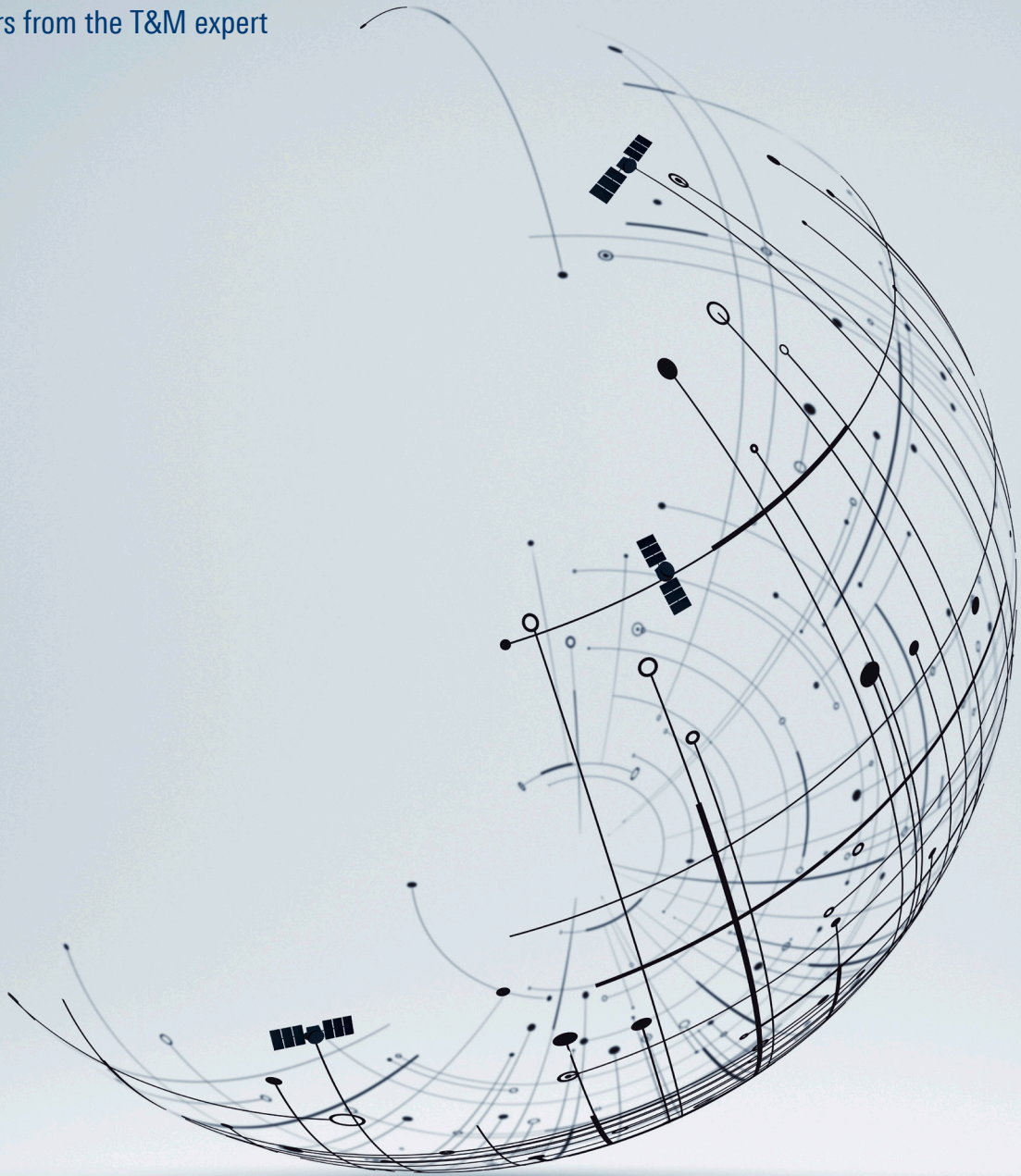


BRING SATELLITES INTO YOUR LAB

GNSS simulators from the T&M expert



ROHDE & SCHWARZ

Make ideas real



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 realistic simulation environment.

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, making it 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.

... 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®SMBV100B)
- ▶ GNSS constellation simulator for multi-frequency receiver characterization (R&S®SMBV100B)
- ▶ 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.

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 obstructions
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 may process only the multipath components.

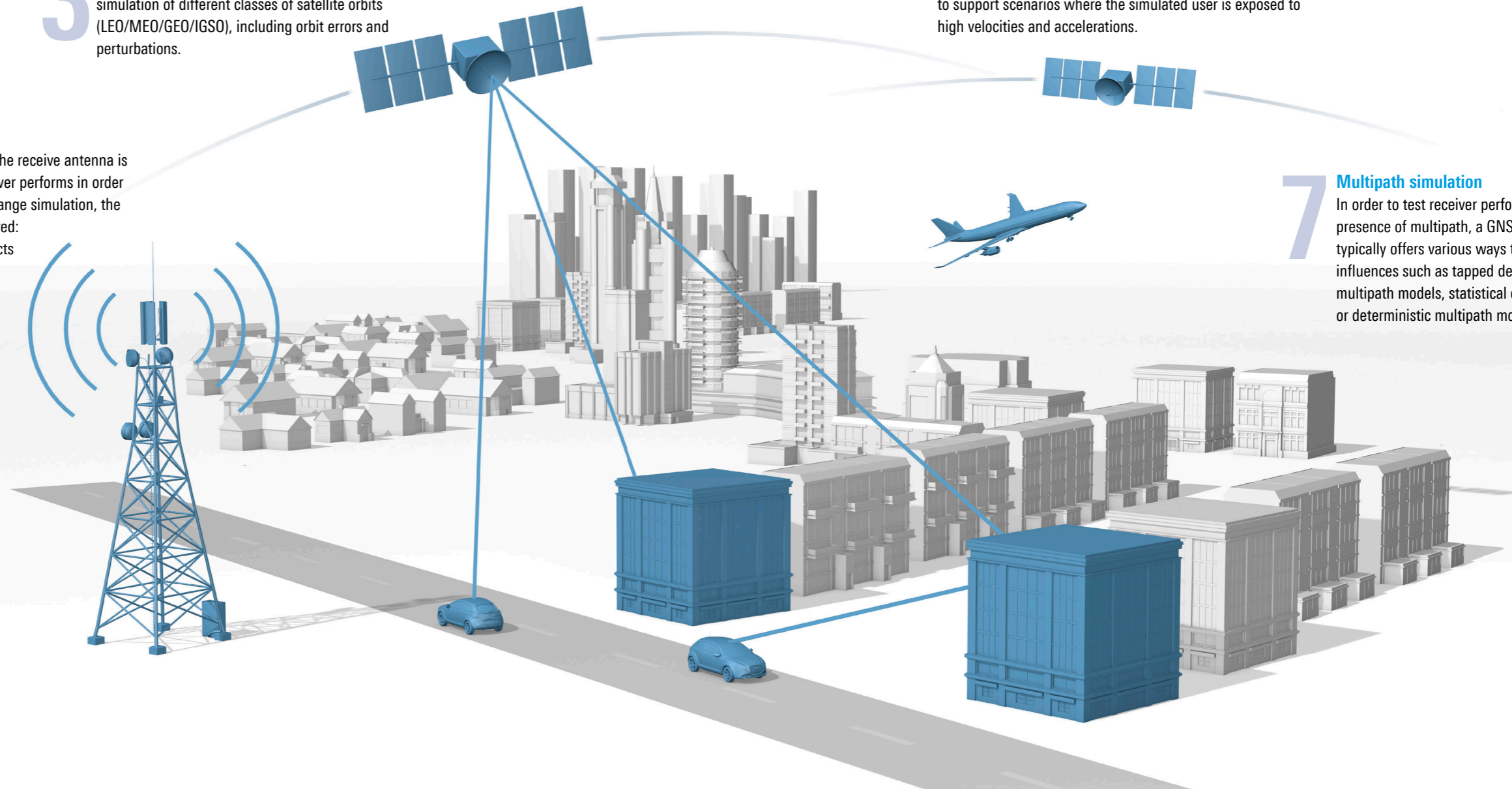
6 Vehicle movement
Many test tasks require simulation of a moving receiver which accounts for vehicle attitude. In order to test moving receivers under high signal dynamics, the GNSS simulator has to be able to support scenarios where the simulated user is exposed to high velocities and accelerations.

7 Multipath simulation
In order to test 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.

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.



BASIC GNSS RECEIVER DEVELOPMENT AND PRODUCTION TESTING

Entry-level GNSS test solutions

Single-satellite 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.

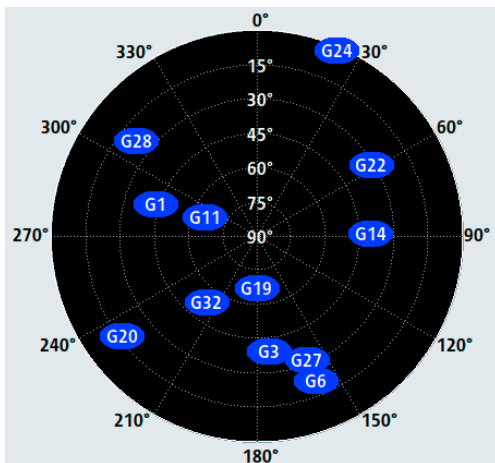
GNSS waveforms can be created using the R&S®WinIQSIM2 simulation software and are available for the following instruments:

- ▶ R&S®SMCV100B
- ▶ R&S®SMBV100B
- ▶ R&S®SGT100A
- ▶ R&S®SMW200A
- ▶ CMA
- ▶ CMW500

www.rohde-schwarz.com/product/winiqsim2

Multi-satellite GNSS waveforms for TTFF testing

For simple tests that require the GNSS receiver to compute a position fix (e.g. to determine the time to first fix (TTFF)), a set of predefined multi-satellite waveforms can be used. Various scenarios are available for GPS, Galileo, GLONASS and BeiDou signals in the L1 frequency band.



Functional Go/NoGo and TTFF tests with the R&S®SMCV100B based on predefined multi-satellite GNSS waveforms.

They are limited in time and represent signal reception conditions at predefined user locations and times. Multi-satellite waveforms are available for the R&S®SMCV100B.

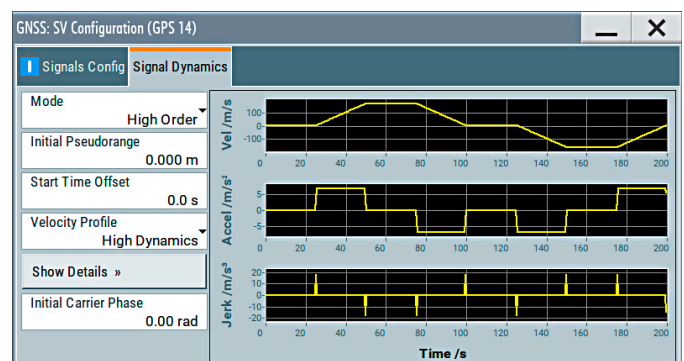
www.rohde-schwarz.com/product/smcv100b

GNSS production tester

The GNSS production testers from Rohde&Schwarz address 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®SMBV100B can be turned into a single- or multi-frequency GNSS production tester that generates signals for GPS, GLONASS, BeiDou, Galileo and NavIC 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 and customizable velocity 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/smbv100b



The GNSS production test solution based on the R&S®SMBV100B meets all requirements for GNSS chipset and production testing.

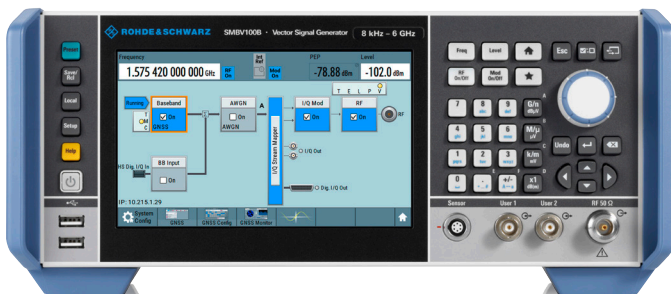
MULTI-FREQUENCY RECEIVER CHARACTERIZATION

Midrange GNSS test solution

GNSS simulator in the R&S®SMBV100B

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®SMBV100B 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.

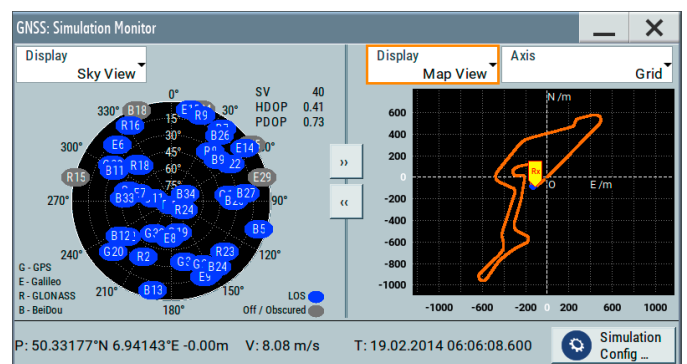


The R&S®SMBV100B is a general purpose vector signal generator that can be turned into a full-featured GNSS simulator.

Key facts

- ▶ Multi-constellation, multi-frequency GNSS scenarios
- ▶ Support of GPS, GLONASS, BeiDou, Galileo, NavIC, SBAS and QZSS, including GPS P-Code
- ▶ Simultaneous signal generation in the frequency bands L1, L2 and L5 with up to 102 GNSS channels
- ▶ 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®SMBVB-K360/-K361
- ▶ Automated GNSS performance testing against customized pass/fail criteria with R&S®SMBVB-K362
- ▶ Automated GNSS performance testing against current Chinese automotive test standards with R&S®SMBVB-K363/-K364

www.rohde-schwarz.com/product/smbv100b



Simulation of a combined GPS/GLONASS/BeiDou/Galileo constellation for a moving GNSS user.

ADVANCED MULTI-FREQUENCY GNSS TESTING

High-end GNSS test solution

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

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, NavIC, SBAS and QZSS, including GPS P-Code
- ▶ Simultaneous signal generation in different GNSS frequency bands
- ▶ Up to 612 GNSS channels

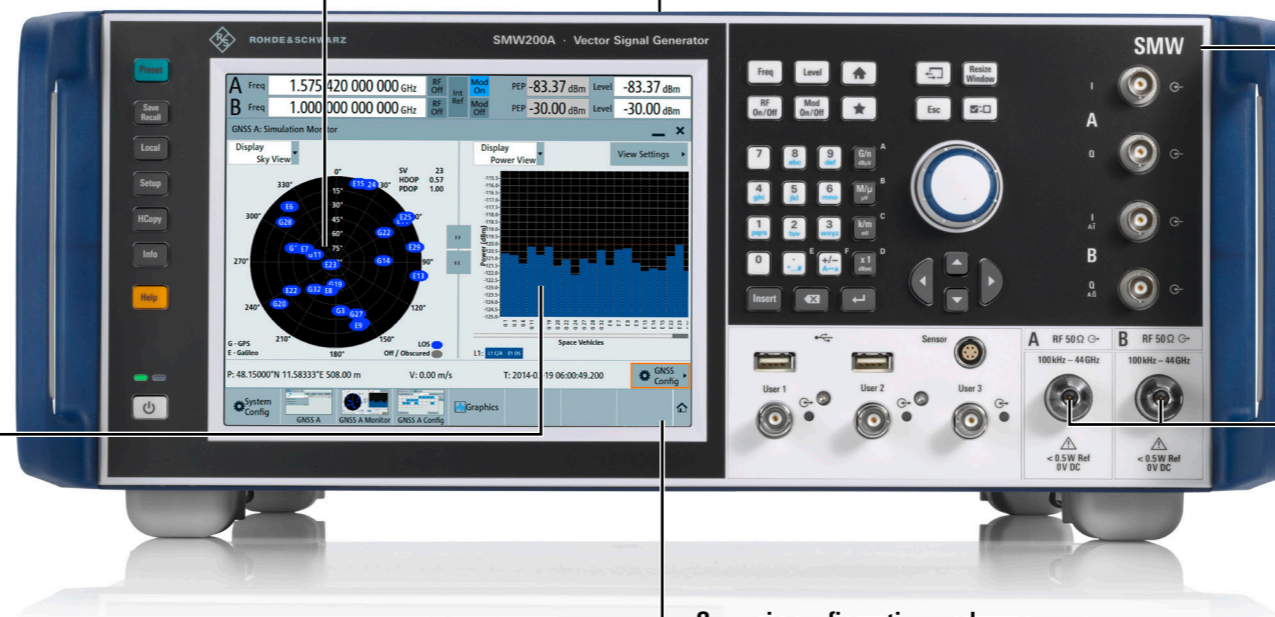
Connectivity

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 multiple 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 two RF outputs. In case even more RF outputs are needed, two or more instruments can be combined and operated together. This allows the generation of phase-coherent GNSS signals and enables the execution of advanced test tasks such as CRPA testing.

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

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).

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.

MC
MF

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

Service at Rohde & Schwarz You're in great hands

- ▶ Worldwide
- ▶ Local and personalized
- ▶ Customized and flexible
- ▶ Uncompromising quality
- ▶ Long-term dependability

Rohde & Schwarz

The Rohde&Schwarz technology group is among the trailblazers when it comes to paving the way for a safer and connected world with its leading solutions in test&measurement, technology systems and networks&cybersecurity. Founded 90 years ago, the group is a reliable partner for industry and government customers around the globe. The independent company is headquartered in Munich, Germany and has an extensive sales and service network with locations in more than 70 countries.

www.rohde-schwarz.com

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

Rohde & Schwarz training

www.training.rohde-schwarz.com

Rohde & Schwarz customer support

www.rohde-schwarz.com/support

