DATASHEET

GSS9000

Maximum performance without compromise for PNT test environments

Spirent GSS9000 GNSS Simulator

Purpose of this Document

This datasheet describes the functionality of the Spirent GSS9000 GNSS Simulator, which sets the standard of excellence in GNSS RF Simulation for R&D and performance testing.

This datasheet also provides technical data and configuration information.

The GSS9000 offers a very wide range of features and capabilities. Please speak to your Spirent sales representative before ordering to ensure your specific needs are met.

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Introduction

To develop positioning, navigation and timing systems for military, space, and other high precision applications you require comprehensive, highly sophisticated testing. The GSS9000 GNSS simulator sets a new standard of excellence in future-proofed simulation for R&D and performance testing.

Powered by SimGEN®, and using the latest state-of-the-art SDR technology designed specifically for GNSS signal simulation, the GSS9000 produces a comprehensive range of emulated RF signals with industry-leading flexibility, fidelity, performance and reliability.

Ultimate Flexibility, Supreme Performance, Comprehensive Capability

The GSS9000 supports an extensive range of constellation configurations, from GPS L1 C/A through to multi-GNSS, multi-frequency systems, including authorised signals. Configurations are available that support multi-antennas and multi-vehicles, for example differential-GNSS, attitude determination, interference/jamming, spoofing and Controlled Reception Pattern Antenna (CRPA) testing.

Some of the GSS9000's key attributes are:

- World-leading performance in several key areas such as:
  - 2000 Hz System Iteration Rate (SIR) and Hardware Update Rate (HUR)
  - 0.3 mm RMS Pseudorange Accuracy
  - 0 mm uncertainty due to inter-channel bias
  - <0.005 Rad RMS Phase Noise
- Highly flexible and configurable enabled through a software defined architecture
- Backward compatibility with legacy scenarios enabling seamless transition from existing Spirent platforms
- In-field upgradeability of principal GNSS functionality and capability
- On-the-fly re-configuration of constellation and signal configurations
- Real-time injection of RINEX data for close alignment to live-sky signals
- Multi-RF output options available
- Embedded Interference Sources (GTx) available
- Embedded Spoofing available
- Generation of in-band RF signals from I/Q data files
- Fully future-proofed for all advances in GNSS systems, signals, modulations, codes and data

A key benefit of the GSS9000 is that the signal performance specification is met under ALL operating conditions, including the full range of ultra-high dynamics.

In view of the wide range of possible permutations, Spirent recommends that you discuss your current and future needs with your local sales representative. Spirent will provide specific configuration and pricing information to meet your needs.

Spirent GSS9000 GNSS Simulator

GSS9000 Hardware

The GSS9000 system consists of a Signal Generator Chassis and a dedicated C50r Host Unit running Spirent's SimGEN™ scenario definition and simulation control software, as shown in **Figure 1**.

Figure 1: GSS9000 GNSS Simulator

GSS9000 Signal Generator Chassis

The GSS9000 Signal Generator Chassis contains one or more SDR radio cards. Each radio card consists of a digital signal generator and an RF upconverter and can be licenced to support; 4, 8, 12, 16 or 32 separate channels. Each radio card is capable – at any one time – of supporting any number of licenced GNSS constellations in the same frequency band.

Given the highly flexible software-defined architecture of the GSS9000, many different system configurations are possible. Some systems may have the required number of radio cards to support simultaneous generation of all licenced signals, some systems may have more licenced signals than radio cards to support them, and so different combinations of signals are possible.

The Signal Generator Chassis is available in 2 main variants:

- Single RF Output – with up to 10 SDR radio cards installed.
- Dual RF Output - with up to 5 SDR radio cards installed behind RF output 1 and up to 5 SDRnradio cards installed behind RF output 2[1].

Optional Single-RF Combination in a Dual-RF GSS9000

Some use cases require all GNSS signal types from just one RF output. To satisfy this requirement on dual-RF GSS9000s, an RF link cable is provided free-of-charge. When required, the RF Link cable is fitted to the rear of the Signal Generator Chassis and it combines all the signals associated with RF2 with those of RF1, outputing them all at RF1[2]. SimGEN allows the user to select an operating mode which compensates for power level and group delay of the re-routed signal path.

GSS9000 C50r SimGEN Host

The Signal Generator Chassis is controlled by a dedicated, rack-mountable C50r SimGEN Host, which is a Spirent proprietary design, multi-processor/core system, configured with a mixed Operating System (OS) environment (Linux and Windows® 10 Professional for Embedded Systems ESD [Virtualisation Only]). This combination of processing power and dual OS provides the perfect platform to enable the GSS9000's new bench-mark performance levels, and to support Spirent's SimGEN™ scenario definition and simulation control software application. The C50r SimGEN Host is supplied with a free-standing monitor, desktop keyboard and mouse.

[1] Optionally, the dual-RF Signal Generator can be configured to generate high-power interference signals on RF output 2 using a dedicated rear panel link cable.

[2] The RF Link Cable can only be used on signal generator chassis without the front-panel high-level ports option fitted. The use of this cable prevents access to the high-level port for RF1 on the rear panel.

Multi-Output Capability

The GSS9000 architecture supports the provision of a multiple-RF output capability where the signal on each radio card can be output via a dedicated N-type RF connector on the front panel. This provides significant flexibility in support of various multi-antenna and/or multi-vehicle test configurations.

This system has been specifically developed to provide the core element in GNSS test applications that require independent access to each simulated satellite signal at RF. Up to 10 independent signal output ports, each with its own dedicated baseband signal generator channel and RF up-converter are provided.

These multi-output RF options are commonly supplied as Tailored Solutions. Applications include:

- **CRPA[3] - Control unit testing**. The system can be integrated with a user-supplied multi-element RF phase shift or delay matrix to produce an RF wave-front at multiple simulated antenna elements.
- **CRPA - System Testing**. The system can be used as the signal generator attached to multiple transmission antennas installed in an anechoic chamber. The antennas are spatially distributed to present the appropriate arrival vectors of the simulated satellite signals at the antenna site. Interference sources can then be located anywhere in the chamber to represent different test cases. This is the only possible alternative to live testing of a complete CRPA system, including the actual antenna. By mounting the antenna on a rate table that replicates the attitude changes of the simulated vehicle platform, comprehensive evaluation of all aspects of the CRPA system can be achieved in a secure environment, free from unintentional interference, both incoming and outgoing, and free from external observation.
- **Radiated Testing**. Using an anechoic chamber with radiating antennas, the system can provide spatial signal diversity for testing items such as GPS-equipped mobile telephones and PDAs through the actual antenna. Items such as reflectors, signal attenuators can be physically placed adjacent to the unit under test to emulate environments.
- **Indoor GPS**. With appropriate real-world time synchronisation and transmission antennas, the system can form the basis of an experimental indoor GPS implementation.

For further information on this configuration, see reference MS9790. If you are interested in GSS9000 multi-output capabilities, please contact Spirent to discuss your requirements.

Multi-Chassis Capability

The GSS9000 can be configured to include up to 4 Signal Generator Chassis controlled as a coherent system via a single C50r and one SimGEN scenario. This configuration is suitable for applications in which multiple multi-GNSS antennas are required, and/or an increase in the number of simulated satellites is needed.

Spirent can provide equipment rack solutions to house GSS9000 systems consisting of multiple components. Depending on the system configuration, ancillary components may be required to distribute, synchronise and combine signals from more than one chassis. These include a Signal Distribution Unit (for systems with more than two chassis) and a Multi-chassis Combiner Unit. If these elements are required for your system configuration these will be detailed on the quotation.

Please note that the performance of GSS9000 in multi-chassis configurations can vary depending on several factors. Please refer to the Performance in Multi-Chassis Configurations section for more information.

The scalability of the GSS9000 architecture enables configurations with significantly more than 4 Signal Generator Chassis. Please, discuss your requirements with Spirent's Tailored Solutions team.

[3] Some CRPA systems are subjected to a valid customer export license to export from the UK.

GNSS Constellations

The GSS9000 architecture supports GNSS signal generation capability in a very flexible way. With the appropriate constellation feature licence keys, each generic radio card can support **– at any one time –** any one of the constellation/frequency variations as shown in **Table 1** (for current ICD compliance, see **Table 19**).

The combinations of constellations generated can vary from scenario to scenario and even between successive runs of the same scenario, depending on the settings in SimGEN. The principle is that at an instant in time, signals from any constellation can be generated provided there is a valid feature licence key and an available radio card in the system.

Table 1: Supported constellations and frequencies*

Variation	Constellation	Frequency
1	GPS/SBAS*	L1
2	GPS	L2
3	GPS/SBAS*	L5
4	Galileo	E1
5	Galileo	E5
6	Galileo	E6
7	GLONASS	F1
8	GLONASS	F2
9	GLONASS	L1
10	GLONASS	L2
11	GLONASS	L3
12	BeiDou	B1I
13	BeiDou	B2I, B2B
14	BeiDou	B1C
15	BeiDou	B2A
16	BeiDou	B3I
17	SBAS*	L1
18	SBAS*	L5
19	QZSS	L1
20	QZSS	L2
21	QZSS	L5
22	QZSS	L6
23	NavIC (IRNSS)	L5
24	Others**	-

*In addition to the support of GPS-based SBAS augmentations (WAAS, EGNOS, MSAS, GAGAN) and SDCM on any dedicated GPS radio card, it is possible to have a radio card solely generating SBAS augmentations.

**Please contact Spirent for further information if you have a requirement for capability not explicitly detailed in this specification.

Authorised Testing[4]

GPS Authorised Testing

The GSS9000 supports GPS authorised testing via a range of additional options (see Related Brochures, Data Sheets and Specifications referenced within this datasheet specification). **In all cases, the options are available for authorised users only**.

Standard product broadcasts a spectrally representative “M-Noise” signal from each satellite when enabled, with no data message.

[4] Please see relevant datasheets for the authorized testing products.

Selective Availability/Anti-Spoofing (SA/A-S) simulation is available for GSS9000 as an option. The applicable package is SimSAAS (for customers in USA) or SimCLASS (non-US).

MNSA M-Code requires the SimMNSA option which is available for US authorised users only.

AES M-Code requires the SimMCODE option – US customers can purchase directly from Spirent subject to approval by US authorities; non-US customers can only purchase SimMCODE software via Foreign Military Sales (FMS) program.

SDS-M-Code requires the SimMCODE and SDS-M-Code via data server option[5] – US customers can purchase directly from Spirent subject to approval by US authorities; non-US customers can only purchase SDS software via Foreign Military Sales (FMS) program.

Further detail is given in ***Detailed Performance Specifications***.

Galileo Authorised Testing

Galileo FOC authorised testing can be supported with the Public Regulated Signal (PRS) at E1 and E6 and the encrypted part of the Commercial Service (CS) at E6. Full PRS requires the PRS[WARE] upgrade option. Full CS requires the SimCS upgrade option, (which also enables Safety-of-Life at E5). Both PRS[WARE] and SimCS provide the required full PRN data for the respective signals they support (non-authorised users are only supplied with 'dummy' data for these signals).

In all cases, the options are available for authorised users only.

Order processing for the "PRS[WARE]" solution is entirely managed by LZE GmbH of Erlangen, Germany, with Munich-based Fraunhofer IIS having complete responsibility for the current and future development, fulfilment and support of PRS[WARE] operating on the Spirent GSS9000 and future Spirent GNSS test solutions.

Fraunhofer IIS is the sole owner of PRS[WARE] software/firmware, therefore, all issues and questions relating to PRS and PRS[WARE] must be directed to Fraunhofer IIS.

Spirent cannot provide any support relating to PRS, please contact LZE and Fraunhofer IIS directly for all questions relating to the PRS capability and ordering.

LZE can be contacted as follows:

LZE GmbH, Tel: +49 9131 92894-85, contact@prs-ware.de

[5] SDS-M-Code via data server option is not a customer in-field upgrade.

Spirent GSS9000 GNSS Simulator

GSS9000 Software: SimGEN™

SimGEN™ is the world's leading GNSS simulation software for test scenario definition, execution, data management and GNSS RF constellation simulator command and control. With the fullest capability, features and performance continuously developed in close consultation with GNSS system authorities over more than 30 years, SimGEN™ supports all the GNSS test parameters and control capabilities needed for comprehensive GNSS testing for research, development and design of GNSS systems, services and devices across any application.

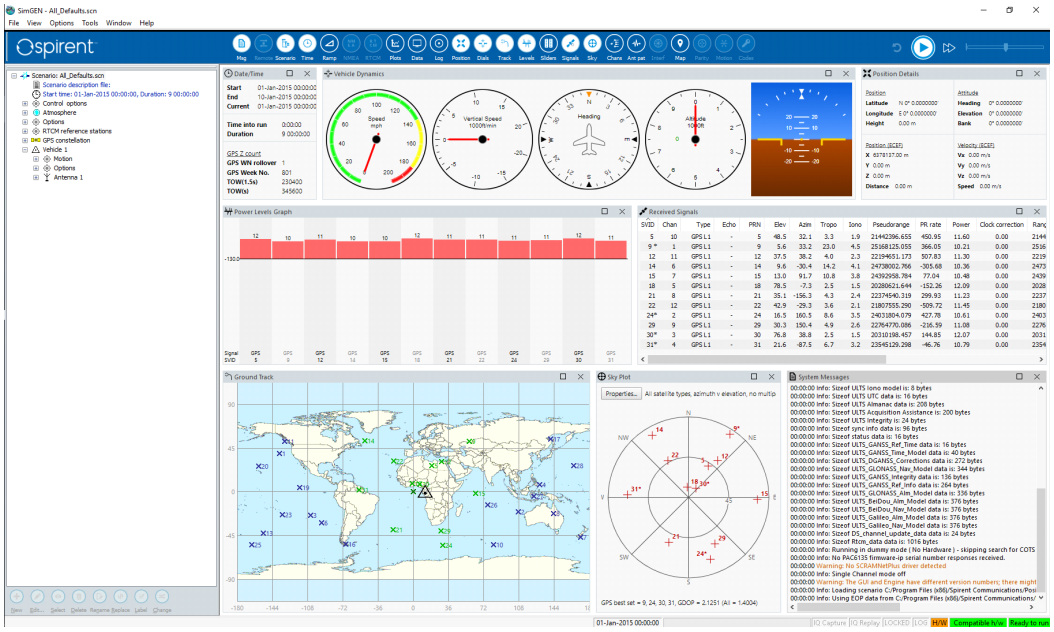


Figure 2: SimGEN scenario definition and simulation control software

Some of SimGEN's fundamental performance and modelling capabilities include:

- Fully automatic and propagated generation of precise satellite orbital data, ephemerides and almanac
- Multiple mechanisms for applying declared and undeclared errors and modifications to navigation data, Satellite clocks and orbits
- Comprehensive simulation control and 6-DOF trajectory delivery capability via SimREMOTE. Flexible API available for programming languages and software environments such as C++ and LabVIEW.
- Data logging and streaming of signal, time, control, vehicle and trajectory data over a variety of interfaces in real-time and to file
- Range of models for multipath reflections and terrain obscuration.
- Independent satellite signal power, modulation and code control
- Multi-copy constellations
- In-built customisable vehicle dynamics models for aircraft, spacecraft, marine vessels and land vehicles
- Reception and satellite transmit antenna gain and phase pattern control
- Clock g-sensitivity
- Antenna lever arm effects
- Ionosphere and Troposphere effects including ionospheric scintillation
- DGPS corrections
- Pseudorange ramps (for RAIM testing)
- Coherent and non-coherent Interference and noise modelling (with optional GSS7765 Interference Simulation System)
- Spoofing testing option
- Leap-second and week roll-over event testing

More information about the capabilities of SimGEN™ can be found in the separate specification document, see **Table 18**.

Additional Options

Interference Testing

The GSS9000 counts with several options for interference testing including: embedded generation of interference signals using SimGEN, use of I/Q files with user-defined interference and a turn-key solution with an interference simulator to generate high-power interference signals.

Embedded Interference

Interference I/Q Files

External Interference Simulator

Embedded Interference

The embedded interference option allows users to natively generate L-band interference alongside GNSS signals with their GSS9000 GNSS Simulator. A wide range of signal types and options is supported, including CW, FM, AM, PM, AWGN, BPSK and CW pulses. Users can predefine their interference waveforms and simulate all the corresponding RF environment without the need of external hardware or I/Q files.

See

Table 13 for further information on the signal types supported and the definition parameters.

Custome Waveform using I/Q Files

The GS9000 allows the generation of high-power custom waveform interference from user supplied I/Q files, alongside standard SimGEN GNSSS signals, using the 2RF interference-capable chassis architecture. Via the SimIQ Replay Interference feature key, SimGEN allows the definition of transmitters objects that can be associated with the replayed I/Q file. This association brings additional realism to the I/Q-based simulation by applying the corresponding attenuation power levels to the signal replayed from the I/Q file depending on the distance travelled from the transmitter to the antenna. Transmitters can have an absolute or relative position to the vehicle under test.

The SimIQ Replay interface also comes with a series of tools to facilitate I/Q testing in the lab. These include:

- Looping I/Q files: Automatically loop I/Q file pre-defined sequencies when I/Q playback has been completed. Consequently, there is no need to have the I/Q files in the right scenario length or to store very large I/Q files.
- Creating I/Q playlists: Generate a playlist of multiple I/Q files to be replayed in a predefined order. This allows maximum flexibility and the recreation of different environmental conditions in simulation.
- Randomising I/Q files: Select a group of I/Q files that will be replayed a random order. Essential to apply machine learning in Rx development to avoid signal patterns over time.

For further information on SimIQ Replay Interference and the use of I/Q files with the GSS9000, see reference MS3108.

External Interference Simulator

The GSS9000 can be combined with Spirent's external interference simulator, the GSS7765, to offer a comprehensive solution for testing satellite navigation equipment in the presence of intentional or unintentional RF interference. The GSS7765 offers a very broad range of interfering signal options, which may be used to represent a varied array of threat sources. The interference signals available include Continuous Wave (CW), AM and FM (pulsed signals also available). The interference simulator also supports noise generation with variable bandwidth.

This solution is fully compatible with the embedded interference and I/Q interference options, providing a wide variety of interference types at a large power and frequency range. The seamless integration with the GSS9000 offers full support for SimGEN scenarios and control over the interference signal content and dynamics.

For further information on the GSS7765 interference simulator, see reference MS3055.

Spirent GSS9000 GNSS Simulator

Spoofing Testing

Either through the embedded spoofing capabilities of the GSS9000 or via additional software applications already integrated with the simulator, GSS9000 users can evaluate the spoofing risks to safety and liability-critical systems. The optional spoofing feature covers cases such as meaconing, code/carrier attacks, navigation data attacks, application-level spoofing and multi-method attacks.

Embedded Spoofing **SimSAFE**

Embedded Spoofing

The Spoofing feature for the GSS9000 comprises built-in and user-configurable capabilities to generate spoofing scenarios in SimGEN®, such as trajectory spoofing, navigation data spoofing and meaconing attacks. It can simulate up to **4** independent spoofers in a given scenario, allowing user definition of the following parameters, for each spoofer:

- Number of spoofer transmitters (up to 64) and their location (absolute or vehicle relative)
- Power level selection; fixed or modelled
- False vehicle position (spoofed position)
- Spoofing signal content selection, including navigation data and errors

The resulting spoofer RF signal will be automatically calculated by SimGEN® based on user scenario settings, with the correct spoofer signal arrival angle and spoofer signal content. Spoofing is supported on the four GNSS (GPS, GLONASS, Galileo, BeiDou) and IRNSS, provided that the appropriate constellation feature licence keys are present on the GSS9000. Dedicated spoofing channels which are available only for spoofing can be provided.

SimSAFE

SimSAFE is an additional software application that interfaces with SimGEN and GNSS receivers to facilitate laboratory evaluation of receiver's vulnerabilities. It allows user-defined modification of key parameters (e.g., power, pseudo-range, navigation message content) of the spoofing signal with respect to its reference or genuine signal, while monitoring the device under attack.

For further information on SimSAFE, see reference MS3092.

Non-SIS ICD Signals

The GSS9000 is built upon a flexible hardware architecture that allows the generation of user-definded RF signals. Custom waveforms, noise, interference or non-current ICD SIS can be easily generated at RF using the GSS9000 flexible signal simulation or directly injected using I/Q files.

Flexible Signal Simulation

User-Defined Signals from I/Q

Flexible Signal Simulation

FLEX simulation comprises built-in and user-configurable control and set-up of non-current SIS ICD PRN codes, navigation data content, navigation data rate, chipping rate, edge shaping, and modulation types, as shown in **Table 2**.

A single GSS9000 can support 8 or 16 FLEX transmitters or SVs, each with 2 or 3 FLEX signals respectively (comprising a primary and secondary code).

Table 2: FLEX Signal Definitions

Parameter	Value	Units
Carriers	L1,L2,L5,E1,E5[6],E6,B1,B2,QZL1	
Codes	Two or three user-definable signals per SV	
Code Assignment	+I, -I, +Q, -Q	
Code Definition	User-definable memory codes (primary and secondary for each Flex signal)	
Base Chip Rate	1.023	Mcps
Chip Rate Multiplier	1, 2, 2.5, 3, 4, 5, 6, 7, 8, 9, 10	
BOC Rates Multiplier	Integer multiple of Base Chip Rate	
Nominal Signal Level	-123 to -133	dBm
Nav Message	Standard for constellation	

For further information on FLEX, please contact you Spirent representative.

User-Defined Signals from I/Q

SimIQ Replay allows the generation of user-defined RF signals from I/Q. With SimIQ Replay, the GSS9000 can generate RF from up to 3 simultaneous L-band I/Q files, allowing sample rates up to 60 Msps and up to 16-bit bitdepth.

For further information on SimIQ Replay Interference and the use of I/Q files with the GSS9000, see reference MS3108.

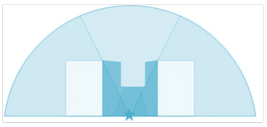
[6] Galileo E5 AltBOC signal structure is not supported.

Spirent GSS9000 GNSS Simulator

Multipath Testing

Spirent offers the most comprehensive test solutiions against multipath and obscuration effects. Not only supports by default a configurable feature for embedded multipath, but can also generate multipath based on a virtual 3D-scene via Sim3D.

Embedded Multipath



Modelled Multipath

Realistic 3D Environment

Embedded Multipath

The GSS9000 can generate up to 4 multipath channels per satellite signal source. These multipath channels are delayed and attenuated copies of the primary channel and are applied to the first 16 channels of each SDR radio card. The delay and attenuation of each path is user-specified. This includes real-time modification of the individual embedded multipath channels in terms of power level (up to -60 dB) and code delay (up to 4000 m) through a remote interface.

Modelled Multipath

The embedded multipath simulation capability is in addition to the comprehensive multipath modelling supported by SimGEN that uses spare generator channels, see **Table 18**. The modelled multipath provides full control of multipath signals, including navigation data, using independent channels, upon licensed allowance.

SimGEN supports different models for multipath signals that can be applied to 1 or more echoes of the LoS. They range from basic statistical (sinusoidal multipath and fifth-order polynomial and Legendre multipath) and offset models (range, power or doppler offset) to more complex simulation models to represent the ground reflections (including range and AoA computations), signal reflections from building surfaces in an urban environment (vertical plane) or the use of predefined echoes that change depending on the vehicle's motion (reflection pattern and land mobile multipath).

Realistic 3D Environment

Via Sim3D, the GSS9000 offers a unique approach to simulating multipath and obscuration effects based on a synthetic environment and an advanced GNSS propagation model. The propagation model relies on a 3D-scene, which is used to generate the multipath and obscuration signature that strictly depends on the location of the receiver's antenna.

Sim3D full solution supports all constellations, frequencies and codes currently simulated by the GSS9000 in static and dynamic scenarios (including dynamic trajectory generation – HIL). It can simulate up to 31 multipath signals per LoS and up to 6 reflections per multipath computed. It supports user-defined filtering algorithms (to simulate only multipath in chosen delay/power ranges) and counts with a real-time visualisation of the multipath angle of arrival (see Figure 3).

For further information on Sim3D, see reference MS3105.

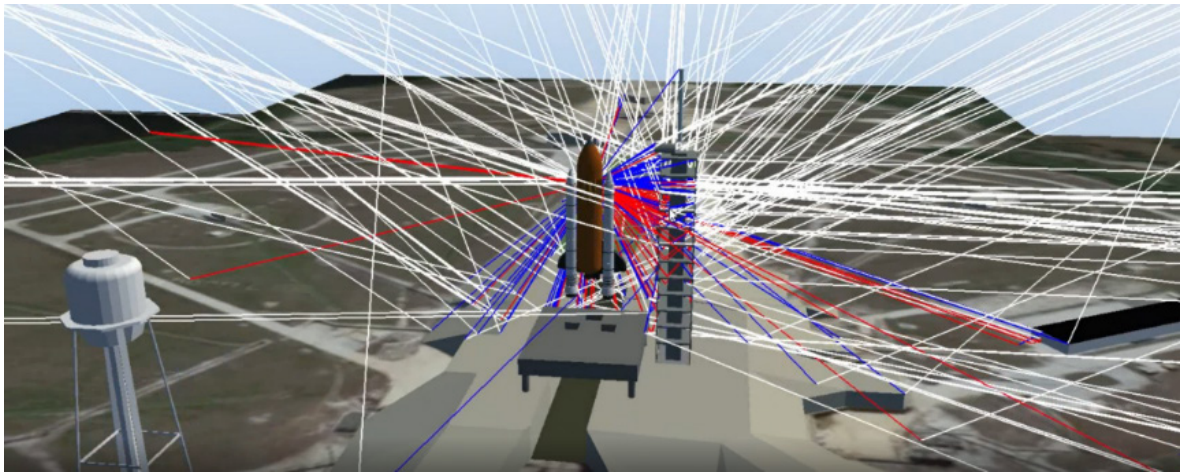


Figure 3: Real-time computation of the multipath effects during a space shuttle launch

Complementary PNT Sensor Simulation

The GSS9000 can generate other sensor data closely aligned with GNSS signals based on an input trajectory. The range of sensors and signals supported include accelerometers, gyroscopes, magnetometers, compasses, barometers, GBAS Landing Systems data and LEO satellite signals for altnernative navigation.

Inertial Sensors **GBAS**

Inertial Sensors

Coupled with Spirent's GSS9000, and powered by SimGEN, Spirent's inertial simulation tools provide real-time emulation of raw measurements that can be fed into filters within the positioning engine.

Spirent's inertial simulation tools enable users of embedded GPS/inertial systems (EGIs), individually coupled GNSS/INS systems (IGIs) or standalone IMUs to simulate coherent GNSS and sensor measurements to evaluate the positioning algorithms. Modelling physical sensors using accurate error parameters in our simulation environment enables users to tune integrations and algorithms prior to deployment.

Via SimINERTIAL™, the GSS9000 provides full support for a wide variety of data interfaces, formats and sensors, including accelerometers, gyroscopes, magnetometers, compasses and barometers.

For further information on SimINERTIAL, see reference MS3030.

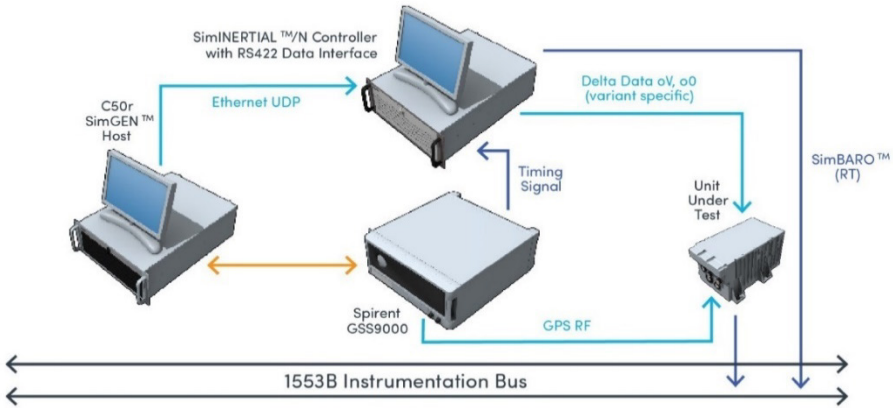


Figure 4: SimINERTIAL Typical Configuration

GBAS

The GBAS VHF, also known as GSS4150, is a turn-key solution that can bee added to the GSS9000 in order to meet RNP for precision guidance of aircraft approach and landing operations. The GSS4150 delivers simulated GBAS Landing System data via VHF, at low power levels.

For further information on the GSS4150, see reference MS3014.

Remote Control

In addition to its native Ethernet remote control facility, the GSS9000 can be configured to utilise GPIB and SCRAMNet. Via SimREMOTE, the GSS9000 can be controlled remotely allowing the following functions within a Hardware-In-the-Loop set-up:

- Simulation control: such as selecting scenarios, start/stop and run-time control.
- Signal modification: finite manipulation of signal phase, delay and Doppler plus enabling/disabling of codes/data.
- Trajectory delivery: 6DOF trajectory delivery in real-time of from a file up to 2000Hz update rate.

All commands are time-stamped and multiple commands can be scheduled for the same timestamp. For further information see reference MS3015.

Open-source APIs are also available to support third-party applications in programming languages (such us C++) and test environments (such us LabVIEW).

Additional Features

Subscription Licenses

The flexibility of the GSS9000 allows constellations and frequencies to be temporarily enabled on a subscription-based model. This is particularly useful if the system is to be used for short to medium-term projects requiring additional constellations and/or additional satellite signals for a defined period. An existing GSS9000 system can have additional feature(s) enabled by providing the user with a suitably revised software licence key.

If licences are consecutively renewed for a requisite number of times, the feature becomes permanent and the licence runs in perpetuity.

System Upgrades

The extensibility of the GSS9000 means that **in-field upgrading** of the system can be achieved easily, flexibly and in a way which matches the developing needs of your testing requirements as closely as possible.

- Existing radio cards can be issued with new licence keys.
- Additional constellation licences can be added allowing other signal types to be enabled.
- New radio cards can be added to enable signal types using existing feature keys.
- Both radio cards and new feature keys can be added in the field. It is not necessary for the system to be returned to Spirent.

Additional upgrade options are listed in the Related Product References, see **Table 18**. Please contact Spirent to discuss your requirements.

System Calibration

Spirent Positioning Technology calibrate the GSS9000 simulator to the ISO/IEC 17025 standard. This Accredited Calibration comes with a default 12-month calibration period. Annual re-calibration must be carried out at a Spirent facility or accredited laboratory to maintain this accreditation.

Please note that installation of additional purchased radio cards or performing calibrations outside of a Spirent authorized ISO/IEC17025 accredited laboratory will invalidate this accredited calibration.

This includes customer use of the Auto Calibration Utility (where installed) and certain upgrade procedures. Customers are advised to refer to procedural documentation for further details.

For more information on Spirent’s calibration service, seen reference MS3089. Customers who require more information on how to renew the annual accredited calibration, may contact their local Spirent representative.

Detailed Performance Specifications

GNSS Signals

Table 3: Nominal Signal Levels[7]

System	Carrier	Signal	Level
GPS	L1	C/A	-130.0 dBm
		L1c Pilot code	-128.25 dBm
		L1c Data code	-133.0 dBm
		P	-133.0 dBm
		M Noise	-128.5 dBm
	L2	L2c or C/A	-136.0 dBm
		P	-136.0 dBm
		M Noise	-132.5 dBm
	L5	I, Q	-127.9 dBm
Galileo	E1	E1-A	-125.5 dBm
		E1-A PRS Noise	-125.5 dBm
		E1-B, E1-C (50/50 power sharing)	-128.0 dBm
	E6	E6-A	-125.5 dBm
		E6-A PRS Noise	-125.5 dBm
		E6-B, E6C (50/50 power sharing)	-128.0 dBm
	E5ab	E5a(I+Q) and E5b(I+Q) (50/50 power sharing)	-122.0 dBm
GLONASS	F1	C/A	-131 dBm
		P	-131 dBm
	F2	C/A	-137 dBm
		P	-137 dBm
	L1	L1OC	-128.5 dBm
	L2	L2OCp	-128.5 dBm
	L3	L3OC	-128.5 dBm
BeiDou	B1 (1.561098 GHz)	B1I	-133 dBm
	B1 (1.57542 GHz)	B1C	-130 dBm
	B2 (1.20714 GHz)	B2I	-133 dBm
	B2 (1.17645 GHz)	B2A	-127 dBm
	B2 (1.20714 GHz)	B2B	-130 dBm
	B3 (1.26852 GHz)	B3I	-133 dBm
QZSS	L1	C/A, C/B	-128.5 dBm
		S	-131 dBm
		L1c Data + Pilot	-127 dBm
	L2	L2c	-130 dBm
	L5	I + Q	-124.9 dBm
		S	-127 dBm
	L6	D+E	-126.82 dBm[8]

7 Nominal signal power levels as defined by Spirent. Through SimGEN, the user has extensive facilities to adjust these nominal power levels to meet individual GNSS ICD conditions.
8 Default power level setting is for Block II satellites.

NavIC (IRNSS)	L5	C/A	-130 dBm
FLEX	All	User-Defined	User-Defined

Table 4: Navigation Messages Types per Constellation

Constellation	Message Type	Applicable Signal	Requirements	Notes
GPS	Legacy	C/A, P, Y	Support for Y code requires SimCLASS/SimSAAS Option	
	CNAV	L2c, L5-I		
	CNAV-2	L1c		
	MNAV	AES-M, M, MNSA	MNSA-M requires SimMNSA option. AES-M requires SimMCODE option. M requires SimMCODE and SDS-M-Code via data server options	
Galileo	I/NAV	E1-B, E5b-I	OS Galileo – Excludes SOL support FOC Galileo – Includes SOL support	
	F/NAV	E5a-I	OS Galileo – Supported FOC Galileo – Supported	
	C/NAV (HAS)	E6-B	HAS Galileo – Supported PRS Galileo – Requires 3rd party PRS[WARE] product	
	G/NAV	E1-A, E6-A	PRS Galileo – Requires 3rd party PRS[WARE] product	
GLONASS	Public	L1-C/A, L2C/A		There is no data message on the GLONASS P-Code
	L1OC	CDMA L1		
	L3OC	CDMA L3		
BeiDou	D1 and D2	B1I, B2I, B3I		D2 does not include differential corrections or Iono grid
	B-CNAV1	B1C		
	B-CNAV2	B2A		
	B-CNAV3 and PPP-B2b_I	B2B		
SBAS	Data	L1		
	DFMC Data	L5-I		
QZSS	QZ-Legacy	L1 C/A, L1 C/B		
	SLAS	L1S		
	QZ-CNAV	L2c, L5-I		
	QZ-CNAV-2	L1c		
	CLAS	L6D		
	CLAS-E (MADOCA)	L6E		

NavIC	IRNSS legacy	C/A	
FLEX	Standard	All	See **Table 2**

GPS Simulation

The supported ranging signal types of the GPS constellation are shown in **Table 5**.

Table 5: GPS Signals

Carrier	Standard Signal Types	Optional Signal Types	Notes
L1	C/A, L1c Data/Pilot, P, M Noise, Pseudo Y	Y, MNSA-M, AES-M and SDS-M-Code via data server, GTx	"Pseudo-Y" code is generated through public-domain encryption of P-code to fully support L1/L2 squaring or 'Z-tracking', with data message. "M Noise" is a spectrally representative M-Code signal from each satellite when enabled, with no data message. See section GPS Authorised Testing for information on optionally available GPS authorised signals.
L2	L2c, P, Pseudo Y, M Noise	Y, MNSA-M, AES-M and SDS-M-Code via data server, GTx	C/A code is also supported as on this carrier as an alternative to L2c. See section GPS Authorised Testing for information on optionally available GPS authorised signals.
L5	I, Q	N/A	N/A

SBAS Simulation

SBAS (defined as WAAS, EGNOS, MSAS, SDCM and GAGAN) simulation capability is included with GPS configurations at L1 and/or L5. Note that SBAS uses available GPS channels when choosing channel count for GPS L1 and L5. In addition, a separate SBAS licence key can be purchased which allows SBAS to be run on a separate radio card, without the need to 'use up' GPS L1 or L5 channels.

The supported ranging signal types of the SBAS constellation are shown in **Table 6**.

Table 6: SBAS Signals

Carrier	Standard Signal Types
L1	C/A
L5	I

Galileo Simulation

The supported ranging signal types of the Galileo constellation are shown in **Table 7**.

Table 7: Galileo Signals

Carrier	Standard Signal Types	Optional Signal Types	Notes
E1	PRS Noise, OS Data/Pilot	PRS via 'PRS[WARE]'	See section Galileo Authorised Testing for information on Galileo authorised signals
E6	E6-A, E6-B, E6-C, PRS Noise	PRS via 'PRS[WARE], CS Data/Pilot (with encryption)	

E5ab	E5a Data/Pilot, E5b Data/Pilot	N/A	E5ab signalling employs 8-PSK modulation of E5a and E5b onto a single carrier. Appropriate carrier dispersion is applied from E5a to E5b

Galileo Open Service (OS) ICD support is supplied as standard. Optional support for Galileo Full Operational Capability (FOC) signals is available with Spirent's **SimCS™** option, subject to user status.

Galileo PRN data is available form a user definable file. Open Service users are supplied with PRN data for the E1B/C and E5a signal components, PRN data for other signal types is 'dummy data'.

FOC authorised users are supplied with PRN data signal for all signal types, except for PRS. PRS requires the third-party extension **PRS[WARE]** upgrade, see section Galileo Authorised Testing.

GLONASS Simulation

The supported ranging signal types of the GLONASS constellation are shown in **Table 8**.

Table 8: GLONASS Signals

Carrier	Signal types
F1	C/A, P (Chan Number -7 to +6)
F2	C/A, P (Chan Number -7 to +6)
L1	L1OC
L2	L2OCp
L3	L3OC

BeiDou Simulation

The supported ranging signal types of the BeiDou constellation are shown in **Table 9**.

Table 9: BeiDou Signals

Carrier	Signal types
B1 (1.561098 GHz)	B1I
B1 (1.57542 GHz)	B1C
B2 (1.20714 GHz)	B2I, B2B
B2 (1.17645 GHz)	B2A
B3 (1.26852 GHz)	B3I

Quasi-Zenith (QZSS) Simulation

The supported ranging signal types of the Quasi-Zenith constellation are shown in **Table 10**.

Table 10: QZSS Signals

Carrier	Signal types
L1	S, C/A, C/B, L1c
L2	L2c
L5	C/A, I + Q
L6	L6D, L6E

NavIC (IRNSS) Simulation

The supported ranging signal types of the Quasi-Zenith constellation are shown in **Table 11**.

Table 11: NavIC Signals

Carrier	Signal types
L5	C/A
S	Available as a Tailored Solution only – please contact Spirent

Spirent GSS9000 GNSS Simulator

System Performance

Table 12: Performance Levels for GSS9000

Parameter	Detail		Value	Foot note
RF Signal Level	Carrier Level Control	Maximum	+20 dB	9
		Minimum	-40 dB	10
		Resolution	0.1 dB	
		Linearity +20 dB to -30 dB -30.1 dB to -40 dB	<0.10 dB <0.20 dB	
	Absolute Accuracy Run to Run Repeatability		±0.5 dB ±0.1 dB	11
Configurable Iteration Rate	Supported SimGEN Simulation Iteration Rates (SIR)		10, 100, 250, 500,1000, 2000 Hz	12
	Hardware update rate		1000, 2000 Hz	
Limit of Signal Dynamics	Relative Velocity		120,000 m/s	13
	Relative Acceleration		192,600 m/s^2	14
	Relative Jerk		890,400 m/s^3	
	Angular Rates (indicative)	(at 1.5 m lever arm) (at 0.05 m lever arm)	>15π rad/s >60π rad/s	
Signal Accuracy	Pseudorange Accuracy		0.3 mm RMS	15
	Pseudorange Bias		0 mm RMS	16
	Delta-range Accuracy		< ±1.0 mm RMS	
	Inter Frequency Alignment		< ±230ps (±69mm)	17
	1PPS to RF Alignment		< ±2 ns	18
Spectral Purity	Harmonics		< -40 dBc	
	In-band Spurious		< -182 dBW	19, 20
	Phase Noise (single sideband)		< 0.005 Rad RMS	21
Signal Stability	Internal 10.00 MHz OCX Oscillator (after warm up)		± 5 x 10-10 per day	

9 Maximum signal level of +20 dB is available for up to 16 channels per radio card. A maximum of +17 dB is supported for up to 32 channels per radio card.
10 The control range extends to -50 dB, but performance is unspecified below -40 dB.
Operation below -20 dB is primarily to support antenna pattern and multipath functionality.
11 RSS at 21±5°C, +20 to -30 dB. ±1.5 dB 3-sigma, all conditions.
12 2000 Hz SIR supports up to 80 simultaneous channels (or up 5 radio cards with 16 channels each) per simulation run, up to 24-hour duration and 7 different constellation/frequencies per scenario.
13 For 6-DOF data externally supplied via SimREMOTE or from data file.
14 When operating at >=250 Hz SIR.
15 For signal acceleration < 450 m/s^2, jerk < 500 m/s^3, 1000 Hz SIR.
16 Single radio card – supporting up to 32 channels. When the same signal is generated across multiple radio cards the inter radio card bias uncertainty is +/-230ps (+/-69mm).
17 PRN code alignment between frequency band.
18 Between any RF carrier at the output port(s). Applicable for both single and multi-output systems.
19 For relative velocities <50,000 m/s.
20 In-Band Spurious Bandwidths (relative to centre frequency unless otherwise stated):
GPS: L1 ± 20.5 MHz, L2 ± 20.5 MHz, L5 ± 20.5 MHz
Galileo: E1 ± 20 MHz, E6 ± 20 MHz, E5a ± 25.5 MHz, E5b ± 25.5 MHz
GLONASS: (relative to channel frequency 0) L1 ± 20 MHz, L2 ± 20 MHz
BeiDou: B1/B2 ± 20.5 MHz
21 Value is typical, integrated over a 1 Hz to 10 kHz bandwidth. Worst case < 0.01 rad RMS.

Static Multipath Channels	Fixed path-length delay per path	0 to 1245 m
	Resolution (approximately)	2.4 m

Table 13: Interference Signals (GTx) Performance

Parameter	Detail	Value	Footnote
Signal sources	Per centre frequency	Configuration dependant	22
Frequency Bands		Centre frequency	23
	GPS L1	1.57542 GHz	
	GPS L2	1.2276 GHz	
	GPS L5	1.17645 GHz	
	Galileo E1	1.57542 GHz	
	Galileo E5	1.191795 GHz	
	Galileo E6	1.27875 GHz	
	GLONASS L1	1.602 GHz (F0)	
	GLONASS L2	1.246 GHz (F0)	
	BeiDou B1i	1.561098 GHz	
	BeiDou B2i	1.20714 GHz	
	BeiDou B2a	1.17645 GHz	
	BeiDou B2b	1.20714 GHz	
	BeiDou B1c	1.57542 GHz	
	BeiDou B3i	1.26852 GHz	
Carrier frequency offset	Independent for each source Range Resolution	 ± 25 MHz 0.5 kHz	24
Signal Purity	Unmodulated in-band spurious Modulated in-band spurious	≤ -60 dBm < 40 dBc	
CW	Power	See ‘RF Signal Level’	
BPSK	Power	See ‘RF Signal Level’	
	Narrowband main lobe width Broadband main lobe width	0.1023 MHz 20.46 MHz	
CW Pulse	Power	See ‘RF Signal Level’	25
	Pulse width	1 to 10000 µs	
	Pulse repetition interval range	50 to 10000 µs	
	Pulse repetition interval resolution	50 µs	
	Rise time (10% to 90%)	100 ns (max)	
	On/Off ratio	30 dB	

22 For civilian GNSS signals.
23 Subject to licence.
24 In addition to Doppler caused by vehicle motion. Applies to all signal types.
25 At 100% duty cycle. Average power reduces in proportion to duty cycle.

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Parameter	Detail	Value	Footnote
AWGN	Power	See 'RF Signal Level'	
	3 dB **Variable** Bandwidth	From 0.1 to 20 MHz	
	Bandwidth Resolution	0.01 MHz	
	Bandwidth accuracy	±5%	
FM CW	Power	See 'RF Signal Level'	
	FM deviation	±0.01 to ±15 MHz	
	FM rate	0.005 to 10 kHz	
	FM rate step size	0.005 kHz	
	Modulating Waveform	Triangular	
AM	Power	See 'RF Signal Level'	
	Modulation depth	10 to 90%	
	Modulation depth step size	10%	
	AM rate	0.5 to 10 kHz	
	Modulating Waveform	Sinusoidal	
PM	Power	See 'RF Signal Level'	
	Modulation deviation	±0 to ±5 rad	
	PM rate	0.5 to 10 kHz	
	Modulating Waveform	Sinusoidal	
Chirp	Power	See 'RF Signal Level'	
	Deviation	±0.01 to ±15 MHz	
	Sweep Rate	±0.005 to 50 kHz	
	Modulation Type	Sawtooth	
RF Signal Level	Single signal	-47 dBm (max)	26
	Multiple signals	-72 dBm (max)	27
	Minimum level per signal	-117 dBm	
	Linearity, per signal, >-97 dBm	<0.1 dB	
	Linearity: per signal, > –107 dBm	<0.2 dB	
	Linearity: per signal, > –117 dBm	<0.5 dB	

26 Single signal per radio card (CW, FM, PM, Chirp), -49dBm (BPSK, pulsed CW), -53dBm (AM), -60dBm (AWGN).
27 Per signal, up to 16 signals of AWGN on the same radio card – other signal types can be up to 3dB higher.

Performance in Multi-Chassis Configurations

There is a practical limit to how much data can be reliably processed by the simulation engine at the designated simulation iteration rate. There are many factors that can influence the processing capacity of the simulation system, but in practical terms the main sources are:

- The total number of active radio cards (influenced by the number of antenna outputs in the configuration and the selected signal types).
- The total number of satellite signals (channel density).
- The volume of data logging enabled and the logging rate.

The variety of permutations from these contributing factors is extremely difficult to fully characterise. Instead Spirent provides guidance based on previously explored cases in order to set a reasonable expectation of the performance that can be achieved. For a system with a capability of 256 channels or greater:

- The simulation iteration rate shall be 100Hz
- SimGEN 'truth' data logging capability, during real-time scenario playback, must be limited to bulk logging in binary format OR data-streaming UDP output OR nav data binary dump.
- To access scenario 'truth' data from any other source, or to employ two or more sources concurrently, SimGEN should be run in 'no hardware mode'.

For a system with more than 256 channels, up to and including 512 channels:

- It will be necessary to strike a balance between the increasing channel density and truth data output by:
  - Decreasing the real-time data logging rate; or
  - Needing to rely solely on UDP data-streaming; or
  - Having to disable real-time logging and rely solely on 'no hardware mode' pre/post-processing data capture.

If these operating criteria present a challenge to the intended test application, and for systems of more than 512 channels, Spirent is pleased to discuss the challenges of each user case and to determine whether an alternative system architecture might be suitable in those circumstances, via a Tailored Solution.

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Connectivity

Table 14: Signal Generator Connectivity

Port	Type	Parameter
Main RF Port	Output	N-type coax female, 50 Ω, VSWR <1.2:1 AC coupled ±50 V DC, maximum reverse RF 30 dBm
High Level RF Port	Output	N-type coax female, 50 Ω, VSWR <1.2:1 AC coupled ±50 V DC, maximum reverse RF 30 dBm
Individual RF Ports	Output	N-type coax female, 50 Ω, VSWR <1.2:1 AC coupled ±50 V DC, maximum reverse RF 30 dBm
Auxiliary RF	Input	N-type coax female, 50 Ω, VSWR <1.4:1 0.5 to 2 GHz, Insertion Loss 14.5 dB typical
External Frequency Standard	Input	BNC coax socket, 50 Ω -5 to +10 dBm at 1 MHz, 5 MHz, 10 MHz
Internal Frequency Standard	Output	BNC coax socket, 50 Ω 10.00 MHz at +5 dBm nominal
1PPS IN	Input	BNC coax socket, 50 Ω, TTL level compatible
1PPS OUT	Output	BNC coax socket, 50 Ω, TTL level compatible
Trigger IN	Input	BNC coax socket, 50 Ω, TTL level compatible
PCI Express	Private Bus	Cabled PCIe

Table 15: C50r SimGEN Host Connectivity

Interface	Type	Parameter
PCI Express	Private Bus	Cabled PCIe
USB	I/O	Maximum of 4 spare ports for general file access
Ethernet	I/O	RJ-45 Ethernet interface standard. Used for general network access and available for remote control
Optional GPIB	I/O	Available for remote control and GSS7765 control
Optional ScramNET	I/O	Available for remote control

Physical and Environmental Properties

Table 16: Physical and Environmental Properties

Part	Parameter	Value
Signal Generator	Approximate Dimensions (H x W x D) (19” 4U chassis)	175 mm x 445 mm x 620 mm 6.9” x 17.75” x 24”
	Typical Weight	<30 kg (66 lb) (configuration dependent)
	Operating Environment	+10 to +40°C (50 to 104°F) (40-90% RH, non-condensing)
	Storage Environment	-40 to +60°C (-90 to 140°F) (20-90% RH, non-condensing)
	Electrical Power	100-120 V 220-240 V 4.0 A 2.0 A 48 to 66 Hz 48 to 66 Hz
Standard C50r SimGEN Host	Approximate Dimensions (H x W x D) (19” 4U chassis)	177.8 mm x 426.0 mm (482.0 mm with Rack Mount installed) x 600.6 mm (Not including front handles and front bezel door closed) 7.00” x 16.77” (18.98”) x 23.65”
	Weight (excl. peripherals)	<20 kg (44 lb)
System Mean Time Between (component) Failure (MTBF)	2,562,327	hours (per Bellcore 6)

Accreditation and Compliance

Table 17: Safety and EMC Compliance

Compliance	Applicable Standard
Safety	Low Voltage Directive (LVD) 2014/35/EC IEC 62368-1:2014 (Second Edition) Audio/video, information and communication technology equipment. Safety requirements
EMC	EMC Directive 2014/30/EC EN 61326-1:2013 Electrical equipment for measurement, control and laboratory use. EMC requirements. General requirements
MET	MET Certification. Listing number E113897; MET Project Number 109752 UL 62368-1/CAN C22.2 CSA 62368-1, Second Edition: Audio/video, information and communication technology equipment. Safety requirements

Related Brochures, Data Sheets and Specifications

Table 18: Related Product References

Related Product	Description	Data Sheet / Specification
SimGEN	GNSS Software Suite	MS3008
GBAS	GSS4150 VHF Data Broadcast Simulator for GBAS Product Specification	MS3014
SimREMOTE	Simulator Remote Control Additional Options	MS3015
SimINERTIAL	Inertial Sensor Emulation Option	MS3030
GSS7765	Generic Interference Generator Option	MS3055
SimBARO	Barometric Pressure Emulation Option	MS3056
SimROUTE	Road-Matched Trajectory generation Tool	MS3073
SimSENSOR	MEMS Sensor Simulation Option	MS3086
SimSAFE	Vulnerability Test Tool	MS3092
Sim3D	Real-time Multipath Simulation Software based on a Synthetic Environment	MS3105
SimIQ	I/Q Data Generation and Replay Software Tool	MS3108
SimCLASS	GPS SA/A-S Upgrade Option (Non-USA)	MS9020
SimCS	Galileo FOC Upgrade Option	MS9043
SimMNSA	MNSA M-code Upgrade Option	MS9018
SimMCODE	AES M-Code Upgrade Option	MS9048
SDS-M-Code	SDS-M-Code via server Upgrade to SimMCODE	
GSS9790	GSS9790 Multi-Output Constellation Simulator	MS9790
SimSAAS	GPS SA/A-S Upgrade Option (USA only)	SF1001

ICD Compliance – Applicable Documents

Table 19: ICD Compliance[28]

Constellation	Reference	Title
GPS	IS-GPS-200	Navstar GPS Space Segment / Navigation User Interfaces
	IS-GPS-705	Navstar GPS Space Segment / User Segment L5 Interfaces
	IS-GPS-800	L1C Interface Specification
Galileo	GAL OS SIS ICD	Galileo Open Service Signal-in-Space Interface Control Document
	GAL-ICD-ESA-SYST-X-0027	FOC Galileo Signal-in-Space Interface Control Document
GLONASS	GLONASS SISICD	GLONASS Interface Control Document
BeiDou	BeiDou SIS ICD OS	BeiDou Navigation Satellite System Signal-in-Space Interface Control Document Open Service Signal – B2I
		BeiDou Navigation Satellite System Signal-in-Space Interface Control Document Open Service Signal – B1C
		BeiDou Navigation Satellite System Signal-in-Space Interface Control Document Open Service Signal – B2a
		BeiDou Navigation Satellite System Signal-in-Space Interface Control Document Open Service Signal – B3I
		BeiDou Navigation Satellite System Signal-in-Space Interface Control Document Open Service Signal – B1I
		BeiDou Navigation Satellite System Signal-in-Space Interface Control Document Open Service Signal – B2B
RTCA	DO-246E	LAAS
	DO229	WAAS MOPS
QZSS		IS-QZSS-PNT
		IS_QZSS-L1S
		IS-QZSS-TV
		IS-QZSS-L6
		Correction Data on Centimeter Level Augmentation Service for Experiment Data Format Specification
SBAS	RTCA-DO229	Minimum Operational Performance Standards (MOPS) for Global Positioning System/Satellite-Based Augmentation System Airborne Equipment
IRNSS		ISRO-IRNSS-ICD-SPS
		IRNSS Restricted SPS and RS SISICD
		SISICD for INCOIS messages via Navic messages services
NMEA	0183	NMEA 0183 Interface Standard

28 For the latest ICD compliance, please refer to the latest issue of DGP00686AAA SimGEN software user manual. Compliance assumes that the latest version of SimGEN™ is installed and is being used on the C50r.

RINEX		The Receiver Independent Exchange Format
RTCM	RTCM 10403.2 Amend 1 & 2	Differential GNSS Services – Version 3

Spirent operates a policy of upgrades to meet ICD changes as they are adopted. To obtain ongoing upgrades your system needs to be under warranty or a current support agreement.

Please contact Spirent for current ICD compliance, including for information relating to export-controlled options and those for authorised users that are not shown here.

Glossary of Terms

1PPS	One Pulse-Per-Second
AM	Amplitude Modulation
AWGN	Additive White Gaussian Noise
BITE	Built In Test Equipment
AOC	Auxiliary Output Chip
BOC	Binary Offset Carrier
BeiDou	Chinese GNSS System
BPSK	Binary Phase-Shift Keying
CS	Commercial Service - Galileo
CW	Continuous Wave
DOP	Dilution Of Precision caused by satellite geometry
EMC	Electromagnetic Compatibility
FLEX	Flexible constellation with user defined code and BOC rates
FM	Frequency Modulation
FPGA	Field-Programmable Gate Array – a reconfigurable electronic device
FOC	Full Operational Capability – available to authorised Galileo customers via SimCS
GALILEO	EU GNSS System
GPS	Global Positioning System US GNSS system
GNSS	Global Navigation Satellite System (Galileo +GPS+SBAS+GLONASS+IRNSS+BeiDou)
GLONASS	GLObal NAvigation Satellite System (Russian Federation)
GNSS	Global Navigation Satellite System
GTx	Ground Transmitters – Embedded interference generation
GUI	Graphical User Interface
HAS	High Accuracy Service – Galileo
HUR	Hardware Update Rate
IRNSS	Indian Regional Navigation Satellite System
ICD	Interface Control Document
IEEE-488	An 8-bit parallel Hardware Interface
MTBF	Mean Time Between Failure
NavIC	Navigation with Indian Constellation
NMEA	National Marine Electronics Association
OS	Open Service – Galileo
PM	Phase Modulation
PRS	Public Regulated Service -Galileo
PRS-NOISE	A signal with the same spectral distribution as PRS, but with an arbitrary code structure of the correct chip rate that is phase and frequency correlated with the other Galileo signals
PRN	Pseudo-Random Number, representing the unique transmitted signal code
QZSS	Quasi-Zenith Satellite System
RAIM	Receiver Autonomous Integrity Monitoring
RF	Radio Frequency
RNP	Required Navigation Performance
SBAS	Satellite-Based Augmentation System (such as WAAS, EGNOS, MSAS)
SDR	Software Defined Radio
SDS	SDS-M-Code via data server
SIR	Simulation Iteration Rate
SIS	Signal In Space
SOL	Safety Of Life

Spirent GSS9000 GNSS Simulator

For more information

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About Spirent Positioning Technology

Spirent enables innovation and development in the GNSS (global navigation satellite system) and additional PNT (positioning, navigation and timing) technologies that are increasingly influencing our lives.

Our clients promise superior performance to their customers. By providing comprehensive and tailored test solutions, Spirent assures that our clients fulfil that promise.

Why Spirent?

Over five decades Spirent has brought unrivalled power, control and precision to positioning, navigation and timing technology. Spirent is trusted by the leading developers across all segments to consult and deliver on innovative solutions, using the highest quality dedicated hardware and the most flexible and intuitive software on the market.

Spirent delivers

- Ground-breaking features proven to perform
- Flexible and customisable systems for future-proofed test capabilities
- World-leading innovation, redefining industry expectations
- First-to-market with new signals and ICDs
- Signals built from first principles — giving the reliable and precise truth data you need
- Unrivalled investment in customer-focused R&D
- A global customer support network with established experts

ISO/IEC 17025:2017
The GSS9000 is calibrated to the ISO 17025 standard at the time of delivery.

About Spirent Communications
Spirent Communications (LSE: SPT) is a global leader with deep expertise and decades of experience in testing, assurance, analytics and security, serving developers, service providers, and enterprise networks. We help bring clarity to increasingly complex technological and business challenges. Spirent's customers have made a promise to their customers to deliver superior performance. Spirent assures that those promises are fulfilled. For more information visit: www.spirent.com

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