

Bring satellites
into your lab:
GNSS simulators
from the T&M expert.

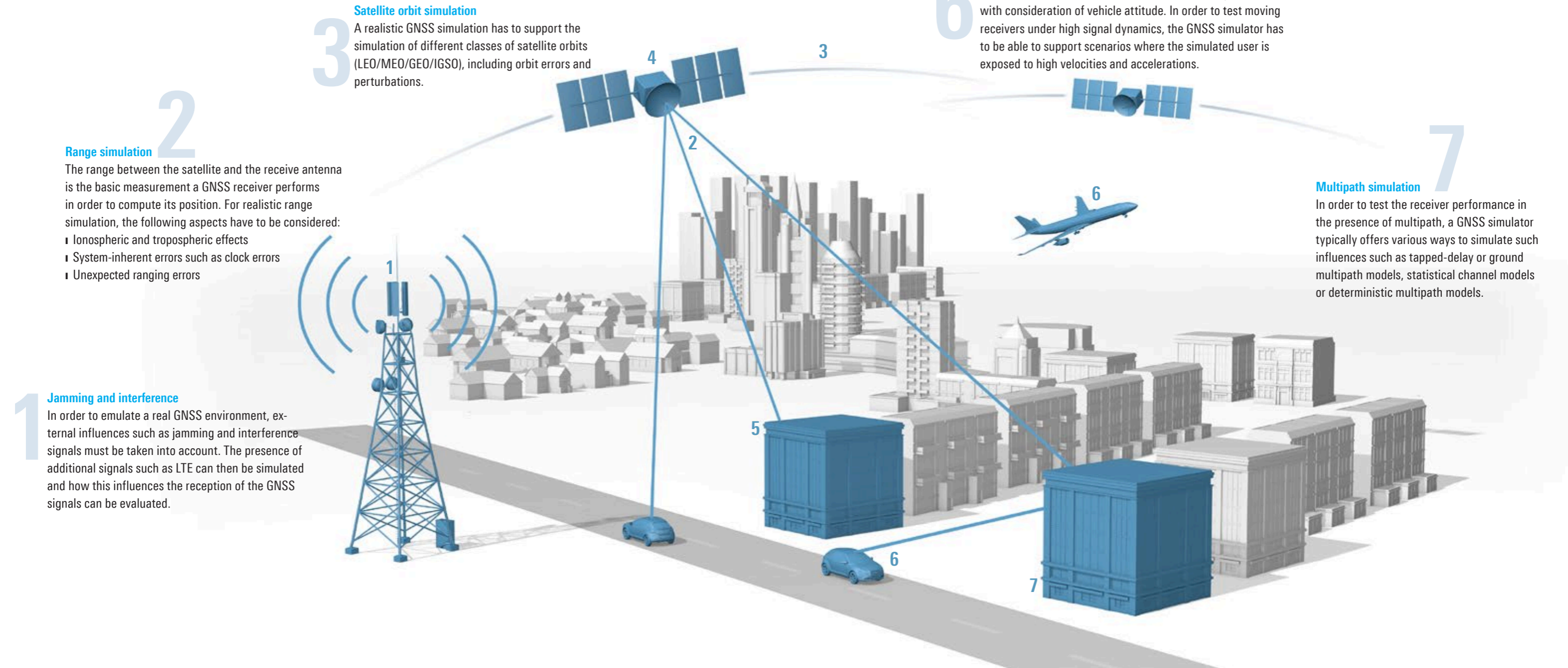


www.rohde-schwarz.com/GNSS-solutions

Your challenge ...

GNSS receiver tests can only be conclusive when they are performed under realistic conditions. A complete GNSS scenario must include proper simulation of the satellite orbits, the signal propagation characteristics, the characteristics of the receive antenna and the receiver environment. Realistic modeling of user movement taking into consideration vehicle attitude is also part of this simulation process. Generation of interfering signals may also be of interest to set up a simulation environment that is close to reality.

Using signal generators for GNSS simulation has some major advantages over using a live GNSS signal. When using live signals, test conditions can change permanently and unpredictably, so that it is very unlikely that two successive test runs can be performed under identical conditions. Repeatable testing – probably the most important test requirement – is impossible when using live GNSS signals.



2 Range simulation

The range between the satellite and the receive antenna is the basic measurement a GNSS receiver performs in order to compute its position. For realistic range simulation, the following aspects have to be considered:

- Ionospheric and tropospheric effects
- System-inherent errors such as clock errors
- Unexpected ranging errors

1 Jamming and interference

In order to emulate a real GNSS environment, external influences such as jamming and interference signals must be taken into account. The presence of additional signals such as LTE can then be simulated and how this influences the reception of the GNSS signals can be evaluated.

3 Satellite orbit simulation

A realistic GNSS simulation has to support the simulation of different classes of satellite orbits (LEO/MEO/GEO/IGSO), including orbit errors and perturbations.

4 Systems and signals

In order to meet today's testing needs, a GNSS simulator has to provide multi-constellation and multi-frequency scenarios, simulating all relevant systems and signals in all GNSS frequency bands at the same time.

5 Signal obscuration

Especially in an urban environment, GNSS signals are often obstructed by buildings. In many cases, signal obstruction needs to be combined with multipath simulation since the line of sight signal might be completely obstructed and the receiver processes only the multipath components.

6 Vehicle movement

Many test tasks require the simulation of a moving receiver with consideration of vehicle attitude. In order to test moving receivers under high signal dynamics, the GNSS simulator has to be able to support scenarios where the simulated user is exposed to high velocities and accelerations.

7 Multipath simulation

In order to test the receiver performance in the presence of multipath, a GNSS simulator typically offers various ways to simulate such influences such as tapped-delay or ground multipath models, statistical channel models or deterministic multipath models.

Our solutions ...

A variety of software options can turn Rohde&Schwarz vector signal generators into powerful GNSS test solutions:

- GNSS waveforms for basic receiver testing
- GNSS production tester (R&S®SMBV-P101)
- GNSS constellation simulator for single-frequency receiver characterization (R&S®SMBV100A)
- High-end GNSS constellation simulator for sophisticated multi-constellation, multi-frequency, multi-antenna and multi-vehicle testing (R&S®SMW200A)

All these test solutions ensure that GNSS simulations are performed under well-defined, **controlled conditions**. They offer fully **customizable and repeatable scenarios**, i.e. one and the same test scenario can be replayed as often as needed and produce the same signals with the same characteristics.

Basic GNSS receiver development and production testing

Entry-level GNSS test solutions

Using GNSS waveforms for basic receiver tests

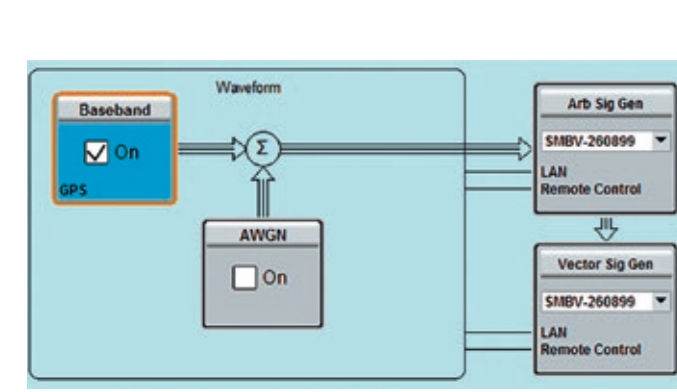
Many Rohde&Schwarz signal generators can be used to play back GNSS waveforms. This approach is ideal for setting up a basic and cost-efficient single-channel test environment for use in the early stages of GNSS receiver development. It is suitable for verifying the receiver's acquisition and tracking capabilities and performing basic sensitivity tests.

GNSS waveforms can be created using the R&S®WinIQSIM2 simulation software and are available for the following instruments:

- R&S®SMBV100A
- R&S®SGT100A
- R&S®SMW100A
- R&S®CMA180
- R&S®CMW500

www.rohde-schwarz.com/product/winiqsim2

R&S®WinIQSIM2™ makes it easy to generate digitally modulated signals, including GPS, Glonass, BeiDou and Galileo waveforms.



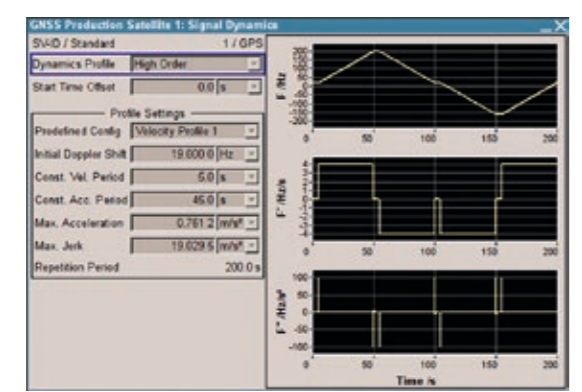
GNSS production tester

The R&S®SMBV-P101 GNSS production tester addresses specific needs for GNSS chipset testing and speed-optimized production testing of GNSS receivers. During such tests, the basic GNSS signal reception and the connection between the antenna and GNSS chipset need to be verified.

The R&S®SMBV-P101 generates signals for GPS, Glonass, BeiDou and Galileo in the L1/E1 band with one satellite per system. The four satellites can be activated individually and level changes can be made on the fly, enabling users to simultaneously perform independent sensitivity tests for each system. Additional key features include customizable navigation data content, movement profiles for verifying the maximum signal dynamics the receiver can handle and the generation of CW signals for interference testing.

www.rohde-schwarz.com/product/smbvp101

The GNSS production tester R&S®SMBV-P101 meets all requirements for GNSS chipset and production testing.



Single-frequency receiver characterization

Mid-range GNSS test solution

GNSS simulator in the R&S®SMBV100A

In order to characterize the performance of GNSS receivers, their basic functions need to be tested under controlled and repeatable conditions. Typical tests include the determination of the receiver's time to first fix, acquisition and tracking sensitivity, reacquisition time and its ability to provide an accurate positioning solution. Such location accuracy tests are typically performed assuming a static or a moving receiver. In addition to these standard tests, it is often required to test the receiver's performance under special conditions or in dedicated environments such as interference or multipath environments or under the influence of atmospheric effects and dynamic stress.

The R&S®SMBV100A vector signal generator can be equipped with a multitude of GNSS options, turning the instrument into a reliable, full-featured GNSS signal source. It has advanced simulation capabilities for configuring realistic and complex yet repeatable GNSS scenarios that can be run under controlled conditions. This includes realistic modeling of GNSS orbits, signal propagation effects and system errors as well as realistic modeling of the user environment.

The R&S®SMBV100A is a general purpose vector signal generator that can be turned into a full-featured GNSS simulator.

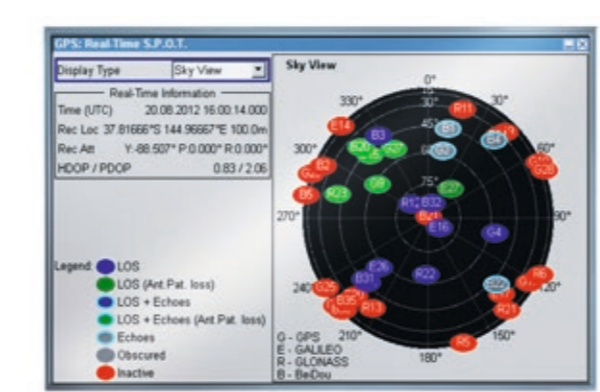


Key facts

- Support of GPS, Glonass, BeiDou, Galileo, SBAS and QZSS, including GPS P-Code
- Signal generation in the L1 or L2 frequency bands for up to 24 satellites
- Support of moving scenarios, including realtime external trajectory feed for hardware-in-the-loop applications
- Configuration of realistic GNSS scenarios, including obscuration, multipath, atmospheric effects, antenna characteristics and vehicle attitude
- Integrated noise and CW interference generator
- Avionics standards (ILS/VOR/DME/GBAS) in the same instrument
- Automated GNSS performance testing for eCall and ERA-Glonass modules with R&S®SMBV-K360/K361

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Simulation of a combined GPS/Glonass/BeiDou/QZSS constellation with consideration of signal obscuration and multipath.



Advanced multi-frequency GNSS testing

GNSS simulation with the R&S®SMW200A

When it comes to more advanced, complex and demanding GNSS test tasks, the R&S®SMW200A is the tool of choice. It can be used to generate GNSS signals and other signals at the same time or be operated as a pure GNSS constellation simulator. With its powerful simulation capabilities and hardware extension options, the R&S®SMW200A meets all important requirements for high-end GNSS testing. It can simultaneously simulate signals from all important GNSS constellations and frequency bands. Using its integrated simulation software, even complex GNSS scenarios can be configured in an easy, user-friendly and efficient way. A comprehensive set of configuration parameters ensures that the scenarios are as realistic as possible.

www.rohde-schwarz.com/product/smw200a

Realistic GNSS scenarios

The R&S®SMW200A generates all GNSS signals in real-time, taking into account all important signal propagation, user environment and system characteristics such as:

- Orbit and clock errors
- Tropospheric and ionospheric effects
- Signal obscuration and multipath
- Antenna gain and phase patterns
- Vehicle motion and vehicle attitude
- Pseudorange steps and ramps for RAIM testing

Applications

The R&S®SMW200A can be turned into a powerful and feature-rich GNSS simulator. With its ability to simulate multi-constellation and multi-frequency (MCMF), multi-antenna and multi-vehicle scenarios, the R&S®SMW200A is able to cover a variety of high-end GNSS applications.



Multi-constellation/multi-frequency applications

- Characterization of multi-frequency receivers
- Ionospheric monitoring
- Atmospheric sounding
- RAIM testing



Multi-antenna applications

- Baseline determination
- Beamforming (CRPA testing)
- Attitude determination
- Multipath direction finding



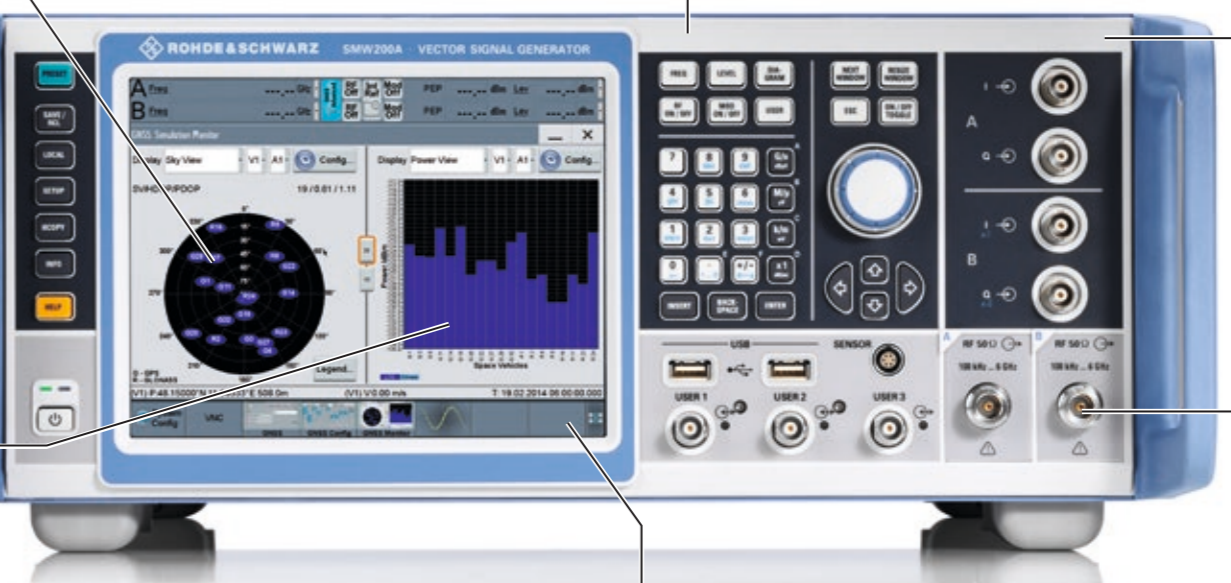
Multi-vehicle applications

- Differential GNSS
- Collision avoidance
- Spacecraft formation flying
- Time and frequency transfer



Advanced interference simulations

- Testing the receiver's resilience to jamming and spoofing attacks
- Coexistence testing with several interferers



Signals and systems

The R&S®SMW200A supports signal generation for all global satellite navigation systems as well as for satellite-based augmentation systems. Key capabilities:

- Support of GPS, Glonass, BeiDou, Galileo, SBAS and QZSS, including GPS P-Code
- Simultaneous signal generation in different GNSS frequency bands
- Up to 144 GNSS channels

Connectivity

With its full-featured trigger, marker and instrument synchronization capabilities, the R&S®SMW200A can be easily integrated into larger test systems. Features include:

- 10 MHz reference out
- Flexible reference input (1 MHz to 100 MHz)
- 1PPS, 1PP2S, 10PPS out
- External trigger input
- External trajectory feed for hardware in the loop applications

GNSS plus interferer in one box

The R&S®SMW200A can simulate GNSS signals plus up to 7 different interferers. This includes the generation of a CW interferer, signals for other digital standards such as LTE and even pulsed signals. The R&S®SMW200A can be equipped with an internal noise generator to add well-defined noise to GNSS and interfering signals. That way, complex coexistence scenarios to test the receiver's resilience against unwanted interference or jamming attacks can be set up.

Multiple RF outputs

The R&S®SMW200A itself can be equipped with 2 RF outputs. The system is in-field upgradable: up to 2 compact R&S®SGT100A generators can be connected to the instrument so that the simulated GNSS signals can be routed to up to 4 RF outputs. This allows the execution of advanced test tasks such as differential GNSS and multi-antenna applications.

Scenario configuration made easy

The R&S®SMW200A comes with integrated GNSS simulation software that allows user-friendly simulation configuration, monitoring and interactive control using the instrument's large touchscreen. Simulation data can be logged for postprocessing. No external PC is required to configure scenarios. Scenario generation can be fully automated by making use of the R&S®SMW200A generator's extensive remote control capabilities (via Ethernet, USB or GPIB).

Service that adds value

- | Worldwide
- | Local und personalized
- | Customized and flexibel
- | Uncompromising quality
- | Long-term dependability

Rohde & Schwarz

The Rohde & Schwarz electronics group offers innovative solutions in the following business fields: test and measurement, broadcast and media, secure communications, cybersecurity, monitoring and network testing. Founded more than 80 years ago, the independent company which is headquartered in Munich, Germany, has an extensive sales and service network with locations in more than 70 countries.

Sustainable product design

- | Environmental compatibility and eco-footprint
- | Energy efficiency and low emissions
- | Longevity and optimized total cost of ownership

Certified Quality Management

ISO 9001

Certified Environmental Management

ISO 14001

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