Global Positioning System Simulation and Test

Benefield Anechoic Facility

The BAF is an excellent facility to conduct several types of GPS testing. The chamber shielding effectiveness (≥ 100dB) allows GPS tracking and jamming tests without frequency management or regulatory agency approval. GPS signals can be transmitted free-space to the SUT using one of three simulators: the GPS Simulation system, GPS Retransmission System or the Advanced Global Navigation Simulator (AGNS) GPS simulator.

The Interstate Electronics (L-3) GPS Simulation System is capable of generating 24 fully independent RF channels of L1 (1575.42 MHz) and L2 (1227.60 MHz) GPS signals. It can be configured in combinations of GPS Space Vehicle (S) signals, GPS Ground Transmitter (GT) signals, GPS multipath signals, GPS "spoolers", and jammers, or up to 12 full up L1/L2 satellites transmitted over a single RF channel. The GPS Retransmission System repeats an external GPS L1 signal from outside the BAF into the chamber.

The AGNS GPS simulator (available in 2014) provides sixteen (16) RF channels into seven (7) separate L1 and L2 transmit antennas. This is significant for testing GPS steering and nulling antenna systems (e.g. CRPA). The AGNS system can simulate C/A, L2C, P and P(Y) and M codes to support Advanced Encryptions Code (AEC). The system can be configured for L5 carriers and the Modernized NAVSTAR Security Algorithm (MNSA).

This fact sheet highlights the AGNS, the programmable simulator that provides satellite position transmissions and other signals. In addition to generating GPS signals, AGNS can create both intentional and unintentional interfering signals. including multipath, jamming signals, and potential future navigation signals. The signals generated by AGNS create an RF environment that is a high fidelity representation of a potential real world scenario. At the BAF the seven fixed radiation locations are available above the SUT in addition to mobile locations. The BAF enables the test of GPS equipment under precisely repeatable conditions as well as under rare and extreme conditions that would be difficult if not impossible to create in field tests.

- **Controlled Reception Pattern Antenna (CRPA) pattern and nulling effectiveness characterization**
  - Antenna pattern measurements – passive installed
  - Nulling system characterization – GPS anti-jam
  - Performance when integrated with antenna electronics to provide nulled pattern vs. full pattern data
  - Time-convergence (detection-nulling response time) measurements
  - Capture data at operating frequency ranges and varying geometries
  - Installed system verification and model correction and validation
- **System & receiver performance against jamming**
  - Noise jamming
  - Smart techniques
  - Targeted anti-jam against specific assets
- **Evaluation of GPS environment changes**
  - Programmable and flexible scenario generation
  - Interoperability evaluations at the installed systems level
  - Spectrum encroachment assessments

Benefield Anechoic Facility (BAF)

Global Positioning System (GPS) Simulation and Testing

U.S. AIR FORCE

Key BAF Characteristics

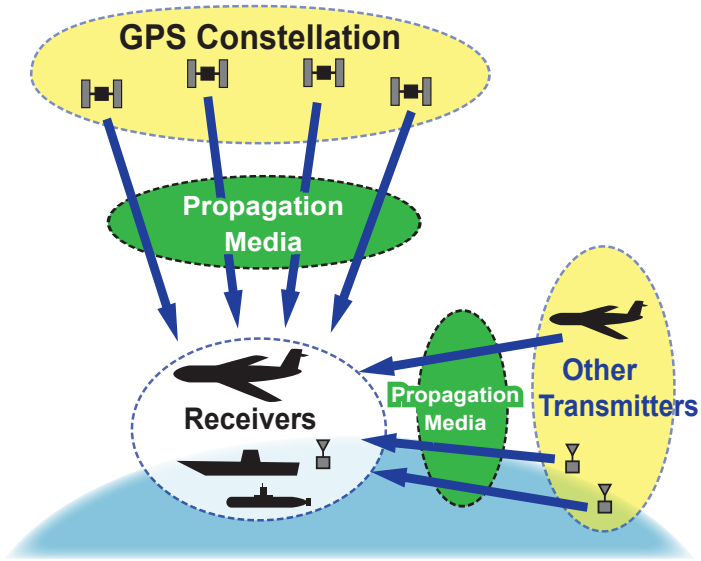
- 264 ft. long by 250 ft. wide by 70 ft. high
- ≥ 100 dB shielding to/from outside environment
- ≈ 84 dB isolation between SUT and chamber at 1 GHz
- ≥ 90 dB isolation between SUT and chamber at 2 GHz
- 80 ft. diameter 175-ton capacity turntable
- Two (2) 40-ton SUT hoists
- A unique indoor RF test environment
- Antenna Measurement Suite
- Three GPS test support systems available
  - GPS Retransmission system
  - Interstate Electronics GPS Simulator
  - Advanced Global Navigation Simulator (AGNS)

AGNS Capabilities and Functions

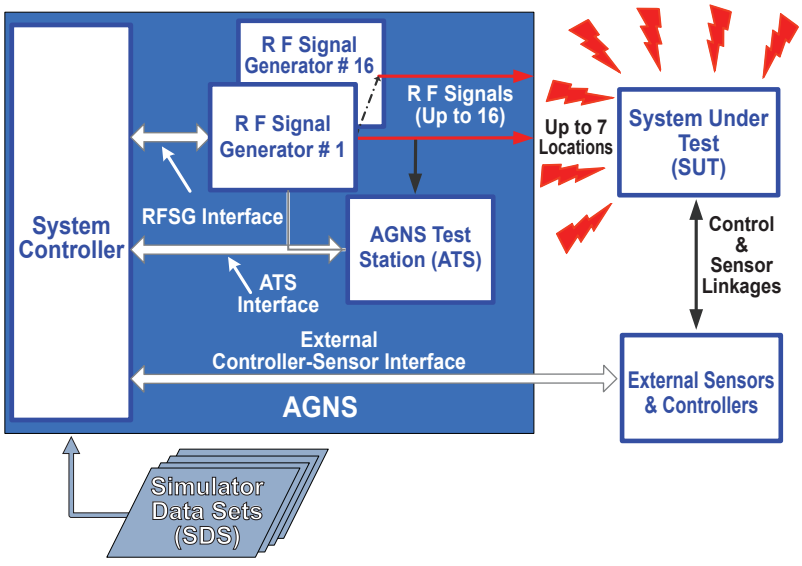
- Transmitter Vehicles
  - GPS
  - L1, L2, and L5 frequencies with Doppler
  - C/A, L2C, P(Y), M, PA, FA, L5 codes.
  - Legacy NAV, MNAV, and CNAV data messages
  - Ephemeris parameters – Coarse (representing almanac) and fine (precision)
  - Satellite clock offset model
  - Carrier and code power control
  - Lever arm offsets of vehicle and antenna elements
  - Antenna Patterns
- Receiver Vehicle
  - Vehicle motion model, orientation, lever arms, antenna patterns
  - Jammers
  - Flexible noise bandwidth for jamming (0 to 40 MHz)
  - Programmable waveforms to evaluate the effects of navigation augmentation, spoofing, prevention, and interference/jamming signals
- Atmospheric Effects
  - Ionosphere, troposphere, free-space attenuation, earth blockage models

Parameters

- Frequency: 1176.0 – 1576.0 MHz
- Frequency Resolution: 0.10 Hz
- Phase Resolution: 0.10°
- SSB phase noise: - 120 dBc (at 20 KHz offset)
- Spurious Output: - 70 dBc (in band)
- Harmonics: -40 dBc
- Switching Speed (synthesizers): < 50 msec
- Output Power: -140 to -20 dBm (independently set for each signal)
- Attenuation step size: 0.1 dB
- Power level accuracy: ± 1.5 dB
- Power level repeatability: ± 0.5 dB
- Doppler Frequency Shift
- Modulation Bandwidth: 40 MHz
- Modulation types: CW, FM, AM, PSK (BPSK, QPSK, etc.), OOK, QAM, Swept, Pulsed, CDMA, FDMA and TDMA
- Codes:
  - Internal Pseudorandom code sequences independently controllable
  - External PRN input available
  - Modulo-2 addition of code and data sequences
  - Chipping rate: 0 – 21 MHz
  - Chipping rate resolution: 0.1 MHz
- Data Message: Two 800-bit registers at 0 – 19.2 baud



Simple RF Scenario



AGNS Simplified Block Diagram

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