Signal Generators R&S®SMx

Perfectly simulated: GPS signals for complex localization scenarios

Due to the increasing use of the global positioning system (GPS) in the automobile and handheld industries, it has become a popular technology. Experts agree that GPS – and later also Galileo, which is the European counterpart – will open up yet another large market: The term *Assisted GPS* is already being used for the combination of mobile radio with satellite navigation. The R&S®SMU-K44 option expands the large scope of functions of the R&S®SMx signal generator family for generating real GPS signals.

Up to eight satellites

In contrast to the predecessor of the R&S®SMx family – the Vector Signal Generator R&S®SMIQ, which simulated only one satellite – you can now simulate four realtime satellites with significantly expanded capabilities. By using the R&S®SMU or R&S®SMATE with a second baseband, you can even simulate up to eight synchronized satellites, which is necessary for some *Assisted GPS* test cases.

The signal generators are impressive with their easy and intuitive operating concept. By using the two modes *Generic* and *Localization*, you can either control the various GPS parameters in detail or automatically create a useful configuration at the press of a button. The R&S®SMx family with the R&S®SMU-K44 option is thus ideal both for development and production applications.

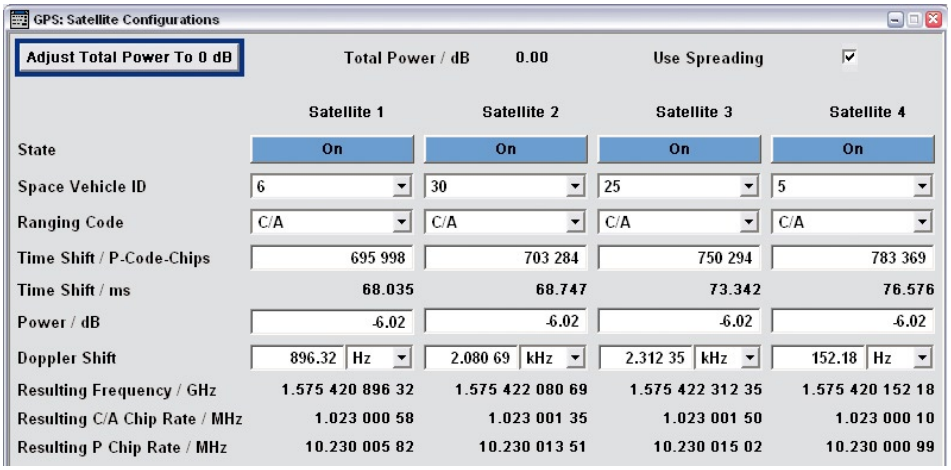
Generic and Localization modes

In the *Generic mode*, you can configure up to four satellites as needed (FIG 1). In addition to various levels, this also includes the setting of different signal delays from which the receiver ultimately determines its location. It is especially important to adapt the individual Doppler shift for each simulated satellite. In practice, this shift results from the motion of the satellites relative to the receiver. In the simulation, the Doppler shift must be synchronized with the satellite paths described in the navigation message sent so that a receiver is able to determine the location. The *Localization mode* performs the exact setting of these parameters. This mode allows you to enter the place to be simulated, which is determined by longitude and latitude as well as altitude, or to select a city from a list (FIG 2). The appropriate satellite signals are then configured automatically; this allows you to send the GPS receiver any place in the world with only a few keystrokes.

Real navigation data

To generate a highly realistic test signal, the new option allows you to generate the navigation message to be transmitted on the basis of real satellite data. This almanac data is updated several times a week, and is available on the Internet page of the US Coast Guard, for example. This data can then be transmitted to the signal generator via USB or LAN, which allows you to generate up-to-date test signals at any time. However, it is also possible to generate your own navigation message and integrate it in the form of a file.

FIG 1 Configuration menu of the four satellites that can be simulated.



GPS: Satellite Configurations

Adjust Total Power To 0 dB | Total Power / dB 0.00 | Use Spreading ☑

	Satellite 1	Satellite 2	Satellite 3	Satellite 4
State	On	On	On	On
Space Vehicle ID	6	30	25	5
Ranging Code	C/A	C/A	C/A	C/A
Time Shift / P-Code-Chips	695 998	703 284	750 294	783 369
Time Shift / ms	68.035	68.747	73.342	76.576
Power / dB	-6.02	-6.02	-6.02	-6.02
Doppler Shift	896.32 Hz	2.080 69 kHz	2.312 35 kHz	152.18 Hz
Resulting Frequency / GHz	1.575 420 896 32	1.575 422 080 69	1.575 422 312 35	1.575 420 152 18
Resulting C/A Chip Rate / MHz	1.023 000 58	1.023 001 35	1.023 001 50	1.023 000 10
Resulting P Chip Rate / MHz	10.230 005 82	10.230 013 51	10.230 015 02	10.230 000 99

Versatile use

The addition of the R&S®SMU-K44 option makes the R&S®SMx family usable in virtually any application. Especially in mobile radio development, a special GPS tester is thus no longer needed since the new option covers many tests – from easy sensitivity measurements through to complex localization scenarios.

A two-path R&S®SMU or R&S®SMATE can generate a complete GPS signal with the two L1 and L2 RF carriers including associated C/A or P codes in only one instrument (FIG 3). The AWGN module (option R&S®SMU-K62) and the optional Fading Simulator R&S®SMU-B14 allow you to perform simulations under realistic propagation conditions.

Summary

One significant advantage of the R&S®SMx family compared to other GPS simulators is the combination of GPS signal generation with the know-how of many other standards, such as 3GPP FDD or GSM/EDGE, which are already available as options for the R&S®SMx family.

Due to the one-path, all-purpose R&S®SMJ100A, the R&S®SMx family is not only suitable for development applications but also for easy chip tests particularly in production. You can also set all GPS signal parameters by using SCPI commands via an IEC/IEEE bus (IEEE 488) or LAN (VXI-11, TCP/IP).

Gerald Tietscher

GPS

The global positioning system (GPS) was developed by the US Department of Defense and is still under its direction. The principle of GPS is that a GPS receiver, which is located on the earth, receives the signals of several satellites and calculates its position on the basis of their delay differences. You need the signals of at least four satellites to determine the four unknowns (three space coordinates and time). The satellites transmit on two RF carriers (L1 = 1.57542 GHz, L2 = 1.2276 GHz) and identify themselves by means of a CDMA method via the two ranging codes C/A (coarse/acquisition, for civil applications) and P (precision, for military applications).

Assisted GPS

In the case of *Assisted GPS*, a GPS receiver is integrated in a mobile phone and obtains information with regard to its approximate location via the mobile phone channel. This significantly reduces the time to first fix (TTFF) – the time up to the first localization.

FIG 2 Main menu for the Localization mode in the R&S®SMU200A.

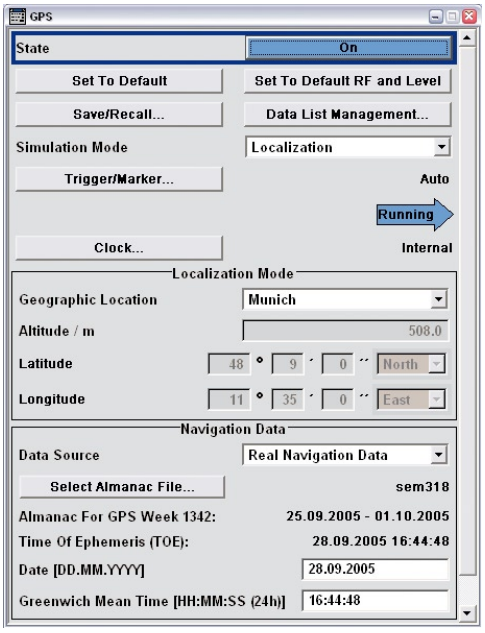


FIG 3 Generation of the L1 and L2 RF carriers in a two-path R&S®SMU200A.