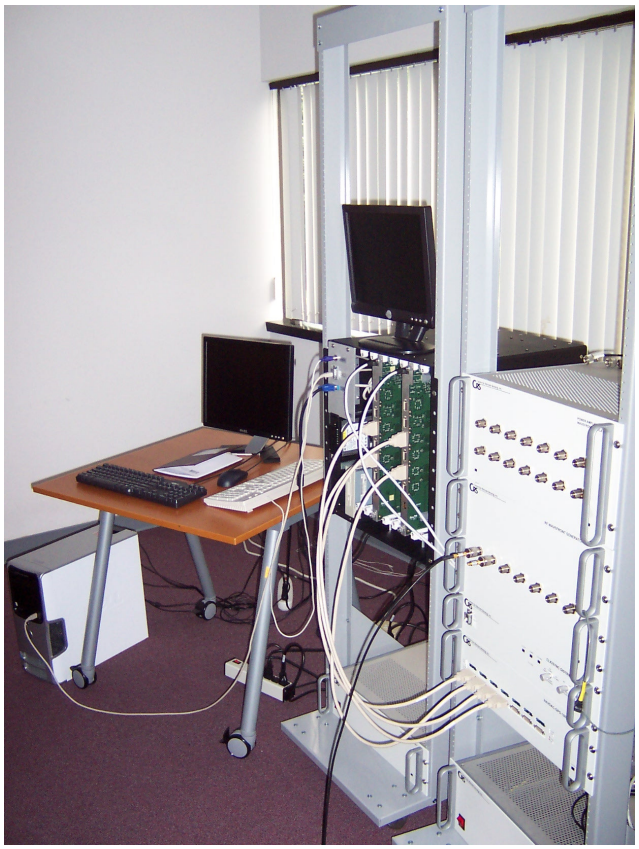
CENTER FOR REMOTE SENSING, INC.

Multiband GNSS Wavefront Simulator

Multifrequency, Multichannel GNSS Signal Generation for all Constellations and all Situations (GNSS-MBW-011-07)



CRS has developed the most comprehensive and advanced GPS and GNSS simulators in the world. A comprehensive family of simulators for all signals in space has been developed and highly precise wavefront simulation with exceptional platform dynamics and other capabilities are provided through various modular units. It is modular, flexible, and provides precise simulated signals for almost all available constellations (GPS, Galileo, GLONASS, SBAS, EGNOS, QZSS). It provides a true replica of the signal wavefront (7 antenna outputs standard) under wide ranging user dynamics. The relative phase errors are less than 1 mm.

Modular units for GPS, Galileo, Glonass, EGNOS, SBAS, etc. are provided in order to seamlessly integrate with each other in both digital and analog domains. Additional modules such as LAAS, IMU emulator, high dynamics jammer/interferer, etc. also integrate with the system providing a truly comprehensive simulation system never attempted before. The simulator is housed in a 19 inch rack and different modules are interfaced through versatile combination modules, providing both digital and RF outputs at multiple antenna ports. A built-in calibrator ensures the precision to unprecedented accuracy of 1 mm.

The entire simulator is operated using a highly evolved software interface enabling a variety of platform maneuvers, complex environmental simulation, receiver and satellite anomalies, and almost every possible modifications in the signal structure. Yet the user interface is extremely simple and intuitive with comprehensive graphical displays.

The simulator modules comprise of:

1. Mulitband GPS wavefront simulator (GPSS-MBW-008-06) provides L_1, L_2, and L_5 bands at 7 antenna ports. All GPS signals (C/A, P(Y), M, L_2C, and L_5) are provided.
2. Multiband Galileo Wavefront Simulator (GALS-MBW-010-07)
3. Multiband Glonass Wavefront Simulator (GLOS-MBW-012-07)
4. Multiband SBAS/EGNOS Wavefront Simulator
5. Multiband Jammer Wavefront Simulator
6. IMU Simulator

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Each of these modules can operate independently. They are driven from a common user interface and the outputs are provided both individually and combined with each other.

The jammer simulator can provide a dynamic range of 120 dB in conjunction with other navigational signals. A built-in calibrator ensures the phase accuracies of 1 mm.

The control software is simple, intuitive, and allows extreme flexibility and versatility in terms of controlling the user motions with extremely high dynamics and complexities (200 km/s, 100 km/s^2, 20 km/s^3). A variety of environmental models can be introduced. The user antenna models (independent antenna elements) as well as satellite antenna models can be changed. A variety of signal fault conditions can be introduced. The signal generation module enables complete control over the navigation messages.

The software provides complete visualization, scripting and logging features. The simulator can also operate using external event generators (HWIL), enabling the simulator to be integrated with complex test facilities.

To facilitate testing a comprehensive jammer and interfering signal suite is available as standard. Up to 20 jammers with a dynamic range of 120 dB and varying waveforms and dynamics can be generated.

The wavefront simulators utilize real-time software-based architecture that was pioneered by CRS. A variety of environmental models (ionosphere, troposphere, specialized plasma effects, scintillation, fading, scattering, and multipath, etc.) are incorporated with fidelities never achieved before. A variety of antennas with appropriate gain and phase patterns are used to ensure the correct code and phase relationships at the outputs of the wavefront simulator.

The simulator responds to external stimuli instantaneously enabling it to be used as a Hardware in the Loop (HWIL) simulator with networking capabilities. It has an intuitive and user friendly GUI and several options are built in for operator control.

- Performance
  - Flexible Software-based Design
    - 12 to 24 independent channels
    - GPS – L_1, L_2, and L_5: all C/A, P(Y), M, and L_2C signals
    - SBAS – support at L_1, WAAS, EGNOS
    - GLONASS – all signals in L_1
    - Galileo – all signals (L_1, E5, and E6)
    - Jammer – 24 independent jammer signals with selectable waveforms and dynamics
    - LAAS
- High Accuracy
  - Code: < 1 mm
  - Differential Phase: < 0.1 mm
- Complex Scenarios
  - High Dynamics – suitable for EKV, satellite, projectiles, aircrafts (600 km/s; 20,000 g)
  - Arbitrary motion (6 DOF)
  - Wavefront Simulation
  - Independent controls over all aspects of antennas and platforms
- HWIL control – latency between 2 to 5 ms
- Comprehensive Models
  - Constellation
    - Full Control; definition and modeling
    - Navigation message bits, HOW, TLM, and sub-frame error data.
  - Waveforms
    - Full controls (independent) over waveform errors, nav bits
    - Clock errors
  - Environment
    - Ionosphere/Troposphere/Scintillation
  - Antenna
    - Gain and Phase (3-D), Real-time, Lever Arms
  - Multipath
    - Dynamic
  - Terrain Obscuration
    - Dynamic
- Operation and Control
  - Manual
    - Menu-based
    - Script file based
    - Interactive (Real-time)
  - HWIL
    - Real-time execution (2 ms latency)
  - Remote Control
    - External control via Ethernet
- Real-time Display
  - Satellite Constellation
  - Ground Trajectory
  - User motion parameters (6 DOF)
  - Individual Antennas
- Other Facilities
  - Comprehensive Logging
  - Remote Control via Ethernet
  - Digital Output
  - 1 PPS in/out
  - 10 MHz / 10.23 MHz operation
  - Large Dynamic Range ~ 120 dB

GNSS Wavefront Simulator

Signal Dynamics

- **Velocity**: ± 200,000 m/s
- **Acceleration**: ± 200,000 m/s^2
- **Jerk**: ± 20,000 m/s^3

RF Output

- **Signal Bands:** L_1, L_2, L_5
- **Output ports:** 2 or 7 antenna outputs at RF, 2 or 7 antenna outputs (digital)
- **Dynamic range**: 120 dB
- -130 dBm at 50 ohms
- -10 dBm Jammer signal at 50 ohms
- **Level Resolution**: 0.1 dB
- **Level Accuracy**: ± 0.1 dB RSS
- **Spurious (max)**: < -50 dBc
- **Harmonics (max)**: < -60 dBc
- **Phase Noise (max)**: < 0.02 Rad RMS
- **VSWR**: 1.5:1

Clock

- **Internal**: 1 X 10^{-10}/day
- **External Input**: 10 MHz

Waveform

- **Inertial Emulator**: IMU output
- **Digital Output**: 24 bit at each front end

The Most Advanced Navigation Simulation

- *Comprehensive*
- *Accurate*
- *Flexible*
- *Versatile*
- *User Friendly*
- *Modular*

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