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Federal Systems

GSS9790 Multi-Output GNSS Simulator

For the testing of Controlled Reception Pattern Antennas (CRPAs)

Datasheet with Product Specification

Spirent **GSS9790 Multi-Output GNSS Simulator**

Purpose of this Document

This datasheet describes the functionality of the Spirent GSS9790 Multi-Output GNSS Simulator for the testing of Controlled Reception Pattern Antennas (CRPAs).

This datasheet also provides technical data and configuration information.

The GSS9790 offers a very wide range of capabilities and options. Please speak to your Spirent sales representative before ordering to ensure your specific needs are met.

Table of Contents

Spirent **GSS9790 Multi-Output GNSS Simulator**

List of Tables

List of Figures

Introduction

Why is testing essential for CRPA technology?

Anti-jamming and anti-spoofing capabilities are becoming essential features of mission-critical GNSS receivers that are likely to encounter deliberate or accidental signal jamming or spoofing.

Threats from signal jamming and spoofing are increasing; both from civilian sources (e.g. illegal personal privacy devices (PPDs) intended to mask a commercial vehicle's whereabouts) and from the use of radio frequency interference (RFI) as an electronic warfare (EW) method deployed by nation states to disrupt an adversary's operations.

For example, the International Civil Aviation Organisation (ICAO) received 174 reports of GPS disruption in the Eastern Mediterranean region in *2018 (International Civil Aviation Organization, MIDANPIRG/17 and RASG-MID/7 Meeting, Cairo, Egypt, 15 – 18 April 2019)*, compared to just 32 between 2015 and June 2018 *(International Civil Aviation Organization, RASG-MID SAFETY ADVISORY – 14 (RSA-14), April 2019*), attributed to the conflict in Syria.

The role of the CRPA in anti-jam and anti-spoofing systems

Most anti-jam and anti-spoofing systems rely on a multi-element, controlled reception pattern antenna (CRPA), together with antenna electronics to drive the CRPA's behaviour.

The electronics use algorithms to analyse the direction and strength of signals received by the antenna to determine whether any are being jammed or spoofed, and directs the antenna to respond accordingly, using techniques including:

• Beamforming / beam steering: Steering positive antenna gain towards signals that are not jammed or spoofed, to minimise the impact of the interference.

• Null generation / null steering: Steering negative antenna gain towards a source of RFI to try to cancel out the interference.

• Space-time and space-frequency adaptive processing (STAP and SFAP): Advanced algorithms that further increase the antenna's ability to steer a null towards sources of jamming interference.

• Direction-finding: CRPAs enable the general location of the jammer or spoofer to be identified, by determining the angle of arrival of the interference.

The mission-critical nature of the CRPA and its associated electronics make thorough testing essential. Because of the wide range of jamming and spoofing conditions it could encounter, the antenna must be tested in a wide range of realistic interference scenarios.

GSS9790 – Controllable, repeatable and accurate CRPA testing in an Anechoic chamber

The GSS9790 Multi-Output GNSS Simulator uses a modified variant of the world leading GSS9000 Multi-constellation Simulator signal generator chassis. It is a unique product providing the core element for GNSS test applications that require a solution that can be used in both conducted (lab) and radiated (chamber) conditions and is ideally suited for the testing of Controlled Reception Pattern Antennas (CRPAs). For more information on CRPA test methods, please see Spirent Application Note *DAN037 Test Options for CRPA.*

The GSS9790 Multi-Output GNSS Simulator chassis can significantly reduce the need to perform expensive field trials and provides an accurate, repeatable and controllable tool, free of the constraints imposed by testing in an operational system environment. Equally important, the GSS9790 Multi-Output GNSS Simulator enables development and evaluation of GNSS receivers in advance of actual satellite transmissions.

The GSS9790 Multi-Output GNSS Simulator is a full constellation simulator, offering total user control over the satellite orbital definitions and accurately models the resulting satellite motion with respect to the user-specified simulation location, date and time.

Spirent **GSS9790 Multi-Output GNSS Simulator**

When operated with Spirent's SimGEN® control software, the user equipment under test behaves as if it were receiving RF signals from real satellites when installed on a vehicle performing complex and/or high-speed manoeuvres as set up in the test case, or scenario.

Standard features enabled by SimGEN include simulation of multipath reflections, terrain obscuration, antenna reception gain patterns, differential corrections, trajectory generators for land, air, sea and space vehicles and comprehensive error generation and system modelling. The product also accepts user-supplied trajectories, either from a file or supplied in real-time via remote control interface (reference c)). This enables hardware-in the-loop applications and supports ultra-low latency and high update rates.

System Design

The GSS9790 Multi-Output GNSS Simulator in its baseline configuration consists of a GNSS Signal Generator (based on the GSS9000) and a c50r Host running SimGEN.

The flexible system architecture of the GSS9790 signal generator chassis enables selectable RF signal output from composite outputs or from multiple, individual outputs. The chassis are supplied with one N-type composite RF ports as well as ten N-type individual ports, as shown in Figure 1.

A single GSS9790 chassis has the capacity for up to 10 RF Channel Banks. The signals from each channel bank are routed both to their own individual RF port as well as being combined with other channel bank signals at the composite RF port.

The composite outputs provide standard co-axial test capability. From herein, operation of the unit in this way shall be referred to as ***Composite Output Mode.***

The individual outputs provide anechoic chamber test capability. From herein, operation of the unit in this way shall be referred to as ***Individual Output Mode***.

Figure 1 GSS9790 chassis

Composite Output Mode

In this mode the chassis operates just like a standard GSS9000, see reference a). Simulation of a multi-channel, multi-constellation, multi-carrier frequency scenario is possible.

Signal Generator Channel Banks (up to 10 in a single chassis) are programmed with appropriate feature keys to support satellite signals for the relevant licensed constellation at a given frequency. Only those channel banks required for Composite Output Mode are fully licenced. This is less than the total quantity of installed channel banks, which is influenced primarily by Individual Output Mode operation.

There are two types of composite RF output – Low Level and High Level. The Low Level port provides nominal GNSS signal levels, e.g. -130dBm for GPS L1C/A. Please see reference a) for a comprehensive listing of the nominal GNSS signal levels. The High Level Port provides GNSS signal levels that are +47dB above nominal, e.g. -83dBm for GPS L1C/A.

There is also a 2RF version of the chassis, which has 2 composite ports.

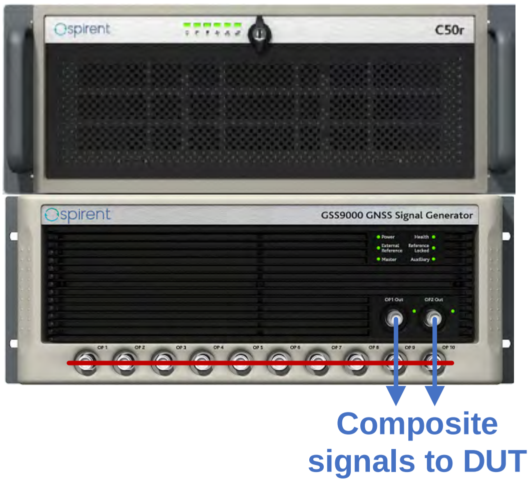

Figure 2 GSS9790 composite mode

Individual Output Mode

In this mode each channel bank is programmed to generate a single satellite signal, for the same constellation, at the same carrier frequency, at any one time, and this is output from the corresponding individual output port. See

Figure 3.

Even though the same comprehensive selection of GNSS signal type feature options are available, only one type is enabled on all channel banks at a time.

The 10 channel bank capacity of a single chassis is thus suited to simulation of 10 satellite signals from one constellation at one carrier frequency, e.g. 10 channels GPS L1. For this reason, a single chassis is installed with the full complement of 10 channel banks.

To support 10 channels of multi-frequency simulation, additional auxiliary chassis can be added as shown in

Figure 3.

Individual outputs are connected to transmit antennas located around an anechoic chamber representing the approximate sky positions of the transmitting GNSS satellites, with the DUT located at the centre (focal point) of the chamber. To overcome the external RF cable, OTA path and coupling losses in the chamber, which can be in excess of 60dB depending on chamber dimensions, the individual output ports provide GNSS signal levels that are +71dB above nominal, e.g. -59dBm for GPS L1C/A.

Spirent **GSS9790 Multi-Output GNSS Simulator**

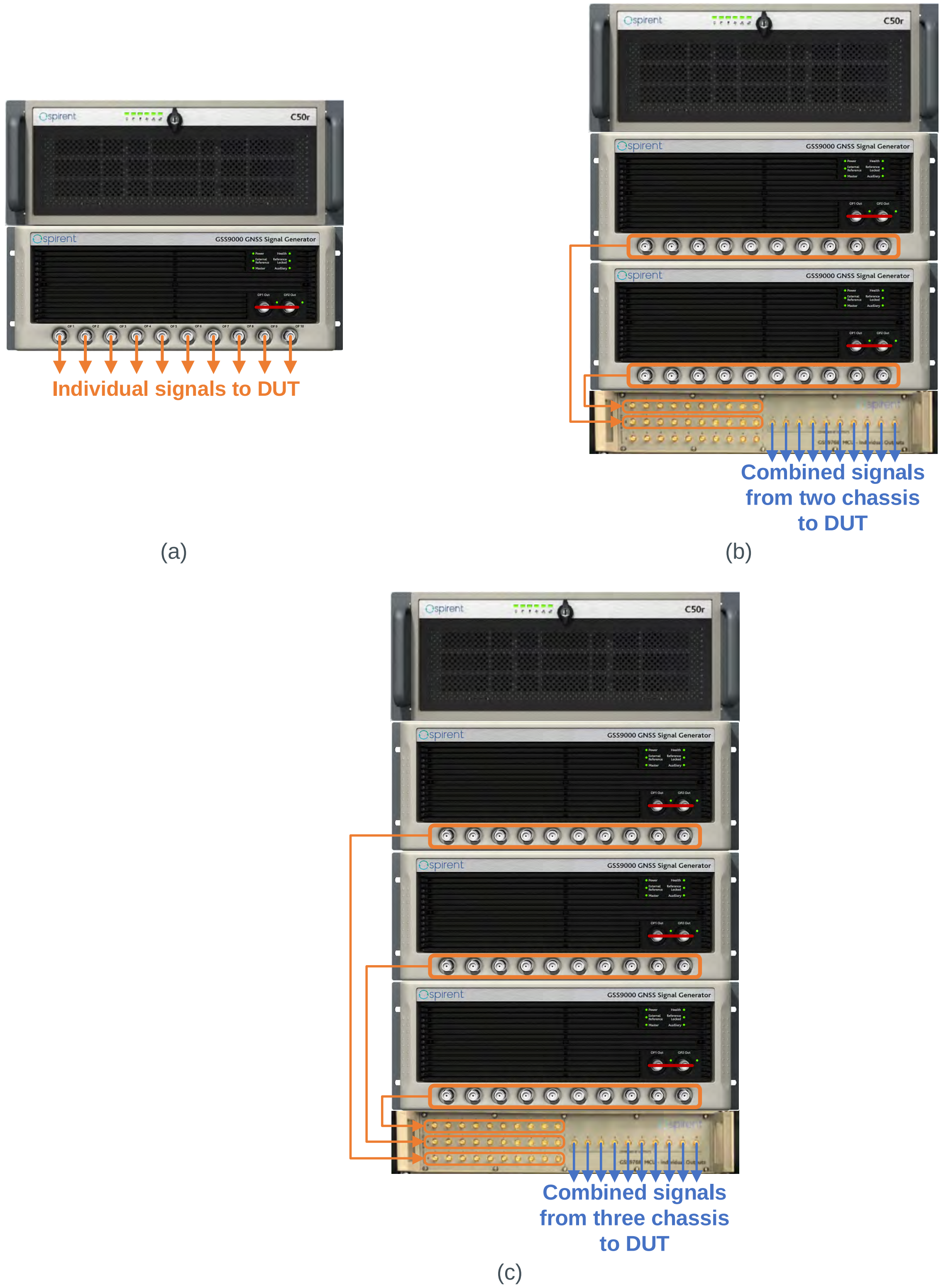

Figure 3 GSS9790 Individual mode configurations:
(a) Single-chassis, (b) Dual-chassis, and (c) Three-chassis.

These standard configurations are readily available; however, Spirent frequently provide customised systems with greater capability in terms of numbers of CRPA elements and generated signals, including support for spoofers/repeaters and multiple Jamming/interference signal types and classified/restricted signals. Please contact your Spirent sales representative to discuss your needs.

SimGEN® Scenario Definition and Simulation Control Software

SimGEN is Spirent's software application suite that supports the GSS9000.

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.

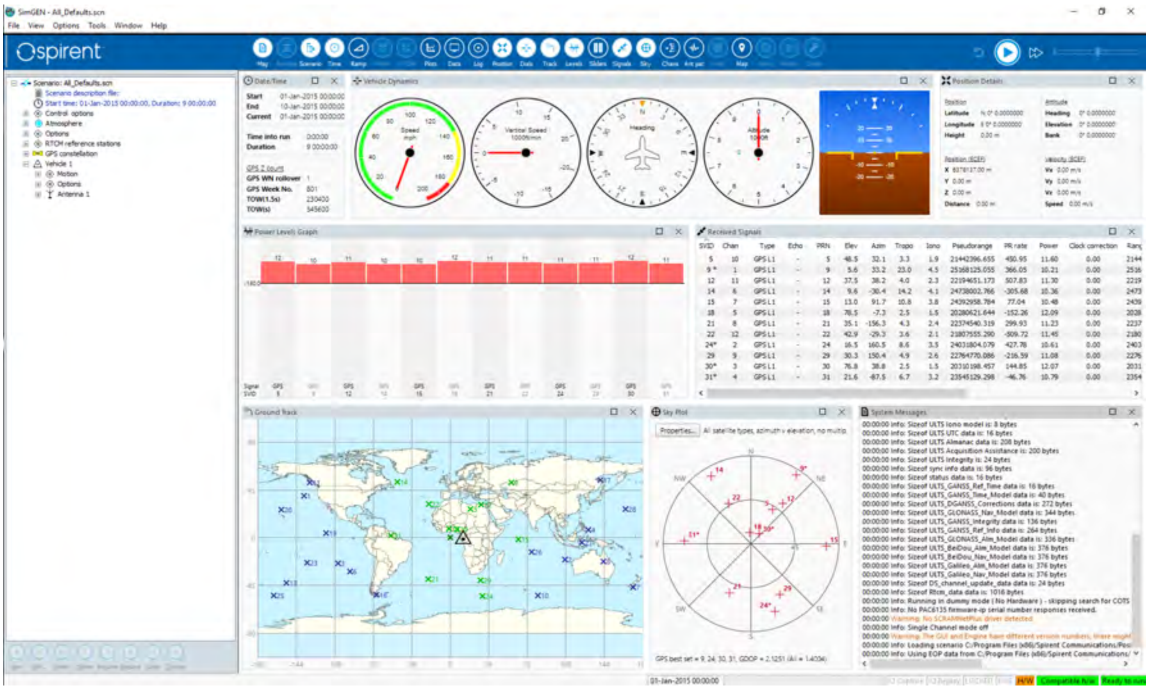

Figure 4 SimGEN scenario definition and simulation control software

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

- Fully automatic and propagated generation of precise satellite orbital data, ephemerides and almanac
- Multiplicity of mechanisms for applying declared and undeclared errors and modifications to navigation data, Satellite clocks and orbits
- SimREMOTE: Comprehensive simulation control and 6-DOF trajectory delivery capability
- 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
- Multi-copy constellations for spoofing testing
- 2-vehicles to 1RF for trajectory spoofing
- Vehicle personalities and motion modelling for aircraft, spacecraft, marine vessels and land vehicles
- Antenna reception gain and phase patterns
- Satellite transmit antenna pattern control

- Clock g-sensitivity
- Antenna lever arm effects
- 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 (with optional GSS7765 Interference Simulation System)
- 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 14.

GNSS Constellations

The GSS9790 Multi-Output GNSS Simulator architecture supports GNSS signal generation capability in a very flexible way. In ***Composite Output Mode***, with the appropriate constellation feature licence keys, each generic RF Channel Bank can support – at any one time – any one of the constellation/frequency variations as shown in Table 1 (for current ICD compliance, see Table 15).

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 RF Channel Bank in the system.

Table 1 Supported variations for each channel bank

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	L1
8	GLONASS	L2
9	BeiDou	B1I
10	BeiDou	B2I
11	BeiDou	B1C
12	BeiDou	B2A
13	BeiDou	B3I
14	SBAS (note 1)	L1
15	SBAS (note 1)	L5

Notes:

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

2. The GSS9790 is technology-ready for support of other future GNSS systems/signals, some of which can be supported today as Tailored Solutions, and some of which are planned on the current product roadmap. Please contact Spirent for further information if you have a requirement for capability not explicitly detailed in this specification.

GPS Simulation

The supported ranging signal types of the GPS constellation are shown in Table 2.

Table 2 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 ***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 ***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 RF Channel Bank, without the need to 'use up' GPS L1 or L5 channels.

The supported ranging signal types of the SBAS constellation are shown in Table 3.

Table 3 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 4.

Table 4 Galileo Signals

Carrier	Standard Signal Types	Optional Signal Types	Notes
E1	PRS Noise, OS Data/Pilot	PRS via 'PRS[WARE]'	See section ***Authorised Testing*** for information on Galileo authorised signals.
E6	PRS Noise, CS Data/Pilot (without encryption)	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) signalling 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 ***Authorised Testing***.

GLONASS simulation

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

Table 5 GLONASS Signals

Carrier	Signal types
L1	C/A, P (Chan Number -7 to +6)
L2	C/A, P (Chan Number -7 to +6)

GLONASS is supported in accordance with the GLONASS SIS ICD, see Table 15.

BeiDou simulation

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

Table 6 BeiDou Signals

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

BeiDou Phase-2 is supported in accordance with the BeiDou-2 Open Service SIS ICD, see Table 15. Spirent's implementation includes the B1I signal described in the SIS ICD and offers the same signalling on the B2I frequency. D1 and D2 navigation data supports the provision of full Ephemerides and Almanacs as well as system time offsets.

Authorised Testing[1]

GPS authorised testing

GPS authorised testing is supported 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.**

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). These options add additional capabilities - that includes SA/A-S simulation - to standard GSS9000 systems.

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

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

AES M-Code requires the **SimMCODE** option – available subject to end-user approval by US authorities.

SDS-M-Code requires the **SimMCODE and SDS-M-Code via data server** option – available subject to end-user approval. Note: SDS-M-Code via data server option is not a customer in-field upgrade.

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.

The way PRS is supplied for the GSS9000 has changed. Order processing for the new "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

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

Spirent **GSS9790 Multi-Output GNSS Simulator**

Embedded Multipath Simulation

The GSS9000 can generate up to 4 multipath channels per satellite signal source. The delay and attenuation of each path is user-specified and fixed for the simulation duration of that satellite. This embedded multipath simulation capability is not the same as the full multipath modelling supported by SimGEN™ in a GSS9000 which that uses dedicated hardware channels, e.g. enabling additional control of nav data, for details see

Ancillary 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.

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 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.

This extensibility makes the GSS9000 very flexible in terms of future-upgradeability.

Reference documents for additional upgrade options are provided in Table 14. Please contact Spirent to discuss your requirements.

Calibration status

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 channel banks 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, 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.

Extensions and Options

Extensions and options are available with the GSS9790 to facilitate development and testing of systems and applications which use other GNSS codes/signals and alternative technology for position, navigation and time determination alongside GNSS. These include:

- Authorised GPS and Galileo signal generation for authorised users (see section ***Authorised Testing***).
- GBAS VHF Data Broadcast Simulation available with the GSS4150 solution.

- Inertial Test input simulation of several types of Integrated GPS/Inertial (IGI) navigation sensors (also known as EGIs) and emulation of the presence of Inertial Measurement Units (IMU) with SimINERTIAL™ and SimAUTO™.
- Interference signal generation, using the GSS7765™ Interference Simulation System, where the interference sources are positioned and dynamically modelled by the GSS9790 system.
- Embedded in-band interference (Ground Transmitters – GTx) with a variety of modulations and signal controls.
- Sophisticated jamming laboratory testing using the GSS7765 Interference Simulation System and spoofing laboratory testing using Spirent's SimSAFE™ solution alongside in-built capabilities

Please contact Spirent to discuss your requirements.

Spirent **GSS9790 Multi-Output GNSS Simulator**

Detailed Performance Specifications[2]

Table 7 Nominal Signal Levels[3]

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	-128.0 dBm
	E6	E6-A	-125.5 dBm
		E6-A PRS Noise	-125.5 dBm
		E6-B, E6C	-128.0 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	-130 dBm
	B2 (1.20714 GHz)	B2I	-133 dBm
	B2 (1.17645 GHz)	B2A	-127 dBm
	B3 (1.26852 GHz)	B3I	-133 dBm

[2] Data from DTS0014AAA Issue 22-04 GSS9000 (PAC6135) Multi-Channel Simulator Performance Specification, and DTS00029AAA Issue 2-00 GSS9790 (PAC6200) Multi-Output GPS Simulator Product Specification.

[3] 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.

Table 8 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	E6-B	Requires 3rd party PRS[WARE] product	
	G/NAV	E1-A, E6-A	Requires 3rd party PRS[WARE] product	
GLONASS	Public	L1-C/A		There is no data message on the GLONASS P-Code
BeiDou	D1 and D2	B1I, B2I		D2 does not include differential corrections or Iono grid.
		B1C, B2A		
	Legacy	B3I		
SBAS	Data	L1, L5-I		The same message is broadcast at L1 and L5 for any satellite.

Spirent **GSS9790 Multi-Output GNSS Simulator**

Table 9 Performance Levels for GSS9000 Series

Parameter	Detail	Value	Footnote
RF Signal Level	Carrier Level Control		
	Maximum	+20 dB	4
	Minimum	-40 dB	5
	Resolution	0.1 dB	
	Linearity		
	+20 dB to -30 dB	<0.10 dB	
	-30.1 dB to -40 dB	<0.20 dB	
	Absolute Accuracy		
	Run to Run	±0.5 dB	6
	Repeatability	±0.1 dB	
	Individual RF Output Ports ***(in Individual Output Mode)***	+71dB	7, 8
Iteration Rates	Supported SimGEN Simulation Iteration Rates (SIR)	10, 100, 250, 500,1000 Hz	
	Hardware update rate	1000 Hz	
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 (indicative)		
	1.5 m lever arm	>15π rad/s	
	0.05 m lever arm	>60π rad/s	
Signal Accuracy	Pseudorange Accuracy	0.3 mm RMS	11
	Pseudorange Bias	0 mm RMS	12
	Delta-range Accuracy	Better than ±1.0 mm RMS	
	Inter-carrier Bias	Better than ±2 ns	13

4 Maximum signal level of +20 dB is available for up to 16 channels per channel bank. A maximum of +17 dB is supported for up to 32 channels per channel bank
5 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.
6 RSS at 21±5°C, +20 to -30 dB. ±1.5 dB 3-sigma, all conditions.
7 Signal level of individual RF ports with respect to the Low Level RF output port(s) in all respects (in scenario mode).
8 A 'Cal-9' calibration file is required in the SimGen 'System Data' folder to correct for offsets from +71dB w.r.t. the Low Level port.
9 For 6-DOF data externally supplied via SimREMOTE or from data file
10 When operating at >=250 Hz SIR
11 For signal acceleration < 450 m/s^2, jerk < 500 m/s^3, 1000 Hz SIR
12 Single Channel Bank – supporting up to 32 channels. When the same signal is generated across multiple Channel Banks the inter channel bank bias uncertainty is +/-230ps (+/-69mm)
13 Between any RF carrier.

Parameter	Detail	Value	Footnote
	1PPS to RF Alignment	Better than ±2 ns	14
Spectral Purity	Harmonics	< -40 dBc	
	In-band Spurious	< -182 dBW	15, 16
	Phase Noise (single sideband)	< 0.005 Rad RMS	17
Signal Stability	Internal 10.00 MHz OCX Oscillator (after warm up)	± 5 x 10-10 per day	
Static Multipath Channels	Fixed path-length delay per path	0 to 1245 m	
	Resolution (approximately)	2.4 m	

Table 10 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

14 Between any RF carrier at the output port(s). Applicable for both single and multi-output systems.
15 For relative velocities <50,000 m/s
16 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
17 Value is typical, integrated over a 1 Hz to 10 kHz bandwidth. Worst case < 0.01 rad RMS.

Table 11 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

Table 12 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 4.0 A 48 to 66 Hz	220-240 V 2.0 A 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)	34,961	System mean time between component failure (hours) per Bellcore 6 Standard at 40°C ambient temp. (assuming a single-chassis/one channel bank system).	

Table 13 Safety and EMC Compliance

Compliance	Applicable Standard
Safety	Low Voltage Directive (LVD) 2006/95/EC BS EN 60950-1:2006 Information technology equipment. Safety. General requirements
EMC	EMC Directive 2004/108/EC EN 61326-1:2006 Electrical equipment for measurement, control and laboratory use. EMC requirements. General requirements

Spirent **GSS9790 Multi-Output GNSS Simulator**

Related Brochures, Data Sheets and Specifications

Table 14 Related Product References

Related Product	Description	Data Sheet / Specification
GSS9000	GSS9000 Constellation Simulator Datasheet with Product Specification	MS9000
SimGEN	GNSS Software Suite	MS3008
SimINERTIAL	Inertial Sensor Emulation Option	MS3030
SimBARO	Barometric Pressure Emulation Option	MS3056
SimAUTO	Automotive Sensor Emulation Option Single Axis Rate Table Option	MS3023 MS3049
SimCS	Galileo FOC Upgrade Option	MS9043
SimCLASS	GPS SA/A-S Upgrade Option (Non-USA)	MS9020
SimSAAS	GPS SA/A-S Upgrade Option (USA only)	SF1001
SimMNSA SimMCODE SDS-M-Code	MNSA M-code Upgrade Option AES M-Code Upgrade Option SDS-M-Code via server Upgrade to SimMCODE	MS9018 MS9048
SimSAFE	Vulnerability Test Tool	MS3092
SimREMOTE	Simulator Remote Control Additional Options	MS3015
GBAS	GSS4150 VHF Data Broadcast Simulator for GBAS Product Specification	MS3014
GSS7765	Generic Interference Generator Option	MS3055
SimSENSOR	MEMS Sensor Simulation Option	MS3086
SimROUTE	Road-Matched Trajectory generation Tool	MS3073

ICD Compliance – Applicable Documents

Table 15 ICD Compliance[18]

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 SISICD 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
RTCA	DO246	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
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
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.

[18] 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.

Spirent **GSS9790 Multi-Output GNSS Simulator**

Glossary of terms

1PPS	One Pulse-Per-Second
BITE	Built In Test Equipment
AOC	Auxiliary Output Chip
BOC	Binary Offset Carrier
BeiDou	Chinese GNSS System
CRPA	Controlled Reception Pattern Antenna
CS	Commercial Service – Galileo
DOP	Dilution Of Precision caused by satellite geometry
EMC	Electromagnetic Compatibility
FLEX	Flexible constellation with user defined code and BOC rates
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)
GTx	Ground Transmitters – Embedded interference generation
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
MTBF	Mean Time Between Failure
NavIC	Navigation with Indian Constellation
OS	Open Service – Galileo
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
SBAS	Space-Based Augmentation System (such as WAAS, EGNOS, MSAS)
SDS	SDS-M-Code via data server
SOL	Safety Of Life
SIR	Simulation Iteration Rate

For more information

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