

PNT GSS7000 GNSS Simulator

Flexible, High-Performance PNT Testing

Delivering Reliable Results Faster with Keysight's PNT GSS7000 Simulation Solution

Getting successful products to market demands precise, reliable, and flexible test capabilities. The GSS7000 offers exceptional accuracy, fidelity, and authentic Global Navigation Satellite System (GNSS) signal emulation, ensuring true performance at every test stage.



Precision multi-frequency, multi-GNSS simulation: purpose-built hardware including positioning, navigation, and timing (PNT)-specific software-defined radios delivers high-precision simulation across all current and planned GNSS and SBAS signals.



Flexible and powerful architecture: built on Keysight's proven architecture for realistic testing and easy upgrade and calibration in the field.



Advanced features: embedded multipath, interference, and spoofing capabilities deliver comprehensive vulnerabilities testing.

From smartphones to autonomous vehicles, modern applications are demanding greater accuracy and robustness in positioning, navigation, and timing than ever before. The GSS7000 is the ultimate tool for developers of GNSS-enabled consumer products, delivering the flexibility required for comprehensive testing and the true performance needed for reliable results.

Proven Architecture

Employing state-of-the-art SDR technology, refined over five decades of leading the industry, the GSS7000 has been designed and built for PNT testing. This dedicated architecture enables the GSS7000 to maintain the precision specifications for accuracy, synchronization, and latency needed to truthfully represent the constellation and operating environment under the full range of specified dynamics.

Uncompromising Signal Generation

Keysight have patented Direct Digital Synthesis (DDS) techniques for generating signals that are 100% representative of the 'truth data.' With the GSS7000, you can be sure that the results you see represent the true performance of the device under test.

Ultimate Flexibility

A highly digital architecture enables real-time configuration of signals generated and in-field upgrades of both hardware and software. In addition, the GSS7000 is designed to integrate seamlessly with a broad range of Keysight and third party tools, giving you the flexibility to grow and vary your test capabilities.

Unrivaled Control

Keysight's industry-leading Positioning Application software family enables adjustment of virtually every parameter imaginable — from signal control to bit-level manipulation of the navigation message, to adjustment of models such as orbital parameters and atmospheric errors.

Verified Performance

Keysight signal ICD implementations and performance specifications are verified by leading external entities.

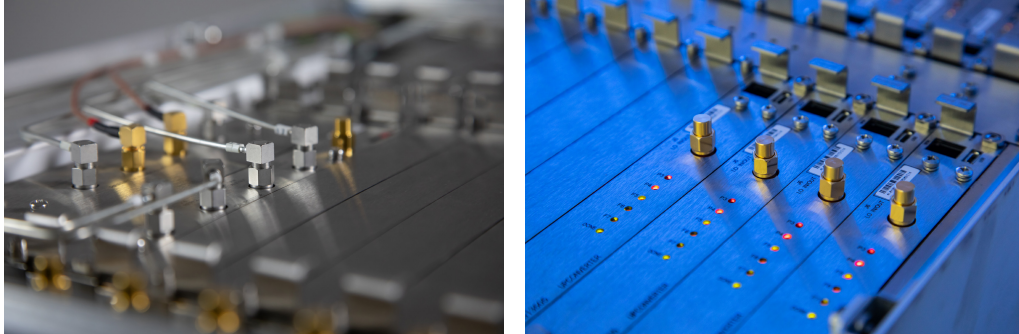


Figure 1. GSS7000 internal cards

Features and Capabilities

Embedded Interference

Embedded interference generation capability enables realistic and precise reproduction of in-band interference signals in a test lab. It allows users to set transmitter locations, trajectories, and antenna patterns, and also enables the customer-defined interference signal parameters such as center frequency, signal modulation, and power level:

- Simulation of multiple interference transmitters
- Maximum power level -47 dBm
- User-defined interference transmitter trajectory and antenna patterns

Embedded Spoofing

Spoofing is a growing concern for any safety- or mission-critical application. Without any additional hardware required, the GSS7000 is capable of simulating real-world spoofing test cases such as meaconing attacks, trajectory spoofing, base station spoofing, and satellite navigation data spoofing.

The user can define, among other parameters, the number of spoofer transmitters and their location (absolute or vehicle relative), the spoofer power levels, the false vehicle position (spoofed position), and the spoofing signal content, including navigation data and errors.

The resulting spoofer RF signal will be automatically calculated based on user scenario settings, with the correct spoofer signal arrival angle and spoofer signal content.

Realistic 3D test environments: Assess the impact of multipath and obscuration effects on GNSS signals based on a virtual 3D local environment.

Hardware-in-the-loop testing: The GSS7000's open and rich interface enables seamless integration into hardware-in-the-loop (HIL) test configurations.

Interference testing: The GSS7000 offers a broad range of high-power interfering signal options and can be configured to support multiple fully independent interference sources. It also supports noise generation with variable bandwidth.

Route-matched trajectories: The GSS7000 interfaces with the most popular free mapping tools, enabling real-world routes to be scheduled and tested.

GNSS/inertial testing: The GSS7000 enables users to test the operational performance of integrated GNSS/inertial systems and IMUs by emulating sensor outputs to match the simulated vehicle trajectory.

Live sky synchronization: The GSS7000 has the capability to synchronize with live sky GNSS signals, enabling highly realistic spoofing testing.

Single Channel Utility (SCU): The GSS7000's SCU enables generation of a single signal for each licensed constellation and frequency. SCU is validated to support test tools such as Qualcomm's QDART.

Remote control: In addition to its native ethernet remote control facility, the GSS7000 can take advantage of comprehensive APIs for Labview, C++, and other common programming languages and test environments.

Multi-antenna, multi-vehicle simulation: 6-DOF trajectories from one or two independent RF outputs.

Correction support: streaming of RTCM data over RS232 or via in-built NTRIP server interface.

"We needed a new approach to R&D testing that combined best-in-class components. By working with Keysight's experts, we have created a system that will help to bring connected cars to market faster."

Antonio Casu
Chief Technical Officer, Italdesign

Simulation Control

Multipath and obscuration: including embedded models, or seamless integration with Keysight's advanced 3D environment modeling tool — Sim3D

Ionospheric and tropospheric effects: multiple configurable models available

Satellite orbital editing: enabling complete control over orbital parameters and induced errors

Satellite clock error and navigation data errors: adding declared and undeclared errors to create a comprehensive test methodology — including recreation of real-world events

Satellite transmit antenna pattern control: unique capability to model gain and phase patterns for different transmission frequencies

Receiver antenna modelling: reception gain and phase pattern control for flexible conducted testing

Remote control: remote control and integration with automation tools via native SimREMOTE API

Signal Generation

Generating signals from first principles is the only way a simulator can generate truthful signals with the control developers and integrators need. The GSS7000 generates signals via bit-by-bit generation of the navigation message by full implementation of the relevant SIS-ICD. All the orbital data and ephemerides are calculated to create the perfect truth data that downloaded observed datasets with potential decoding and SIS errors cannot provide.

Available Signals

| Signal | Frequencies |
|----------|------------------------------|
| GPS | L1 C/A, L2 C/A, L5 I/Q |
| GLONASS | L1OF, L2OF, L1OC, L2OC, L3OC |
| Galileo | E1 OS, E5 A/B, E6 |
| BeiDou-2 | B1I, B2I |
| BeiDou-3 | B1C, B2a, B2b, B3I |
| QZSS | L1, L2, L5, L6 |
| IRNSS | L5 |

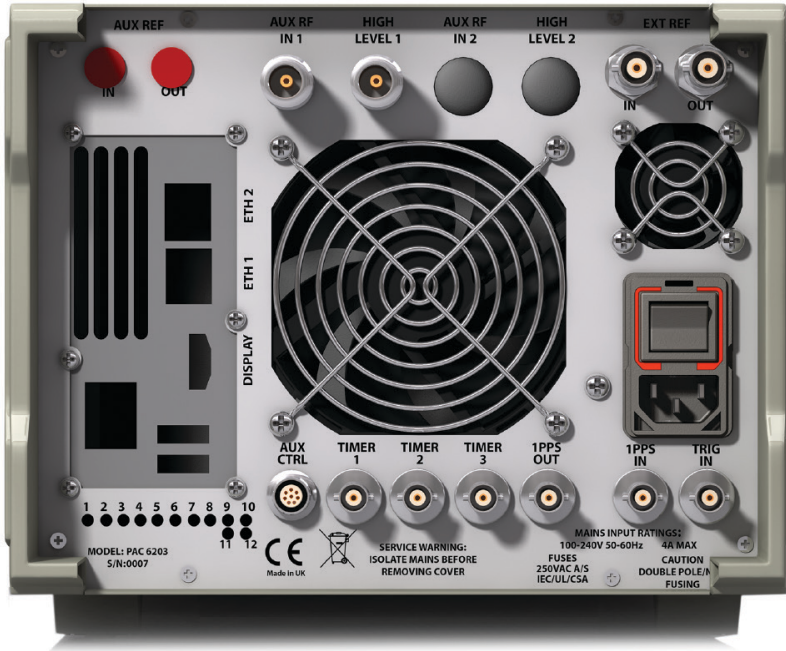


Figure 2. Rear panel of a GSS7000



Figure 3. Hardware and software of a GSS7000 system

Signal Characteristics

A test instrument must be many times more accurate than the device it is testing. Without this, the performance of the instrument can have a significant and unwanted effect on results. The GSS7000 uses advanced SDR technology to accurately represent signals without introducing artificial phase noise and spurious signal effects to the test, enabling complete confidence and powerful analysis.

Rate

- Simulation iteration rate configurable up to 1000 Hz

Signal Accuracy

- Pseudorange ± 0.3 mm RMS
- Interchannel bias zero

All signal accuracy specifications are achieved under the highest dynamics and maximum simulation iteration rate.

Signal Dynamics

- Relative velocity $\pm 120,000$ m/s
- Relative acceleration $\pm 192,600$ m/s²
- Relative jerk $\pm 890,400$ m/s³

Signal Quality

- Spurious (Max) -182 dBW
- Harmonics (Max) -40 dBc
- Phase noise (Max) 0.02 rad RMS
- Frequency stability $\pm 5 \times 10^{-10}$

Signal Control

- Level control range +15 dB to -40 dB
- Level control resolution 0.1 dB
- Level control accuracy ± 0.5 dB

“Keysight has world-class products and services, which provide good support for our scientific research and talent training.”

Professor Mingquan Lu

Department of Electronic Engineering, Tsinghua University

Environmental, Social, and Governance (ESG)

Keysight’s Positioning Technology business unit has been committed to ESG good practice and improvement since achieving ISO14001:2015 Environmental Management System certification in 2004.

ESG is a priority for Keysight across all aspects of our business, from sustainable buildings and sustainable product design to sustainable supply chain, manufacturing and shipping/export processes. As is best practice, we follow a continuous improvement process in respect of ESG.

Many of Keysight’s test solutions rely on physical test equipment used in situ by our customers. We are working to reduce the lifecycle impacts of our products, and the environments in which they are used, in a number of ways:

- Designing for environment and end of life, including compliance with all legal requirements
- Reducing the size, weight, noise, and power use of our products
- Virtualization and the development of Test-as-a-Service via PNT Professional Services
- Improving utilization and automation
- In-field servicing and upgrades

We use formal sustainability metrics in the product development process.

For more specific information on how ESG applies to our PNT test solutions, please contact your Keysight representative.

Keysight enables innovators to push the boundaries of engineering by quickly solving design, emulation, and test challenges to create the best product experiences. Start your innovation journey at www.keysight.com.



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