



SPG9000 User Manual

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THIRD-PARTY SOFTWARE LICENSE

The SPG9000 PTP option uses open source software from the Linux PTP Project (ptp4l), which is licensed under GPL v2.0. The ptp4l source code has been modified for use on the SPG9000, so a copy of the modified source code will be made available upon request in accordance with the GPL v2.0 license. Visit www.telestream.net/telestream-support/video/support.htm to find contacts in your area.

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Important Compliance and Safety Information

United States of America Compliance Notices

Class A Interference Statement

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15, Subpart B of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a commercial installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Caution

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause unexpected operation.

Safety

UL 61010-1: 2012 R7.19: Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements.

Environmental

Perchlorate Materials: this product contains one or more type CR lithium batteries. According to the state of California, CR lithium batteries are classified as perchlorate materials and require special handling.

See www.dtsc.ca.gov/hazardouswaste/perchlorate for additional information.

Canada Compliance Notices

Department of Communications Radio Interference Regulations

This digital apparatus does not exceed the Class A limits for radio-noise emissions from a digital apparatus as set out in the Radio Interference Regulations of the Canadian Department of Communications. This Class A digital apparatus complies with Canadian ICES-003.

Règlement sur le brouillage radioélectrique du Quadstere des Communications

Cet appareil numérique respecte les limites de bruits radioélectriques visant les appareils numériques de classe A prescrites dans le Règlement sur le brouillage radioélectrique du Quadstere des Communications du Canada. Cet appareil numérique de la Classe A est conforme à la norme NMB-003 du Canada.

Safety

CAN/CSA-C22.2 NO. 61010-1-12 + GI1 + GI2 (R2017) + A1: Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements.

Sécurité

CAN/CSA-C22.2 NO. 61010-1-12 + GI1 + GI2 (R2017) + A1: Exigences de sécurité pour l'électricité Matériel de mesure, de contrôle et d'utilisation en laboratoire - Partie 1: Généralités Exigences.

European Union, European Free Trade Association (EFTA), and United Kingdom Compliance Notices

This equipment may be operated in the countries that comprise the member countries of the European Union and the European Free Trade Association. These countries, listed in the following paragraph, are referred to as The European Community throughout this document:

AUSTRIA, BELGIUM, BULGARIA, CYPRUS, CROATIA, CZECHIA, DENMARK, ESTONIA, FINLAND, FRANCE, GERMANY, GREECE, HUNGARY, IRELAND, ITALY, LATVIA, LITHUANIA, LUXEMBOURG, MALTA, NETHERLANDS, POLAND, PORTUGAL, ROMANIA, SLOVAKIA, SLOVENIA, SPAIN, SWEDEN, UNITED KINGDOM, ICELAND, LIECHTENSTEIN, NORWAY, SWITZERLAND

Declaration of Conformity

Marking by the "CE" symbol indicates compliance with the Essential Requirements of the EMC Directive of the European Union 2014/30/EU

This equipment meets the following conformance standards:

Safety

EN 61010-1: 2010 + A1: Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements Low Voltage Directive 2014/35/EU

Emissions

EN 55032: 2015 + A11: 2020, CISPR 32: 2015, EN 61000-3-2: 2014, EN 61000-3-3: 2013

Immunity

EN 55035: 2017, EN 61000-4-2: 2009,

EN 61000-4-3: 2006 + A1: 2008 + A2: 2010, EN 61000-4-4: 2012,

EN 61000-4-5: 2014 + A1: 2017, EN 61000-4-6: 2014, EN 61000-4-8: 2010,

EN 61000-4-11: 2020

Environments: E2

Warnings



Warning! This is a Class A product. In a domestic environment, this product may cause radio interference, in which case, the user may be required to take appropriate measures.



Achtung! Dieses ist ein Gerät der Funkstorgrenzwertklasse A. In Wohnbereichen können bei Betrieb dieses Gerätes Rundfunkstörungen auftreten, in welchen Fällen der Benutzer für entsprechende Gegenmaßnahmen verantwortlich ist.



Attention! Ceci est un produit de Classe A. Dans un environnement domestique, ce produit risque de créer des interférences radioélectriques, il appartiendra alors à l'utilisateur de prendre les mesures spécifiques appropriées.

Notes:

1. For Compliance with the EMC standards listed here, high-quality shielded interface cables should be used.
2. Emissions which exceed the levels required by this standard may occur when this equipment is connected to a test object.

Environmental Compliance

This section provides information about the environmental impact of the product.

Product end-of-life handling

Observe the following guidelines when recycling an instrument or component:

Equipment recycling



Production of this equipment required the extraction and use of natural resources. The equipment may contain substances that could be harmful to the environment or human health if improperly handled at the product's end of life. To avoid release of such substances into the environment and to reduce the use of natural resources, we

encourage you to recycle this product in an appropriate system that will ensure that most of the materials are reused or recycled appropriately.

This symbol on the product or its packaging indicates that this product complies with the applicable European Union requirements according to Directives 2012/19/EU and 2006/66/EC on waste electrical and electronic - equipment (WEEE) and batteries.

It also indicates that this product must not be disposed of with your other household waste. Instead, it is your responsibility to dispose of your waste equipment by handing it over to a designated collection point for the recycling of waste electrical and electronic equipment. The separate collection and recycling of your waste equipment at the time of disposal will help conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment. For more information about where you can drop off your waste for recycling, please contact your local authority, or where you purchased your product.

Battery Recycling

This product may contain a rechargeable battery, which must be recycled or disposed of properly. Please properly dispose of or recycle the battery according to local government regulations.

Transporting Batteries or products with Batteries in them

The capacity of the lithium-ion secondary battery shipped with this product is under 100 Wh. The lithium content of the installed primary battery is under 1 g. Each battery meets the applicable requirements of UN Manual of Tests and Criteria Part III Section 38.3. Battery quantity is under the limit for shipment according to Section II of the relevant Packing Instructions from the IATA Dangerous Goods Regulations. Consult your air carrier for applicability and determination of any special lithium battery transportation requirements.

Restriction of Hazardous Substances

This product is classified as an industrial monitoring and control instrument, and is required to comply with the substance restrictions of the RoHS 3 Directives 2011/65/EU and EU 2015/863.

Korea Compliance Statement

사 용 자 안 내 문
이 기기는 업무용 환경에서 사용할 목적으로 적합성평가를 받은 기기로서 가정용 환경에서 사용하는 경우 전파간섭의 우려가 있습니다.

Taiwan Compliance Statement

警告使用者：
這是甲類的資訊產品，在居住的環境中使用時，可能會造成射頻干擾，在這種情況下，使用者會被要求採取某些適當的對策。

This is a Class A product based on the standard of the Bureau of Standards, Metrology and Inspection (BSMI) CNS 13438, Class A. In a domestic environment this product may cause radio interference, in which case the user may be required to take adequate measures.

Japan Compliance Statement

この装置は、クラスA情報技術装置です。この装置を家庭環境で使用すると電波妨害を引き起こすことがあります。この場合には使用者が適切な対策を講ずるよう要求されることがあります。 VCCI-A

This is a Class A product based on the standard of the VCCI Council (VCCI 32: 2016). If this equipment is used in a domestic environment, radio interference may occur, in which case the user may be required to take corrective actions.

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, see the Service Safety Summary that follows the General 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.

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.

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. Do not use the provided power cord for other products.

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, ensure 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 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 rating 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 manual's installation instructions 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 Telestream 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 the Manual

These terms may appear in this manual:



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



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

Terms on the Product

These terms may appear on the product:

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

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

CAUTION indicates a hazard to property including the product.

Symbols on the Product

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 which have to 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:



General Safety Product Specific Statements

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.

Use personal protective equipment to prevent shock and arc blast injury where hazardous live conductors are exposed.

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



WARNING: Injury or death can occur as the result of electrical shock. To avoid electrical shock, do not connect power to the instrument when the top cover is off. There are dangerous potentials present on the power supply circuit boards when the power cord is connected.

Disconnect the power cord from a power supply module before you remove the module from the instrument. Also, do not connect a power cord to a power supply module while the module is not installed in the instrument. There are dangerous high voltages on the module when the power cord is connected.



WARNING: Prevent risk of shock or fire by ensuring that the GNSS antenna is protected from lightning strikes when it is mounted outside a building or facility. The instrument does not have isolation protection from lightning, so the facility installation must provide suitable protection for the GNSS antenna external to the instrument and surge suppression for the cable. Failure to use appropriate precautions can result in injury or death. It is important the antenna and cable installation complies with all regulations for the location in which it is installed.



WARNING: To avoid personal injury and instrument damage, do not use slides provided with other instruments from other kits (for example, General Devices, Chassis Trak C-300) with the rails from this kit. The locking feature will not function and will result in an instrument that is not secured properly and could fall out of the rack, causing personal injury or instrument damage.



WARNING: To prevent the rack-mounted instrument from tipping forward onto the operator, install the instrument so the operator is able to access all of its rear-panel connectors without pushing down on the instrument. Verify that the rack does not become unstable with the instrument fully extended. Do not leave the instrument extended when finished accessing the rear panel.



WARNING: To reduce the risk of injury and equipment damage, make sure that levers are properly installed. An improperly installed lever can prevent the slide from locking or prevent the instrument from being removed from the rack. Make sure that the lever is installed so the long handle is facing forward and the short hook is facing downward.



WARNING: To prevent injury during product installation, use care not to pinch hands or fingers in the rails and slides.



WARNING: To prevent injury when removing the product from the rack, do not forcefully and abruptly pull the product from the rack. Pull with the minimum force required to move the instrument with a consistent, even motion.



CAUTION: The instrument does not have a power switch. When you connect the power cable to the AC line connector, the instrument powers on.

Do not install or remove a power supply module when a power cord is attached to that module.



CAUTION: To avoid antenna damage, do not turn on the DC antenna power until you know that the antenna is designed to handle the selected voltage. Antenna damage can occur if the antenna is not designed to handle the voltage you select.



CAUTION: Be careful to select the correct screw type for your instrument (metric or SAE). If the screws do not insert easily (do not use excessive force or you might damage the threads), it is possible you are using the wrong screw.



CAUTION: To prevent damage to the instrument and rackmount, do not force the instrument into the rack if it does not slide smoothly. The rails assembly might need to be adjusted to resolve the problem.



CAUTION: To prevent an unexpected shutdown of the instrument, be sure to disconnect the correct power cord if you are replacing a faulty power supply module.



CAUTION: The instrument might automatically reboot at the end of the upgrade process. Do not perform the upgrade while the instrument is in use as a sync reference. When the instrument has started to erase the internal flash, do not remove power from the instrument.



CAUTION: To prevent static damage to the SFP modules, if you remove the SFP modules from the instrument, always transport the SFP modules in an anti-static bag or container.



CAUTION: To prevent damage to the SFP modules, remove the SFP modules before transporting the SPG instrument.



CAUTION: To prevent dust from contaminating the SFP module, use its cover when the SFP is not in use. If SPF modules or fiber optic cable have been left exposed, we recommend it is cleaned before use. This is especially important on the long-reach, single-mode SFP modules and fiber.



CAUTION: We strongly recommend using the timeout function to keep the display backlight at a low level when the front panel interface is not actively being used, to maximize the life of the display backlight.

Preface

This manual contains information to help you use the SPG9000 timing and reference system:

- How to operate the instrument using the front panel controls
- How to configure the instrument for network access and operate the instrument using the web interface
- How to monitor the status of the instrument during normal operation

Where to Find More Information

Other information about your product are available for download at www.telestream.net/video/resources.htm. The Product Documentation table lists all the documentation for the SPG9000 timing and reference system.

Product Documentation

Document	Manual type	Part number	Description
SPG9000 User Manual	User	D00013571x	Provides detailed operating information.
Release Notes	Release Notes	P00010606x	Describes the new features, improvements, and limitations of the instrument firmware.
Read-this-first	User	P00010592x	Lists all relevant documents.
SPG9000 Installation and Safety Instructions	User	P00010606x	Describes how to install and set up a SPG9000 generator, and provides basic safety and operating information.
SPG9000 Rack Accessory Installation Manual	User	P0001x	Describes how to install an SPG9000 generator in a rack. Provides basic safety information.
Manual, Rackmount Slides and Rails Kit	User	071370600x	Describes how to connect rack equipment to an SPG9000 generator. Provides basic safety information.

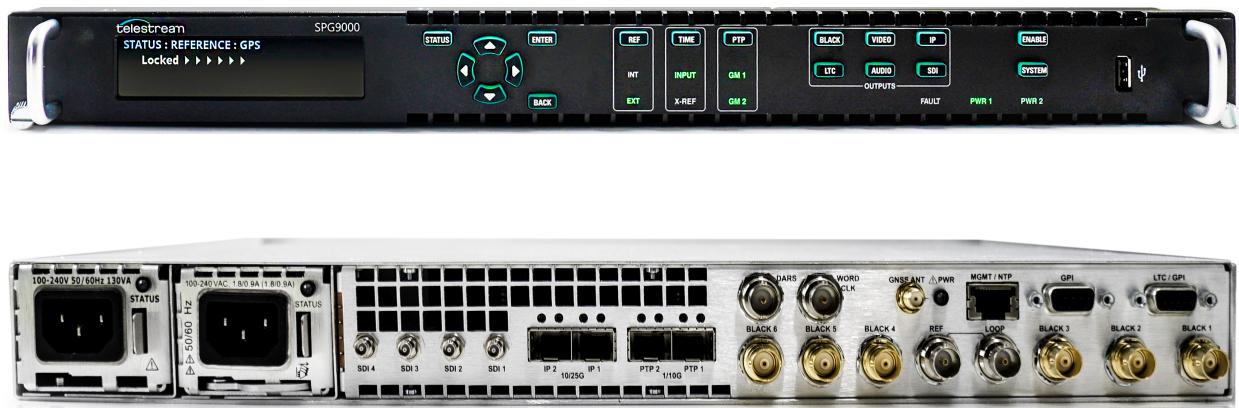
Telestream Contact Information

To obtain product information, technical support, or provide comments on this guide, contact us using our website, email, or phone number listed.

Resource	Contact Information
Telestream Video Support	Website: www.telestream.net/telestream-support Email: videosupport@telestream.net US and Canada Toll-free: 1-844-219-5329 Outside of US and Canada: 1-503-967-9833
Telestream	Website: www.telestream.net Sales and Marketing Email: info@telestream.net Address: Telestream 848 Gold Flat Road, Suite 1 Nevada City, CA. USA 95959
International Distributor Support	Website: www.telestream.net See the Telestream website for your regional authorized Telestream distributor.
Telestream Technical Writers	Email: techwriter@telestream.net If you have comments or suggestions about improving this document, or other Telestream documents—or if you've discovered an error or omission, please email us.

Product Description

The SPG9000 is a precision multiformat video signal generator and timing system, suitable for primary synchronization and reference applications. It provides multiple video, audio, and time reference signals, and it can synchronize to different reference sources. The instrument uses optional licenses to enable additional functionality, such as GNSS-based synchronization, PTP (Precision Time Protocol) support, and test signal generation for SDI and ST 2110 IP interfaces. The sample images show the front and back of the SPG9000.



Base Capabilities

These capabilities and hardware are available on all SGP9000 instruments.

The SPG9000 has six sync outputs that can be configured with independent output formats (NTSC/PAL black burst and/or HD tri-level sync) and independently adjustable timing offsets. It includes two dedicated audio reference signal outputs: a 48 kHz word clock output and an AES DARS (Digital Audio Reference Signal) output.

A high-accuracy, oven-controlled micro-electromechanical system (MEMS) oscillator provides a stable frequency reference for the system, or the loop-through genlock input can be used to lock to an external video reference or 10 MHz continuous wave signal. The Stay GenLock® feature avoids synchronization shock, which can result in many possible video and audio errors as a result of a sudden change in timing. If the external reference suffers a temporary disturbance, Stay GenLock® maintains the frequency and phase of each output signal. When the external reference is restored, Stay GenLock® ensures that any accumulated clock drift is removed by slowly adjusting the system clock instead of suddenly forcing the system clock back to the correct phase.

Time reference outputs are available in multiple formats. Three independent LTC (linear time code) outputs are available, and a fourth LTC connection can be used as input or output. Each LTC output has independent frame rate selection, time source (time of day or program time) and time zone offset. VITC (vertical interval time code) is available on each NTSC or PAL black output, also with independent time sources and offsets.

For remote access to the instrument, a 10/100/1000BASE-T Ethernet interface is included. A web-based user interface can be used for all configuration settings and for monitoring system status. A web-services application programming interface can be used for all configuration settings and to get status and performance monitoring information; this enables easy integration with management and dashboard systems.

Optional Capabilities

These capabilities are available as separately licensed features, and can be added to any SPG9000 at the initial time of purchase or as a later upgrade.

Optional GNSS-based Synchronization

Option SPG9000-GNSS enables an integrated receiver inside the SPG9000 that can receive GNSS (Global Navigation Satellite System) signals from multiple satellite constellations (GPS, GLONASS, BeiDou, Galileo, and QZSS) and frequency bands (L1 and L5). When connected to an external antenna that supplies the standard GNSS RF signal (for example, SPG9000-ACC-ANT), the SPG9000 can use the GNSS system's stable frequency reference.

The GNSS signal also includes a precise time-of-day reference that can be used for all time code outputs. Similar to the Stay GenLock® feature, the SPG9000 can maintain the video frequency and phase when the GNSS signal is interrupted, and the Holdover Recovery mode ensures a shock-free realignment of frequency and phase when the GNSS signal is restored.

Optional PTP Support

Option SPG9000-PTP enables two PTP (Precision Time Protocol) engines for IP network-based synchronization. Two SFP+ ports provide two network interfaces that can operate at 1 Gbps or 10 Gbps depending on the SFP module type. Each port has an independent PTP instance that can operate as a primary (grandmaster), follower, or as an Ordinary Clock that can adaptively change between leader and follower states. With two instances, the SPG9000 can operate as a dual leader, providing PTP to two separate networks (such as a primary + backup network pair as used by ST 2022-7); as a dual follower, synchronized to the GM on either the primary or backup network; or as a follower on one network and a leader on another, bridging the two separate PTP domains. A follower instance can be used to monitor PTP operation on the network without having to function as the reference source of the instrument.

The SPG9000 supports IEEE 1588, ST 2059-2 and AES67 profiles, and each instance can operate with multicast, unicast, or mixed communication models.

The status of each instance, including performance monitoring measurements such as offsets, delays and message rates can be viewed on the web interface or retrieved by the API for integration into management dashboard systems.

The black outputs support a 1 PPS output signal. This is useful for measuring timing between systems.

Optional Test Signal Outputs

The SPG9000 includes video, audio, and data test signal generation for a variety of formats on multiple outputs. Option SPG9000-SDI enables four SDI (Serial Digital Interface) outputs capable of SD, HD, or UHD signals at interface rates up to 12G-SDI.

Option SPG9000-IP enables two SFP28 ports for ST 2110 IP stream generation over 25 Gbps or 10 Gbps interfaces depending on the SFP type.

Both the SPG9000-SDI and SPG9000-IP options will be available in a future firmware update.

Optional Backup Power Supply

For critical applications, the instrument can be configured with a second power supply module. Under normal operation, the designated backup supply is seldom used, ensuring that it has maximum remaining life should the primary supply fail. The backup supply is load-tested each day to verify that it can serve as the primary supply if necessary. The usage time of each supply is logged as “temperature-weighted hours”, a metric that best estimates the calculated life of the supply. A front-panel LED indicates when the supply is nearing its end-of-life. If the primary supply is interrupted for any reason, the system switches to the backup without any disruption to system operation. Power supply modules are hot-swappable for easy replacement and feature a locking mechanism to prevent the power cable from accidental disconnection.

Instrument Installation

This section describes:

- how to install the SPG9000 into a standard 19-inch equipment rack, it includes a list of the parts in the mounting kit and the required tools (not included),
- how to connect the SPG9000 to external power,
- the physical connectors on the rear panel of the instrument and which signals are used with each connector,
- how to install and remove SFP modules, and
- how to connect an external GNSS antenna and its associated cables.

Rackmount Slides and Rails

The SPG9000 is typically installed in a standard 19-inch equipment rack. The rack mount kit consists of a pair of slides that are attached to the SPG9000 and a pair of rails that are attached to the rack. This section describes how to install the slides and rails.

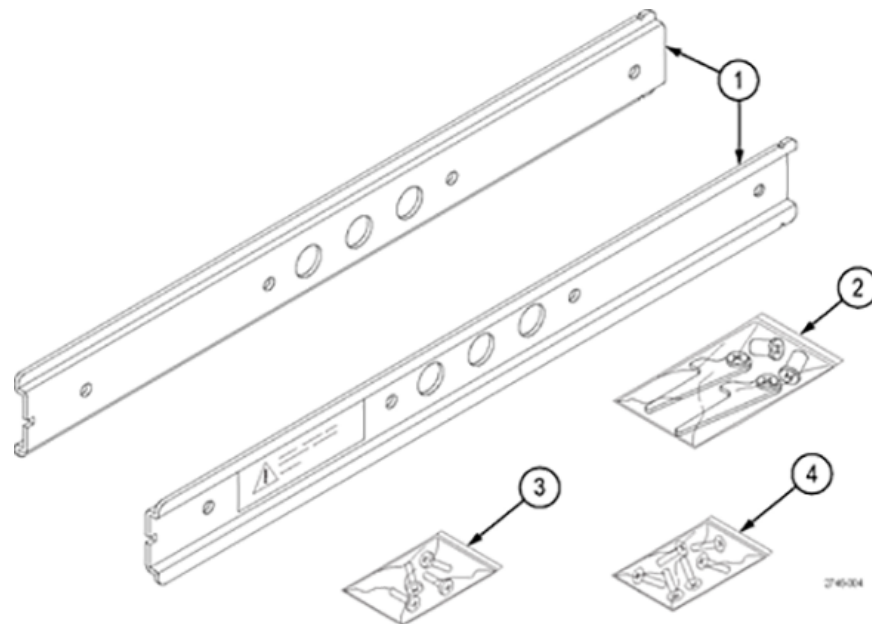
The rack mount kit can be ordered as option SPG9000-RACK at the same time as the base unit. In this case, the slides are pre-installed onto the SPG9000 before it is shipped. The kit can also be ordered as SPG9000-ACC-RACK as a standalone kit after the initial purchase.

Kit Parts List

The slides assembly parts list has the parts contained in this kit. The associated figures show what the parts look like. If your kit was shipped with your instrument, the slides are already installed.

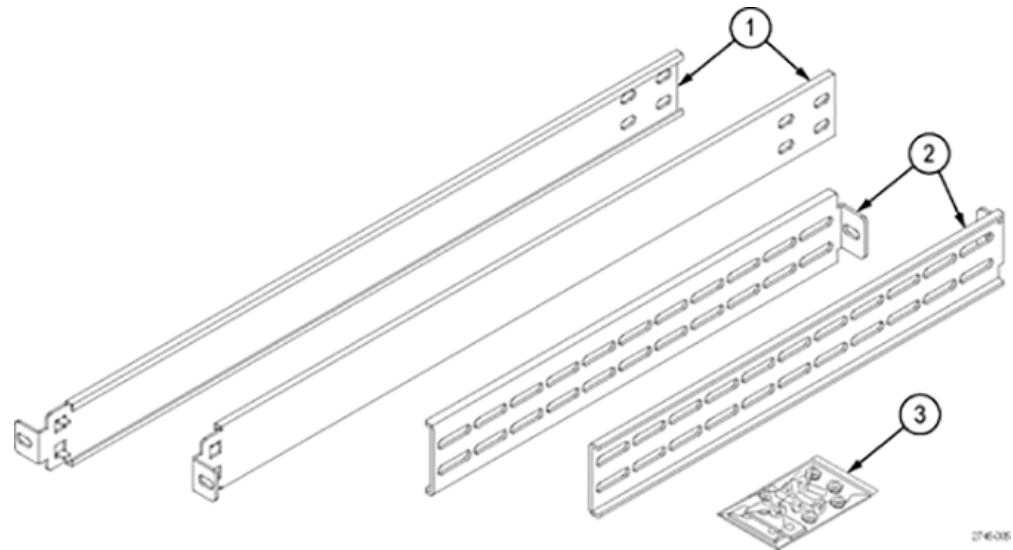
Slides assembly parts list

Number in example	Qty	Name and description
1	2	BRACKET, RACK, CHASSIS-SIDE
2	2	BRACKET, RACK, LEVER, CHASSIS-SIDE
	2	BUSHING, RACK, CHASSIS-SIDE
3	2	SCREW, MACHINE; 8-32 X 0.5, FLH, 100 DEG, STL, ZN PL, PHIL (SAE)
	6	SCREW, MACHINE; 8-32 X 0.375, PNH, STL, ZN PL, PHIL (SAE)
4	2	SCREW, MACHINE; M4X10MM L, FLH, STL, ZN PL, PHIL (metric)
	6	SCREW, MACHINE; M4 X 8MM L,PNH, STL, ZN PL, PHIL (metric)



Rails assembly parts list

Number in example	Qty	Name and description
1	2	BRACKET, RACK, STATIONARY
2	2	BRACKET, RACK, REAR CABINET
3	2	BRACKET, RACK, BAR NUT
	8	SCREW, MACHINE; 10-32 X 0.625, TRH, ZINC PLATED STEEL, PHIL
	4	NUT ASSY; 10-32 X 0.375 HEX, ZINC PLATED STEEL, LOCK WASHER



Installation Instructions

This section provides instructions:

- Installing the slides onto the SPG9000 if they are not already installed
- Installing the rails into a standard 19-inch equipment rack
- Installing the instrument into the rails in the rack



WARNING: To avoid personal injury and instrument damage, do not use slides provided with other instruments from other kits (for example, General Devices, Chassis Trak C-300) with the rails from this kit. The locking feature will not function and will result in an instrument that is not secured properly and could fall out of the rack, causing personal injury or instrument damage.

Equipment List

These tools are required to install the kit hardware:

- #2 crosshead screwdriver
- 3/8-inch wrench



WARNING: To prevent the rack-mounted instrument from tipping forward onto the operator, install the instrument so the operator is able to access all of its rear-panel connectors without pushing down on the instrument. Verify that the rack does not become unstable with the instrument fully extended. Do not leave the instrument extended when finished accessing the rear panel.

Install Slides

Screw Selection

For the slides installation, this kit provides two sets of screws (metric and SAE), but the SPG9000 only needs the 3 metric screws.

Procedure

Attach the slides to the instrument:

Note: The slides might already be installed on your instrument. If they are, skip this procedure and go to Installing the Rails.

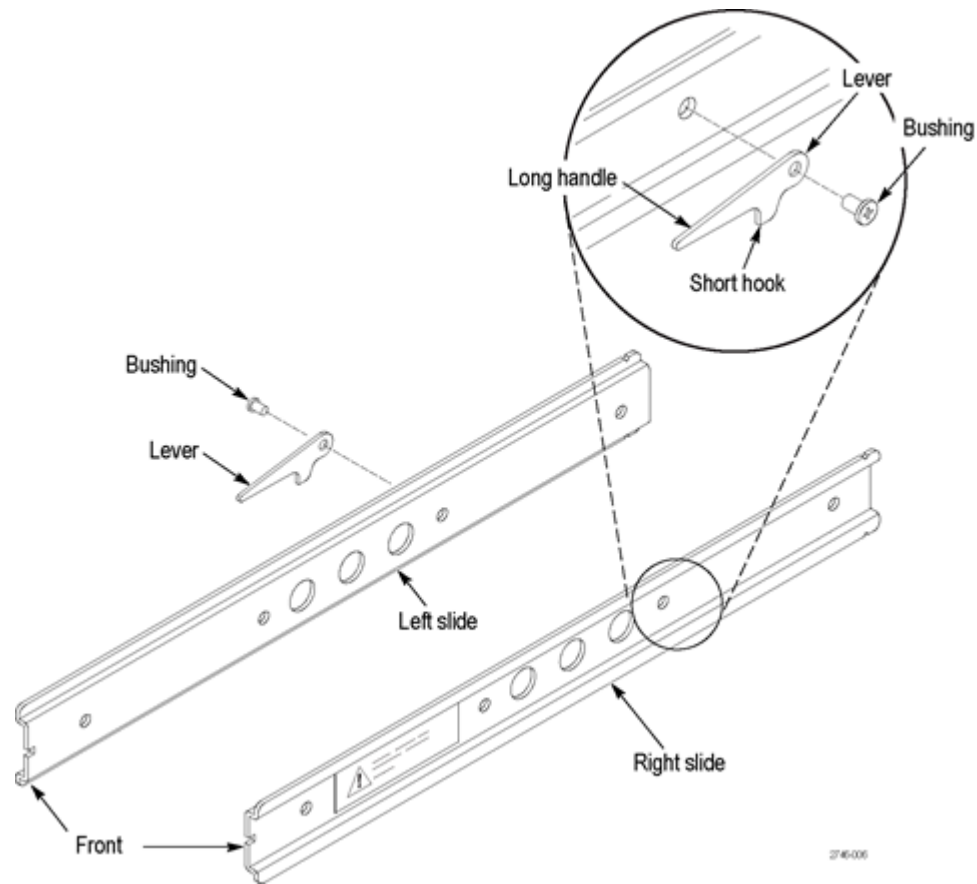
1. Identify the right rear and left rear of each slide. A warning label is on the outside side of each slide.
2. Make sure that the rear of the slide is nearest to the rear of the instrument. The front of each slide has a notch in the center edge.
3. Align the mounting holes on the right slide to the mounting holes on the right side of the instrument.
4. Use the shorter screws provided (8mm) and a screwdriver with a #2 Phillips tip; attach the right slide to the right side of the instrument:



CAUTION: Be careful to select the correct screw type for your instrument (metric or SAE). If the screws do not insert easily (do not use excessive force or you might damage the threads), it is possible you are using the wrong screw.

- A. Insert the metric screws into the first two mounting holes.
- B. Place the lever, with the long handle facing the front of the slide and the short hook facing downward, over the remaining mounting hole.
- C. Insert a metric screw into the bushing for the lever.
- D. Insert the bushing and screw into the lever so the lever is attached to the slide and the slide is secured to the instrument.

The example shows how to attach the slide levers for the SPG9000 instrument.



5. Rotate the instrument to face the left side and repeat this procedure to install the left slide.



WARNING: To reduce the risk of injury and equipment damage, make sure that levers are properly installed. An improperly installed lever can prevent the slide from locking or prevent the instrument from being removed from the rack. Make sure that the lever is installed so the long handle is facing forward and the short hook is facing downward.

Install Rails

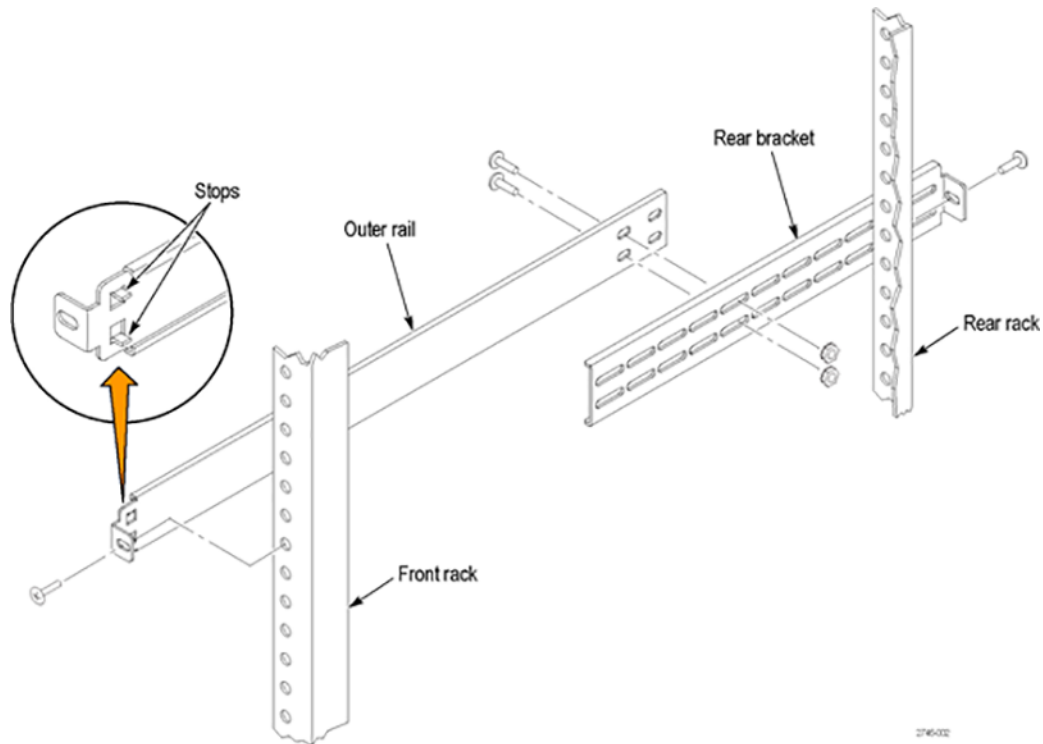
This two-part procedure describes how to assemble and install the rails in the equipment rack.

Assemble Rails

1. Measure the distance between the front and rear rail of the equipment rack.
2. Align the rear bracket to the right rail. Notice that the rear bracket has multiple pairs of mount-through holes. When aligning the bracket and rail, be sure to select a pair

of holes that mount the rear bracket so the flange-to-flange distance matches the front rail to rear rail spacing of the rackmount rack just measured in step 2.

3. Using a screwdriver with a #2 Phillips tip, attach the rear bracket to the right rail using two 10-32 screws and 10-32 nuts or a bar nut as necessary. Leave the screws loose so you can adjust the overall length of the rail assembly in the rack.
4. Repeat this procedure to assemble the left rail assembly.



Mount Rails

1. Select a ½-inch-spaced hole in the front rack.
2. Select the mounting method according to your rack type:
 - Mount the rails with their front and rear flanges *outside* the front and rear racks; add a bar nut to the installation only if the rails have untapped holes.
 - Mount the rails with their front and rear flanges *inside* the front and rear racks; add a bar nut. This mounting method assumes untapped holes.
 - Some racks have square mounting holes and require cage nuts to be inserted. These are supplied from the rack vendor.
3. Using the method and hardware determined from step 2, attach the right rail assembly to the equipment rack front and rear rails. The screws should be fully, but lightly, seated so you can adjust the rack later.
4. Tighten the screws still loose when you assembled the rails, apply 28 inch-lbs of torque, to fix the front to rear flange spacing of the rail assembly.
5. Repeat this procedure to mount the left rail assembly.

Install Instrument in Rack

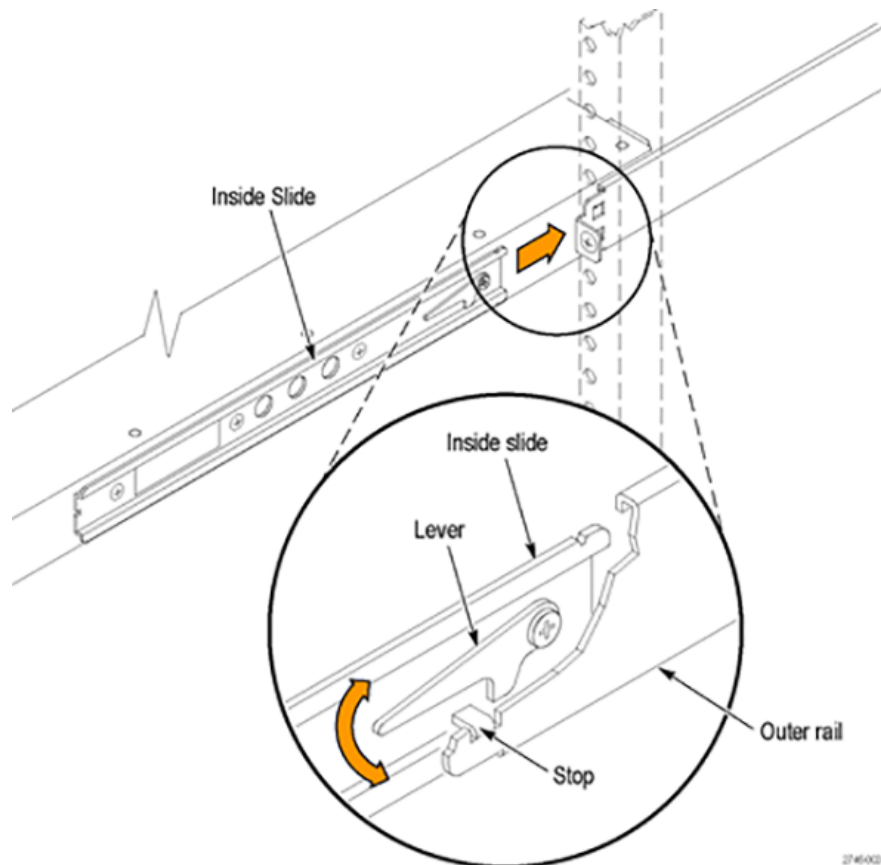
This procedure describes how to install the instrument into the equipment rack.



WARNING: To prevent injury during product installation, use care not to pinch hands or fingers in the rails and slides.

1. Insert the instrument left and right slides into the ends of the rack rails while tilting the long handle of each lever upward.

Note: Be sure to insert the instrument slides *inside* the inner rack rails. You might need to tilt rear of the instrument up or down at a slight angle to fit the slides into the rails.



2. Push the instrument into the rack until it stops.



CAUTION: To prevent damage to the instrument and rackmount, do not force the instrument into the rack if it does not slide smoothly. The rails assembly might need to be adjusted to resolve the problem.

3. Retighten any loose screws and push the instrument all the way into the rack. If the tracks do not slide smoothly, readjust the rail assemblies.
4. When adjusting is completed, tighten all rail assembly 10-32 screws.
5. If the instrument has knob screws on the front corners, tighten them so they are secured in the rack.

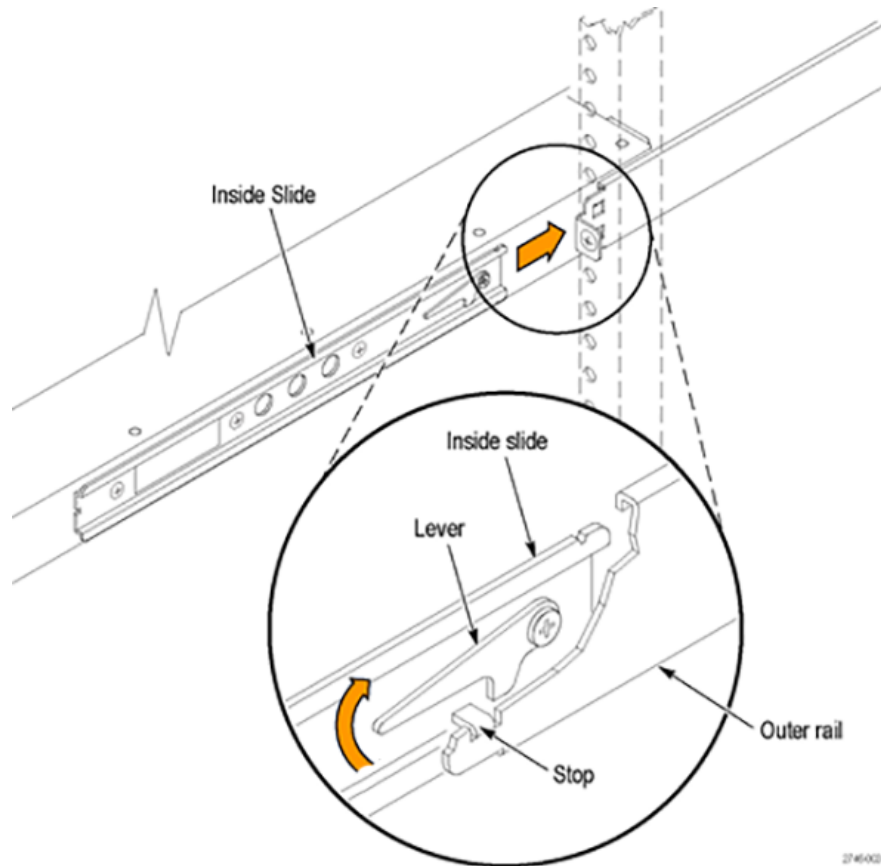
Remove Instrument from Rack

This procedure describes how to remove the instrument from the equipment rack.



WARNING: To prevent injury when removing the product from the rack, do not forcefully and abruptly pull the product from the rack. Pull with the minimum force required to move the instrument with a consistent, even motion.

1. Loosen the knob screws, if present, at the front of the instrument.
2. Gently pull the instrument out until you can reach the levers on the inside slides.
3. Tilt both lever handles upward at the same time to clear the stops.



4. Pull the instrument past the stops and out of the rack.

Power Connection

The instrument operates from a single-phase power source with the neutral conductor at or near earth ground. The line conductor is fused for over-current protection. A protective ground connection through the grounding conductor in the locking power cord is essential for safe operation.

With option SPG9000-SPW, a single power supply module is installed. With Option SPG9000-DPW, a second, hot-swappable, redundant (backup) power supply module is also installed. When two power supply modules are installed in the instrument, one is configured to be the primary supply and the other is configured to be the backup supply. In the event that the primary supply fails, the backup supply automatically provides power to maintain instrument operation. See [Power Supply Monitoring and Replacement](#) about how to operate the instrument with two power supplies.



WARNING: Injury or death can occur as the result of electrical shock. To avoid electrical shock, do not connect power to the instrument when the top cover is off. There are dangerous potentials present on the power supply circuit boards when the power cord is connected.

Disconnect the power cord from a power supply module before you remove the module from the instrument. Also, do not connect a power cord to a power supply module while the module is not installed in the instrument. There are dangerous high voltages on the module when the power cord is connected.

Power Characteristics

AC power source

Rating voltage 100 V to 240 V



WARNING: To reduce the risk of fire and shock, ensure the mains supply voltage fluctuations do not exceed 10% of the operating voltage range.

Frequency 50 or 60 Hz

Typical power 130 VA

Maximum power 180 VA

Surge current, typical 20 A peak (25 °C) for ≤ 5 lines cycles, after the instrument has been turned off for at least 30 seconds.

Inrush current, typical 10 A RMS half cycle at initial turn on according to EN55103-1:2009 Annex B.



CAUTION: The instrument does not have a power switch. When you connect the power cable to the AC line connector, the instrument powers on.

Do not install or remove a power supply module when a power cord is attached to that module.

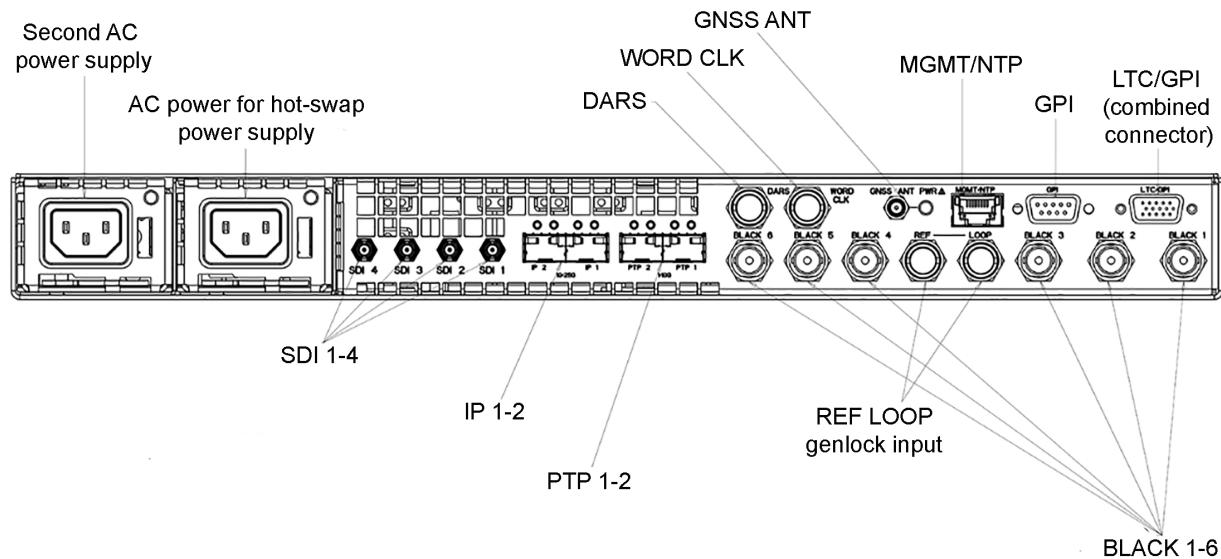
Connect Power

Connect the power cable to the instrument first and then connect it to the AC power source. Connecting the power cable causes the instrument to power on. If there is a backup power supply (option SPG9000-DPW), connect the second power cable to the instrument and then connect it to the AC power source.

After the instrument boots up and initializes, check that the FAULT indicator on the front panel is not illuminated and no faults are reported on the instrument display. If the FAULT indicator is illuminated, take the appropriate action.

Each power supply module has an LED (labeled STATUS) visible on the rear panel that mirrors the corresponding PWR indicator on the front panel. Under normal conditions, the LED for the active power supply is bright green and the LED for the backup power supply is dim green. See [FAULT](#) and [PWR 1 and PWR 2](#) for descriptions of the FAULT and PWR indicators.

Rear Panel Connectors



The descriptions of the connectors start with the base outputs on the right and move to the optional outputs on the left.

LTC/GPI Connector

The LTC/GPI connector is a 15-pin, D-sub connector (DE-15 socket) that includes both Linear Time Code (LTC) input and outputs, and a subset (3 inputs and 2 outputs) of the General Purpose Interface. See [Linear Time Code Input and Outputs](#).

A breakout cable is available for this connector with XLR connectors for the four LTC outputs and BNC connectors for the GPI input (1 only) and outputs (1-2 only). It can be ordered as option SPG9000-XLR at the same time as the base SPG9000 purchase or as SPG9000-ACC-XLR, a standalone accessory purchased later.

In addition, the pin assignments were selected so a standard RGBHV cable can be used for a subset of signals. These cables have been used to connect VGA computer output to the component video inputs of a CRT monitor, with a DE-15-pin connector at one end and five BNC connectors at the other end.

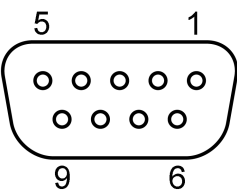
The pin assignments for the connector are shown, with the RGBHV BNC connector shown if available:

Pin	Function	RGBHV Cable	Diagram
1	GPI output 1	Red BNC	
2	GPI output 2	Green BNC	
3	GPI input 1	Blue BNC	
4	GPI input 2		
5	LTC 4 negative		
6	Ground	Ground	
7	LTC 3 negative	Ground	
8	LTC 2 negative	Ground	
9	Ground		
10	LTC 1 negative	Ground	
11	GPI input 3		
12	LTC 3 positive		
13	LTC 2 positive	H BNC	
14	LTC 1 positive	V BNC	
15	LTC 4 positive		

GPI Connector

The General Purpose Interface (GPI) connector is a 9-pin, D-sub connector (DE-09 socket) reserved for future use. The GPI includes four ground closure inputs and three ground closure outputs.

The pin assignments for the connector are:

Pin	Function	Diagram
1	Ground	
2	GPI output 1	
3	GPI output 2	
4	GPI input 1	
5	+5 V (1 kΩ source resistance, limited current)	
6	GPI output 3	
7	GPI input 4	
8	GPI input 3	
9	GPI input 2	

MGMT/NTP Port

Use the Management/NTP port to connect to your local Ethernet network. You can control the instrument remotely through the port to connect to the web-based user interface or the web services API.

This network interface will also be used for NTP (Network Time Protocol) messages in a future firmware release.

See [Management Network Interface](#).

GNSS ANT Connector

With option SPG9000-GNSS, the GNSS antenna connector allows you to synchronize the instrument timing to one or more GNSS (Global Navigation Satellite Systems). The integrated receiver supports the global GPS (United States), GLONASS (Russia), BeiDou (China), and Galileo (European Union) systems, and the regional QZSS (Japan) system. You must connect a GNSS antenna to the instrument to use this functionality. The GNSS antenna input must meet specific requirements. See [Antenna Requirements](#).

You can enable this connector to provide 3.3 V or 5 V DC power to the antenna, or disable power if the antenna is externally powered. When the connector is configured to provide power to the antenna, the rear-panel GNSS ANT indicator is illuminated:

- Blinks green to indicate an open circuit. This occurs if no antenna is connected or if the current load is less than expected because a splitter or DC block is being used.
- Displays solid red if the connected antenna is shorted.
- Displays solid green if the current load of the antenna is within the nominal range.

See [GNSS Receiver Settings](#).

WORD CLK Output Connector

The Word Clock connector outputs a 48 kHz word clock signal.

DARS Output Connector

The DARS connector outputs an AES11 DARS (Digital Audio Reference Signal) signal.

BLACK 1–6 Output Connectors

The six BNC connectors labeled BLACK 1 to BLACK 6 are used to each output a black burst (NTSC or PAL), HD tri-level sync, 1 PPS (pulse-per-second) or 10 MHz CW (continuous wave) signal.

Note: The 10 MHz CW signal is only available on the BLACK 3-6 outputs.

You can set the format and timing of the six black outputs independently and enable VITC to be applied to the output signal. For HD tri-level sync signals, the BLACK 1-3 and BLACK 4-6 outputs are independent groups. Within each group, any of the three outputs configured to a tri-level format must have all integer (25, 24, 30, etc.) or non-integer (29.97, 23.98, etc.) frame rates. See [Black Outputs](#).

REF LOOP Input Connectors

Use the Reference Loop input loop-through connectors for an external reference signal (genlock input), which can be an NTSC/PAL black burst or HDTV tri-level sync signal. The reference input requires proper external termination. The signal can connect to other devices through the loop connection; however, the signal must be terminated eventually, either on the instrument or at the other device. See [Genlock Reference](#).

PTP 1-2 Ports

With option SPG9000-PTP, the PTP 1 and PTP 2 ports are enabled. Each port corresponds to an independent PTP instance. Two SFP+ slots are provided for use with SFP modules that can operate at 10 Gbps or 1 Gbps line speed depending on the SFP type.

These SFP modules are available as accessory options:

SPG9000-SFP-1GESR	1 G (gigabit) Ethernet, short reach, 850 nm SFP transceiver module
SPG9000-SFP-10GESR	10 G Ethernet, short reach, 850 nm SFP+ transceiver module
SPG9000-SFP-10GELR	10 G Ethernet, long reach, 1310 nm SFP+ transceiver module

See [PTP Configuration](#).

These two Ethernet ports have LEDs that show the current link status. The left LED is green when the link is up and flickers when there is network activity. The right LED is green when the interface operates at the 10 Gbps line rate, but it is not on when the interface operates at the 1 Gbps line rate.

IP 1-2 Ports

With option SPG9000-IP, the IP 1 and IP 2 ports are enabled for generation of ST 2110 IP streams of video, audio, and data test signals. Two SFP28 slots are provided for use with SFP modules that can operate at 25 Gbps or 10 Gbps line speed depending on the SFP type.

These SFP modules are available as accessory options:

SPG9000-SFP-10GESR	10 G (gigabit) Ethernet, short reach, 850 nm SFP+ transceiver module
SPG9000-SFP-10GELR	10 G Ethernet long reach, 1310 nm SFP+ transceiver module
SPG9000-SFP-25GESR	25 G Ethernet short reach, 850 nm SFP28 transceiver module
SPG9000-SFP-25GELR	25 G Ethernet, long reach, 1310 nm SFP28 transceiver module

Option SPG9000-IP will be available in a future firmware update.

SDI 1-4 Output Connectors

With option SPG9000-SDI, the SDI 1 to SDI 4 outputs are enabled for test signal generation through HD-BNC connectors. Each output has an independent line rate of SD-SDI (270 Mbps), HD-SDI (1.5 Gbps and 3 Gbps), or UHD (6G-SDI and 12G-SDI).

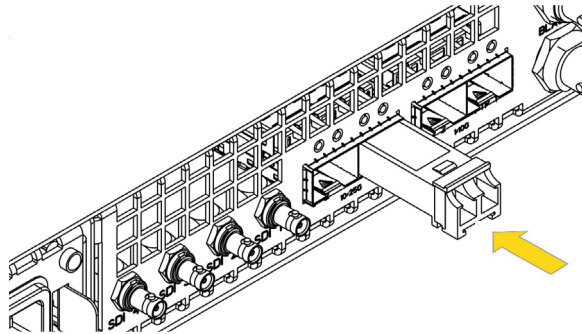
Option SPG9000-SDI will be available in a future firmware update.

SFP Module Installation

This section explains how to install and remove an SFP module from an SPG9000.

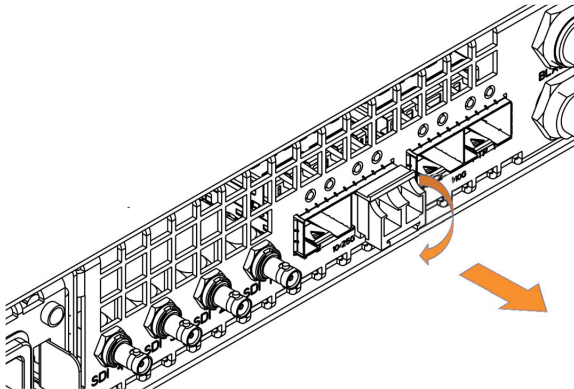
Install SFP Module

1. Remove the protective plug from the SFP connector.
2. Insert the SFP module into the PTP connector on the rear-panel of the instrument as shown. The module latches into place when fully inserted.



Remove SFP Module

Pull down on the latch and pull the module out of the PTP connector as shown.



The SFP module should be removed from the generator while the instrument is being transported.



CAUTION: To prevent damage to the SFP modules, remove the SFP modules before transporting the SPG instrument.



CAUTION: To prevent static damage to the SFP modules, if you remove the SFP modules from the instrument, always transport the SFP modules in an anti-static bag or container.



CAUTION: To prevent dust from contaminating the SFP module, use its cover when the SFP is not in use. If SFP modules or fiber optic cable have been left exposed, we recommend cleaning it before use. This is especially important on the long-reach, single-mode SFP modules and fiber.

GNSS Antenna Installation

If your instrument has option SPG9000-GNSS enabled, you need to connect a GNSS antenna and check the main oscillator calibration before you put the instrument into service.

If you ordered SPG9000-ACC-ANT, you received a GNSS rooftop antenna (5.0 VDC, dual-band (L1 and L5), type-N connector) that is matched with the internal GNSS receiver.

After installation, see [GNSS Receiver Settings](#).

Antenna Requirements

The instrument requires an external antenna to receive GNSS signals from satellites. You must set up an antenna system to provide the GNSS signal as an input to the instrument. You can configure the instrument to provide 3.3 V or 5 V DC power for the antenna.



WARNING: Prevent risk of shock or fire by ensuring that the GNSS antenna is protected from lightning strikes when it is mounted outside a building or facility. The instrument does not have isolation protection from lightning, so the facility installation must provide suitable protection for the GNSS antenna external to the instrument and surge suppression for the cable. Failure to use appropriate precautions can result in injury or death. It is important the antenna and cable installation complies with all regulations for the location in which it is installed.



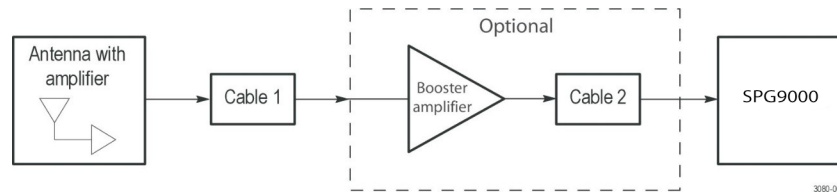
CAUTION: To avoid antenna damage, do not turn on the DC antenna power until you know that the antenna is designed to handle the selected voltage. Antenna damage can occur if the antenna is not designed to handle the voltage you select.

Note: The frequencies for the different GNSS systems are slightly different from each other. Be sure to choose an antenna that supports all of the satellite constellations you intend to use. We recommend you use an antenna, amplifiers, and splitters that can receive signals from multiple GNSS systems and frequency bands. This allows the instrument timing to be more stable because a GNSS antenna can communicate with more satellites.

When a GNSS signal is first connected to the antenna input on the instrument, it can take several minutes for the signal quality to reach its nominal potential. How long that takes depends on such things as antenna site, cable plant design, and available satellites. Excluding those variables, the typical time to acquire satellites and achieve specified stability with a good satellite signal, known position, and a warmed up instrument, is two minutes.

Antenna Systems

Antenna systems vary depending on the operating environment and on safety and regulatory requirements. A simplified GNSS antenna and cable block diagram is shown to help you with planning and understanding the trade-offs of one setup versus another.



A GNSS-specific antenna with amplifier provides sufficient gain to drive a reasonable length of cable, and provides filtering to reject signals at other frequencies. A typical example for GNSS signals is the Protomips Bullet™ 720, 35±3 dB, 5 V antenna.

In a simple system without the optional booster, Cable 1 connects the antenna to the instrument. The length of this cable is limited by its attenuation at the carrier frequency (L1: 1559~1610 MHz, L5: 1164~1214 MHz). The instrument should have a signal that is 18 dB or greater above the ambient level. For example, for a 35 dB antenna, the allowed loss is 17 dB.

Antenna Location

It is important that the GNSS antenna location has a clear view of a large part of the sky. Because GNSS satellites are constantly orbiting the earth, they can be in any direction at a given time. If part of the sky is blocked by buildings, trees, mountains, etc., then fewer satellites are visible. It is also possible to get reflected signals that come by a longer path than expected, which can degrade timing accuracy and stability. When evaluating a site, it is important to monitor it over several days and with a variety of weather conditions present.

This antenna information is not intended to cover all aspects of the antenna system design. Important topics that were not covered include items like lightning protection and drip loops. For information about the cable plant design in your system, contact the appropriate person or group in your organization, or contract with a qualified installer.

Cables

Attenuation varies significantly depending on cable type. Cable loss is about 13 dB/100 ft for a miniature coaxial cable like the Belden 1855, while for a RG 1 style like the Belden 7731, the loss is only 5.5 dB/100 ft. This correlates to an allowable length of 130 ft for the small cable, to over 300 ft for the larger cable.

A booster amplifier can be added if more length is needed, as shown in the optional block in the signal path system. The booster amplifier should be closer to the antenna than to the SPG9000.

If a 20 dB amplifier is added, then 20 dB more cable loss can be accommodated. This equates to another 150 ft of small coaxial cable, or 360 ft of large coaxial.

Although the GNSS input and most of the other components are 50 Ω , either 50 Ω or 75 Ω cables can be used in most installations. The reflections from the impedance mismatch will not cause significant changes in the system because the signal is narrow band and the cable loss is usually many decibels. However, you should not mix short cable lengths of different impedances, as this might create reflections with the potential to cause signal degradation.

Amplification

The instrument provides either 3.3 V or 5 V DC power to drive the amplified antenna and booster amplifier. The power is carried on the same coaxial cable as the GNSS signal, and can be turned off if the antenna is powered by a separate supply. When you are designing the antenna system, check the voltage and current requirements of the components to insure compatibility.

The location of the booster amplifier is important. It needs to be before the second length of cable, shown in the simplified GNSS antenna and cable block diagram.

If the booster amplifier is placed just *before* the instrument, then the signal has been attenuated too far and the output might be noisy. If you cannot put the optional booster amplifier in the middle of a long run of cable, then put it near the antenna rather than near the instrument end.

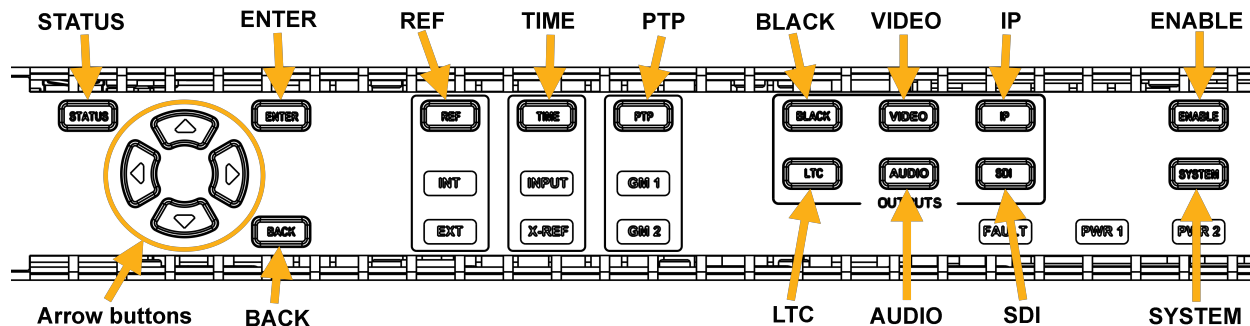
For more complex systems, a variety of booster amplifiers, powered and passive splitters, DC blocks, and filters are available from a number of vendors.

System Operation

This section describes the basic operation of the SPG9000. This includes descriptions of the front panel of the SPG9000 and how to navigate the on-screen menus. There are also details of how to use the web interface: how to log in, information in the tabs, and how to understand the available information. This section also explains how to control the instrument through API. Finally this section explains how to create, save, and recall presets.

Front Panel Interface

This section provides information about operating the instrument using the front-panel buttons and display. These menus and selections are similar to those on the web interface.



Front Panel Layout

The SPG9000 front panel includes a color display for configuration menus and status messages, and a set of buttons for accessing and navigating these menus.

STATUS: Press to view the current status of the instrument, such as the state of the reference source, time-of-day, GNSS signal, and PTP instances. See [System Status and Monitoring](#).

ENTER: Press to accept the selected option.

Arrow buttons: Use the \triangle (up) and ∇ (down) buttons to scroll through the list of available menus, use the \triangleleft (left), and \triangleright (right) buttons to view the list of available options for the current menu.

BACK: Press to return to a previous menu or exit Edit Mode.

REF: Press to configure the reference source and GNSS receiver parameters. See [Reference and Time Sources](#).

TIME: Press to configure the time-of-day source and options for daylight saving time, leap second, and daily jam sync management. See [Reference and Time Sources](#).

PTP: Press to configure the two PTP instances. See [PTP Operation](#).

BLACK: Press to configure the six black outputs. See [Black Outputs](#).

LTC: Press to configure the four LTC outputs (or one input and three outputs). See [Linear Time Code Input and Outputs](#).

VIDEO, AUDIO, IP, and SDI: These are reserved for future test-signal generation functions.

ENABLE: Press and hold to enable and disable the front-panel interface. See [Front Panel Disable and Enable](#).

SYSTEM: Press to configure system-wide parameters such as presets, network interfaces, passwords, and power supplies.

Front Panel Disable and Enable

Access to the front-panel interface can be configured to end after a period of idle time. See [Front Panel Settings](#).

Disable Front-panel Interface

Press-and-hold **ENABLE** for 2 seconds. The display backlight is dimmer when the interface is disabled. When the front-panel interface is disabled, pressing any front panel button does not have an effect, except the **ENABLE** button is

illuminated as a reminder that the front panel is currently disabled.

Enable Front-panel Interface

Press-and-hold **ENABLE** for 4-5 seconds. The display backlight is brighter when the interface is enabled.

Menu System

The SPG9000 front-panel interface is organized as a set of menus. Each of the front panel menu buttons is associated with one of the menu lists. For example, press the REF button to open the REFERENCE menu list. The top line of the display shows the name of the current menu in its hierarchical structure. For example, the REFERENCE : GENLOCK : TIMING menu is a third-level menu under the REFERENCE menu list.

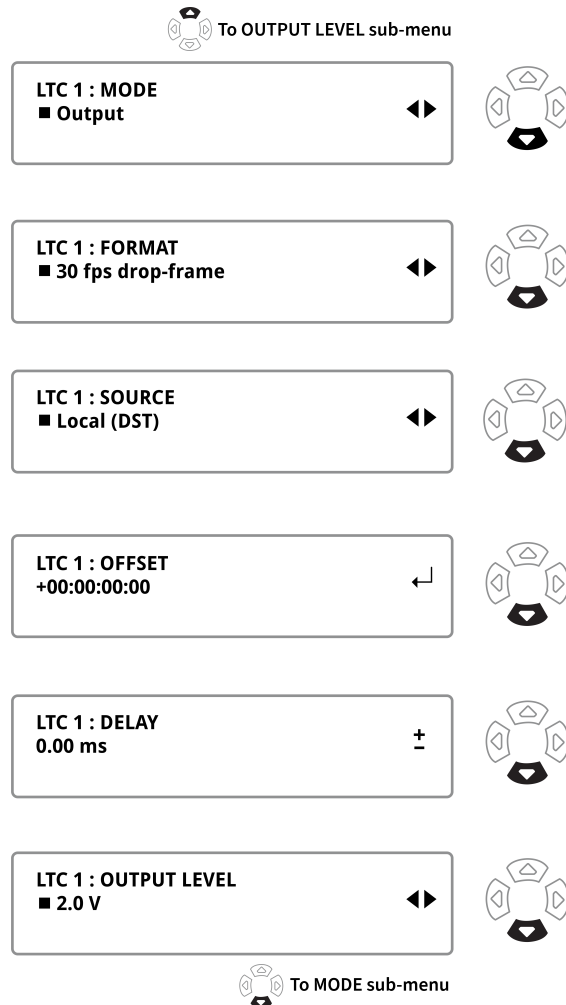
1. Press **REF** to open the REFERENCE menu.
2. Press the \triangle or ∇ button to move between menus.

Note: Menus are organized in a circular structure; if you press the same arrow repeatedly, you will view all available menus and return to your original starting menu.

3. When the REFERENCE : GENLOCK menu is displayed, press ENTER.
4. Repeat the process to find the TIMING submenu, and press ENTER.

Some buttons are associated with multiple outputs or ports. Press a menu button repeatedly to cycle through the menus for each of the outputs. For example, press the LTC button to cycle through the four menus for LTC 1 through LTC 4. Within any of these menus, press the \triangle or ∇ button to cycle through the complete set of menus for that output. The LTC 1 menu has six submenus: MODE, FORMAT, SOURCE, OFFSET, DELAY, and OUTPUT LEVEL. The list of submenus is circular, meaning you can go directly from

the first submenu (in this example MODE) to the last submenu (in this example OUTPUT LEVEL) by pressing the \triangle button, or from the last submenu to the first by pressing the ∇ button.



Note: Menus might be hidden if they are not applicable or available in the current configuration settings. In this example, the MODE submenu is only available for LTC 1 because only LTC 1 can be configured as an input or as an output. When it is configured as an input, the other five submenus (FORMAT through OUTPUT LEVEL) are hidden because they are only applicable for LTC outputs.

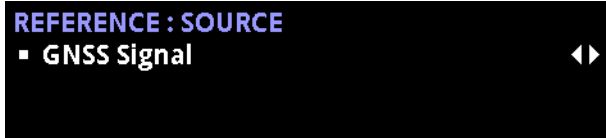
Menu Operations

There are four kinds of menus used for making configuration changes and for viewing the instrument status. Each menu type is indicated by a symbol displayed on the right side of the second menu line.

Note: In all menus, except in edit mode, the up and down arrows change the selected menu.

Selection Menus

Selection menus are marked by the pair of left- and right-facing triangles on the right, as shown in the example.



Use selection menus to choose one option from an available list. When the menu first opens, the current setting is indicated by a square bullet symbol to the left of the item.

1. Press the ◀ or ▶ button to cycle through the available options.
2. When the required option is displayed, press **ENTER**. The menu text blinks to confirm the selection and the bullet indicates the new selection.

Adjustment Menus

Adjustment menus are marked by a plus-minus sign on the right, as shown in the example.



Use these menus to make immediate adjustments to the configuration parameters.

- Press the *right* arrow to *increase* the parameter by the smallest increment available (for example, 0.0185μs).
- Press the *left* arrow to *decrease* the parameter by the smallest increment available.
- Press-and-*hold* the left or right arrow to increase or decrease the parameter until the button is released.
- Press both left and right arrows at the same time to return the parameter to the default value.

Edit Menus

Edit menus are marked by the carriage-return symbol, as shown in the example.



Use these menus to change editable strings like passwords, IP addresses, and parameters with multiple fields. Edit menus are modal, which means the arrow buttons have different behaviors when the menu is in edit mode from when the menu is in navigation mode.

1. Press ENTER to switch the menu to edit mode, confirmed by an underline under the first editable character, digit, or field.

Note: When in edit mode, you must press ENTER or BACK to leave.

2. Press the ◀ or ▶ button to change to the next or previous editable character, digit, or field.
3. Press the △ or ▽ button to move through the available values for the character, digit, or field. For example, when editing an IP address, press the △ or ▽ button to cycle through the numeric digits 0-9.
4. When you have set the value for a character, digit, or field, press the ▶ button to move to the next item and repeat.
5. When all changes have been made, exit edit mode:
 - To exit edit mode and *accept* the currently displayed values, press ENTER.
 - To exit edit mode and *cancel* the editing changes, press BACK.

Multiple-Page Menus

Multiple-page menus are used to display read-only status information, not for making configuration changes. These menus are marked by a pair of arrows, facing opposite directions, as shown in the example.



The arrows mark there is more information to be viewed by pressing the left or right arrows.

Press a left or right arrow repeatedly to move through all available pages of information.

Front Panel Settings

There are several settings to change the appearance and behavior of the front panel interface. These settings may only be changed from the front panel itself; you cannot change these settings remotely from the web interface or the API. They are not saved in preset files, but some settings are saved in the non-volatile memory of the instrument so they are preserved when the system cycles power.

The table summarizes the menu structure that is accessed when you press the SYSTEM button. Indentation indicates the menu hierarchy; for example, you need to access the SYSTEM : FRONT PANEL submenus to configure the front panel settings. Other SYSTEM menus are shown collapsed and with dim highlighting to show their position in the menu list. For example, when you press the SYSTEM button, the first menu to be displayed is SYSTEM : PRESET. Press the down arrow button three times to go to the SYSTEM : FRONT PANEL menu. Press ENTER to go to the SYSTEM : FRONT PANEL : TIMEOUT menu. Press the up or down arrow buttons to cycle between the three sub-menus (TIMEOUT, DISP BACKLIGHT, and BEEPER).

Menu lists like this are used in other sections of this document to help you move through the front panel menu system.

SYSTEM :

PRESET :
INFO :
NETWORK :
FRONT PANEL :
 TIMEOUT
 DISP BACKLIGHT
 BEEPER
WEB :
POWER SUPPLY :
FIRMWARE UPGRADE
CALIBRATE OVEN
DIAGNOSTICS

TIMEOUT

Select the idle time period before the front panel buttons are disabled. This feature can be used to prevent accidental configuration changes. An operator must explicitly re-enable the front panel interface to access any menus.

Select Disable if you never want the front panel interface to time out. See [Front Panel Disable and Enable](#).



CAUTION: We strongly recommend using the timeout function to keep the display backlight at a low level when the front panel interface is not actively being used, to maximize the life of the display backlight.

DISP BACKLIGHT

Select the brightness of the backlight for the front panel LCD. The display brightness can be adjusted from a value of 1 (dim) to 8 (bright). When the front panel interface is disabled, the display backlight brightness changes to the dimmest value (1) until it is re-enabled and the selected brightness is restored.

BEEPER

Select Enable to permit the internal beeper to sound. The beeper emits a short chirping sound every second when there is a hardware fault. See [FAULT](#).

This setting is not saved in non-volatile memory. If the beeper is disabled, it re-enables when power is cycled. This ensures that the hardware fault alarm is not unintentionally ignored.

Management Network Interface

The instrument has a 10/100/1000 BASE-T Ethernet port on the rear panel that is used for management functions. You can remotely control the instrument through the web interface or through the application programming interface (API), and system events can be logged to a remote server from the management interface.

This section provides instructions for configuring the network parameters of the management network interface.

Note: The management port can only be configured using the front panel user interface.

Front Panel Menu for NETWORK

To use the front panel of the SPG9000 for this process, press **SYSTEM** and then select the **NETWORK** option. See [Menu Operations](#) for details of using the front panel menus. The table shows the submenus for the NETWORK menu.

SYSTEM :
PRESET :
INFO :
NETWORK :
 MGMT :
 DHCP
 IP ADDRESS
 SUBNET MASK
 GATEWAY
 MAC ADDRESS
 HOSTNAME
 DOMAIN NAME
 PTP 1
 PTP 2
FRONT PANEL :
WEB :
POWER SUPPLY :
FIRMWARE UPGRADE
CALIBRATE OVEN
DIAGNOSTICS

Configuration Settings for NETWORK

The NETWORK settings are used to configure all the Ethernet ports for the SPG9000, including the management interface, the PTP ports, and the IP ports.

MGMT

The MGMT submenu includes all the configuration settings for the management network interface.

DHCP

Select Enable to use Dynamic Host Configuration Protocol (DHCP) on the management interface. In this case, a DHCP server must be present on the network, and it assigns the IPv4 address, subnet mask, and gateway address. If you enable DHCP, manual configuration of those values is disabled but the values provided by the DHCP server are displayed.

IP ADDRESS

Enter the four octets of the IPv4 address, in dotted decimal notation. An edit menu (see [Edit Menus](#)) is used to enter the address, with three digits for each octet with leading zeros if necessary. For example, an address of 192.168.1.50 would appear as 192.168.001.050 in this menu. If DHCP is enabled, the IPv4 address supplied by the DHCP server is displayed instead and cannot be edited.

SUBNET MASK

Enter the four octets of the subnet mask, in dotted decimal notation. If DHCP is enabled, the subnet mask supplied by the DHCP server is displayed instead and cannot be edited.

GATEWAY

Enter the four octets of the gateway address for this subnet, in dotted decimal notation. If DHCP is enabled, the gateway address supplied by the DHCP server is displayed instead and cannot be edited.

MAC ADDRESS

This is a read-only menu that displays the physical (MAC) address of the management port. The first three octets of a MAC address indicate an Organizationally Unique Identifier (OUI), to help identify equipment on the network. The OUI for Telestream is 00-90-56, so the MAC addresses always begin with these three octets.

HOSTNAME

Enter the hostname portion of the fully qualified domain name (FQDN) for the instrument. This name can be used to access the instrument instead of using its IP address. Valid characters for the hostname include alphanumeric characters (A-Z, a-z, and 0-9) and the hyphen character. The first character must be a letter or numeral.

The factory default hostname is "spg9000-s0000000" where the last six digits represent the numeric portion of the device's serial number. The serial number can be seen on a sticker on the left side of the SPG9000, and appears on a label on the packaging box.

DOMAIN NAME

Enter the domain name portion of the FQDN. Valid characters for the domain name include alphanumeric characters (A-Z, a-z, and 0-9), the hyphen character, and the "dot" character (to separate levels in the domain hierarchy). The first character must be a letter or numeral. Do not include the leading or trailing "." character.

The factory default domain name is "telestream.net", so this must be changed to your local domain name.

Web User Interface

After the management network interface has been configured, the SPG9000 can be accessed through a web-based user interface, using any modern browser. The default URL is:

`http://hostname`

where *hostname* is replaced with a fully qualified domain name of the SPG9000, or:

`http://ip_address`

where *ip_address* is replaced with the IP address of the management network interface.


Operational Considerations

We recommend a maximum of four simultaneous users be connected to the instrument that is using the web interface. If more users are connected, it can result in lower performance and inconsistent behavior.

Note: The web interface requires Javascript to run.

Web Interface for User Login and Access Control

When you first open the web interface URL, you will see a login page. The SPG9000 has two built-in user accounts for web interface access: admin and operator. When you first go to the web interface page, you will see a login prompt. The admin account has full read-write control for all system settings. The operator account has a read-only view of the instrument; the web interface shows status information but configuration settings cannot be changed.



telestream SPG9000

Username

Password

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The default password for the admin account is "admin" and the default password for the operator account is "operator". We recommend you change these passwords to a unique value for each instrument. You can change both passwords from the **SYSTEM : WEB : ADMIN PASSWORD** and **SYSTEM : WEB : OPERATOR PASSWORD** menus on the front panel interface, or you can change the currently logged-in user's password from the General Settings section on the System tab of the web interface.

Front Panel Menu for WEB

To use the front panel of the SPG9000 for this process, press **SYSTEM** and then select the **WEB** option. See [Menu Operations](#) for details of using the front panel menus. The table shows the submenus for the WEB menu.

SYSTEM :

PRESET :

INFO :

NETWORK :

FRONT PANEL :

WEB :

ADMIN PASSWORD

OPERATOR PASSWORD

POWER SUPPLY :

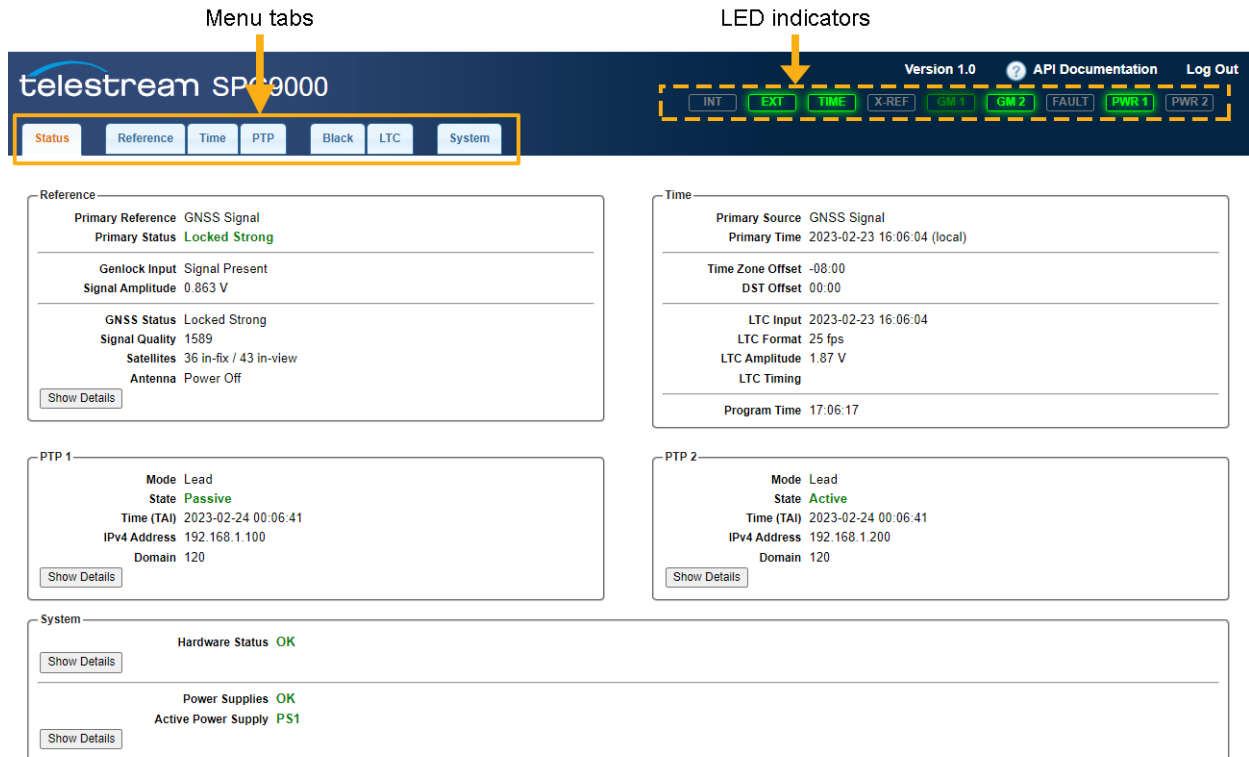
FIRMWARE UPGRADE

CALIBRATE OVEN

DIAGNOSTICS

Elements of Web User Interface

The web interface for the SPG9000 is a single-page application that dynamically updates based on current configuration and system state. The top banner (with a blue background) is always present, but the main page body (with a white background) depends on user navigation.



Menu tabs

The name of each tab corresponds to a specific button on the front panel, and items on the tab are similar to the front panel menu system; see [Front Panel Interface](#). On the web page, select the tab to go to that item and see its menus.

Status

Select to observe the current operational status of the instrument. See [System Status and Monitoring](#).

Reference

Select to configure the current reference source (genlock input, GNSS signal, PTP follower, or internal) and to configure the GNSS receiver (option SPG9000-GNSS required). See [Reference and Time Sources](#).

Time

Select to configure the time of day source (including any time zone offset), daylight saving time parameters, leap second adjustments, daily jam sync schedule, and program time. See [Reference and Time Sources](#).

PTP

Select to configure the two PTP instances associated with the two SFP ports, labeled PTP 1 and PTP 2. This tab is not present unless the SPG9000-PTP option is licensed. See [PTP Operation](#).

Black

Select to review and configure the six analog sync signal outputs. These are labeled BLACK 1 through BLACK 6. See [Black Outputs](#).

LTC

Select to configure the four linear time code (LTC) outputs, or three outputs and one input. See [Linear Time Code Input and Outputs](#).

System

Select to manage several system-wide settings, such as:

- Save and recall presets: see [Presets](#).
- Update option licenses: see [Licensed Features](#).
- Configure the web server, including security and authentication: see [Secure Web Interface](#).
- Configure system logging: see [Syslog](#).
- Configure the network interfaces for the SFP ports: see [Configuration Settings for PTP Network Interfaces](#).
- Manage the power supply modules: see [Power Supply Monitoring and Replacement](#).

LED indicators

The indicators are the same as those on the front of the instrument. See [Indicators](#).

API Documentation

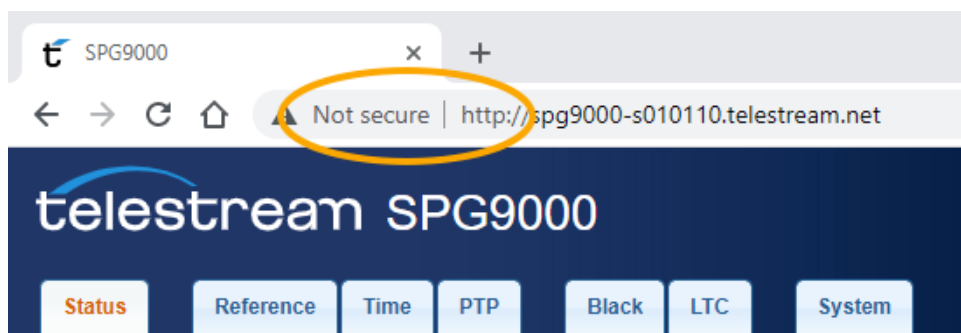
Select to open the SPG9000 HTTP API web page. See [HTTP API](#).

Secure Web Interface

The SPG9000 integrated web server can use HTTPS instead of HTTP to provide a secure web interface. This might be required by your organization cybersecurity requirements, such as EBU R 143.

The factory configuration for the web interface is to use HTTP but you can install your organization certificate files and use HTTPS.

Most browsers show the site status and protocols. For example, with plain HTTP, the Chrome browser indicates the SPG9000 web interface is "Not secure":



Configure Web Server

To install new SSL certificate files and switch to HTTPS,

1. Click the **System** tab and open the General Settings section.
2. Go to the Web Server subsection.

A screenshot of the "Web Server" configuration page. It contains several input fields and buttons. At the top, there are "Web Page Password" and "API Key" fields, each with a "View" and "Change" button. Below these, the "Web Server Protocol" is set to "HTTP (Port 80)" with a dropdown arrow. Underneath, there are three rows for SSL configuration: "SSL Certificate", "SSL Certificate Key", and "SSL Password File". Each row has a "Choose File" button and a status indicator that says "No file chosen". At the bottom left, there are two buttons: "Install Certificate" and "Restart Web Server".

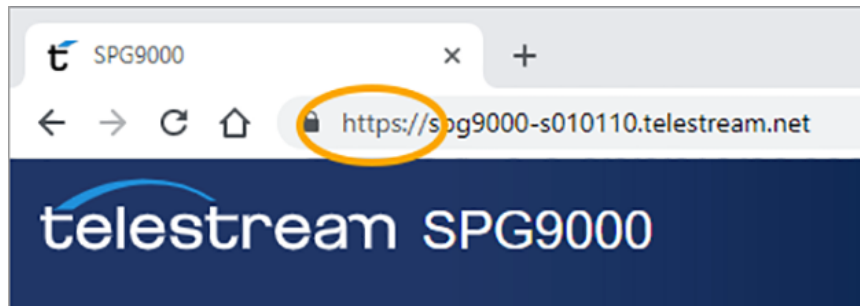
Two or three SSL certificate files are needed to complete the installation. Your IT organization should provide the files for your domain. Use the web interface to select these files from a location on a local computer.

SSL Certificate: Choose the certificate file. This file should use the PEM format and have a filename extension of .crt.

SSL Certificate Key: Choose the private key file. This file should use the PEM format and have a filename extension of .key.

SSL Password File: Choose the password file. This file is optional and only needed if the key file uses passphrases. The password file should have a filename extension of .txt.

3. When the certificate, key, and optional password files have been selected, click **Install Certificate** to upload the files to the SPG9000.
4. If the certificate files are installed successfully, select **HTTPS (Port 443)** from the Web Server Protocol menu and click **Restart Web Server**. After the web server restarts, the web page shows as secure.



Application Programming Interfaces

The SPG9000 has multiple application programming interfaces (APIs) for remote access to the instrument. Client-side applications, such as data visualization dashboards, can use the APIs for system management and monitoring.

HTTP API

The primary API for the SPG9000 is based on Hypertext Transfer Protocol (HTTP) messages with JavaScript Object Notation (JSON) text. This API style is commonly referred to as a REST (Representational State Transfer) API. Strictly speaking, the SPG9000 API is not RESTful, but the message formats are familiar to developers with REST API experience.

Messages and Endpoints

The SPG9000 HTTP API uses three HTTP message types:

GET: Used to read status and/or configuration information from the SPG9000. The GET message sent to the SPG9000 does not have a message body, but the normal response from the SPG9000 (200 OK) includes a JSON object (content-type: application/json) including the requested values.

PUT: Used to set configuration parameters. The message body for the PUT message must be a JSON object with the parameter to be updated. The SPG9000 accepts a partial JSON object for PUT messages, so a subset of configuration parameters can be changed while keeping other parameters unchanged.

POST: Used to command the SPG9000 to perform an internal operation.

Endpoints are described in the documentation with a path such as `/system/status` that corresponds to a complete URL:

`http://spg9000/api/v1.0/system/status`

where *spg9000* is the hostname or the IP address of the system. The prefix `/api/v1.0` is required for every endpoint.

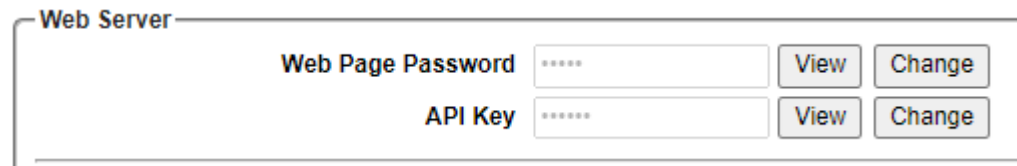
Note: If the SPG9000 web server has been configured to use HTTPS with an SSL certificate (see [Secure Web Interface](#)), the API URL uses the protocol `https://`.

Authentication

The SPG9000 API requires all messages to be authenticated, similar to requiring a user to log in with a password for the web interface. The header field `X-API-Key` must be included in every HTTP request sent to the SPG9000. If this header field is missing or does not match the user-configurable key value, the SPG9000 returns a response message: 401 Unauthorized.

The factory default value for the API key is "apikey". This value can be changed at the web interface, in the General Settings section of the System tab.

Note: You must be logged in as the admin user to view or change the API key.

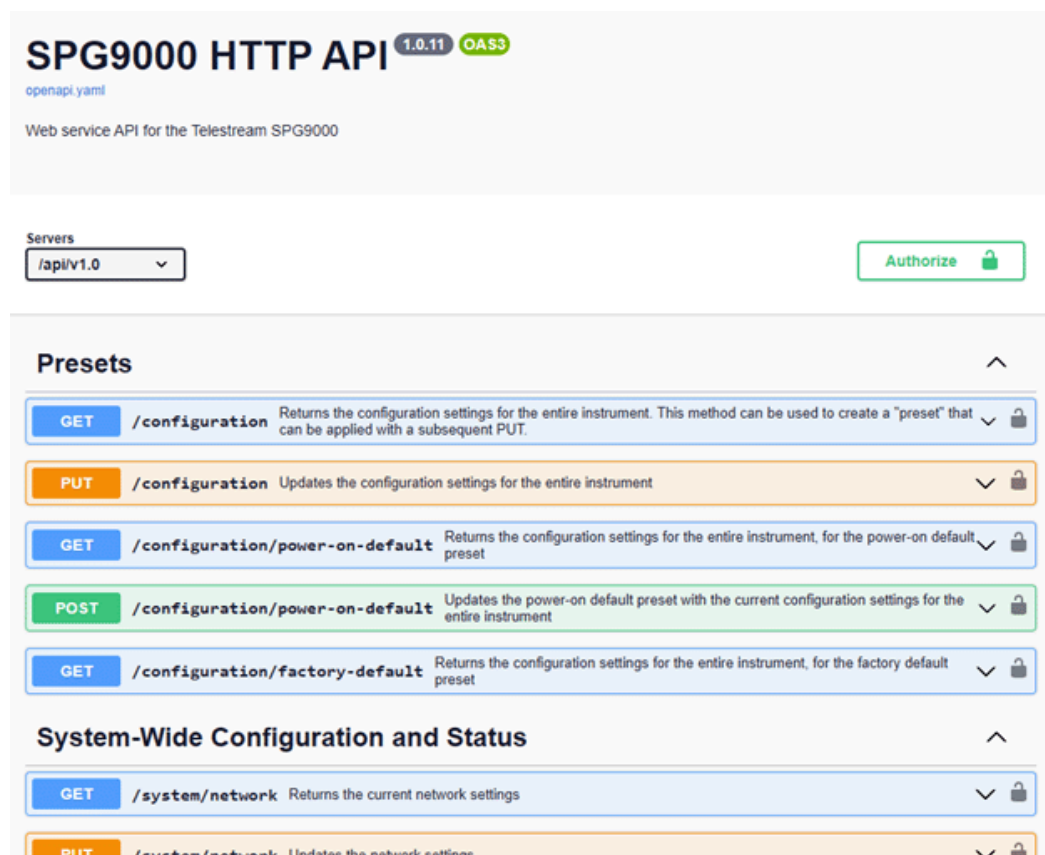


Note: We recommend you change this value to a strong password, and do not share the key outside your organization.

API Documentation

Documentation for the HTTP API is available in the SPG9000 web interface. In the top banner, select **API Documentation**.

A new browser window appears for the documentation page.



The complete set of available messages is organized into categories on the documentation page:

Presets: Messages with an endpoint starting with /configuration are used to manage the configuration settings for any part of the entire instrument. See [Presets](#).

System-Wide Configuration and Status: Messages with an endpoint starting with /system correspond to configuration settings found on the System tab of the web interface or the SYSTEM menu, and to status information found on the Status tab or STATUS menu.

Reference and Time: Messages with an endpoint starting with /reference are used to manage the configuration settings of the frequency and time reference sources of the instrument, and to get the current status of all available reference sources.

PTP: Messages with an endpoint starting with /ptp are used to manage the two PTP instances corresponding to the PTP 1 and PTP 2 ports. The option SPG9000-PTP is required for this feature. The /ptp messages in the API are directly based on the SMPTE RP 2059-15 YANG data model for PTP.

GNSS: Messages with an endpoint starting with /gnss are used to configure the GNSS receiver and to get current status information about the received signals. The option SPG9000-GNSS is required for this optional feature. Some of these messages are based on the SMPTE RP 2059-15 YANG data model.

SMPTE RP 2059-15: Endpoints starting with /ptp-smpte, /grandmaster, or /rfc-8173 are based on the SMPTE RP 2059-15 YANG data model. They are used to access additional information not present in any of the /ptp endpoints, such as values specific to the SMPTE ST 2059-2 PTP profile.

Black Outputs: Endpoints starting with /blacks are used to manage the configuration settings of the 6 analog sync (BLACK) outputs. See [Black Outputs](#).

LTC Outputs: Messages with an endpoint starting with /ltc are used to manage the configuration settings of the 4 Linear Time Code (LTC) outputs (or 3 outputs plus 1 input). See [Linear Time Code Input and Outputs](#).

To view the details for a particular message, select the message name to open a panel with example values and schema descriptions for the response body (GET messages) and request body (PUT messages).

You can use the documentation to interactively send HTTP API messages to the SPG9000 without requiring the use of external software:

1. Select **Authorize** at the top of the page and enter the API key.
2. Select **Try it out**.
3. You might have to enter a parameter for the URL; for example, for the GET /blacks/{output} message enter an output number to create the complete endpoint (that is, /blacks/1 for the BLACK 1 output).
4. For PUT messages, you also need to edit the JSON message body, starting with the example provided.
5. Select **Execute** to send the message to the SPG9000. The Responses section shows the request and the server response.

Syslog

The SPG9000 uses the standard syslog function to record log messages about system status and events. Syslog messages can be directed to a remote server using the management network interface. Syslog messages are not stored locally in the SPG9000 internal memory, so a remote server must be used to capture log messages.

Syslog uses a set of predefined facility codes to identify the event source. For example, events related to security or authentication use the "auth" facility and events related to the Linux kernel use the "kern" facility. Messages related to SPG9000 software (including the PTP processes) use the "user" facility.

Syslog has eight defined severity levels. You can configure the threshold for reporting events. For example, setting a threshold of Warning means that any Notice, Informational, and Debug messages are not logged.

Severity Level	Description
Emergency	The system is unusable
Alert	Action must be taken immediately
Critical	Critical conditions
Error	Error conditions
Warning	Warning conditions
Notice	Normal but significant conditions
Informational	Informational messages
Debug	Debug-level messages

Most messages logged by the SPG9000 use the Informational, Notice, Warning, or Error severity levels.

Web Interface for System Logging

1. In the SPG9000 web interface, select the **System** tab.
2. Select the **General Settings** and find the System Logging section.
3. Make the necessary changes to the four parameters.

4. Select **Apply Changes** for the settings to take effect.

Configuration Settings for System Logging

Log to Remote Server

Select this box to enable logging. By default, logging is disabled.

Syslog Server

Enter the IP address of the remote server. Be sure that any firewall on the remote computer is configured to permit syslog traffic to be received.

Transport Protocol

You can select UDP (port 514) or TCP (port 6514) for sending messages to the remote server. The default is UDP, because it is a lightweight connectionless protocol with little overhead. Select TCP for connection-oriented message transmission to the server.

Minimum Severity

You can select the minimum threshold for sending messages to the remote server. The default value is Warning, which means that only Error and Warning level messages would typically be logged. Severity levels of Emergency, Alert, and Critical are unlikely to be observed, but they would be logged.

Message Format

Syslog messages are plain text but follow a specific format. In this example:

```
<13>Mar 16 12:34:56 spg9000-s012345 SPG9000[820]: Primary reference source is now locked
```

the string is made up of five elements:

- The first field is the facility and severity level, "<13>" in this example. The decimal number between the < and > brackets can be converted to binary digits (such as 00001101), and the 5 most significant bits (00001) indicate the facility (in this case "user") and the 3 least significant bits (101) represent the severity level (in this case "notice"). Many syslog servers automatically decode <13> as "user.notice" to make logs easier to read.

- The second field is the date, "Mar 16 12:34:56" in this example. This time is the system time of the instrument, which could differ from local time if the instrument does not have a time zone or daylight saving time offset applied.
- The third field is the hostname of the SPG9000, "spg9000-s012345" in this example. The syslog messages originating from the PTP processes use a modified hostname with an ending of "-2" (such as spg9000-s012345-2).
- The fourth field is the process name, "SPG9000[820]" in this example. Syslog messages from the PTP processes use a process name of "ptp4l" and messages from the main application use a process name of "SPG9000".
- The fifth and final field is the message body text, "Primary reference source is now locked" in this example.

Presets

A preset is a set of configuration parameters for the instrument. Save and recall presets to quickly change configuration settings at once, instead of changing each parameter individually. The system maintains two special presets (power-on default and factory default) and any number of user-defined presets:

Web Interface for Presets

In the SPG9000 web interface, select the **System** tab and then select **Preset**.

▼ Presets

Power-On Default

Factory Default

Preset File

New Preset File

Note: With the front panel interface, a user can save or recall the power-on default preset, or recall the factory default preset. File operations are only supported on the web interface.

Front Panel Menu for PRESET

To use the front panel of the SPG9000 for this process, press **SYSTEM** and then select the **PRESET** option. See [Menu Operations](#) for details of using the front panel menus. The table shows the submenus for the PRESET selection.

SYSTEM :

PRESET :

POWER-ON DEFAULT (to Save)
POWER-ON DEFAULT (to Recall)
FACTORY DEFAULT

INFO :

NETWORK :

FRONT PANEL :

WEB :

POWER SUPPLY :

FIRMWARE UPGRADE

CALIBRATE OVEN

DIAGNOSTICS

Configuration Settings for Presets

Power-On Default

This preset is applied whenever the instrument is powered on. Save the current settings to the Power-On Default preset so they are automatically restored when the instrument is restarted. Recall this preset to reset the configuration since the last time the system was restarted or since this preset was updated. This is useful for applications when the SPG9000 is frequently powered off and on again, such as between different locations for a mobile broadcast truck.

Factory Default

This preset includes the fixed factory default values for most configurable settings in the instrument. Recall this preset to restore the instrument to a known state. The Factory Default preset cannot be updated.

Preset File

There are several options for existing preset files:

Recall User-defined Preset

After the JSON file has been saved, it can be recalled at any time.

1. Select the preset file from the Preset File menu.
2. Select **Recall** to restore the configuration parameters from the preset file.

Update User-defined Preset

You can update an existing user-defined preset file.

1. Select the preset file from the Preset File menu.
2. Select **Save Current** to overwrite the preset file with the current configuration parameters for the instrument.

New Preset File

User-defined presets are saved as JSON text files in non-volatile memory on the instrument. To create a new user defined preset:

1. Enter the preset name in the New Preset File field.
2. Select **Save as New**.
3. The .json filename suffix is added automatically. The new file is added to the menu for the Preset File actions.

Configuration Settings Not Saved in Presets

Several parameters are saved in non-volatile memory of the SPG9000 so they are restored when the instrument is powered off and on again, but they are not saved in preset files. These are parameters that typically would not change in different operational environments, such as between different mobile production locations:

- Installed license keys
- Network parameters:
 - Hostname and domain name
 - Management port IP address, subnet mask and gateway address
 - PTP and IP port addresses, subnet masks, and gateway addresses
- Web server configuration:
 - Web interface passwords
 - API key
 - SSL certificates
- Syslog configuration:
 - Server address
 - Transport protocol
 - Severity level
- Front panel interface settings:
 - Timeout duration
 - Display backlight brightness
 - Beeper enable

System Status and Monitoring

The SPG9000 has multiple features for monitoring the status of the instrument and its reference signals. The front panel has colored LED indicators for quickly checking several status items, and a set of menus accessed from the STATUS button for more detailed information. The web interface also shows the same indicators on the banner at the top of the page and has a Status tab to see detailed information. The API has several messages for getting the status of the reference, GNSS, and PTP functions.

Indicators

There are nine colored LED indicators on the front panel of the instrument:



These indicators are mirrored on the web interface, on the right side of the banner at the top of the page. When a physical front panel indicator changes state, the web page indicator also changes.

The front panel indicators are grouped according to function:



Reference

The INT and EXT indicators (located under the REF button) show the status of the reference source. See [Reference Sources](#).

Reference Source	EXT LED State	INT LED State	Operational Status
Internal	Off	Solid green	Good
	Off	Blinking green	Warming up
Genlock Input	Solid green	Off	Locked
	Solid yellow	Off	Near Loss of Lock
	Solid red	Solid green	Unlocked
GNSS Signal ¹	Solid green	Off	Locked
	Solid yellow	Off	FOM is less than the GNSS signal warning threshold. See Signal Warning Threshold .
	Solid red	Solid green	Unlocked or Holdover
PTP Follower ²	Solid green	Off	Locked
	Solid yellow	Off	The reference is locked to the PTP time, but the time from the grandmaster is near the lock range limit of the system.
	Solid red	Solid green	Unlocked or Holdover

1. Option SPG9000-GNSS must be licensed to select GNSS Signal as the reference source.

2. Option SPG9000-PTP must be licensed to select PTP Follower as the reference source.

Time

The INPUT indicator (located under the TIME button) shows the status of the main time-of-day (MTOD) source. On the web interface, the INPUT indicator is labeled TIME. See [Time-of-Day Sources](#) for information on the MTOD source.

Time of Day Source	(TIME) INPUT LED State	Operational Status
Internal	Off	Time is based on the internal main time-of-day register. This might have been previously set by an external source or by manual input.
VITC Input	Solid green	VITC data is present in the genlock input signal and is being used for the MTOD source.
	Solid red	There is no genlock input signal, or the signal is present and there is no VITC data detected, or the VITC data is discontinuous.
LTC Input	Solid green	The LTC input signal is present and is being used for the MTOD source.
	Solid yellow	The timing of the LTC input signal and the genlock input signal are the same frame rate, but the relative timing is outside the SMPTE ST 12 specification.
	Solid red	The LTC input signal is missing, the LTC data is discontinuous, or the LTC frame rate is badly timed relative to the genlock input signal.
GNSS Signal ¹	Solid green	The system is using the time from the GNSS receiver as the MTOD source.
	Solid red	The system is not locked to the GNSS signal.
PTP Follower ²	Solid green	The system is using PTP time as the MTOD source.
	Solid red	The system is not locked to a PTP leader.

1. Option SPG9000-GNSS must be licensed to select GNSS Signal as the time and reference source

2. Option SPG9000-PTP must be licensed to select PTP Follower as the time and reference source

The X-REF indicator (also located under the TIME button) is for future use.

PTP

The GM 1 and GM 2 indicators (located under the PTP button) show the grandmaster status of the PTP 1 and PTP 2 instances respectively. See [PTP Configuration](#) to configure the PTP instances. Option SPG9000-PTP must be licensed to enable PTP operation.

GM LED State	PTP Status
Bright green	Active Leader
Dim green	Passive Leader
Red	Faulty
Off	Listening, Disabled, or Follower

FAULT

The FAULT indicator is illuminated when there is a problem with the instrument hardware.

FAULT LED State	Instrument Condition	Examples
Off	The instrument is operating properly.	
Solid yellow	A fault condition exists, but the instrument is still usable.	<ul style="list-style-type: none">• The phase-locked loops (PLLs) are unlocked.• A power supply module has reached the TWH limit. See Temperature-Weighted Hours.
Blinking red	A fault condition exists that has the potential to damage the instrument hardware.	<ul style="list-style-type: none">• The main fans have stopped.• The internal temperature is too high.
Solid red	A fault condition exists that renders the instrument unusable.	<ul style="list-style-type: none">• A fan speed is out of range.• An internal voltage is out of range.

See [System Status](#) to view the detailed diagnostic data. If the FAULT indicator is blinking red or solid red, record the fault details, unplug the instrument from the power source, and contact Telestream customer support.

PWR 1 and PWR 2

These two indicators show the status of the two power supply modules.

Note: If the SPG9000 was purchased with option SPG9000-SPW, only one power supply module is installed in the instrument. If it was purchased with option SPG9000-DPW, two power supply modules are installed in the instrument. A second or replacement power supply can be added at any time by purchasing option SPG9000-ACC-DPW.

When one power supply module is installed, the corresponding PWR 1 or PWR 2 indicator is on and the other indicator is off.

PWR1 / PWR2 Indicator State	Power Supply Module Condition	Description	User Actions
Green	No faults	Normal operation	None
Yellow	Warning	<ul style="list-style-type: none"> A marginally out-of-range power supply voltage is detected. The supply has exceeded the specified TWH. See Temperature-Weighted Hours. The power supply fan has stopped. 	<ol style="list-style-type: none"> 1. Install a second power supply module. 2. Remove the faulted power supply module for repair.
Red	Fault	The power supply voltage is out of range.	<ol style="list-style-type: none"> 1. Install a second power supply module. 2. Remove the faulted power supply module for repair.

When two power supplies are installed, both PWR 1 and PWR 2 indicators are on.

PWR1 / PWR2 Indicator State	Power Supply Module Condition	Description	User Actions
Off	Not installed	The power supply is not properly installed; the system is only detecting one power supply.	Check that the module is fully inserted into its rear panel slot.
Bright green	No faults	This is normal operation for the active power supply.	None
Dim green	No faults	This is normal operation for the inactive (backup) power supply.	None

PWR1 / PWR2 Indicator State	Power Supply Module Condition	Description	User Actions
Yellow	Warning or fault in the active supply	<ul style="list-style-type: none"> • A marginally out-of-range power supply voltage for the active supply is detected. • The supply has exceeded the specified TWH. See Temperature-Weighted Hours. • The active supply fan has stopped. 	<p>If the status of the inactive supply is not faulted (dim green), remove the faulted power supply module for repair. The other supply becomes active.</p> <p>If the status of the inactive supply is also faulted (red), remove that power supply module for repair first.</p>
Red	Fault or no power	<ul style="list-style-type: none"> • The power cable for the supply is unplugged, or there is no power from the source. • The power supply voltage of the active supply is out of range. • The fan of the backup supply has stopped. <p>Note: In the case of a failed fan on both supplies, the instrument operates as long as the voltage is adequate.</p>	<ul style="list-style-type: none"> • Verify the power cable is connected to the power supply module and the power cable is connected to the power source. • Remove the associated power supply module for repair.

Status Information

Detailed status information can be viewed on the Status tab of the web interface. The displays are updated in real-time, so the user can see changes as they occur. A subset of important status information can also be viewed from the front panel STATUS menu.

Web Interface for Status

On the SPG9000 web interface, click the **Status** tab.

The web page Status contents are organized into several main sections:

Reference includes information about the status of the primary reference source, the genlock input signal, and the GNSS receiver status.

Time includes the current time-of-day from its primary source, any local time offsets, status of any time code input, and the current value of the program time counter.

PTP 1 and **PTP 2** include status for the two PTP instances.

System includes diagnostic information for the system hardware, including the power supply modules.

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INT EXT TIME X-REF GM 1 GM 2 FAULT PWR 1 PWR 2

Status Reference Time PTP Black LTC System

Reference

Primary Reference GNSS Signal
Primary Status **Locked Strong**

Genlock Input No Signal
Signal Amplitude 0.005 V

GNSS Status Locked Strong
Signal Quality 2379
Satellites 55 in-fix / 61 in-view
Antenna Power Off

Show Details

Time

Primary Source GNSS Signal
Primary Time 2023-03-20 11:29:02 (local)

Time Zone Offset -08:00
DST Offset +01:00

LTC Input Not available, LTC 1 set as output

Program Time 17:13:39

PTP 1

Mode Lead
State **Active**
Time (TAI) 2023-03-20 18:29:39
IPv4 Address 192.168.1.50
Domain 121

Show Details

PTP 2

Mode Follow
State **Tracking**
Time (TAI) 2023-03-20 18:29:39
IPv4 Address 192.168.1.51
Domain 120

Show Details

System

Hardware Status **Warning** ⚠

Show Details

Power Supplies **OK**
Active Power Supply **PS1**

Show Details

Front Panel Menu for STATUS

To use the front panel of the SPG9000 for this process, press **STATUS**. See [Menu Operations](#) for details of using the front panel menus. The table shows the submenus for the STATUS menu.

STATUS :

FAULT	Only available if a fault is detected
ALERT	Only available if there is an alert
REFERENCE	
TIME :	
PTP 1 :	Only available if the SPG9000-PTP license is installed
PTP 2 :	Only available if the SPG9000-PTP license is installed
GNSS :	Only available if the SPG9000-GNSS license is installed

The front-panel menus for STATUS are multiple-page menus (see [Multiple-Page Menus](#)), so the user can press the left and right arrow buttons to see all the available information for the current menu.

The FAULT submenu is only displayed if there are any hardware faults. This menu provides additional details if the FAULT indicator is illuminated. See [FAULT](#).

The ALERT submenu is only displayed if there are any signal warnings, such as a loss of lock on the primary reference source. This menu is persistent, so if the alert condition is cleared, the menu still shows the past status so the user can see the event happened.

Reference Status

The Reference section on the Status tab contains information about the current reference source, the genlock input signal, and the received GNSS signal.

Note: Option SPG9000-GNSS must be licensed to view GNSS signal status. Without the option, these items are not shown on the web page.

Reference

Primary Reference GNSS Signal
Primary Status **Locked Strong**

Genlock Input Signal Present
Signal Amplitude 0.331 V

GNSS Status Locked Strong
Signal Quality 1011
Satellites 23 in-fix / 24 in-view
Antenna Power Off

Show Details

Primary Reference

Displays the current reference source, one of:

- Internal
- Genlock Input
- GNSS Signal
- PTP Follower

Primary Status

Displays the status of the current reference source. The status text is colored green, yellow, or red indicating good, warning, or error status respectively.

Reference Source	Status Value	Status Color	Description
Internal	Off	Green	The internal oven-controlled MEMS oscillator is used as the frequency reference.
Genlock Input	Locked	Green	Locked to the genlock input signal
	Near Loss of Lock	Yellow	The system is locked but within 1×10^{-6} of the limits of the tune range.
	Unlocked	Red	The system is unable to lock to the genlock input signal.
	Unlocked - Waiting for Manual Lock	Red	The system is waiting for user input to manually relock. This happens when the Lock Action Mode is set to Manual. See Lock Action Mode .
	No Signal	Red	There is no detectable signal at the genlock input.
GNSS Signal ¹	Locked Strong	Green	Locked to the GNSS signal with 8 or more satellites reporting a carrier-to-noise ratio (C/N) of 40 dB or better
	Locked Nominal	Green	Locked to the GNSS signal with 4 or more satellites reporting C/N of 30 dB or better
	Locked Minimum	Green	Locked to the GNSS signal with 4 or more satellites reporting C/N of 10 dB or better
	Locked (possible jamming or spoofing)	Yellow	Locked to the GNSS signal but the receiver is reporting possible jamming or spoofing of the received signal.
	Holdover	Yellow	The system has previously locked to the GNSS signal but is now unlocked. The holdover mode continues until the system relocks.

Reference Source	Status Value	Status Color	Description
GNSS Signal (cont.)	Adjusting Phase	Yellow	The system has a good GNSS signal and is now adjusting its time base and frame timing to align with the GNSS signal within 150 ns.
	Acquiring Position	Yellow	The system is acquiring multiple satellite fixes to compute a new position that be stored in non-volatile memory.
	Bad Position	Yellow	The system has detected that the stored position is different from the current position. The position will be reacquired.
	Acquiring Satellites	Yellow	The system is receiving satellite data to determine which signals to use.
	Unlocked	Red	The system is unable to lock to the GNSS signal because there is no signal or the signal quality is too low.
PTP Follower ²	Locked 50 ns	Green	The system is locked to the PTP leader with an offsetFromMaster value of 50 ns or less, and the system phase is within 50 ns of the PTP-derived timing.
	Locked 100 ns	Green	The system is locked to the PTP leader with an offsetFromMaster value of 100 ns or less, and the system phase is within 100 ns of the PTP-derived timing.
	Locked 250 ns	Green	The system is locked to the PTP leader with an offsetFromMaster value of 250 ns or less, and the system phase is within 250 ns of the PTP-derived timing.
	Locked 1 μ s	Green	The system is locked to the PTP leader with an offsetFromMaster value of 1 μ s or less, and the system phase is within 500 ns of the PTP-derived timing.
	Holdover	Yellow	The system has a valid PTP time from a previous lock, but the PTP instance is no longer tracking the leader.
	Adjusting Phase	Yellow	The PTP instance is tracking within 1 μ s of the PTP leader and the system is now adjusting its time base and frame timing to align with the PTP-derived timing.
	Listening	Yellow	The PTP instance is waiting to receive Announce and Sync messages from a PTP leader in the same domain.
	Unlocked	Red	The PTP instance is disabled, initializing, or faulty (possibly because the link is down).

1. Option SPG9000-GNSS must be licensed to select GNSS Signal as the time and reference source

2. Option SPG9000-PTP must be licensed to select PTP Follower as the time and reference source

Genlock Input

Displays information about the received genlock input signal (from the REF LOOP connectors on the back panel). Detailed information is available when the reference source is Genlock Input. Simple signal detection is the only available status when the reference source is not Genlock Input.

Reference source	Genlock Input status	Description
Genlock Input	NTSC Burst	The system is locked to the genlock input signal and the input format is NTSC Burst.
	PAL Burst	The system is locked to the genlock input signal and the input format is PAL Burst.
	Any of the HD tri-level formats, such as 1080 59.94i or 1080 25p	The system is locked to the genlock input signal and the input format is HD Tri-Level. The specific tri-level sync format is displayed. See Web Interface for Genlock Input .
	CW 10 MHz	The system is locked to the genlock input signal and the input format is 10 MHz CW (continuous wave).
	Signal Present	There is a detectable signal on the genlock input, but the system cannot lock to it. This usually indicates a mismatch between the expected genlock input format and the format of the received signal.
	No Signal	There is no detectable signal on the genlock input.
Internal or GNSS Signal or	Signal Present	There is a detectable signal on the genlock input, but the system cannot identify the specific format when the reference source is not Genlock Input.
PTP Follower	No Signal	There is no detectable signal on the genlock input.

Signal Amplitude

Displays the peak-to-peak signal level (in volts) measured at the genlock input. The instrument can lock to signals within -8 to $+6$ dB of the nominal signal level for NTSC, PAL, and HD tri-level formats and 0.5 to 2V for the CW 10 MHz signal.

If the displayed signal amplitude is greater than expected, the loop-through input on the back panel might be unterminated. Connect the second connector to the genlock reference input of another device or add a 75 Ω terminator.

GNSS Status

Displays the status of the received GNSS signal. The possible values and what they mean are listed in the table.

Note: Option SPG9000-GNSS must be licensed for the GNSS status items to appear on the web interface.

GNSS Status Value	Description
Locked Strong	The GNSS signal has data from 8 or more satellites with a carrier-to-noise ratio (C/N) of 40 dB or better.
Locked Nominal	The GNSS signal has data from 4 or more satellites with C/N of 30 dB or better.
Locked Minimum	The GNSS signal has data from 4 or more satellites with C/N of 10 dB or better.
Locked (possible jamming or spoofing)	The GNSS receiver is reporting possible jamming or spoofing of the received signal.
Acquiring Position	The system is acquiring multiple satellite fixes to compute a new position that will be stored in non-volatile memory.
Unusable Signal	The pulse-per-second (PPS) signal from the GNSS receiver is questionable.
Acquiring Satellites	The system is receiving satellite data to determine which signals to use.
Low Signal	Some satellites are in view, but none are in fix.
No Signal	No satellites are in view. This is normal for a short time after the signal is applied but if this status persists it usually means one of three problems: there is a problem in the antenna or cable; the antenna is blocked from direct line of sight to the satellites; the power is not getting to the antenna.

Signal Quality

Displays the sum of C/N from all satellites currently in fix. A value of about 200 or higher is usually sufficient for Locked Strong status.

Satellites

Displays the number of satellites in-fix and in-view. A satellite whose signal is received by the internal GNSS receiver is counted in-view, but it must be used in the time and position calculation to be counted in-fix. A satellite with a low C/N value, or that is low in the sky (close to the horizon) is not used.

Antenna

Displays the status of the external GNSS antenna; the table explains what each value means:

Antenna status value	Description
Normal Operation	The external GNSS antenna is operating normally.
Power Off	The antenna is not powered from the instrument. This is a normal condition if the antenna is powered from an external source. See GNSS Receiver Settings to change the antenna power settings.
Short Circuit	The antenna is shorted. A shorted antenna does not damage the internal GNSS receiver. If a splitter is used on the antenna, it might appear as a short at DC but still pass through the RF signal, which would allow the internal GNSS system to function.
Open Circuit	An open circuit condition occurs if no antenna is connected or if the current load is less than expected because a splitter or DC block is being used.

Show Details

Click to open a panel on the web interface that provides details information about the received GNSS data. The position data of the GNSS antenna is shown along with a table with data of every satellite that is currently in view.

Latitude 45.457788					
Longitude -122.790513					
Altitude 45.213					
View in Google Maps					
GNSS ID	Satellite	Signal	C/N (dB)	Health	Used
Galileo	7	L1-A	32	ok	no
Galileo	7	E5a	30	ok	no
Galileo	1	L1-A	39	ok	yes
Galileo	1	E5a	40	ok	yes
GPS	14	L1 C/A	46	ok	yes
GPS	14	L5-I	44	ok	yes
GPS	7	L1 C/A	48	ok	yes
Galileo	27	L1-A	48	ok	yes
Galileo	27	E5a	47	ok	yes
GPS	13	L1 C/A	42	ok	no
BDS	45	B1C	45	ok	yes
BDS	45	B2-a	36	ok	yes
Galileo	19	L1-A	41	ok	yes
Galileo	19	E5a	35	ok	yes
GLONASS	12	L1 C/A	43	ok	yes
GLONASS	23	L1 C/A	29	ok	no

Latitude and Longitude

Displays the position in degrees of the GNSS antenna, which might be located at a distance from the GNSS receiver inside the SPG9000. The latitude value is a positive number (0 to 90) for the northern hemisphere and a negative number (–90 to 0) for the southern hemisphere. The longitude value is a positive number (0 to 180) for the eastern hemisphere and a negative value (–180 to 0) for the western hemisphere.

Altitude

Displays the altitude of the GNSS antenna location in meters relative to sea level.

View in Google Maps

Click to open a new browser tab with the location of the GNSS antenna shown at <https://google.com/maps>. This can be used as a diagnostic aid to confirm that the GNSS signal is showing the correction position if there are concerns that the signal is being spoofed.

GNSS ID

Indicates the Global Navigation Satellite System for this satellite.

GNSS ID	System Name	Operator	Coverage
GPS	Global Positioning System	United States	Global
GLONASS	Global Navigation Satellite System	Russia	Global
Galileo	Galileo	European Union	Global
BDS	BeiDou Navigation Satellite System	China	Global
QZSS	Quasi-Zenith Satellite System	Japan	Regional (Asia-Oceania, centered around 135° E longitude)

Satellite

Displays the space vehicle identifier for this satellite. Each GNSS constellation has its own numbering system for its set of satellites.

Signal

Displays the signal identifier. The GNSS receiver of the SPG9000 can receive signals from both the L1 and L5 bands, but this also requires an external antenna that also

supports L1 and L5 frequency bands. If the user only sees L1 signals in this table, it usually means the antenna does not support L5 bands.

Bands	Frequencies	Constellations
L1	1575.42 MHz	GPS, Galileo, QZS
	1561.098 MHz	BeiDou
	1602 MHz	GLONASS
L5	1176.45 MHz	GPS, Galileo, BeiDou, QZSS

C/N (dB)

Displays the carrier-to-noise ratio in decibels of the satellite signal. Values above 10 are usable for a nominal fix and values above 40 are used for a strong fix.

Health

Reports the satellite's health status. If the status is not ok, the satellite is reporting an issue and the receiver would not use its data for a timing and position solution.

Used

Indicates if this satellite signal is used by the receiver for the timing and position solution. Satellite data is usually used unless the vehicle is low in the sky (close to the horizon) or its C/N value is low.

Time Status

The Time section on the Status tab contains information about the current time-of-day source, local offsets, time code inputs, and the program time counter.

Time	
Primary Source	LTC Input
Primary Time	2023-04-11 08:41:29 (local)
Time Zone Offset	-08:00
DST Offset	+01:00
LTC Input	2023-04-11 08:41:29
LTC Format	30 fps drop-frame
LTC Amplitude	1.87 V
LTC Timing	0.01 ms (ST 12 OK)
Program Time	00:00:22

Primary Source

Displays the current MTOD source, one of:

- Internal
- VITC Input
- LTC Input
- GNSS Signal
- PTP Follower

Primary Time

Displays the current main time-of-day value (date and time) including offsets for the local time zone and daylight saving time if applicable.

Time Zone Offset

Displays the current time zone offset relative to UTC. For example, Central European Time (CET) is shown as +01:00 and Pacific Time for North America is shown as -08:00.

DST Offset

Displays the current daylight saving time offset. For standard time, this is 00:00. For daylight saving time (in regions that observe it), the offset is almost always 01:00.

VITC Status

Indicates the presence or absence of the Vertical Interval Time Code (VITC) data on the genlock input signal. When VITC is present, its detected line number in the NTSC or PAL input signal is displayed. The status shows "Discontinuous" for a few seconds if there is an unexpected change in the received time code counter sequence.

VITC Input

Displays the received time code value. If the date and time zone information is encoded (described in SMPTE ST 309), the displayed format is YYYY-MM-DD HH:MM:SS. If the ST 309 data is missing, only the HH:MM:SS digits are displayed.

LTC Input

Displays the received Linear Time Code (LTC) value. LTC 1 must be set to Input mode for the time code to be available. If the date and time zone information is encoded

(described in ST 309), the displayed format is YYYY-MM-DD HH:MM:SS. If the ST 309 data is missing, only the HH:MM:SS digits are displayed.

Note: If the reference source is Genlock Input and the time-of-day source is either VITC Input or Internal, the VITC status is displayed instead of the LTC status.

LTC Format

Displays the detected format of the LTC input signal, such as "30 fps drop-frame"

LTC Amplitude

Displays the detected signal level in volts of the LTC input signal

LTC Timing

Displays the timing offset in milliseconds between the LTC input signal and the genlock input signal. The offset should be within $-32\ \mu\text{s}$ to $+160\ \mu\text{s}$, according to SMPTE ST 12-1. If the measured value is within these limits, a status of ST 12 OK is displayed. If the measured value is outside these limits a status of ST 12 Warning is displayed.

Program Time

Displays the current value of the program time counter. See [Program Time Counter](#).

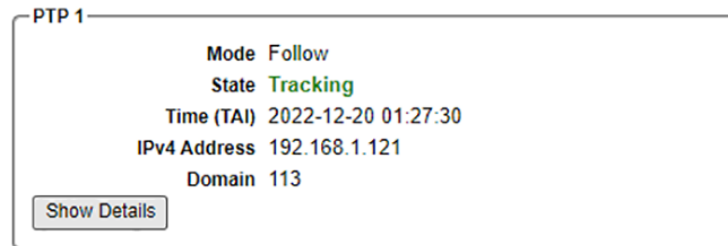
PTP Status

The PTP 1 and PTP 2 sections on the Status tab contain information about the PTP instances corresponding to the two networks ports labeled PTP 1 and PTP 2 respectively.

Note: Option SPG9000-PTP must be licensed for the PTP status items to appear on the web interface.

Main PTP Status

The PTP status sections include some common items that are always visible as in the example, and a details section that depends on the mode and state of the PTP instance.



Mode

Displays the mode of the PTP instance: Lead, Follow, or Ordinary Clock.

State

Displays the state of the PTP instance according to Table 27 of IEEE 1588-2019.

State Name	IEEE 1588 State	Description
Initializing	INITIALIZING	Temporary state when the PTP instance is re-started after some configuration changes
Faulty	FAULTY	Fault state for the instance, usually because the Ethernet link is down or the IP address is mis-configured. Check the rear panel port indicators (see PTP 1-2 Ports) for link status. See Configuration Settings for PTP Network Interfaces for the IP address settings.
Disabled	DISABLED	PTP instance is currently disabled.
Listening	LISTENING	PTP instance is waiting to receive Announce messages from any PTP leaders on this domain.
Pre-master	PRE_MASTER	Temporary state before the instance becomes a lead clock for the domain
Active or Active Leader	MASTER	Normal state for a leader that is the grandmaster (GM) for the domain. The reference and time-of-day source of this instrument is used for followers in this domain to lock to the GM. If the PTP Mode is set to Ordinary Clock, the state name is shown as Active Leader.
Passive	PASSIVE	Normal state for a leader that is not the grandmaster for the domain. Another PTP leader is functioning as the GM, but this instance can assume the GM role if the Best Master Clock Algorithm (BMCA) decides so. At that point, the instance transitions from Passive to Active.

State Name	IEEE 1588 State	Description
Uncalibrated	UNCALIBRATED	Temporary state while the PTP instance is making clock adjustments so it can lock to the GM. The instance should transition to the Tracking state when calibration is complete.
Tracking	SLAVE	Normal state for a follower that is locked to the GM for this domain

Time (TAI)

Displays the current time value that is being used by the PTP instance in its messages. PTP uses International Atomic Time (TAI, Temps Atomique International), which is different from Coordinated Universal Time (UTC) by exactly 37 seconds (as of 2023). TAI is continuous and does not use leap seconds. See [Leap Second Management](#).

The Primary Time value displayed at the top right of the Status tab is based on UTC, with adjustments for time zone and DST offsets. Therefore, it differs from PTP TAI time by at least 37 seconds. See [Primary Time](#).

IPv4 Address

Displays the IP address for the PTP 1 or PTP 2 port. See [Configuration Settings for PTP Network Interfaces](#) to configure the IP address parameters.

Domain

Displays the domain number for the PTP instance.

Details of Leader PTP Status

The PTP status sections display some information only when the PTP Mode is set to Leader.

Click **Show Details** to see the information. The button changes to Hide Details.

PTP 2

Mode Lead

State Active

Time (TAI) 2023-04-19 20:14:01

IPv4 Address 192.168.2.51

Domain 120

Hide Details

Profile SMPTE ST 2059-2

Communication Model Both Multicast and Mixed

Priority 1 128

Priority 2 128

Clock Identity 00:90:56:FF:FE:01:0F:AB

Clock Class 6

Clock Accuracy Within 100 ns (0x21)

Time Source GNSS

Profile

Displays the PTP profile in use for this instance:

- SMPTE ST 2059-2, typically used for video broadcast applications.

Note: Grandmasters send PTP Management messages once per second with a Synchronization Metadata (SM) TLV. Followers using this profile decode the received SM values.

- AES67, typically used for professional audio applications
- IEEE 1588-2019 Default

Communication Model

Displays the communication model in use by the profile:

- Both Multicast and Mixed: Leader can use either multicast or mixed models, depending on the communication models used by its followers.
- Unicast: All PTP messages are sent to specific IPv4 destination addresses.

Priority 1 and Priority 2

Displays the priority 1 and priority 2 values used by this leader in Best Master Clock Algorithm (BMCA) calculations. A lower number indicates a higher priority.

Clock Identity

Displays the clock identity of this leader instance. The clock identity is an 8-byte value that is constructed from the first 3 bytes of the MAC address of the Ethernet port,

followed by 0xFF FE, followed by the last 4 bytes of the MAC address. For example, a MAC address of 00-90-56-01-10-01 (as viewed in the Network Settings section of the System tab, see [MAC Address](#)) corresponds to a clock identity of 00:90:56:FF:FE:01:10:01.

Note: The first 3 bytes (00:90:56) of the clock identity values used by the SPG9000 correspond to the Organizationally Unique Identifier (OUI) of Telestream, LLC.

Clock Class

Displays the clock class attribute of this leader instance, according to Table 4 of IEEE 1588-2019. Some common values:

- 6: Instance is directly synchronized to a primary reference time source (such as GNSS).
- 7: Instance was previously using clock class 6 but is now in holdover mode.
- 13: Reference source is Genlock Input and the time-of-day source is a time code input (LTC or VITC) or internal time.
- 14: Instance was previously using clock class 13 but is now in Stay Genlock mode.
- 187: Instance is in Ordinary Clock mode and can be a follower in this domain.
- 248: Default value, used if the instrument is using an internal reference.

Clock Accuracy

Displays the clock accuracy attribute of this leader instance, according to table 5 of IEEE 1588-2019. Both the description and the numeric value (in hexadecimal) of the clock accuracy are displayed.

Time Source

Displays the time source attribute of this leader instance, according to table 6 of IEEE 1588-2019. The SPG9000 can use any of these values:

- GNSS
- PTP
- Hand Set (Internal time-of-day)
- Serial Time Code (LTC or VITC)

Details of Follower PTP Status

The PTP status sections display some information only when the PTP Mode is set to Follower.

Click **Show Details** to see the information. The button changes to Hide Details.

PTP 1

Mode Follow

State Tracking

Time (TAI) 2023-04-19 20:08:12

IPv4 Address 192.168.2.50

Domain 120

Hide Details

Profile SMPTE ST 2059-2

Communication Model Multicast

GM Clock Identity 00:90:56:FF:FE:01:0F:AB

GM Clock Class 6

GM Clock Accuracy Within 100 ns (0x21)

GM Time Source GNSS

Offset From Master -6 ns

Path Delay 2.11 μs

Leader-Follower Delay 2.12 μs

Follower-Leader Delay 2.12 μs

	Instant.	Average
Announce Rate	1	1
Sync Rate	17	16
Delay_Req Rate	6	7
Delay_Resp Rate	6	7

SMPTE Synchronization Metadata

Frame Rate 60000/1000

Locking Status Locked

Time Address Flags Non drop-frame, Color Frame ID not in use

Local Offset -07:00:37

Next Jump Time 2023-11-05 09:00:37

Jump Seconds -3600

Next Jam Time 2023-04-20 07:00:37

Previous Jam Time 2023-04-19 07:00:37

Previous Jam Offset -07:00:37

Daylight Saving Current DST in effect, Next jump not in effect, Previous jam in effect

Leap Second Other

Profile

Displays the PTP profile in use for this instance: SMPTE ST 2059-2, AES67, or IEEE 1588-2019 Default

Communication Model

Displays the communication model in use by the profile:

- Multicast: All PTP messages are sent using the assigned multicast IPv4 destination address for PTP (224.0.1.129).
- Unicast: All PTP messages are sent to specific IPv4 destination addresses.
- Mixed Multicast/Unicast: Leaders use multicast for Announce, Sync, Follow_Up, and Management messages. Followers use unicast for Delay_Req messages and the leader also sends the Delay_Resp message as unicast.

GM Clock Identity

Displays the clock identity information that was sent in the Announce message from the leader. See [Clock Identity](#).

GM Clock Class

Displays the clock class information that was sent in the Announce message from the leader. See [Clock Class](#).

GM Clock Accuracy

Displays the clock accuracy information that was sent in the Announce message from the leader. See [Clock Accuracy](#).

GM Time Source

Displays the time source information that was sent in the Announce message from the leader. See [Time Source](#).

Offset From Master

Displays the current Offset From Master measurement, defined as the time error between the lead clock and the follower clock as calculated from the PTP message timestamps. This can be a positive or negative offset, ideally close to zero. A stable PTP lock typically has an Offset From Master value of 100 nanoseconds or less.

Path Delay

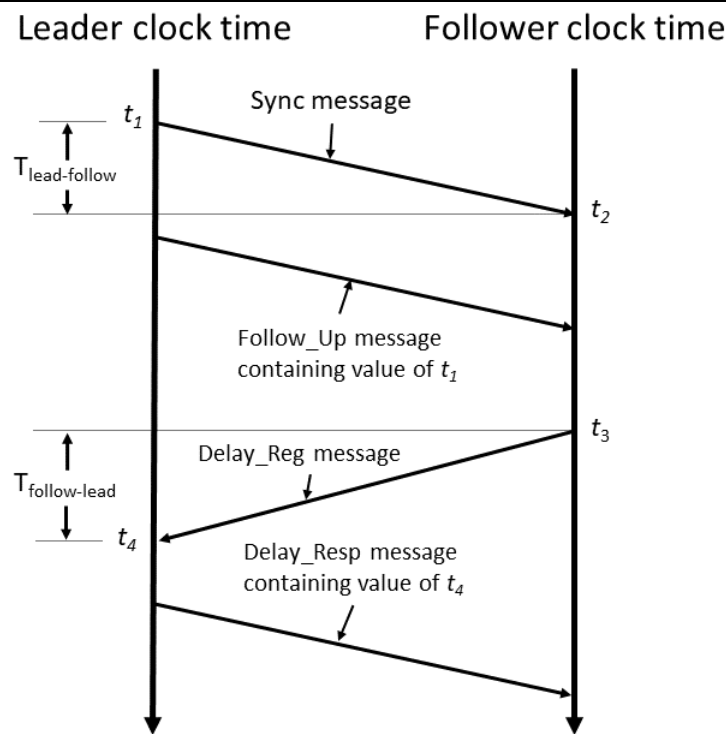
Displays the current Path Delay measurement, defined as the mean of the Leader-Follower Delay and Follower-Leader Delay measurements. Typically, these delay values are a few microseconds or less.

Leader-Follower Delay

Displays the current Leader-Follower Delay measurement, computed from the timestamps used with Sync and Follow_Up messages. The leader-follower delay is $t_2 - t_1$. See the messages example illustration.

Follower-Leader Delay

Displays the current Follower-Leader Delay measurement, computed from the timestamps used with Delay_Req and Delay_Resp messages. The follower-leader delay is $t_4 - t_3$. See the messages example illustration.



Announce Rate

Displays the instantaneous and average message rates for Announce messages received from all leaders. This rate can be used to verify that messages are being received from at least one leader and at the expected rate.

Sync Rate

Displays the instantaneous and average message rates for Sync messages received from all active leaders.

Delay_Req Rate

Displays the instantaneous and average message rates for Delay_Req messages received from visible followers.

Delay_Resp Rate

Displays the instantaneous and average message rates for Delay_Resp messages received from all leaders.

Note: All messages received on the Ethernet port are counted, including those from other domains.

SMPTE Synchronization Metadata

This table displays the values decoded from the most recent Management message received with the SMPTE 2059-2 Synchronization Metadata (SM) TLV. The PTP profile must be set to ST 2059-2 for this data to be sent from the leader and received by the follower.

System Status

The System section at the bottom of the Status tab displays diagnostic information for the instrument hardware.



Hardware Status

Indicates if the system is operating normally, or if there are any hardware faults or warnings. Select **Show Details** to open a panel with detailed diagnostic information, including:

- Power-On Self Test (POST) results
- Voltage measurements
- Fan speed measurements
- Temperature sensor measurements
- Oven-controlled MEMS oscillator diagnostic values
- Phase-locked loop (PLL) diagnostic values
- Real-time clock (RTC) battery status
- Other internal diagnostic values

If any values are displayed with a Warning or Error indicator, as in the example, the user might need to contact Telestream Technical Support.



Note: The error indicator is displayed when operating with two power supplies but only one supply is connected to the power source. Connect the second supply to the power source to clear the error condition. If the error indicator is still displayed after the power source is connected to both supplies, replace the faulty supply.

Power Supplies

Shows the state of the power supply modules in the instrument. See [Power Supply Monitoring and Replacement](#) for information on power supply operation.

Select **Show Details** to open a panel with power supply information:

- Which power supply is active
- Number of hours in which the power supply was active or on standby
- Load test history

Reference and Time Sources

This section describes the frequency and time-of-day references for the SPG9000 and how they are used to provide synchronization of its various outputs.

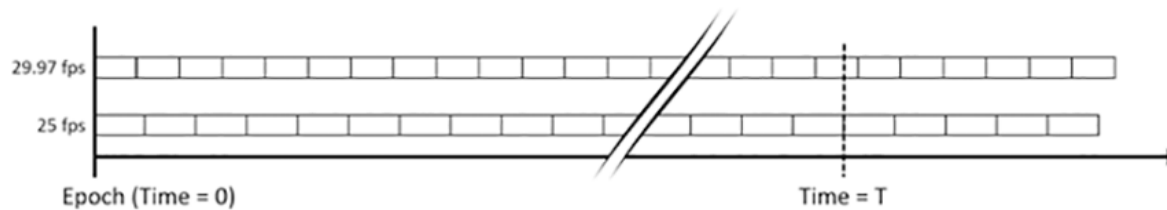
Theory of Operation

The SPG9000 functions by synchronizing its internal clock to a stable frequency source and an accurate time-of-day source. Its outputs are in turn synchronized to that internal clock, ensuring that all devices locked to the SPG9000 are all synchronized with each other.

Epoch-Based Synchronization

The SPG9000 uses epoch-based synchronization. An epoch is a fixed moment in time that is an absolute reference for subsequent events. The SMPTE epoch (defined in ST 2059-1) and the PTP epoch (defined in IEEE 1588-2019) are both 00:00:00 on January 1, 1970 TAI (*Temps Atomique International*). At this time, we can consider video and audio signals of various formats and frame rates to all be aligned with each other.

A video signal with a frame rate of 29.97 (30/1.001) frames per second has a frame duration of about 33.367 ms, but video of 25 fps has a frame duration of 40 ms. At the epoch, and exactly every 1001 seconds afterwards, the two frame sequences are aligned. At any arbitrary time relative to the epoch, we can precisely compute the expected phase of these (or any other) frame rates.



The SPG9000 uses a main time-of-day (MTOD) value that represents the integer and fractional number of seconds since the epoch. For example, a time value of 1677608972.00000000 corresponds to February 28, 2023 at 18:29:32 TAI. TAI time does not include leap seconds, and as of 2023, UTC time is behind TAI by exactly 37 seconds.

When the SPG9000 is synchronized to a GNSS signal it receives a pulse-per-second (1 PPS) signal and a time-of-day value in a data message from its internal GNSS receiver. When synchronized to another PTP grandmaster, it computes the time-of-day value from the exchange of PTP messages. In either case, the SPG9000 adjusts its own MTOD to align with the externally received time so the seconds of the MTOD increment at the same time as the 1 PPS signal.

The SPG9000 also uses three frame-reset signals to synchronize its outputs (Black, LTC, SDI) that can be set to different frame rates:

Frame Reset	Clock Rate	Video Format or Frame Rate (fps)
1	2.997 Hz	NTSC, 29.97, 59.94, 23.98, 47.95

Frame Reset	Clock Rate	Video Format or Frame Rate (fps)
2	6.250 Hz	PAL, 25, 50
3	3.000 Hz	24, 30, 48, 60

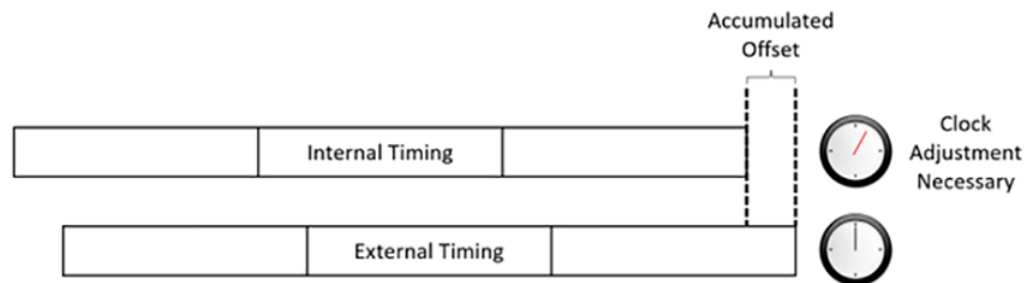
When locked to an absolute time source or when in internal mode, the three frames are all aligned as if they started at the epoch. This enables the frames to have predictable and consistent timing relationships and line up every 4004 seconds.

Phase Adjustment

When the SPG9000 is initially powered up and locks to the external reference, there is a phase difference between the external and internal clocks. The SPG9000 forces the internal clock to match the external reference for the initial lock and a quick startup.

When the instrument is locked to an external reference source, its internal clock is continually and slowly adjusted to align with the external reference clock. These adjustments are small so the SPG9000 remains locked without any sudden synchronization or abrupt phase changes.

Afterward, in normal operation, there could be a disruption to the external reference, such as GNSS signal loss. In this case the SPG9000 goes into holdover mode and uses its internal clock to maintain the timing based on the signal history just before signal loss. If the instrument remains in holdover mode for an extended period, a timing offset from the external reference accumulates.



When the external reference is restored, the SPG9000 finds the actual offset between its internal clock to the reference source. The SPG9000 then goes into holdover recovery mode to re-align the internal clock to the reference clock. The SPG9000 can slowly make this adjustment within clock tolerances that are compliant with SMPTE standards or the SPG9000 can force the adjustment for instant recovery. The stay legal mode (adjustment-within-clock-tolerances method) can take a long time to recover (about 300 seconds for 64 μ s line of timing error) but no synchronization shock occurs.

Reference Sources

There are four choices for the Reference source of the instrument.

Internal

The system uses its internal oven-controlled MEMS oscillator as the timing reference for the instrument. External devices can synchronize to this SPG9000 and synchronize relative to each other, but the SPG9000 itself has independent timing relative to any unconnected devices.

Genlock Input

The system uses the video sync signal received at the loop-through connectors labeled REF LOOP, typically a NTSC or PAL black burst analog video signal, an HD tri-level signal, or a 10 MHz continuous wave (CW) signal. See [Genlock Reference](#).

GNSS Signal

The system uses the PPS output from an integrated GNSS receiver as the timing reference for the instrument. See [GNSS Receiver Settings](#) for configuring the GNSS receiver.

Note: The SPG9000-GNSS option must be licensed for this reference source to be available.

PTP Follower

The system uses an internal PPS signal that is synchronized to an external PTP grand-master. This source is only available if at least one of the PTP instances is configured as a follower. See [Configuration Settings for PTP Instances](#).

Note: The SPG9000-PTP option must be licensed for this reference source to be available.

Time-of-Day Sources

The SPG9000 maintains a main time-of-day (MTOD) value that represents the current TAI time. An accurate time-of-day source is necessary for epoch-based synchronization as described above. The MTOD can be modified by various offsets when creating time code outputs. For example, the leap seconds offset is added to TAI time to create UTC time, then a time-zone offset and a daylight-saving-time offset could be applied to the MTOD to create the local time.

There are five options for the MTOD source. The time-of-day source is constrained by the reference source, with seven combinations possible:

Reference	Time-Of-Day Source	Notes
Internal	Internal	
	LTC Input	Only available when LTC 1 is configured as Input. See LTC 1 Mode .
Genlock Input	Internal	
	VITC Input	Only available when Genlock Input format is NTSC or PAL. See Configuration Settings for Genlock Input .
	LTC Input	Only available when LTC 1 is configured as Input. See LTC 1 Mode .
GNSS Signal	GNSS Signal	
PTP Follower	PTP Follower	

Internal

The system uses a user-supplied date and time value that is entered from the front panel interface, the web interface, or the application programming interface. When set, the MTOD is accurately changed each second. The internal time is maintained by a battery-backed, real-time clock (RTC) that preserves the time when the system is powered off. The RTC is automatically updated with the time when the system initially locks to a GNSS signal or PTP leader.

VITC Input

The system reads the date and time from the vertical interval time code (VITC) decoded from the received genlock input signal. The genlock input format must be NTSC Burst or PAL Burst because other genlock input formats (HD tri-level or CW 10 MHz) do not carry VITC data. If the time code only includes time information (hours, minutes, seconds, and frames) but not the date information (year, month, and day), according to SMPTE ST 309, the internal date (from the RTC) is used.

LTC Input

The system reads the date and time from the linear time code (LTC) signal received on the LTC 1 pins of the LTC/GPI connector. See [LTC/GPI Connector](#). LTC 1 can be configured as input or output (see [LTC 1 Mode](#)) and therefore must be set to input for this time source to be available. If the time code only includes time information (hours, minutes, seconds, and frames) but not the date information (year, month, and day), according to SMPTE ST 309, the internal date (from the RTC) is used.

GNSS Signal

The system uses the date and time information decoded from the received GNSS signal. This time-of-day source is automatically selected and is the only option when the reference source is set to GNSS Signal.

Note: The SPG9000-GNSS option must be licensed for this reference source to be available.

PTP Follower

The system uses the date and time data received from the PTP follower instance. This time-of-day source is automatically selected and is the only option when the reference source is set to PTP Follower.

Note: The SPG9000-PTP option must be licensed for this reference source to be available.

Reference and Time Sources

The reference and time-of-day sources are closely related, and should be configured together.

Web Interface for Reference

On the SPG9000 web interface, click the **Reference** tab.

telestream SPG9000

Version 1.0

API Documentation

Log Out

INT

EXT

TIME

X-REF

GM 1

GM 2

FAULT

PWR 1

PWR 2

Status

Reference

Time

PTP

Black

LTC

System

Reference

Primary Source

Genlock Input

Loss of Lock Action

Stay at Current Frequency

Holdover Recovery

Stay Legal

Genlock Input

Format

NTSC Burst

Lock Action Mode

Auto

Lock Now

Genlock Timing

Vertical Delay

0

lines

Horizontal Delay*

0.00000

µs

* Includes both coarse and fine timing adjustment.

GNSS Receiver

GNSS Constellation

GPS + BeiDou + Galileo + GLONASS

Antenna Power

Off

Cable Delay

0.00

µs

Position

Fixed

Reacquire Fixed Position

Signal Warning Threshold

Locked Warning

Front Panel Menu for REFERENCE

To use the front panel of the SPG9000 for this process, press **REF**. See [Menu Operations](#) for details of using the front panel menus. The table shows the submenus for the REFERENCE menu.

REFERENCE :	
SOURCE	
GENLOCK :	Only available if SOURCE is Genlock Input
LOSS OF LOCK ACTION :	Not available if INPUT FORMAT is Internal
HOLDOVER RECOVERY	Not available if INPUT FORMAT is Internal
PTP FOLLOWER	Only available if INPUT FORMAT is PTP Follower
GNSS RCVR :	Requires SPG9000-GNSS license to be enabled

Configuration Overview

Setting the reference and time-of-day sources to the configuration is a multi-step process for each of the four reference sources:

Set GNSS Signal Source

1. Configure the GNSS receiver. See [GNSS Receiver Settings](#). Wait for a Locked signal. See [GNSS Status Value](#).
2. On the Reference tab, in Primary Source, select **GNSS Signal**. The time-of-day source automatically changes to GNSS Signal.
3. Set the [Loss of Lock Action](#) and [Holdover Recovery](#) behavior.

Set PTP Follower Source

1. Configure one or both of the PTP instances as a follower or Ordinary Clock. See [Configuration Settings for PTP Instances](#). Wait for the PTP instances to reach the Tracking state. See [PTP Status](#).
2. On the Reference tab, in Primary Source, select **PTP Follower**. The time-of-day source automatically changes to PTP Follower.
3. If both PTP instances are configured as followers, configure the single or dual follower modes. See [PTP Follower](#).
4. Set the [Loss of Lock Action](#) and [Holdover Recovery](#) behavior.

Set Genlock Input Source

1. On the Reference tab, in Primary Source, select **Genlock Input**.
2. Configure the [Configuration Settings for Genlock Input](#) including Genlock Timing.
3. Set the [Loss of Lock Action](#) and [Holdover Recovery](#) behavior.
4. If LTC Input is the required time-of-day source, configure the LTC 1 connector pins to Input mode. See [LTC 1 Mode](#).
5. On the SPG9000 web interface, click the **Time** tab.
6. In Primary Reference, select one of VITC Input, LTC Input, or Internal.
7. Configure the time code input settings if applicable. See [LTC/VITC Mode](#) and [SMPTE 309 Data](#).
8. Set the [Internal Date/Time](#) if applicable.

Set Internal Source

1. On the **Reference** tab, in Primary Source, select **Internal**.
2. If LTC Input is the required time-of-day source, configure the LTC 1 connector pins to Input mode. See [LTC 1 Mode](#).
3. On the SPG9000 web interface, click the **Time** tab.
4. In Primary Reference, select either LTC Input or Internal.

- 5. Configure the time code input settings if applicable. See [LTC/VITC Mode](#) and [SMPTE 309 Data](#).
- 6. Set the [Internal Date/Time](#) if applicable.

Configuration Settings for Reference

The reference settings are configured from the Reference tab of the web interface.

Reference

Primary Source

PTP Follower

PTP Follower

Dual Follower, Port 1 Priority

Loss of Lock Action

Stay at Current Frequency

Holdover Recovery

Stay Legal

To use the front panel for this process, see [Front Panel Menu for REFERENCE](#).

Primary Source

Selects the current reference source for the instrument, as described in the [Reference Sources](#).

Reference	Time-Of-Day Source	Notes
Internal	Internal	
	LTC Input	Only available when LTC 1 is configured as Input. See LTC 1 Mode .
Genlock Input	Internal	
	VITC Input	Only available when Genlock Input format is NTSC or PAL. See Format .
	LTC Input	Only available when LTC 1 is configured as Input. See LTC 1 Mode .
GNSS Signal	GNSS Signal	
PTP Follower	PTP Follower	

The GNSS Signal option is only available if the SPG9000-GNSS license is enabled. The PTP Follower option is only available if the SPG9000-PTP license is enabled, and at least one PTP instance is configured as a follower. See [Configuration Settings for PTP Instances](#).

PTP Follower

Selects how PTP instances are used for the reference source. This setting is only applicable when the reference source is set to PTP Follower. If only one PTP instance is set to follower mode, that instance is used. If both PTP instances are available as followers, then this setting determines which instance (or both) is used for the reference source.

PTP 1 Only or PTP 2 Only: Uses the specified instance as the reference source. The other PTP instance still operates as a follower and takes performance monitoring measurements if it is tracking its leader. This is useful if the user wants the second PTP instance strictly as a monitoring node on the PTP network.

Dual Follower, Port 1 Priority or Dual Follower, Port 2 Priority: Uses either instance as the reference source, with the specified instance as the preferred source. This selection is useful when redundant networks are used, such as with SMPTE ST 2022-7. If the preferred PTP follower loses its lock, the other instance becomes the reference source. The instrument goes into holdover mode briefly during this transition. If both instances lose their PTP lock, the instrument enters holdover mode. If one instance relocks to its PTP grandmaster, it resumes its role as the reference source. If both instances relock, the priority instance is the reference source.

Loss of Lock Action

Selects the instrument's behavior when a loss of lock event occurs. This setting is not applicable when the reference source is set to Internal.

Stay at Current Frequency: Sets the system timing to keep operating at the current frequency from just prior to the loss of lock event. This mode is called Stay Genlock™ when the reference source is Genlock Input, and *holdover* when the reference source is either GNSS Signal or PTP Follower.

Use Internal Frequency: Sets the system timing to use the internal clock at the frequency of the current calibration until the reference source is recovered.

Holdover Recovery

Selects the instrument's behavior when the reference signal is restored after a loss of lock. This setting is not applicable when the reference source is set to Internal.

Stay Legal: Adjusts the system clock to match the external reference while staying within the specified frequency offset and frequency rate of change specifications for NTSC and PAL reference signals.

Jam Phase: Adjusts the system clock to match the external reference immediately. This causes a synchronization shock to the system.

Fast Slew: Adjusts the system clock to match the external reference at a rate 25 times faster than the Stay Legal rate, but does not jam and cause synchronization shock.

Web Interface for Time of Day

On the web interface, click the **Time** tab.

Time of Day

Primary Source

Internal

Internal Date/Time

01/01/2023

12:00:00 AM

Time Zone Offset

-08:00

Front Panel Menu for TIME OF DAY

To use the front panel of the SPG9000 for this process, press **TIME** and then select the **TIME OF DAY** option. See [Menu Operations](#) for details of using the front panel menus. The table lists the menus for TIME OF DAY.

TIME :

TIME OF DAY :

SOURCE :

INTERNAL

Only available if SOURCE is Internal

TIME CODE MODE :

Only available if SOURCE is LTC Input or VITC Input

ST 309 DATA :

Only available if SOURCE is LTC Input or VITC Input

TIME ZONE OFFSET :

DST SCHEDULE :

PROGRAM TIME :

JAM SYNC :

LEAP SECOND :

Configuration Settings for Time of Day

Configuring the time of day provides a point of reference for the SPG9000. There are several potential sources for this and several aspects of the internal time.

Primary Source

Selects the current time source for the instrument, as described in [Time-of-Day Sources](#). When the reference source is changed, the time-of-day source can be coerced to a valid combination. For example, if the reference source is changed to GNSS Signal, the time source also changes to GNSS Signal. Choose the required reference source before choosing the time-of-day source.

Internal Date/Time

Sets the main time-of-day (MTOD) and the internal real-time clock (RTC) to the specified date and time. These values can only be set manually if the time source is Internal.

Time Zone Offset

Sets the offset from UTC (in hours and minutes) for the local time zone. A leading plus or minus sign represents time zones west or east of UTC respectively. For example, an offset of +01:00 would be used for Central European Time (CET) and an offset of -05:00 would be used for Eastern Standard Time (EST).

LTC/VITC Mode

Selects the synchronization mode when time code (either LTC or VITC) is used as the time-of-day source. This setting is only available if the time-of-day source is either LTC Input or VITC Input.

The screenshot shows a configuration panel titled "Time of Day". It contains four settings, each with a label and a dropdown menu:

- Primary Source:** Set to "LTC Input".
- LTC/VITC Mode:** Set to "Follow".
- SMPTE 309 Data:** Set to "Ignore".
- Time Zone Offset:** Set to "+00:00".

To the right of these settings is a button labeled "Synchronize Now".

Follow: The time of day follows the time code on the input signal if the signal is stable for at least 100 consecutive frames. If the time code input has any discontinuity, the MTOD also jumps to the new value.

Synchronize Once: The time code on the input signal is continuously monitored until a stable signal is received (at least 100 consecutive frames). At that time, the time of day synchronizes (once) to this reference. After that, the MTOD counts according to the internal clock.

Synchronize Now: The time of day attempts to synchronize with the time code on the input signal when the user clicks the Synchronize Now button. A total of ten attempts to synchronize are made. After ten attempts, no further attempts are made to synchronize regardless if synchronization occurred or failed. A stable signal of at least 100 consecutive frames is needed.

SMPTE 309 Data

Sets the mode for handling date and time zone information that can be present in the time code data according to the SMPTE ST 309M standard. This setting is only available if the time-of-day source is either LTC Input or VITC Input.

Ignore: The hours, minutes, seconds, and frames digits of the time code input are used to set the MTOD, but the date and time zone information from the time code

input are ignored. The date from the internal real-time clock and the user-specified time zone offset are used instead. This setting is appropriate if the received time code input lacks the date and time zone information, which is possible because SMPTE ST 309M is not mandatory for ST 12 time code.

Use as Input: The date, time zone, and daylight saving information from the time code input are used to set the MTOD (along with the hours, minutes, seconds and frames digits). For example, if the received time code value is 2023-01-01 20:00:00 with a signaled time zone offset of UTC−08:00, the MTOD is set to 2023-01-02 04:00:37 (TAI). The extra 37 seconds represents the offset from UTC (time code input) and TAI (uses for MTOD). However, in this mode the time code data on LTC and VITC outputs are recalculated using the user-specified time zone offset and any daylight saving time offset. This mode is useful if the incoming time code data is from a different time zone than the outputs the user intends to create.

Use as Output: The date, time zone, and daylight saving information from the time code input are used to set the MTOD. The information is also used for time code outputs. The user-specified time zone offset is ignored. This mode ensures that time code outputs match the time code input.

Genlock Reference

When the reference source is set to Genlock Input, additional configuration is necessary. The Genlock Input settings are configured from the Reference tab on the web interface and from the REFERENCE : GENLOCK submenu from the front panel interface.

Web Interface for Genlock Input

On the web interface, click the **Reference** tab and set the Primary Source to **Genlock Input**. The sample shows a Genlock Input section with additional configuration settings.

Genlock Input

Format

NTSC Burst

Lock Action Mode

Auto

Lock Now

Genlock Timing

Vertical Delay

0

 lines

Horizontal Delay*

0.00000

 μ s

* Includes both coarse and fine timing adjustment.

Front Panel Menu for GENLOCK

To use the front panel of the SPG9000 for this process, press **REF** and then select the **GENLOCK** option. See [Menu Operations](#) for details of using the front panel menus. The table lists the menus for GENLOCK. The GENLOCK submenu is only available when the SOURCE is Genlock Input.

REFERENCE :	
SOURCE	
GENLOCK :	
INPUT FORMAT	
TIMING	Not available if INPUT FORMAT is 1 pps
Vertical	
Horizontal Coarse	
Horizontal Fine	
ACTION MODE	
MANUAL LOCK	
CW FRAME RESET	Only available if INPUT FORMAT is CW 10 MHz
LOSS OF LOCK ACTION	

REFERENCE :

HOLDOVER RECOVERY

GNSS RCVR : Requires SPG9000-GNSS license to be enabled

Configuration Settings for Genlock Input

The additional configuration of Genlock Input helps the SPG9000 use the incoming signal.

Format

Selects the expected format for the input signal received at the REF LOOP connector:

NTSC Burst: Sets the expected input format as NTSC black burst (525 lines at 59.94 interlaced fields per second). The signal can have a black level at either 7.5 IRE (NTSC-M) or 0 IRE (NTSC-J, as used in Japan).

PAL Burst: Sets the expected input format as PAL black burst (625 lines at 50 interlaced fields per second).

HD Tri-Level: Sets the expected input format as a tri-level sync signal. The SPG9000 supports genlock using one of several different tri-level formats:

1080 60i	1080 30p	1080 24sF	720 60p
1080 59.94i	1080 29.97p	1080 23.98sF	720 59.94p
1080 50i	1080 25p		720 50p
	1080 24p		
	1080 23.98p		

The instrument automatically detects the specific frame rate, scan type (interlaced, progressive, or segmented frame), and number of lines (1080 or 720) for the input HD tri-level signal.

CW 10 MHz: Sets the expected input format as a continuous wave (CW) signal at 10 MHz frequency.

Lock Action Mode

Selects the behavior after a loss of lock condition and the system is able to relock to the genlock input signal.

Auto: The instrument automatically relocks to the genlock input signal when possible. This could potentially cause a disruption (synchronization shock) to the system timing.

Manual: The instrument waits for the user to manually relock. This mode is useful to avoid synchronization shock at an inconvenient time. While waiting for approval,

the EXT indicator (on the front panel and the web interface banner) is red, and the reference status on the web interface shows "Unlocked - Waiting for Manual Lock". Click **Lock Now** to force the genlock.

CW Frame Reset

Selects the frame reset to use to adjust the phase of the 10 MHz CW signal. This is only available when the Format is set to CW.

The screenshot shows the 'Genlock Input' section with the following settings: Format is set to 'CW' (dropdown), Lock Action Mode is set to 'Auto' (dropdown), and there is a 'Lock Now' button. The 'CW Frame Reset' dropdown is set to '2.997 Hz: NTSC, 59.94, 23.98 Hz Group'. Below this is the 'Genlock Timing' section with 'Vertical Delay' set to '0' lines and 'Horizontal Delay*' set to '0.00000' μ s. A note below the horizontal delay field states: '* Includes both coarse and fine timing adjustment.'

2.997 Hz: NTSC, 59.94, 23.98 Hz Group: Selects frame reset 1.

6.250 Hz: PAL and 50 Hz Group: Selects frame reset 2.

3.000 Hz: 60 and 24 Hz Group: Selects frame reset 3.

Note: For best results we recommend the 6.250 Hz (frame reset 2) option.

Genlock Timing

The Genlock Timing settings adjust the timing offset of the SPG9000 clock relative to the input signal. The selections are only available when the reference source is set to Genlock Input.

The total timing offset is a combination of whole lines (vertical delay) and partial lines (horizontal delay). A negative value means the clock is advanced relative to the genlock input.

Vertical Delay

Enter an integer number of lines in 1-line increments.

Horizontal Delay

Enter the delay value in microseconds.

The front panel interface has two adjustment menus for entering the horizontal delay value. (For detail on how to use the menus, see [Adjustment Menus](#).) Go to the REFERENCE : GENLOCK : TIMING menu and the Horizontal Coarse sub-menu can be used to make adjustments in step sizes of one frame clock interval. The Horizontal Fine sub-menu can be used to make further adjustments in step sizes of 0.01 nanoseconds.

The web interface has a single text box for the combined Horizontal Delay.

The range of the timing adjustment depends on the selected signal format:

Format	Vertical (lines)	Horizontal Coarse (μ s)	Horizontal Fine (ns)
NTSC	± 525	± 63.5556	± 10.00
PAL	± 1250	± 64.0000	± 10.00
1080 60i	± 562	± 29.6296	± 7.00
1080 59.94i	± 562	± 29.6593	± 7.00
1080 50i	± 562	± 35.5556	± 7.00
1080 30p	± 562	± 29.6296	± 7.00
1080 29.97p	± 562	± 29.6593	± 7.00
1080 25p	± 562	± 35.5556	± 7.00
1080 24p	± 562	± 37.0370	± 7.00
1080 23.98p	± 562	± 37.0741	± 7.00
1080 24sF	± 562	± 37.0370	± 7.00
1080 23.98sF	± 562	± 37.0741	± 7.00
720 60p	± 375	± 22.2222	± 7.00
720 59.94p	± 375	± 22.2444	± 7.00
720 50p	± 375	± 26.6667	± 7.00
CW 10 MHz	± 1125	± 64.0000	n/a

When the genlock input format is CW 10 MHz, timing adjustments are with respect to the selected [CW Frame Reset](#).

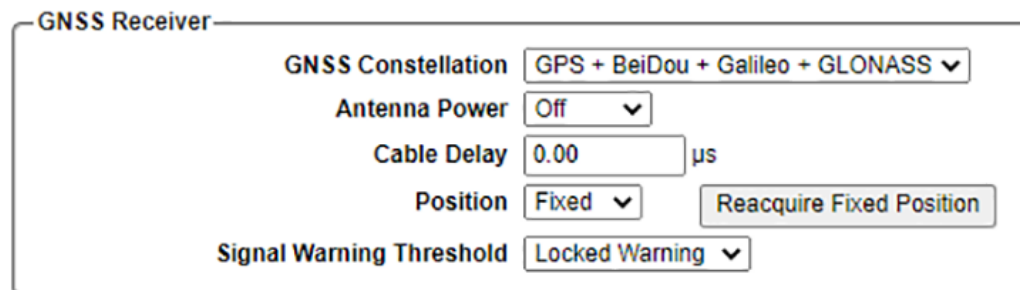
GNSS Receiver Settings

If the reference source is set to GNSS Signal, additional configuration of the internal GNSS receiver might be necessary.

Note: The SPG9000-GNSS license must be enabled for these menus to be available.

Web Interface for GNSS Receiver

On the SPG9000 web interface, click the **Reference** tab.



GNSS Receiver

GNSS Constellation

Antenna Power

Cable Delay µs

Position

Signal Warning Threshold

Front Panel Menu for GNSS RCVR

To use the front panel of the SPG9000 for this process, press **REFERENCE** and then select the **GNSS RCVR** option. See [Menu Operations](#) for details of using the front panel menus. The table lists the menus for GNSS RCVR.

REFERENCE :

SOURCE

GENLOCK :

LOSS OF LOCK ACTION :

HOLDOVER RECOVERY

PTP FOLLOWER

GNSS RCVR :

Requires SPG9000-GNSS license to be enabled

CONSTELLATION

ANTENNA POWER

CABLE DELAY

POSITION

ACQUIRE POSN

SIGNAL WARNING

Configuration Settings for GNSS Receiver

The additional configuration of the GNSS receiver helps the SPG9000 find and track the satellite and satellite signal.

GNSS Constellation

Selects the satellite constellation to track. The SPG9000 can receive data from up to four different global navigation satellite systems and one regional system:

GNSS	System Name	Operator	Coverage
GPS	Global Positioning System	United States	Global
GLONASS	Global Navigation Satellite System	Russia	Global
Galileo	Galileo	European Union	Global
BeiDou	BeiDou Navigation Satellite System	China	Global
QZSS	Quasi-Zenith Satellite System	Japan	Regional (Asia-Oceania, centered around 135° E longitude)

Select one of the specific combinations of available systems:

- GPS Only
- BeiDou Only
- Galileo Only
- GPS + GLONASS
- GPS + BeiDou
- GPS + Galileo
- GPS + QZSS
- GPS + BeiDou + Galileo + GLONASS

For most applications, the GPS + BeiDou + Galileo + GLONASS selection is the best choice because more satellites are available to compute the timing solution.

Antenna Power

Selects the power setting for the GNSS Antenna connector on the rear panel:

Off: No power is supplied to the GNSS antenna

3.3 Volt: Supplies 3.3 V DC to power the GNSS antenna

5 Volt: Supplies 5 V DC to power the GNSS antenna

CAUTION: To avoid antenna damage, do not turn on the DC antenna power until you know the antenna is designed to handle the specific voltage. Antenna damage can occur if the antenna is not designed to handle the selected voltage.

When the GNSS ANT connector is configured to provide power to the antenna, the rear panel POWER indicator is on:

- Blinking green means an open circuit. This occurs if no antenna is connected or if the current load is less than expected because a splitter or DC block is being used.
- Solid red means the connected antenna is shorted. A shorted antenna does not damage the GNSS receiver. If a splitter is used on the antenna, it might appear as a short at DC but still pass through the RF signal, which would allow the internal GNSS system to function.
- Solid green means the current load of the antenna is within the nominal range.

Cable Delay

Sets a delay value to compensate for the cable length from the antenna to the instrument. The propagation delay depends on the cable type but is typically 5 nanoseconds per meter. The timing delay can be adjusted to a maximum of 99 microseconds. The delay value is negative to compensate for the positive delay from the physical cable.

Position

Selects the mode in which the GNSS receiver calculates time and position information:

Fixed: An averaged position is stored in flash memory, and only the time is calculated each second. This provides greater stability of the time information and allows operation with fewer satellites. This mode is well suited to installations such as a broadcast facility, where the antenna and instrument do not move.

Mobile: Recalculates both the position and time each second. This allows for compensation of velocity and acceleration, so the frequency and timing information stay correct while moving, at the expense of some stability. This mode is required if the antenna and instrument are moving, such as an electronic news gathering vehicle.

For applications where the position changes occasionally, but where the antenna and instrument are not moving, then either mode can be applicable. Mobile mode might start up faster since it does not need to average 60 fixes to establish a fixed location. However, fixed mode can operate with fewer satellites when the position is stored.

Signal Warning Threshold

Selects the GNSS status level below which a warning notification would occur. The warning appears as a message in the system log; see [Syslog](#). See [GNSS Status](#) for a complete list of status levels.

Locked Warning: The GNSS receiver is reporting possible jamming or spoofing of the received signal.

Locked Minimum: The GNSS signal has data from 4 or more satellites with a carrier-to-noise ratio (C/N) of 10 dB or better.

Locked Nominal: The GNSS signal has data from 4 or more satellites with C/N of 30 dB or better.

Locked Strong: The GNSS signal has data from 8 or more satellites with a carrier-to-noise ratio (C/N) of 40 dB or better

For example, if the threshold is set to Locked Warning, a notification occurs if the GNSS Status is in any of the unlocked states (from No Signal to Acquiring Position). If the threshold is set to Locked Strong, a notification occurs if the GNSS Status is any other state.

Daily Jam Sync

For installations that use drop-frame time code, such as NTSC black outputs with VITC, a daily jam sync event is required.

Drop-frame time code (defined in SMPTE ST 12-1) is used for non-integer frame rates, specifically 29.97 (30/1.001) and 59.94 (60/1.001) frames per second. In actuality, video frames aren't dropped; instead, the frame counter skips two counts every minute, except for every 10th minute. For example:

HH:MM:SS;FF	Description
12:06:23;29	30 fps time code normally counts frames from 00 to 29 each second. When the seconds digits change from 23 to 24, the frame counter rolls over from 29 to 00.
12:06:24;00	
...	
12:07:59;29	The 00 and 01 frame counts are skipped when the minutes digits change, in this case from 07 to 08. The frame digits skips from 29 to 02.
12:08:00;02	
...	
12:09:59;29	When the minutes digits change to 00, 10, 20, 30, 40, or 50, the frames digits do not skip 00 and 01, but roll over from 29 to 00.
12:10:00;00	

There are 107,892 frames counted in a time code hour, such as from 00:00:00;00 to 01:00:00;00, but the true frame rate of 30/1.001 results in approximately 107,892.108 frames per hour, that is, with 0.108 more fractional frames every hour. The drop-frame algorithm corrects for most of the difference between 30 fps count and 30/1.001 frame rate, but there is a small difference that accumulates approximately 2.6 frames every 24 hours.


To prevent that offset from diverging indefinitely, the solution is to perform a regular (daily) jam sync. At the scheduled time, 2 or 4 additional frame counts are skipped.

Web Interface for Jam Sync

On the SPG9000 web interface, click the **Reference** tab.

Jam Sync

Scheduled Jam Sync ☒ Enable

Scheduled Time 12:00 AM 

Synchronize now

Front Panel Menu for JAM SYNC

To use the front panel of the SPG9000 for this process, press **TIME** and then select **JAM SYNC**. See [Menu Operations](#) for details of using the front panel menus. The table lists the menus for JAM SYNC.

TIME :

TIME OF DAY :

DST SCHEDULE :

PROGRAM TIME :

JAM SYNC :

MANUAL

MODE

SCHEDULED TIME

LEAP SECOND :

Configuration Settings for Jam Sync

The jam sync configuration enables the jam sync and defines when it happens.

Scheduled Jam Sync

Select to enable a daily jam sync. We recommend this when using 30 fps drop-frame time code on any outputs, but is not needed when working exclusively with integer frame rates such as PAL and 25 fps.

Scheduled Time

Enter the local time of day (hours and minutes) for the daily jam sync. Typically, a time such as 02:00 am is used in broadcast applications, when the viewing audience is small. The selected time must have minutes digits of 00, 10, 20, 30, 40, or 50 past the hour.

Daylight Saving Time Management

In several parts of the world, daylight saving time (summer time) is in effect during warmer months so darkness occurs at a later time in the day. Typically, local clocks are advanced one hour in the spring and return to standard time (winter time) in autumn.

On the SPG9000, a daylight saving time offset is used (along with the time zone offset) to compute the local time that can be used in time code outputs.

Web Interface for Daylight Saving Time

On the SPG9000 web interface, click the **Time** tab.

Front Panel Menu for DST SCHEDULE

To use the front panel of the SPG9000 for this process, press **TIME** and then select the **DST SCHEDULE** option. See [Menu Operations](#) for details of using the front panel menus. The table lists the menus for DST SCHEDULE.

TIME :

TIME OF DAY :

DST SCHEDULE :

MODE

OFFSET

ONCE DATE/TIME

RECURRING START

RECURRING END

PROGRAM TIME :

JAM SYNC :

LEAP SECOND :

Configuration Settings for Daylight Saving Time

The daylight saving time configuration allows the SPG9000 to change the internal time as needed when DST starts and ends.

Scheduled Mode

Selects the daylight saving schedule mode used by the instrument:

Disable: No daylight saving time offset is used.

Once: At the specified time, the daylight saving offset is applied and the mode resets to Disable. That is, only a single time change is scheduled until the user sets a new schedule.

Recurring: Use the rules defined by the Recurring Start and Recurring End menus to keep an indefinite schedule of DST changes. We recommend this mode for most applications.

Offset

Enter the time offset (hours and minutes) to apply when the daylight saving event occurs. For the Once mode, the offset is applied a single time. Use a positive offset to advance the local clock to daylight saving time or a negative offset to return the local clock to standard time.

Once Date/Time

Enter the date and local time of day (hours and minutes) for the daylight saving time event to occur for Once mode.

Recurring Start

Enter the relative date and local time of day for daylight saving time to begin. The relative date is described using the day of the week and the ordinal number (for example First, Second, Last) of that day within the month. The rules (as of 2023) for daylight saving time in several parts of the world are listed:

Countries	Start	End
Most of United States and Canada	Second Sunday in March at 02:00	First Sunday in November at 02:00
European Union	Last Sunday in March at 01:00 UTC	Last Sunday in October at 01:00 UTC
Parts of Australia	First Sunday in October at 02:00	First Sunday in April at 03:00

Note: In European countries that observe daylight saving time, the local clocks change simultaneously at 01:00 UTC, which can be 01:00, 02:00, or 03:00 local time. Be sure to use local time when setting the DST start and end times on the SPG9000.

Recurring End

Enter the relative date and local time of day for daylight saving time to end.

Leap Second Management

A leap second is a one second adjustment that can be applied to UTC time to accommodate the difference between TAI time and the observed solar time, which varies due to irregularities in the earth's rotation. A leap second can be added at the discretion of the International Earth Rotation and Reference Systems Service (IERS). As of 2023, the most recent leap second was at the end of 2016.

Leap seconds are typically inserted just before 00:00:00 UTC on July 1 or January 1. For example, the positive leap second inserted at the end of 2016 resulted in a time sequence of:

2016-12-31 23:59:59	
2016-12-31 23:59:60	Normally the seconds digits would roll over from 59 to 00.
2017-12-31 00:00:00	

A hypothetical negative leap second would cause the time sequence to roll over from 23:59:58 to 00:00:00 (skipping the 59th second), but a negative leap second has never happened since the introduction of leap seconds in 1972.

If a leap second is scheduled to occur, it is signaled by GNSS data. GPS, Galileo, and BeiDou satellites send the date and time of the next leap second adjustment and the current number of leap seconds in their respective data messages. A "leap second pending" flag is set in the data message several months before the event. When the actual leap second occurs, the UTC offset is updated and the flag is cleared. A PTP grandmaster that is synchronized to GNSS can also signal this information to its followers using the SMPTE ST 2059 synchronization metadata.

Because leap second adjustments always happen at 00:00:00 UTC, this could be an inconvenient time for some applications. For example, that time would be 19:00 in the Eastern Time Zone of the United States and Canada, at the start of prime-time television programming. Therefore, the SPG9000 has the ability to postpone the adjustment by up to 24 hours. The user can choose a time such as 04:00 in the local time zone, when there are few viewers.

Web Interface for Leap Second

On the SPG9000 web interface, click the **Time** tab.

Leap Second

Mode Use GNSS Time (00:00 UTC) ▼

Scheduled Time 12:00 AM ⌚

Front Panel Menu for LEAP SECOND

To use the front panel of the SPG9000 for this process, press **TIME** and then select the **LEAP SECOND** option. See [Menu Operations](#) for details of using the front panel menus. The table lists the menus for LEAP SECOND.

TIME :

TIME OF DAY :

DST SCHEDULE :

PROGRAM TIME :

JAM SYNC :

LEAP SECOND :

MODE :

OFFSET :

Configuration Settings for Leap Second

The leap second configuration allows the SPG9000 to add the leap second when it is needed, for the least amount of disruption.

Mode

Select when the leap second adjustment should be made

Use GNSS Time (00:00 UTC): Use the default behavior of making the adjustment at 00:00 UTC, regardless of the local time zone.

Defer to Schedule Time: Defer the leap second adjustment up to 24 hours, to the specified local time.

Scheduled Time

Enter the local time (hours and minutes) for the leap second adjustment.

Program Time Counter

As an alternate to the time-of-day, a program time counter can be used as a time code source for any output. This counter can represent elapsed time, such as the time code associated with program content during the editing process.

The program time counter starts counting from the user-specified initial value. Program time can be reset to this value at any time using either the user interface or the API.

Web Interface for Program Time

On the SPG9000 web interface, click the **Time** tab.

The screenshot shows a web interface titled "Program Time". It contains the following elements:

- Initial Time**: A text input field with the value "01:00:00".
- Apply Initial Time Now**: A button to the right of the Initial Time field.
- Alarm**: A checkbox labeled "Enable" which is currently unchecked.
- Alarm Time**: A text input field with the value "00:00:00".

Front Panel Menu for PROGRAM TIME

To use the front panel of the SPG9000 for this process, press **TIME** and then select the **PROGRAM TIME** option. See [Menu Operations](#) for details of using the front panel menus. The table lists the menus for PROGRAM TIME.

TIME :

TIME OF DAY :
DST SCHEDULE :
PROGRAM TIME :
 RESET
 INITIAL TIME
 ALARM
 ALARM TIME
JAM SYNC :
LEAP SECOND :

Configuration Settings for Program Time

The program time configuration includes a reset of the time counter and alarms to note when the selected value is reached.

Initial Time

Set the initial time for the program time counter, in hours, minutes, and seconds (HH:MM:SS).

Apply Initial Time Now

Click to reset the program time counter to the initial value

Alarm

Check this box to enable the program time alarm. When the program time counter reaches the alarm time, a notification event is generated in the system log. See [Syslog](#).

Alarm Time

Enter the required program time counter value (in the format HH:MM:SS) to trigger the alarm.

PTP Operation

Precision Time Protocol (PTP) is defined by IEEE Std 1588™-2019, *IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems*. The protocol is used to synchronize clocks using an IP network.

The SPG9000 has two dedicated network interfaces for PTP. The instrument can operate as a leader or grandmaster (GM), providing accurate time-of-day to a set of followers that are synchronized to it, or it can operate as a follower to another GM. Each PTP instance can also be configured as an Ordinary Clock that adapts between leader and follower in response to other PTP devices on the network. As either a leader or a follower, the SPG9000 outputs (black burst, time code, etc.) are synchronized to PTP time.

Note: The SPG9000-PTP license must be enabled for the PTP ports to be operational.

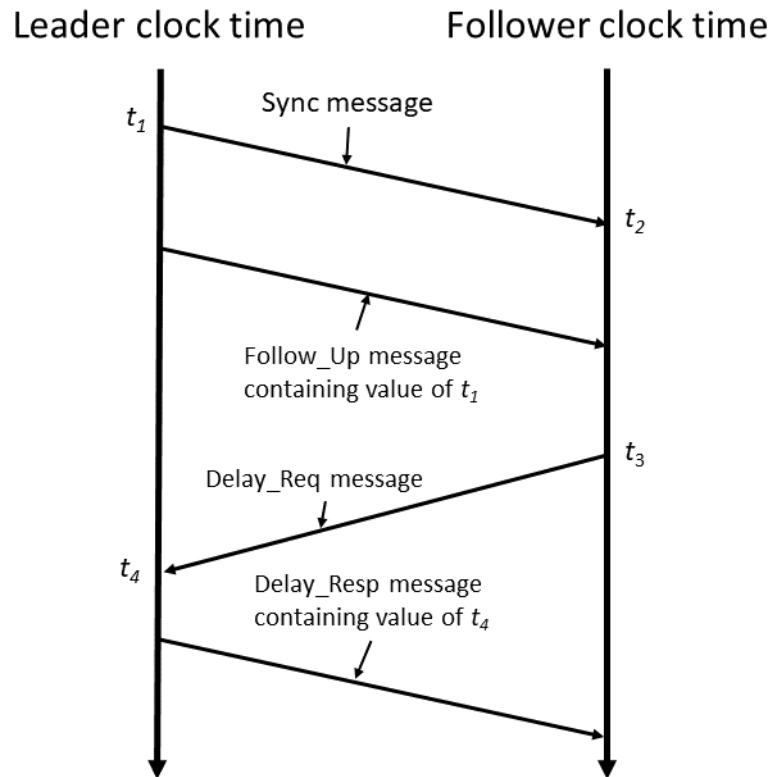
Theory of Operation

PTP operates by exchanges of IP messages between leaders and followers. Through these messages the time of the grandmaster clock is distributed to all other instances so they are all synchronized and share the same time.

A PTP instance is an implementation of the PTP protocol engine that is associated with one or more physical network interfaces. The SPG9000 has two PTP instances; each uses one network port. The two instances are independent of each other, and can operate in different modes and run at different interface speeds.

Messages Types

There are seven different PTP message types used by the PTP implementation in the SPG9000. Four timing messages (Sync, Follow_Up, Delay_Req, and Delay_Resp) are used to exchange time information between leaders and followers:



Sync

The Sync message is sent by the leader and is used to measure the propagation delay from the leader to follower. The Sync message might contain the timestamp indicating when it was transmitted, or that timestamp might be in the Follow_Up message. The receiver must timestamp the Sync message upon receipt. These two timestamps are

usually called t_1 and t_2 and provide the first delay measurement: leader-to-follower delay or $t_2 - t_1$.

Follow_Up

The Follow_Up message is sent when the PTP network hardware does not insert the t_1 timestamp into the Sync message. Instead, the t_1 timestamp is included in a corresponding Follow_Up message; this is called two-step operation. If the Sync message does include its t_1 timestamp, the Follow_Up message is not required; this is called one-step operation.

A leader instance on the SPG9000 uses two-step operation and sends both Sync and Follow_Up messages. A follower instance on the SPG9000 can operate with either one-step or two-step leaders.

Delay_Req

The Delay_Req message is sent by the follower. The timestamp at which it is transmitted (t_3) is noted by the follower but is not included in the message. When this Delay_Req message is received by the leader, it timestamps the receive time of the message as t_4 .

Delay_Resp

The Delay_Resp message is sent from the leader to the follower in response to the associated Delay_Req message. The response contains the t_4 timestamp from when the leader received the Delay_Req message. When the follower receives the Delay_Resp message, it has the second pair of timestamps needed to calculate the second delay measurement: follower-to-leader delay or $t_4 - t_3$.

Announce

The Announce message is sent by the leader to advertise its capabilities. This message contains the clock quality and priority settings needed for the [Best Master Clock Algorithm](#) to evaluate which instance is the best leader.

Management

Management messages are typically used by external systems to query and update data sets used by the PTP instance through in-band messaging. For the SPG9000, Management messages are used to broadcast synchronization metadata from the leader to its followers when the SMPTE ST 2059-2 profile is used. See [Synchronization Metadata](#).

Signaling

Signaling messages carry information, requests, and commands between PTP instances. For the SPG9000, Signaling messages are used only for unicast negotiation. See [Unicast](#).

IEEE 1588-2019 also defines three other PTP message types (Pdelay_Req, Pdelay_Resp, and Pdelay_Resp_Follow_Up) that are used for the peer-to-peer delay mechanism. These are not used by the SPG9000; it only utilizes the end-to-end delay mechanism.

Domains

A PTP domain is a set of PTP instances that are synchronized to the grandmaster of the domain. The domain number is used to identify all the devices within this set.

Multiple domains may coexist on the same physical network. For example, on a given network, one leader and several followers can use domain 100 and a second leader and its followers use domain 101. The two domains are completely independent and can use different communication models and profiles if needed, such as SMPTE ST 2059-2 for media devices and AES67 for audio-only devices. With two PTP instances, the SPG9000 can be configured to use two different domains simultaneously.

Clock Types and Modes of Operation

PTP defines three types of clock devices:

Ordinary Clock: This is a PTP instance that has a single port in its domain. Both PTP instances of the SPG9000 are always Ordinary Clocks, as are PTP-capable audio-visual devices such as cameras or microphones.

Boundary Clock: This is a PTP instance that has multiple ports in its domain. This is typically a PTP-capable network switch in which one port is a follower to a leader and the other ports are leaders to followers. Boundary Clocks are frequently used—and strongly recommended—in larger broadcast and media networks.

Transparent Clock: This is a PTP instance (typically a PTP-aware network switch) that does not function as a leader or a follower but instead updates the time information in PTP messages that it forwards.

An Ordinary Clock may be constrained to only function in one of three modes:

Leader Only: The instance either serves as the grandmaster for the domain or it is a passive leader, ready to take over as the active grandmaster if the BMCA determines that it should.

Follower Only: The instance only synchronizes with a separate leader within the domain. If no leader is available, the instance listens for a new leader.

Ordinary Clock: The instance can adapt to network conditions and either follow a higher priority leader or it can become the leader for the domain.

Most media networks utilize a strict hierarchy with Leader Only devices serving as the active grandmaster or as passive backup leaders, and Follower Only devices at the

network edge. However, there are situations where the unconstrained Ordinary Clock mode is very useful.

For example, a large live stadium event may require multiple mobile production units, and accurate time from a GNSS signal may not be available in some vehicles. The SPG9000 in one vehicle can be set to Ordinary Clock mode and locked to a grandmaster in another vehicle that does have a GNSS time source. If that GM is dropped from the network, the Ordinary Clock can become the new leader and assume the GM role for the domain. Its time is continuous from the previous GM time source, even without the availability of a direct time source from GNSS.

Best Master Clock Algorithm

The Best Master Clock Algorithm (BMCA) is the mechanism PTP instances use to determine which of the potential leaders should be the active leader. PTP instances do not negotiate which instance should be the active leader; instead, they each independently use the BMCA to arrive at the same result.

The BMCA uses information sent by each leader in Announce messages. These values are compared across all leaders to determine the best leader. The comparisons are made in a specific order:

1. Priority 1 is a user-configurable number in the range 0-255. Priority values must be in the range 0-128 for the instance to become an active leader. Because this value is considered first by the BMCA, it takes precedence over all other values. This can force a device to be the active leader even if its clock is not the most accurate. Therefore, Priority 1 values are typically set to the same number (for example 128) for all potential leaders in the domain, to let clock quality metrics determine the best leader. More complex networks can use Priority 1 to define a specific fail-over sequence. For example, the SPG9000 grandmasters are configured with Priority 1 of 10, spine switches (Boundary Clocks) are configured with Priority 1 of 20, and leaf switches (also Boundary Clocks) are configured with Priority 1 of 30.
2. Clock Class is a number that indicates the current state and performance of the time and frequency source. Specific values are listed in Table 4 of IEEE 1588-2019. For example, the SPG9000 uses class 6 when it is locked to a GNSS signal and class 7 when it is in holdover mode after GNSS signal loss. A lower Clock Class number is better for BMCA purposes, so in this example an SPG9000 that is locked to GNSS is better than an SPG9000 currently in holdover mode.
3. Clock Accuracy is a number that represents a conservative estimate of the expected accuracy of the clock. Specific values are listed in Table 5 of IEEE 1588-2019. For example, when the SPG9000 is locked to a GNSS signal, it uses a Clock Accuracy value of 0x21 (hex), which corresponds to an estimate of "within 100 ns". If the SPG9000 is in holdover mode after GNSS signal loss, the Clock Accuracy changes to 0x26, or "within 25 μ s".
4. Variance, or Offset Scaled Log Variance, is an estimate of the inherent precision of the timestamps generated by the local clock. The SPG9000 uses a conservative value of 14848 for the Offset Scaled Log Variance value that is included in its

Announce messages, which corresponds to a variance measurement of about $8.5 \times 10^{-22} \text{ s}^2$.

5. Priority 2 is the second user-configurable number used by the BMCA. This value is typically used to designate primary, secondary, etc. leaders in a network with multiple leaders. The Priority 2 number is also in the range 0-255 (with a default of 128), with lower numbers representing higher priorities.
6. Clock Identity is the final tie-breaker when comparing PTP instances using the BMCA. Because the Clock Identity is created from the MAC address of the instance network interface, and MAC addresses are unique within a network, the Clock Identity of two devices should never be the same.

The Clock Class, Clock Accuracy, and Offset Scaled Log Variance values are collectively called the Clock Quality.

Communication Models

PTP can operate over several types of networks. The SPG9000 only uses Internet Protocol version 4 (IPv4) for message transport.

PTP messages are carried by User Datagram Protocol (UDP) packets using port 319 for event messages (Sync and Delay_Req) and port 320 for general messages (Announce, Follow_Up, Delay_Resp, Management, and Signaling).

Depending on the profile and mode, PTP can use one of three different communication models:

Multicast

Using IPv4 multicast, multiple hosts on the local network receive all messages destined for the multicast group address. Hosts use the Internet Group Management Protocol (IGMP) to join or leave specific multicast groups. The multicast group address for PTP is 224.0.1.129.

With full multicast operation, the leader can send one Announce, Sync, or Follow_Up message to the multicast group address and it is received by all followers. However, every exchange of Delay_Req and Delay_Resp messages between each follower and the leader is received by all instances.

The multicast communication model is the simplest model from a configuration perspective. A follower simply joins the PTP multicast group and it discovers the leader from the Announce messages it receives.

The leader sets the rate for the Announce and Sync messages that it sends. The leader also includes the maximum allowed Delay_Req message rate as a parameter within the Delay_Resp message. Ideally, the follower uses that value to set its Delay_Req message rate. This rate is typically the same as the Sync message rate.

Because any potential leader in a network receives multicast Announce messages from the active leader, it can use the BMCA to determine if it is better. If so, it sends its own Announce messages and transitions from passive to active state. The previous active

leader also receives the new Announce messages and also concludes that it is no longer the best leader. It stops sending Announce messages and transition to the passive state.

Unicast

Unicast operation is the usual method of point-to-point communication on IP networks, but for PTP there is additional configuration and additional complexity. Each follower is required to be configured with the Unicast Discovery List of the set of possible leaders.

When a unicast follower starts operation, it first sends a Signaling message to each address in the Unicast Discovery List. This message includes type-length-value (TLV) parameters to request the leader start sending Announce messages to the follower. The leader may grant or deny the request. If denied, the follower can try again by sending a new request with a slower message rate.

After the follower starts receiving Announce messages from one or more leaders, it uses the BMCA to determine the preferred leader. It then sends additional Signaling messages to that leader with TLVs to request the leader send Sync and Delay_Resp messages at the requested rates. Again, the leader might grant or deny those requests and the follower can try again with slower message rates. When the follower starts receiving Sync and Delay_Resp messages, it can synchronize with the leader clock.

Leaders using the unicast model do not communicate with each other. Therefore, the leaders do not use the BMCA and are in the active state as long as they are serving followers that have grants for Announce, Sync, and Delay_Resp messages.

If the unicast communication model is used, all PTP instances in the domain must use unicast. If the followers in the network do not have the same set of leaders in their respective Unicast Discovery Lists, they may choose different leaders. It is important to configure all unicast followers the same way.

Mixed Multicast/Unicast

Mixed mode utilizes multicast for Announce, Sync, Follow_Up and Management messages and unicast for Delay_Req and Delay_Resp messages. This mode minimizes the message processing load for leaders, so they can support a larger number of followers. The mode also reduces the message processing load for followers because each one does not have to receive and discard the Delay_Req and Delay_Resp messages from the other followers. Multicast is used for messages that can be shared among all followers. Unicast is used for one-to-one messages.

A mixed mode follower does not need to be configured with a Unicast Discovery List. It receives Announce messages from the leader and it can extract the IP address from the Announce message for the unicast destination address for subsequent Delay_Req messages. Mixed mode also does not require unicast negotiation.

The multicast and mixed multicast/unicast communication models may co-exist in the same domain. Followers can use either model and leaders must support both. A leader

responds to received Delay_Req messages using the same model for the Delay_Resp message.

Mixed mode does not provide any advantage in a network that uses switches in Boundary Clock mode, because each port of the Boundary Clock is a leader with only one follower.

Profiles

A PTP profile is a set of features, constraints, and parameter values that are used for a PTP instance. Profiles are published by various organizations to suit the needs for their specific applications. The SPG9000 supports three profiles:

SMPTE ST 2059-2

Profile name	SMPTE profile for synchronization in a professional broadcast environment
Version	1.0
Profile identifier	68-97-E8-00-01-00
Organization	Society of Motion Picture and Television Engineers
Specification	SMPTE ST 2059-2:2021 (section 6)

AES67

Profile name	PTP profile for media applications
Version	1.0
Profile identifier	00-0B-5E-00-01-00
Organization	Audio Engineering Society Standards Committee
Specification	AES67-2018 (Annex A)

IEEE 1588-2019 Default

Profile name	Default delay request-response profile
Version	1.0
Profile identifier	00-1B-19-01-01-00
Organization	IEEE Precise Networked Clock Synchronization Working Group of the IM/ST Committee
Specification	IEEE Std 1588-2019 (Annex I.3)

Each profile includes a set of mandatory, optional, and prohibited PTP features; default values and permissible ranges for several PTP attributes and parameters; and other profile-specific behavior.

For the SPG9000 PTP instances, the profile-specific differences are:

- The SMPTE profile includes support for the SM TLV in Management messages. The grandmaster sends a Management message once per second and whenever its locking status changes. Each follower can use the TLV information to adjust its time code outputs. See [Synchronization Metadata](#).
- The Mixed Multicast/Unicast communication model is not available with the AES67 profile, only full multicast or full unicast.
- Parameters such as Announce and Sync message intervals have different default values and permissible ranges. See [Set Profile Parameters to Default](#).

Synchronization Metadata

The SMPTE ST 2059-2 specification defines how a grandmaster can share metadata with its followers so they can generate time code outputs consistent with each other and with PTP time. The Synchronization Metadata (SM) TLV includes parameters such as the system frame rate (for example 25 fps for PAL-based time code outputs and 29.97 fps for NTSC-based time code outputs), the offset between TAI time and local time, and the time of the next daily jam sync (see [Daily Jam Sync](#)).

On the SPG9000, a PTP instance configured as a leader with the SMPTE ST2059-2 profile sends Management messages with the SM TLV once every second. These messages can be sent as multicast messages for the multicast or mixed communication models, or as unicast messages to each follower for the unicast model.

Most SM TLV parameters are automatically inserted based on other configuration settings and the current state. For example, the Local Offset is calculated from the time zone offset (configured from the Time tab or front panel menu), the current DST offset, and the difference between TAI and UTC (37 seconds). The Next Jam Time is calculated from the Jam Sync Scheduled Time converted to TAI time.

See [SMPTE Synchronization Metadata](#) for the user-configurable SM TLV parameters for the leader. See [Details of Follower PTP Status](#) for a description of the decoded SM TLV.

Asymmetric Delay Compensation

Asymmetric delay compensation allows correcting the follower timing for any asymmetric delay in the network. If the network only uses PTP-aware switches (Boundary Clocks or Transparent Clocks), delay asymmetry is typically not a problem.

Several factors can cause the propagation delay for PTP messages to be different for the leader-to-follower direction than the follower-to-leader direction. Unless corrected, this propagation delay asymmetry will cause an offset in the clock phase that will be equal to half of the difference of the two path delays.

There are five main causes of asymmetric delay:

- **Rate mismatch** in a switch is when two ports operate at different line speeds (for example 1 Gbps and 10 Gbps). In this case delay asymmetry occurs because of the effects of message processing; the entire message must be stored in a buffer before it is forwarded from the switch on the output port.
For example, using a 1 Gbps input port and a 10 Gbps output port, the switch must wait for the entire message to clock in at the slower rate before it can start outputting the message at the higher rate. Conversely, with a 10 Gbps input port and a 1 Gbps output port, the entire packet is received at the faster rate and the output can start sooner (but at a slower rate).
Although the total transit time is the same for both directions, the delay on the fast-in, slow-out direction is shorter for the packets which contain the PTP timestamps. This effect is more significant at lower port speeds, such as the mismatch between 100 Mbps and 1 Gbps ports.
If the switch can operate as a Transparent Clock or Boundary Clock, the rate mismatch delay effect is corrected by the switch.
- **Traffic mismatch** between the two paths occurs when there is significantly higher traffic utilization on one path than on the other. PTP message processing may be delayed because the switch is busy processing other types of traffic. This effect can be quite large depending on the amount of traffic, the quality of the switch, and the number of switches in the network.
Transparent Clock switches insert residence time information to allow the follower to correct for this delay, and Boundary Clock switches correct for traffic mismatch effects because the switch port is a new leader for its follower or followers. Also, switches that support Differentiated Services give PTP Event messages priority over most other traffic types. See [DiffServ Code Points](#).
- **Route path difference** can happen if the leader-to-follower path takes a different route in the network than the follower-to-leader path. This is uncommon in local area networks, but it is not uncommon when PTP is used over wide area networks.
- **Message type mismatch** may happen when using the mixed multicast/unicast communication model. Some switches may process multicast Sync messages differently than unicast Delay_Req messages.
- **Cable delay variation** occurs when the propagation delay through the cable is different in one direction than the other. In electrical network cable, such as Category 5 cable, it can be due to the twist rate on the pairs, routing inside the sheath, or material differences. With optical fiber it is primarily due to cable length differences for the two strands.

See [Delay Asymmetry](#) for how to set the delay asymmetry correction factor for the follower instance.

PTP Configuration

Most PTP configuration parameters are set from the PTP tab of the web interface or by pressing the PTP button on the front panel interface, but the network interface settings are configured from the System tab of the web interface or the SYSTEM : NETWORK menu of the front panel menu.

Web Interface for Network Settings

On the web interface, click the **System** tab and then click **Network Settings**.

▼ Network Settings

	Enable	MAC Address	DHCP	IPv4 Address	Subnet Mask	Gateway
PTP 1	<input checked="" type="checkbox"/>	00-90-56-01-10-01	<input type="checkbox"/>	192.168.1.50	255.255.0.0	192.168.1.1
PTP 2	<input checked="" type="checkbox"/>	00-90-56-01-0f-ab	<input type="checkbox"/>	192.168.1.51	255.255.0.0	192.168.1.1

	PTP Event	PTP General
PTP 1	EF (46)	DF (0)
PTP 2	EF (46)	DF (0)

Front Panel Menu for NETWORK

To use the front panel of the SPG9000 for this process, press **SYSTEM** and then select the **NETWORK** option. See [Menu Operations](#) for details of using the front panel menus. The table lists the NETWORK menu, and submenus for PTP 1 and PTP 2.

SYSTEM :

PRESET :

INFO :

NETWORK :

MGMT :

HOST NAME

DOMAIN NAME

PTP 1 :

PORT

DHCP

IP ADDRESS

SUBNET MASK

GATEWAY

MAC ADDRESS

DSCP :	
PTP Event	
PTP General	
PTP 2 :	Same menu and submenu as PTP 1
FRONT PANEL :	
WEB :	
POWER SUPPLY :	
FIRMWARE UPGRADE	
CALIBRATE OVEN	
DIAGNOSTICS	

Configuration Settings for PTP Network Interfaces

Before configuring PTP instance settings, check that the network interfaces for the two ports are configured appropriately for the network. The factory default settings are IPv4 addresses of 172.16.1.50 for PTP 1 and 172.16.2.50 for PTP 2. These almost certainly need to be changed for the local network.

Enable

Check this box to enable the network interface. This setting is distinct from the PTP Instance Enable selection (see [Instance](#)) because it is possible to enable the network interface but disable the PTP instance. In that case, the network interface would respond to ping messages but would not respond to PTP messages.

MAC Address

This is a read-only value of the physical address of the network interface. The first three octets of a MAC address indicate an Organizationally Unique Identifier (OUI), to help identify equipment on the network. The OUI for Telestream is 00-90-56, so the MAC addresses always begin with these three octets.

The MAC address is also used to create the PTP clock identity, as seen on the PTP status (see [Clock Identity](#)). The OUI is followed by hexadecimal values of FF FE, followed by the three remaining digits of the MAC address. For example, a MAC address displayed as 00-90-56-01-10-01 in the network interface configuration would appear as a PTP clock identity of 00:90:56:FF:FE:01:10:01. This makes it easier to identify SPG9000 units in the PTP network. The OUI for Tektronix is 08-00-11, so earlier SPG8000A units (Tektronix manufacture) use a clock identity starting with 08:00:11:FF:FE and recent SPG8000A units (Telestream manufacture) use a clock identity starting with 00:90:56:FF:FE.

DHCP

Check this box to enable Dynamic Host Configuration Protocol (DHCP) on the interface. In this case, a DHCP server must be present on the network and it assigns the IPv4 address, subnet mask, and gateway address. If the user enables DHCP, manual

configuration of those values is disabled but the values provided by the DHCP server are displayed.

IPv4 Address

Enter the four octets of the IPv4 address, in dotted decimal notation. On the front panel interface, an edit menu (see [Edit Menus](#)) is used to enter the address, using three digits for each octet with leading zeros if necessary. For example, an address displayed as 192.168.1.50 on the web interface appears as 192.168.001.050 on the front panel interface. If DHCP is enabled, the IPv4 address supplied by the DHCP server is displayed instead and cannot be edited.

Subnet Mask

Enter the four octets of the subnet mask, in dotted decimal notation. If DHCP is enabled, the subnet mask supplied by the DHCP server is displayed instead and cannot be edited.

Gateway

Enter the four octets of the gateway address for this subnet, in dotted decimal notation. If DHCP is enabled, the gateway address supplied by the DHCP server is displayed instead and cannot be edited.

DiffServ Code Points

Select the DSCP values for PTP Event messages and PTP General messages.

Differentiated Services (DiffServ) is a mechanism for applying quality of service (QoS) to IP networks. A DiffServ Code Point (DSCP) is a 6-bit value (between 0 and 63) that is included in the header of an IP packet. It identifies the type of traffic and its associated priority.

PTP messages types are grouped into two message classes:

- **Event** messages include Sync and Delay_Req.
- **General** messages include Announce, Follow_Up, Delay_Resp, Management, and Signaling.

PTP Event messages typically use the Expedited Forwarding (EF) class, which is intended for low-loss and low-latency traffic. EF is assigned a DSCP value of 46. It is important for the timestamp of transmitted Sync and Delay_Req messages to be as accurate as possible; this is why Event messages use a higher priority class.

PTP General messages can simply use the Default Forwarding (DF) class for best-effort traffic, which has a DSCP value of 0.

Apply Changes

Click to accept any changes made to the network settings since opening the panel on the web interface.

Cancel Changes

Click this button to cancel any changes made to the network settings and restore the previously saved settings.

Web Interface for PTP Instances

On the web interface, go to the PTP tab for the configuration menus for the two instances. When the tab is first opened, the two sections labelled "PTP 1" and "PTP 2" are collapsed:

Status	Reference	Time	PTP	Black	LTC	System
▶ PTP 1	Follower Only	Mixed Multicast/Unicast	Domain: 120			
▶ PTP 2	Leader Only	Both Multicast and Mixed	Domain: 121			

The section headers for PTP 1 and PTP 2 each show a summary of the current configuration, displaying the selected mode, communication model, and domain number. This makes it easy to view the configuration of both instances together, in a table-like format. Click on a header to open that section to see the menus for that PTP instance.

The menus available for a PTP instance depend on the selected Mode, Profile, and Communication Model as noted. For example, the menus available for a Follower Only instance using the mixed multicast/unicast model are:

▼ PTP 1 Follower Only Mixed Multicast/Unicast Domain: 120

Instance ☒ Enable

Mode

Profile

Communication Model

Domain

Max Steps Removed

Delay Asymmetry μ s

Messages

Announce Timeout

The menus available for a Leader Only instance using the SMPTE profile are:

▼ PTP 2 Leader Only Both Multicast and Mixed Domain: 121

Instance ☒ Enable

Mode

Profile

Communication Model

Domain

Priority 1

Priority 2

Messages

Announce Interval

Announce Timeout

Sync Interval

SMPTE Synchronization Metadata

Video Frame Rate

Drop-Frame Flag

Color Frame ID Flag

Front Panel Menu for PTP Instances

To use the front panel of the SPG9000 for this process, press **PTP** repeatedly to alternate between the two instance sub-menus and then press **ENTER** for the selected instance. See [Menu Operations](#) for details of using the front panel menus. The table lists the menus and submenus for PTP 1 and PTP 2.

PTP 1 :

INSTANCE	
MODE	
PROFILE	
COMMUNICATION MODEL	
DOMAIN	
PRIORITY 1	Not available for Follower Only mode
PRIORITY 2	Not available for Follower Only mode
MAX STEPS REMOVED	Not available for Leader Only mode
DELAY ASYMMETRY	Not available for Leader Only mode
MESSAGES :	
ANNOUNCE INTERVAL	Not available for Follower Only mode for multicast and mixed models
ANNOUNCE TIMEOUT	
SYNC INTERVAL	Not available for Follower Only mode for multicast and mixed models
SMPTE SYNC METADATA :	Only available for Leader Only or Ordinary Clock modes and SMPTE ST 2059-2 profile
Video Frame Rate	
Drop-Frame Flag	
Color Frame ID Flag	
UNICAST DISCOVERY LIST :	Only available for Follower Only or Ordinary Clock modes and Unicast communication model
IP 1 - IP 8	

PTP 2 : Same menus as PTP 1

Configuration Settings for PTP Instances

The PTP Instances section on the Status tab contains information about the current reference source, the genlock input signal, and the received GNSS signal.

Instance

Check this box to enable the PTP instance. When disabled, the instance does not send or receive any PTP messages on the network interface. It may still respond to "ping" messages if the port is enabled but the instance is disabled. See [Enable](#).

Mode

Selects the operational mode of the PTP instance. See [Clock Types and Modes of Operation](#).

Leader Only: The instance only functions as a leader for this domain. It can be in the Active state, in which case it is the current grandmaster (GM), or it can be in the Passive state, in which case another leader in this domain is the current GM.

Follower Only: The instance only functions as a follower in this domain. If one or both of the PTP instances are configured as follower, the reference source for the instrument can be set to PTP Follower (see [Configuration Settings for Reference](#)). If a follower instance is not used for the reference source, it can still lock to a leader for the domain and report its status information. See [PTP Status](#).

Ordinary Clock: The instance can function either as a leader or a follower, depending on network conditions. When the BMCA selects this instance, it assumes the Active leader role. But unlike a Leader Only instance that assumes a passive role when the BMCA selects another leader, an Ordinary Clock assumes a follower role and tracks the active leader.

Profile

Selects the PTP profile for the instance. See [Profiles](#).

SMPTE ST 2059-2: The SMPTE profile is the preferred profile for professional networked media applications.

AES67: The AES67 Media profile is typically used for audio-only applications or for video applications that cannot process the management SM TLV messages used by the SMPTE profile.

IEEE 1588-2019: The IEEE profile is the default for use with the delay request-response mechanism.

Set Profile Parameters to Default

Click this button to reset certain parameters to the default values for the selected profile.

	SMPTE ST 2059-2	AES67	IEEE 1588-2019
Domain 0	127	0	0
Priority 1	128	128	128
Priority 2	128	128	128
Announce Interval	1 s (1 Hz)	2 s (0.5 Hz)	2 s (0.5 Hz)
Announce Timeout	3	3	3
Sync Interval	125 ms (8 Hz)	125 ms (8 Hz)	1 s (1 Hz)

Communication Model

Selects the communication model used by the instance. See [Communication Models](#). The list of available models depends on the selected Mode and Profile.

Multicast: With the multicast model, all PTP messages between the leader and its followers use multicast addressing.

Unicast: With the unicast model, all PTP messages between the leader and each individual follower use unicast addressing. Followers must be pre-configured with a list of addresses of possible leaders.

Mixed Multicast/Unicast: With the mixed model, leaders use multicast addressing for Announce, Sync, Follow_Up, and Management messages (SMPTE profile). Followers use the address from the Announce message to send unicast Delay_Req messages to that leader. The leader sends the Delay_Resp message back to the follower using its unicast address. The mixed model is only available for SMPTE and IEEE profiles, and for the Follower Only mode.

Both Multicast and Mixed: This selection is only available for the SMPTE and IEEE profiles and for the Leader Only mode. Leaders are required to simultaneously support followers that use Multicast and followers that use Mixed Multicast/Unicast models.

Domain

Select the domain number for this PTP instance, within the range 0-127. See [Domains](#).

The default domain number is profile dependent; SMPTE uses 127, and AES and IEEE profiles use 0. We advise using a different domain number from the default to prevent improperly configured devices from assuming the grandmaster role.

Priority 1 and Priority 2

Enter the priority 1 and priority 2 values for the leader, which are used for BMCA decisions. See [Best Master Clock Algorithm](#). These menus are not available for Follower Only mode.

Max Steps Removed

Enter the upper limit for the stepsRemoved value for Announce messages received from the leader. This menu is not available for Leader Only mode.

Steps removed refers to the number of steps or hops between the PTP instance and the grandmaster. Each Boundary Clock in a path counts as a step or hop. A follower with a path to the grandmaster that goes through a PTP-unaware switch or Transparent Clock has a step count of 1. If the switch is replaced with a Boundary Clock, the step count is 2.

If the stepsRemoved value in a received Announce message is greater than or equal to the Max Steps Removed value, that Announce message is ignored.

Delay Asymmetry

Enter the delay asymmetry value for the follower instance. See [Asymmetric Delay Compensation](#).

The value must be an integer number of microseconds between $-20\ \mu\text{s}$ and $+20\ \mu\text{s}$, in $1\text{-}\mu\text{s}$ steps. A positive value means the leader-to-follower propagation time is longer than the follower-to-leader propagation time, and a negative value means the opposite. This menu is not available for Leader Only mode.

Announce Interval

Select the time interval between successive Announce messages transmitted by the leader. The available choices are described both in terms of the time interval and the corresponding message rate. For example, an interval of 2 seconds represents a message rate of 0.5 messages per second.

This menu is not available for Follower Only mode with multicast or mixed multicast/unicast communication models. For Follower Only mode with unicast communication model, the Announce Interval setting is the requested value sent to a leader in a grant request Signaling message. See [Unicast](#).

Announce Timeout

Select the maximum number of Announce messages that are missing before the PTP instance assumes the leader is no longer present. After that time, instances in the domain start the process of selecting a new leader by the BMCA.

It is a good practice to configure all devices in the domain with the same announce interval and timeout count so that they all respond in a similar time-frame. For example, using the multicast communication model with an Announce interval of 1 second and a timeout count of 3, a passive leader starts sending its own Announce messages 3 seconds after the active leader stops sending Announce messages.

Sync Interval

Select the time interval between successive Sync messages transmitted by the leader. The available choices are described both in terms of the time interval and the corresponding message rate. For example, an interval of 125 milliseconds represents a message rate of 8 messages per second.

The Sync Interval has a significant effect on the lock time and stability of PTP followers. The SMPTE profile default value of 8 messages per second was chosen to provide a trade-off between PTP performance and network load. Most PTP devices are optimized for the default rates. If other rates are chosen, additional testing is necessary to ensure acceptable performance.

This menu is not available for Follower Only mode with multicast or mixed multicast/unicast communication models. For followers using the unicast communication model,

the Sync Interval setting is the requested value sent to a leader in a grant request Signaling message. See [Unicast](#).

Unicast Discovery List

Enter the IP addresses of up to 8 potential leaders. Use a value of 0.0.0.0 for entries that are not used. See [Unicast](#) for more about the Unicast Discovery List. These menus are only available for the unicast communication model and the Follower Only or Ordinary Clock modes.

Unicast Discovery List			
1	<input type="text" value="10.1.1.10"/>	2	<input type="text" value="10.1.1.11"/>
3	<input type="text" value="10.1.1.12"/>	4	<input type="text" value="0.0.0.0"/>
5	<input type="text" value="0.0.0.0"/>	6	<input type="text" value="0.0.0.0"/>
7	<input type="text" value="0.0.0.0"/>	8	<input type="text" value="0.0.0.0"/>

To use the front panel for this process, see [Front Panel Menu for PTP Instances](#).

SMPTE Synchronization Metadata

When the SMPTE ST 2059-2 profile is used, the active leader sends Management messages with the SM TLV at a rate of one per second. See [Synchronization Metadata](#).

Most parameters of the SM TLV are automatically computed, but three are user-configurable. These menus are only available for Leader Only and Ordinary Clock modes with the SMPTE profile.

SMPTE Synchronization Metadata	
Video Frame Rate	<input type="text" value="29.97"/>
Drop-Frame Flag	<input type="text" value="Enable"/>
Color Frame ID Flag	<input type="text" value="Enable"/>

To use the front panel for this process, see [Front Panel Menu for PTP Instances](#).

Video Frame Rate

Select the frame rate for the video outputs of the follower. Interlaced formats typically refer to fields per second, so be sure to choose the frames-per-second value. For example, NTSC uses 59.94 fields per second, which is 29.97 frames per second.

Drop-Frame Flag

Select whether the drop-frame format should be enabled or disabled for the time code outputs of the follower. Normally this flag is only enabled for a video frame rate of 29.97 fps or 59.94 fps.

Color Frame ID Flag

Select whether color frame identification should be enabled or disabled for the time code outputs of the follower. The color frame flag appears in the LTC and VITC code words, according to SMPTE ST 12-1.

Synchronization Outputs

The SPG9000 has multiple outputs that can deliver synchronization signals to downstream devices that genlock to the SPG. There are six outputs (BLACK 1 to BLACK 6) that can generate signals such as NTSC or PAL black burst or HD tri-level sync. Four linear time code outputs (LTC 1 to LTC 4) can distribute time code to the facility. Two more outputs deliver audio reference signals: Word Clock and Digital Audio Reference Signal (DARS).

Black Outputs

The SPG9000 includes six outputs labeled BLACK 1 to BLACK 6, which can be configured for a variety of analog synchronization signal formats.

Web Interface for Black

On the web interface, click the **Black** tab for the configuration menus for the six outputs. When the tab is first opened, the six sections labeled Black 1 to Black 6 are collapsed:

Black 1	NTSC	Timing: 0 lines, 0.0185μs
Black 2	PAL	Timing: 0 lines, 0μs
Black 3	1080 59.94i Tri-Level	Timing: 0 lines, 0μs
Black 4	1080 24p Tri-Level	Timing: 0 lines, 0μs
Black 5	1080 50i Tri-Level	Timing: 0 lines, 0μs
Black 6	CW 10 MHz	Timing: 0 lines, 0μs

Black Output HD Tri-Level Frame Rates

Black 1-3 Non-Integer Rates (59.94, 47.95, 29.97, 23.98) ▼

Black 4-6 Integer Rates (60, 50, 48, 30, 25, 24) ▼

Below these six output sections is an additional menu section to select the available frame rates for any outputs configured for HD tri-level sync formats. See [HD Tri-Level Frame Rate](#).

The section headers for Black 1 to Black 6 each show a summary of the current configuration, displaying the selected format and timing offsets. This makes it easy to

view the configuration of all outputs at once, in a table format. Click a Black header to open that section to see the menus for that output.

▼ Black 1

NTSC

Timing: 0 lines, 0µs

Output

FormatNTSC

Field Reference☒ Enable

Timing

Vertical Delay0lines

Horizontal Delay0µs

Vertical Interval Time Code

SourceLocal (DST)

Offset+00:00:00:00

Line Numbers14☒ Enable16☐ Enable

Drop-Frame (30 fps)☒ Enable

Front Panel Menu for BLACK

To use the front panel of the SPG9000 for this process, press **BLACK** repeatedly to select from the six output sub-menus and the two HD TRI-LEVEL SYNC RATE sub-menus. See [Menu Operations](#) for details of using the front panel menus. The table shows the submenus for the BLACK menu and the submenus for BLACK 1.

BLACK 1 :		
FORMAT		
FIELD REFERENCE		Only available if FORMAT is NTSC, NTSC-J, or PAL
TIMING :		Not available for 1 PPS format
Vertical		
Horizontal Coarse		
Horizontal Fine		
TIME CODE :		Only available if FORMAT is NTSC, NTSC-J, or PAL
SOURCE		
OFFSET		
DROP-FRAME		Only available if FORMAT is NTSC or NTSC-J
VITC 1		
VITC 1 LINE		
VITC 2		
VITC2 LINE		
BLACK 2-6		Same menu options as Black 1

BLACK 1-3 : HD TRI-LEVEL SYNC RATE
BLACK 4-6 : HD TRI-LEVEL SYNC RATE

Configuration Settings for Output

Configure the specific black output:

On the web interface, click the **Black** tab, and then click the specific Black section (1-6) to configure.



Output

Format **NTSC** ▼

Field Reference ☒ Enable

To use the front panel for this process, see [Front Panel Menu for BLACK](#).

Format

Selects the output format. The list of available formats in this menu is variable.

These formats are available on all outputs:

NTSC: Selects NTSC black burst (525 lines at 59.94 interlaced fields per second). The signal has a black level of 7.5 IRE, according to NTSC-M as used in North America and several other countries.

NTSC-J: Selects NTSC black burst with a black level of 0 IRE as used in Japan.

PAL: Selects PAL black burst (625 lines at 50 interlaced fields per second).

1 PPS: Selects a pulse-per-second signal. The signal level is 2 V for the Black 1-3 outputs and 5 V for the Black 4-6 outputs when unterminated. The signal levels are half those amplitudes into a 75 Ω termination.

This format is available on outputs 3-6, but not outputs 1-2:

CW 10 MHz: Selects a continuous wave (CW) signal with a frequency of 10 MHz and a signal level of 1.5 Vp-p.

The set of available HD tri-level sync formats depends on the selection in the Black Output HD Tri-Level Frame Rates menu. Either the set of non-integer rates or the set of integer rates is available for each of Black 1-3 and Black 4-6.

Frame Type	Non-Integer Rates	Integer Rates
Interlaced	1080 59.94i	1080 60i
		1080 50i

Frame Type	Non-Integer Rates	Integer Rates
Progressive	1080 59.94p	1080 60p
	1080 47.95p	1080 50p
	1080 29.97p	1080 48p
	1080 23.98p	1080 30p
	720 59.94p	1080 25p
		1080 24p
		720 60p
		720 50p
Segmented Frame	1080 23.98sF	1080 24sF

Field Reference

Check this box to enable the field reference signal. This menu is only applicable if the selected format is black burst (one of NTSC, NTSC-J, or PAL). When enabled, a 700 mV (white) signal appears for the complete active line duration on line 10 (NTSC) or line 7 (PAL) of field 1 only. This makes it easier to identify the first field in the 4-field (NTSC) or 8-field (PAL) sequence.

Configuration Settings for Timing

The Timing settings adjust the timing offset of the output signal relative to the internal frame reset. See [Epoch-Based Synchronization](#) to understand how frame resets are synchronized with respect to the reference source.

The total timing offset is a combination of whole lines (vertical delay) and partial lines (horizontal delay). A negative value means the internal clock is advanced relative to the frame reset.

On the web interface, click the **Black** tab, and then click the specific Black section (1-6) to configure.

Timing

Vertical Delay

0

lines

Horizontal Delay

0

µs

To use the front panel for this process, see [Front Panel Menu for BLACK](#).

Vertical Delay

Enter an integer number of lines, in 1 line increments.

Horizontal Delay

Enter the delay value in microseconds.

The front panel interface has two [Adjustment Menus](#) for entering the horizontal delay value. Go to the BLACK # : TIMING submenu and the Horizontal Coarse submenu can be used to make adjustments in step sizes of one frame clock interval. The Horizontal Fine sub-menu can be used to make further adjustments in step sizes of 0.10 nanoseconds.

The web interface has a single text box for the combined Horizontal Delay.

The range of the timing adjustment depends on the selected signal format:

Format	Vertical (lines)	Horizontal Coarse (μ s)	Horizontal Fine (ns)
NTSC and NTSC-J	± 525	± 63.5556	± 10.00
PAL	± 1250	± 64.0000	± 10.00
1080 60i	± 562	± 29.6296	± 7.00
1080 59.94i	± 562	± 29.6593	± 7.00
1080 50i	± 562	± 35.5556	± 7.00
1080 60p	± 562	± 14.8148	± 7.00
1080 59.94p	± 562	± 14.8296	± 7.00
1080 50p	± 562	± 17.7778	± 7.00
1080 48p	± 562	± 18.5185	± 7.00
1080 47.95p	± 562	± 18.5370	± 7.00
1080 30p	± 562	± 29.6296	± 7.00
1080 29.97p	± 562	± 29.6593	± 7.00
1080 25p	± 562	± 35.5556	± 7.00
1080 24p	± 562	± 37.0370	± 7.00
1080 23.98p	± 562	± 37.0741	± 7.00
1080 24sF	± 562	± 37.0370	± 7.00
1080 23.98sF	± 562	± 37.0741	± 7.00
720 60p	± 375	± 22.2222	± 7.00

Format	Vertical (lines)	Horizontal Coarse (μ s)	Horizontal Fine (ns)
720 59.94p	± 375	± 22.2444	± 7.00
720 50p	± 375	± 26.6667	± 7.00

Configuration Settings for VITC

Outputs configured to one of the black burst formats (NTSC, NTSC-J, or PAL) can also carry time code in the vertical blanking area of the video frame. Vertical Interval Time Code (VITC) on each output can use different time sources and independent offsets.

On the web interface, click the **Black** tab, and then click the specific Black section (1-6) to configure.

Vertical Interval Time Code

Source: Local (DST)

Offset: +00:00:00:00

Line Numbers: 14 ☒ Enable 16 ☒ Enable

Drop-Frame (30 fps) ☒ Enable

To use the front panel for this process, see [Front Panel Menu for BLACK](#).

Source

Select the time source for the time code counter:

Disabled: No time code will be inserted in the video output signal.

Local (DST): Use the main time-of-day and the time zone offset and the daylight saving time offset to compute the local time.

Local (No DST): Use the main time-of-day and the time zone offset, but exclude any daylight saving time offset to compute the local time.

UTC: Use Coordinated Universal Time instead of a local time.

Program Time: Use the program time counter instead of a time-of-day value. See [Program Time Counter](#).

The VITC data includes the hours, minutes, seconds, and frames digits (in the format HH:MM:SS:FF) according to SMPTE ST 12-1 and the year, month, day, and time zone information according to SMPTE ST 309.

Note: VITC insertion also requires at least one Line Number is set to Enable.

Offset

Enter a time offset (hours, minutes, seconds, and frames) relative to the selected source time. For example, you could use the time code for a different time zone than the system's normal time zone by specifying an offset of ± 1 -or-more hours.

Line Numbers

Enter the required line numbers in the vertical interval and check the boxes to enable the lines. The SPG9000 can insert the VITC data into one or two different lines in the vertical interval. When two lines are enabled, they should be nonconsecutive lines.

According to SMPTE ST 12-1, the preferred locations and limits for VITC are:

	NTSC	PAL
Preferred Line	14	19
Optional Line	16	21
Earliest Line	10	6
Latest Line	20	22

Drop-Frame (30 fps)

Check this box to enable drop-frame time code. This option is only available when the format is NTSC or NTSC-J. This option should be selected for most applications where the time code represents time-of-day; this is so the time code is similar to the real-time clock. See [Daily Jam Sync](#) for keeping 30 fps drop-frame time code aligned with the main time-of-day (MTOD).

Non-drop frame (NDF) time code is sometimes used in editing and post-production, typically when also using the Program Time source.

HD Tri-Level Frame Rate

The six black outputs of the SPG9000 are grouped into two sets (Black 1-3 and Black 4-6). In each group, any of the three outputs configured to HD tri-level sync formats must have an integer frame rate (30, 25, 24, etc.) or all have a non-integer frame rate (29.97, 23.98, etc.). If your application requires both 1080i 59.94 and 1080i 50 signals, for example, you must use any of Black 1-3 for one output and any of Black 4-6 for the other output. There are no restrictions on which outputs are NTSC or PAL.

On the web interface, click the **Black** tab, and then click the specific Black section (1-6) to configure.

Select either Integer Rates or Non-Integer Rates for Black 1-3 and Black 4-6.

Black Output HD Tri-Level Frame Rates

Black 1-3	Integer Rates (60, 50, 48, 30, 25, 24) ▼
Black 4-6	Non-Integer Rates (59.94, 47.95, 29.97, 23.98) ▼

To use the front panel for this process, see [Front Panel Menu for BLACK](#).

Linear Time Code Input and Outputs

The SPG9000 has four sets of pins on the rear-panel LTC/GPI connector for LTC input and outputs. These can be configured as one input and three outputs, or as four outputs.

See [LTC/GPI Connector](#) for the connector pin diagram.

Web Interface for LTC

On the web interface, go to the Linear Time Code (LTC) tab for the configuration menus for the four outputs. When the user opens the tab, the four sections LTC 1 through LTC 4 are collapsed as shown:

Status	Reference	Time	PTP	Black	LTC	System
▶ LTC 1	Input					
▶ LTC 2	30 fps drop-frame	Local (DST)				
▶ LTC 3	30 fps drop-frame	UTC				
▶ LTC 4	24 fps	Program Time				

The section headers for LTC 1 to LTC 4 each show a summary of the current configuration, displaying the selected format and time source. This makes it easy to view the configuration of all outputs at once, in a table-like format. Click on a header to open that section to see the menus for that output.

▼ LTC 1

30 fps drop-frame

Local (DST)

LTC 1 Mode

Output ▼

Source

Local (DST) ▼

Offset

+00:00:00:00

Format

30 fps drop-frame ▼

Level

2

 V

Delay

0

 ms

Front Panel Menu for LTC

To use the front panel of the SPG9000 for this process, press **LTC** repeatedly to select from the four output sub-menus. See [Menu Operations](#) for details of using the front panel menus. The table shows the submenus for the LTC 1 menu.

LTC 1 :

MODE	Only available for LTC 1
FORMAT	
SOURCE	
OFFSET	
DELAY	
OUTPUT LEVEL	

LTC 2-4 :

Configuration Settings for LTC

These settings can be configured from both the web interface and the front-panel menus.

LTC 1 Mode

Select Output or Input for the LTC 1 pins on the rear panel connector. This menu is only available for LTC 1; LTC 2-4 are always configured as outputs. When LTC 1 is configured as an input, it can be used as a time-of-day source when the reference source is either Genlock Input or Internal. See [Configuration Settings for Time of Day](#).

Source

Select the time source for the time code counter:

Disabled: The LTC output is disabled.

Local (DST): Use the main time-of-day plus the time zone offset plus the daylight saving time offset to compute the local time.

Local (No DST): Use the main time-of-day plus the time zone offset, but exclude any daylight saving time offset to compute the local time.

UTC: Use Coordinated Universal Time instead of a local time.

Program Time: Uses the program time counter instead of a time-of-day value. See [Program Time Counter](#).

The LTC data includes the hours, minutes, seconds, and frames digits (HH:MM:SS:FF) according to SMPTE ST 12-1 and the year, month, day and time zone information according to SMPTE ST 309.

Offset

Enter a time offset (hours, minutes, seconds, and frames) relative to the selected source time. For example, you could use the time code for a different time zone than the system's normal time zone by specifying an offset of ± 1 or more hours.

Format

Selects the linear time code format and frame rate.

The LTC format refers to the allowed range of digits for the frame count, along with the method in which they are counted and roll over at the end of each second. For example, 24 fps time code counts frames from 00 to 23 each second, and then rolls over back to 00. 30 fps drop-frame time code counts frames from 00 to 29 in most seconds, but skips the 00 and 01 counts at specific times. See [Daily Jam Sync](#).

An LTC frame is the period over which the LTC codeword (80 bits long) is transmitted, aligned with the corresponding video frame. For example, a LTC frame rate of 25 fps results in an LTC signal with a bit rate of 2000 bps, with the start of each LTC frame aligned with the start of 25 fps video frames, such as PAL black outputs.

Select one of the LTC formats:

24 fps

25 fps

30 fps: Select non-drop frame time code, with frames counted from 00 to 29 for every second, at a frame rate of 30 fps.

30 fps drop-frame: Select drop-frame time code at a frame rate of 29.97 fps.

24 fps @ 23.98 Hz: frames are counted from 00 to 23 each second, but the frame rate is 23.98 fps. Five frames at this rate are aligned with four complete video frames at 29.97 fps.

Level

Enter the signal level for the LTC output. Valid values are from 0.5 V to 5.0 V in 0.5 V steps.

Delay

Enter the time offset (in milliseconds) by which the LTC frame will be delayed from its normal video frame alignment.

Audio Reference Outputs

The Word Clock output generates a simple 48 kHz square wave at an output level of ± 1.0 V.

The DARS (Digital Audio Reference Signal) output generates an AES3 digital audio signal that can be used as a synchronization reference for audio equipment.

System Maintenance

This section describes how to maintain the SPG9000 system functionality, including how to:

- operate with dual power supplies,
- upgrade the instrument with new licensed features,
- upgrade the instrument firmware, and
- calibrate the internal oscillator.

Power Supply Monitoring and Replacement

This section describes how the SPG9000 operates with one or two power supply modules, how to check the status of the power supplies, and how to replace a power supply module if necessary.

Dual Power Supply Operation

When ordered with option SPG9000-SPW, the instrument has one power supply module installed. When ordered with option SPG9000-DPW, two power supply modules are installed. With two power supply modules installed in the instrument, one operates as the active supply and the other is a backup supply. Power is only drawn from the active power supply and the backup supply remains idle. This ensures that the two supplies do not age at the same rate. Once per day, the system automatically performs a load test on the backup supply.

If the active power supply fails, the system automatically switches to the backup supply, which becomes the new active supply. This switch is instantaneous so power to the instrument is uninterrupted. You can remove and replace a failed supply without having to remove the instrument from operation. See [Hot-Swap Power Supply Module](#).

Temperature-Weighted Hours

The instrument keeps track of the age of each power supply module by calculating a metric of temperature-weighted hours (TWH). When the operating temperature is 25 °C or cooler, the power supply module is expected to last 15 years. At the maximum operating temperature of 50 °C, the expected life of the supply decreases to only 5 years.

Every hour, the instrument measures the temperature and updates the TWH total for each power supply. The active supply operates at a warmer temperature than the backup supply so the TWH of the active supply increases faster than the TWH of the backup supply. When the TWH value reaches 131400 hours, the associated PWR 1 or PWR 2 indicator on the front panel changes to orange to indicate the power supply should be replaced.

Preferred Power Supply

When two power supply modules are installed, one can be selected as the preferred power supply. The preferred power supply is the active supply if possible.

The system keeps track of the most recent load test result for each power supply. When the system first powers on, new test results are required, so the active power supply may not be the preferred power supply until each power supply has been tested and passes.

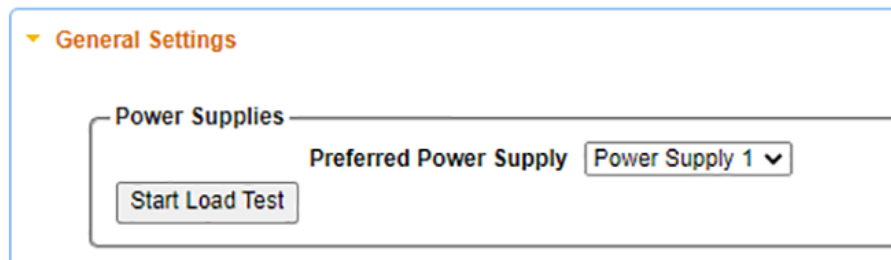
The recommended usage strategy is to configure one supply as preferred and use the second supply only in case the first supply has a failure. This usage strategy allows the backup supply to have the maximum remaining life when it is needed.

The preferred supply configuration is not saved as part of the preset system, so it does not change when you activate any of the system presets, including the Factory Default preset. See [Presets](#).

Web Interface for Power Supplies

To use the web interface of the SPG9000 for this process:

1. In the web interface, click **System** and then click **General Settings**.
2. Select the Preferred Active Power Supply option.



Front Panel Menu for POWER SUPPLY

To use the front panel of the SPG9000 for this process, press **SYSTEM** and then select the **POWER SUPPLY** option. See [Menu Operations](#) for details of using the front panel menus. The table shows the submenus for the POWER SUPPLY selection.

SYSTEM :

- PRESET :**
- INFO :**
- NETWORK :**
- FRONT PANEL :**
- WEB :**
- POWER SUPPLY :**
 - PREFERRED**
 - LOAD TEST**
 - FIRMWARE UPGRADE**
 - CALIBRATE OVEN**
 - DIAGNOSTICS**

Load Test

Once every 24 hours the backup power supply undergoes a load test. The backup supply, which normally runs as a powered standby, has a load applied to it, similar to that of the operating instrument, for several seconds. The voltage is measured to check if it is within tolerance for the expected 12 V value. The load test results are reported on the Status tab of the web interface.

If the load test passes, that power supply can be selected as the preferred supply. The system switches the preferred supply to active if possible. Depending on which power supply starts first when the system is powered up, the preferred supply may not be used as the active supply until the first successful load test (either manually or scheduled).

A load test can also be started manually:

- On the web interface, in the Power Supplies section, click **Start Load Test**.
- On the front-panel interface, go to the SYSTEM : POWER SUPPLY : LOAD TEST menu on the front-panel interface.

Power Supply Status

The status of each power supply module can be viewed from the front or rear of the instrument. On the front panel, the PWR 1 and PWR 2 indicators illuminate in different colors to show the status of the power supply modules. The rear panel of each power supply module has a STATUS indicator that matches the status shown on the PWR 1 and PWR 2 front-panel indicators. See [PWR 1 and PWR 2](#).

To see more detailed information on the web interface:

1. On the web interface, click the **Status** tab.
2. In the System section at the bottom of the page, click **Show Details**.

The information for the power supplies status appears. A table shows the voltage measurement, usage data (active, standby, and temperature-weighted hours) and the load test history.

System		
Hardware Status OK		
Show Details		
Power Supplies OK		
Active Power Supply PS1		
Hide Details		
	Power Supply 1 (Active)	Power Supply 2
Voltage (+12V)	11.93 V (OK)	11.94 V (OK)
Active Hours	2508	1469
Standby Hours	1	474
Temp Weighted	3148 (OK) (limit: 131400)	1943 (OK) (limit: 131400)
Manufacture Date	2023-02-06 16:42:03 (UTC)	2023-03-15 14:36:35 (UTC)
Load Test History		
Last Test	2023-04-06 21:38:19 (UTC)	2023-04-06 22:54:22 (UTC)
Pass	2	158
Fail	0	0
Last Pass	2023-04-06 21:38:19 (UTC)	2023-04-06 22:54:22 (UTC)
Last Fail	n/a	n/a

Hot-Swap Power Supply Module

This procedure describes how to replace a power supply module while the instrument is in operation. To hot-swap a power supply module:



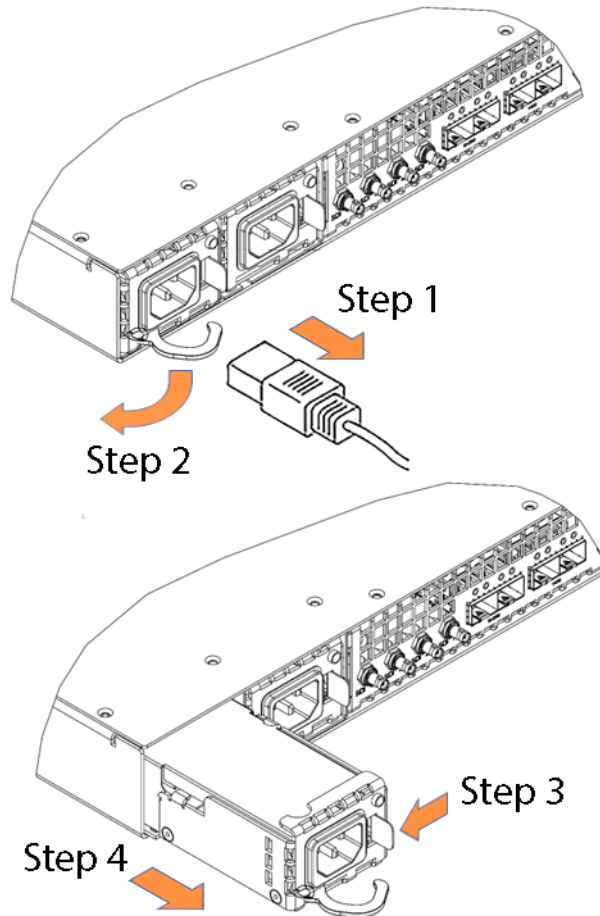
WARNING: Disconnect the power cord from the power supply module before you remove the module from the instrument. Also, do not connect a power cord to the power supply module while the module is not installed in the instrument. There are dangerous high voltages inside the module when the power cord is connected.



CAUTION: To prevent an unexpected shutdown of the instrument, be sure to disconnect the correct power cord if you are replacing a faulty power supply module.

When viewed from the front of the instrument, Power Supply 1 is the left power supply module and Power Supply 2 is the right power supply module. This matches the orientation of the PWR 1 and PWR 2 indicators on the front panel. The STATUS indicator on the rear panel of each power supply module matches the status shown by the front-panel PWR 1 and PWR 2 indicators.

1. Remove the power cable from the power supply module that you are removing or replacing.
2. Pull out the handle located at the bottom of the supply.



3. Push the retaining latch to the left and hold.
4. Use the handle to pull the power supply module out of the instrument (release the retaining latch when the latch clears the instrument).
5. Insert the replacement supply into the instrument until it latches into place.
6. If necessary, push the handle of the supply into the storage position.
7. Connect the power cable to the power supply module you installed.
8. Check that the status of the power supply module you just installed is bright or dim green.
9. If needed, change the preferred supply configuration. See [Preferred Power Supply](#).

We recommend you configure the supply with the most TWH to be used as the primary preferred supply. This allows for the newer supply to be preserved so it can provide the best possible backup if the primary supply fails.

Licensed Features

The SPG9000 has several features that are enabled when the corresponding license is installed. Licenses are pre-installed on the system if they are purchased at the same time as the base unit. Licenses can also be added at any later time by purchasing them as upgrades.

There are four licensed options for the SPG9000:

SPG9000-GNSS: This enables the internal GNSS receiver and its associated time synchronization features. This license is required to view the GNSS signal status on the Status tab of the web interface and the STATUS : GNSS menu of the front panel interface. The license is also required to configure the GNSS Receiver settings from the Reference tab of the web interface and the REFERENCE : GNSS RCVR menu of the front panel interface.

SPG9000-PTP: This enables the PTP instances associated with the network interfaces labeled as PTP 1 and PTP 2. This license is required to view the PTP 1 and PTP 2 status on the Status tab of the web interface and the STATUS : PTP 1 and PTP 2 menus of the front panel interface. The license is also required to configure the two instances from the PTP tab of the web interface and the PTP button on the front panel interface.

SPG9000-SDI: This enables the SDI outputs for test signal generation. This feature will be available in a future firmware update.

SPG9000-IP: This enables the IP ports for test signal generation. This feature will be available in a future firmware update.

View Installed Licenses

Check the installed Licenses to find details of the licenses. This includes what licenses have been purchased, when they expire, and their uses.

Web Interface for Licensed Options

To use the web interface, select the **System** tab and then select **System Information**.

The Expiration column in the Licensed Options table shows if the license is Permanent, Not Installed, or has a specific expiration date.

Licensed Options		
	Expiration	Description
SPG9000-GNSS	Permanent	Enable internal GNSS receiver and time synchronization features
SPG9000-PTP	Permanent	Enable PTP (IEEE 1588) support on two ports
SPG9000-SDI	2023-07-31	Enable SD/HD/UHD test signal generation on four SDI outputs
SPG9000-IP	Not Installed	Enable ST 2110 test signal generation on two IP ports

Update Licenses

Front Panel Menu for LICENSED OPTIONS

To use the front panel, press **SYSTEM**, then select the **INFO** option, and then select **LICENSED OPTIONS**. See [Menu Operations](#) for details of using the front panel menus. The table shows the submenus for the INFO selection.

SYSTEM :
PRESET :
INFO :
VERSIONS
LICENSED OPTIONS
NETWORK :
FRONT PANEL :
WEB :
POWER SUPPLY :
FIRMWARE UPGRADE
CALIBRATE OVEN
DIAGNOSTICS

Install New Licenses

When you purchase a licensed option, you receive a Software Serial Number from Telestream. This string is associated with this specific SPG9000 instrument, as identified by the Host ID and (hardware) Serial Number listed at the top of the license application information. The Software Serial Number is a set of 20 digits and letters such as SG7J-U6E8-2S4F-UQRJ-6CL2.

1. In the SPG9000 web page, select the **System** tab and then select **System Information**.

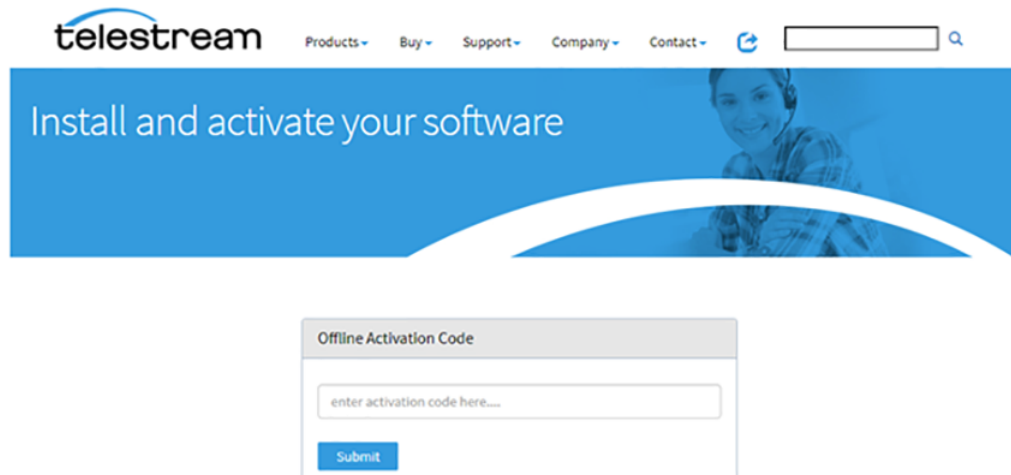
2. Under the Licensed Options table, select **Update Licenses**.
The Update Licenses panel opens.

Host ID SPG-FA2BAM2LTVY4AR6A8PPCAAJ54U
Serial Number S010110

1. Locate the Software Serial Number in the email message from Telestream and enter it here:
2. Get the Activation Code for this SPG9000 system.
 ⇒
3. Go to the Telestream Offline Activation Site at <https://cws.telestream.net/offlineactivation.aspx> and submit this code.
4. Open the license file that was downloaded to your browser.
 No file chosen
5. Review the new licensed options and apply if ok.

3. Enter the Software Serial Number in the first field.
4. Select **Get Activation Code**.
The activation code appears in the next field.
5. Select **Copy to Clipboard**.

6. Select the link to the Telestream Offline Activation Site (<https://cws.telestream.net/offlineactivation.aspx>). If the SPG9000 is not on a network connected to the outside Internet, you will have to manually transfer the activation code to another computer.



7. Paste the activation code into the text box and select **Submit**.

Your browser prompts you to save a file named "TelestreamLicense".

If the SPG9000 is not on a network connected to the Internet, you will have to transfer this file to a computer that is connected to the SPG9000.

Note: This process is the only time the SPG9000 needs to access the Internet.

8. Save the TelestreamLicense file.
9. In the SPG9000 web page, select **Choose File** and select the TelestreamLicense file.
The license file is checked and a summary of its contents is displayed in the last text box on the web page, as in the sample:

```
Host ID: SPG-FA2BAM2LTVY4AR6A8PPCAAJ54U

Licenses:
SPG9000-SPG9000
SPG9000-GNSS
SPG9000-PTP
```

If the Host ID matches the SPG9000 and the set of licenses is correct, the Apply Licenses button becomes available.

10. Select **Apply Licenses**. The table at the top of the web page is updated and any new features are now available.

Note: The SPG9000-SPG9000 license code in the TelestreamLicense file contents refers to the base unit and is always present in the license file, but it is not in the optional license table.

Upgrade Instrument Firmware

Telestream releases software and firmware updates for products to add new features and to fix product problems. You can find the latest firmware for your product at the Telestream website: www.telestream.net/video/resources.htm#Software and select *Signal and Synchronization Generators*.

Check Current Firmware Version

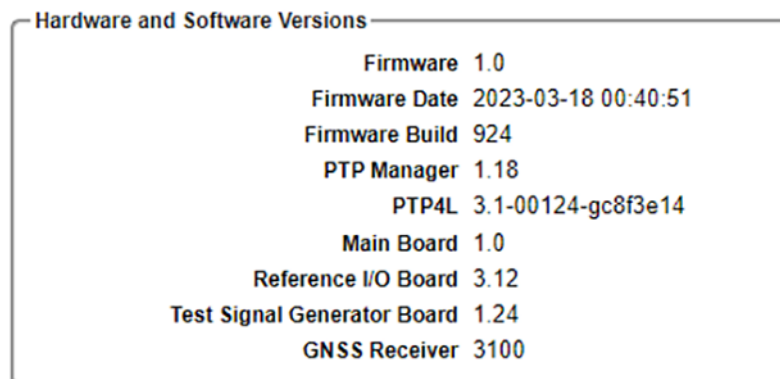
You can check the current version of the instrument firmware by looking at the top banner of the web interface. The example shows version 1.0.



Web Interface for Hardware and Software Versions

More version information (for software components, hardware board versions, etc.) is available on the web interface.

In the web interface, click **System** and then click **System Information**.



Front Panel Menu for INFO

More version information is available through the front panel interface.

Press **SYSTEM** and then select the **INFO** option. See [Menu Operations](#) for details of using the front panel menus. The table shows the submenus for the INFO menu.

SYSTEM :
 PRESET :
 INFO :
 VERSIONS
 LICENSED OPTIONS
 NETWORK :

FRONT PANEL :
WEB :
POWER SUPPLY :
FIRMWARE UPGRADE
CALIBRATE OVEN
DIAGNOSTICS

Upgrade Firmware

The SPG9000 firmware can be upgraded by copying the new firmware package to a USB memory device and installing it from the front panel USB port.

Note: The firmware can only be upgraded through the front panel.

SYSTEM :
PRESET :
INFO :
NETWORK :
FRONT PANEL :
WEB :
POWER SUPPLY :
FIRMWARE UPGRADE
CALIBRATE OVEN
DIAGNOSTICS

Note: The time required to complete the firmware upgrade is approximately 10 minutes.



CAUTION: The instrument might automatically reboot at the end of the upgrade process. Do not perform the upgrade while the instrument is in use as a sync reference. When the instrument has started to erase the internal flash, do not remove power from the instrument.

To upgrade the system firmware:

1. Insert a USB memory device into a USB port in the computer containing the latest instrument firmware.
2. Open the USB device to view its file contents.
3. On the USB device, create a directory named SpgUpgrd.
4. Open the SpgUpgrd directory and copy the spg9000.deb file from the downloaded ZIP file to the USB device. The USB device should have a directory path of SpgUpgrd\spg9000.deb.

5. Eject and safely remove the USB device from the computer.
6. Insert the USB device into the front-panel USB port on the instrument.
If necessary, power on the instrument and wait for the instrument to fully start up before inserting the USB device into the front-panel USB port on the instrument.
7. On the front panel of the SPG9000, press **SYSTEM**.
8. Select the **FIRMWARE UPGRADE** option and press **ENTER**.
A confirmation message appears.

! Continue with firmware upgrade? !

* Yes : ENTER / No : BACK *

9. Select ENTER to continue with the upgrade or select BACK to cancel the upgrade.
During the upgrade process, the instrument displays messages indicating the upgrade status.
10. After the firmware upgrade, remove and reconnect the power cables. This forces a hard power cycle.
11. After the upgrade is complete, remove the USB device.

System Oscillator Calibration

Because the oscillator frequency was adjusted accurately at the factory, you should not need to adjust the oven oscillator frequency immediately after the initial installation. However, you can adjust the oscillator frequency at any time to improve the accuracy of the internal frequency.

Calibration might be needed periodically to compensate for drift in the oven oscillator. The drift is typically greater during the first 30 days of operation. After the first 30 days we recommend using the calibration procedure to check and calibrate the oscillator if appropriate. After that a yearly calibration is typically adequate to maintain good frequency accuracy when in internal mode.

When option SPG9000-GNSS or option SPG9000-PTP is installed, you might be able to improve the accuracy slightly after installation because the instrument is at the normal temperature for your specific installation site.

Note: The calibration can only be done through the front panel.

Check if the oven oscillator needs to be calibrated:

1. While the instrument is locked to a GNSS signal, a PTP follower, or a precise genlock reference (such as a CW 10 MHz signal from a calibration source), press **SYSTEM**.
2. Select the **DIAGNOSTICS** option. See [Menu Operations](#) for details of using the front panel menus.

SYSTEM :

PRESET :

INFO :

NETWORK :

FRONT PANEL :

WEB :

POWER SUPPLY :

FIRMWARE UPGRADE

CALIBRATE OVEN

DIAGNOSTICS

2. Press **ENTER** to view the TUNE submenu.

3. On the first page of the TUNE submenu, there is a status menu similar to:

SYSTEM : DIAGNOSTICS : TUNE
Tune: -0.00e-6 (2078823 --> 2078823)

4. Press the left or right arrow button to view the second page of the TUNE submenu.
There is a status menu similar to:

SYSTEM : DIAGNOSTICS : TUNE
Phase: 0x7FFFFFFA DDS: 2078823 Fine

5. Verify the second page reads "Fine" not "Coarse".
6. Check if the Tune value is greater than $\pm 0.10e-6$
 - If the value is less than $\pm 0.10e-6$, no calibration is required.
 - If it is greater, calibrate the oven oscillator.
 - i. Press **BACK** to exit the DIAGNOSTICS submenu and select the **CALIBRATE OVEN** option.
 - ii. Press **ENTER** to calibrate the oven oscillator.