Signals for GPS, Galileo and digital communications standards in a single instrument

With its new software options, the R&S®SMBV100A vector signal generator can now generate signals for GPS and Galileo receiver testing as well as perform realtime simulation of open-ended, real-world scenarios with up to 12 satellites. It also handles multipath propagation and satellite shadowing.

Advance of location-based services
Many mobile network operators offer their customers added value with location-based services (LBS), providing selective information and data based on the user’s current location. Of course, operators have to find the user’s location first, which they typically do using a global navigation satellite system (GNSS) receiver that is integrated into mobile phones. This receiver must be tested, both in development and production. There are numerous commonly used tests, such as determining how quickly a receiver can fix its position after being powered on, defining the sensitivity level, or determining how accurately the calculated position matches the user’s actual location. Since today’s mobile phones support wireless standards such as WLAN and Bluetooth® in addition to mobile radio standards, it’s a definite bonus to have a generator that can generate all of the necessary test signals.

R&S®SMBV100A: GNSS simulator and all-round vector signal generator in one
That’s exactly what the R&S®SMBV100A can do with its excellent RF characteristics and its new, versatile GNSS options. It can simulate GPS and Galileo signals separately or simultaneously (in hybrid mode), just as they are “seen” by today’s GNSS receivers in the real world. Hybrid mode improves accuracy and availability, especially in cities where shadowing occurs.

The GNSS simulator for the R&S®SMBV100A consists of several options, allowing users to adapt it to their specific needs and to define the most suitable scope of functions for development or production.

The R&S®SMBV100A can directly generate signals for a number of different standards, making it unique in its class. It supports both the GSM/EDGE, 3GPP with HSPA, and LTE mobile radio standards and the Bluetooth® and Wi-Fi wireless standards, which are frequently used in both cellular and satellite navigation devices. Signals for the various sound broadcasting standards, such as FM stereo (with RDS), HD Radio™, Sirius and XM Satellite Radio, and DAB round out its portfolio.

An important criterion when using smartphones for location-based services is the time required to fix the device position. This time is kept to a minimum because the mobile radio network transmits GPS data (known as assistance data) to allow...
the receiver to track the satellites faster. The GNSS simulator in the R&S®SMBV100A generates this assistance data, which a radiocommunications tester then transmits to the phone via an active mobile radio connection at the same time as the R&S®SMBV100A generates the corresponding satellite signal.

**For development or production – the right signals are always available**

Only a few keystrokes are needed to generate complex, open-ended scenarios with up to 12 satellites. To handle the wide range of application requirements, the GNSS simulator in the R&S®SMBV100A offers a number of modes tailored to the specific needs of each application, thereby simplifying the required measurements (FIG 1).

**Receiver tests in development**

RF receiver tests, cross-correlation tests and jamming tests performed during development require signals from one or more satellites. The number and level of the satellites can vary, but – to ensure a constant level for sensitivity tests – the signals should typically not move on the horizon like real satellites. These tests are performed in the Static simulation mode. In this mode, the simulated satellites do not move, though their number and characteristics can be changed as needed.

**Functional tests on chipsets**

When performing functional tests during the development of chipsets or when implementing the GNSS application in a variety of instruments, Auto Localization is the best simulation mode, for example, to quickly fix a device’s position. For this mode, the GNSS simulator comes with a number of predefined cities on various continents. The simulator automatically selects up to 12 satellites that offer the best constellation for the selected position at the current moment in time. The GNSS simulator in the R&S®SMBV100A comes preloaded with an almanac file containing the information needed to calculate the satellite paths so the user can start testing immediately. From the Internet, users can also download GPS almanac files that are updated weekly with the latest satellite paths.

The Auto Localization mode isn’t just good for carrying out tests with a static position, such as time to first fix (TTFF). It can also simulate a moving receiver, making it easy to perform a virtual drive through downtown Manhattan, followed by a quick tour around the Colosseum in Rome. Automatic, realtime exchange of satellite signals in the R&S®SMBV100A make it possible to generate scenarios that are unlimited in time.

**Comprehensive functional tests under real-world conditions**

The User Localization simulation mode is used to perform comprehensive functional tests, such as short-term shadowing and multipath propagation of satellite signals, simulating real-world conditions. As in Auto Localization mode, a moving receiver can be simulated in this mode. The user has full control over the number and selection of simulated satellites as well as their signal level (FIG 2). Users can change the signal level or activate/deactivate satellites in realtime without interrupting the GNSS signal, so that the receiver remains synchronized. It is therefore possible to simulate a drive through a city in which some satellites are blocked by high-rise buildings and others are only sometimes visible. It is even easy to simulate a drive through a tunnel: The user first turns off all satellites, then after a few seconds activates the same or different satellites and checks how the receiver responds to total shadowing and how it behaves during resynchronization.

In cities, satellite signals are sometimes reflected, causing multipath reception. Since the reflections typically differ for each satellite, the R&S®SMBV100A can define the multipath propagation for various satellites separately. It is capable of supporting up to a total of 16 paths. Settings such as signal level and delay can be made separately for each path (FIG 2). For the best real-world simulation for GNSS receivers, the propagation characteristics for the troposphere and the ionosphere can be modeled and included in the signal generation process.
Visualization of the satellites at the simulated time. The picture shows a hybrid setup with color coding of the active and passive satellites; G stands for GPS satellites and E for Galileo satellites.

**GNSS receiver test in production**

Full position fixes are rarely performed during GNSS receiver tests in production because they take quite long. Usually it suffices to ensure that the receiver is functioning correctly and the antenna connection is good. The fastest way to do this is with the receiver in a special test mode using only one static satellite. The user first sets the mode to Static and then uses a low test level to test the sensitivity, the antenna connection and the functioning of the receiver.

**Summary**

With its GNSS simulator, the R&S®SMBV100A offers versatile, comprehensive tests for GPS and Galileo applications and is also a full-featured vector signal generator with excellent RF characteristics for all other wireless standards commonly used in navigation devices and mobile phones. This unique combination makes it possible to perform many tests both simply and cost effectively.

Markus Lörner

**Key features**

- Support of GPS L1 / L2 and Galileo E1, including hybrid constellations
- Simulation of realistic constellations with up to 12 satellites in realtime (no precalculated waveforms)
- Flexible scenario generation, including moving scenarios (e.g. through the import of NMEA\(^1\) waypoints), multipath propagation, dynamic level control and atmospheric modeling of propagation characteristics – without the need for additional software tools
- Unlimited simulation time with automatic, on-the-fly exchange of satellites
- User mode for full flexibility to select satellites and define navigation data (import of RINEX\(^2\) files)
- Support of predefined and user-defined A-GPS test scenarios, including generation of assistance data

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\(^1\) National Marine Electronics Association.

\(^2\) Receiver independent exchange format.