Technical Note: GSG-6 GPS/GNSS Simulator

Testing SAASM and Carrier Phase Receivers

Orolia's GSG-6 GPS/GNSS simulators can be configured for dual frequency L1/L2 simulation. They generate both the C/A and P code signals simultaneously for the GPS and GLONASS navigation systems. Though they do not have an encryption capability to simulate a true classified P(Y) signal, they are still powerful tools for acceptance testing of classified Selective Availability/Anti-Spoofing Module (SAASM) receivers. This technical note explains how to use Orolia simulators for military SAASM receiver testing and also testing commercial carrier phase receivers that use the L2 P(Y) signal.

Overview

SAASM receivers are capable of receiving and decoding the military's encrypted satellite signal, called P(Y) code, to ensure it is receiving the bona fide navigation signal and not some false spoofing signal. The encryption keys for decoding the signal are highly classified and vigorously protected by the US military so they are not available for civilian use.

However, the signal structure of the P code is not classified and is widely known, so some commercial receivers use the RF carrier of the P code signal to improve their accuracy. These receivers, called carrier phase receivers, are capable of millimeter accuracy using this method. They are used routinely in the Surveying, Construction and Agriculture industries for high accuracy position and navigation. Both SAASM and carrier phase receivers can be tested using an Orolia L1/L2 dual frequency GSG- 6 simulator.

Test Set-up

It is always important to do a cold reset on the receiver under test before starting a simulation because most receivers have non-volatile memory where they will remember the location and time it last tracked the satellites and attempt to search for satellites from that point. If the simulated scenario is not exactly at the time and position it is expecting, it will take a very long time for the receiver to recognize the new situation. Usually just powering off is not sufficient. For most SAASM receivers, performing an Emergency Zeroize will cold reset the receiver, clearing all of its memory, including its previous navigation solution and memory of previously tracked satellites.

We know of some other situations where SAASM receivers do not track a GNSS simulator due to their default configuration or connection loading issues when bypassing an RF antenna with a direct connection to the simulator output. If you are having trouble with your SAASM receiver accepting a simulated signal, please request the document *GSG-5/6 Series Operation with SAASM GPS Addendum*, Spectracom Part Number 1211-5000-0056, which is available for authorized users of SAASM receivers.

Simulator Configuration for Orolia SAASM Receivers

- GSG-62 GNSS dual frequency L1/L2 simulator (referred to as "GSG" below)
- GSG StudioView™ scenario editor software
- Signals Tab, turn On the L1 C/A, L1 P, and L2 P GPS signals. Turn Off the Pseudo-Y code for initial testing. See below.
- SAASM receiver

This configuration has been tested with the popular SAASM receivers compliant with ICD-GPS-153 such as DAGR, GB-GRAM, Force-22E, etc.

GSG StudioView scenario editor setup

SAASM Acceptance Testing

This is a two step process:

1. With the Pseudo-Y feature in the GSG turned Off and the encryption keys zeroized in the SAASM receiver, perform all performance tests necessary with the simulator to verify that the receiver under test is operating properly after several minutes – enough time for the receiver to accept the full almanac data which can take up to 12.5 minutes – the receiver should be able to obtain a fix and begin tracking satellites. This verifies the test configuration.

2. Load the encryption keys into the receiver and turn the Pseudo-Y feature On. The receiver under test should now reject the simulated P(Y) signal since it does not have the proper encryption values. Some receivers will even indicate that a bad encrypted signal is being received. However, it still should be able to track the unencrypted L1 C/A code.

If the receiver indicates that its keys have been successfully loaded, then there is full assurance that this receiver is operating properly.

Pseudo Y Code Simulation

The Pseudo-Y feature of the GSG outputs an RF representation of P(Y) without the real encryption.

The signal pattern output of any effective encryption algorithm is truly random so there are no patterns which can be detected to break the secret code. Using this fact, the GSG will randomize the signal output of the P code when the Pseudo-Y feature is enabled to make the signal appear like an encrypted signal even though the private keys are unknown.

Spectrally, the real L1/L2 P(Y) signals and the Pseudo-Y signals will look identical. In a SAASM receiver, the real and pseudo signals will both pass through the receiver in the same way, will be demodulated the same and then decoded. The only difference is that the pseudo signal will fail the decode process because it is not encrypted properly.

In this same manner, commercial surveying receivers are able to use the L2 P(Y) signal. Regardless of whether they receive the real or pseudo signal, they will fail to decode it: the real signal fails because it doesn't know the correct key and the pseudo signal fails because it is uses an arbitrary unknown random key. But it doesn't matter. The receiver is only using the signal to recover the RF carrier, which it does in the front-end of the receiver before the decode process. Hence, this process is sometimes called "Codeless" and the receivers called "Codeless Receivers". With the recovered carrier from both the L1 and L2 bands, the receiver can more accurately track the satellites' timing points and therefore more accurately determine their position.

Carrier Phase Receiver Testing

Turn On the Pseudo-Y feature when testing commercial carrier phase or codeless receivers. This ensures that the P-code transmitted in both the L1 and L2 bands look spectrally identical to the real live satellite signal. This may not always be necessary for all receivers, but offers the most realistic testing.