



Spirent SimGEN with the GSS6700 Multi-GNSS Simulator



Spirent SimGEN with the GSS6700 Multi-GNSS Simulator

Purpose of this document

This datasheet describes the functionality of SimGEN software and the performance achieved when operated as part of a GSS6700 Multi-GNSS constellation simulator system.

This datasheet also provides technical data and configuration information. Please speak to your Spirent sales representative before ordering.

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About SimGEN with the GSS6700

The GSS6700 is designed to support a range of GNSS device and system development, verification and integration testing where un-encrypted L1/E1/B1 GNSS signals from one or more constellations need to be generated. For the generation of encrypted, military / government or multi-frequency signals Spirent offers the GSS9000 which also operates with SimGEN software.

Product Range Summary

- Powerful software
 - Complete scenario generation capability using Spirent's SimGEN for Windows software
 - Full user control of constellations, errors and atmospheric effects
 - Interactive run time control
 - Generate and save scenario for use by systems using SIMPLEX or SimREPLAY software
 - Save and compare device under test data with logged simulated data
 - Receiver antenna pattern modelling
 - Import motion from logged NMEA and Google Maps® via the SimROUTE tool
 - Fully featured remote control
 - Real time remote motion for hardware in the loop testing

- Multi-GNSS
 - GPS/SBAS/QZSS, GLONASS and Galileo supported together in a single chassis
 - GPS/SBAS/QZSS, GLONASS and BeiDou-2 supported together in a single chassis
 - System can be supplied equipped with 1, 2, 3 or 4 constellations enabled¹
 - GPS L1 C/A Signal, SBAS L1 Signal and QZSS L1 C/A Signal²
 - GLONASS L1 C/A Signal
 - Galileo E1B/C OS Signal (with CBOC)
 - Beidou-2 B1(I) signal
 - 12 independent channels of each primary constellation³ enabled

- Flexible and capable hardware
 - Field upgrade to add constellations minimises downtime as your needs grow
 - Supports multiple chassis operation for multi-RF testing (e.g. DGPS)⁴
 - All digital architecture
 - Class leading accuracy, fidelity and reliability

- Range of Options and system extensions available

¹ Systems with 4 primary constellations are supplied in two chassis

² QZSS L1 SAIF is not supported

³ Primary constellations are GPS, GLONASS, Galileo and BeiDou

⁴ Excludes systems where both Galileo and BeiDou-2 are present

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- Interference and noise
- Automotive sensor package
- MEMS sensor package
- Local Area Augmentation System (LAAS)

What SimGEN and the GSS6700 Multi-GNSS Simulator do

The GSS6700 provides a coherent simulated signal from GPS, SBAS (WAAS, EGNOS, GAGAN, MSAS and SDCM), QZSS, GLONASS, BeiDou-2 and Galileo satellites⁵ at the L1 / E1 / B1 frequency.

Generation of signals from the various constellations is enabled by Electronic Feature key. If all Electronic Feature keys are present, the GSS6700 system can generate 12 channels of GPS/SBAS/QZSS⁶, 12 channels of GLONASS, 12 channels of BeiDou-2 and 12 channels of Galileo concurrently.

When operated with SimGEN for Windows software the GSS6700 generates similar RF signals to those that would be seen by a GNSS receiver when installed on a vehicle with time, place and motion defined by the user in a test “scenario”.

This enables the performance of the receiver to be assessed in the laboratory as if it were receiving RF signals from real satellites whilst stationary or performing complex user defined manoeuvres.

Standard features enabled by SimGEN include simulation of multipath reflections, terrain obscuration, antenna reception gain patterns, differential corrections (currently only specified for GPS), trajectory generators for a range of vehicles and comprehensive error generation and system modelling.

The GSS6700 can be used on its own or integrated with other equipment using a comprehensive remote control command set. System extensions available from Spirent include interference and noise generation and automotive sensors.

“Truth” data from the simulation is available to facilitate results analysis or integrate with other systems for hardware in the loop applications.

This makes the GSS6700 with SimGEN an essential tool in quantifying the performance envelope of GNSS receivers. The extensive control of simulation conditions provided by SimGEN makes the GSS6700 with SimGEN ideal for the exploratory work required to understand the mechanisms behind the performance observed.



⁵ Constellations may not all be present. Constellation may be enabled at the factory or in the field as an upgrade.
⁶ SBAS and QZSS share the GPS allocation of 12 channels.

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How SimGEN with the GSS6700 works

The GSS6700 comprises two major sub-systems:

- RF signal generator(s)⁷
- A controller consisting of SimGEN for Windows pre-installed on a personal computer

Together, these elements combine to generate RF simulations representative of a wide variety of environments.

Hardware Description

The signal generator uses direct digital waveform synthesis resulting in an accurate, stable generator capable of high fidelity and resolution.

Communication between the signal generator and the SimGEN PC is by USB. Data transmission is synchronised by an embedded 1PPS 'tick'.

The GSS6700 signal generator chassis is housed in a 2U, full width rack-mountable⁸ case and is powered via the ac mains connector. The rear panel mounted fan provides forced-air cooling.

The primary RF output is fitted on the front of the unit. All other connections are accessed via the rear-panel. Calibration adjustments may also be made via the rear panel.

The GSS6700 is available with one or more of the GNSS constellations installed.

Note that constellations not specified at initial purchase may be enabled subsequently by a straightforward field upgrade process. This process does not require the unit to be returned to the factory and can be performed by the user.

Multiple chassis systems for applications requiring more than one RF output (e.g. DGPS) can be constructed by linking one master chassis with up to 3 auxiliary chassis.⁹

The unit includes a temperature controlled crystal oscillator and its signal is made available for external use. Alternatively, the generator may be locked to an external frequency reference signal. A selection of external reference frequencies is supported.

The simulator can be synchronised with other test equipment using its 1PPS input and output signals.

Correct operation of the unit can be confirmed from the front panel indicators or remotely using BITE (Built in Test Equipment) interrogated over one of the digital interfaces.

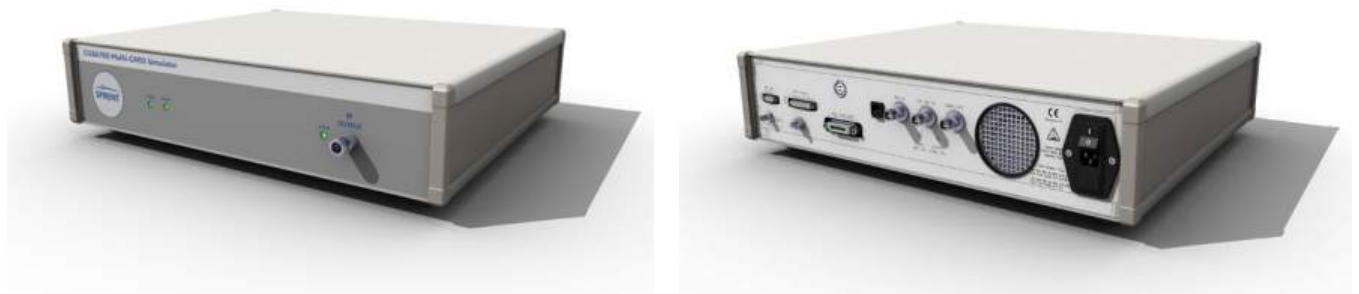


Figure 1 Front and rear images of the GSS6700 signal generator chassis (typical)

⁷ Systems where Galileo and BeiDou2 are required simultaneously require two interconnected chassis

⁸ A rack mount kit consisting of handles and mounting flanges is available and recommended for rack mounting.

⁹ Excludes systems where both Galileo and BeiDou-2 are present

Software and Control

The signal generator is controlled by SimGEN, a GNSS simulation application running on a PC supplied with the system and pre-configured by Spirent. Controller options are described under Options and Accessories later in this document.

SimGEN is supplied via a generic application, Spirent Positioning Application, and a licence key which enables the SimGEN feature set. It is the result of thirty years' experience in GNSS simulation and represents the pinnacle of simulation power and capability. This makes the GSS6700 with SimGEN ideal for research and development tasks where performance envelopes are explored and causal relationships determined.

SimGEN controls the signal generator in real time with no requirement to pre-compute any simulation variables. Consequently tests can be set up very quickly. Interactive changes during the course of the simulation run are also possible.

All aspects of the simulated environment can be controlled, providing the user with a highly repeatable set of test conditions to which real world impairments can be added individually in a totally deterministic fashion.

Table 1 Outline SimGEN modelling capabilities

System Segment	SimGEN Models
Space Segment	Full manipulation of the satellite orbits and message content
Ground Segment	Control upload timing and content
User Segment	Editable receiver antenna gain and phase patterns
Propagation and terrain	A selection of tropospheric, ionospheric, multipath and terrain obscuration models

In addition to the powerful simulation capabilities SimGEN includes a wide range of features designed to provide ease of use before, during and after the simulation.

Examples include intuitive editors with familiar Windows GUI, interactive control during the run, comprehensive remote control API, logging and data streaming of all simulator data, input of user-defined trajectories from NMEA data and from Google Map-matched trajectories using the SimROUTE trajectory generation utility.

Note that graphical representations of the SimGEN software appearing in this document should be considered as typical and for illustrative purposes and are subject to change and enhancement.

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System Details – supported constellations

The GSS6700 may be specified in a range of configurations from GPS only to GPS + GLONASS + Galileo + BeiDou-2 + QZSS multi-GNSS systems. Constellations may be enabled at the factory or by subsequent field upgrade.

Table 2 Constellation ICDs

GNSS	ICD
GPS	GPS System Specification ICD-GPS-200H
SBAS	SBAS System Specification RTCA-DO229D WAAS MOPS
GLONASS	GLONASS ICD Version 5.1(2)
Galileo	Galileo System Specification Galileo OS SIS ICD Issue 1.1
BeiDou-2	BeiDou SISICD Open Service B1I_ V2.0_Dec_13
QZSS	IS-QZSS Ver 1.6 Interface Specification

Some of the most common combinations are shown in Table 3.

Table 3 Common (but not exhaustive) GSS6700 with SimGEN configuration options

Descriptor
GSS6700 GPS simulator with SimGEN
GSS6700 GPS / GLONASS simulator with SimGEN
GSS6700 GPS / Galileo simulator with SimGEN
GSS6700 GPS / BeiDou simulator with SimGEN
GSS6700 GPS / QZSS simulator with SimGEN
GSS6700 GPS / GLONASS / BeiDou simulator with SimGEN
GSS6700 GPS / GLONASS / Galileo / QZSS simulator with SimGEN

Options and Accessories

Controllers

The system controller comprises a personal computer (PC) pre-installed with SimGEN for Windows software.

Due to the rapidly changing nature of the commercial PC market the PC's supplied by Spirent with the GSS6700 may change from time to time.

There are currently four variants of PC available. The standard controller uses the default PC option and is recommended in most cases. Note that some options and system extensions (e.g. SimAUTO) require a PC with available PCI slots. In these cases the rack-mountable or rack-mount PC options should be selected. Spirent will advise if this is applicable.

1. Standard PC. This is a commercially available, compact desktop model supplied as standard with a 19" wide-screen monitor, UK keyboard and mouse. Other keyboards may be available upon request.
2. Laptop PC. This is a commercially available, UK specification laptop PC.
3. Rack-mountable PC. This PC is a 4U 19 inch rack-mountable industrial PC supplied with a free-standing 22" TFT monitor, UK keyboard & mouse. The rack-mountable PC is also supplied with a rack-mount kit for the GSS6700 signal generator chassis.
4. Full rack-mount PC. This PC is a 4U 19 inch rack-mountable industrial PC supplied with a drawer mounted 17" monitor, keyboard and trackball system for full rack-mounting. The full rack-mount PC is also supplied with a rack-mount kit for the GSS6700 signal generator chassis.

System Extensions

A range of compatible system extensions is available for GSS6700 systems. These include:

- SimAUTO to add automotive sensors and rate table drive.
- SimSENSOR to add MEMS sensor and error model simulation for Hybrid Location applications
- A rate table (driven by SimAUTO) to stimulate integrated gyro sensors..
- GSS7765 to add noise and interference simulation..

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Performance and Features

Signal Capability

Table 4 Signal Generator Performance

Parameter	Comment	Value	Units	
GNSS Constellations	GPS or SBAS	12	channels	
	GLONASS	12	channels	
	Galileo	12	channels	
	BeiDou-2	12	channels	
	QZSS	4 ¹⁰	channels	
Signals	GPS L1 C/A signal with data (SPS)	1 – 63	PRN	
	SBAS L1 signal with data	120 -141	PRN	
	GLONASS L1 C/A signal with data (SPS)	-7 to +6	Channels	
	Galileo E1-B/C CBOC signal with data (OS)	1-50	PRN	
	BeiDou-2 B1(I) signal with data (OS)	1-37	PRN	
	QZSS L1 C/A signal with data	183 - 202	PRN	
Signal Dynamics	Maximum Relative Velocity	±15,000	m/s	
	Maximum Relative Acceleration	±450	m/s ²	
	Maximum Relative Jerk	±500	m/s ³	
	Maximum Angular rate (1.5 m lever arm)	2π	rad/s	
Signal Bandwidths	GPS L1 , Galileo E1 and QZSS L1	20	MHz	
	GLONASS L1	10	MHz	
	BeiDou-2 B1	16	MHz	
In-band ¹¹ spectral purity	Referred to unmodulated carrier power at RF output	< -30 ¹²	dBc	
Out-of-band Spectral Purity (within Bands specified)	GSM 900	925 to 960 MHz		
	GSM 1800	1805 to 1880 MHz		
	GSM 1900	1930 to 1990 MHz	-165	dBm
	3G	2110 to 2170 MHz		
	4G	2500 to 2690 MHz		
Harmonics	Referred to unmodulated carrier power at RF output	<-40	dBc	
Phase noise close to unmodulated carrier	Integrated between 1 Hz and 10 kHz (Single Sideband)	< 0.02	rad RMS	
Time Synchronisation between GNSS signals	Adjustable pseudorange	± 1	ms	
	Resolution	1	ns	
Nominal signal power at Primary RF port	GPS	-130	dBm	
	SBAS	-130	dBm	
	GLONASS	-131	dBm	
	Galileo ¹³	-127.0	dBm	
	BeiDou-2	-133	dBm	
QZSS	-130	dBm		

10 GPS L1 channels are re-allocated to QZSS L1

11 'in band' refers to appropriate constellation signal bandwidth.

12 At nominal RF output power and above.

13 Power specified with B and C codes present.

Parameter	Comment	Value	Units
Primary RF to Mon Cal port power offset	See footote ¹⁴	Approx 57	dB
Signal power control	Per channel (+15 to -20dB from nominal)	35	dB
	Resolution	0.1	dB
Nominal carrier frequency	GPS L1 / SBAS L1 / Galileo E1 / QZSS L1	1575.42	MHz
	BeiDou-2 B1	1561.098	MHz
	GLONASS L1, Channel 0	1602	MHz
Master clock stability (internal)	Over temperature range	$\pm 1 \times 10^{-8}$	
	Over one day (24 hours warm up)	$\pm 5 \times 10^{-10}$	
	Over one year, continuous	$\pm 1 \times 10^{-7}$	
External Reference Frequency Input	Selectable	10, 5, 1	MHz
External Reference Power	5 or 10 MHz (sine or square wave)	-5 to +10	dBm
	1 MHz (square wave)	0 to +10	dBm
External Trigger Input	To control start of simulation (TTL logic levels, rising edge trigger)	>2	μ s pulse
1PPS OUT to RF Delay (Per constellation)	Timing Uncertainty between a rising transition on 1PPS OUT port and its corresponding event on the Primary RF port.	0 ± 5	nsecs 1σ (RSS) ref: 1PPS OUT 1.5 V into 50 Ohm
Channel Hardware Update Rate	Maximum rate for a single constellation	100	Hz
	Maximum rate for a multiple constellation	10	Hz

¹⁴ The GSS6700 provides both the calibrated front-panel RF output port (Primary RF) for testing, and a rear-panel output port (MON CAL) to allow MONitoring of the un-calibrated signal at a high-level, and a means of CALibrating the primary RF. Both ports are isolated to dc voltages.

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Accuracy

Table 5 Signal Generator Accuracy

Parameter	Condition	Definition
Pseudorange ± 0.002 m (RMS)	Dynamics < 40 m/s ² / 50 m/s ³	Uncertainty in SV code phase offset, that offset being calculated from range, ionospheric/tropospheric delay and SV clock error
± 0.01 m (RMS) including interchannel bias	Dynamics < 450 m/s ² / 500 m/s ³	
Pseudorange rate ± 0.001 m/s (RMS)	Dynamics < 45 m/s ² / 50 m/s ³	Uncertainty in rate of change of pseudorange measured with respect to the simulator reference oscillator (not cumulative)
± 0.01 m/s (RMS)	Dynamics < 450 m/s ² / 500 m/s ³	
Interchannel bias Zero		Difference in code phase at the RF output between any 2 channels simulating the same satellite
Interchannel carrier bias Zero		Difference in carrier phase at the RF output between any 2 channels simulating the same satellite
Satellite signal power ±1.0 dB (RSS), ±2.0 dB Max		Uncertainty in overall simulated power level under all conditions
<±0.2 dB		Run-to-Run variance under same environmental conditions
<0.1 dB		Inter-channel level bias
± 0.1 dB	(range: +15 to -5 dB)	Linearity
± 0.2 dB	(range: <-5 to -10 dB)	
± 0.5 dB	(range <-10 to -20 dB)	
Carrier Frequency ±8 Hz to ±158 Hz at L1 after 1 year (absolute)		Master clock may be manually adjusted to < 0.05 Hz error at calibration interval (1 year). The unit can be phase locked to an external reference

Calibration Requirements

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

Software Features

SimGEN's operation can be considered in three phases.

Phase 1 - Test definition

SimGEN includes a set of tools and editors to assist in the development of the test environment including factors such as vehicle motion, satellite configurations and propagation effects. This collection of test conditions is stored as a set of source files known as a scenario. It should be noted that there is no computation required at this phase as SimGEN calculates all simulation output in real-time, and hence this initial phase is very rapid.

SimGEN also has the ability to generate and save scenarios for use by other Spirent systems including those running SIMPLEX, SimREPLAY and SimREPLAY_{plus} control software.

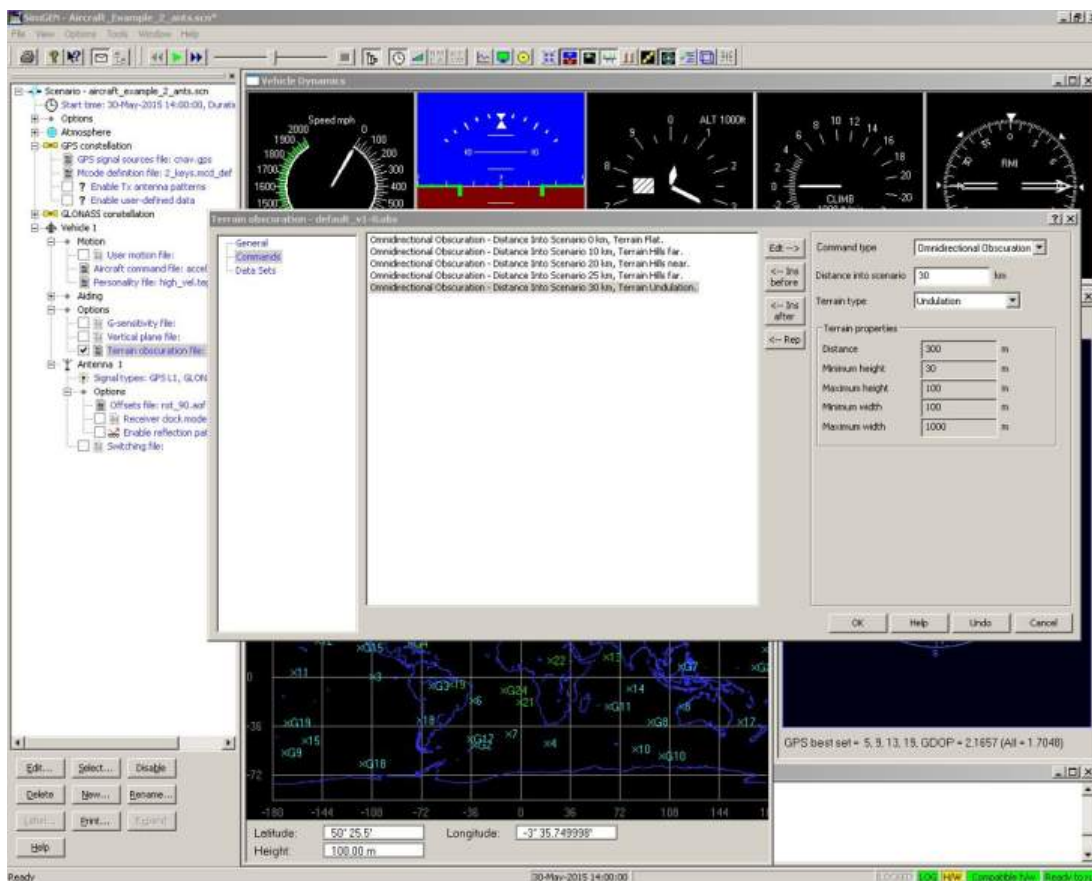


Figure 2 SimGEN during Phase 1 showing a typical event editor

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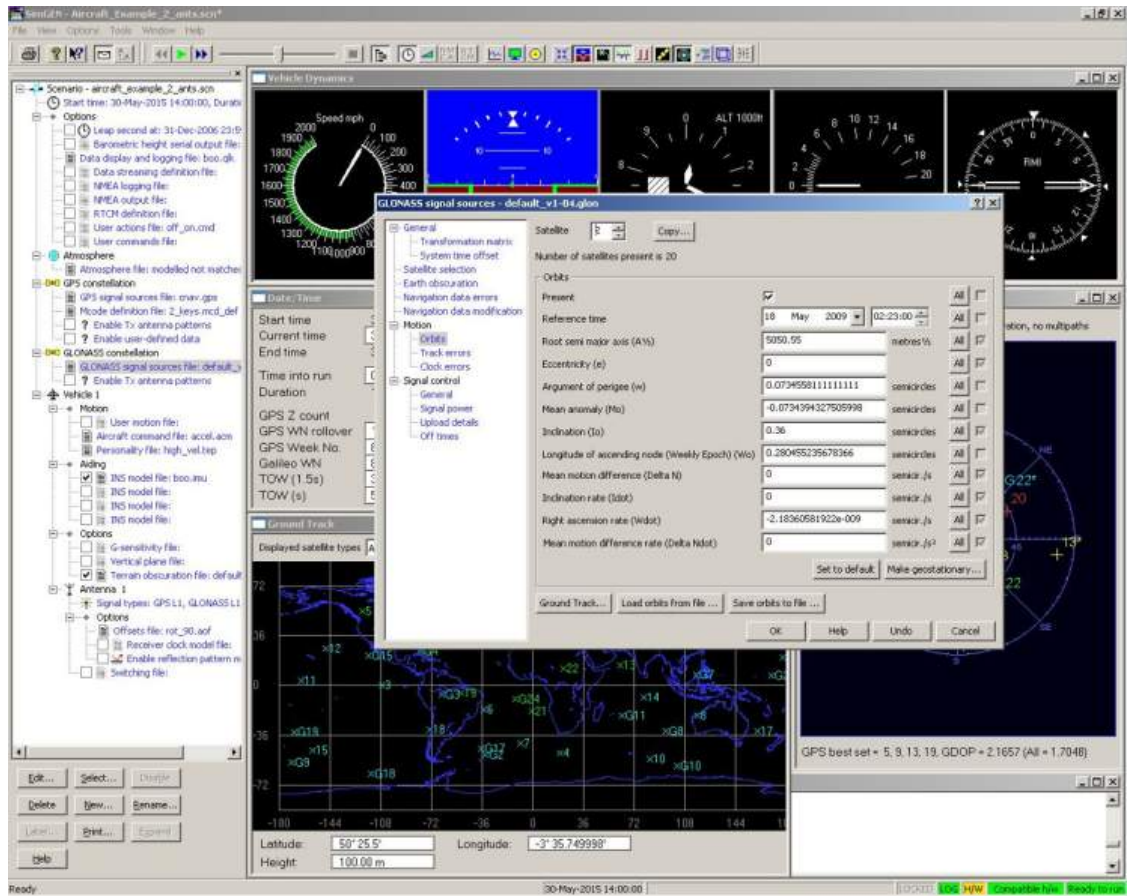


Figure 3 SimGEN during Phase 1 showing GLONASS constellation editor

Phase 2 - Real time simulation

SimGEN runs the relevant definition models using the source files that were defined in Phase 1 and in real-time¹⁵, compiles the required data streams that drive the RF signal generator and on-screen displays. The resulting RF signals are used to stimulate the satellite navigation receiver input.

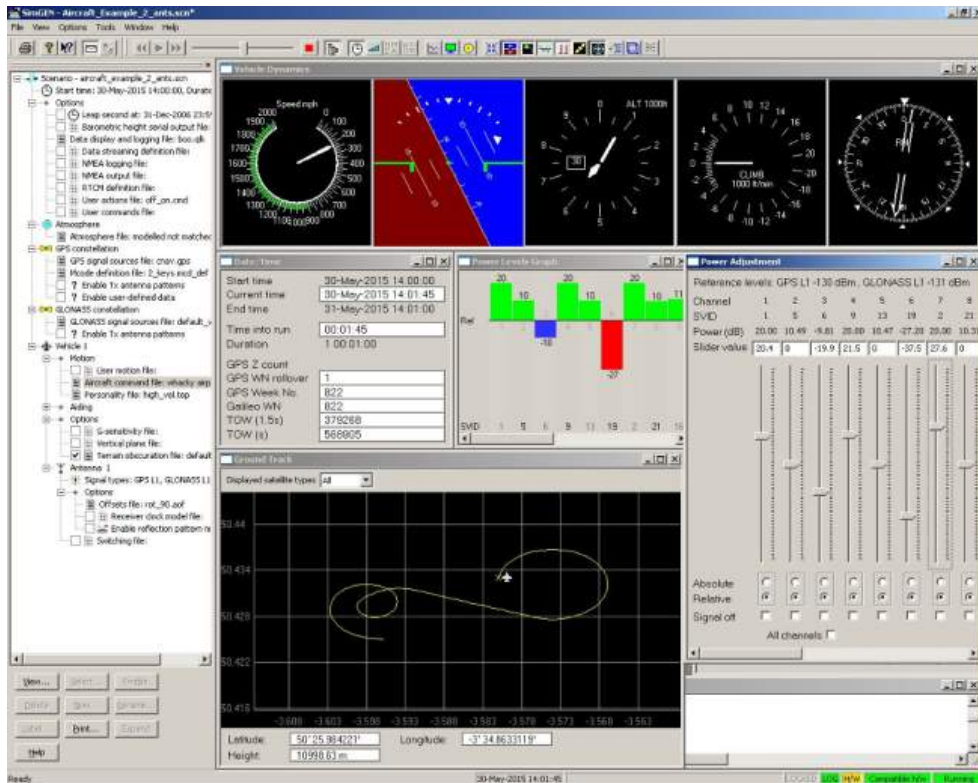


Figure 4 Typical SimGEN screenshot during Phase 2

During this phase, the user has the opportunity to vary power levels, to apply Pseudorange Steps/Ramps, to create some Multipath reflections and to ‘Ban’ or ‘Force’ satellite selection. These “user actions” can be recorded to a script file to aid post-run analysis or to allow the same actions to be replayed in subsequent runs of this or other simulations. This script file may be edited to customise the actions for subsequent runs.

Note that the scenario tree entries are now black showing that the contents of the scenario can be displayed but not edited during the run. Run time changes are limited to the user actions described above.

The user also has the ability to define and display tabular and graphical representations of parameters being generated, such as graphs of Latitude versus Longitude. The list of parameters selected for tabular display may be recorded, allowing re-use of the same parameter list in other simulations.

Selected data generated during phase 2 can be saved to a file for analysis later.

It is possible to locally use the same commands as those provided by the remote control function in scripts. Most of the interactions that may be performed manually during a simulation run may also be performed in this mode. You can also run a sequence of scenarios consecutively from a command file.

¹⁵ The default update rate, at which data is sent from the controller to the signal generator, is 10 Hz (i.e. every 100 ms). This may be increased to 100 Hz (i.e. every 10 ms) for GPS, QZSS, GLONASS, BeiDou-2, Galileo or GPS / GLONASS scenarios. For multi-constellation scenarios which include Galileo, the maximum update rate is 10 Hz (i.e. update every 100 ms).

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Phase 3 – Post simulation analysis

The data generated in phase 2 is in Comma Separated Variable format and so can be manipulated and displayed using any commercial package compatible with Microsoft Windows that supports CSV data, such as a spreadsheet.

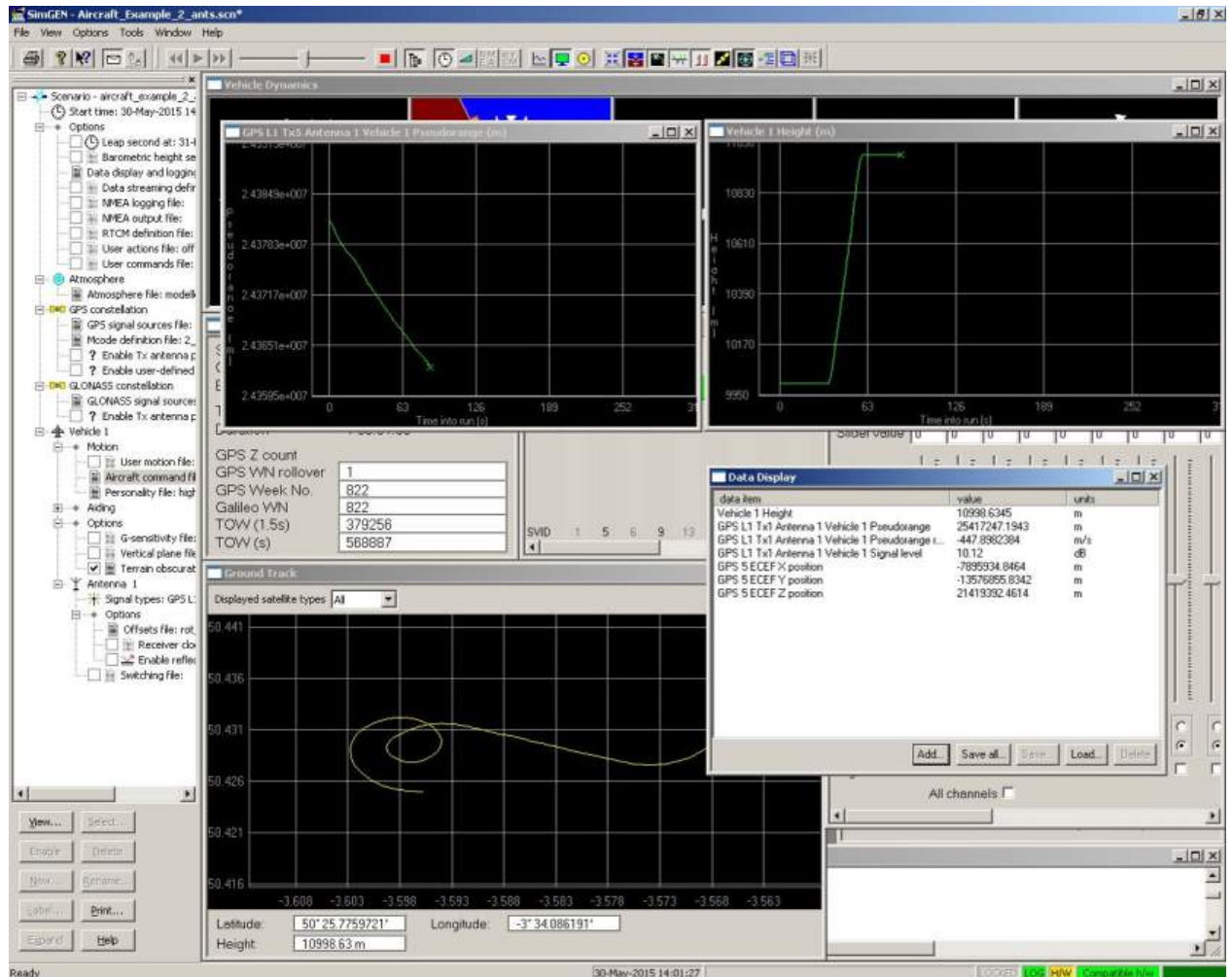


Figure 5 SimGEN Phase 3 showing a selection of data display (graphical and text)

SimGEN also includes a reporting tool called SimPROCESS, based on a compiled version of MatLab, which can also display some popular performance data graphically.

Editors

Test scenarios are defined using a collection of data source and scenario files defined by the user. For each of the following there is an editor or GUI to assist in the generation of these scenario files:

- Start Time and Date
- Definition of the appropriate GNSS constellation
- Atmospheric parameters for both the ionosphere and troposphere.
- Vehicle performance envelope - personality
- Antenna placement and orientation
- Antenna reception patterns (gain and phase)
- Vehicle motion commands (Initial position and trajectory definition for all vehicles)
- Multipath definition
- Terrain obscuration

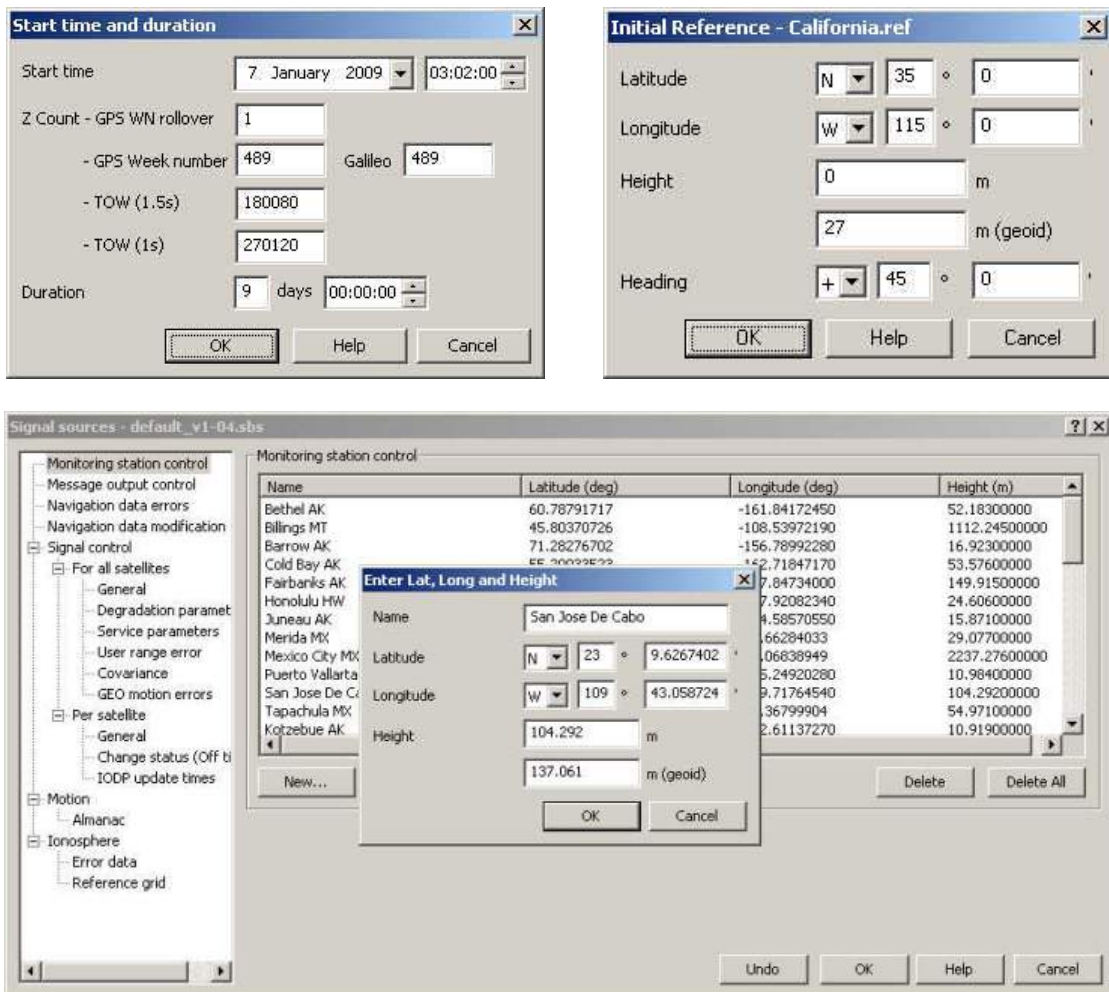


Figure 6 Typical source editors

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Models

SimGEN contains a collection of mathematical models it uses to control the generation of the RF signals. The coefficients for these models are stored in the scenario data files generated by the editors discussed above.

Each model has a default case to facilitate rapid scenario generation whatever the GNSS experience of the user.

Satellite modelling

SimGEN is able to calculate position, velocity, orbital trajectory plus almanac and ephemeris data of up to 36 navigation satellites in user-defined constellations. Definition of the constellations is via file editors that independently describe the orbits of the satellites in the terminology of the relevant ICDS.

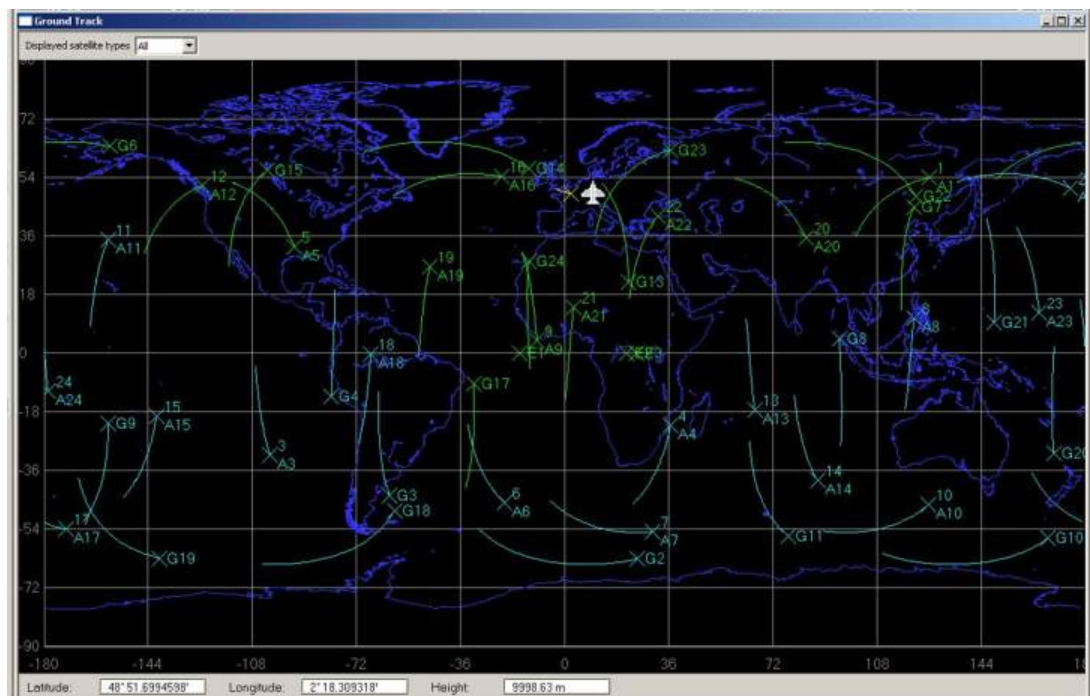


Figure 7 Satellite ground tracks

A wide range of user controls and error functions are also supported including the ability to enable or suppress elements of the transmitted signals on a per-satellite basis.

Ground-segment modelling

SimGEN allows the user to command a variety of Ground Segment activities.

A facility is provided to periodically remove any satellite from the simulated constellation and for this to be reflected in the transmitted Navigation Data message where appropriate.

Any Ephemeris or Almanac is derived directly from the orbital definition specified by the user. The data is extrapolated from the time-of-validity in the source file to the value that would be valid at the simulated time, including divergence after upload. This relieves the user of the need to relate constellation file data to simulation date and time. Data uploads and Ephemeris cutovers are fully supported where appropriate.

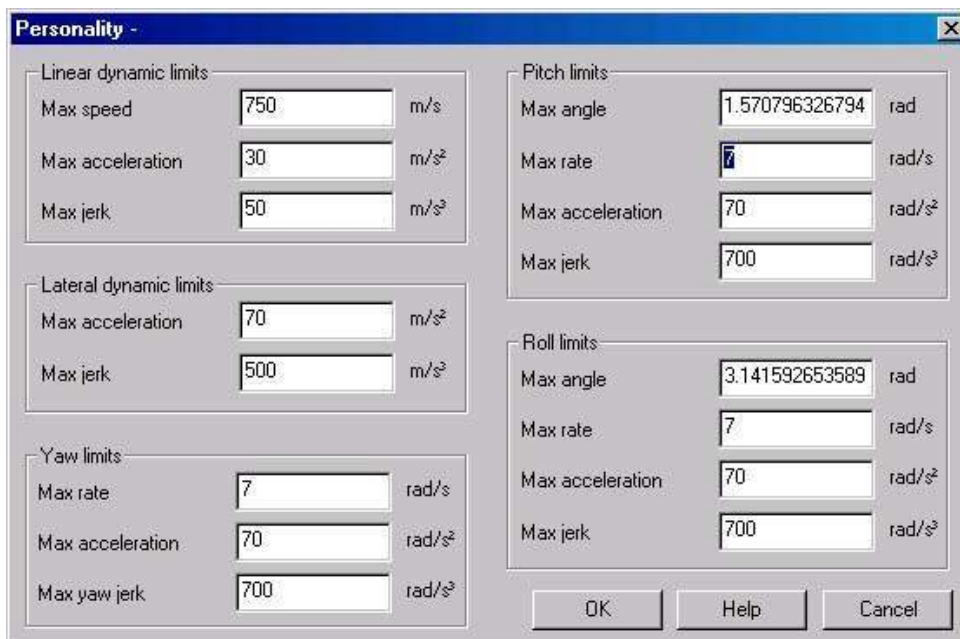
Facilities are provided to specify the satellite health data fields and to manipulate various specific data fields and flags in the data messages. In addition, bit-wise message editors are included that allows manipulation of any field through bit forcing, clearing and inversion, whilst maintaining valid parity.

Vehicle modelling

SimGEN is supplied complete with a range of vehicle trajectory models and data converters to allow logged data (e.g. NMEA format) to be used to define simulated vehicle motion.. These are designed to provide the user with all the tools necessary to describe vehicle dynamics that exercise all aspects of satellite tracking ability in the receiver or system under test.

Vehicle models for land, sea, air and space are included.

A user-defined vehicle personality that operates in 6DOF serves to ensure that manoeuvres don't exceed user-defined limits (excludes simple motion models) or to characterise the manoeuvre dynamics.



The screenshot shows a dialog box titled "Personality" with several sections for defining vehicle performance limits:

- Linear dynamic limits:**
 - Max speed: 750 m/s
 - Max acceleration: 30 m/s²
 - Max jerk: 50 m/s³
- Lateral dynamic limits:**
 - Max acceleration: 70 m/s²
 - Max jerk: 500 m/s³
- Yaw limits:**
 - Max rate: 7 rad/s
 - Max acceleration: 70 rad/s²
 - Max yaw jerk: 700 rad/s³
- Pitch limits:**
 - Max angle: 1.570796326794 rad
 - Max rate: 7 rad/s
 - Max acceleration: 70 rad/s²
 - Max jerk: 700 rad/s³
- Roll limits:**
 - Max angle: 3.141592653589 rad
 - Max rate: 7 rad/s
 - Max acceleration: 70 rad/s²
 - Max jerk: 700 rad/s³

Buttons for "OK", "Help", and "Cancel" are located at the bottom right of the dialog.

Figure 8 Personality editor defining vehicle performance envelope

User trajectory

The user may choose to supply a trajectory independent of the models supplied. The user defines the trajectory in an ASCII form supported by many commercial packages that support comma-separated file output, such as spreadsheets. The format of each data record is the same as that used for external trajectory data.

The data is read and used in real time.

Lever-arm effects due to antenna positioning are handled automatically.

External trajectory - hardware-in-the-loop

User trajectories may be supplied in real-time as standard via Ethernet using TCP/IP Sockets.

This feature, allows full Hardware-in-the-loop capability for simulation of feedback control systems or for integration with vehicle motion simulators.

Lever-arm effects due to antenna positioning are handled automatically.

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Propagation

Atmospheric modelling

Satellite signals contain correction coefficients in their navigation message structure to support correction of ionospheric delay on the transmitted signal. Inclusion of ionospheric and tropospheric effects are fully supported by SimGEN.

Separate modelling coefficient sets are provided; one set applied to the RF signal and one set for subsequent navigation message uploads; see Figure 9. Deliberate divergence between the data in the RF and data broadcast sets is possible and allows pseudorange errors to be introduced. Note that implementation of these features is constellation specific. We recommend that you discuss your specific detail requirements with us.

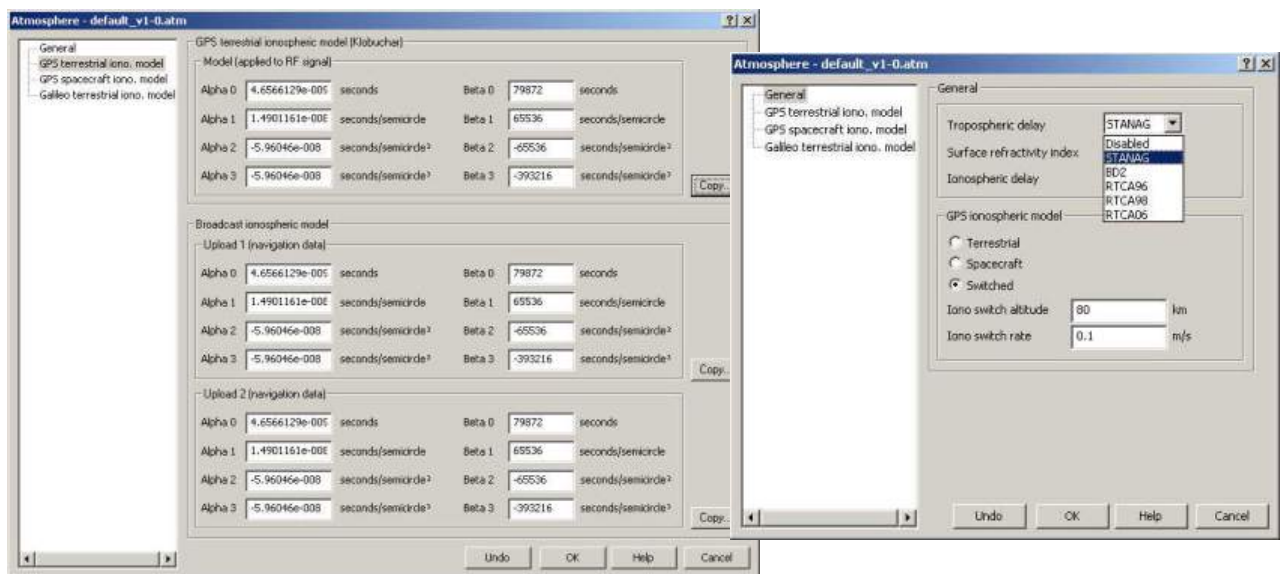


Figure 9 Atmospheric Model Coefficients

Antenna modelling

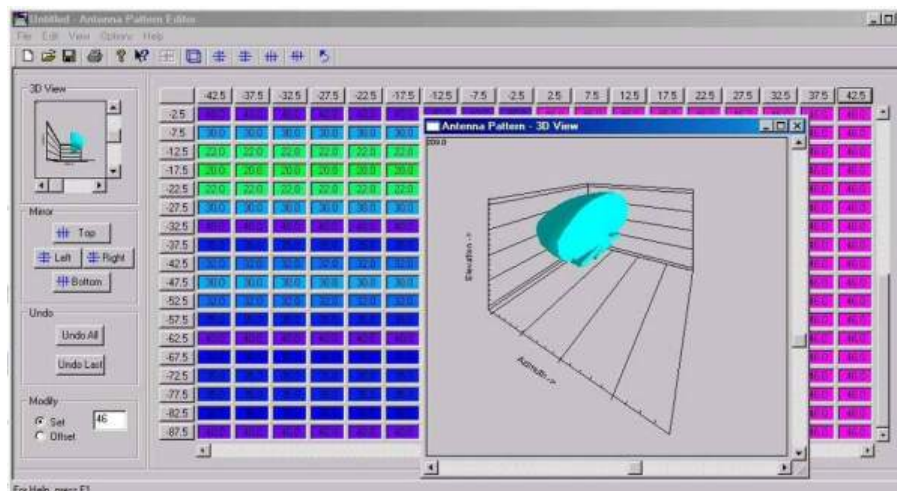


Figure 10 Antenna pattern editor

SimGEN supports modelling of the reception pattern of the navigation sensor's antenna in terms of amplitude and phase with selectable resolution up to 1° in both azimuth and elevation. The patterns are fully linked to the vehicle trajectory, allowing automatic simulation of masking of satellite signal due to vehicle obscuration during manoeuvres.

Satellite transmit antenna patterns can also be edited to explore propagation effects at low altitudes.

Terrain obscuration

A comprehensive Terrain Obscuration model is included for terrestrial vehicles, which simulates the temporary and intermittent masking of the GNSS Satellite signals when manoeuvring at low altitude in mountainous terrain. Whilst this does not represent an actual region of the earth, the effects perceived by the receiver-under-test are typical of those experienced in a terrain of the specified type.

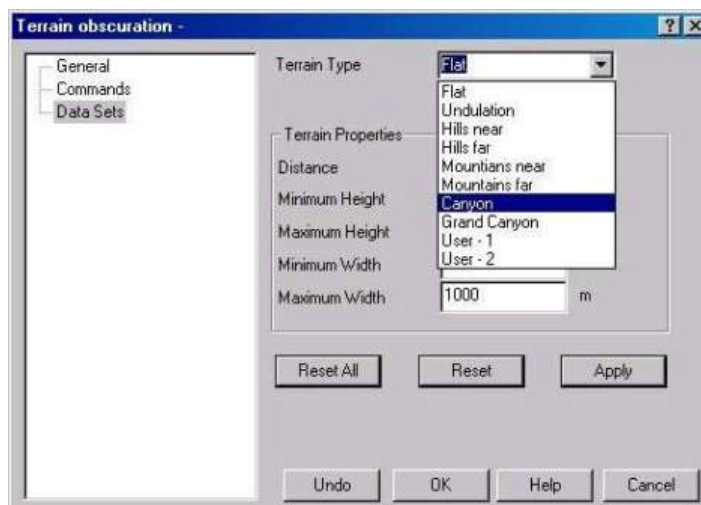


Figure 11 Terrain obscuration editor

The input to the model is the vehicle height above the WGS-84 ellipsoid and the arrival elevation vector of the satellite signal.

The terrain is user configurable in terms of the proximity of the terrain, its maximum and minimum height above the ellipsoid, and its maximum and minimum width.

Terrain height and width are varied pseudo-randomly, and the pattern of interruption is accurately repeated on consecutive simulation runs with the timing of changes proportional to the vehicle speed.

The terrain type can be modified during the simulation, with horizontal distance travelled governing the point at which the terrain is deemed to have changed.

Multipath modelling

Extensive Multipath modelling is supported within SimGEN allowing the user to test in an environment that is subject to reception of reflected signals.

In the GSS6700 Multipath reflections (echoes) are simulated using a signal generator channel.

Spirent SimGEN with the GSS6700 Multi-GNSS Simulator

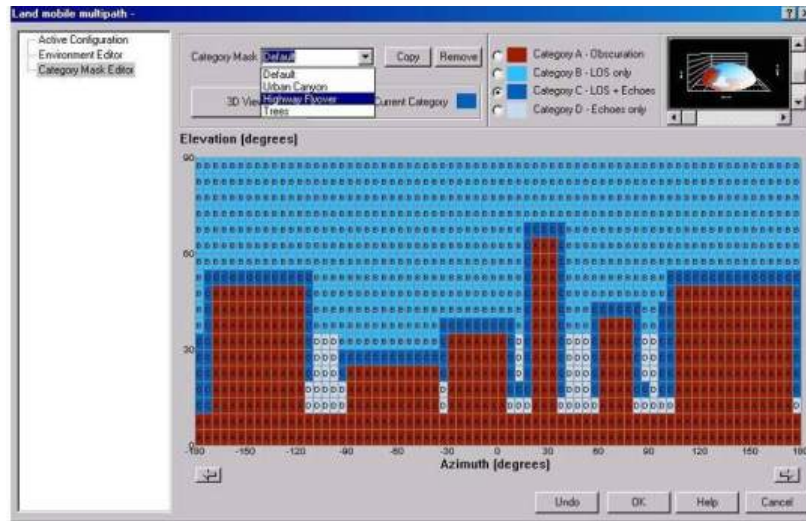


Figure 12 Statistical multipath category mask editor

At least five main models are supplied:

- Fixed offset
- Ground Bounce
- Vertical Plane
- Pattern
- Statistical

Data access

Data may be displayed whilst the scenario is being run in real-time or stored for off-line processing. Data stored includes (but is not limited to) all vehicle position and attitude data, pseudorange data, signal amplitudes, error values, and transmitted data messages.

Data streaming and Data capture

Simulation truth data can also be streamed in real-time at rates up to 100Hz. Data available includes vehicle motion parameters and satellite parameters.

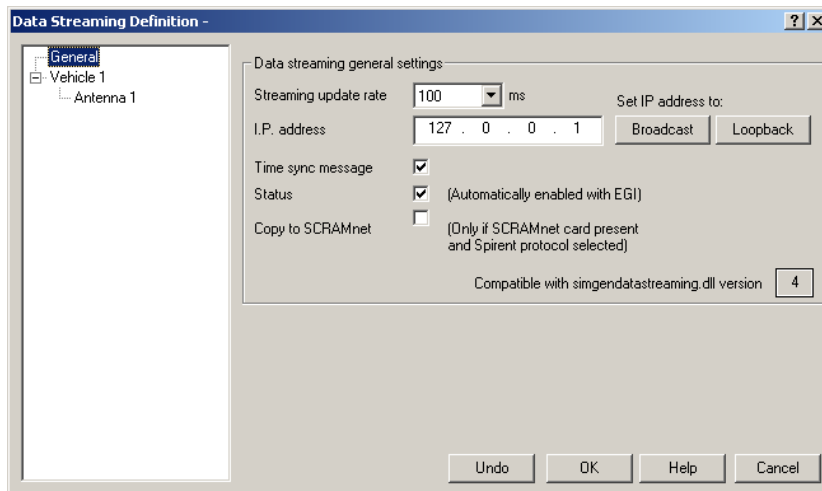


Figure 13 Data streaming

Data can be directed to an Ethernet port using UDP protocol or can be directed to another PC application running on the SimGEN PC via an operating-system socket connection.

SimGEN supports capture of data from an external source, typically a receiver navigating from signals generated by the simulation system. This is useful when post-test quantitative analysis is to be performed facilitating comparison of logged device under test (DUT) data with logged truth data.

Single Channel Operation

The GSS6700 is also supplied with SimCHAN, a single channel simulation controller application. This allows the GSS6700 to be used for single channel work and to develop test routines for use with Spirent's GSS6300 single channel multi-GNSS simulator. More details on SimCHAN are available on request.

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Physical and Environmental

Mechanical

The GSS6700 can be mounted in the following ways:

- Free standing horizontally on a desk
- Free standing vertically on a desk. The unit can be mounted on its side, using supplied feet for stability.
- Rack mounted within a 19" rack. Note that this will require the chassis to be fitted with a rack mount kit.

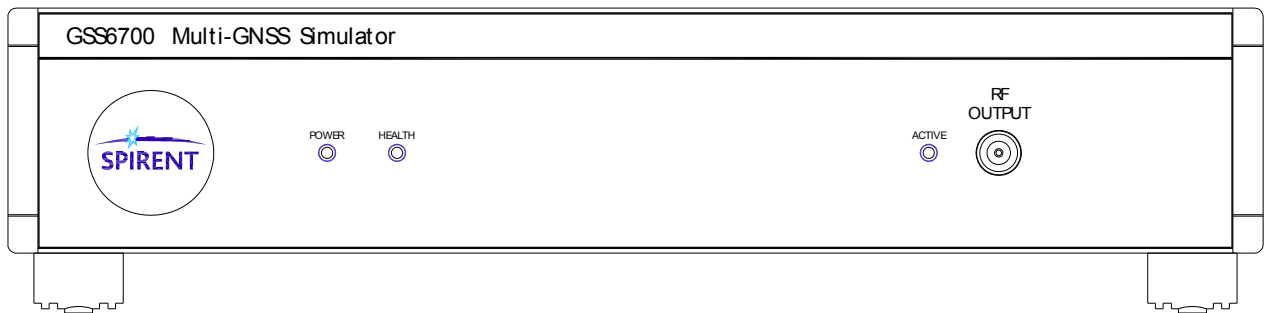


Figure 14 GSS6700 Signal Generator, front panel (typical)

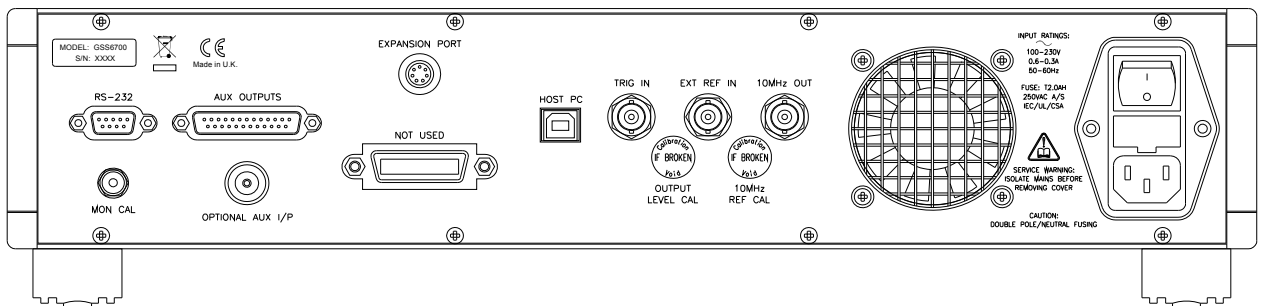


Figure 15 GSS6700 Signal Generator, rear panel (typical)

Table 6 Physical dimensions and environmental limits (Signal Generator)

Parameter	Value
Dimensions, nominal	449 mm x 386 mm x 89 mm (W x D x H) (17.75 inch x 15.25 inch x 3.5 inch)
Weight	
Signal Generator (approx)	7.0 kg (15.5 lb)
Operating Temperature	+10 to + 40oC (50 to 104oF)
Humidity	40 to 90% RH (non-condensing)
Storage Temperature	-40 to + 60oC (-40 to 140oF)
Humidity	20 to 90% RH (non-condensing)
Electrical	
Voltage	100 - 240 V ac
Current	0.6 - 0.3A max
Frequency	50 - 60 Hz

Table 7 Signal Generator Connectivity

Port	Type	Detail	Description
Primary RF (RF OUTPUT)	OUT	COAXIAL Type 'N' Socket Front Panel	Provides the primary RF GNSS signal output at specified power. 50 Ohm. VSWR <1.2:1 (in band). DC isolated ¹⁶ .
Monitor Calibrate (MON CAL)	OUT	COAXIAL SMA Socket Rear panel	Provides a high power output suitable for calibration with a power meter. 50 ohm. VSWR <1.45:1 (in band). DC isolated ¹⁶ .
Internal Reference Oscillator (10MHz OUT)	OUT	COAXIAL BNC Socket Rear Panel	10 MHz Sine 50 Ohm 0 dBm nominal
External Reference (EXT REF IN)	IN	COAXIAL BNC Socket Rear Panel	Allows the equipment to be locked to an external reference. 50 Ohm Required ext ref accuracy <0.1 ppm.
External Trigger (TRIG IN)	IN	COAXIAL BNC Socket Rear Panel	Trigger input to control the start of simulation. 50 Ohm. TTL level compatible.
1PPS OUT ¹⁷ (1-pulse-per-second)	OUT	25-Way D-Type Rear Panel	50 Ohm Nominal width 100 ms TTL level compatible
1PPS IN (1-pulse-per-second)	IN	25-Way D-Type Rear Panel	In combination with the External Reference input, can be used to synchronise the simulator to an external system. 50 Ohm TTL level compatible
USB (single dedicated port)	IN / OUT	USB Rear Panel	Main interface with Controller.
Expansion	Multi- way	Rear Panel	For optional multi-generator use.
Output Level Cal	ADJ	Rear Panel	Annual cal, power level adjustment pot.
10MHz Ref Cal	ADJ	Rear Panel	Annual cal, frequency adjustment pot.

¹⁶ DC isolated ports can withstand a maximum DC level of ± 60 V and reverse RF levels to a maximum of 1 W.

¹⁷ Programmable 1PPS Output with following settings: Gated, Rising – High whilst box is active, High– High all the time, Low – Low all the time

Spirent SimGEN with the GSS6700 Multi-GNSS Simulator

Safety and EMC Conformity

Table 8 Safety and EMC Compliance

Criteria	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

Deliverables

Table 9 Deliverable Items (may vary with specifics of system configuration)

Item	Quantity	Description	Comment
1	1	Multi-GNSS Signal Generator	
2	1	Vertical mount foot	
3	1	Personal Computer	See Options and Accessories above for details
4	1	Data CD	Contains software and manuals
5	1	USB cable	
6	1 set	Power cords	Country specific
7	1 (optional)	Expansion cables (Multi-box)	Optional (only required for multi-box configurations)
8	1 (or more)	Electronic Feature Key	Defines the system capability. Pre-installed in the chassis or supplied electronically on registration (for upgrades)

Applicable Documents

- a) GPS System Specification ICD-GPS-200¹⁸.
- b) SBAS System Specification RTCA-DO229¹⁸ WAAS MOPS.
- c) Galileo System Specification Galileo OS SIS ICD¹⁸
- d) GLONASS ICD¹⁸
- e) IS-QZSS Ver 1.2 (Draft) Interface Specification
- f) MS3008 SimGEN for Windows Product Specification
- g) BeiDou-2 system specification: BDS-SIS-ICD-B1I-1.0 2012-12

¹⁸ See Table 2 Constellation ICDs for applicable issue

Glossary of Terms

Term	Meaning
1PPS	One Pulse-Per-Second
BeiDou-2	BeiDou Navigation System (China Regional Navigation System)
BITE	Built In Test Equipment
CSV	Comma Separated Variable. A text file format.
DOP	Dilution Of Precision caused by satellite geometry
DUT	Device Under Test
EMC	Electro Magnetic Compatibility
Galileo	Proposed European GNSS
GLONASS	Global Navigation Satellite System (Russian GNSS)
GNSS	Global Navigation Satellite System
GPS	Global Positioning System (US GNSS)
GUI	Graphical User Interface
ICD	Interface Control Document
LAAS	Local Area Augmentation System
Mon / Cal	A high power RF output port on Spirent simulators
NMEA	National Marine Electronics Association
PC	Personal Computer
QZSS	Quasi-Zenith Satellite System (Japanese GNSS)
RF	Radio Frequency
SBAS	Satellite Based Augmentation System, a system that adds integrity and correction for GNSS errors
SimCHAN	Single channel simulator application
SimPLEX	Controller software for STR4500
SimPLEX45	Optional controller software for STR4500
SimREPLAY	Simulator controller application
SimREPLAYplus	Simulator controller application
Truth data	Data relating to the “true” simulated position of the vehicle or antenna.
USB	Universal Serial Bus
VDB	VHF Data Broadcast (part of a LAAS system)
VHF	Very High Frequency

Spirent **SimGEN** with the **GSS6700** Multi-GNSS Simulator

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