Solutions for

GPS Receiver Verification

Ensuring fast and cost-effective verification of GPS capabilities and other wireless standards in today's multifunctional devices

Application Note

Overview

One of the more compelling trends in the mobile phone market these days is the migration from dual-band to tri- and even quad-band designs. These complex phones must also now have the ability to handle various signals for peripheral radios such as Bluetooth®, FM, WLAN and WiMAX™ on a single integrated device. Another key functionality expected to become pervasive in mobile phones and other consumer electronic devices is Global Positioning System (GPS), a global navigation satellite system (GNSS) that provides precise location and time information based on an unobstructed line-of-sight to four or more GPS satellites. Over the years, GPS has become increasingly common in everyday life. Today it is used in everything from automotive navigation systems and geo-tracking to a range of location-based services. While the GPS capability is a useful benefit for the consumer, it places added hardship on multi-function device manufacturers, OEM integrators and contract manufacturers who now have to determine the appropriate standard tests to verify GPS receiver performance, in addition to having to test any other supported wireless standards on their devices.

Problem

Testing GPS functionality is a difficult enough task for the engineer, but having to test all the functionality on a multifunctional device makes it all the more complicated. First, the engineer has to determine the appropriate standard tests to verify GPS receiver performance. Then, a controlled environment facilitating precise repeatability must be found in which to conduct the verification procedure. Using actual GPS satellite signals received through an antenna typically does not fulfill this requirement because the signals presented to the receiver are highly variable and non-repeatable. Moreover, testing under specific conditions such as in remote locations or at high velocities can be both expensive and impractical.

A traditional GPS signal simulator with GPS-dedicated hardware is often used to address this issue since it produces an output signal that models the signal that would be received by the GPS receiver, which is a mix of signals from many different satellites with different time delays, Doppler shifts and power levels. Unfortunately, these simulators do not provide signals for other wireless standards that may be in the device under test. As a result, engineers testing multifunctional devices must purchase and use multiple instruments, a costly and time-consuming proposition.

Solution

Testing multifunctional devices with GPS functionality requires a real-time GPS signal simulation solution that is capable of generating the required GPS signals for a repeatable and flexible test environment. A high-performance, general-purpose simulation solution that can also create signals for testing other wireless standards is necessary for complete verification of the multifunctional device.

In particular, to enable R&D and verification of GPS receivers, the simulator should be able to generate 12 or more satellite signals for maximum satellite visibility. It should also support multipath fading impairments, have the ability to simulate stationary and moving GPS receiver scenarios, and be able to generate scenarios for any date, time and location.

By providing quality GPS signals and GPS verification functionality, this type of simulation solution is able to perform the typical tests required for receiver verification. The three tests are the following:

- Time To First Fix (TTFF)—TTFF is the time between "turn-on" of the GPS signal and the acquisition of a location fix by the GPS receiver. TTFF can be tested under cold, warm and hot start conditions, which refer to the state of the GPS receiver when the GPS signal is turned on.
- Sensitivity—Sensitivity refers to the minimum level of signal that allows the GPS receiver to either acquire or track the GPS signal. Acquisition sensitivity is the minimum signal required to successfully obtain a location fix, and tracking sensitivity is the minimum signal required to maintain a location fix once it has been attained.
- Location Accuracy—Location accuracy refers to the ability to achieve a location fix as close to the desired position as possible. Relative accuracy refers to comparisons between the location obtained from multiple tests, and absolute accuracy refers to comparisons between the calculated location and the simulated location. Accuracy can also be measured for moving GPS receivers and individual satellite tracking capability.

The N7609B Signal Studio for GNSS application from Agilent Technologies provides the performance, flexibility and functionality required to perform the TTFF, sensitivity and location accuracy tests. Offering advanced GPS verification with impairments, it enables engineers to easily create multi-satellite GPS signals with up to 15 line-of-sight satellites. Up to 24 channels are available, allowing the addition of multipath signals using the N7609B's scenario editor. Custom scenarios (for static and moving GPS receivers) can be created, with real-time satellite power and visibility control during signal simulation.

The N7609B software runs on Agilent's N5106A PXB baseband generator and channel emulator platform with a vector signal generator such as the N5182A MXG for RF upconversion (Figure 1). Because it is the only 15-satellite, 24-channel GPS signal simulator built on a high-performance, general-purpose signal source, it provides a reliable and repeatable test solution for full verification and validation of GPS receivers, as well as for most of today's wireless standards (e.g., LTE, 802.11n WLAN, WiMAX, Bluetooth, WCDMA, and cdma2000). The flexibility and expandability of the PXB/MXG platform also ensures support for future wireless standards. In addition, the N7609B solution can be combined with Agilent's 8960 Wireless Communication Test Set and test executives to provide a system for design verification and pre-conformance testing of Assisted-GPS (A-GPS) devices.

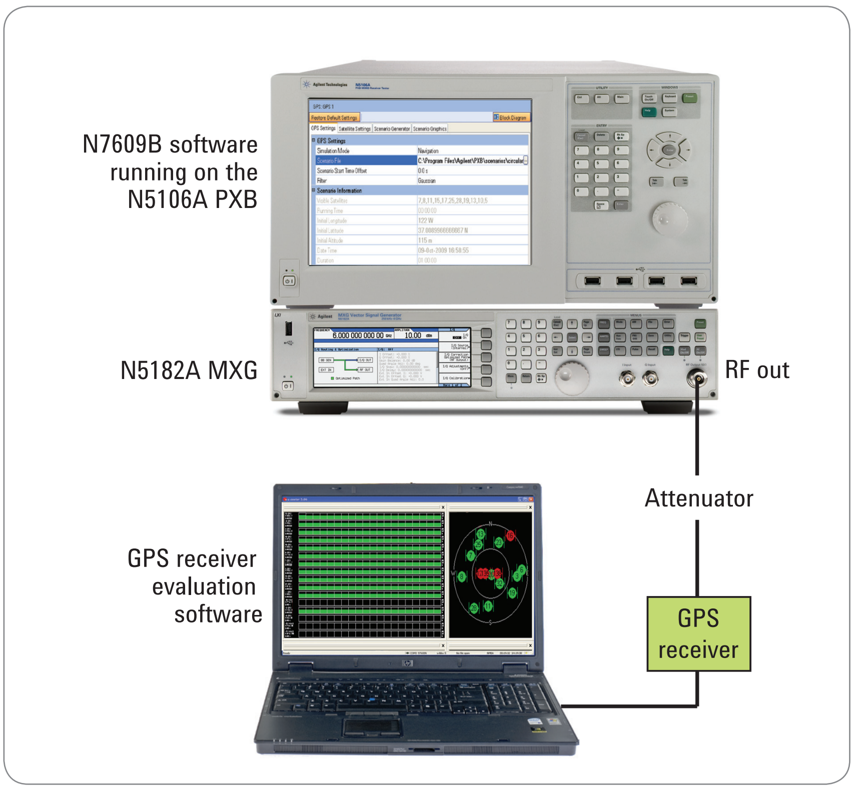

FIGURE 1: *Shown here is a typical GPS receiver test setup with the N7609B. The baseband GPS signal is created by the N7609B running on the N5106A PXB, upconverted to RF by the MXG and sent to the GPS receiver. The GPS receiver output is then sent to evaluation software on a PC.*

Running the N7609B solution on the PXB/MXG platform enables the engineer to access a number of compelling features when testing multifunctional devices. The PXB provides up to 6 baseband generators (BBGs) with 512 MSa of playback memory per BBG, 8 real-time faders, the industry's widest bandwidth of 120 MHz, and supports testing and troubleshooting of 2x2, 2x4, and 4x2 MIMO (Multiple-Input Multiple-Output) systems (Figure 2). For its part, the MXG RF vector signal generator features fast switching speed (≤ 1.2 ms in SCPI mode), industry-best ACPR (even at high power levels or over a wide range of output power levels), high power, small form factor, and simplified self-maintenance.

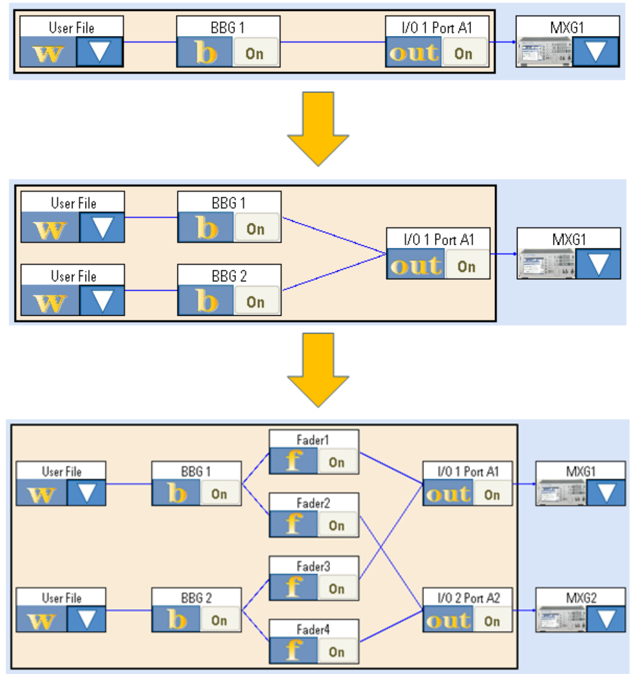

FIGURE 2: *The PXB can be easily reconfigured in software to provide different test capabilities. This diagram shows three different possible configurations: single-channel signal generation for creating one format such as GPS, 2-channel generate and sum for interference testing using a single RF signal generator, and 2x2 MIMO with 4 channels of fading for testing MIMO formats such as LTE and WiMAX.*

Adding Impairments

The ability to include signal impairments such as multipath signals is critical for any GPS test solution. Multipath signals are indirect GPS signals that are received by the GPS receiver at lower power levels, with delay and different Doppler shifts than the line-of-sight signals (Figure 3). Typically such signals are caused by reflections from buildings, trees and other obstructions. These signals and other impairments can have an effect on GPS receiver capabilities and therefore must be taken into consideration during verification.

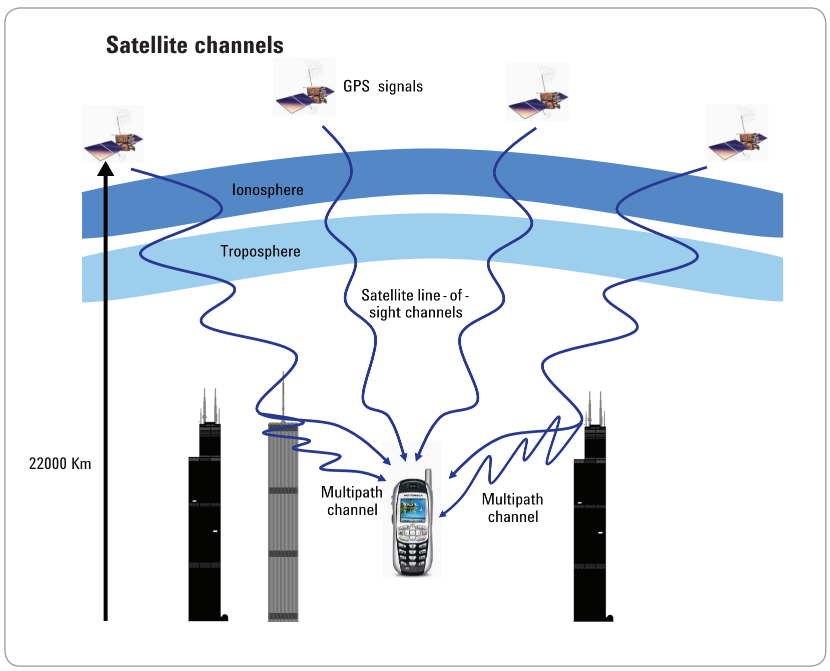

FIGURE 3: *Multipath signals are reflected GPS signals that have different attenuation, delay and Doppler shifts when compared to the line-of-sight satellite signals.*

The N7609B solution provides support for multipath fading impairments. To access this capability, a scenario file with the ideal line-of-sight GPS satellite signals for the desired location and time is first created. The scenario editing function can then be used to add multipath versions of the line-of-sight satellite signals. To simulate other impairments, power offsets can be applied over a user-specified time interval to model attenuation or loss of a signal, as in the case of a car going through a tunnel. An elevation mask can be applied to hide satellites below a certain angle above the horizon to model obstructions such as a mountain range or surrounding buildings. The N7609B also provides modeling for ionospheric and tropospheric conditions, application of a static antenna pattern, and addition of calibrated additive white Gaussian noise (AWGN). This ability to create impairments makes the N7609B ideal for use in R&D for GPS receiver verification.

Summary of Results

Testing GPS functionality is a challenging task, one that's made all the more difficult by the trend toward multifunctional devices. Utilizing a simulation solution with the performance, flexibility and expandability to not only verify GPS receivers, but other wireless standards as well, is key to addressing this challenge. Agilent's N7609B Signal Studio for GNSS effectively meets these challenges by providing engineers with the ability to create GPS signals capable of fully verifying GPS receiver capabilities along with those required to test most other wireless standards. Using this solution, GPS receiver manufacturers, OEM integrators and contract manufacturers can now more quickly and cost-effectively test their multifunctional devices.

The Power of X

The Agilent PXB baseband generator and channel emulator and MXG signal generator are key products in Agilent's comprehensive Power of X suite of test products. These products grant engineers the power to gain greater design insight, speed manufacturing processes, solve tough measurement problems, and get to market ahead of the competition.

Offering the best combination of speed and scalability, and created and supported by renowned worldwide measurement experts, Agilent's X products are helping engineers bring innovative, higher-performing products to emerging markets around the globe.

To learn more about Agilent's suite of X products please visit:
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Related Applications

- Assisted GPS (A-GPS) Testing:
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Related Agilent Products

- N7609B Signal Studio for Global Navigation Satellite Systems
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- N5106A PXB Baseband Generator and Channel Emulator
  www.agilent.com/find/pxb
- N5182A MXG RF Vector Signal Generator
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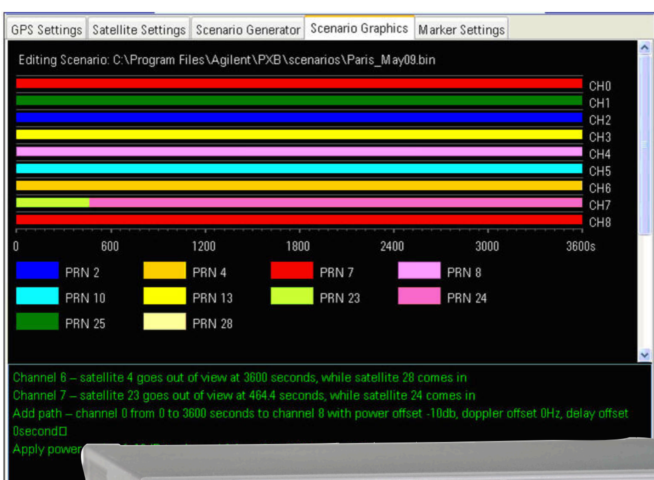
N7609B Signal Studio for GNSS



N5182A MXG RF Vector Signal Generator

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