instrument chassis.

5. Pull the Power Combiner board away from the Main board connectors and out of the instrument.
6. To replace the board, reverse the procedure. To reconnect the cables, see the interconnect illustrations. (See page 42, *Interconnect illustrations*.)

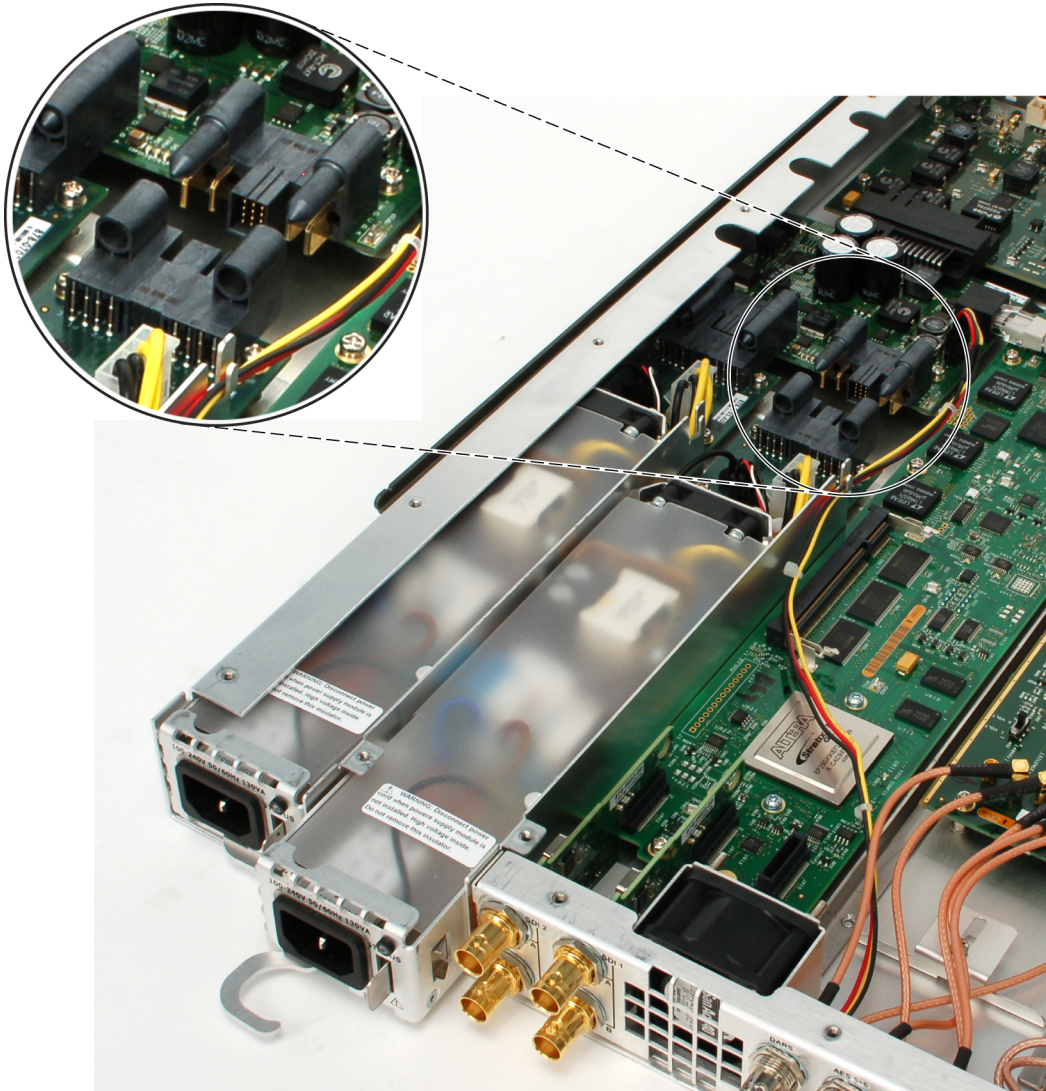


Figure 21: Removing the Power Combiner board

- Main board**
1. Locate the Main board in the locator diagram. (See Figure 13.) Refer also to the exploded view diagram for more details. (See Figure 31.)
 2. Remove the Front Panel assembly. This is required because of the USB connector on the Main board. (See page 48, *Front panel assembly*.)
 3. Remove the Power Supply module(s). (See page 52, *Power supply*.)
 4. Remove the Power Combiner board. (See page 53, *Power Combiner board*.)
 5. Remove the rear panel. (See page 47, *Rear panel*.)
 6. Remove the Genlock/Black generator assembly. (See page 59, *Genlock/Black board and Option GPS board*.)
 7. Remove all installed option boards. (See page 57, *Option AG board*.) (See page 62, *Option SDI board and Option SDI Output boards*.)
 8. Verify that all cables are disconnected from the Main board.
 9. Set the instrument bottom down on the work surface with the right side facing you.
 10. Remove the Main board as follows.
 - a. Use a screwdriver with a #2 Phillips tip to remove the eight screws securing the Main board to the chassis.
 - b. Lift the board up and away from the chassis.
 11. To replace the Main board, perform steps 2 through 10 in reverse order. Torque all screws to 5.5 in/lbs.

- Breakout board**
- To remove and replace the Breakout board, follow these instructions:
1. Remove the jackscrews from the DSUB connectors on the rear panel.
 2. Disconnect the three cables from the Breakout board. (See page 42, *Interconnect illustrations*.)
 3. Remove the board from the instrument. (See Figure 31.)
 4. Reverse the steps to reinstall the Breakout board. To connect the cables, see the interconnect illustrations. (See page 42, *Interconnect illustrations*.)

Option BG board You can remove and replace the Option BG board, the mounting plate under the board, and the associated rear-panel connectors.

To remove the Option BG board.

1. Remove the rear panel. (See page 47, *Rear panel*.)
2. The circuit board is installed on top of a metal mounting plate, or “sled.” Do not remove the screws that attach the board to the plate at this time. There is one screw near the rear of the mounting plate that attaches the it to the SPG8000 chassis. Remove only that one screw.
3. Verify that all necessary cables are disconnected and that you have a clear path to slide the board and mounting plate assembly from the rear of the instrument.



CAUTION. *Circuit boards are sensitive to pressure. When disconnecting the option boards from the Main board, be careful not to exert pressure on any circuit board.*

5. Loosen the Option BG circuit board from the Main board. Pull the option board straight out the rear of the chassis and place it on a static-free surface.

To replace the Option BG board.

1. Make sure that your replacement board is installed on the mounting plate.
2. Starting with the rear panel removed, slide the replacement assembly into a position that is close to where it will connect to the Main board. See the Module locator diagram. (See Figure 13.)
3. Line up the connector on the replacement assembly with the corresponding connector on the Main board. Make sure that the pins line up and are not offset.
4. Mate the connectors on the Main board with the new board connectors by “pinching” them together.
5. Install the screw that attaches replacement assembly (near the rear of the mounting plate) to the instrument chassis.
6. Replace the instrument rear panel and all nuts and locking washers that were removed from the rear panel.
7. Connect all cables that were disconnected during the removal.

To remove an Option BG rear-panel connector.

All of the rear-panel connectors associated with the Option BG are replaceable. These connectors are labeled: BLACK 4, BLACK 5, CMPST1, and CMPST2. To replace one of these connectors, follow these steps:

1. Use the 9/16" nut driver to remove the nut securing the damaged connector to the rear panel. Remove the lock washer.
2. On the inside of the chassis, follow the cable that is attached to the BNC you are removing. Disconnect that cable from the circuit board jumper. Refer to the *Interconnect illustrations*. (See page 42, *Interconnect illustrations*.)
3. Push the BNC inward and remove the cable assembly.
4. Replace the BNC/cable assembly by reversing the steps.
5. Tighten the BNC connector to 14 in/lbs.

To remove the Option BG mounting plate. To remove the mounting plate, follow the procedure for removing a mounting plate. (See page 66, *Mounting plate*.)

Option AG board

You can remove and replace the Option AG board, the mounting plate under the board, and the associated rear-panel connectors.

To remove the Option AG board.

1. Remove the top cover. (See page 46, *Top cover*.)
2. The circuit board is installed on top of a metal mounting plate, or "sled." Do not remove the screws that attach the board to the plate at this time. There is one screw near the rear of the mounting plate that attaches the it to the SPG8000 chassis. Remove only that one screw.
3. Verify that all necessary cables are disconnected and that you have a clear path to slide the board and mounting plate assembly out of the instrument.



CAUTION. *Circuit boards are sensitive to pressure. When disconnecting the option boards from the Main board, be careful not to exert pressure on any circuit board.*

5. Loosen the Option AG circuit board from the Main board. Pull the option board out of the instrument and place it on a static-free surface.

To replace the Option AG board.

1. Make sure that your replacement board is installed on the mounting plate.
2. Place the replacement assembly into a position that is close to where it will connect to the Main board. See the Module locator diagram. (See Figure 13.)
3. Line up the connector on the replacement assembly with the corresponding connector on the Main board. Make sure that the pins line up and are not offset.
4. Mate the connectors on the Main board with the new board connectors by “pinching” them together.
5. Install the screw that attaches replacement assembly (near the rear of the mounting plate) to the instrument chassis.
6. Replace the instrument rear panel and all nuts and locking washers that were removed from the rear panel.
7. Connect all cables that were disconnected during the removal.

To remove an Option AG rear-panel connector.

All of the rear-panel connectors associated with the Option AG are replaceable. These connectors are labeled: AES1+2, AES 3+4, AES 5+6, AES 7+8, Silence. To replace one of these connectors, follow these steps:

1. Use the 9/16” nut driver to remove the nut securing the damaged connector to the rear panel. Remove the lock washer.
2. On the inside of the chassis, follow the cable that is attached to the BNC you are removing. Disconnect that cable from the circuit board jumper. Refer to *Interconnect illustrations*. (See page 42, *Interconnect illustrations*.)
3. Push the BNC inward and remove the cable assembly.
4. Replace the BNC/cable assembly by reversing the steps.
5. Tighten the BNC connector to 14 in/lbs.

To remove the Option AG mounting plate. To remove the mounting plate, follow the procedure for removing a mounting plate. (See page 66, *Mounting plate*.)

**Genlock/Black board and
Option GPS board**

You can replace the Genlock/Black board, the Option GPS Receiver board, the GPS ANT rear-panel connector, the light pipe connector, and the Genlock/Black board mounting plate. The high-speed BLACK 1, BLACK 2, and BLACK 3 connectors are not replaceable.

NOTE. *If the genlock/black board is replaced, the system must be locked up to GPS or GLONASS at least 15 minutes to initialize some variables such as the leap seconds. If you do not have option GPS installed, you must at least temporarily install Option GPS, and allow the instrument to capture the leap seconds.*

To remove the Genlock/Black board.

1. Remove the rear panel. (See page 47, *Rear panel*.)
2. The Genlock/Black board is installed on top of a metal mounting plate, or “sled.” Do not remove the screws that attach the board to the plate at this time. (See Figure 35.)
3. Verify that all necessary cables are disconnected and that you have a clear path to slide the board and mounting plate assembly from the rear of the instrument.



CAUTION. *Circuit boards are sensitive to pressure. When disconnecting the option boards from the Main board, be careful not to exert pressure on the Main board.*

5. Loosen the Genlock/Black circuit board from the Main board. Pull the Genlock/Black board straight out the rear of the chassis and place it on a static-free surface.

To replace the Genlock/Black board.

1. If you have Option GPS, make sure that the Option GPS Receiver board is installed on your replacement Genlock/Black board. Verify that your replacement Genlock/Black board is installed on the mounting plate and that all screws attaching the board to the plate are installed. Verify that the light pipe header is installed on the board. This must be pressed in before the board is mounted on the sled.
2. Starting with the rear panel removed, slide the replacement Genlock/Black assembly into a position that is close to where it will connect to the Main board. See the Module locator diagram. (See Figure 13.)
3. Line up the connector on the replacement Genlock/Black assembly with the corresponding connector on the Main board. Make sure that the pins line up and are not offset.
4. Mate the connectors on the Main board with the replacement Genlock/Black board connectors by “pinching” them together.

5. Replace the rear panel and all nuts and locking washers that were removed from the rear panel.
6. Connect all cables that were disconnected. Refer to *Interconnect illustrations*. (See page 42, *Interconnect illustrations*.)

To remove and replace the Option GPS Receiver board. To remove and replace the Option GPS Receiver board, follow these instructions.

1. Remove the instrument top cover. (See page 46, *Top cover*.)
2. Disconnect the cables from the two connectors on the board. (See page 42, *Interconnect illustrations*.)
3. Use the torque driver (T10 tip) to remove the four screws connecting the receiver board to the Genlock/Black board and remove the Receiver board.
4. Reverse the procedure to replace the board. Tighten the screws to 8 in/lbs.

To remove and replace the rear-panel GPS ANT connector. To replace the GPS ANT connector, you will need to replace the BNC and the attached cable. Proceed as follows:

1. Remove the Breakout board. (See page 55, *Breakout board*.)
2. Remove the nut securing the damaged connector to the rear panel. Remove the lock washer.
3. On the inside of the chassis, follow the cable that is attached to the GPS ANT connector. Disconnect that cable from the circuit board. Refer to *Interconnect illustrations*. (See page 42, *Interconnect illustrations*.)
4. Push the BNC inward and remove the cable assembly.
5. Replace the BNC/cable assembly by reversing the steps.
6. Tighten the BNC connector to 14 in/lbs.

To remove and replace the light-pipe connector. To replace the light-pipe board connector, proceed as follows:



CAUTION. *Do not remove the light pipe board connector from the board unless you have a replacement board connector available. Removing the light pipe board connector damages it, so it cannot be reused.*

1. Pull the light pipe out of the board connector. This is a slip-fit and should come apart easily.
2. Remove the instrument rear panel. (See page 47, *Rear panel*.)
3. Move the instrument rear panel away from the chassis, pulling the light pipe out with it.
4. Pull the light pipe out of the light pipe lens in the external rear panel. This is a slip-fit and should come apart easily.
5. Gently remove the light pipe lens from the instrument rear panel.
6. When reassembling, follow this sequence:
 - a. Insert the light pipe into the new light pipe lens.
 - b. Thread the light pipe through the instrument rear panel until the lens is against the rear panel.
 - c. Gently push the light pipe lens into place in the rear panel.
 - d. Replace the instrument rear panel.
 - e. Plug the light pipe into the light pipe board connector.

To remove and replace the Genlock/Black board mounting plate. To remove the mounting plate, follow the procedure for removing a mounting plate. (See page 66, *Mounting plate*.)

Option SDI board and Option SDI Output boards

You can remove and replace the Option SDI board, the two Option SDI Output boards, and the Option SDI board mounting plate. The four gold rear-panel BNCs attached to the Option SDI board are not replaceable.

To remove and replace the bracket securing the SDI output boards.



WARNING. *Attaching and removing cables from the SDI Output boards can loosen them from the SDI board connectors. This can cause the pins between the output boards and SDI board connectors to not be fully engaged. The bracket attached to the chassis fan keeps the output boards connections secure.*

1. Remove the instrument top cover. (See page 46, *Top cover*.)
2. Remove the two nuts securing the bracket to the chassis fan screws using a 7/32 inch nut driver.

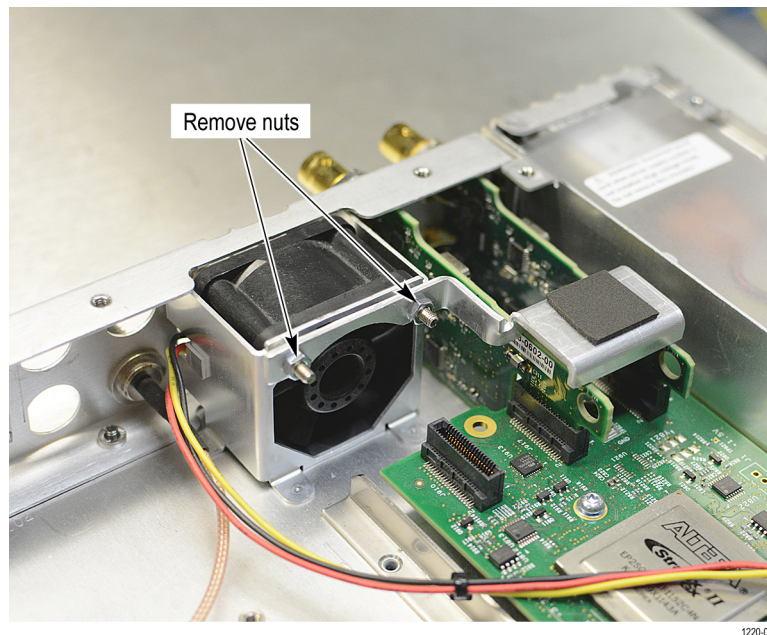


Figure 22: Remove the two nuts

3. Pull the bracket from the two extended screws on the chassis fan and remove it from the instrument.

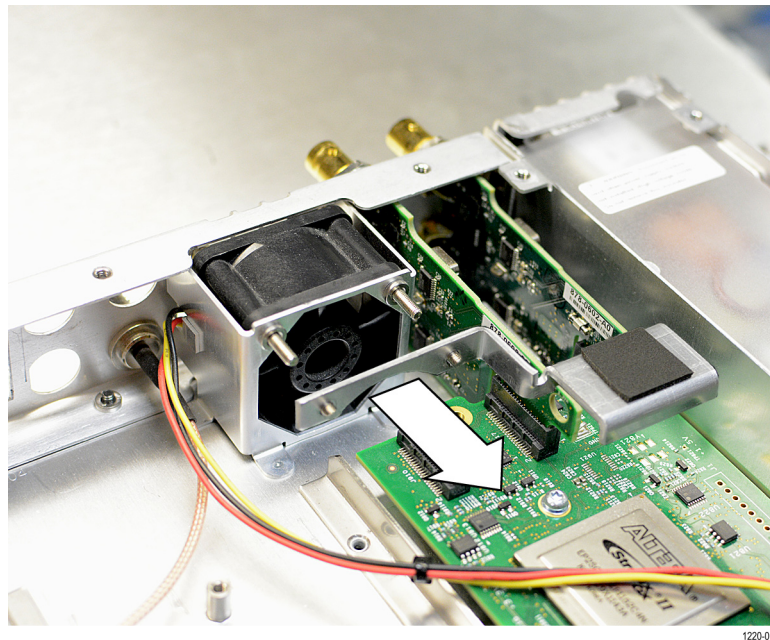


Figure 23: Remove the bracket from the fan

4. To replace the bracket reverse steps 1 through 3.

To remove and replace the Option SDI Output boards.



CAUTION. *These output boards contain sensitive components that are easily damaged. Be careful not to flex the boards as you remove them. Adhere to proper handling procedures, shown in the beginning of this section.*

1. Remove the SDI output board bracket. (See page 62, *To remove and replace the bracket securing the SDI output boards.*)
2. Remove the rear panel. (See page 47, *Rear panel.*)
3. Remove the output boards by carefully pulling them straight up and away from the Option SDI board.
4. Place the output boards on a static-safe surface.
5. To replace the output boards, handle them carefully, so that you do not flex the boards or touch the components on the boards. Install the output boards into J922 and J917 on the Option SDI board.
6. After replacement, secure the output boards to the SDI board with the bracket attached to the chassis fan.

To remove the Option SDI board.

1. Remove the SDI output board bracket. (See page 62, *To remove and replace the bracket securing the SDI output boards.*)
2. Remove the rear panel and the Option SDI Output Boards. (See page 63, *To remove and replace the Option SDI Output boards.*)
3. The Option SDI board is installed on a metal mounting plate, or “sled.” Do not remove the screws that attach the board to the mounting plate at this time. One screw near the rear of the chassis attaches the mounting plate to the chassis. Remove only that one screw.
4. Verify that all necessary cables are disconnected and that you have a clear path to slide the board and mounting plate assembly from the rear of the instrument.



CAUTION. *Circuit boards are sensitive to pressure. When disconnecting the option boards from the Main board, be careful not to exert pressure on the Main board.*

6. Loosen the Option SDI circuit board from the Main board. Pull the option board straight out the rear of the chassis and place it on a static-free surface.

To remove and replace the mounting plate or heat sink. Follow this procedure to remove and replace a heat sink or mounting plate for the Option SDI.

NOTE. *You can reuse a removed heat sink, but you must use a new gap pad.*

1. Remove the Option SDI board and sled from the instrument. (See page 62, *Option SDI board and Option SDI Output boards.*)
2. Remove the three screws attaching the heat sink to the mounting plate.
3. Remove the 7 screws that attach the SDI board to the mounting plate and heat sink (2 screws are next to the FPGA) and remove the board. Place the removed circuit board assembly on a static-free surface. Follow proper handling instructions for a circuit board. Instructions are provided at the beginning of this remove and replace section.
4. Turn the SDI board upside down and gently remove the heat sink. Be careful not to flex the circuit board. Clean any remaining parts of the old gap pad off the circuit board using alcohol. Allow the board to dry.
5. Install the new heat sink to the sled using the three screws.
6. Peel the protective film from one side of new the gap pad and install it on top of the heat sink.
7. Remove the film from the other side of the new gap pad.
8. Position the Option SDI board over the heat sink and gap pad, aligning the holes in the circuit board (on each side of the FPGA) with the threaded posts of the heat sink. Use care not to damage the gap pad.
9. Loosely install the two T10 TORX screws with English threads through the circuit board and into the heat sink. Do not tighten.
10. Loosely install the 5 additional screws (Phillips head metric) that attach the circuit board to the mounting plate.
11. Tighten all 7 screws attaching the Option SDI board to the mounting plate and torque to 5.5 in/lb.

To replace the Option SDI board.

1. Verify that the Option SDI board is installed on the metal mounting plate.
2. Starting with the rear panel removed, slide the replacement Option SDI assembly into a position that is close to where it will connect to the Main board, as shown in the module locator diagram. (See Figure 13.)
3. Line up the connector on the replacement Option SDI board with the corresponding connector on the Main board. Make sure that the pins line up and are not offset.
4. Mate the connectors on the Main board with the replacement board connectors by “pinching” them together.
5. Install the two SDI Output boards in connectors J922 and J917 on the Option SDI board.
6. Reinstall the rear panel and all of the nuts and lock washers that were removed from the rear panel.
7. Install the screw that attaches the Option SDI assembly (near the rear of the mounting plate) to the chassis.
8. Reinstall the bracket that secures the SDI output boards by reversing the remove procedure for the bracket. (See page 62.)
9. Connect all cables that were disconnected. Refer to *Interconnect illustrations*. (See page 42, *Interconnect illustrations*.)
10. Replace the instrument top cover.

Mounting plate

The Genlock/Black, Option BG, and Option AG are mounted on a metal mounting plate or “sled”. This piece protects the circuit board from being flexed during installation or removal. If you need to replace this mounting plate, follow these instructions:

1. Remove the circuit board assembly from the instrument. See the remove and replace instructions for that board. (See page 59, *Genlock/Black board and Option GPS board*.) (See page 57, *Option AG board*.) (See page 56, *Option BG board*.)
2. Remove the screws that attach the circuit board to the mounting plate. (Genlock/Black board 4 screws, Option BG board 6 screws, Option AG board 5 screws).
3. Carefully remove the circuit board from the mounting plate and place the circuit board on a static-safe surface. Do not flex the circuit board.
4. To replace the mounting plate, reverse the procedure. Tighten the screws to 5.5 in/lbs.

Troubleshooting

This section contains information about how to troubleshoot instrument problems in order to isolate faulty modules in the SPG8000.

Diagnostics and performance checks

When troubleshooting an unknown instrument problem, perform the performance verification procedures for the SPG8000 and installed options. If the problem is known, run only the diagnostic portion of the performance verification procedures to gain information about the subsystems. (See the *SPG8000 Specifications and Performance Verification Technical Reference* manual.)

Included in the performance verification procedures are instructions for running and viewing the SPG8000 internal diagnostics. The diagnostics include the following:

- Readouts of tests including power-on diagnostics, clock frequencies, temperatures, Main board and slot voltages, and fan speed
- Read/write tests for the signal memory of Option BG.
- Diagnostics for Genlock/Black, Option GPS, and Option SDI
- Slot diagnostics to test the power supply and signal connections on the Main board I/O slot connectors.

If the message **Fail: "a module name" Diag error** is displayed, replace the module.

Event Log

The Event Log records when some types of events occur. These events can be normal or they may indicate an issue. The exact use of the event log for troubleshooting will vary with the type of problem. The event log is especially useful in finding intermittent problems or problems that can be correlated to outside events by the log time stamps. See the *SPG8000 Quick Start User Manual* for details on the types of events recorded in the Event Log.

Back up your instrument settings



CAUTION. *After you execute the diagnostics, you will need to cycle power on the instrument. If you have not saved the instrument settings, be sure to save the current instrument settings to a preset, and then recall the settings after the diagnostic tests are completed.*

1. Press the **SYSTEM** button.
2. Press the up (▲) or down (▼) arrow button to select **PRESET**.
3. Press the **ENTER** button.
4. Press the up (▲) or down (▼) arrow button to select **SAVE**.
5. Press the left (◀) or right (▶) arrow button to select the preset number to which you will save the instrument settings.
6. Press the **ENTER** button.

To power up in factory mode

Putting the instrument into factory mode allows access to calibration, and it allows the module to show in the menus even if it fails the POST routine. When you perform a procedure that requires you to restart the instrument in factory mode, proceed as follows:

1. Press and hold the **STATUS**, **ENTER**, and **Front Panel ENABLE** buttons simultaneously.
2. Continue holding the buttons until the message **SPG8000 Booting...** displays.
3. When the message **SPG8000 Booting...** displays, while continuing to hold the **Front Panel ENABLE** button, release the **STATUS** and **ENTER** buttons.
4. When the message **SPG8000 Start up with Factory Mode** displays, release the **Front Panel ENABLE** button.

Oscillator calibration

The diagnostic readouts in the **SYSTEM : DIAGNOSTICS** menu include readouts for Tune and Cal, which are related to the oscillator calibration as described below:

- **TUNE** The Tune readout indicates how far the system is being pulled from the calibrated internal frequency value in order to lock to an external reference. If you use Option GPS or an AGL7 module installed in a TG8000 generator to lock to a video source that is 5 parts per million high, the tune will say +5e-6. This allows you to measure the frequency of the reference input and to see if the input is near the end of the available tuning range. If the system is in internal mode, the tune value should be 0.00 e-6 and the integer values will equal the calibration value.

The integer values indicate the actual tuning control word. The allowed range of this tuning word is 0 to 4,194,304. The first number is the actual value at the present time, and the second value is the target value for the control loop. In most cases, these two values are the same. However, when the system must make a large frequency change (depending on instrument mode), the value may slew slowly to the target value to stay inside the allowed slew rate for reference systems. In this case, the first value will slew over seconds or minutes until it equals the second value. If the instrument is taking a long time to lock, this display may provide valuable information about what is happening.

The Tune diagnostic readout allows you to see if the instrument must be calibrated. If the instrument is locked to a traceable reference, any tune value indicates error in the instrument calibration. For example, if the instrument is locked to GPS or GLONASS and the Tune is more than 0.1 e-6, you should consider calibrating the internal frequency of the instrument. This can be done in service with no disruption to the operation. See the Oven oscillator calibration procedure in the *SPG8000 Quick Start Manual* for instructions.

- **CALIBRATION** This readout represents the correction applied to the oven oscillator clock to calibrate the frequency when in internal mode. The integer value is the tuning control word to make this happen. An example readout is “0.59e-6”. This is the fractional correction being applied, which in this case this is 0.59 parts in 1 million. When the instrument calibration is performed, this number will typically change.

Over the life of the oven, the expected drift is $\pm 2.5 \text{ e-6}$, so this number should always be in this range. If the number is not in this range, the instrument may have been miscalibrated or the oven may have drifted out of specification. See the Oven oscillator calibration procedure in the *SPG8000 Quick Start Manual* for instructions.

Slot I/O Test The Slot I/O test runs diagnostics on the busses between the main instrument and the generator modules. This test provides a message that tells whether the slot passed, and if not, provides an error code. The error codes and meanings are shown in the table. (See Table 13.)

To run the slot I/O test.

1. Power up the instrument in factory mode. (See page 105, *To power up in factory mode.*)
2. Press the **SYSTEM** button.
3. Use the up (▲) or down (▼) arrow button to select **DIAGNOSTICS**.
4. Press **ENTER**.
5. Use the up (▲) or down (▼) arrow button to select **SLOT I/O**.
6. Press **ENTER** to run.
7. Check to see whether the slot passed the test, or whether there is an error message to help you troubleshoot the problem.

Table 13: Slot I/O test error codes

Error code	Description
1	Data Bus Test 1
1A	Data Bus Test 2
2	Data Bus Test 3
3	Data Bus Test 4
4	Data Bus Test 5
5	Data Bus Test 6
6	Address Bus Test 1
7	Address Bus Test 2
8	Address Bus Test 3
9	MCLK Test
A	ACLK Test
B	54 MHz CLK test
C	74.176 MHz CLK test
BC	Frame 0 / 54 and 74.176 MHz clock test
D	54 MHz CLK test
E	74.25 MHz CLK test
DE	Frame 1 / 54 and 74.25 MHz clock test
F	Frame 2 / 54 MHz test
10	Genlock Frame test
11	+5 V test

Table 13: Slot I/O test error codes (cont.)

Error code	Description
12	+8 V test
13	–5 V and +3.3 V test
14	IRQ signal test
99	Incorrect Hardware configuration

SPG8000 diagnostics

The following table lists the diagnostics that are available in the SPG8000. (See Table 14.) The diagnostic type is accessed using the up and down arrow buttons (▲ / ▼). The tests are accessed using the left and right arrow buttons (◀ / ▶). To check the results of a diagnostic test, proceed as follows:

1. Enter the factory mode. (See page 105, *To power up in factory mode*.)
2. Press the SYSTEM button.
3. Use the up (▲) or down (▼) arrow button to select **DIAGNOSTICS**.
4. Press **ENTER**.
5. Use the up, down, right, and left arrow buttons to navigate through all of the diagnostic reports, as shown in the following table. (See Table 14.)
6. Check that the tests report (**OK**) unless otherwise specified in the following table. If a warning is given, take corrective action until the test reports (**OK**).

Table 14: SPG8000 system diagnostics

SYSTEM: DIAGNOSTICS:**TUNE: (▲ / ▼)**

Tune: (◀ / ▶) "Tune" indicates how much the Genlock, GPS or GLONASS reference is pulling the box from the Cal value. If not externally referenced, this will be zero.

Phase: (◀ / ▶) "Phase" is for GPS lock mode only, shows the phase measurements and the synthesizer correction value.

CALIBRATION: (▲ / ▼)

Cal: This test indicates the correction applied to the oven to calibrate the clocks.

PLL STATUS MAIN: (▲ / ▼)

12.288Lk 54:Lk 74.25Lk 74.176Lk

This test checks the lock status of the four secondary audio and video clocks. All should read "Lk" to indicate locked.

PLL STATUS SDI: (◀ / ▶)

Flex0: Lock Flex1: Lock

This tests the Flexible Clock Generators on the SDI board. "Unlock" indicates an error.

DDS STATUS SDI: (◀ / ▶)

DDS0 Phase: Lock DDS1 Phase: Lock

This tests that each DDS in the SDI flexible clock generator is phased up to the selected incoming frame.

"Unlock" indicates an error.

Table 14: SPG8000 system diagnostics (cont.)

TEMPERATURE: (▲ / ▼)	These tests check the temperature of the internal sensors:
Main & CPU (◀ / ▶)	
Ref Brd (◀ / ▶)	
SDI BOARD & SDI FPGA (◀ / ▶)	
VOLTAGE: (▲ / ▼)	These tests check voltages on various supplies and fuses; all should indicate "OK".
Main board – voltage checks for the Main board (+5.0 V, +3.3 V, +2.5 V, +1.8 V, +1.5 V, +1.2 V, –5.00 V, +3.3 AV) (◀ / ▶)	
Slots 1 through 4 voltage checks (+5.00 V, +3.3 V, +8.0 AV, +5.0 AV) (◀ / ▶)	
Fan +5.0 V check (◀ / ▶)	
RTC Battery (◀ / ▶)	
REF BRD 1: +5 V and +8 V (◀ / ▶)	
REF BRD 2: –5 V relative to +3.3 V (◀ / ▶)	
SDI Bd 1: 1.2 V & 1.2 VA checks (◀ / ▶)	
SDI Bd 2: 3.3 V & 3.3 VA checks (◀ / ▶)	
SDI Bd 3: 1.5 V & 3.0 VA checks (◀ / ▶)	
SDI Bd 4: 1.8 V & Dref checks (◀ / ▶)	
FAN SPEED: (▲ / ▼)	
Main: (◀ / ▶)	
PS1: (◀ / ▶)	
PS2: (◀ / ▶)	
POWER SUPPLY 1 and POWER SUPPLY 2: (▲ / ▼)	
Active: / Standby: (◀ / ▶)	Hours of use as the active or standby supply.
TMP WTD: (◀ / ▶)	Temperature Weighted hours of use.
12.0 V: (◀ / ▶)	
Manufacture date: (◀ / ▶)	
GPS PHS DET RAMPS: (▲ / ▼)	Present values of the phase detector self-calibration loops.
UP: A= / B= : (◀ / ▶)	
DOWN: A= / B= : (◀ / ▶)	
GPS ADC BUS: (▲ / ▼)	
Stuck: / Short (◀ / ▶)	
In the Stuck field, an H or an L indicates that the bit is not moving.	
In the Short field, an S indicates a short between some of the bits.	
GENLOCK INPUT: (▲ / ▼)	
Min: / Max:	
LTC INPUT: (▲ / ▼)	
POS: Min (Raw) & Max (Raw): (◀ / ▶)	
NEG: Min (Raw) & Max (Raw): (◀ / ▶)	
DDS SWEEP (▲ / ▼)	
SRAM ADDR BUS 1 through 3: (▲ / ▼)	

Table 14: SPG8000 system diagnostics (cont.)

SRAM DATA bus 1 through 3: (▲ / ▼)
SRAM MEM TEST: (▲ / ▼)
DDR2 ADDRESS BUS 1 and BUS 2: (▲ / ▼)
DDR2 MEM TEST: (▲ / ▼)
RUN: (▲ / ▼) Pressing ENTER runs the module memory tests.
MANUAL TUNE: (▲ / ▼) Press (◀ / ▶) buttons to tune the synthesizer outputs.
GPS IO TEST: (▲ / ▼) Press ENTER to run the Slot I/O test.

SPG8000 troubleshooting The following table lists some common problems and tells how to troubleshoot them.

Table 15: SPG8000 troubleshooting procedures

Problem	Troubleshooting steps
No power or lights	Check the main power supply as follows: 1. Remove instrument top cover. 2. Apply AC power. 3. Use a voltmeter to check the voltage on TP21 / Fuse F1. TP21 is unlabeled; it is located just to the left of Fuse F1. (See Figure 24 on page 74.) 5. If power is present on TP21, check fuses F1 and F2. Replace fuses if necessary. 4. If 5 V is not present, check the Power Combiner board, then the power supply module(s). 6. If there still no power, replace the Main board.
Fault LED illuminated	All of the conditions that drive the fault light should be displayed in the mainframe diagnostic screen. To view the diagnostics, refer to <i>SPG8000 System Diagnostics</i> . (See page 71, <i>SPG8000 diagnostics</i> .)
Any of the fans not working	Run diagnostics and check the fan speeds. The main fan is near the rear panel. The PS1 fan is in the first supply, and the PS2 fan is in power supply 2. If one of the three fans is not working, check the voltage on the three fans with a voltmeter. The voltage should be in the 8 V to 12 V range. If the voltage is not within that range, replace the Power Combiner board. If the voltage is within the range, replace the fan.
Instrument not able to genlock	Adjust/check the master clock. (See page 13, <i>Adjust master clock using a frequency signal generator</i> .) After adjustment, go into the diagnostics and verify that the CAL value readout is less than $\pm 2.5e-6$. If it is not, replace the oven or the Main board. In Factory mode, run the PLL Range Check from the diagnostics (perform the common diagnostic tests in the <i>SPG8000 Specifications and Performance Verification Technical Reference</i> manual). Verify that all the secondary clocks can tune at least $\pm 90e-6$. If they cannot, replace the Main board.
Display problems	On power up, the LCD display should initially be dark except for a visible set of black squares on the top row. After a second or two, the LCD backlight should come on and a booting message should appear. If the backlight does not come on, check fuse F700 on the Main board, and then replace the display. If the text is not there, replace the display, then the cable, and finally the Main board, if necessary.

Table 15: SPG8000 troubleshooting procedures (cont.)

Problem	Troubleshooting steps
Keyboard/front panel problems	<p>On power up, the front panel buttons and indicators should light up in groups of 3 to 5. This sequence will repeat about 4 times while waiting for the instrument to boot. The flashing sequence is controlled by the front panel, only power is required from the Main board. So if the flashing does not occur, replace the front panel.</p> <p>An unprogrammed new front panel will not flash until the instrument software has fully booted and loaded the code into the front panel. After the system has booted, run the keyboard diagnostics as follows:</p> <ol style="list-style-type: none"> 1. Restart the instrument in Factory mode. (See page 105, <i>To power up in factory mode.</i>) 2. Press the SYSTEM button. 3. Use the up arrow (▲) to get to DIAGNOSTICS. 4. Press ENTER. 5. Use the up arrow (▲) to select DIAGNOSTICS : RUN. 6. Use the right arrow (▶) to select FRONT PANEL KEY test. 7. Press ENTER. 8. Follow the instructions on the display to run the keyboard diagnostics. <p>If there is an error, replace the keyboard. If that does not fix the problem, replace the cable. If that does not fix the problem, replace the Main board.</p>
Remote interface problems	Use the GPI submenu under the SYSTEM menu to verify that the GPI alarm output is enabled and that the desired error conditions are also enabled
Module(s) not working properly	Refer to the troubleshooting procedure in this section for the module in question.

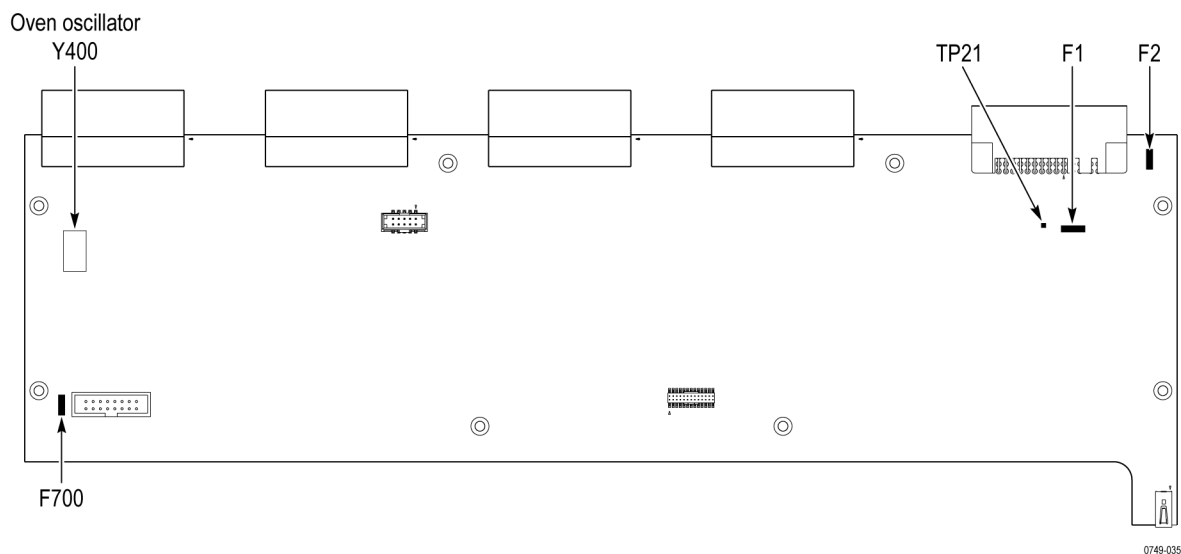


Figure 24: Main board (view from top)

Option AG troubleshooting

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

If the SPG8000 does not boot up or if the display is not working, go to the beginning of the troubleshooting section. (See page 67, *Troubleshooting*.)

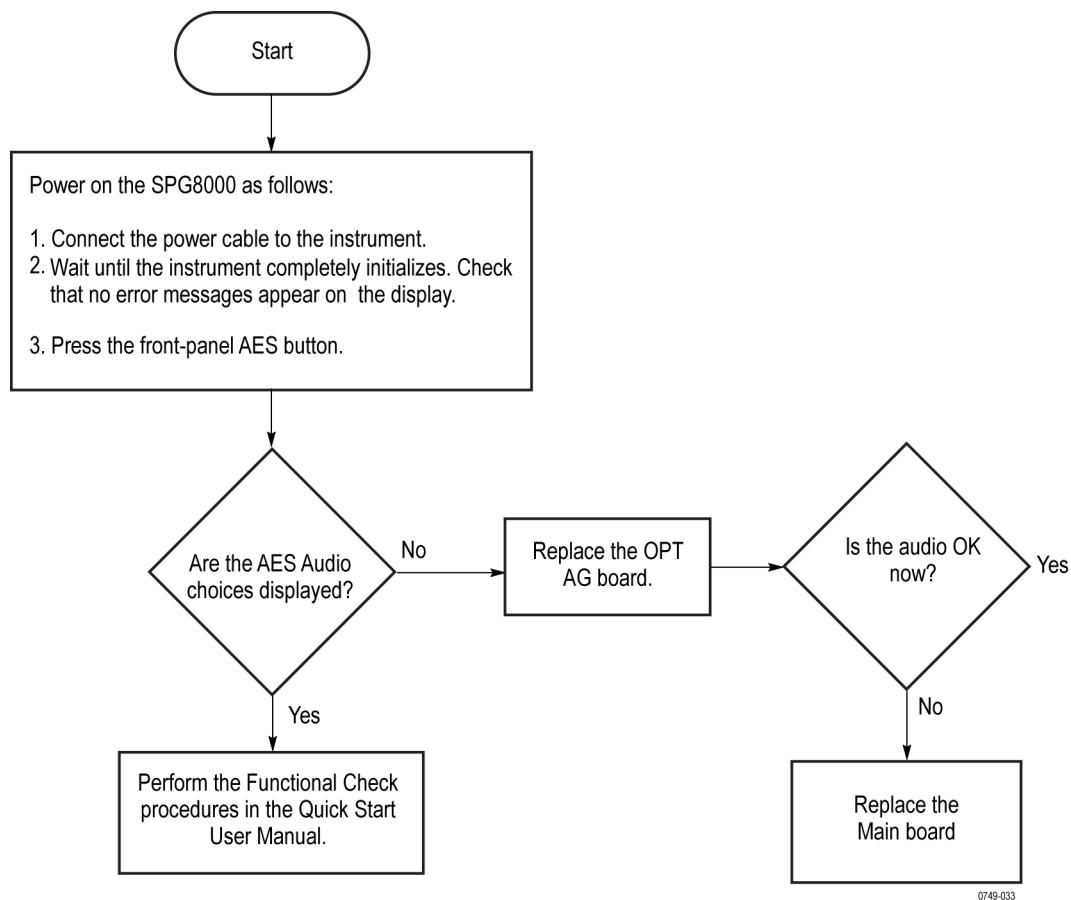
Required equipment. The equipment listed in the following table is required for troubleshooting.

Table 16: Equipment required to troubleshoot the Option AG

Equipment description	Minimum requirements/example
Screwdriver handle	Accept Phillips-driver bits
#1 Phillips tip	Phillips-driver bit for #1 size screw heads

Procedure.

1. Before you start to troubleshoot a problem, back up your instrument settings to a preset. (See page 68, *Back up your instrument settings*.)
2. Check the diagnostics in the SPG8000 troubleshooting table. (See Table 15.) The diagnostics check many of the signals that the Main board provides to the AG board.
3. Run the slot I/O test on the Genlock/Black board. This tests many of the signals needed by the AG board.
4. Use the troubleshooting diagram to troubleshoot Option AG. (See Figure 25.)
5. After the problem is solved, recall the preset you created.

**Figure 25: Option AG troubleshooting procedure**

Option BG troubleshooting

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

If the SPG8000 does not boot up or if the display is not working, go to the beginning of the troubleshooting section. (See page 67, *Troubleshooting*.)

Required equipment.

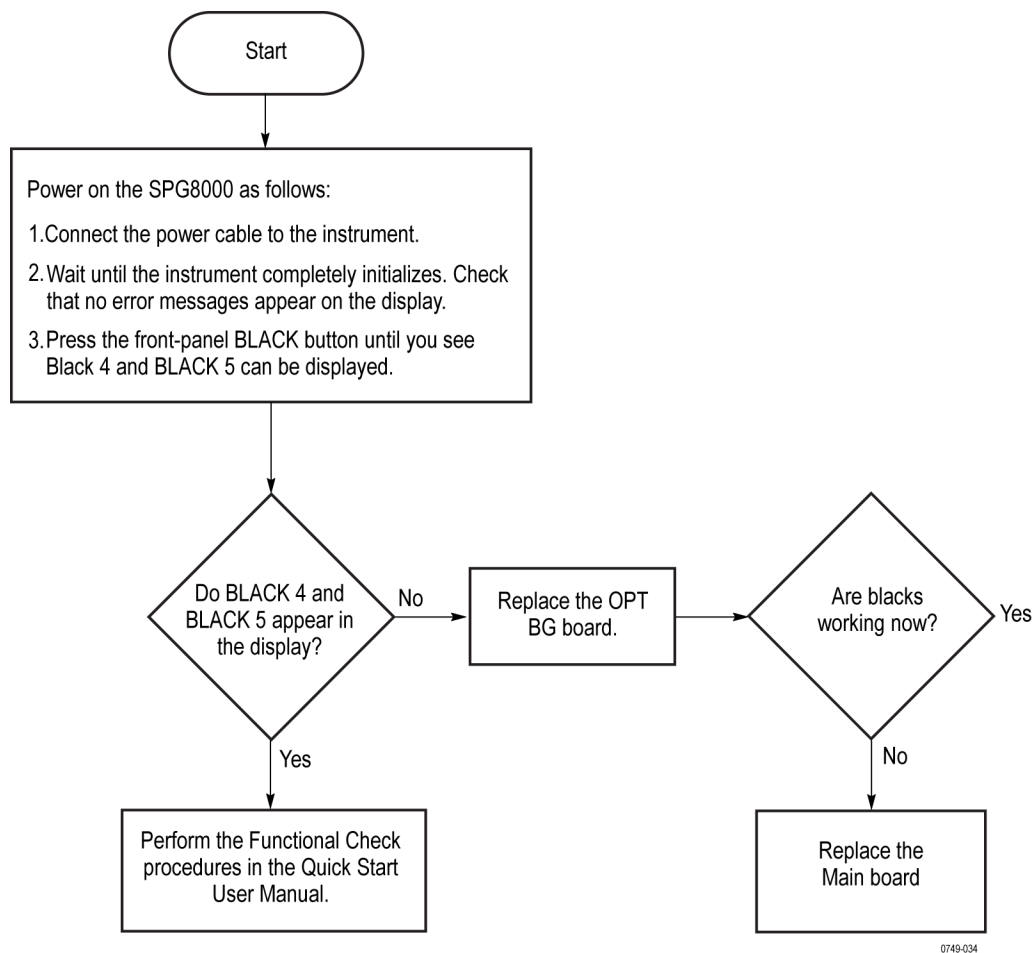
The equipment listed in the following table is required for troubleshooting.

Table 17: Equipment required for Option BG troubleshooting

Equipment description	Minimum requirements/example
Screwdriver handle	Accept Phillips-driver bits
#1 Phillips tip	Phillips-driver bit for #1 size screw heads

Procedure.

1. Before you start to troubleshoot a problem, back up your instrument settings to a preset. (See page 68, *Back up your instrument settings*.)
2. Check the diagnostics in the SPG8000 troubleshooting table. (See Table 15.) The diagnostics check many of the signals that the Main board provides to the BG board.
3. Run the slot I/O test on the Genlock/Black board. This tests many of the signals needed by the BG board.
4. Use the Option BG troubleshooting diagram to troubleshoot the option. (See Figure 25.)
5. After the problem is solved, recall the preset that you created.

**Figure 26: Option BG troubleshooting procedure**

Genlock/Black troubleshooting

This section contains instructions and procedures for troubleshooting Genlock/Black board. These procedures help you decide whether it is necessary to replace your module.

If the SPG8000 does not boot up or if the display is not working, go to the beginning of the troubleshooting section. (See page 67, *Troubleshooting*.)

Required equipment. The equipment listed in the following table is needed to troubleshoot the Genlock/Black generator module.

Table 18: Equipment required for troubleshooting the Genlock/Black generator module

Equipment	Requirement	Suggested equipment
Option GPS		If the DUT does not have an Option GPS installed, must have an Option GPS to temporarily install in the DUT
GPS or GLONASS Antenna signal source (2) ¹	Good GPS or GLONASS signal required for both the Option GPS under test and the reference unit. If only one antenna feed is available, a signal splitter may be used	
Digital Multimeter	Used to check power supply voltages and fuses	Fluke 87 or equivalent
75 Ω BNC cables (4)	Length: 42 inches, used to connect the instruments	Tektronix part number 012-0074-00
ROHS compliant ESD safe soldering workstation	Any soldering must be ROHS compliant	
Frequency Counter (optional)	Used for an alternate method to check frequency accuracy	Fluke PM6685 or equivalent

¹ The reference unit must have the same type of GPS receiver as the DUT unit. (See page 8, *How to determine which GPS receiver is installed in your instrument*.)

Performance verification. If there is a problem, first perform the Base Unit Functional Test, found in the *SPG8000 Specifications and Performance Verification* manual. Any problems found using that procedure can be a starting point for troubleshooting. Even if you do not perform the entire performance verification procedure, at a minimum check the diagnostics. These give valuable information on the generator board and the mainframe signals that drive it.

General problems. General problems and actions to follow are shown in the following table. (See Table 19.)

Table 19: General problems – Genlock/Black board

Problem	Actions
<ul style="list-style-type: none"> ■ Fails Power On Self Test (POST) ■ GPS does not appear in menu 	<ul style="list-style-type: none"> ■ Run power on test procedure. (See page 91, <i>Power on self test for Option GPS (POST).</i>) ■ Check for current software. (See page 81, <i>Check the installed firmware version.</i>) ■ Run power supply test. (See page 83, <i>Test power supply.</i>) ■ Power up in factory mode and run the slot I/O test. (See page 70, <i>Slot I/O Test.</i>)
<ul style="list-style-type: none"> ■ No Black Burst outputs ■ No LTC outputs 	<ul style="list-style-type: none"> ■ Run power supply test. ■ Verify configuration by setting to factory defaults. (See page 91, <i>Set to factory defaults (Option GPS).</i>) ■ Check diagnostics reported values. (See page 82, <i>Check diagnostic reported values.</i>) ■ Power up in factory mode and run the slot I/O test. (See page 70, <i>Slot I/O Test.</i>) ■ If no other problems found, replace the Genlock/Black board.
<ul style="list-style-type: none"> ■ Unstable genlock or unable to genlock 	<ul style="list-style-type: none"> ■ Run Internal Mode Oven test. (See page 86, <i>Test internal mode oven.</i>) ■ Check that the reference select is set to the correct mode. See the SPG8000 User manual for directions. ■ Verify reference signal is valid and is the correct format. Use a WFM7120 or WFM8300 waveform monitor. ■ Check ADC Bus diagnostics. (See page 87, <i>ADC bus diagnostics.</i>) ■ Power up in factory mode and run the slot I/O test. (See page 70, <i>Slot I/O Test.</i>) ■ If no other problem found, replace Genlock/Black generator board.
<ul style="list-style-type: none"> ■ Unable to detect or use time code 	<ul style="list-style-type: none"> ■ Verify that the time code is present on the input signal. Use a WFM7120 or WFM8300 waveform monitor. ■ Verify that the time source select is set to VITC. See the <i>SPG8000 Technical Reference</i> manual for directions. ■ Verify that the time sync method is set as needed. The “Follow” mode is best for troubleshooting purposes. <i>SPG8000 Technical Reference</i> manual for directions. ■ Check the STATUS menu for the Genlock input amplitude and VITC present indicators. See the <i>SPG8000 Technical Reference</i> manual for directions. ■ Power up in factory mode and run the slot I/O test. (See page 70, <i>Slot I/O Test.</i>) ■ Lock to GPS or GLONASS to set leap seconds. (See page 88, <i>Lock to GPS to set leap seconds.</i>) ■ If no other problem found, replace the Genlock/Black generator module.

Power on self test (POST). When you first apply power to an SPG8000, the Genlock/Black generator board runs a Power On Self Test (POST). If an error is encountered during this POST, the display will show one of several error codes. Watch the display as the instrument powers on, and note any error codes. Check the table to see the meaning of the error codes. (See Table 20.)

Table 20: POST error codes for the Genlock/Black module

Error Code	Meaning
1:	CPLD constant 1 check (0xAAAA or 0x00AA based on cpld version at addr 0x8)
2:	CPLD constant 2 check (0x5555 or 0x0055 based on cpld version at addr 0xA)
3:	CPLD R/W error (writes 0x5555 to addr 0x102 and confirms)
4:	CPLD R/W error (writes 0xAAAA to addr 0x102 and confirms)
5:	Error copying DO Fpga to Genlock/Black EEPROM
7:	Error copying BB Fpga to Genlock/Black EEPROM
9:	DO Fpga constant check (0x55 at addr 0x501000)
10:	DO Fpga R/W error (writes 0x5555 to addr 0x501024 and confirms)
11:	DO Fpga R/W error (writes 0xAAAA to addr 0x501024 and confirms)
12:	BB Fpga R/W error (writes 0x5555 to addr 0x400008 and confirms)
13:	BB Fpga R/W error (writes 0xAAAA to addr 0x400008 and confirms)
255:	Not an error. This code may appear following some firmware updates.

Check the installed firmware version.

1. Press the **SYSTEM** button.
2. Press the up (▲) or down (▼) arrow buttons to select **VERSION INFO (F/W)**.
3. Read the firmware version.
4. If the version is not **V 1.3** or later, install current software. The latest software is available on the Web at www.tektronix.com/downloads.

Set to factory defaults (Genlock/Black). The SPG8000 under test and the SPG8000 reference unit must be configured correctly to avoid problems while troubleshooting. Ensure a common setup by setting both instruments to the factory presets as follows. (After troubleshooting, disconnect and reconnect the power cord to return the unit to your previous settings.)

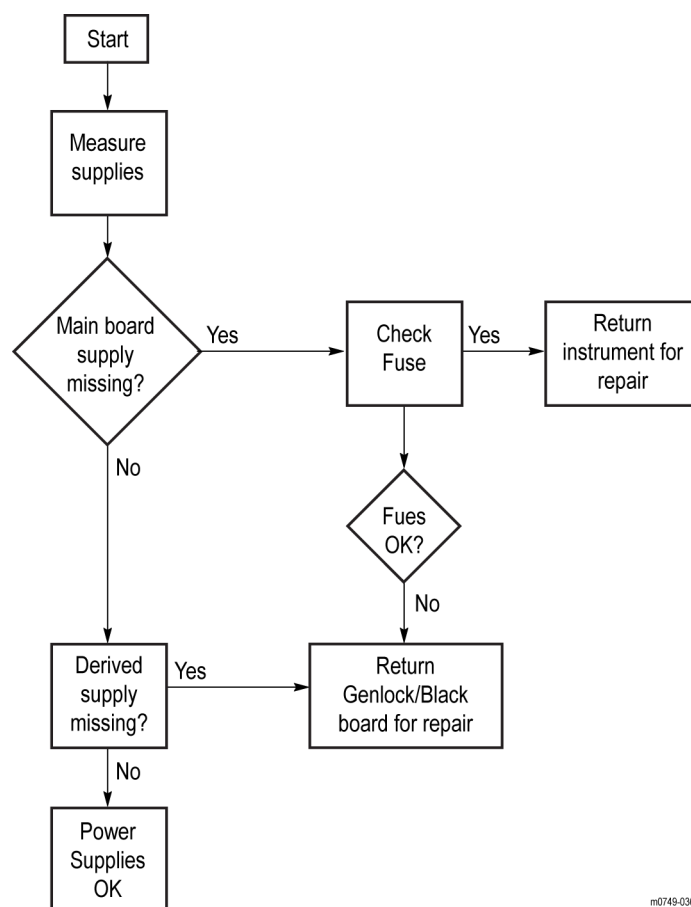
1. Press the **SYSTEM** button.
2. Press the up (▲) or down (▼) arrow button to select **PRESET**.
3. Press the **ENTER** button.
4. Press the up (▲) or down (▼) arrow button to select **RECALL**.
5. Press the left (◀) or right (▶) arrow button to select **FACTORY DEFAULT**.
6. Press the **ENTER** button to load the factory defaults.

Check diagnostic reported values. There are several internally detected physical measurements which are reported by the Main board and the Genlock/Black generator board. Check the following (see the *SPG8000 Technical Reference* manual for more information on these diagnostics).

- **Tune – Phase value:** The Phase value indicates the second by second differences between the Pulse per Second (PPS) signal from the GPS receiver and the Local 1 PPS signal from the Master Time of Day clock. At lock this signal should be near hex 8000 0000.
- **Tune – DDS value:** The DDS value is the control word the processor has written to the clock synthesizer. In internal mode, this is the calibration value needed to compensate for the any small error in the master oven frequency. When locked to a reference such as video, GPS or GLONASS, the DDS value is the value needed to track the reference signal frequency. The valid range of the DDS word is 0 to 4,194,303. If the DDS word is near either end of this range, the system is near the frequency limits to which it can lock.
- **Voltage Mon 1 (+5 V, +8 V), Voltage Mon 2 (-5 V rel to +3.3 V):** The voltage monitors measure the mainframe supplies. If the display indicates that they are out of range, check them manually. (See page 83, *Test power supply*.) If one of these supplies is bad, replace the Main board. If manual measurement shows that the supplies are correct, the Option GPS module is not measuring them correctly. Replace the Option GPS module.
- **PHASE DET RAMPS (Up: A, Up: B), PHASE DET RAMPS (Down: A, Down: B):** These four values show critical values in the phase detector. The values may vary from unit to unit, as a result of the auto-calibration that adjusts them, but if all the power supplies are good and any of the ramp diagnostics indicate “WARN” (for Warning), replace the Option GPS module.
- **12.288/54/74.25/74.176 PLL Status page:** The VCO lock page verifies that all the clocks are all correctly phase locked. The 54 MHz locks to the 20 MHz Oven clock, so if it is not locked then troubleshoot that first. The other VCOs lock to the 54 MHz.

Test power supply. There are two types of power supplies in the Genlock/Black circuitry: those provided by the instrument and those that are derived by the Genlock/Black generator. The supplies that are provided by the instrument are fused on the Genlock/Black board; they have an 'M' at the start of the supply name. (See Table 21.) Derived supplies depend on the instrument supply fuses for protection.

1. Remove the SPG8000 top cover. (See page 46, *Top cover*.)
2. Use the following flowchart and table of power supply test points to determine if the Genlock/Black generator power supply is operating correctly. (See Figure 27.) (See Table 21.)



m0749-036

Figure 27: Genlock/Black generator module power supply test

Table 21: Power supply test points

Test point	Supply name	Limits	Notes
Mainframe supplies			
TP111	M +5 VD	+4.75 V to +5.25 V	Main board Fused 5 V digital supply, fuse F132
TP211	M +3.3 V	+3.1 V to +3.5 V	Main board Fused 3.3 V digital supply, fuse F131
TP213	M-5 VA	-4.75 V to -5.25 V	Main board Fused -5 V analog supply, fuse F111
TP214	M +5 VA	+4.75 V to +5.25 V	Main board Fused +5 V analog supply, fuse F121
TP215	M +8 V	+7.6 V to +8.4 V	Main board Fused +8 V analog supply, fuse F122
Derived supplies			
TP311	ANT+5 V	0 to 5.8 V	Switched GPS or GLONASS antenna supply – user setup
TP411	RAMP +7 V	6.75 V to 7.25 V	Derived from M +8 V
TP511	RAMP -4 V	-4.25 V to -3.75 V	Derived from M -5 V
TP711	CIR +2.5 V	2.375 V to 2.625 V	Derived from M +3.3 V
TP911	VID +4.1	4.08 V to 4.11 V	Derived from M +5 VA
TP821	LTC +3.3 V	3.30 V to 3.39 V	Derived from M +5 VA
TP0821	BB +1.2 V	1.15 V to 1.25 V	Derived from M +3.3 V
TP0421	DO +1.2 V	1.15 V to 1.25 V	Derived from M +3.3 V, test point is under the Option GPS Receiver board

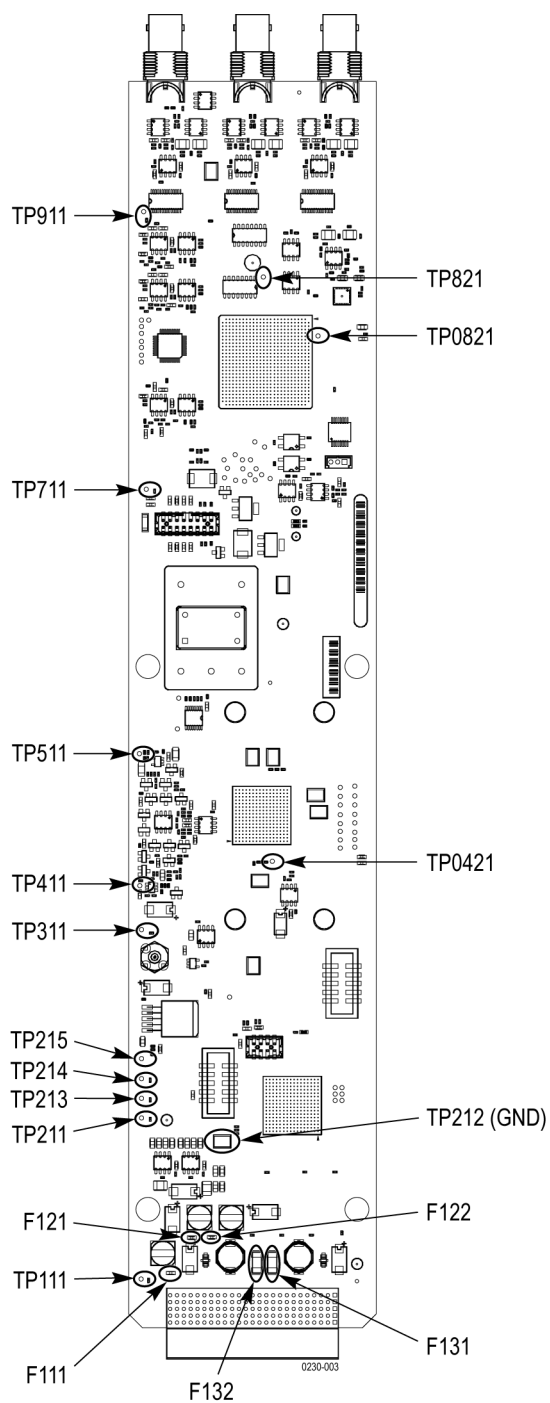


Figure 28: Genlock/Black generator board voltage test point and fuse locations

Test internal mode oven. Perform this procedure to determine if the oven oscillator is working and within specifications.

1. Set the instrument to internal reference mode as follows:
 - a. Press the **REF** button.
 - b. Press the up (▲) or down (▼) arrow buttons to select **SOURCE**.
 - c. Press the **ENTER** button.
 - d. Press the left (◀) or right (▶) arrow buttons to select **INTERNAL**, and then press the **ENTER** button.
2. Compare the Black Burst signals.
 - You can use the frequency accuracy setup from the *SPG8000 Specifications and Performance Verification Technical Reference* manual to compare the Black Burst signals from the under test to the signals from the reference unit.
 - As an alternative, you can use the following procedure to compare the signals:
 - a. Connect the frequency counter to the **BLACK 3** output.
 - b. Configure the **BLACK 3** output to produce a 10 MHz CW signal.
 - c. Measure the frequency accuracy directly. At 10 MHz, 1 ppm = 10 Hz, so a measured frequency of 10,000,010 Hz is 1 ppm high.
 - d. If either measurement method yields an internal frequency error of more than 0.1 ppm, the instrument may need calibration, or the oven may not be able to tune to the correct frequency.
 - e. If the GPS module will lock to GPS or GLONASS, perform an oven calibration. (See page 16, *Adjust master clock while locked to GPS*.) If that fixes the problem, the system is functioning correctly.
 - f. If the GPS system will not lock, or if Option GPS is not present, use a known good signal into the Genlock input and calibrate the oven. Refer to the section on adjusting the master clock for details on this procedure. (See page 13, *Adjust master clock using a frequency signal generator*.)
 - g. If the internal frequency is >3 ppm off, or steps e or f are not able to calibrate it to the correct frequency, replace the Main board.
3. Use the timing display to measure how fast the timing is shifting.

Since the instrument under test is in internal mode, the timing may shift. The vector will probably spin relative to the reference unit, which is locked to GPS or GLONASS. A 1 μ s shift per second equates to a 1 ppm difference in the time bases of the two units. Measure the timing shift for a reasonable time and then calculate the frequency error. For example, a 25 μ s shift in 10 seconds = $25/10 =$ a 2.5 ppm error.

ADC bus diagnostics. Perform this procedure to determine if all the bits on the ADC are properly connected to the FPGA logic.

1. Connect the BLACK 1 output to the REF IN connector. Make sure the loop through is unconnected and unterminated.
2. Press the **REF** button.
3. Press the up (▲) or down (▼) arrow button until **SOURCE** appears in the display.
4. Press the right (▶) arrow button until **NTSC BURST** appears.
5. Press the **ENTER** button.
6. Press the **BLACK** button until **BLACK 1** appears.
7. Press the left (◀) or right (▶) arrow button to select **NTSC**.
8. Press the **ENTER** button.
9. Press the up (▲) or down (▼) arrow button until **FIELD REF** appears.
10. Press the left (◀) or right (▶) arrow button to select **ENABLE**.
11. Press the **ENTER** button.
12. Press the **SYSTEM** button.
13. Press up (▲) or down (▼) arrow button until **DIAGNOSTICS** appears.
14. Press the **ENTER** button.
15. Press the up arrow button until **GPS ADC BUS DIAGNOSTICS** appears.
16. Check for the following conditions:
 - If any bits in the *Stuck* field show an *H* or an *L*, the bit is not moving. Replace the Genlock/Black generator.
 - If any bits in the *Short* field show an *S*, there is a short between some of the bits. Replace the Genlock/Black generator.

Lock to GPS to set leap seconds.

NOTE. *Leap seconds must have been set once in order for the LTC and VITC inputs to work. Leap seconds can only be set using the GPS input.*

1. If the instrument does not have Option GPS, temporarily install Option GPS for this test
2. Set the instrument for GPS lock mode.
3. Apply a GPS signal, and verify that it is locked.
4. Press the **STATUS** button.
5. Use the Time: GPS display.
6. The second row of the LCD will show the date and time. If the leap seconds have not been received since the last power up, there will be an asterisk "*" after the time. Wait until the asterisk goes away, which can take up to 15 minutes.
7. Remove the GPS antenna input, and check that the front panel indicator shows EXT as red.
8. Reconnect the GPS antenna input and wait for it to show Ext as green. This will set the RTC correctly.
9. Turn the instrument off.
10. Remove the GPS antenna signal.
11. If the Option GPS installation was temporary, remove Option GPS.

Option GPS troubleshooting

This section contains instructions and procedures for troubleshooting the Option GPS Receiver board. These procedures help you decide whether it is necessary to replace your module.

If the SPG8000 does not boot up or if the display is not working, go to the beginning of the troubleshooting section. (See page 67, *Troubleshooting*.)

Required equipment. The equipment listed in the following table is needed to troubleshoot the Genlock/Black generator module.

Table 22: Equipment required for troubleshooting the Option GPS module

Equipment	Requirement	Suggested equipment
SPG8000 with an Option GPS module installed	Reference instrument in addition to DUT	Tektronix SPG8000 with OPT GPS
Waveform monitor	Used to verify correct GPS or GLONASS phase lock operation. Must be able to lock to a reference and display composite inputs	Tektronix WFM7120
GPS or GLONASS antenna signal source (2) ¹	Good GPS or GLONASS signal required for both the Option GPS under test and the reference unit. If only one antenna feed is available, a signal splitter may be used	
75 Ω BNC cables (4)	Length: 42 inches, used to connect the instruments	Tektronix part number 012-0074-00
ROHS compliant ESD safe soldering workstation	The Option GPS boards do not contain any user-serviceable parts, but any soldering must be ROHS compliant	

¹ The reference unit must have the same type of GPS receiver as the DUT unit. (See page 8, *How to determine which GPS receiver is installed in your instrument*.)

Performance verification. If there is a problem, first perform the Base Unit Functional Test, found in the *SPG8000 Specifications and Performance Verification* manual. Any problems found using that procedure can be a starting point for troubleshooting. Even if you do not perform the entire performance verification procedure, at a minimum check the diagnostics. These give valuable information on the generator board and the mainframe signals that drive it.

General problems. General problems and actions to follow are shown in the following table. (See Table 19.)

Table 23: General problems – Option GPS

Problem	Actions
■ Option GPS does not lock	■ Run power on test procedure. (See page 91, <i>Power on self test for Option GPS (POST).</i>)
■ Option GPS does not acquire satellite — Option GPS only	■ Check DC antenna power voltage. (See page 94, <i>Check DC antenna output power voltage (Option GPS only).</i>) ■ Check GPS or GLONASS antenna signal source. (See page 92, <i>Check the GPS or GLONASS antenna signal source.</i>) ■ Check diagnostics reported values. (See page 82, <i>Check diagnostic reported values.</i>) ■ Power up in factory mode and run the slot I/O test. (See page 70, <i>Slot I/O Test.</i>)
■ Unstable GPS or GLONASS lock (determined by Performance Verification or through normal use) — Option GPS only	■ Verify 20 minute warm-up, recheck stability relative to reference unit. ■ Check GPS or GLONASS antenna signal source. (See page 92, <i>Check the GPS or GLONASS antenna signal source.</i>) ■ Verify configuration by setting to factory defaults. (See page 91, <i>Set to factory defaults (Option GPS).</i>) ■ Check diagnostics reported values. (See page 82, <i>Check diagnostic reported values.</i>) ■ Run Internal Mode Oven test. ■ If both units have not acquired position, run Acquire New Position procedure.
■ Frame phase wrong (determined by Performance Verification — Option GPS only)	■ Verify configuration by setting to factory defaults. (See page 91, <i>Set to factory defaults (Option GPS).</i>) ■ Check time zone offset configuration and time of day source. See the Time button menu information in the <i>SPG8000 Quick Start</i> manual for directions.
■ Time of Day wrong — Option GPS only	■ Lock to GPS or GLONASS to set leap seconds. (See page 88, <i>Lock to GPS to set leap seconds.</i>) ■ Check diagnostics reported values. (See page 82, <i>Check diagnostic reported values.</i>) ■ Run Acquire New Position procedure. (See page 94, <i>Acquire new position.</i>)
■ Long GPS or GLONASS lock time — Option GPS only	■ Check GPS or GLONASS antenna signal source. (See page 92, <i>Check the GPS or GLONASS antenna signal source.</i>) Adjust oven oscillator. (See page 93, <i>Adjust oven oscillator frequency.</i>) ■ Verify configuration by setting to factory defaults. (See page 91, <i>Set to factory defaults (Option GPS).</i>) ■ Check diagnostics reported values. (See page 82, <i>Check diagnostic reported values.</i>) If no other problem found, replace the Option GPS module.

Power on self test for Option GPS (POST). When you first apply power to an SPG8000, the Option GPS runs a Power On Self Test (POST). If an error is encountered during this POST, the display will show one of several error codes. Watch the display as the instrument powers on, and note any error codes. Check the table to see the meaning of the error codes. (See Table 24.)

Table 24: POST error code for Option GPS

Error Code	Meaning
14:	DO fpga Trimble Module communications error - GPS receiver is disconnected or failed

Check the installed firmware version.

1. Press the **SYSTEM** button.
2. Press the up (▲) or down (▼) arrow buttons to select **VERSION INFO (F/W)**.
3. Read the firmware version.
4. If the version is not **V 1.3** or later, install current software. The latest software is available on the Web at www.tektronix.com/downloads.

Set to factory defaults (Option GPS). The SPG8000 under test and the SPG8000 unit must be configured to use the GPS or GLONASS signal correctly, to avoid problems while troubleshooting. Ensure a common setup by setting both instruments to the factory presets as follows. (After troubleshooting, disconnect and reconnect the power cord to return the unit to your previous settings.)

1. Press the **SYSTEM** button.
2. Press the up (▲) or down (▼) arrow button to select **PRESET**.
3. Press the **ENTER** button.
4. Press the up (▲) or down (▼) arrow button to select **RECALL**.
5. Press the left (◀) or right (▶) arrow button to select **FACTORY DEFAULT**.
6. Press the **ENTER** button to load the factory defaults.

Check diagnostic reported values. The Option GPS module detects the temperature. Check the following (see the *SPG8000 Technical Reference* manual for more information on these diagnostics).

- **Temperature:** Temperature is detected on the Option GPS Receiver board. This temperature is normally about 15 °C above ambient temperature. If the temperature is very high or low, check that the fan is operating, the installation clearances are correct, and that all cables in the Option GPS module are connected properly. If there is still a problem, replace the Option GPS module and the Genlock/Black generator board.

NOTE. *For GPS modules with a GPS/GLONASS receiver, the temperature readout is N/A because there is no temperature sensor on the receiver. (See page 8, How to determine which GPS receiver is installed in your instrument.)*

Set to factory defaults (Option GPS). The SPG8000 under test and the SPG8000 unit must be configured to use the GPS or GLONASS signal correctly, to avoid problems while troubleshooting. Ensure a common setup by setting both instruments to the factory presets as follows. (After troubleshooting, disconnect and reconnect the power cord to return the unit to your previous settings.)

1. Press the **SYSTEM** button.
2. Press the up (▲) or down (▼) arrow button to select **PRESET**.
3. Press the **ENTER** button.
4. Press the up (▲) or down (▼) arrow button to select **RECALL**.
5. Press the left (◀) or right (▶) arrow button to select **FACTORY DEFAULT**.
6. Press the **ENTER** button to load the factory defaults.

Check the GPS or GLONASS antenna signal source. For proper operation, an outside antenna signal source must be connected to the instrument and functioning correctly. If a sufficient signal is not applied to the antenna connector, Option GPS will not operate properly. Use this procedure to verify the antenna signal:

1. Press the **STATUS** button.
2. Press the up (▲) or down (▼) arrow buttons to select **GPS**.
3. Wait for the Signal Quality readout to stabilize. This may take several minutes.
4. Check the **Signal Quality** and **Sats**.
5. If signal quality is ≥ 30 and the number of detected satellites is ≥ 4 , end this test. If it is not, continue with the rest of this procedure.

6. If the SPG8000 module under test is the antenna power source, check that the menu is set to the correct antenna voltage:
 - a. Press the REF button.
 - b. Press the (▼) arrow button to select **GPS SETUP**, and then press **ENTER**.
 - c. Press the (▼) arrow button to select **POWER**.
 - d. Check for proper antenna power setting.
 - e. Check the antenna PWR LED. If the LED is red or blinking green, check for a problem with the antenna or the cabling system, such as an RF splitter that blocks or short circuits the antenna power DC voltage.
7. Check the reference unit.
 - a. Repeat steps 1 through 5 for the reference unit.
 - b. If the reference unit passes, exchange antenna feeds between the reference unit and the Option GPS unit under test and retest the Option GPS unit under test.
 - c. If the Option GPS unit under test does not receive a GPS or GLONASS signal on a known, good, antenna, swap the Option GPS option module between two instruments. If the device under test now works, replace the Option GPS module. If the device under test still does not work, replace the Option GPS Receiver board and the Genlock/Black generator board to which it is attached.

Adjust oven oscillator frequency. The oven oscillator frequency adjustment saves the tuning code word for the oven. This will be used when the instrument is in “internal” mode. This adjustment can be done without any disruption to operation, and is best done in the instrument's operating environment. This adjustment can be done without putting the instrument into Factory Mode, so the instrument does not have to be taken out of service.

1. To adjust the oven oscillator frequency, perform the adjustment procedure. (See page 16, *Adjust master clock while locked to GPS*.)
2. If the instrument is locked to a GPS or GLONASS signal, perform this adjustment periodically to account for crystal drift.

Acquire new position. Option GPS requires a valid 3D GPS or GLONASS position to properly lock to GPS or GLONASS time. If the GPS or GLONASS antenna is moved, a new position must be acquired for correct time information. There must be a good antenna feed, and the GPS receiver must be locked to at least four GPS or GLONASS satellites.

1. Press the **REF** button.
2. Press the up (▲) arrow button to select **REFERENCE : ACQUIRE GPS POSITION**.
3. Press the **ENTER** button to reacquire fixed position. This takes about 60 seconds.
4. Wait until the status display shows Locked.
5. This process requires four satellites to complete successfully. If the signal is marginal, the acquisition may take longer. If the signal is poor, or if there is no signal, the acquisition will not finish.

Check DC antenna output power voltage (Option GPS only). The Option GPS module can provide power to a GPS or GLONASS antenna. Use this procedure to verify that the Option GPS module is providing power correctly.

1. Disconnect the antenna from the Option GPS module.
2. Connect the voltmeter to the Option GPS Antenna input, using a coaxial cable, BNC T connector, and a BNC to Banana plug adapter. Do not connect a terminator at this time. The Antenna Power light should be blinking green.
3. Note the voltmeter reading for later use.
4. Set the antenna voltage to 3.3 V.
5. Check the voltmeter reading. It should be between 3.1 V and 4.0 V.
6. Set the antenna voltage to 5 V.
7. Check the voltmeter reading. It should be between 5 V and 6 V.
8. Connect a 75 Ω precision terminator to the BNC T connector, to simulate a typical load. The Antenna Power light should change from blinking green to solid green.
9. Check the voltmeter reading. It should be between 4 V and 5 V.
10. If the Option GPS module does not provide the correct voltages, replace the Option GPS module.
11. Disconnect the cable from the Option GPS Antenna connector.
12. Reset the Option GPS module to the voltage noted in step 3 or to the correct voltage for the antenna in use.
13. Reconnect the antenna.

Option SDI troubleshooting

This section contains instructions and procedures to troubleshoot Option SDI. These procedures will help you decide whether it is necessary to replace your module.

If the SPG8000 does not boot up or if the display is not working, refer to *SPG8000 troubleshooting*. (See Table 15.)

Required equipment. The equipment listed here is needed to troubleshoot Option SDI.

Table 25: Equipment required to troubleshoot the Option SDI

Equipment	Requirement	Suggested equipment
HD Waveform monitor	Must be able to display 3 Gb/s SDI signal and jitter	Tektronix WFM7120
Oscilloscope	>500 MHz bandwidth, 50 Ω input	Tektronix DPO4104
Digital Multimeter	Used to check power supply voltages and fuses	Fluke 87 or equivalent
75 Ω BNC cables (2)	Length: 42 inches, used to connect the instruments	Tektronix part number 012-0074-00
50 Ω BNC cable (1)	Length: 43 inches, used to test trigger output	Tektronix part number 012-0057-01
ROHS compliant ESD safe soldering workstation	The Option SDI boards do not contain any user-serviceable parts, but any soldering must be ROHS compliant	
Other modules	Used to test instrument operation	Option BG – or – A TG8000 with an AVG7 module or a DVG7 module installed.

Problem identification. If there is a problem, first perform the Option SDI Performance Verification procedure, found in the *SPG8000 Specifications and Performance Verification* manual. Any problems found with that procedure can be a starting point for troubleshooting.

General problems and actions to follow are shown in the following table.

Table 26: Option SDI troubleshooting

Problem	Actions
■ Fails Power On Self Test (POST)	■ Run power on test procedure.
■ SDI does not appear in menu	■ Run power on in Factory mode test procedure.
	■ Check for current software.
	■ Run power supply test.
	■ Perform the slot I/O test on the Genlock/Black generator module to test the instrument resources.
	■ Check that the output cards are properly seated into the connectors on the SDI FPGA board.
■ No output from Signal BNCs	■ Run power on test procedure.
	■ Check diagnostics reported values.
	■ Run power supply test.
	■ Verify configuration.
	■ Check that the output cards are properly seated into the connectors on the SDI FPGA board.
■ Generator video color errors	■ Verify configuration.
	■ Restore Factory Defaults, save them as power-on preset, and reboot instrument.
■ Unstable video	■ Check diagnostics reported values.
■ Excessive jitter	■ Run Test Multiple Frame Rate procedure.
■ Generator output lost when format is changed	■ Run Test Multiple Frame Rate procedure.
■ No 3 Gb/s signal formats available in the menus	■ Verify that Option 3G is enabled. (See page 105, <i>Verify that Option 3G is enabled.</i>)
■ Frame picture mode is not working	■ Run the <i>Check module diagnostics</i> procedure. (See page 98, <i>Check the SDI diagnostics.</i>)
	■ Run the <i>Download a frame picture with a known good image</i> procedure. (See page 106.)
	■ If no other problem found, replace the Option SDI module.

Power on self test. When you first apply power to the instrument, it runs a Power On Self Test (POST). If an error is encountered during this POST, the display will show one of several error codes. (See Table 27.) Watch the display during boot up and note any error codes. Error codes may appear for as short a time as three seconds.

Table 27: POST error codes for Option SDI

Error code	Meaning	Action
2:	No output board in slot 1 or slot 2 - The output module is not detected by the processor.	Check that the module is correctly seated into the connector on the SDI FPGA board. IF that does not work replace the Output module.
3:	PLD keyword != 0xAAAA - The processor did not read the correct code interfacing to the module.	These errors indicate a failure of basic communications between the mainframe processor and the PLD on the module. Run the slot I/O test on the Genlock/Black board to test common instrument resources. (See page 70, <i>Slot I/O Test</i> .) If that passes, replace the Option SDI module.
4:	PLD keyword != 0x5555 - The processor did not read the correct code interfacing to the module.	
5:	FPGA not configured	Check the SW version. If necessary, reload the Module flash that holds the FPGA configuration file. (See page 97, <i>Reload the module flash</i> .) If the SW is current and correctly installed and this error is still encountered, replace the Option SDI module.
6:	FPGA R/W check 0x55 failed (0x20040A)	These errors indicate the main processor cannot communicate with the FPGA on the SDI board..Run the slot I/O test on the Genlock/Black board. (See page 70, <i>Slot I/O Test</i> .) If that passes, replace the Option SDI module.
7:	FPGA R/W check 0x55 failed (0x20040C)	
8:	FPGA R/W check 0xAA failed (0x20040A)	
9:	FPGA R/W check 0xAA failed (0x20040C)	

Reload the module flash. It might become necessary to reload the module flash that holds the FPGA configuration file. (See Table 27.) To reload the module flash, proceed as follows:

1. Press the **STATUS** button.
2. Press up (▲) or down (▼) arrow button to display **STATUS: SDI1:**.
3. Press and hold the **ENTER** button for 5 seconds.
4. When the upgrade message appears, press **ENTER** to accept.

Check the SDI diagnostics. There are several internally detected physical measurements, which are reported by the Option SDI diagnostics. Some of the diagnostic tests are available only in factory mode.

Perform the following procedure to access the Option SDI diagnostics:

1. Restart the instrument in Factory mode. (See page 105, *To power up in factory mode.*)
2. Press the **SYSTEM** button.
3. Press the up (**▲**) or down (**▼**) arrow buttons to choose **DIAGNOSTICS**.
4. Press the **ENTER** button.
5. Press the up (**▲**) or down (**▼**) arrow buttons to scroll through the following diagnostics. In some cases, you will need to use the left (**◀**) or right (**▶**) arrow buttons to scroll through the choices within a certain diagnostics submenu, such as **TEMPERATURE**, **PLL**, or **RUN**.
 - **PLL Status SDI:** Flex0:Lock (output channel 1) and Flex1:Lock (output channel 2) should be displayed. If the appropriate Locked message is not displayed when expected, it can indicate a problem with the Option SDI module or with the instrument's input clock.
 - **DDS Status:** DDS0 Phase:Lock (output channel 1) and DDS1 Phase:Lock (output channel 2) should be displayed. If the appropriate Locked message is not displayed when expected, it can indicate a problem with the option board or with the instrument's input clock.
 - **Temperatures:** The Option SDI module detects the temperature on the board. This temperature is normally about 15 °C above ambient temperature. If the temperature is very high or low, check that the fan is operating, the installation clearances are correct, and that all cables are connected properly. If there is still a problem, replace the Option SDI board.
 - **FPGA Version:** *Current:* shows the FPGA version that is loaded. *Expected:* shows the version that the operating firmware expects. If these are different, consider upgrading the firmware.
 - **Voltage Mon (1, 2, 3, & 4):** All internal voltages except the +5 V supply are measured and displayed with "OK" if they are within the established limits (+1.2 V, +1.5 V, +1.8 V, and +3.3 V). If any voltages are out of the established limits, the Option SDI board must be replaced.
 - **DDS Sweep:** This diagnostic capability is available only in factory mode and is not used in normal module troubleshooting. If you run this test, you must restart the instrument to continue.

- **SRAM Address Bus (1, 2, & 3):** Each of the 18 dashes represents one address bus line. A dash “-” indicates OK, “S” indicates shorted, “H” indicates stuck high, and “L” indicates stuck low.
 - **SRAM Data Bus (1, 2, & 3):** Each of the 16 dashes represents one data bus line. A dash “-” indicates OK, “S” indicates shorted, “H” indicates stuck high, and “L” indicates stuck low.
 - **SRAM Memory Test:** Press the ENTER button to start the test. The test takes approximately 60 seconds to complete. If **0 bad sectors detected** is not displayed, replace the Option SDI.
 - **DDR2 Address Bus (1 & 2):** Each of the 15 dashes represents one address bus line. A dash “-” indicates OK, “S” indicates shorted, “H” indicates stuck high, and “L” indicates stuck low.
 - **DDR2 Data Bus (1 & 2):** Each of the 16 dashes represents one data bus line. A dash “-” indicates OK, “S” indicates shorted, “H” indicates stuck high, and “L” indicates stuck low.
 - **DDR2 Memory Test:** Press the ENTER button to start the test. The test takes approximately 7 seconds to complete. If **0 errors detected** is not displayed, replace the Option SDI module.
6. Remove power and then reapply power to the SPG8000 to exit the factory mode.

Check the installed firmware version.

Use this procedure to check the installed firmware versions:

1. Press the **SYSTEM** button.
2. Press the up (▲) or down (▼) arrow buttons to select **VERSION INFO (F/W)**.
3. Read the firmware version.
4. If the version is not **V 1.3** or later, install current software. The latest software is available on the Web at www.tektronix.com/downloads.

Verify the configuration.

To eliminate the configuration of the SPG8000 as the source of a problem, reset the instrument to the factory default settings:

1. If necessary, save the user configuration in a preset. (The user configuration may already be saved as the power on preset.)
2. Restore the factory default:
 - a. Press the **ENTER** button.
 - b. Press **Enter** to select **Preset**.

- c. Press the up (▲) or down (▼) arrow button to select **RECALL**.
 - d. Press the left (◀) or right (▶) arrow button to select **Factory Default**.
 - e. Press the **ENTER** button to reset the instrument to the factory default settings.
3. Check to see if the problem still exists.

If the problem has been fixed, compare the settings between the factory default and the user configuration to find the issue. (See Table 28.)

Table 28: Option SDI module factory default settings

Menu item name	Settings
TEST SIGNAL	100% Color Bars
FORMAT	1080 59.94i
SAMPLE STRUCTURE/DEPTH	YCbCr 4:2:2 10b
OUTPUT MODE	HD (1920 x 1080)
MOVING PICTURE	
H Step	0 Sample(s)
V Step	0 Line(s)
Period	1 Frame(s)
Random	Disable

Table 28: Option SDI module factory default settings (cont.)

Menu item name	Settings
OVERLAY : LOGO	
Status	Disable
Source	Tektronix_logo_500x125.bmp
	<p>NOTE. The default logo is the "first" file in the SDI7/LOGO directory, as sorted by the date of the logo file (oldest first). If the factory-provided logo files are installed, the default logo is "Tektronix_logo_500x125.bmp."</p> <p>However, if the user has removed the factory-provided logo files and added their own custom files, the default logo will be the oldest file installed in the SDI7/LOGO directory.</p>
X Position	-5 % APW
Y Position	-5 % APH
OVERLAY : ID TEXT	
Status	Disable
Source	User-entered string
X Position	5.0 % APW
Y Position	5.0 % APH
Font Size	8.0 % APH
OVERLAY : CIRCLE	
Status	Disable
X Position	0.0 % APW
Y Position	0.0 % APH
Diameter	90.0 % APH
OVERLAY : BLINK	
Text/Circle Blink	Off
OVERLAY : BORDER	
Text/Circle Border	Enable

Table 28: Option SDI module factory default settings (cont.)

Menu item name	Settings
AUDIO (EMBEDDED)	
Status (Level A)	
Group 1–4	Disable
Status (Level B)	
Group 1–4 Link A	Disable
Group 1–4 Link B	Disable
Channel	
Status	Active
Frequency	1000
Amplitude	–20 dBFS
Audio Click	OFF
Channel Origin	A1-1 through A4-4
Sampling	Frame
TIMING	
Vertical	0 Line(s)
Horizontal	0.0000 μ s
Relative To	Serial (0H)
TIMECODE	
Source	Without Option GPS: Program Time With Option GPS: Time of Day
30 Drop Frame	Enable
ATC-LTC	OFF
ATC-VITC	OFF
VIDEO	
Y	ON
Cb	ON
Cr	ON
Edge Filter	Enable
AV Timing Mode	OFF
EDH (SD output mode only)	ON

Table 28: Option SDI module factory default settings (cont.)

Menu item name	Settings
ANC PAYLOAD	
Output	Disable
Parity	Automatic
DID	0x101
SDID	0x200
DC	0x101
UDW	0x200
CS	0x200
Auto-Calculate CS	Enable
Line	9
Field 1, Line:	9
Field 2, Line:	9
Start Sample	1928
Video Channel	Luma
Link Location	Link A
Stream Location	HS Stream 1
SMPTE 352 PAYLOAD	Enable
SECONDARY OUTPUT	Test Pattern

Check the power supplies. Two of the power supplies require manual verification.

1. Remove the SPG8000 top cover. (See page 46, *Top cover*.)
2. Check the +5 V supply by measuring the voltage at F121, which should be in the range of +4.75 V to +5.25 V. (See Figure 15.)
3. Check the +3.3 V supply by measuring the voltage at F122, which should be in the range of +3.135 V to +3.465 V. (See Figure 15.)

Make sure that the voltage is present on both ends of the fuse. If the voltage is present on only one end of the fuse, the Option SDI board must be replaced. If the voltage is not present on either end of the fuse, check the power and the connector between the SDI board and the Main board. If they are okay, the instrument must be repaired.

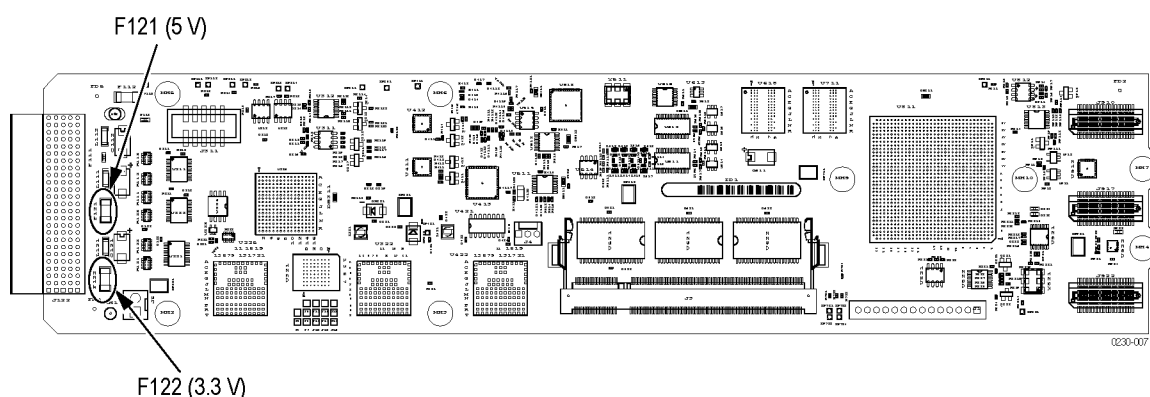


Figure 29: SDI power supply test points

Check the multiple frame rates.

The Main board provides three frame pulses, which are used to set the module timing relative to the rest of the instrument. Different frame pulses are used, depending on the signal format the instrument is set for. Use this procedure to investigate problems in that circuitry.

1. Connect the SDI outputs to a waveform monitor.
2. Apply power to the SPG8000.
3. Recall the Factory Default preset as follows:
 - a. Press the **ENTER** button.
 - b. Press **Enter** to select **Preset**.
 - c. Press the up (▲) or down (▼) arrow button to select **RECALL**.
 - d. Press the left (◀) or right (▶) arrow button to select **Factory Default**.
 - e. Press the **ENTER** button to reset the instrument to the factory default settings.

4. Verify that all four SDI signal outputs (SDI 1A, SDI 1B, SDI 2A, and SDI 2B) are set to provide a 59.94, 1080i format, 100% color bar signal (factory default signal).
5. Check the DDS0:Phase and DDS1:Phase lock status, as described in the Module Diagnostics. (See page 98, *Check the SDI diagnostics*.)
6. Change the SDI signal format to 50 Hz:
 - a. Press the **SDI** button until **SDI 1** appears on the display.
 - b. Press the up (▲) or down (▼) arrow button to select **FORMAT**.
 - c. Press the left (◀) or right (▶) arrow button to select **1080 50i**.
 - d. Press the **ENTER** button.
 - e. Repeat the steps to set the **SDI 2** channel to **1080 24p**.
7. Check the DDS0:Phase and DDS1:Phase lock status, as described in the Module Diagnostics. (See page 98, *Check the SDI diagnostics*.)

If one of the formats (59.94 Hz, 50 Hz, or 24 Hz) works correctly, but the other one does not, the sync pulse may be missing.

To power up in factory mode. Putting the instrument into factory mode allows access to calibration, but it also allows the module to show in the menus even if it fails the POST routine.

Restart the instrument in factory mode. (See page 105, *To power up in factory mode*.)

1. Run the **Check module diagnostics** routine. (See page 98, *Check the SDI diagnostics*.)

Verify that Option 3G is enabled. If your instrument has Option 3G enabled, an option key was entered to enable the 3G software option. You need to enter the option key only once.

Perform the following steps to verify that Option 3G is enabled.

1. Press the front-panel **SYSTEM** button.
2. Press the up (▲) or down (▼) arrow button until **SYSTEM : OPTIONS** are displayed.
Press the **ENTER** button.
3. Press the up (▲) or down (▼) arrow button and check for **SYSTEM: OPTIONS : ENABLED: 3G**, which indicates that this option is enabled.

Download a frame picture with a known good image. If you are having problems with generating a frame picture using Option SDI, perform the following steps to install a known good frame picture so that you can determine whether the problem is with the signal you were trying to generate or with the module:

1. Download one of the sample frame pictures from the *SPG8000 SW Library and Documentation DVD* that shipped with your product. The sample images are located in the SAMPLE/SDI7 directory on the DVD.

NOTE. For information on how to transfer or install user files to your SPG8000, refer to the *Quick Start User Manual*, Tektronix part number 071-3080-XX.

2. Configure the Option SDI to output a 1080i 59.94 format HD signal.
3. Press the **SDI** button to display **SDI 1**.
4. Press the up (▲) or down (▼) arrow button to select **TEST SIGNAL**.
5. Press **ENTER**.
6. Press the up (▲) or down (▼) arrow button to select **FRAME PICTURE**.
7. Press the left (◀) or right (▶) arrow button to select the file you downloaded.
8. Press the **ENTER** button to load that signal into the generator.
9. Check to see if the Option SDI is providing a proper frame picture:
 - a. If a proper frame picture is generated when using the signal that you downloaded, but not when using a customer signal, the problem is probably something in the customer signal.
 - b. If a proper frame picture is not generated with the signal that you downloaded, there is probably a problem with the Option SDI.

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. 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.

Replaceable parts

This section contains a list of the replaceable modules for the SPG8000 generator and available options. Use this list to identify and order replacement parts.

Parts ordering information

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

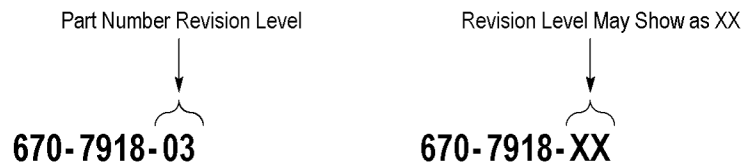
Changes to Tektronix products are sometimes made to accommodate improved components as they become available and to give you the benefit of the latest improvements. Therefore, when ordering parts, it is important to include the following information in your order.

- Part number (see Part Number Revision Level below)
- Instrument type or model number
- Instrument serial number
- Instrument modification number, if applicable

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

Part number revision level

Tektronix part numbers contain two digits that show the revision level of the part. For most parts in this manual, you will find the letters XX in place of the revision level number.



When you order parts, Tektronix will provide you with the most current part for your product type, serial number, and modification (if applicable). At the time of your order, Tektronix will determine the part number revision level needed for your product, based on the information you provide.

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 1-800-833-9200. Outside North America, contact a Tektronix sales office or distributor; see the Tektronix Web site for a list of offices: www.tektronix.com

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

This section contains a list of the mechanical and/or electrical components that are replaceable for the SPG8000. Use this list to identify and order replacement parts. The following table describes each column in the parts list.

Table 29: 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.

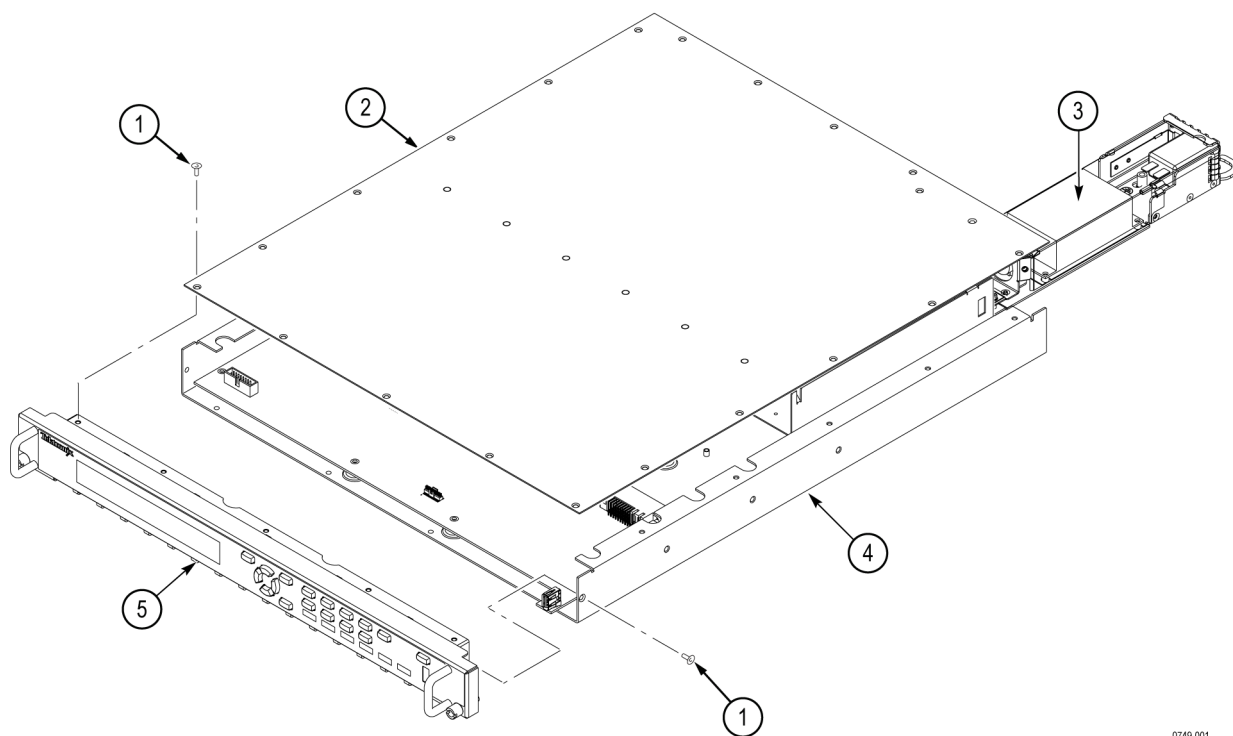
Abbreviations Abbreviations conform to American National Standard ANSI Y1.1-1972.

Replaceable parts lists

The following tables list the replaceable parts for the SPG8000.

Table 30: Main instrument replaceable parts

Fig. & index number	Tektronix part number	Qty	Name & description
30-1	211-1194-XX	28	SCREW, MACHINE; M3 X 6MM, FLH BLACK, CROSS REC
-2	200-5248-XX	1	CABINET; TOP MAIN CHASSIS
-3	650-5545-XX	1	POWER SUPPLY ASSY STANDARD
		2	POWER SUPPLY ASSY OPTION DPW
-4	441-2690-XX	1	MAIN CHASSIS ASSY The chassis assembly has replaceable subparts. (See Figure 31 on page 113.)
-5	650-5547-XX	1	FRONT PANEL ASSY The Front Panel assembly has replaceable subparts. (See Figure 32 on page 115.)



0749-001

Figure 30: Main instrument exploded view

Table 31: Chassis assembly replaceable parts

Fig. & index number	Tektronix part number	Qty	Name & description
31-1	441-2691-XX	1	MAIN CHASSIS ASSY
-2	863-0648-XX	1	CIRCUIT BD ASSY; MAIN
-3	211-A245-XX	10	SCREW, MACHINE; M3 X 6 MM L, PNH, STL, NI PL, CROSS REC, W/NUT & LOCK WASHER
-4	344-0629-XX	1	MOUNT, CLIP; WIRE ROUTING CLIP, NYLON 6/6, ADHESIVE BACKING, NATURAL COLOR
-5	174-6138-XX	1	CABLE ASSY, 2 X 5 FEMALE TO FEMALE, KEYED
-6	174-6143-XX	1	CABLE 2 X 8, 2 MM PITCH, RIBBON FEMALE TO FEMALE, TAB
-7	174-6137-XX	1	CAT5E CABLE CABLE ASSEMBLY, RJ45, MALE/MALE, 2 FT
-8	878-0652-XX	1	CIRCUIT BD ASSY: BREAKOUT
-9	214-3903-XX	4	SCREW, JACK; 4-40 X 0.312 EXT THD, 4-40 INT THD, 0.188 HEX, ZINC PLATED STEEL
-10	333-4681-XX	1	REAR PANEL
-11	----	1	CIRCUIT BD ASSY: Genlock/Black board (See Figure 35.)
-12	----	1	OPTION BG ASSY (See Figure 34.)
-13	----	1	OPTION AG ASSY (See Figure 33.)
-14	----	1	OPTION SDI ASSY (See Figure 36.)
-15	348-A156-XX	1	GASKET, SHIELD: FINGER TYPE, BE-CU, 8.13MM W X 2.79MM H X 406.4MM L
-16	119-7933-XX	1	FAN ASSY (12 V, 8.62 CFM) 40 X 40 X 28 MM, TERMINATED
-17	211-A265-XX	2	SCREW, MACHINE; M3 X 40MM L, PNH, STL, NI PL, CROSS REC, W/NUT & LOCK WASHER
-18	407-6120-XX	1	BRACKET PCB, HOLD DOWN
-19	220-A095-XX	2	NUT, PLAIN, HEX:M3, STL, NI PL, W/EXT TOOHEED WASHER
-20	878-0650-XX	1	CIRCUIT BD ASSY; POWER COMBINER
-21	211-1194-XX	6	SCREW, MACHINE; M3 X 6MM, FLH BLACK, CROSS REC
-22	146-0109-XX	1	BATTERY, DRY; 3.0 V, LITHIUM MANGANESE DIOXIDE, 210MAH, 20 X 3.22MM COIN CELL WITH SOLDER TABS, CR2032-1HF1
Main board fuses (not shown)			
	159-5018-XX	2	FUSE; 3.0A, 125 V, FAST BLOW, 0.1 X 0.1 X 0.24, UL REG, CSA CERT
	159-5022-XX	15	FUSE; 5.0A, 125 V; FAST BLOW, 0.1 X 0.1 X 0.24, UL REG, CSA CERT; 451005

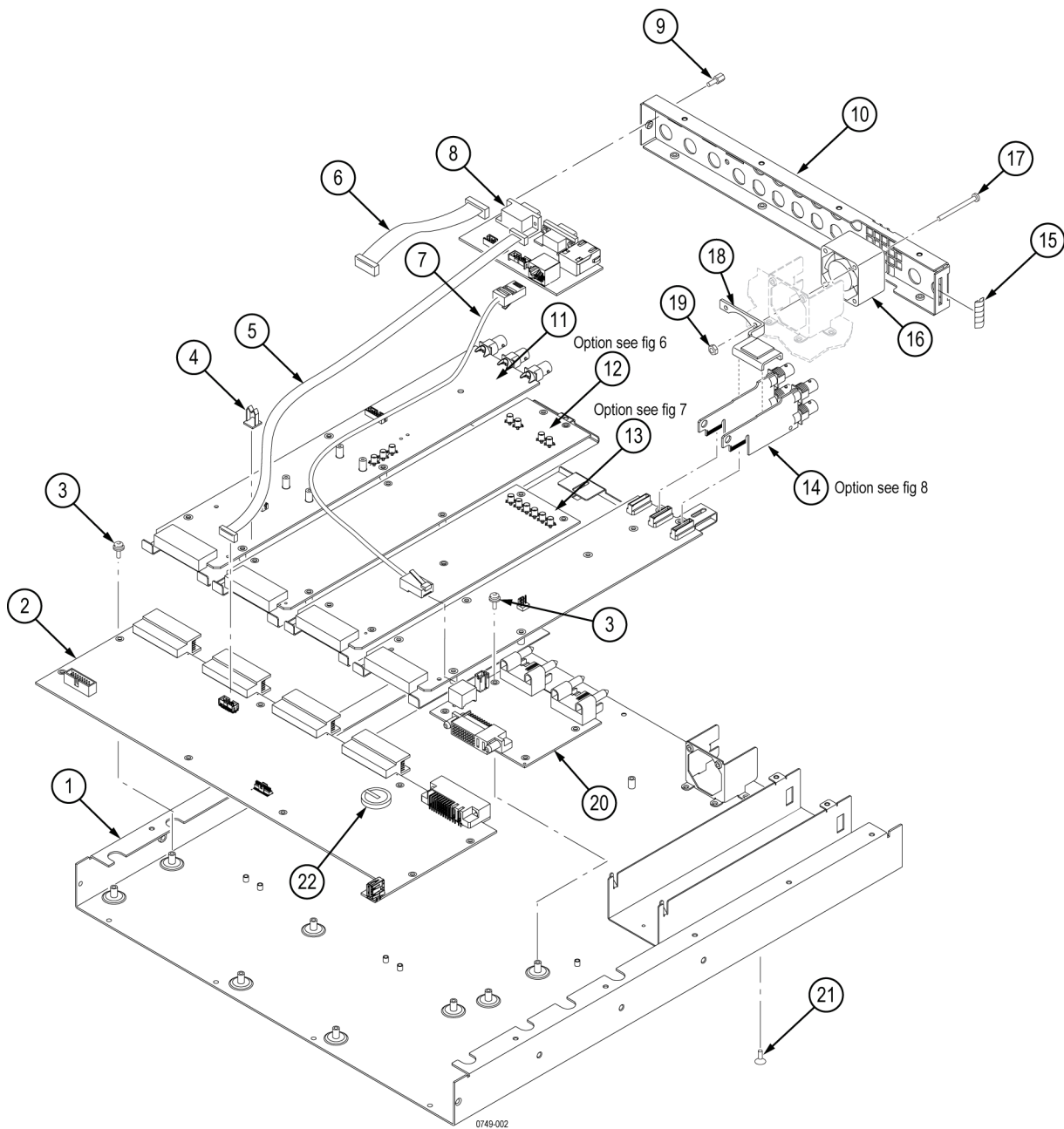
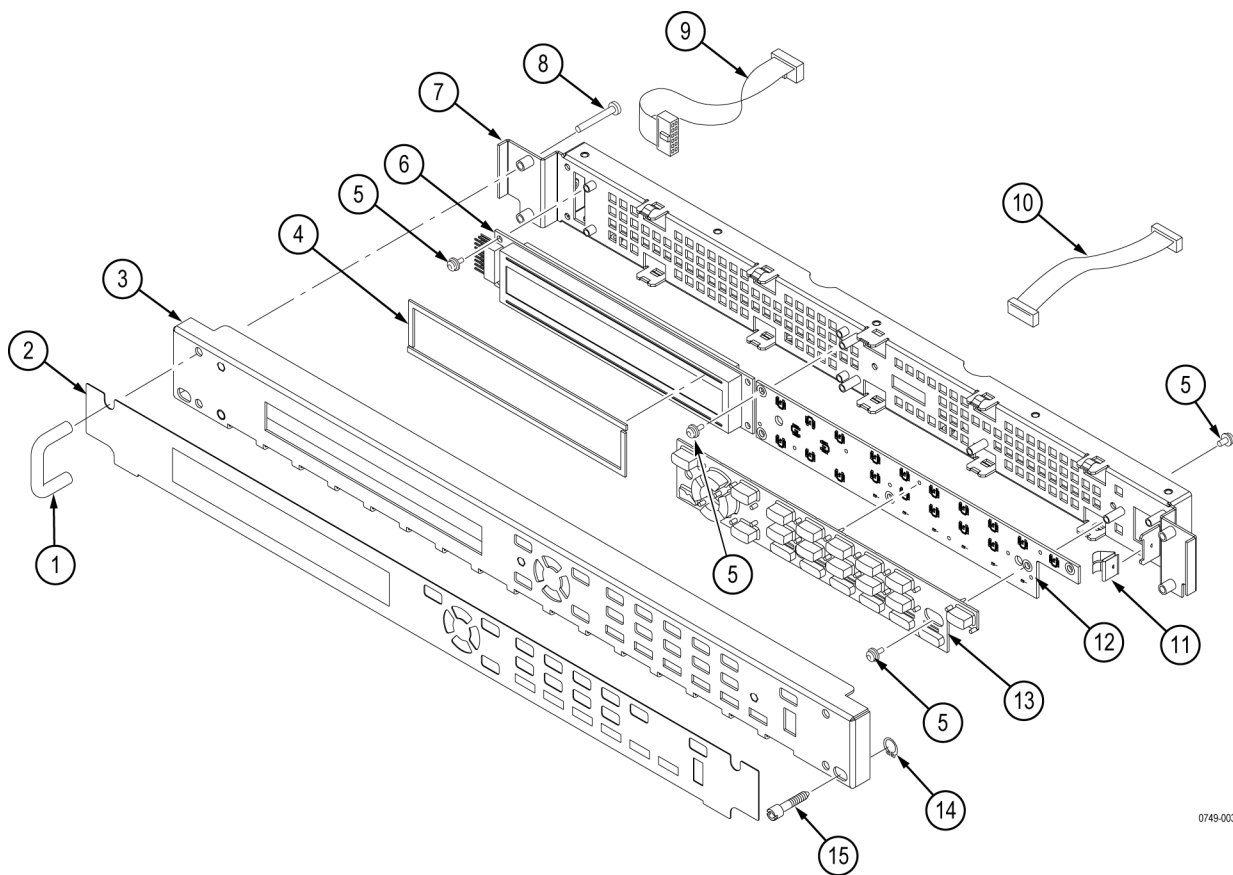


Figure 31: Chassis assembly exploded view

Table 32: Front panel assembly replaceable parts

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discont'd	Qty	Name & description
32-	650-5546-XX			1	FRONT PANEL ASSY
-1	367-0530-XX			2	HANDLE, BOW; AL, 1.0 X 1.25, STAIN FINISH, SAFETY CONTROLLED
-2	335-2801-XX			1	LABEL, FRONT PANEL
-3	426-2637-XX			1	FRONT PANEL BEZEL
-4	348-2061-XX			2	GASKET, DISPLAY DUST SEAL
-5	211-A245-XX			13	SCREW, MACHINE; M3 X 6 MM L, PNH, STL, NI PL, CROSS REC, W/NUT & LOCK WASHER
-6	119-7930-XX			1	DISPLAY MODULE ASSEMBLY
-7	407-5730-XX			1	FRONT PANEL SUPPORT BRACKET
-8	211-0738-XX			4	SCREW, MACHINE; 6-32 X 0.625, PNH, STL BLK ZI, TORX
-9	174-6136-XX			1	CABLE, RIBBON, LCD, 2X8, 0.100 P FEMALE TO FEMALE
-11	174-6135-XX			1	CABLE 2 X 13, RIBBON, KEYBOARD FEMALE TO FEMALE
-12	131-6521-XX			1	CONTACT, ELEC; EMI, CLIP-ON, 0.38 L X 0.460 W (2 CONTACTS) X 0.45 HIGH, ELECTROLESS NICKEL PLATE
-13	878-0649-XX			1	CIRCUIT BD ASSY; FRONT PANEL
-14	260-2952-XX			1	SWITCH KEYPAD; ELASTOMERIC MAT
-15	354-0025-XX			2	RING, RETAINING; EXTERNAL, U/O 0.187 DIA SFT, ZINC PLATED STEEL
-16	213-0216-XX			2	THUMBSCREW; 10-32 X 0.85, 0.375 OD HD, ZINC PLATED STEEL, W/SLOT

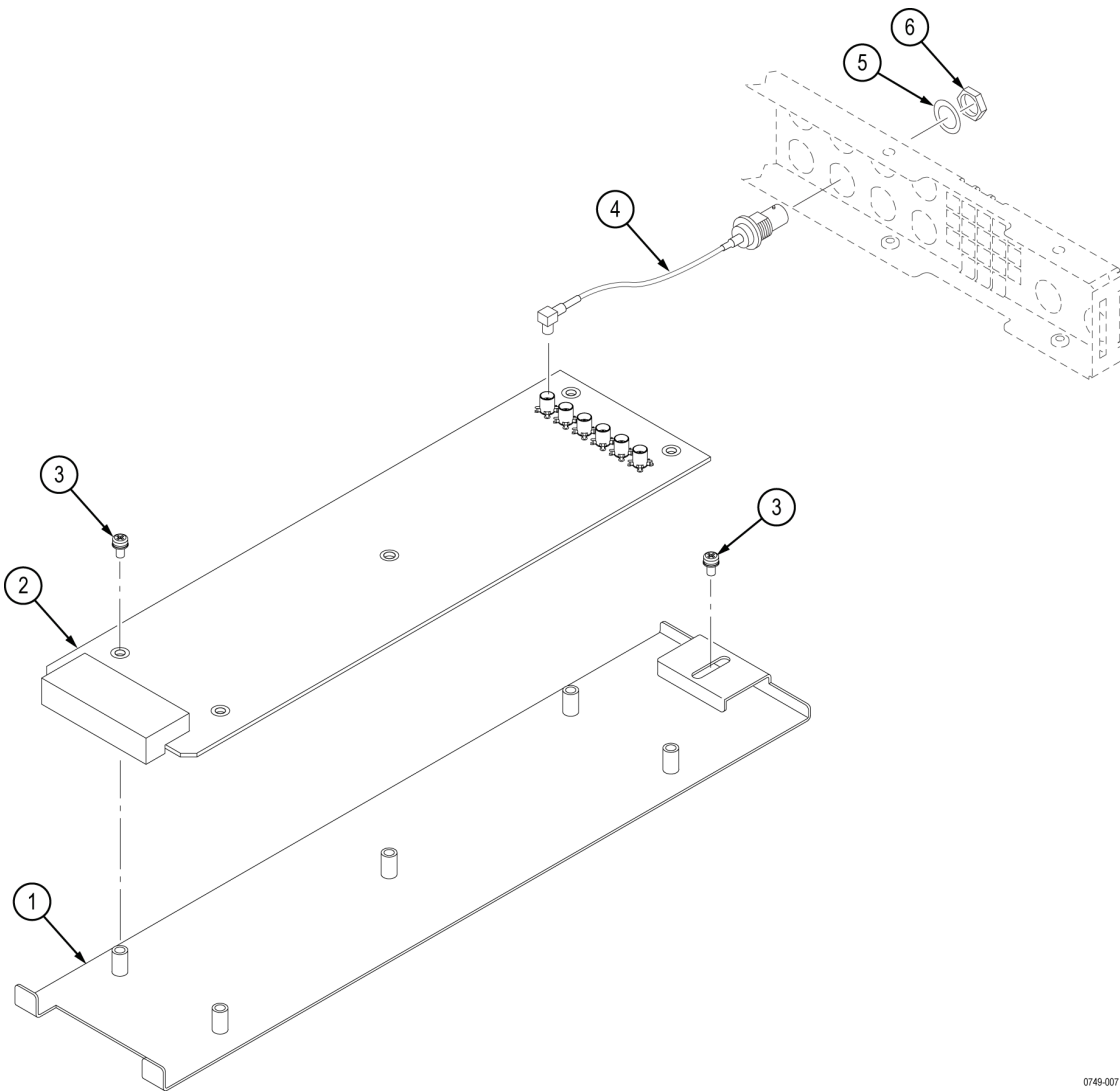


0749-003

Figure 32: Front panel assembly exploded view

Table 33: Option AG – replaceable parts

Fig. & index number	Tektronix part number	Module no. effective	Module no. discont'd	Qty	Name & description
33-1	441-2696-XX			1	MOUNTING PLATE, OPTION AG
-2	878-0729-XX			1	CKT BD SUBASSY; OPTION AG, AUDIO GENERATOR
-3	211-A245-XX			6	SCREW, MACHINE; M3 X 6 MM L, PNH, STL, NI PL, CROSS REC, W/PLAIN & SPLIT LOCK WASHER
-4	174-6145-XX			5	CABLE, COAX, MCX TO FEMALE BNC (LENGTH 6 INCHES, 75 OHM)
-5	210-1039-XX			5	WASHER, LOCK; 0.521 ID, INT, 0.025 THK, STEEL, ZINC FINISH
-6	220-0497-XX			5	NUT, PLAIN, HEX; 0.5-28 X 0.562 HEX, BRS, NI (NICKEL) PLATED

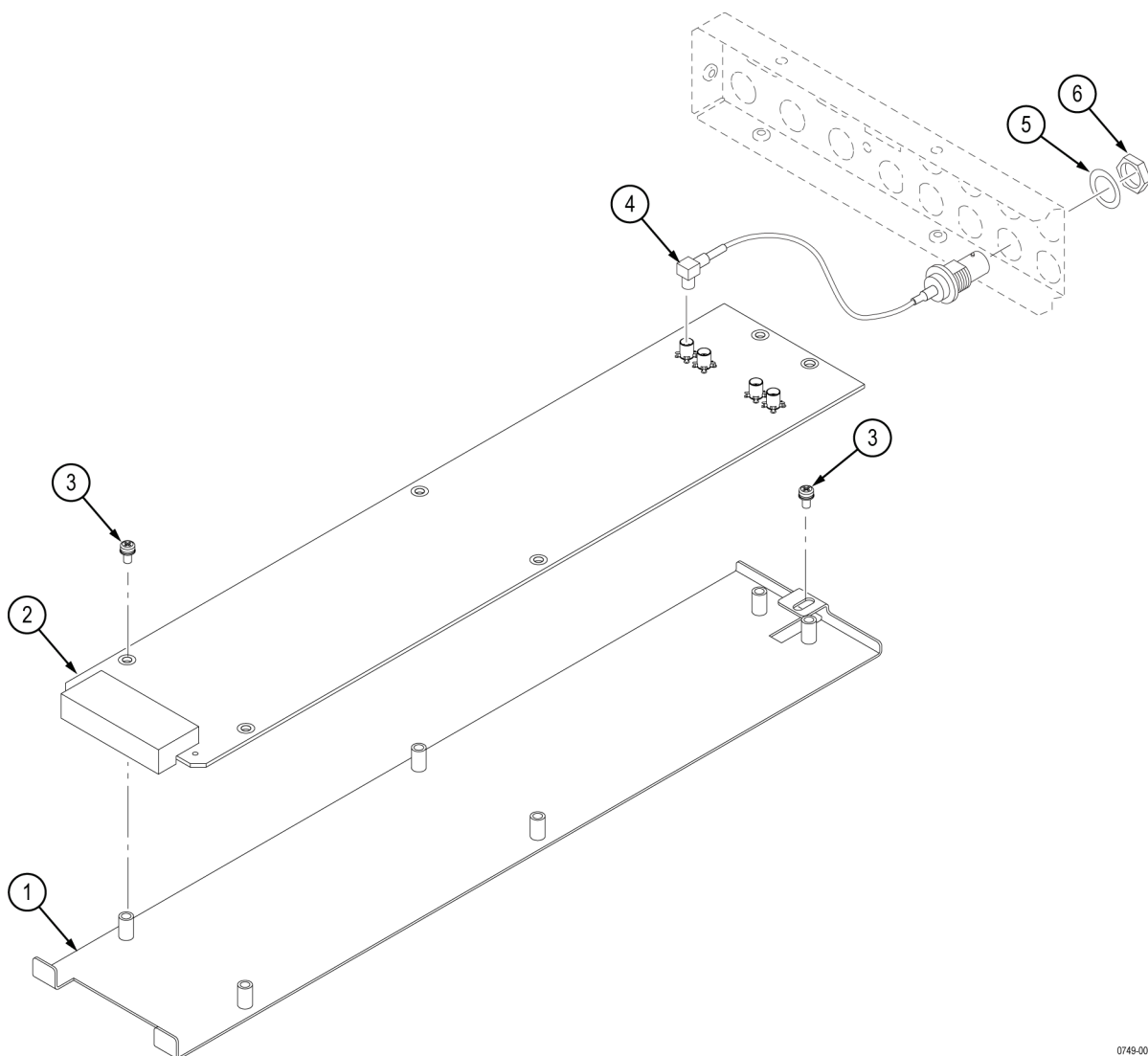


0749-007

Figure 33: Option AG exploded view

Table 34: Option BG – replaceable parts

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discont'd	Qty	Name & description
34-1	441-2693-XX			1	MOUNTING PLATE; OPTION BG
-2	878-0728-XX			6	CKT BD ASSY; OPTION BG
-3	211-A245-XX			7	SCREW, MACHINE; M3 X 6 MM L, PNH, STL, NI PL, CROSS REC, W/PLAIN & SPLIT LOCK WASHER
-4	174-B847-XX			4	CA ASSY, RF; 75 OHM, COAX, RG179, 7.5 CM L, BNC TO MCX; OPTION AG
-5	210-1039-XX			4	WASHER, LOCK; 0.521 ID, INT, 0.025 THK, STEEL, ZINC FINISH
-6	220-0497-XX			4	NUT, PLAIN, HEX; 0.5-28 X 0.562 HEX, BRS, NI (NICKEL) PLATED

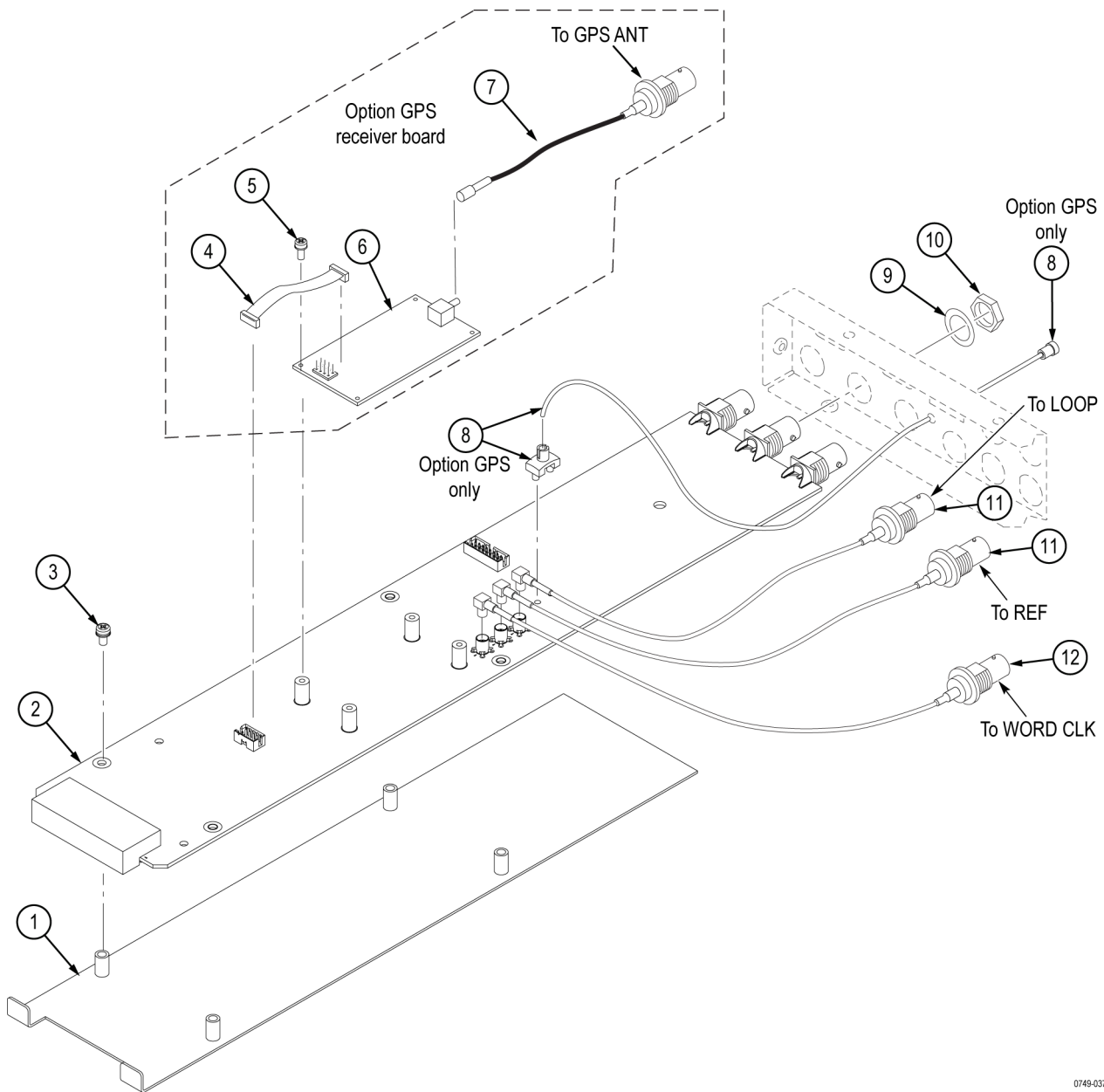


0749-006

Figure 34: Option BG exploded view

Table 35: Genlock/Black board and Option GPS Receiver board – replaceable parts

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discount'd	Qty	Name & description
35-1	441-2694-XX			1	MOUNTING PLATE: GENLOCK/BLACK GENERATOR BOARD
-2	878-0737-XX			1	CIRCUIT BD ASSY; GENLOCK/BLACK GENERATOR
-3	211-A245-XX			4	SCREW, MACHINE; M3 X 6 MM L, PNH, STL, NI PL, CROSS REC, W/PLAIN & SPLIT LOCK WASHER
-4	174-5521-XX			1	CABLE, 2X4, 2MM PITCH, FEMALE TO FEMALE SQUARE PINS OPTION GPS ONLY
-5	211-0408-XX			4	SCR, ASSY, WSHR; 4-40 X 0.250, PNH, STEEL, ZINC FINISH, T-10 TORX DR, SEMS OPTION GPS ONLY
-6	119-7518-XX	C010100	C010999	1	CIRCUIT BD ASSY: OPTION GPS RECEIVER BOARD (GPS ONLY) OPTION GPS ONLY
	119-8313-XX	C011000		1	CIRCUIT BD ASSY: OPTION GPS RECEIVER BOARD (GPS & GLONASS) OPTION GPS ONLY
-7	174-5509-XX			1	CABLE, FEMALE SMB TO FEMALE BNC OPTION GPS ONLY
-8	335-1117-XX			1	LIGHT PIPE, SINGLE LED (ELMA P/N 90-1216-1001) OPTION GPS ONLY
-9	210-1039-XX			5	WASHER, LOCK; 0.521 ID, INT, 0.025 THK, STEEL, ZINC FINISH
-10	220-0497-XX			5	NUT, PLAIN, HEX; 0.5-28 X 0.562 HEX, BRS, NI (NICKEL) PLATED
-11	174-6141-XX			2	CABLE, COAXIAL, MCX TO FEMALE BNC (LENGTH 8 INCHES, 75 OHM)
-12	174-6142-XX			1	CABLE, COAXIAL, MCX TO FEMALE BNC (LENGTH-11 INCHES, 75 OHM)

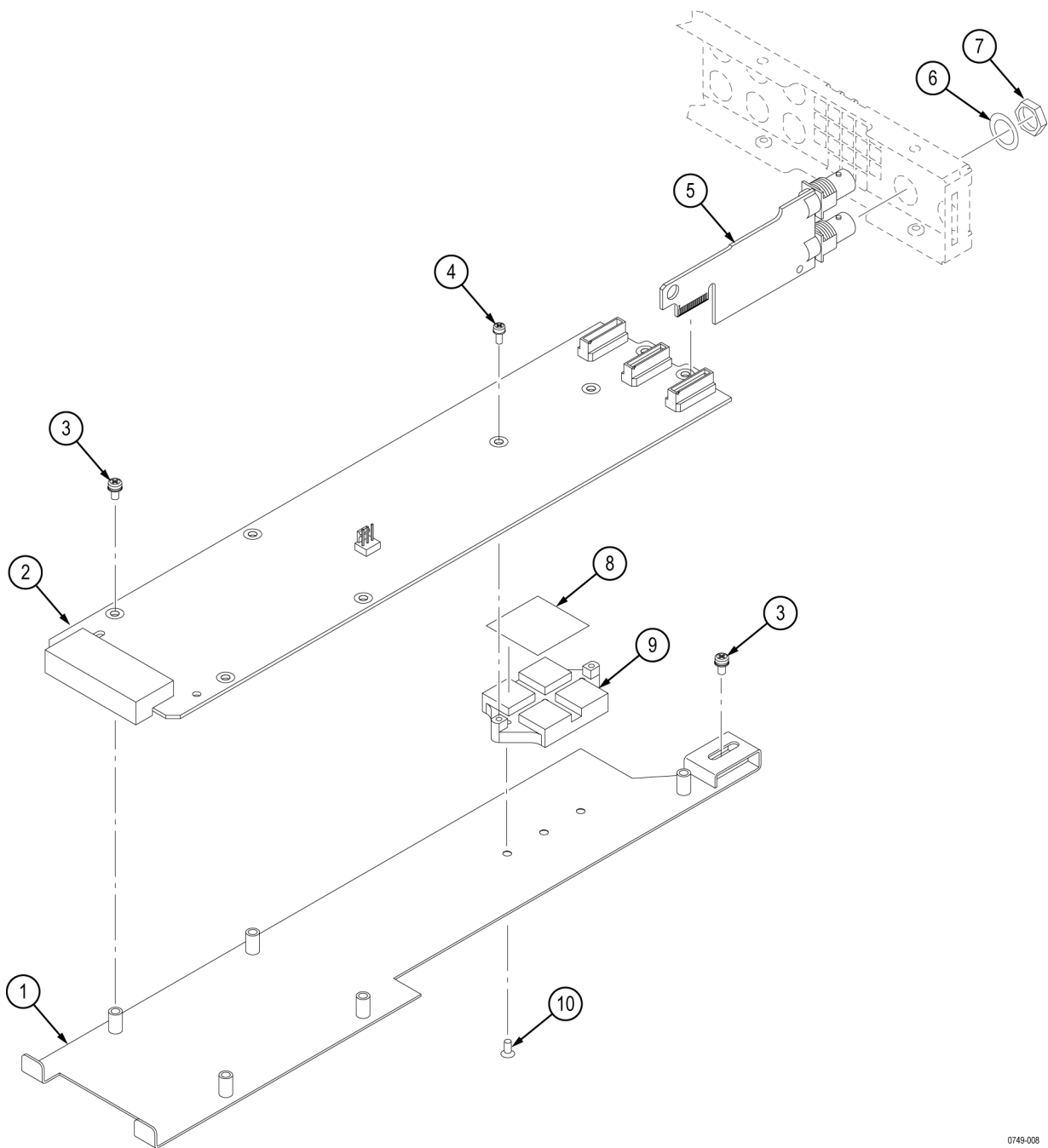


0749-037

Figure 35: Genlock/Black generator board and Option GPS Receiver board exploded view

Table 36: Option SDI – replaceable parts

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discount'd	Qty	Name & description
36-1	441-2695-XX			1	MOUNTING PLATE; SDI
-2	878-0580-XX			1	CIRCUIT BD ASSY; SDI
-3	211-A245-XX			6	SCREW, MACHINE; M3 X 6 MM L, PNH, STL, NI PL, CROSS REC, W/PLAIN & SPLIT LOCK WASHER
-4	211-0408-XX			2	SCR, ASSY, WSHR; 4-40 X 0.250, PNH, STEEL, ZINC FINISH, T-10 TORX DR, SEMS
-5	878-0602-XX			2	CIRCUIT BD ASSY; OUTPUT
-6	210-1039-XX			4	WASHER, LOCK; 0.521 ID, INT, 0.025 THK, STEEL, ZINC FINISH
-7	220-0497-XX			4	NUT, PLAIN, HEX; 0.5-28 X 0.562 HEX, BRS, NI (NICKEL) PLATED
-8	348-1944-XX			1	GAP PAD 3000S30
-9	214-5166-XX			1	HEATSINK, PCB TO CHASSIS
-10	211-0101-XX			3	SCREW, MACHINE; 4-40 X 0.25, FLH, 100 DEG, ZINC PLATED STEEL, T8



0749-008

Figure 36: Option SDI board and Option SDI Output board exploded view

Table 37: Standard and optional accessories for the SPG8000

Component number	Tektronix part number	Serial no. effective	Serial no. discont'd	Qty	Name & description
STANDARD ACCESSORIES					
	351-1137-XX			1	RACK, KIT, RAILS
	063-4474-XX			1	DVD, SOFTWARE LIBRARY & DOCUMENTATION
	071-3080-XX			1	QUICK START USER MANUAL, ENGLISH
	077-0745-XX			1	QUICK START USER MANUAL, JAPANESE
	077-0746-XX			1	QUICK START USER MANUAL, RUSSIAN
	161-0364-XX			1	CABLE ASSY, PWR; 3, 18 AWG, 125 V/10 A, 2M, STR, IEC320, C13, RCPT, NEMA 5-15P, V-LOCK, US, SAFETY CONTROLLED STANDARD
POWER CORDS					
	161-0364-XX			1	OPTION A0: NORTH AMERICA CABLE ASSY, PWR; 3, 18 AWG, 125 V/10 A, 2M, STR, IEC320, C13, RCPT, NEMA 5-15P, V-LOCK, US, SAFETY CONTROLLED
	161-0365-XX			1	OPTION A1: UNIVERSAL EURO CABLE ASSY, PWR; 3, 1MM SQ, 250 V/10 A, 2M, STR, IEC320, C13, RCPT, CEE 7 / VII, V-LOCK, EURO, SAFETY CONTROLLED
	161-0366-XX			1	OPTION A2: UNITED KINGDOM CABLE ASSY, PWR; 3, 1MM SQ, 250 V/10 A, 2M, STR, IEC320, C13, RCPT, BS1363, V-LOCK, UK, SAFETY CONTROLLED
	161-0367-XX			1	OPTION A3: AUSTRALIA CABLE ASSY, PWR; 3, 1MM SQ, 250 V/10 A, 2M, STR, IEC320, C13, RCPT, AS3112, V-LOCK, AUSTRALIA, SAFETY CONTROLLED
	161-0368-XX			1	OPTION A5: SWITZERLAND CABLE ASSY, PWR; 3, 1MM SQ, 250 V/10 A, 2M, STR, IEC320, C13, RCPT, SEV 1011, V-LOCK, SWISS, WITH PARTIALLY INSULATED PINS; SAFETY CONTROLLED; CIQB
	161-0369-XX			1	OPTION A6: JAPAN CABLE ASSY, PWR; 3, 1.25MM SQ, 125 V/12 A, 2M, STR, IEC320, C13, RCPT, JIS 8303, V-LOCK, JAPAN, SAFETY CONTROLLED
	161-0370-XX			1	OPTION A10: CHINA CABLE ASSY, PWR; 3, 1MM SQ, 250 V/10 A, 2M, STR, IEC320, C13, RCPT, GB 2099, V-LOCK, CHINA, SAFETY CONTROLLED
	161-0400-XX			1	OPTION A11: INDIA CABLE ASSY, PWR; 3, 1.0 MM SQ, 250 V/6 A, 2.5 METER, STR, IEC320/C13, RCPT, PLUG, INDIA
	161-0356-XX			1	OPTION A12: BRAZIL CABLE ASSY, PWR; 3, 1.00MM SQ, 250 V/10 A, 2.5 METER, RT ANGLE, IEC320/C13 CERTIFICATION, RCPT, BRAZIL, SAFETY CONTROLLED

