Agilent N7609B
Signal Studio for Global Navigation Satellite Systems

Technical Overview

Create GPS Receiver Test Signals with Ease

The N7609B Signal Studio for Global Navigation Satellite Systems is an advanced signal creation software tool that enables you to easily create reliable and repeatable GPS test signals for receiver verification tests.

The flexibility and features of this intuitive software makes it ideal in an R&D environment and provides accurate test signals for GPS verification. Perform tests using the provided scenarios or create custom scenario files with the scenario generator (requires Option RFP) for real-time playback.

The software simulates up to 15 visible satellites, depending on the scenario and satellite visibility, and provides a total of 24 channels for satellite and multipath signals. The real-time capability of the software enables you to change the satellite power and visibility while the signal is active. Use the static test mode to make real-time adjustments to satellite Doppler shift and delay, and individual channel power settings for all 24 channels.

The scenario generator enables you to specify the location, date, time and duration for a GPS scenario to simulate a stationary or a moving GPS receiver. The software also provides an antenna pattern gain mask that can be applied to the GPS signals. A simple trajectory file generator/editor is available for creating the NMEA GGA message files that are needed for moving receiver scenarios.

The software runs on the N5106A PXB baseband generator and channel emulator connected to an E4438C ESG or N5182A MXG signal generator for RF output.

Take advantage of the flexible configurations in the PXB to perform interference testing, with configurations for 2 independent channels of RF signal generation, or generating and summing 2 baseband channels into a single RF output.

Key Features

- Simulate up to 15 satellites of L1 signal with C/A code

- Supports static scenarios for stationary GPS receivers or dynamic scenarios for moving GPS receivers

- Include impairments, such as multipath, ionospheric and tropospheric effects, calibrated AWGN, and antenna pattern modeling

- Create custom scenarios with the scenario generator option
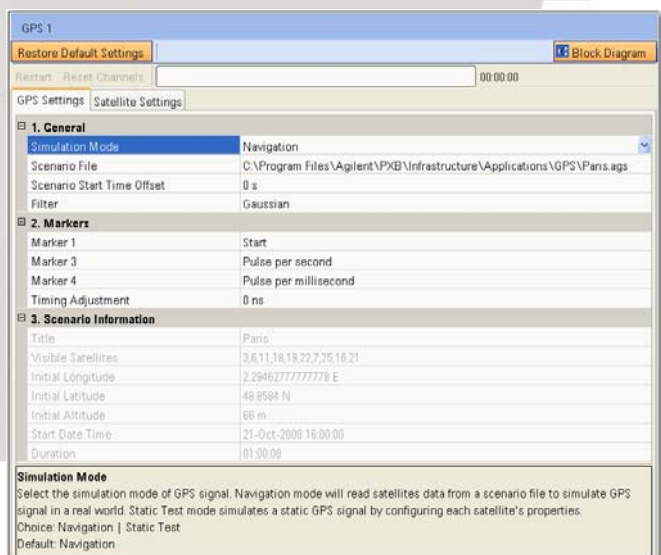
Summary of Features

GPS Satellite Signal Creation:

- Simulate up to 15 satellites of L1 signal with C/A code
- Provides 24 channels for satellite and multipath
- Supports static scenarios for stationary GPS receivers or dynamic scenarios for moving GPS receivers
- Provides real-time adjustments for individual satellite or multipath channels:
  - channel off/on
  - channel power adjustments
  - in static test mode:
    - Doppler shift adjustments
    - delay adjustments
    - channel power control
- Change the Start Time Offset during playback to play back different portions of the scenario
- Add calibrated AWGN for control of C/N ratio (requires option N5106A-JFP)

Scenario Generation and Editing (Option RFP):

- Create custom scenarios with your choice of location, date, time, and duration for static and moving GPS receivers
- Ionospheric and tropospheric modeling
- NMEA GGA format trajectory data input for moving scenario generation
- Scenario editor to add multipath channels, apply power offsets to a channel, delete a channel, or trim the scenario length channels
- Elevation mask for controlling satellite visibility
- Graphical display to show editing results
- Leap seconds information editing
  - Official mode with 15 leap seconds defined
  - User-defined mode allows adding or removing leap seconds or changing the date and time of leap seconds
- Antenna pattern modeling
  - User-defined elevation and azimuth resolution
  - Azimuth rotation
  - Configure the antenna pattern settings through an interactive graphic
  - Pattern can be defined based on absolute azimuth and elevation for static scenarios, or relative to the GPS receiver's orientation for dynamic scenarios
- Trajectory Generator to create NMEA GGA format message files for moving receiver scenarios
- A-GPS assistance data for each scenario

Common Applications

The GPS signals created by the N7609B software enable you to perform the following common GPS verification tests (see Figure 1):

- Time To First Fix (TTFF)

- Sensitivity (acquisition and tracking)

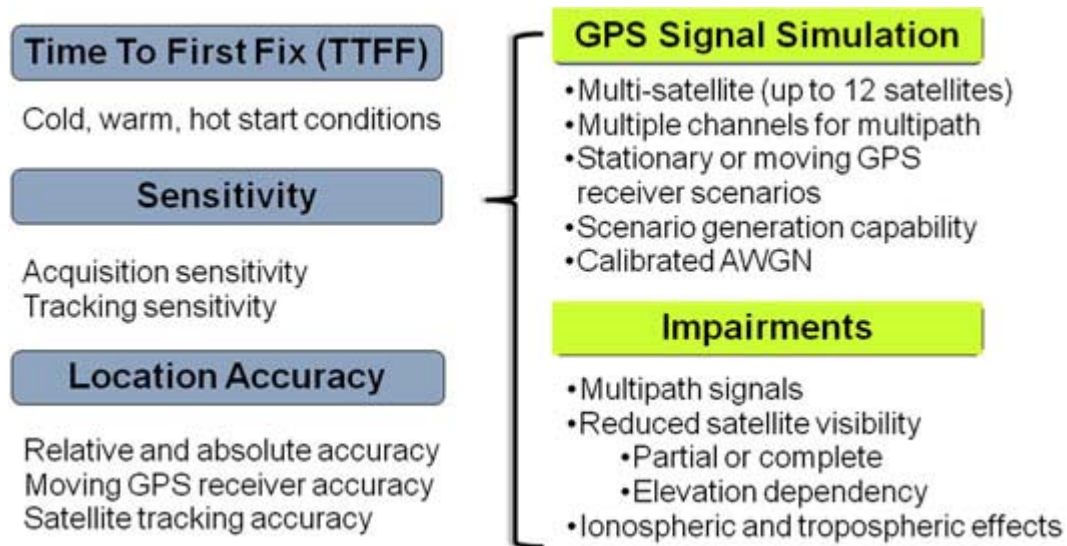- Location accuracy (relative and absolute accuracy for both static and moving GPS receivers)

Time To First Fix (TTFF)

Cold, warm, hot start conditions

Sensitivity

Acquisition sensitivity
Tracking sensitivity

Location Accuracy

Relative and absolute accuracy
Moving GPS receiver accuracy
Satellite tracking accuracy

GPS Signal Simulation

- Multi-satellite (up to 12 satellites)
- Multiple channels for multipath
- Stationary or moving GPS receiver scenarios
- Scenario generation capability
- Calibrated AWGN

Impairments

- Multipath signals
- Reduced satellite visibility
  - Partial or complete
  - Elevation dependency
- Ionospheric and tropospheric effects

Figure 1. Common GPS verification tests and requirements

Using live off-the-air GPS signals for GPS receiver verification is unreliable because of the high variability and non-repeatability of these signals. The N7609B application is able to reproduce GPS signals in an accurate and repeatable manner by simulating the multiple signals from many different satellites, with different time delays, Doppler shifts, and power levels. The GPS signals that are created for these tests must also have the ability to incorporate signal impairments. The N7609B software has the capability to create and transmit impairments such as multipath signals, loss of satellite visibility, and ionospheric and tropospheric atmospheric attenuation. The capability to output these signals under calibrated AWGN conditions also exists with the N7609B. The ability to add these impairments allows the N7609B to provide a complete suite of signals for full verification of GPS receivers.

Real-Time Generation with Custom Scenarios

Real-Time GPS Signal Generation

The real-time signal generation capability of the N7609B software enables you to quickly verify GPS receiver functionality under varying signal conditions. For example, as the GPS signal is playing, individual channels can be turned off or on in real-time, allowing immediate feedback on the GPS receiver performance (see Figure 2). These channels can represent line-of-sight satellites or multipath signals depending on the scenario being played. Individual channel power can also be modified to simulate partial obstruction of satellite signals. The power offset is presented to allow you to calculate individual satellite power based on the ESG or MXG amplitude level (individual satellite power = power offset + ESG/MXG amplitude setting).

Channel	SV ID	Enabled	Relative Power Scale (dB)	Power Offset (dB)
1	3	☑	0.00	0.00
2	6	☑	0.00	0.00
3	11	☑	0.00	0.00
4	18	☑	0.00	0.00
5	19	☑	0.00	0.00
6	22	☑	0.00	0.00
7	7	☑	0.00	0.00
8	25	☑	0.00	0.00
9	16	☑	0.00	0.00
10	21	☑	0.00	0.00
11	N/A	☐	0.00	0.00
12	N/A	☐	0.00	0.00
▶ 13	N/A	☐	0.00	0.00
14	N/A	☐	0.00	0.00
15	N/A	☐	0.00	0.00
16	N/A	☐	0.00	0.00
17	N/A	☐	0.00	0.00
18	N/A	☐	0.00	0.00

Figure 2. Real-time control of individual channels

Scenario Generation

With option RFP, Scenario Generator for Advanced GPS, you can create or play back GPS scenarios for any date, time, and location (see Figure 3). Both static and dynamic scenarios can easily be created. For static scenarios, a date, time, location (altitude, longitude, latitude), duration, and almanac file (Yuma format, available from http://navcen.uscg.gov/gps/almanacs.htm) are required. Moving GPS receiver scenario creation requires a NMEA (GGA format) message file for trajectory path information. These GGA message files can be recorded from a GPS receiver, or created using the Trajectory Generator utility in the software.

Optional parameters during scenario creation include elevation mask angle, and ionospheric and tropospheric atmospheric modeling effects. The elevation mask allows you to select only those satellites that are above a certain angle above the horizon to be used in the scenario. The ionospheric model (Klobuchar) and tropospheric model (NATO) parameters are put into the GPS navigation message and the GPS signal is impaired according to these settings.

Scenario Generator	Scenario Graphics	Antenna Pattern	Trajectory Generator

⊟ 1. Scenario Generator Settings

Generation Mode	Create
Output A-GPS and Ephemeris Files	Off
Ephemeris File (Optional)	
Almanac File	C:\Program Files\Agilent\Scenario Generator\543.alm
Elevation Mask Angle	5.00 °
Troposphere Model	No Model
Ionosphere Model	No Model
Scenario Type	Static
Initial Longitude	116.478479 E
Initial Latitude	40.0096856 N
Initial Altitude	100.00 m
Start Date Time (GPS Time)	2010-01-20 01:00:00
Duration (HH:mm:ss)	01:00:00

Figure 3. Scenario generation settings

Leap Seconds Editing

Two modes are provided for applying leap seconds during scenario creation. Official mode uses leap seconds defined by the International Earth Rotation and Reference Systems Service (IERS) (15 leap seconds as of January 1, 2010), while User Mode allows you to edit the leap seconds, as shown in Figure 4.

The leap second editor allows you to add or remove leap seconds, or to change the time and date when the leap seconds occur, which may be useful in testing GPS chipsets. Both positive and negative leap seconds may be included.
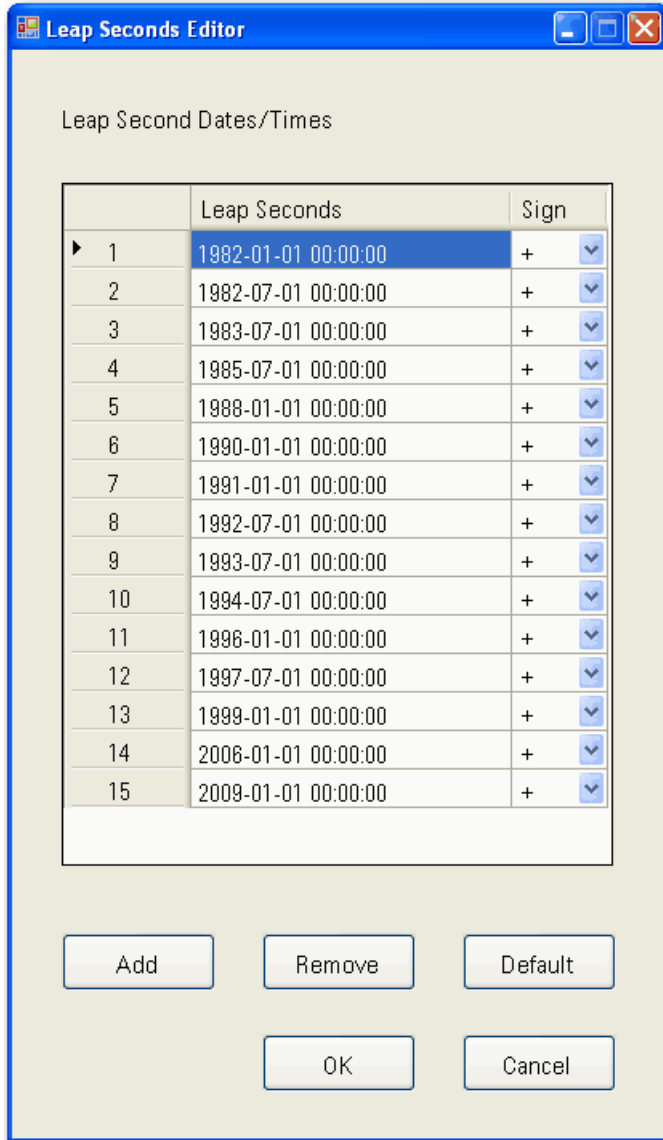

Figure 4. Leap second editing

Scenario Editing

The ability to add multipath impairments to the GPS signal is important to fully verify GPS receiver operation. Scenario editing capability is part of option RFP. It allows the modification of scenarios with the following functionalities:

- Delete Channel – Delete a channel from the scenario

- Apply Power Offset – Apply a power offset to a channel over some time span

- Equalize Power – Sets the power levels for all channels to be the same

- Create Multipath – Create a multipath signal based on another channel

- Trim – Create a new scenario file that contains a portion in time of the selected file

When creating a multipath channel, you specify the source channel (channel to use as the basis for the new multipath signal), destination channel (channel to receive the new multipath signal), power offset, Doppler shift, and delay offset (see Figure 5).
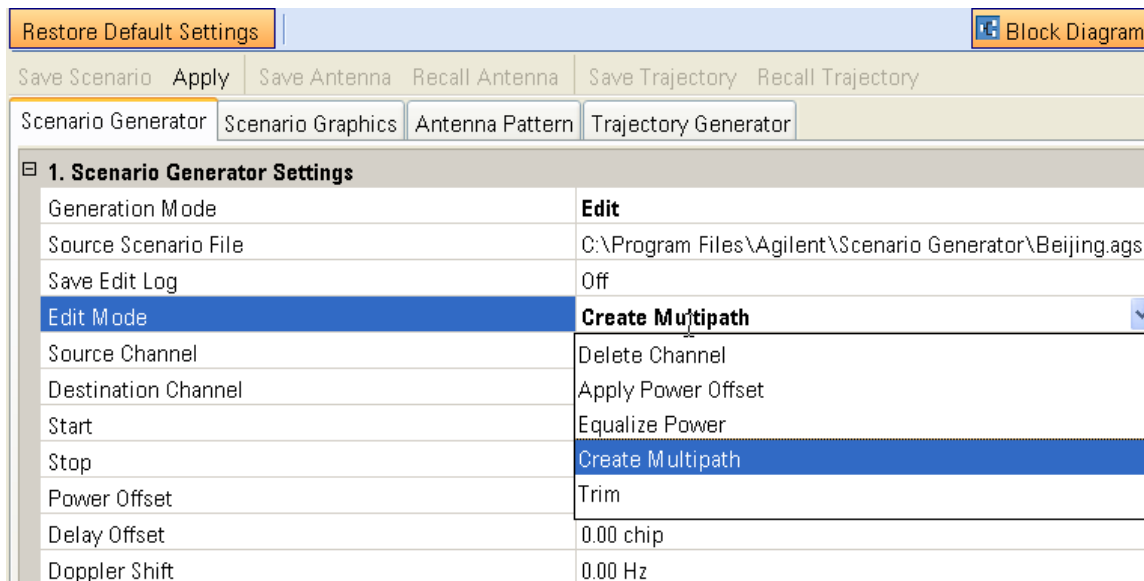
Figure 5. Source channel selection

Visualization Tools

A graphical display tab allows you to visualize the scenario parameters such as satellite visibility, playback time, and channel designation (represented satellite). It also contains a record of the changes that have been made during the editing session (see Figure 6).
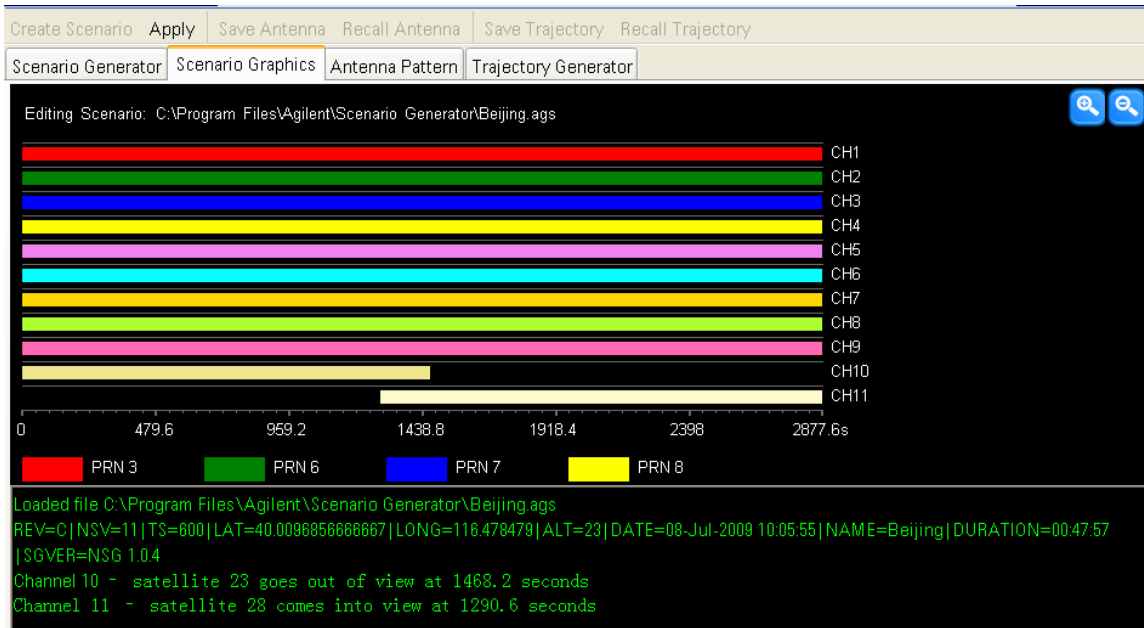

Figure 6. Graphical display of scenario parameters and changes

Antenna Pattern Model

The software allows you to define an antenna pattern gain mask using a simple graphical user interface, as shown in the figure below. The software applies this gain mask to the GPS signal. For the gain mask, you can define the resolution for the elevation and azimuth, and an azimuth rotation to apply to the pattern. This gain mask can also be used to simulate the effects of obstructions in the environment.

For static scenarios, the antenna pattern is based on absolute coordinates with 0 degrees azimuth corresponding to north. For dynamic (moving receiver) scenarios, the antenna pattern is relative to the GPS receiver or vehicle, with 0 degrees corresponding to the front or forward direction. The absolute azimuth angle will depend on the direction of motion of the GPS receiver.
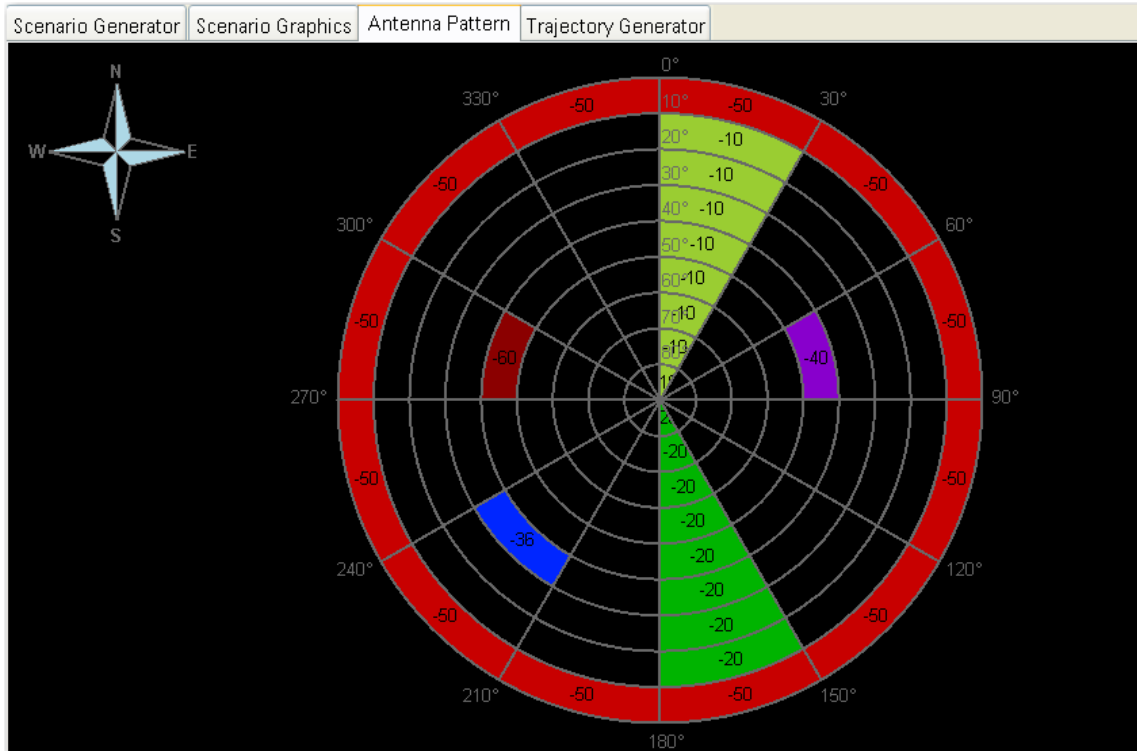

Figure 7. Antenna pattern view – set the power offset for a cell, a circle, a sector, or any combination of the three

Trajectory Generator

A simple trajectory file creator/editor is provided to generate GGA message files for creating dynamic scenarios. It enables the easy generation of trajectory files by adding or deleting segments to indicate a wait, turn or straight path. You can specify velocity and acceleration versus time or distance through an intuitive table with a preview for viewing the receiver's path, as shown in Figure 8. Simple preset shapes, such as a circle or rectangle, are also available for quick configuration. Once the trajectory has been defined, the path data can be saved as an NMEA GGA format file, a Google Map HTML file, or a Google Earth KML file.

Add ▾ Remove Copy Up Down Clear   Shapes ▾ Preview Export ▾

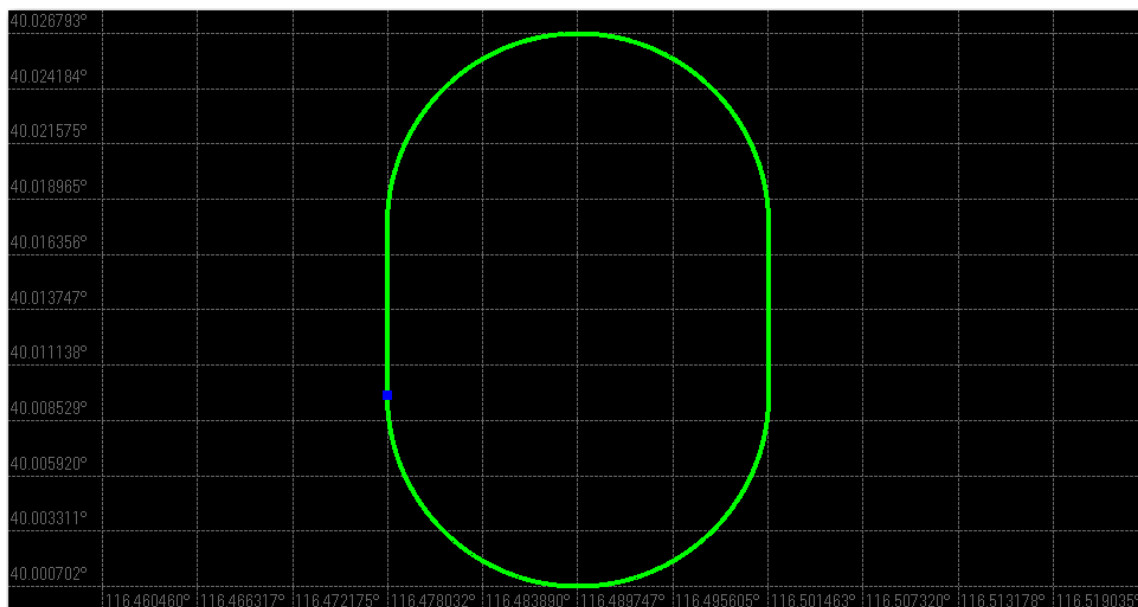|	Segment	Duration(s)	Distance(m)	Accelerate(m/s2)	Ending Velocity(m/s)	Angle(°)	Radius(m)	Climb(m/s)
	Wait	30.00	0.00	0.00	0.00	0.00	0.00	0.00
	Straight	60.00	900.00	0.50	30.00	0.00	0.00	0.00
	Turn	104.72	3,141.59	0.00	30.00	180.00	1,000.00	0.00
	Straight	30.00	900.00	0.00	30.00	0.00	0.00	0.00
▶	Turn	104.72	3,141.59	0.00	30.00	180.00	1,000.00	0.00

Figure 8. Trajectory file generator

Assisted GPS (A-GPS) Test Solutions

Service providers are requiring mobile device testing to ensure A-GPS operation does not interfere with cellular phone calls. Verify that your UMTS or cdma2000® mobile device meets CTIA standards for A-GPS operation and integrates seamlessly into cellular networks with design verification and pre-conformance test solutions from Agilent Technologies. The N7609B application, N5106A PXB, and N5182A MXG combination can easily be incorporated into test systems for a complete A-GPS test solution.

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GS-9000 A-GPS Design Verification Test Systems

Agilent Technologies' GS-9000 family of test systems includes design verification solutions for pre-conformance test as well as a compact bench top functional test solution. The GS-9000 A-GPS Design Verification Test systems include both hardware and software to enable mobile device A-GPS testing in a conducted environment. The hardware includes an 8960 Wireless Communications Test Set for base station emulation and an E4438C ESG Vector Signal Generator or N7609B software and N5106A PXB with N5182A MXG combination to emulate GPS satellites. The GS-9000 family of test systems will support UMTS and cdma2000 A-GPS testing.

Performance Characteristics

| NOTE | This list provides calculated values indicating expected performance. This data is not warranted and is subject to change. |

- Doppler shift valid range: +/−125 kHz

- GPS reference frequency (f0) default: 1.023 MHz

- Code phase accuracy: 0.016 chips

- Doppler resolution: 0.02 Hz

- Doppler accuracy: +/− 0.01025 Hz

- Amplitude resolution: see the signal generator (E4438C ESG or N5182A MXG) data sheet

- Amplitude (output power) level: see the signal generator (E4438C ESG or N5182A MXG) data sheet

- Amplitude level accuracy: see the signal generator (E4438C ESG or N5182A MXG) data sheet

Recommended Configurations

To create and transmit a GPS signal, in addition to the N7609B software, you will need the N5106A PXB and one of the listed signal generators.

For more information about the Agilent PXB, go to http://www.agilent.com/find/pxb

N7609B for GNSS with the following options:	
N7609B-6FP	Connectivity to the N5106A PXB
N7609B-QFP	Advanced Real Time GPS
N7609B-RFP	Scenario generator for advanced GPS (optional; required for creating, editing, or playing back custom scenario files)

N5106A PXB with the following options:	
N5106A[1]	N5106A PXB baseband generator and channel emulator
N5106A-611	1 DSP block on 1 baseband card
N5106A-632	2 I/O channels - 2 analog I/Q out and 2 digital I/O
N5106A-EFP	Baseband generation capability
N5106A-JFP	Calibrated AWGN (optional)

N5182A MXG Vector Signal Generator with the following options:	
N5182A[2]	N5182A MXG vector signal generator
N5182A-503	250 kHz to 3 GHz frequency range

Other MXG options to consider:	
N5182A-506	250 kHz to 6 GHz frequency range
N5182A-1EL	Differential I/Q outputs
N5182A-1EQ	Low Power (<-110dBm)

E4438C ESG Vector Signal Generator with the following options:	
E4438C[3]	E4438C ESG vector signal generator
E4438C-503	250 kHz to 3 GHz frequency range
E4438C-601 or 602	Internal baseband generator (for digital bus capability)

Other ESG options to consider:	
E4438C-UNJ[4]	Enhanced phase noise

[1] Requires firmware revision A.01.60 or later (how to upgrade)

[2] Requires firmware revision A.01.44 or later if using with PXB (how to upgrade)

[3] Requires firmware revision C.05.23 or later if using with PXB (how to upgrade)

[4] Requires Option 601 or 602 internal baseband generator

Additional Information

Explore the Online Documentation

For more information about this Signal Studio software, explore the online documentation (help), which includes this technical overview, release notes, user interface descriptions, tutorials, installation information, and an easy-to-use configuration assistant to help you determine the right option combination for your test needs. Access the online documentation at:

www.agilent.com/find/n7609b

Related Websites

GPS Receiver Testing
www.agilent.com/find/gps

Mobile Device Assisted GPS (A-GPS) Testing
www.agilent.com/find/agps

Signal Creation Software
www.agilent.com/find/signalstudio

Agilent's LTE Design and Test Solutions
www.agilent.com/find/lte

Related Literature

Signal Studio Software, Brochure, 5989-6448EN
http://cp.literature.agilent.com/litweb/pdf/5989-6448EN.pdf

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