

GSS8000 Series - Datasheet

Capability, flexibility & fidelity in GNSS simulation



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Product Range Highlights

Multiple Constellations Available

- GPS, all legacy and modernized signals at all frequencies
- Galileo, with all services and frequencies¹
- GLONASS, civil signals at both primary frequencies
- SBAS, including WAAS, EGNOS and MSAS, supplied with all GPS L1-equipped units
- Architecture extends to support of future systems such as Compass, QZSS, GLONASS L3

Multiple Configurations Available

- Up to 3 dedicated RF carriers in a single chassis
- Up to 16 simultaneous direct line-of-sight satellite channels per carrier
 - Each LOS channel also equipped with 4 additional programmable multipath channels
 - Enables emulation up to 240 distinct signals-in-space
- Single and multiple constellation support in a single chassis
- Multiple chassis supported to create signal-rich, multi-antenna or multi-vehicle environments
- Including CRPA electronics testing

Comprehensive Modelled Environment

- True real-time operation – no data pre-processing
- Fully flexible simulation date and time – past, present and future
- Appropriate satellite motion propagation from user-defined orbital data
 - With error models
- Host vehicle trajectory generators for air, land, sea and space vehicles
 - Also supports user-created 6DOF trajectory from a data file
- User defined atmospheric environment, appropriate to each vehicle type
 - With error models
- Fully modelled and dynamically calculated navigation messages
 - With error models
- Wide range of multipath tools and models

High Signal Accuracy, Dynamics and Quality

- Millimetre-level pseudorange accuracy
- Up to 20,000g signal dynamic capability supports all practical vehicle motion scenarios
- Phase-Noise typically <0.01 Rad RMS
- Harmonics <40dBc

Remote Control and Connectivity

- Command-driven API allows real-time remote control and interaction with simulation
 - Flexible hardware trigger event input for starting simulations
- Low-latency, high accuracy hardware-in-the-control-loop capability as standard
 - Accepts high-rate, real-time delivery of host vehicle 6DOF trajectory data
 - 1PPS and 10MHz inputs; 1, 10 and 100PPS outputs
- Real-time streaming of all simulated data for display and use by external applications
- Full truth data capture to file for off-line analysis
- Capture of NMEA data from compatible GNSS units under test
- Differential correction data transmissions in RTCM-SC104 format

Extensions and Options

- Classified signal generation – SA-A/S, M-Code, PRS
- Inertial Sensor emulation
- Interference and Jamming generation

Introduction

The GSS8000 product series represents a range of radio frequency (RF) Constellation Simulators that has been designed to fully address the needs of all those engaged in GNSS technology and application development.

Constellation Simulators of this type operate in real-time and emulate the RF signals that would be received by a GNSS sensor or receiver with such high fidelity that the device under test is completely unaware that it is not actually operating in its intended real-world environment.

Simulators provide numerous benefits to the GNSS developer or integrator, including full control of all aspects of the GNSS operating environment, inherent repeatability, and the ability to apply systematic errors and incidents that would be impossible to realise using actual satellite signals.

The focus of the GSS8000 design is to provide the most comprehensive range of emulated GNSS RF signals from a single product series, with class-leading flexibility, coherence, fidelity, accuracy and reliability.

The GSS8000 series represents a significant evolution of Spirent's proven and industry-leading GNSS simulator products that have been serving the GPS community for more than 20 years, by providing even better accuracy, more carriers and more signal channels, increased dynamic range and increased signal dynamics.

The GSS8000 series is applicable to all GNSS application areas and markets, whether on land or on the sea, in the air, and even in space.

Standard capability extends from single frequency civil signals to the latest modernised and military signals (including all classified signals) and even yet-to-be-launched systems, allowing users to realise their product development goals in the shortest possible time.

The flexibility and scalability of the series encompasses the ability to specify the required constellation type and quantity, the number of simultaneous satellite signals, and the signal types broadcast as well as supporting multiple antenna and multiple vehicle requirements. There also numerous application-specific enhancements and options available.

Moreover, the GSS8000 is fully interoperable with Spirent's GSS7700 GPS and GSS7800 Galileo systems and can be combined with existing assets of this type to create complex systems thus protecting their investment value. In addition, the system extensions and enhancements which were available to the previous generation of products are fully applicable to the GSS8000, including coherent inertial sensor emulation and interference generation.

This datasheet provides technical data and configuration information, including ordering codes. In view of the wide range of possible permutations, however, Spirent recommends that you discuss your current and future needs with your local sales representative to ensure that an optimal configuration is specified.

SimGEN for Windows[®]

SimGEN is Spirent's software application suite that supports the GSS8000 Series and delivers the modelling capabilities highlighted in this datasheet.

SimGEN is a mature and proven application that represents over 6 years of continuous development and has powered all of Spirent's advanced simulation products over that period.

For GSS8000 SimGEN will operate under Microsoft's Windows Vista™ operating system and features a comprehensive and intuitive user interface. More information can be found on SimGEN in the separate specification document listed at the end of this datasheet.

System Details

A GSS8000 GNSS simulation system comprises two major components:

- Controller computer (running Spirent’s SimGEN Application suite)
- One or more RF Signal Generator chassis.

A range of standard RF carrier configurations is available for each Signal Generator chassis; see Table 1.

In addition to selecting the required carrier configuration for the chassis, the required number of primary signal channels per carrier must be specified; minimum 4, maximum 16, see Table 1.

Note that SBAS uses available GPS channels when choosing channel count for GPS L1 and L5.

Table 1 Signal Generator Chassis Configuration Options

RF Carrier #1	RF Carrier #2	RF Carrier #3	Order Code	Required number of primary channels	Order Code
GPS L1/SBAS	-	-	8501	4 @ RF Carrier #1	8011
GPS L1/SBAS	-	GPS L5/SBAS	8502	8 @ RF Carrier #1	8012
-	GPS L2	-	8503	12 @ RF Carrier #1	8013
GPS L1/SBAS	GPS L2	GPS L5/SBAS	8504	16 @ RF Carrier #1	8014
Galileo E1	-	-	8505		
-	-	Galileo E5ab	8506	4 @ RF Carrier #2	8021
Galileo E1	-	Galileo E5ab	8507	8 @ RF Carrier #2	8022
Galileo E1	Galileo E6	-	8508	12 @ RF Carrier #2	8023
Galileo E1	Galileo E6	Galileo E5ab	8509	16 @ RF Carrier #2	8024
GPS L1/SBAS	Galileo E1	-	8510		
GPS L1/SBAS	Galileo E1	Galileo E5ab	8511	4 @ RF Carrier #3	8031
GLONASS L1	-	-	8512	8 @ RF Carrier #3	8032
GLONASS L1	GLONASS L2	-	8513	12 @ RF Carrier #3	8033
GPS L1/SBAS	Galileo E1	GLONASS L1	8514	16 @ RF Carrier #3	8034
GPS L1/SBAS	-	GPS L5/SBAS	8515		
GPS L1/SBAS	GLONASS L1	-	8516		

Where more than one chassis is required, ancillary components must be specified; see Table 2.

Table 2 Multiple Chassis Ancillary Options

Description	Notes	Order Code
Multi-chassis Combiner Unit (MCU)	Required to combine RF signals from 2 to 8 chassis ²	8051
Signal Distribution Unit	Required to distribute/combine synchronisation/alignment signals for 3 to 5 chassis ³	8052

Finally, the required controller type must be specified; see Table 3. All options include the necessary SimGEN application suite pre-loaded.

Table 3 Controller Options

Description	Notes	Order Code
Standard Controller	Rack-mountable chassis with free-standing 19-inch TFT monitor, desktop keyboard and mouse Default for most installations	8041
Full Rack-mount Controller	As Standard Controller but with fully rack-mountable, retractable, integrated 17-inch monitor, keyboard and trackpad unit	8042
Hard Disk Drive	Additional removable hard drive for Rack-mount Controllers	8043
Laptop Controller	Not compatible with some system options ⁴	8044

Series Performance

Table 4 Performance Levels for GSS8000 Series

Parameter			Notes
RF Signal Level	Maximum (Primary RF port)	-131.6 dBW	5
	Minimum (Primary RF port)	-187.0 dBW	
	Dynamic Control Range (0.1dB resolution)	54 dB	6
	Absolute Accuracy	± 0.5 dB	7
	(Calibration RF port)	$\approx +50$ dB	8
Limit of Signal Dynamics	Relative Velocity	120,000 m/s	9
	Relative Acceleration	192,600 m/s ²	10
	Relative Jerk	890,400 m/s ³	
	Angular Rates (at 1.5m lever arm)	$>15\pi$ rad/s	11
	(at 0.05m lever arm)	$>60\pi$ rad/s	
Signal Accuracy	Pseudorange Accuracy	$< \pm 1.1$ mm RMS	12
	Pseudorange Uncertainty due to Interchannel Bias	$< \pm 3.0$ mm RMS	13
	Deltarange Accuracy	$< \pm 1.0$ mm RMS	12
	Inter-carrier Bias	$< \pm 2$ ns	14
Spectral Purity	Harmonics	≤ -40 dBc	
	In-band Spurious	≤ -182 dBW	15
	Phase Noise	≤ 0.01 Rad RMS	16
Signal Stability	Internal 10.23MHz OCX Oscillator	$\pm 5 \times 10^{-10}$	17

Ranging Signal Types

Table 5 Ranging Signal Types per Constellation¹⁸

Constellation	Carrier	Tx Bandwidth	Signal Types Supported ¹⁸	Notes
GPS	L1	40.92 MHz	C/A, P, Y, M	19, 20
	L2	40.92 MHz	C/A, L2C, P, Y, M	19, 20
	L5	40.92 MHz	I, Q	
Galileo	E1	40 MHz	PRS, OS Data/Pilot	21
	E6	40 MHz	PRS, CS Data/Pilot (with encryption)	21
	E5ab	92 MHz	E5a Data/Pilot, E5b Data/Pilot	22
GLONASS	L1	40 MHz	C/A (Channel No. -7 thru +6)	23
	L2	40 MHz	C/A (Channel No. -7 thru +6)	
SBAS	L1	As GPS L1	C/A	
	L5	As GPS L5	C/A	

Navigation Messages

Table 6 Navigation Messages Types per Constellation

Constellation	Message Type	Applicable Signal	Notes
GPS	Legacy	C/A, P, Y	19
	CNAV	L2C, L5-I	24, 25
	MNAV	M	20
Galileo	I/NAV	L1-B, E5b-I	26
	F/NAV	E5a-I	
	G/NAV	E1-A, E6-A	21
GLONASS	Public	L1-C/A	
SBAS	Data	L1, L5	27

Physical and Connectivity

Table 7 Signal Generator Connectivity

Main RF Port	Output	N-type coax female, 50 ohm, VSWR <1.2:1 AC coupled ±50V DC, max Reverse RF 22dBm max
Calibration RF Port	Output	N-type coax female, 50 ohm, VSWR <1.2:1 AC coupled ±50V DC, max Reverse RF 20dBm max
Auxiliary RF	Input	N-type coax female, 50 ohm, VSWR <1.4:1 0.5 to 2GHz, Insertion Loss 14.5dB typical
External Frequency Standard	Input	BNC coax socket, 50 ohm -5 to +10 dBm @1MHz, 5MHz, 10MHz, 10.23MHz
Internal Frequency Standard	Output	BNC coax socket, 50 ohm 10.23MHz @ +10dBm nominal
Timer (Qty 3)	Output	BNC coax socket, 50 ohm, TTL level compatible Period selectable 10ms, 100ms or 1s (1PPS) Gated or un-gated to appear at start of run
Trigger (Start)	Input	BNC coax socket, 50 ohm, TTL level compatible
Ethernet	Private Bus	RJ-45 Ethernet interface standard

Table 8 Controller Connectivity

Ethernet	I/O	RJ-45 Ethernet interface standard For SimREMOTE, other options available (GPIB, SCRAMNET)
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Table 9 Physical and Environmental Properties

			Notes
Signal Generator	Dimensions (H x W x D) (19" 6U chassis)	266mm x 450mm x 553mm 10.5" x 17.75" x 21.7"	28
	Weight	<30kg (66lb)	29
	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	100-120V 206-264V <5A <2.5A 48 to 62Hz 48 to 62Hz	30
Standard Controller	Dimensions (H x W x D) (19" 4U chassis)	175mm x 445mm x 510mm 6.9" x 17.75" x 20"	
	Weight	<20kg (44lb)	31

Table 10 Safety and EMC Compliance

Safety	Low Voltage Directive 73/23/EEC by application of the harmonised standard: EN60950
EMC	EEC EMC Directive 89/336/EEC by application of the harmonised standard: EN61326 Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements

Notes

- 1 Full Galileo systems may only be supplied in the context of official Galileo projects. Otherwise a generic Galileo simulator will be supplied where the user provides memory codes and navigation data message from a pre-prepared file
- 2 For greater than 8 chassis additional MCUs are required
- 3 For greater than 5 chassis additional units are required
- 4 The laptop controller option is not compatible with SimAUTO. SimREMOTE is supported but not for SCRAMNET or operation at the 250Hz 6DOF update rate. Removable hard drive options are not available for SimSAAS or SimCLASS
- 5 Composite value for GSS8000 series encompassing all constellation types and carrier frequencies
- 6 Contiguous and per channel independent. Nominal level is constellation signal type specific.
Flex-power: Relative levels of the signal components of the GPS L1 and L2 signals may be additionally varied by +6 to -16dB
- 7 Value is RSS at 21°C ±5°C. ±1.5dB 3-sigma all conditions. Run-to-run repeatability ±0.1dB
- 8 Relative to primary RF port
- 9 Applies for 6DOF data externally supplied via SimREMOTE or from data file
- 10 When operating in 250Hz mode
- 11 Angular rates are indicative and are derived from the signal dynamic limits
- 12 Digitisation-induced error for signal acceleration < 450m/s², jerk < 500m/s³. Instantaneous accuracy degrades during higher dynamics. Excludes contribution of inter-channel bias.
- 13 Per carrier with 16 channels operating. For GLONASS only, the value is ±5cm RMS.
- 14 Between RF carrier #1 and any other RF carrier
- 15 For relative velocities <50,000 m/s
- 16 Value is typical. Worst case < 0.02 rad RMS
- 17 Value is per day after 24 hour warm-up. Value over 1 year is ±1 x 10⁻⁷
- 18 Only valid combinations are allowed in accordance with the appropriate Signal-in-Space Interface Control Document
- 19 Full Y-code requires SimSAAS or SimCLASS upgrade – subject to end-user approval
Otherwise, the product supports “Pseudo-Y” code through public-domain encryption of P-code to fully support L1/L2 squaring or ‘Z-tracking’, with data message
- 20 Full M-Code requires SimMCODE upgrade - subject to end-user approval. Otherwise the product broadcasts a spectrally representative M-Noise signal from each satellite when enabled, with no data message
- 21 Full PRS requires SimPRS upgrade - subject to end-user approval. Otherwise the product broadcasts a spectrally representative PRS-Noise signal from each satellite when enabled, with no data message
- 22 E5ab signalling employs 8-PSK modulation of E5a and E5b onto a single carrier. Appropriate carrier dispersion is applied from E5a to E5b
- 23 Includes appropriate auxiliary meander sequence
- 24 There are required differences between the L2C and L5 variants of this message
- 25 Neumann-Hoffman encoding applied to L5Q ranging code
- 26 There are required differences between the E1-B and E5b-I variants of this message
- 27 The same message is broadcast at L1 and L5 for any satellite
- 28 Length is from rear of rack mount angle to rearmost part of the chassis. Add 42mm (1.65”) for fascia
- 29 Actual weight varies with configuration specified
- 30 Operating power consumption, excludes any start up surge
- 31 Excludes peripherals, including keyboard and monitor

Related Brochures, Data Sheets and Specifications

Table 11 Related Product References

Related Product	Description	Brochure Title	Data Sheet / Specification
GSS8000	GNSS Simulators	GSS8000 Series	MS3057
SimGEN	GNSS Application Software Suite	GSS8000 Series	MS3008
GSS8700	Tailored variant GSS8000 GPS Simulators for special applications	GSS8000 Series	MS3058
SimINERTIAL	Inertial Sensor Emulation Option	SimINERTIAL	MS3030
SimBARO	Barometric Pressure Emulation Option	SimINERTIAL	MS3056
SimAUTO	Automotive Sensor Emulation Option	SimAUTO	MS3023
	Single Axis Rate Table Option		MS3049
SimDATA	Performance Data Capture and Device Control option	SimINERTIAL	MS3034
SimPRS	Galileo PRS Upgrade for Galileo	-	MS3042
SimCLASS	GPS SA/A-S Upgrade Option (Non-USA)	Classified Testing	MS3020
SimSAAS	GPS SA/A-S Upgrade Option (USA)	Classified Testing	SF1001
SimMCODE	AES M-CODE Upgrade Option	Classified Testing	MS3018
	SDS M-CODE Upgrade to SimMCODE		MS3048
SimREMOTE	Simulator Remote Control Additional options	-	MS3015
GSS7765	Generic Interference Generator Option	GSS7765	MS3055
GSS4150	LAAS VDB Generator Option (RTCA-DO246)	-	MS3014

Glossary of Terms Used

6DOF	Six Degrees of Freedom – relating to linear and rotational vehicle body axes
Channel	A simulator asset that supports a single RF frequency from a particular GNSS satellite onto which may be modulated a number of satellite signals
CRPA	Controlled Reception Pattern Antenna – for anti-jamming applications
GNSS	Global Navigation Satellite Systems
LAAS	Local Area Augmentation System– provides enhanced GNSS system integrity and accuracy
Pseudorange	The apparent distance to the satellite from the simulated location
SBAS	Satellite-Based Augmentation System – provides enhanced GNSS system integrity

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