# Technical Note: GPS/GNSS Simulators

Sensor Simulation

Background

Modern navigation systems integrate multiple location-aware sensors to improve performance and reliability. GPS RF simulators like Orolia's GSG series are able to test the integration of a GPS/GNSS receiver into the navigation system by generating signals corresponding to virtually any condition including vehicle dynamics. They can also generate signals for other sensors for a comprehensive system test. As the simulator generates navigation satellite data for a given trajectory, it simultaneously calculates position and attitude data in six degrees of freedom in real-time; forward/backward, left/right and up/down as well as the rotations about three perpendicular axes, pitch, yaw, and roll. This capability is available with any 16-channel or higher GSG-5 or 6 series enabled with the either Sensor Simulation option (OPT-SEN) or Real-time Scenario option (OPT-RSG).
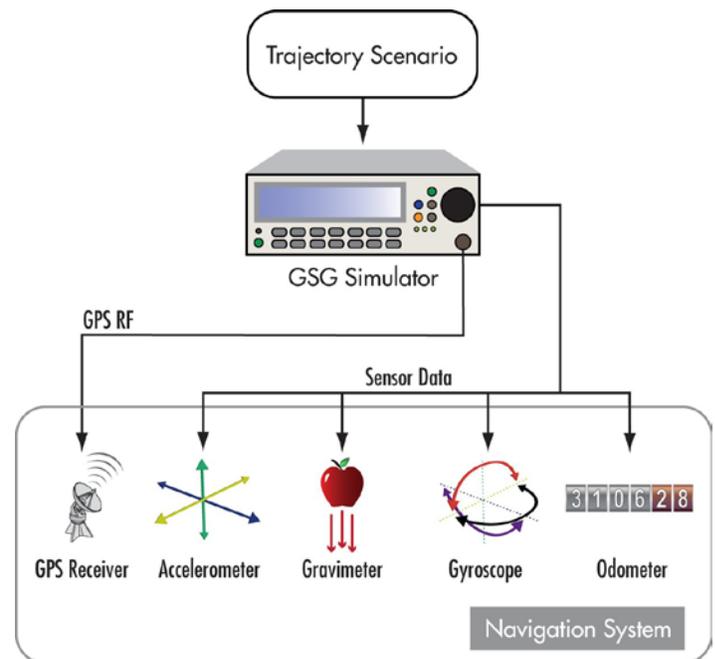
Type	Description	Units	Type Code
Accelerometer	Acceleration along the XYZ axes	g	ACC
Linear Accelerometer	Acceleration along the XYZ axes excluding the force of gravity	g	LIN
Gravimeter	Gravitational force to XYZ axis	g	GRA
Gyroscope	Angular speed around the X,Y, and Z axes	radians/sec	GYR
Odometer	Total distance traveled	meters	ODO
3D Odometer	Total distance traveled in the X,Y, and Z axes	meters	ODO3D

Configuring Simulated Sensors

The sensor output is initialized using protocol commands. The various types of sensor outputs are 'subscribed to' on an individual basis. Each sensor is initially mounted/calibrated so that its XYZ coordinate system is aligned with user's local east, north, up (ENU) coordinate system.

Send the command SOURce:SCENario:SENSor:REGister <SENSORTYPE> to enable the desired sensor. This can be accomplished using the GSG StudioView Windows application console. One sensor can be registered per command but the commands can be sent at the same time, separated by a semi-colon ";".

Example:
SOUR:SCEN:SENS:REG ACC;SOUR:SCEN:SENS:REG LIN;SOUR:SCEN:SENS:REG GRA;SOUR:SCEN:SENS:REG GYR;SOUR:SCEN:SENS:REG ODO;SOUR:SCEN:SENS:REG ODO3D

Use the query SOURce:SCENario:SENSor:REGister? <SENSORTYPE> to verify the sensor was registered. (Optional)

Query the sensor data

The query SOURce:SCENario:SENSor:DATa? retrieves the sensor data. Data for all registered sensors will be returned. The sensors will be listed in the order they were registered. The data can be queried at a maximum 10Hz rate (10 times per second).

This query was done on a static simulation with all sensors registered.

> query SOUR:SCEN:SENS:DAT?
Accel: -0, -0, -1
LinearAccel: -0, -0, -0
Gravimeter: -0, -0, -1
Gyro: 0, 0, 0
Odometer: 0
Odometer3d: 0, 0, 0

All values are zero, except those affected by the force of gravity. The Z-axis for the Accelerometer and the Gravimeter are set to -1g, or 1 x the force of gravity.

This query was done on a unit running the built in 'Circle' trajectory with diameter of 5000m and a speed of 5m/s.

> query SOUR:SCEN:SENS:DAT?

Accel: -0.00101967, -1.82769e-07, -1
LinearAccel: -0.00101967, -1.82769e-07, 3.95651e-07
Gravimeter: -0, -0, -1
Gyro: 0, 0, 0.002
Odometer: 69.5
Odometer3d: 39.6406, 57.0857, 3.52458e-05

Normalizing Data

All available sensors can be normalized so the output is always within the expected range. This is useful when trying to simulate a sensor with a known measurement range. To enable the normalization, first set the range and then turn the normalization for that sensor on.

This query was done on a unit running the built in 'Circle' trajectory with diameter of 5,000 meters and a speed of 500 m/s. No sensors have been normalized.

> query SOUR:SCEN:SENS:DAT?

Accel: -3.67067, -0.0440501, -0.998568
LinearAccel: -3.67067, -0.0440501, 0.00143185
Gravimeter: -0, -0, -1
Gyro: 0, 0, 0.12
Odometer: 3899.44
Odometer3d: 845.501, 3770.77, 0.120117

If an accelerometer has a measurement range of +/- 3g, set the maximum range to 3g and the minimum range equal to -3g.

write SOUR:SCEN:SENS:MAX ACC, 3

The sensor data can also be normalized, that is, keeping outputted values in the range +/-1, where 1 corresponds to the maximum range set. If no maximum range is set, the normalize command will have no effect.

write SOUR:SCEN:SENS:NORM ACC, ON

With the ACCELEROMETER now normalized, and 3g set as its maximum range, for the same 'Circle' trajectory as above we get the following output.

> query SOUR:SCEN:SENS:DAT?

Accel: -1, -0.0146834, -0.332854
LinearAccel: -3.67067, -0.0440501, 0.00143754
Gravimeter: 0, -0, -1
Gyro: 0, 0, 0.12
Odometer: 3869.44
Odometer3d: 943.521, 3695.59, 0.117922

Unregistering Sensors

Sensors can only be unregistered by issuing the unregister command. Once a sensor is registered in a GSG simulator, it will remain registered until the unregister command is given. Restoring factory defaults will not unregister the sensors. Like registration, the unregister commands are issued one for each sensor but can be issued in one write using the semi-colon ";" as a separator.

write SOUR:SCEN:SENS:UNREG ACC;SOUR:SCEN:SENS:UNREG LIN;SOUR:SCEN:SENS:UNREG GRA;SOUR:SCEN:SENS:UNREG GYR;SOUR:SCEN:SENS:UNREG ODO;SOUR:SCEN:SENS:UNREG ODO3D

For more information on the sensor commands see section 4 of the GSG SCPI Handbook

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