Vector Signal Generator Integrates Fully Fledged GNSS Simulator For Upcoming Commercial And Military Applications

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With new software options, the R&S SMBV100A vector signal generator generates signals for GPS, GLONASS, and Galileo multimode receiver testing and performs real-time simulation of open-ended, real-world scenarios for up to 24 satellites. It also handles multipath propagation and satellite obscuration. The R&S SMBV100A is the first vector signal generator to simulate test signals with the military P code from multiple satellites for GPS position fixing.

P Code In GPS Signals – A Special Feature

Satellite-based systems such as GPS, GLONASS, and Galileo are used for navigation and location. Corresponding global navigation satellite system (GNSS) receivers simultaneously support one or more of these systems. But GPS has a special feature: GPS simultaneously transmits two different codes — a coarse acquisition code (C/A code) used by commercial GPS receivers in navigation devices, e.g. for cars, and a precision code (P code) reserved for military applications (*figure 1*). The P code features a tenfold higher clock rate which means higher resolution and better position fixing accuracy.

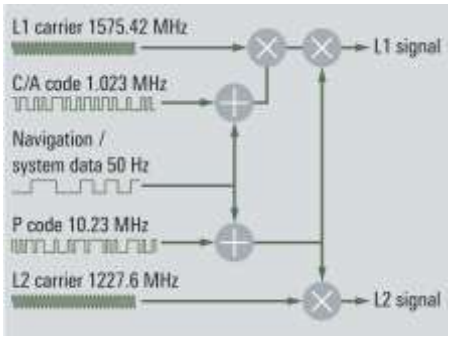

Figure 1: GPS with C/A code and P code. ×: Mixer. +: Modulo 2 addition.

GPS devices can receive the two signals but cannot evaluate them. Since the P code signal is reserved for military applications, it is encrypted with a secret D code (*figure 2*). The resulting signal is referred to as a P(Y) code signal (or simply Y code signal). The D code, however, is not necessarily required to test receivers for P(Y) signal reception. Receivers can easily process these signals without this code, making it possible to test all necessary receiver functions and RF parameters such as sensitivity.

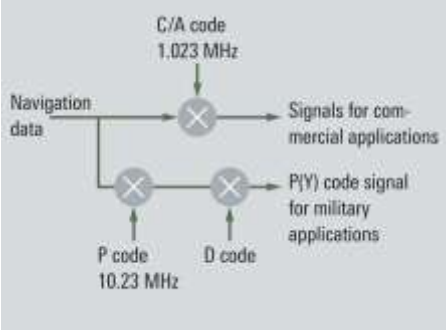

Figure 2: Various codes in GPS signals.

High-precision military GPS receivers are primarily employed for navigation on ships, aircrafts, missiles, and vehicles, but they are also installed in mobile military radios. Development and production of such receivers and mobile radios call for signal generators that are able to operate as GPS simulators and also provide all other test signals required for the radio signals used.

GNSS Simulator And All-Round Vector Signal Generator In One

The R&S SMBV100A is a GNSS simulator and all-round vector signal generator in one — thanks to its excellent RF characteristics and its versatile GNSS capabilities. It can simulate GPS signals with and without P code as well as GLONASS and Galileo signals, separately or simultaneously (in hybrid mode), just as they are "seen" by today's GNSS receivers in the real world (*figure 3*). Hybrid mode improves accuracy and availability, especially in cities where obscuration occurs.

GNSS Simulator For R&S SMBV100A Key Features

- Support of GPS (C/A and P code) L1/L2, GLONASS L1/L2, and Galileo E1, including hybrid constellations
- Simulation of realistic constellations in realtime (no precalculated waveforms)
- Flexible scenario generation, including moving scenarios (e.g. through the import of NMEA (National Marine Electronics Association) 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 (receiver independent exchange format) files)

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.

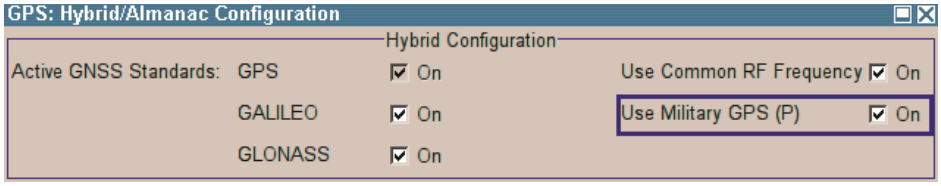

Figure 3: Configuration of hybrid modes.

The R&S SMBV100A can directly generate signals for a number of different standards, making it unique in its class. It supports the GSM/EDGE, 3GPP with HSPA, and LTE mobile radio standards, as well as the Bluetooth and Wi-Fi wireless standards, which are frequently used in satellite navigation devices. The generator can also apply user-definable modulations to generate typical signals used by software-defined radios (SDR).

The Right Signals For Development Or Production

Only a few keystrokes are needed to generate complex, open-ended scenarios. To handle the wide range of application requirements, the GNSS simulator offers a number of modes adaptable to the specific needs of each application, thereby simplifying the required measurements (*figure 4*). The R&S SMBV100A is the first vector signal generator to simulate signals with C/A and P code from up to eight satellites.

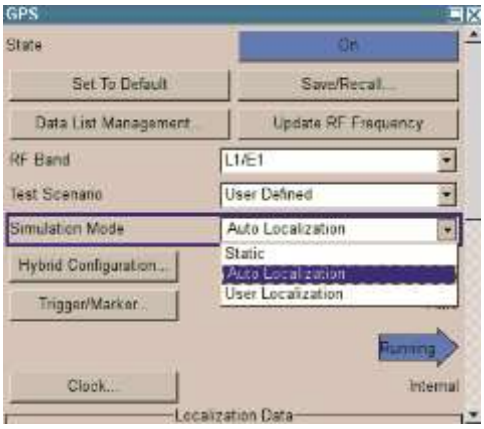

Figure 4: Main GNSS menu for setting the various simulation modes.

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 device, auto localization is the best simulation mode, for example, to quickly do a location fix of a device's position. For this mode, the GNSS simulator comes with a number of predefined cities on various continents. The simulator automatically selects the 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 users 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 is not 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 the Nevada desert, 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 open-ended scenarios.

Comprehensive Functional Tests Under Real-World Conditions

The user localization simulation mode is used to perform comprehensive functional tests, such as short-term obscuration and multipath propagation of satellite signals, simulating real-world conditions. As in the 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 (*figure 5*). Users can change the signal level or activate/deactivate satellites in real time 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 signal blocking and how it behaves during resynchronization.

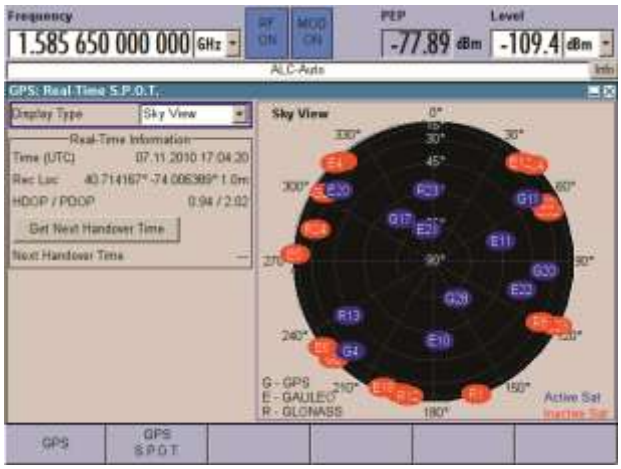

Figure 5: Visualization of the satellites at the simulated time. The picture shows a hybrid setup with color coding of the active and passive satellites; G stands for GPS satellites, R for GLONASS satellites, and E for Galileo satellites.

In cities, satellite signals are sometimes reflected, causing multipath reception. Since the reflections typically differ for each satellite, the R&S SMBV100A can separately define the multipath propagation for the relevant satellite. Settings such as signal level and delay can be made separately for each path (*figure 6*). 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.

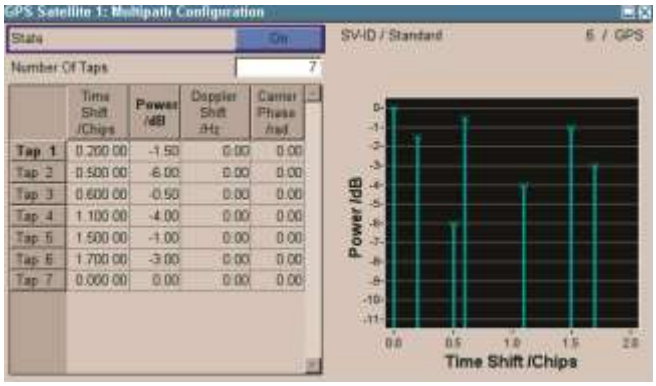

Figure 6: Configuration of multipath propagation for a satellite.

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 that 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 applications with C/A and P code as well as tests for GLONASS and Galileo receivers. It is also a full-featured vector signal generator with excellent RF characteristics for all other digital wireless signals commonly used in navigation devices or SDRs. This unique combination makes it possible to perform a wide variety of tests both simply and cost-effectively.