What is a GNSS Simulator?

Global Navigation Satellite System (GNSS) is a general term for a system that provides navigation and other services to users worldwide. Each GNSS employs a constellation of satellites, which broadcasts signals that are processed by GNSS receivers to determine location, speed, and time for users anywhere in the world. Examples of GNSS include GPS, GLONASS, and Galileo.

A GNSS simulator provides an effective and efficient means to test GNSS receivers and the systems that rely on them. A GNSS simulator provides control over the signals generated by the GNSS constellations and the global test environments all in a box, so that testing can be conducted in controlled laboratory conditions. GNSS simulators generate the same kinds of signals that are transmitted by the GNSS satellites, thus GNSS receivers can process the simulated signals in exactly the same way as those from actual GNSS satellites.

A GNSS simulator provides a superior alternative for testing, compared to using actual GNSS signals in a live environment. Unlike live testing, testing with simulators provides full control of the simulated satellite signals and the simulated environmental conditions. With a GNSS simulator, testers can easily generate and run many different test scenarios for different kinds of tests, with complete control over:

- **Date, time, and location**. Simulators generate GNSS constellation signals for any location and time. Scenarios for any locations around the world or in space, with different times in the past, present, or future, can all be tested without leaving the laboratory.
- **Vehicle motion**. Simulators model the motion of the vehicles containing GNSS receivers, such as aircraft, ships, or automobiles. Scenarios with vehicle dynamics, for different routes and trajectories anywhere in the world, can all be tested without actually moving the equipment being tested.
- **Environmental conditions**. Simulators model effects that impact GNSS receiver performance, such as atmospheric conditions, obscurations, multipath reflections, antenna characteristics, and interference signals. Various combinations and levels of these effects can all be tested in the same controlled laboratory environment.
- **Signal errors and inaccuracies**. Simulators provide control over the content and characteristics of the GNSS constellation signals. Tests can be run to determine how equipment would perform if various GNSS constellation signal errors occurred.

Why use a GNSS Simulator?

Testing with simulators is the widely-accepted best practice for validating the performance of GNSS receivers and systems, in many different scenarios and operating conditions, in controlled laboratory environments. Simulators are used extensively in academia and industry, by virtually all GNSS receiver manufacturers and major system integrators, in many different application fields, including navigation, positioning, telecommunications, aviation, automotive, and space, for both civilian and military applications. Using simulators facilitates several stages of research and product development, including requirements analysis, design and development, integration, production, maintenance, and support.

GNSS simulators provide many benefits, including:

- **Control**. Simulators allow complete control over all aspects of test scenarios, including GNSS constellation signals and environmental conditions.
- **Flexibility**. Users can easily define different scenarios for different testing needs.
- **Completeness**. Equipment can be tested under different operating conditions, ranging from nominal to extreme, including conditions that are impractical or impossible to produce in live testing.
- **Repeatability**. Test scenarios are the same every time they are executed.

- **Reliability**. Because all test conditions are controlled, test results are reliable, and equipment performance can be evaluated against known truth data.
- **Cost**. Tests are conducted in the laboratory, without extra expenses for field tests and test vehicles.
- **Efficiency**. Many different tests can be completed in the same laboratory test bed, without reconfiguring or relocating equipment. New test scenarios can be created and executed quickly.
- **Realism**. The performance of GNSS receivers and systems are tested using the actual hardware. Simulators with real-time control capabilities support advanced hardware-in-the-loop (HWIL) testing.
- **Future**. Simulators provide effective means of testing new and future GNSS capabilities that are not yet supported by actual constellations, such as the GPS L2C and L5 signals and the Galileo system.

A summary of the advantages of testing with GNSS simulators, compared to live testing with actual GNSS constellations, is shown in the table below.

Live Testing with Actual GNSS Constellations	Laboratory Testing with GNSS Simulators
No control over constellation signals	Complete control over constellation signals
Limited control over environmental conditions	Complete control over environmental conditions
Not repeatable; conditions are always changing	Fully repeatable
Unintended interference from FM, radar, etc.	No unintended interference signals
Unwanted signal multipath and obscuration	No unwanted signal effects
No way to test with GNSS constellation errors	Easily test scenarios with GNSS constellation errors
Expensive field testing and vehicle trials	Cost-effective testing in laboratory
Limited to signals available in GNSS constellations	Testing of present and future GNSS signals
Competitors can monitor field testing	Testing conducted in secure laboratory

Spirent GNSS Simulators

Spirent is the industry leader for GNSS simulator products. Spirent offers several different models of GNSS simulators that support a variety of different applications, and which cover the full spectrum of civilian and military GNSS testing needs. The Spirent products range from basic single-channel simulators, suitable for simple production testing, through multi-channel, multi-constellation simulators, suitable for the most demanding research and engineering applications.

For more comprehensive testing, Spirent also offers products that simulate additional system elements simultaneously with the GNSS constellation signals, such as inertial sensors, various automotive sensors, Assisted GPS (A-GPS) data, SBAS and GBAS augmentation system signals, and interference signals.

With over 20 years of GNSS simulator experience, Spirent provides GNSS simulators with unparalleled performance and comprehensive support.

Contact

See how Spirent GNSS simulators can help you test more effectively and efficiently.

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Please visit our website at www.spirentfederal.com/gps/