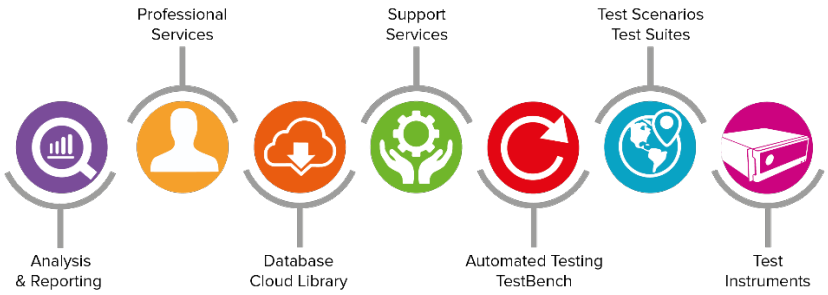
GSS7000 Series GNSS Constellation Simulator



Spirent **GSS7000 Series GNSS Constellation Simulator**

Purpose of this document

This datasheet describes the functionality of the Spirent GSS7000 Series Multi-Frequency, Multi-GNSS RF Constellation Simulators, which sets a new standard of excellence in GNSS RF Simulation for performance testing and evaluation of GNSS systems and devices for civil and consumer applications.

This datasheet also provides technical product specification data and configuration information and is to be used as the basis of a formal quotation or acceptance of a purchase order. Spirent reserves the right to change this specification at any time.

Please speak to your Spirent sales representative to discuss your requirements.

PROPRIETARY INFORMATION

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Introduction

The Spirent GSS7000 Series Multi-Frequency, Multi-GNSS RF Constellation Simulator sets a new standard of excellence in GNSS RF Simulation for performance testing and evaluation of GNSS systems and devices for civil and consumer applications.

The GSS7000 produces a comprehensive range of emulated multi-GNSS, multi-frequency RF signals with class-leading flexibility, coherence, fidelity, performance, accuracy and reliability.

The GSS7000 provides numerous benefits to all those working in GNSS/system technology and application development, including accurate and properly-defined signals, comprehensive and feature-rich simulation and full control of all aspects of the GNSS operating environment, inherent repeatability and the ability to apply systematic errors and incidents that are impossible to realise using real satellite signals.

Application of Spirent's expertise in producing GNSS Test Solutions acquired over the past 30 years, plus advancements in the performance and efficiency of the state-of-the-art core technology on which the GSS7000 is built, means that properly-defined GNSS testing is now more accessible than ever, at the entry-level for fundamental testing, and right through the series to the most capable configuration for advanced testing.

These benefits, together with Spirent's proven global expertise and support make the Spirent GSS7000 Multi-Frequency, Multi-GNSS RF Constellation Simulator the essential choice for all civil and consumer device application test needs.

GNSS testing using the right methods

Regardless of the application for GNSS devices, testing using proper methods is essential. The GSS7000 supports an extensive range of constellation configurations, which support authentic testing of devices using any of the existing and planned open-service/civil-use Satellite Navigation signals.

GSS7000 key attributes:

- The use of correct and accurate techniques/models to derive satellite constellation and navigation data parameters commensurate with the applicable ICDs
- Dual-RF Option (Available with SimGEN and SimREPLAYplus)
- Single Channel Utility for Single Channel Multi-Frequency Simulation
- True[1] performance in several key areas such as:
  - 100 Hz System Iteration Rate (SIR) and Hardware Update Rate (HUR)
  - 3mm Pseudorange Accuracy
  - Zero Pseudorange Bias
  - <0.02 Rad RMS Phase Noise
- Up to 256 channels in one chassis
- Highly flexible configurations selectable via feature licence keys
- Three operating software options to cover all levels of test
- Complete portability of Spirent SimGEN™ scenarios from other Spirent systems
- In-field upgradeability of principal GNSS functionality and capability
- On-the-fly, run-to-run re-configuration of constellation and signal configurations
- All GNSS constellation types and all frequencies within a single chassis
- Fully future-proofed for all advances in GNSS systems, signals, modulations, codes and data

[1] True Performance means the simulator specification is met for ALL dynamic conditions as specified. Many 'GNSS simulators' stop working properly when (even relatively benign) receiver motion is applied because they employ generic hardware.

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- Integrated interference generation and spoofing test solution

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.

SimGEN™ SimREPLAYplus™ and SimTEST™ operating software

The GSS7000 can be operated using any of the three software options from the Spirent “Sim” family, allowing ultimate choice in the capability and complexity of testing.

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 the last 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.

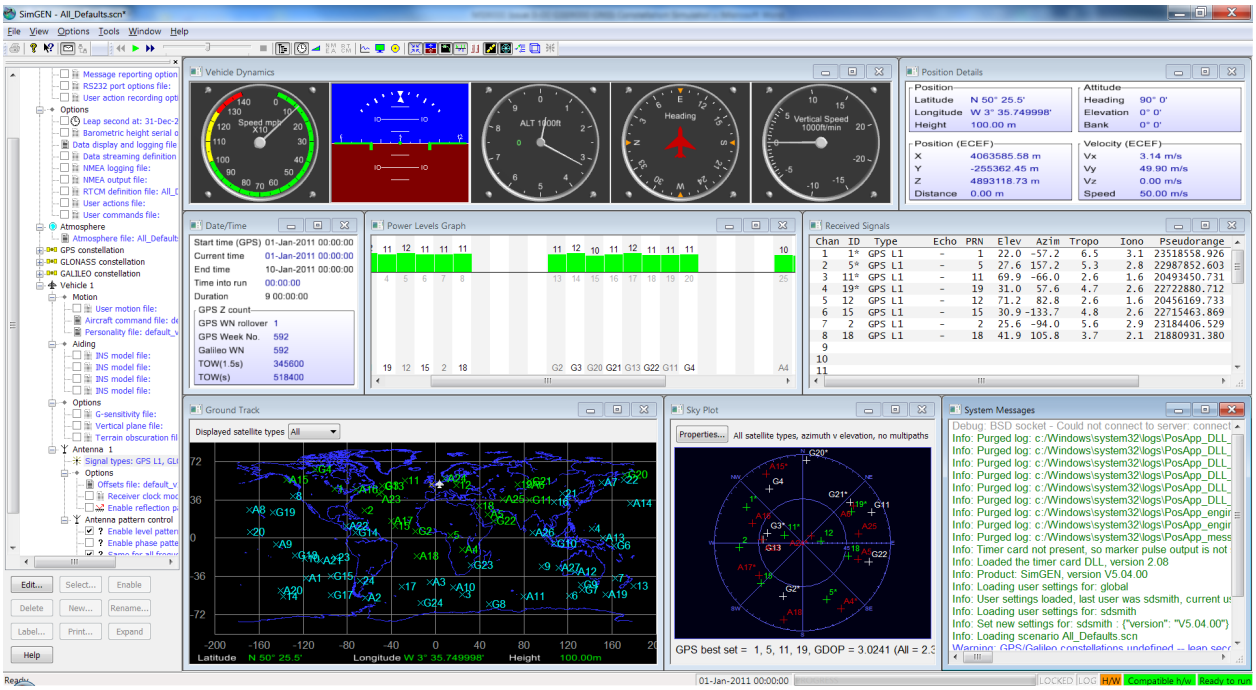

Figure 1 Spirent scenario definition and simulation control software (SimGEN™ shown)

Key SimGEN™ fundamental performance and modelling capabilities:

- Fully automatic and propagated generation of precise satellite orbital data, ephemerides and almanac
- Multiplicity of mechanisms for applying declared and undeclared errors and modifications to navigation data, Satellite clocks and orbits
- SimREMOTE: Comprehensive remote simulation control and 6-DOF trajectory delivery capability
- Generation of trajectories based on extensive Google® Mapping data
- 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
- Terrain obscuration models
- Independent satellite/channel signal power control
- Signal modulation and code control
- Vehicle personalities and motion modelling for aircraft, spacecraft, marine vessels and land vehicles
- Vehicle antenna reception gain and phase patterns
- Satellite transmit antenna pattern control

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- Clock G-sensitivity
- INS aiding data
- Ionosphere and Troposphere effects including ionospheric scintillation
- DGPS corrections
- Pseudorange ramps (for RAIM testing)
- Coherent and non-coherent Interference and noise modelling (optional GSS7765 Interference Generator)
- Leap-second and week roll-over event testing
- RTCM data streaming and in-built NTRIP Server interface
- Trajectory spoofing testing

For more information, please refer to the SimGEN User Manual, Reference a)

SimREPLAYplus™ is designed to allow the replay of pre-defined test scenarios whilst providing a range of tools and capabilities to enhance usability before, during and after testing. A powerful feature of SimREPLAYplus™ is the ability to replay complex scenarios which have been created on other Spirent SimGEN™- controlled systems. Depending on the hardware and constellation licences installed, the full complexity of the SimGEN™ scenario is faithfully replayed in SimREPLAYplus™ but without the detailed scenario editing and modification capability. This is ideal for controlled test planning where a central R&D lab can issue version-controlled test scenarios out to other teams, knowing the detailed test parameters cannot be altered by mistake.

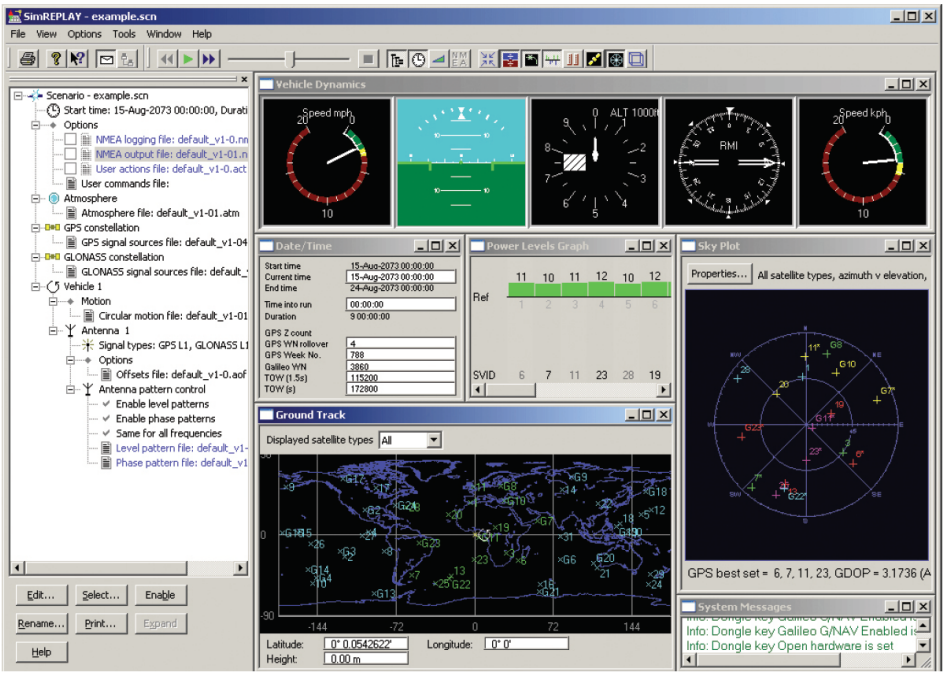

Figure 2 SimREPLAYplus main screen

Key SimREPLAYplus™ features:

- Interactive run time control
- Share scenarios between systems to facilitate collaboration
- Save and compare device under test data with logged simulation data
- Receiver antenna pattern modelling
- Environment terrain modelling
- Edit and save time, date and location
- Use motion from logged NMEA and Google Maps® matched trajectories via the SimROUTE™ tool
- Flexibly allocate available hardware channels across licenced constellations
- Display simulation parameters
- Display sky plot
- Selected remote control capability via Ethernet connection
- Bulk logging of scenario data
- NMEA input and Output
- Licensable RTCM and NTRIP capability
- Trajectory spoofing testing

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For more information, please refer to the SimREPLAYplus for GSS6700 and GSS7000 User Manual, reference b)

SimTEST™ is for essential testing. It provides the capability needed to perform fundamental verification tests. Spirent's complex and precise modelling of constellations and navigation data is built-in providing maximum ease of use to the user. Simply set up a few key parameters and press 'run'.

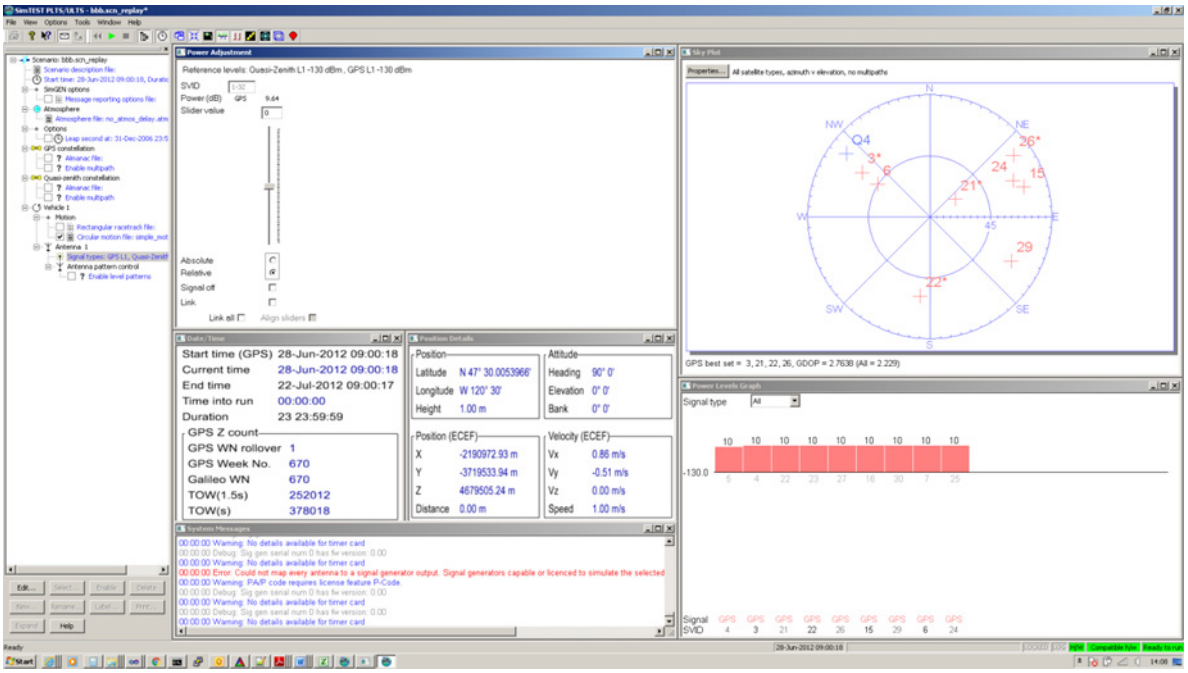

Figure 3 SimTEST main screen

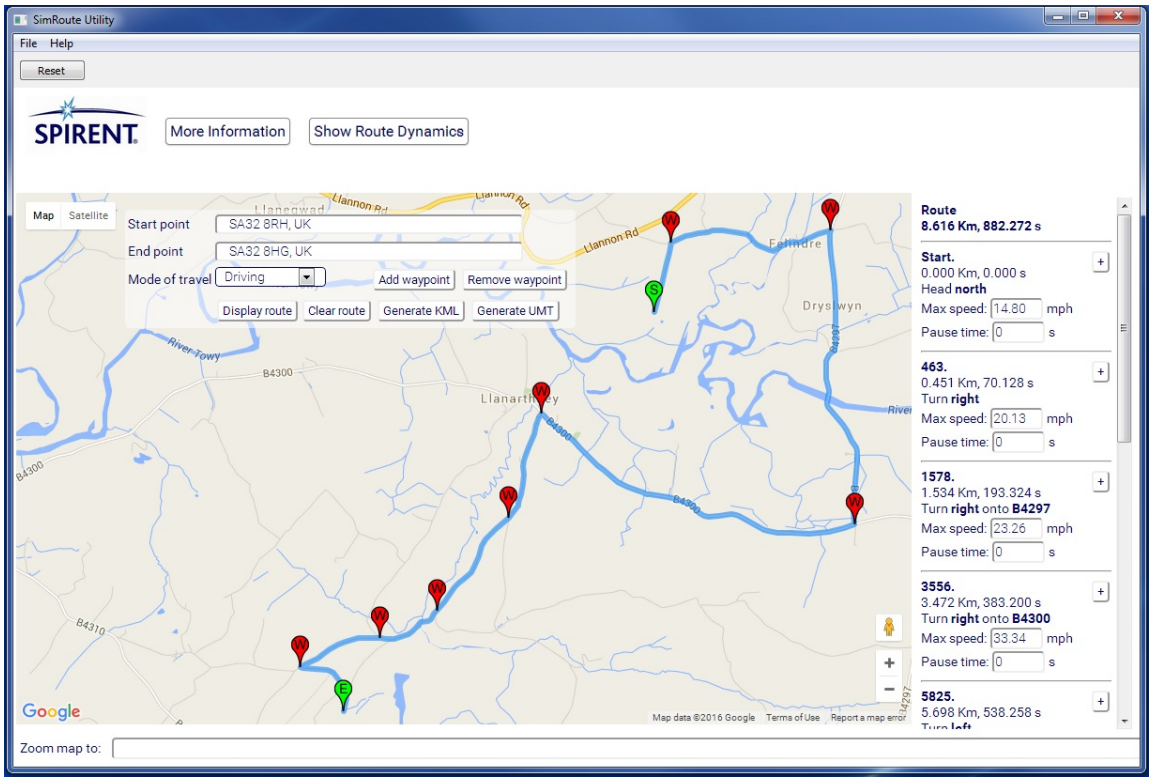

Figure 4 SimROUTE™ Google Maps® User Motion Trajectory generation tool linked to SimTEST™

Spirent **GSS7000 Series GNSS Constellation Simulator**

Key SimTEST™ features include:

- Edit and save time and date
- Enable/disable atmospheric modelling
- Enable/disable multipath
- Interactive power control of each individual constellation
- Load real constellation almanacs
- Choose Static position, simple motion, ‘racetrack motion’ or Google Maps® matched trajectories via the SimROUTE™ tool
- Enable and disable RX Antenna Level Patterns
- Simulate leap second events
- Flexibly allocate available hardware channels across licenced constellations
- Display simulation parameters
- Display sky plot
- Selected remote control capability via Ethernet connection

For more information, please refer to the SimTEST Software User Manual Reference c)

Single Channel Utility (SCU)

The GSS7000 supports the generation of a single channel satellite signal for each licenced constellation. This allows individual control of several parameters via remote commands including: A satellite's carrier frequency, power level, velocity profile and PRN, secondary code and navigation data. Under Single Channel mode, GSS7000 can be controlled via GUI or remote commands. Commands are formatted according to Spirent's SimREMOTE™ ICD and are sent via TCP/IP

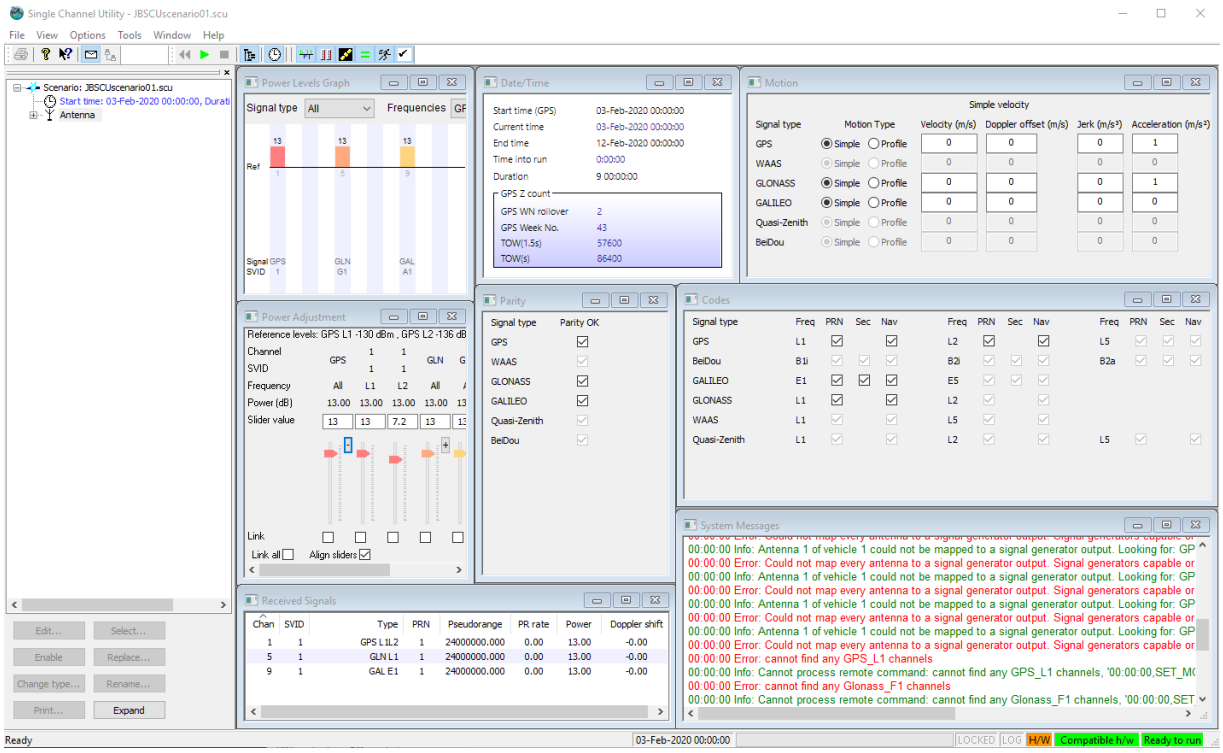

Figure 5 Single Channel Utility main screen

Commands can be grouped into the following 5 sets:

Before a run

Command	Description
SET_ANT_FREQS	Enable constellation frequencies
SET_DIR_INIT_PR	Set the initial pseudorange
SET_DIR_SV	Set the signal SVID and PRN
SET_EXT_REF	Set the external reference frequency
START_TIME	Set the simulation start time and duration
TR	Set the trigger mode

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Starting a run

Command	Description
AR	Arm the simulation
AR_NOWAIT	Arm the simulation, response returned immediately
GET_EXT_REF	Return the status of any time reference signal
RU	Run the simulation
RU_NOWAIT	Run the simulation, response returned immediately

During a run

Command	Description
EN	End a running scenario
POW_LEV_SCU	Set the power level of a satellite signal
SET_DIR_PROFILE	Set signal velocity profile
SET_DIR_VEL	Set signal velocity and doppler
SET_MODS	Set PRN, BeiDou secondary code and navigation data on/off
SET_PARITY_ERR	Turn navigation data parity errors on and off
TIME	Get the time into run

After a run

Command	Description
RW	Rewind a simulation that has ended

Miscellaneous commands

Command	Description
EXIT_SIMGEN	Terminate the PosApp Engine
GET_ANT_FREQS	Return the enabled constellation frequencies
**IDN?*	Return the software version
LOG_DIR	Return the log file folder
MSG_REPORTING_FILE_NAME	Return the message log file name
NULL	Return the status information
STTIME	Return the simulation start time

For more information, refer to the Single Channel Utility User Manual Reference (d)

Extensions and Options

With the appropriate licences; extensions and options are available with the GSS7000 to facilitate development and testing of systems and applications which use other signals for navigation, including;

- MEMS INS sensor output data modelling with SimSENSOR™
- In-Vehicle Navigation System (IVNS) testing with SimAUTO™
- Embedded in-band interference signal generation (see Table 10-11).

Table 1 shows the support for extension and optional products with GSS7000.

Product	Support @ SimTEST	Support @ SimREPLAYplus	Support @ SimGEN
SimINERTIAL	NO	NO	NO
SimAUTO	NO	YES	YES
SimSENSOR	NO	YES	YES
SimSAFE	NO	NO	YES
Sim3D	YES	YES	YES
SimHIL	YES	YES	YES
GSS7765	NO	YES	YES
GSS7725	YES	YES	YES
SimROUTE	Embedded	Embedded	Embedded
Embedded interference generation	Licenced	Licenced	Licenced
Classified options	NO	NO	NO
GBAS Simulation	NO	NO	YES
ScramNET I/O	NO	NO	NO

Table 1 Support of extension and optional products

Table 2 shows a summary of default and licenced options across the three software levels for the GSS7000

Product	Support @ SimTEST	Support @ SimREPLAYplus	Support @ SimGEN
Fixed Offset Multipath	By default	By default	By default
Standalone SBAS and all QZSS	Licenced	Licenced	Licenced
Land Mobile Multipath	X	By default	By default
GPS P Code (inc Pseudo Y)	Licenced	Licenced	By default
GLONASS P Code	Licenced	Licenced	By default
GPS L1C	By default	By default	By default
GPS L2C	By default	By default	By default
BeiDou B1I, B1C, B2I, B2a, B3I	Licenced	Licenced	Licenced
NavIC (IRNSS) L5	Licenced	Licenced	Licenced
SimAUTO	X	Licenced	Licenced
GSS7000 Channel Usage	By default	By default	By default
GSS7765	X	Licenced	Licenced
SimROUTE	By default	By default	By default
REPLAY of SimGEN scenarios	X	By default	By default
GBAS via the GSS4150	X	X	Licenced

Table 2 Summary of supported, default and licensable options

Spirent **GSS7000 Series GNSS Constellation Simulator**

Compatibility with other Spirent simulator hardware

Note the GSS7000 is a standalone system. It is not possible to connect the GSS7000 to other GNSS Simulator hardware platforms in a system controlled by a common test scenario. Note this does not apply to ancillary options such as the GSS7725, SimAUTO and GSS4150 GBAS simulator

GSS7000 System Overview

The GSS7000 consists of a single bench-top unit with internal controller running the appropriate operating software. Peripherals (monitor, keyboard and mouse), are optional and can be supplied.

Figure 6 GSS7000 system (Single and dual RF)

GSS7000 Signal Generation flexibility and capability overview

- A single GSS7000 chassis can support a maximum of 4 generic channel banks (a channel bank consists of a digital signal generator and RF upconverter). The signals from all banks are combined and fed simultaneously to the front-panel primary RF output and rear-panel high-level output.
- Each channel bank can be configured to generate up to 64 channels of any signal type within one of four frequency bands. Multiple constellations can be generated from a single channel bank simultaneously, providing they are all from the same frequency band. Refer to Table 4 for details of signal type groupings.
- The total number of channels in any one chassis is 256.
- The configuration of constellation/frequency is fixed for the duration of the simulation run.
- The constellations/frequencies available to the user are dependent upon the licences that are installed.
- The GSS7000 supports the opportunity for in-field RF channel bank hardware upgrade.
- The GSS7000 supports a 100Hz SIR.
- The GSS7000 supports backwards compatibility with Spirent SimREPLAYplus™ and SimGEN™ scenarios.
- The GSS7000 is available as a single or dual-RF chassis. Table 3 provides details of software support.

Product variant	Support @ SimTEST	Support @ SimREPLAYplus	Support @ SimGEN
GSS7000 Single-RF	YES	YES	YES
GSS7000 Dual-RF	NO	YES	YES

Table 3 Single and Dual-RF GSS7000 Software Compatibility

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Table 4 Channel Band Allocations

Carrier Freq (MHz)	Band
1176.45	1
1191.795	1
1202.025	2
1207.14	2
1227.6	2
1245.781	2
1268.52	3
1278.75	3
1561.098	4
1575.42	4
1575.42	4
1601.719	4

Table 5 Supported constellations for each channel bank

Constellation	Frequency
GPS/SBAS	L1
GPS	L2
GPS/SBAS	L5
Galileo	E1
Galileo	E5
GLONASS	L1
GLONASS	L2
BeiDou-2	B1I
BeiDou-2	B2I
BeiDou B1C	B1C
BeiDou B2a	B2a
Beidou B3I	B3I
SBAS (note 1)	L1
SBAS (note 1)	L5
QZSS	L1
QZSS	L2
QZSS	L5
QZSS	L6
NavIC/(IRNSS)	L5

GNSS Constellations

The GSS7000 architecture supports GNSS signal generation capability in a very flexible way. With the appropriate constellation feature licence keys, each generic RF Channel Bank can support **– at any one time –** any number of constellation types within the same band - as shown in Table 5. (Note: for current ICD compliance, see Table 16).

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 the control software. The principle is that at a particular instant in time, signals from any constellation can be generated provided there is a valid feature licence key and an available RF Channel Bank with the requisite number of licenced channels in the system.

Notes for Table 5

- SBAS (WAAS, EGNOS, MSAS) will be provided with any purchase of GPS L1 or L5, respectively. GPS satellite signals are substituted for SBAS ones as required. For non-GPS systems, it is possible to order SBAS as a separate signal.
- The GSS7000 is technology-ready for support of other future GNSS systems/signals, some of which can be supported today through Spirent's Tailored Solutions. Others are planned on the product roadmap.

Flexible Channel Allocation

A useful feature of the GSS7000 is the flexible way licenced satellite channels can be assigned to constellations.

For example:

- Consider a L1 system with GPS, GLONASS, GALILEO, BEIDOU, QZSS licences and 64 channels
  - User can allocate the 64 channels in any ratio between constellations using a slider control.
  - Note for different signals on the same constellation (i.e. GPS L1 and GPS L5) it is not possible to have an un-equal ratio, as in practice the GPS constellation would transmit L1 and L5 signals equally on all satellites. Figure 6 illustrates the concept of the user slider control.

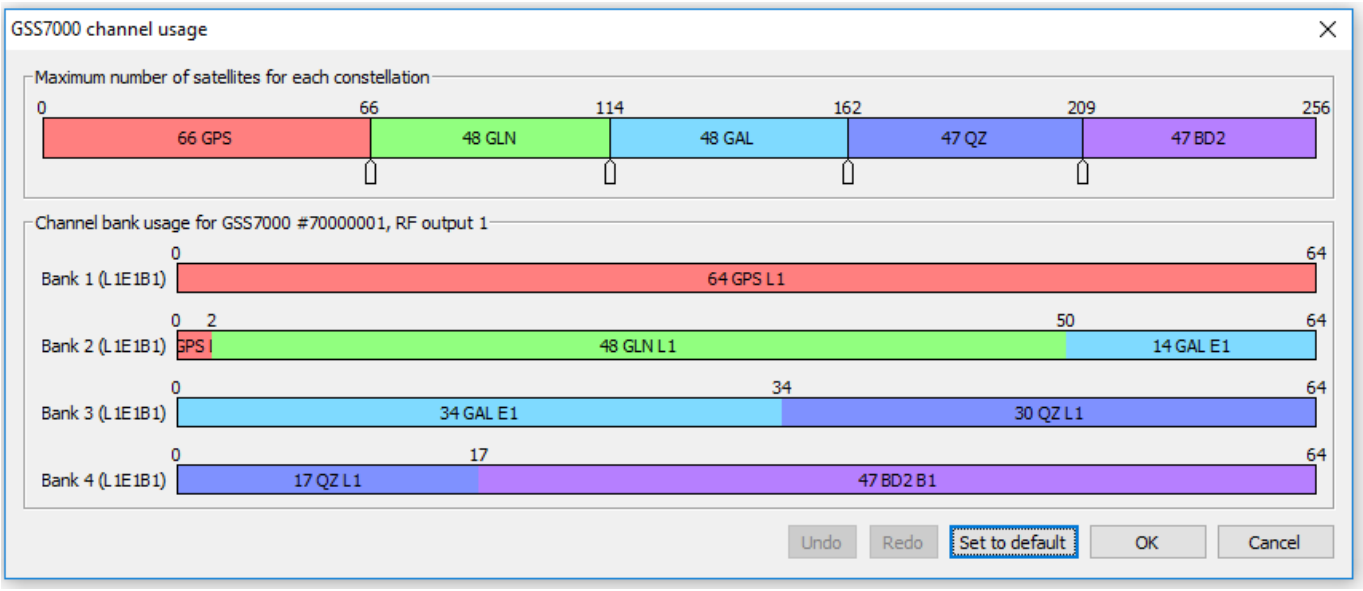

Figure 7 Dynamic channel allocation control concept

Spirent **GSS7000 Series GNSS Constellation Simulator**

Example GSS7000 systems

The highly-flexible architecture of the GSS7000 allows many different system configurations. Some may have the required number of RF Channel Banks to support simultaneous generation of all licenced signals. Some systems may have more licenced signals than RF Channel Banks allowing support for different combinations of signals.

Figure 7 to 12 show just a few examples of the extensive number of possible combinations and modes of operation. Your Spirent sales representative will be pleased to guide you through the process of selecting the best configuration for you current and future test requirements.

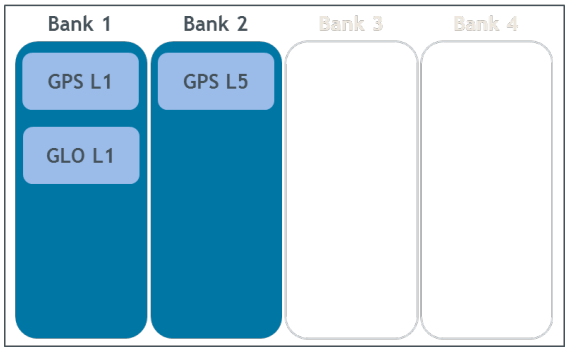

Figure 8 Dual-frequency, 2-constellation system

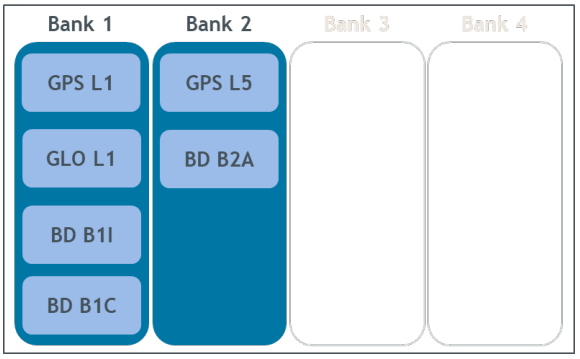

Figure 9 Dual-frequency, 3-constellation system

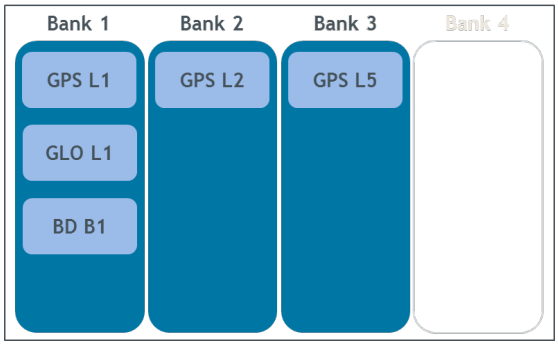

Figure 10 Triple-frequency, 3-constellation system

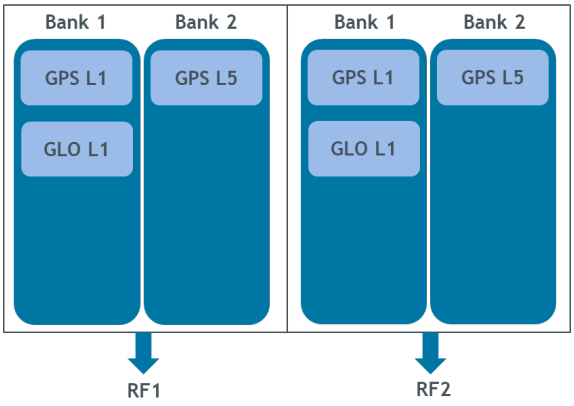

Figure 11 Dual-freq, 2-constellation 2RF system

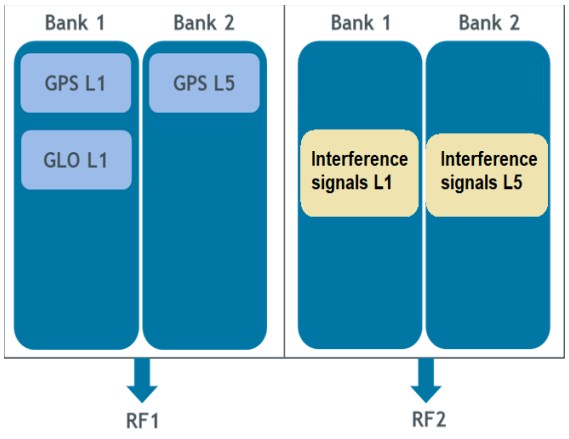

Figure 12 Dual-freq, GNSS + interference 2RF system

Upgrades

The extensibility of the GSS7000 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 RF Channel Banks can be issued with new licence keys, allowing extra channels to be added
- Additional constellation licences can be added allowing other signal types to be enabled
- New RF Channel Banks can be added to enable signal types using existing feature keys
- Both RF Channel Banks and new feature keys can be added in the field. It is not necessary for the system to be returned to Spirent but a one-off purchase is required for a Channel Bank Upgrade Tool Kit which has specific tools to assist with the upgrade.
- Simulation software can be upgraded by licence key

This extensibility makes the GSS7000 very flexible in terms of future-upgradeability.

Additional upgrade options are listed in the Related Product References, see Table 15. Please contact Spirent to discuss your requirements.

Spirent **GSS7000 Series GNSS Constellation Simulator**

Performance Specifications

GNSS constellations and supported ranging signals

The GSS7000 supports the GNSS constellations and ranging signals as shown in Table 6

Constellation	Carrier	Standard Sig Types	Licensed Sig Types	Notes
GPS	L1	C/A,	L1C , P (inc Pseudo Y)	[2]
	L2[3]	C/A, L2C	P (inc Pseudo Y)	[1]
	L5	I, Q		
Galileo[4,5]	E1	OS Data/Pilot		
	E5ab	E5a Data/Pilot, E5b Data/Pilot		[6]
GLONASS	L1	C/A	P (Chan No. -7 thru +6)	
	L2	C/A	P (Chan No. -7 thru +6)	
SBAS[7]	L1	C/A		
	L5	I		
BeiDou	B1	B1I, B1C		
	B2	B2I, B2a		
	B3	B3I		
QZSS	L1	L1S, C/A, L1C		
	L2	L2c		
	L5	I, Q		
	L6	L61 or L62		
NavIC (IRNSS)	L5	L5		

Table 6 GNSS constellations and ranging signals

Multipath is supported through additional channels, where an individual channel is used for every discrete echo.

The GSS7000 supports valid combinations of signals during simulations, per the relevant signal specification documents.

[2] "Pseudo-Y" code is provided using public-domain encryption of P-code to fully support L1/L2 squaring or 'Z-tracking', with data message.

[3] C/A code also supported on this carrier as an alternative to L2c.

[4] Open Service ICD support supplied as standard.

[5] Galileo PRN data available from user definable file. Open Service users are supplied PRN data for E1B/C and E5a signal components, PRN data for other signal types is 'dummy data'.

[6] E5ab signalling employs 8-PSK modulation of E5a and E5b onto a single carrier. Appropriate carrier dispersion is applied from E5a to E5b. Channel count per RF Channel Bank is limited to 16 for E5ab

[7] SBAS includes WAAS, EGNOS, MSA, GAGAN and SDCM for Glonass

Nominal signal levels

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
	L2	L2c or C/A	-136.0 dBm
		P	-136.0 dBm
	L5	I,Q	-127.9 dBm
Galileo	E1	E1-B, E1-C	-127.0 dBm
	E5ab	E5a-I + E5a-Q + E5b-I + E5b-Q	-122.0 dBm
GLONASS	L1	C/A	-131 dBm
		P	-131 dBm
	L2	C/A	-137 dBm
		P	-137 dBm
BeiDou	B1 (1.561098 GHz)	B1I	-133 dBm
	B1 (1.57542 GHz)	B1C	-130dBm
	B2 (1.20714 GHz)	B2I	-133 dBm
	B2 (1.17645 GHz)	B2a	-127dBm
	B3 (1.26852 GHz)	B3I	-133dBm
QZSS	L1	C/A code	-128.5dBm
		L1S	-131dBm
		L1c Data + Pilot	-127dBm
	L2	L2c	-130dBm
	L5	I + Q	-124.9dBm
	L6	L61/L62	-126.82dBm[8]
NavIC (IRNSS)	L5	C/A	-130dBm

Table 7 Nominal Signal Levels[9]

[8] Default power level setting is for Block II satellites

9 Nominal signal power levels as defined by Spirent. Using the simulator software, the user has extensive facilities to adjust these nominal power levels to meet individual GNSS ICD conditions and or specific test needs.

Spirent **GSS7000 Series GNSS Constellation Simulator**

Constellation	Message Type	Applicable Signal	Requirements	Notes
GPS	Legacy	C/A, P		
	CNAV	L2c, L5-I		
	CNAV-2	L1c		
Galileo	I/NAV	E1-B, E5b-I	OS Galileo Excludes SOL support	
	F/NAV	E5a-I	OS Galileo supported	
GLONASS	Public[10]	L1-C/A		
BeiDou	D1 and D2[11]	B1I, B2I		
		B1C, B2a		[12]
	Legacy	B3I		
SBAS	Data	L1, L5-I		[13]
IRNSS	Legacy	L5		
QZSS	QZ-Legacy	L1 C/A, L1S		
	QZ-CNAV	L2c, L5-I		
	QZ-CNAV-2	L1c		
	L6D	L61/L62		
	L6E	L62		

Table 8 Navigation Messages Types per Constellation (standard and optional signals)

[10] There is no data message on the GLONASS P-code
[11] D2 does not include differential corrections or Iono grid.
[12] As at this issue, Generated nav. data in the latest format (i.e. B-CNAV1 and B-CNAV2) for the new B2A and B1C is not currently available. Legacy BeiDou Phase 2 navigation data will be broadcast instead when “generated” nav. will be selected. Note: should legacy navigation data be selected, it will be broadcast at the legacy rate, not the rate defined in reference [g)] for signals B2A and B1. When the nav data was read from file, it will follow the symbol rate defined in reference [g)]. BeiDou Phase-3 is supported in accordance with Beidou3_ICD_B1C_B2a Beta version, 2017-08. Customers purchasing BeiDou Phase-3 licence keys for B1C and/or B2A will receive a FOC software upgrade when the implementation to BDS-SIS-ICD-B1C/B2A-1.0 2017-12 is completed. Spirent plans to complete this implementation by end Q3-2018
[13] The same message is broadcast at L1 and L5 for any satellite.

Table 9 Performance Levels for GSS7000 Series

Parameter	Description	Units	Notes
RF Signal Level	Carrier Level Control Maximum	+15 dB	
	Minimum	-40 dB	[14]
	Resolution	0.1 dB	
	Linearity +15 dB to -30 dB	<0.10 dB	
	-30.1 dB to -40 dB	<0.20 dB	
	Absolute Accuracy Run to Run Repeatability	±0.5 dB ±0.1 dB	[15]
Iteration Rates	Supported SimGEN Simulation Iteration Rates (SIR)[16,]	10, 100 Hz	
	Hardware update rate[17]	100Hz	
	Bulk logging update rate	100Hz	[18]
	Latency (remote data to RF)	4 x SIR	
Limit of Signal Dynamics [19]	Relative Velocity	±30,000 m/s	[20]
	Relative Acceleration	±2000 m/s^2	[21]
	Relative Jerk	±22000 m/s^3	
	Angular Rates (at 1.5m lever arm) (indicative) (at 0.05m lever arm)	>2π rad/s >10π rad/s	
Signal Accuracy	Pseudorange Accuracy	3 mm RMS	[22]
	Pseudorange Bias	0 mm RMS	[23]
	1PPS to RF Alignment	< ±2ns	[24]
	Inter Frequency Alignment	< ±250ps (±75mm)	[25]
Spectral Purity	Harmonics	≤ -40dBc	
	In-band Spurious (highest limit applies)	< -182dBW	[26, 27]
	Phase Noise (single sideband)	≤0.02 Rad RMS	[28]
Signal Stability	Internal 10.00MHz OCX Oscillator (after warm up)	± 5 x 10^{-10} per day	
Static Multipath Channels	Fixed path-length delay per path	0 to 1245m	
	Resolution (approx.)	2.4m	

[14] The control range extends to -50dB but performance is unspecified below -40dB. Operation below -20dB is primarily to support antenna pattern and multipath functionality.
[15] At 21°C ±5°C, +15 to -30dB. ±1.5dB 3-sigma all conditions.
[16] For single box configuration. Not tested for multibox configuration yet.
[17] For the GSS7000 system, the maximum rate at which any value can change is limited by SIR. For example, with a 10Hz SIR, the values applied at the HUR change at 10Hz. In this case the HUR is applying the same value many times over.
[18] Bulk logging at the fastest rate, with many parameters, will result in a reduced scenario duration
[19] Note that the signal dynamic limits are dependent on the SIR and HUR.
[20] For 6DOF data externally supplied via SimREMOTE or from data file.
[21] When operating at 100Hz SIR, with 50m/s^3 jerk and 40m/s^2 acceleration
[22] Digitisation-induced error for signal acceleration < 45m/s^2, jerk < 50m/s^3, 100Hz SIR.
[23] Per carrier operating on a single channel bank. When the same signal is generated across channel banks the inter channel bank bias uncertainty is ±250ps (±75mm)
[24] Between any RF carrier.
[25] PRN code alignment between frequency band.
[26] For relative velocities <50,000 m/s
[27] In-Band Spurious Bandwidths (relative to centre frequency unless otherwise stated):
GPS: L1 ± 20.5MHz , L2 ± 20.5MHz , L5 ± 20.5MHz
Galileo: E1 ± 20MHz , E5a ± 25.5MHz , E5b ± 25.5MHz
GLONASS: (relative to channel frequency 0) L1 ± 20MHz , L2 ± 20MHz
BeiDou: B1/B2 ± 20.5MHz
[28] Value is typical, integrated over a 1Hz to 10kHz bandwidth.

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Parameter	Description	Units	Notes
Scenario Duration	The maximum duration of a single scenario	23 days 23 hours 59 minutes	[29]
Latency	For the operating in the HIL environment, the commands will take 4 times the SIR to be effective at RF	40ms	[30]

Table 10 Embedded interference signal specifications

Parameter	Detail	Value	Notes
Interference Transmitter	Per Frequency Band	8 maximum	
Frequency Bands	L1 band	1539-1615MHz	[31]
	L2 band	1182-1258MHz	
	L5band	1154-1230MHz	
	L6band	1237-1313MHz	
Signal types	CW, PSK narrowband/ broadband, CW pulse, AWGN, FM, AM, PM		
RF Signal Level	Single signal	-47 dBm (max)	[32]
	Multiple signals	-72 dBm (max)	[33]
	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	

Table 11 Embedded interference signal modulation types and performance

Signal type	Detail	Value
BPSK	Main lobe width: Wide Band	20.46 MHz
	Narrow Band	0.1023 MHz
CW Pulse	Pulse width	1 to 10000 µs
	Pulse repetition interval range	100 to 10000 µs
	Pulse repetition interval resolution	100 µs
	Rise time (10% to 90%)	100 ns (max)
	On/Off ratio min	30 dB
AWGN	3 dB Bandwidth	0.1, 0.5, 1, 2 10, 20 MHz

[29] Bulk logging of many parameters will reduce the effective scenario duration
[30] Simulation running at 10ms SIR.
[31] ±38MHz allows for 80% sample rate and 20MHz AWGN
[32] Single signal per channel bank (CW, FM, PM), -49dBm (BPSK, pulsed CW), -53dBm (AM), -60dBm (AWGN)
[33] -72dBm per signal for AWGN signals, other signal types can be up to 3dB higher

Signal type	Detail	Value
	Bandwidth accuracy	±5%
FM	FM deviation	±0.01 to ±5 MHz
	FM rate	0.5 to 10 kHz
	FM rate step size	0.5 kHz
	Modulating Waveform	Triangular
AM	Modulation depth	10 to 90%
	Modulation depth step size	10%
	AM rate	0.5 to 10 kHz
	Modulating Waveform	Sinusoidal
PM	Modulation deviation	±0 to ±5 rad
	PM rate	0.5 to 10 kHz
	Modulating Waveform	Sinusoidal

Table 12 Signal Generator Connectivity

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

Table 13 Internal Controller Connectivity

Interface	Type	Parameter
USB (x4)	I/O	Mouse, keyboard and general file access (2 accessed from front + 2 on rear panel)
Ethernet (x2)	I/O	RJ-45 Ethernet interface standard. Used for general network access and available for remote control
Display Port	I/O	Monitor port

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Table 14 Optional monitor

Type	Type	Manufacturer
P2217H	22-inch	Dell

Table 15 Physical and Environmental Properties

Part	Parameter	Value
Signal Generator	Approximate Dimensions (H x W x D) (9.25” x 4U chassis)	176.95mm x 235.2mm x 555mm 6.96” x 9.25” x 21.85”
	Typical Weight	<15kg (33lb) (configuration dependent)
	Operating Environment	0 to +50°C (32 to 122°F) (40-90% RH, non-condensing) Altitude restriction of 2000m
	Storage Environment	-40 to +60°C (-40 to 140°F) (20-90% RH, non-condensing)
	Electrical Power	100-240V 5A Max 50 to 60Hz

Note(s): Physical and Environmental Properties such as the Operating and Storage Environments apply to the GSS7000 Signal Generator only. Associated equipment such as the monitor, keyboard and mouse or other Spirent supplied equipment may not extend to these environmental limits. Optionally the chassis can be mounted in an equipment rack, details available upon request.

Table 16 Safety and EMC Compliance

Compliance	Applicable Standard
Safety	Low Voltage Directive (LVD) 2014/35/EU IEC 60950-1:2005 (Second Edition) + Am 1:2009 + Am 2:2013 Information technology equipment. Safety. General requirements
EMC	EMC Directive 2014/30/EU EN 61326-1:2013 Electrical equipment for measurement, control and laboratory use. EMC requirements. General requirements

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Calibration Requirements

The digital architecture of the signal generator requires only limited annual calibration, for which a detailed procedure is provided.

The GSS7000 GNSS Constellation Simulator is calibrated to the ISO/IEC 17025 standard at the time of purchase, 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.

Installation of additional purchased channel banks or performing calibrations out of a Spirent authorized ISO/IEC17025 accredited laboratory will invalidate your accredited calibration. This includes customer use of the Auto Calibration Utility (where installed) and certain upgrade procedures.

For more information on Spirent's calibration service, customers may refer to MS3089: Spirent Support Service for Positioning Technology Products, Customers who require more information on how to renew the annual accredited calibration, may contact their local Spirent representative.

Related Brochures, Data Sheets and Specifications

Table 17 Related Product References

Related Product	Description	Data Sheet / Specification
SimGEN	GNSS Software Suite	MS3008
SimAUTO	Automotive Sensor Emulation Option Single Axis Rate Table Option	MS3023 MS3049
SimSAFE	Vulnerability Test Tool	MS3092
SimREMOTE	Simulator Remote Control Additional Options	MS3015
GSS7765	Generic Interference Generator Option	MS3055
GSS7725	Interference Generator option	MS7725
SimSENSOR	MEMS Sensor Simulation Option	MS3086
GBAS	GSS4150 VHF Data Broadcast Simulator for GBAS Product Specification	MS3014
SimROUTE	Road-Matched Trajectory Generation Tool	MS3073
TestBench	PNT TestBench GNSS Automation and Report Generation Tool	MS3097
Sim3D	Realtime Multipath Simulation Tool	MS3105
SimHIL	Remote Vehicle Capabilities	MS3106

ICD Compliance – Applicable Documents

Table 18 ICD compliance[34][35]

Reference	Title	Notes
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	
OS SIS ICD	Galileo Open Service Signal-in-Space Interface Control Document	
SISICD	GLONASS Interface Control Document	
OS_SISICD	BeiDou Navigation Satellite System (Phase-2) Signal-in-Space Interface Control Document Open Service Signal	ForB2I
OS_SISICD	BeiDou Navigation Satellite System (Phase-2) Signal-in-Space Interface Control Document Open Service Signal	For B1I
Beidou3_ICD_B1C_B2a	BeiDou Navigation Satellite System (Phase-3) Signal-in-Space Interface Control Document Open Service Signals	For B1C, B2a[36]
RTCA-DO229	WAAS MOPS	
IS-QZSS-PNT-001	Quasi-Zenith Satellite System Interface Specification Satellite Positioning, Navigation and Timing Service	For L1, L2, L5
IS-QZSS-L6-001	Quasi-Zenith Satellite System Interface Specification Centimeter Level Augmentation Service	For L6
IRNSS_SISICD_SPS	Aug. 2017 IRNSS Signal-in-Space ICD for SPS	
NMEA	0183	
RINEX	-	

[34] For the latest ICD compliance, please refer to the latest issues DGP000686AAA SimGEN software user manual, DGP01449AAA SimREPLAYplus user manual and DGP01446AAA SimTEST user manual
[35] Compliance assumes the latest version of control software is installed and the system is fully calibrated
[36] BeiDou Phase-3 implementation includes BDGIM Ionospheric model

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Spirent operates a policy of upgrades to meet ICD changes as they are adopted, and to implement ICDs for new signals as they are made public. To obtain ongoing upgrades your system needs to be under warranty or a current support agreement.

Please contact Spirent for current ICD compliance.

Glossary of terms

1PPS	One Pulse-Per-Second
BITE	Built In Test Equipment
BeiDou	Chinese GNSS System
DOP	Dilution Of Precision caused by satellite geometry
EMC	Electromagnetic Compatibility
FPGA	Field-Programmable Gate Array – a reconfigurable electronic device
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)
GUI	Graphical User Interface
HUR	Hardware Update Rate
IRNSS	Indian Regional Navigation Satellite System
ICD	Interface Control Document
IEEE-488	An 8-bit parallel Hardware Interface
OS	Open 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
SBAS	Space-Based Augmentation System (such as WAAS, EGNOS, MSAS)
SOL	Safety Of Life
SIR	Simulation Iteration Rate

Referenced Documents

a) DGP00686AAA SimGEN Software User Manual [latest issue]
b) DGP01449AAA GSS7000, GSS6700 and SimREPLAYplus User Manual [latest issue]
c) DGP01446AAA SimTEST Software User Manual [latest issue]
d) DGP01491AAA Single Channel Utility User Manual [latest issue]

Spirent **GSS7000 Series GNSS Constellation Simulator**

For more information

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