Agilent Option 409 GPS Personality for E4438C ESG and E8267D PSG Vector Signal Generators

Technical Overview

The Global Positioning System (GPS) personality (Option 409) for the E4438C ESG or E8267D PSG vector signal generator simulates a multi-satellite GPS signal for GPS receiver testing. This firmware option provides the capability to verify functionality of embedded GPS chips in mobile consumer products such as cellular phones and handheld receivers.

With the GPS personality, a few keystrokes enable you to select a real-world scenario and to transmit the corresponding multi-satellite GPS signal as seen from that location. The synchronized satellite signals contain accurate Doppler shift and navigation messages that quickly allow your GPS receiver to acquire "location fix" and to calculate the Time To First Fix (TTFF). In addition, a receiver sensitivity test can be performed by lowering the RF power of the signal and calculating the carrier to noise level at which the location fix is lost.

The GPS personality can be used with any of the wireless format options in the E4438C ESG or E8267D PSG for a complete mobile phone test solution.

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Key Features

Characterize your receiver's accuracy in providing a location fix

• Select scenario and specific geo-location

• Compare receiver location fix to actual scenario file location

Calculate your receiver's time to first fix (TTFF)

• Consistent and repeatable GPS satellite signals

• Calculate TTFF in receiver cold and warm start conditions

Characterize your receiver's sensitivity

• Detect the signal to noise (C/No) level at which location fix is lost

• Level accuracy < 0.5 dB down to –120 dB[1]

• Programmable instrument for automated tests

Characterize your receiver's capability to reacquire satellite signals

• Adjust the number of satellites visible while the signal is playing

• Number of satellites visible can be adjusted between 1 and 8

Detect parity errors[2]

• Parity bits are pre-computed for both user-created and ESG/PSG data files for parity detection tests

Custom applications[2]

• Download your own data files of any frame structure into the ESG/PSG for modulation onto the GPS signal

• Modify the GPS signal by adjusting filters, reference frequency, clock, code phase, or ranging (P or C/A+P) code[3]

• Test Doppler effects using wide, 250-kHz range Doppler shift without RF signal dropout

Versatile vector signal generator

• Tightly-specified RF performance

• Digital arbitrary (ARB) waveform generator for building custom waveforms

• Options available for other communication formats: IS-95, cdma2000®, 1xEV-DO, 3GPP W-CDMA, GSM, EDGE, 802.11a/b/g/j/p/n WLAN, WiMAX™, digital video, 3GPP LTE

• Serves many of the functions of high-cost, dedicated GPS test equipment for single-channel receivers

1. *Requires external attenuator and shielding to reach levels below –136 dBm and to maintain accuracy below –127 dBm. Specifications apply to frequencies < 2 GHz for the E4438C. Refer to E4438C ESG data sheet, literature number 5988-4039EN or the E8267D PSG data sheet, literature number 5989-0697EN.*

2. *Single satellite mode.*

3. *P code signal is spectrally correct but contains no valid data.*

Multi-Satellite Mode

- Multi-satellite GPS configuration (1 to 8 satellite capability)
- Signal simulates real world scenarios (multiple scenarios available)
- Real satellite data (synchronized satellites with Doppler shifts and navigation messages)
- Scenario playback durations up to 12 hours
- Adjust number of visible satellites between 1 and 8 as real-time GPS signal is playing
- Automate waveform playback with SCPI
- 10baseT LAN, GPIB, and RS-232 connectivity
- Compatible with the E4438C ESG and E8267D PSG, high performance vector signal generators
- Internal software application built-in to signal generator firmware; no PC required

A minimum of 4 GPS satellite signals are required by GPS receivers to acquire a 3D location fix. In some instances, where 2 satellites have similar line-of-sight, more than 4 satellite signals may be required. The GPS personality can provide up to 8 real-world GPS satellite signals to verify functionality of embedded GPS receivers in mobile consumer products such as cellular phones, 2-way radios, and handheld receivers.

The satellite signals are configured based upon pre-configured scenario files. These signals (including Doppler shifts) are synchronized with the actual satellite orbits so that they are consistent with the navigation message contained in the satellite signals. This repeatability provides consistency in your GPS receiver test algorithms and allows your receiver under test to converge quickly on a location fix.

Multiple pre-configured scenarios, based on latitude, longitude, elevation, simulation date and time, and scenario playback duration, are available. These scenarios define the resultant Doppler shift and signal strength for each individual satellite visible from these specific geo-locations. The scenario files also define the navigation message sent by the satellites to create a real-world GPS simulation. Two scenarios will be built into the application and others will be available for download from the Web.

The number of satellites visible (i.e. number of satellite signals being played) can be adjusted between 1 and 8 while the signal is playing. Satellite visibility can be removed and reintroduced to evaluate your GPS receiver's capability to relocate the satellite signal once it has been lost. This is a real-world situation where obstructions may exist to block satellite signal transmission for a period of time. The obstruction may be complete, as in a tunnel, or partial, as in an urban canyon.

Single Satellite Mode

- L1 or L2 carrier
- C/A code with data modulation
- Choice of data source and P or C/A+P code
- Selectable satellite (space vehicle) ID
- Doppler shift from -125 kHz to +125 kHz
- Adjustable filters, satellite clock, code
- GPIB, RS-232 and LAN connectivity

The single satellite mode offers three data choices
The single satellite mode offers telemetry (TLM), raw, and encoded data modes to support different test applications. In each mode, data is continuously modulated with the C/A code at 50 bps.

TLM mode is designed for receiver sensitivity tests. TLM mode structures the continuous GPS sub-frames with a formatted TLM word, formatted handover word (HOW), and a default navigation data message per the 1995 NAVSTAR SPS GPS Signal Specification.

Raw mode supplies a pseudorandom noise (PN) sequence for BER calculations. Also in this mode, user-supplied data can be modulated onto the GPS signal for your proprietary testing. Raw mode generates a continuous data bitstream from one of several available data sources: PN9 or PN15 sequence, repeating 4-bit pattern, or a user-created file downloaded into the instrument.

Encoded (Enc) mode is ideal for parity detection tests. Encoded mode computes parity bits from the selected data source, and inserts the 6 parity bits after every 24 bits in a GPS word. Data sources include: PN9/PN15 sequence, repeating 4-bit pattern, and user-created files.
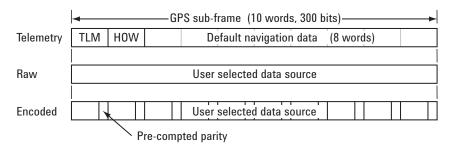
Figure 1. Sub-frame structure for the data modes

GPS personality specifications[1] [Option 409]

Ranging code	C/A
Number of satellites	User-settable 1 through 8
Carrier frequency	User-settable depending on the frequency range option purchased for the ESG or PSG
Satellite ID[2]	Valid range: 1 to 37
Doppler shift[2]	Valid range: −125 kHz to +125 kHz Preset: 0.0
Data modes for C/A code only[2]	Choice of mode: telemetry, raw, encoded Preset: raw
TLM	Choice of data: not user-selectable
Raw	Choice of data: PN9, PN15, fix-4, user file Preset: PN9
Encoded	Choice of data: PN9, PN15, fix-4, user file
GPS reference frequency (f0)	Default: 1.023 MHz Min: 900.000 kcps Max: 1.100000 Mcps
GPS reference frequency (f0)[2]	Valid range: 1 kcps to 12.5 Mcps Preset: 10.23 Mcps
Chip rate	C/A chip rate is automatically set equal to one-tenth of f0-value Preset: C/A chip rate 1.023 Mcps
GPS reference clock	Choice of internal (equal to f0) or external (user supplied) clock source Preset: internal
Scenario files	2 built-in with the firmware, additional files downloadable from the Web
Filter types	Rectangular, IS-95 standard, IS-95 modified (improved ACP), IS-2000, root Nyquist, Nyquist, Gaussian, user FIR Preset: rectangular
I/Q phase	Choice of normal or inverted Preset: normal
Amplitude (output power) level[3]	−136 dBm to +10 dBm (E4438C)
Amplitude level accuracy[3]	< ±0.5 dB above −110 dBm; < +0.7 dB above −127 dBm (E4438C)

1. Features subject to change.

2. Single satellite mode.

3. Requires external attenuator and shielding to reach levels below −136 dBm and to maintain accuracy below −127 dBm. Specifications apply to frequencies < 2 GHz for the E4438C. Refer to E4438C ESG data sheet, literature number 5988-4039EN. For the PSG, refer to the E8267D data sheet, literature number 5989-0697EN.

Ordering Information

The GPS personality is Option 409 for the Agilent E4438C ESG or E8267D PSG vector signal generator. For the E4438C, the GPS personality requires that the ESG be equipped with the optional baseband generator (Option 601 8 MSa memory or Option 602 64 MSa memory) and 6 Gbyte hard drive (Option 005). A minimum frequency of 2 GHz (Option 502) is required to transmit an L1 carrier. For the E8267D, the GPS personality requires that the PSG be equipped with the optional baseband generator (Option 602 64 Msa memory), removable flash memory (Option 009), and a minimum frequency of 20 GHz (Option 520).

Upgrade Kits

If you currently own an Agilent E4438C ESG vector signal generator and wish to obtain an upgrade kit only (license key), order E4438CK Option 409. If you currently own an Agilent E8267D PSG, order E8267DK Option 409. A firmware upgrade may also be required. Visit **www.agilent.com/find/upgradeassistant** for more information and to download the latest firmware.

Related Literature

- E4438C ESG Vector Signal Generator, data sheet,
  literature number 5988-4039EN

- E8267D PSG Vector Signal Generator, data sheet,
  literature number 5989-0697EN

- Comparison of IS-95/IS-2000 Test Sets, product note,
  literature number 5988-3128EN

- 8960 Series 10 Wireless Communications Test Set, brochure,
  literature number 5968-7876E

Web Resources

For more information on the E4438C ESG, visit **www.agilent.com/find/e4438c**

For more information on the E8267D PSG, visit **www.agilent.com/find/e8267d**

For additional scenario files and information on other solutions for GPS receiver test, visit **www.agilent.com/find/gps**

For information on solutions for Assisted GPS (A-GPS) testing for mobile phones, visit **www.agilent.com/find/agps**