Constellator™
real-time multi-constellation & multi-frequency GNSS Simulator

SYNTONY GNSS

The flagship GNSS simulator that grows with your needs
For DESIGN, VALIDATION and PRODUCTION

The history of Constellator™ started more than 20 years ago with the first simulator for Galileo. Its singularity lies in the **Real-time tight coupling of SDR (Software Defined Radio) and state-of-the-art RF Analog front-end**.

Today, RTGS4 represents Syntony's 4th generation of simulators for GNSS and LEO PNT. It has been designed to meet the highest requirements in terms of fidelity, performance, flexibility and ease of use.

Powerful & High-Fidelity

► Realtime, Multi-constellation and Multi-frequency
GPS, Galileo, GLONASS, QZSS, NavIC (IRNSS), BeiDou, SBAS, Encrypted signals.

► Powerful with 1 200+ L1C/A equivalent signals
Simulate fully representative, high-density scenarios with Constellator's full potential.

► From simple trajectories to complex extreme dynamics
Create trajectories in seconds, on earth, in the air or even in space.

► Representing real-life imperfections
Error sources simulation: orbits, clocks, and ionosphere.

► Hardware-in-the-loop with zero effective latency
Even with 6 DoF, up to 10 000 Hz input rate.

Easy to setup and use

► Quick integration & Extended Remote Control
User-friendly GUI or remote control via API.

► Smooth hardware setup, ready for multi-antenna or multi-receiver
Interfaces: 10 MHz Clock reference (IN & OUT), triggers, PPS IN & OUT.

► Extensive documentation, scenario library available & local support
User guides, ICD, Python script examples & .xls tools for data structure.

Extremely configurable for advanced simulations

► Rich multipath and terrain obscuration, with one click presets
Leverage our library of customizable models (urban, suburban, highway…).

► All standard ionospheric & tropospheric models, Advanced 3D space dedicated models
UNB, Klobuchar, Nequick, Customizable grid.

► On the fly scenario modifications & extensive simulation options
Easily test the effect of perturbations to signals in real-time.

► Leverage extensive testing reports in realtime as a source of truth data
Leverage 25+ environment variables and 20+ variables per satellite in view.

► Ready for jamming and spoofing tests
Simulate up to 20 sources of jamming or spoofing, with configurable waveforms and signals.

Built to evolve with your testing requirements

► Scalable SDR architecture allowing continuous enhancements
New signals and features remotely updatable by software licence.

► Designing a new LEO PNT signal, or a cis-lunar PNT constellation?
As demonstrated at ION GNSS+ '22 with LEO PNT, Constellator is adaptable.

SPACE & DEFENSE

AVIATION

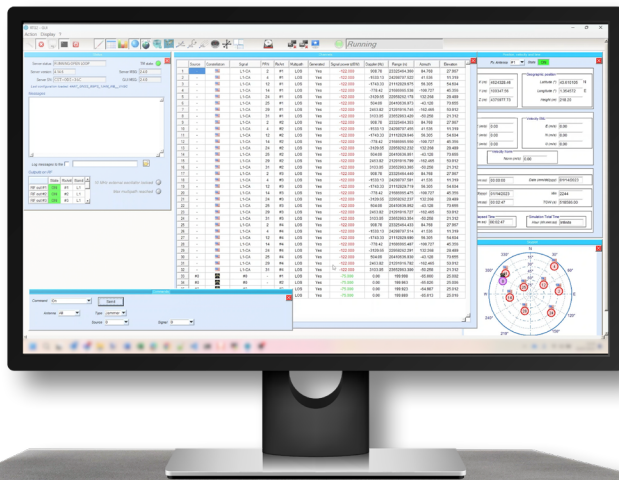**TELECOM & 5G**

AUTOMOTIVE

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A Comprehensive GNSS Simulation Solution

The Constellator family covers the full range of GNSS simulators tailored to address all use-cases. Available in three dedicated series, it can handle:

▶ **Constellator RF Series:** Conducted RF testing of single or multi-antenna receivers, including synchronized multiple receiver tests, from early R&D stages to Final Assembly Lines.

▶ **Constellator CRPA Series**: Specialized testing of CRPA receivers, with extreme phase synchronization and stability between RF outputs.

▶ **Constellator Anechoic Series**: Comprehensive testing in anechoic chambers for all types of GNSS devices.

SIMULATION

Constellations & Signals

GPS	L1C/A, L1C, L2C, L5, L1P(Y), L2P(Y)
Galileo	E1, E5a, E5b, E6HAS
GLONASS	L1OF, L1OC, L2OF, L2OC, L3OC
QZSS	L1C/A, L1C, L2C, L5, L62
NavIC (IRNSS)	L1, L5, S
BeiDou	B1I, B1C, B2a, B3I
SBAS	L1, L5 (EGNOS, WAAS, GAGAN, MSAS, SDCM, SNAS)
Specific signals	GPS L1P(Y) & L2P(Y), NavIC L5-RS & S-RS

Performance

Computation power	1 200+ (equiv. L1C/1A signals)
RF Channels	3 or 6
Simulation Iteration Rate	1 000 Hz
HWIL Input Rate	up to 10 000 Hz
Relativistic Effects	✓
Pseudorange Rate	+/- 0.001 m/s
Pseudorange Accuracy	+/- 0.001 m

SIMULATOR

Connectivity

RF Output Connector	3xSMA Mono-Band and 1xN Female Multi-Band or 6xSMA Mono-Band and 2xN Female Multi-Band
Int. 10 MHz Reference Output	BNC female
Ext. 10 MHz Reference Input	BNC female
External Trigger In/Out	BNC female, TTL Level, 5V DC, Configurable Timing & Pulse widths
PPS in, PPS out	BNC female, 1Hz rate, PPS-In 5 Volts, PPS-out 3.3 Volts, +/- 5 ns from RF output
GUI/Network Connector	RJ45 (1Gb/s)
Dedicated HWIL Connector	RJ45 (1 Gb/s)
PRN Link	RJ45 (10 Gb/s)

RF FRONT END

RF Output

Frequency Range	From 1 100 MHz to 1 700 MHz and from 2 450 to 2 550 MHz
RF Bandwidth	20 up to 25 MHz
RF Power (@50 Ohm)	From -55 to -120 dBm 0.1 dB resolution +/- 0.1 dB Power Accuracy
RF Signal Level (Jamming)	Up to +80 dB J/S with signal (S) reference power at -120 dBm
Output VSWR	< 1.3
Supported VSWR	∞ (permanent)

RF Quality

Harmonic Spurious	< -65 dBc min
Non-harmonic Spurious	< -55 dBc (SF dependent)
RMS Jitter	104 fs
Group Delay Variation	< 15ns @ BW = 55 MHz
Group Delay Stability	< 10ps/°C @ BW = 55 MHz
Phase Noise	$<5.10^{-3}$

Synthesizer - Internal 10 MHz Reference

Signal	Sinus
Stability	5.10^{-9} from +10°C to +40°C
Aging	0.5 ppb/day and 50 ppb/year the first year, then 10 ppb/year
Allan Variance (1s)	2×10^{-12}
Noise Floor Level	< -193 dBW.Hz^{-1}

Synthesizer - Internal 10 MHz Reference Output

Signal	Sinus
Impedance	50 Ohm
Level	6 dBm

	Standard Dynamics	Extended Dynamics
Altitude	No Limitation	No limitation
Acceleration	No limitation	No limitation
Velocity	< 600 m/s	No limitation
Jerk	No limitation	No limitation

HARDWARE

Input Voltage Range	100 to 240 V AC +/-10%
Input Frequency Range	50 to 60 Hz
Power Consumption	120 W
Operating Temp. Rang	0 °C to +50 °C
Storage Temp. Range	-20 °C to +70 °C
Relative Humidity (Operating/Storage/Transit)	10-93%, @ 40 °C, non condensing
Operating altitude	5000 m
Shock (according to EN 60068-2-27)	Operating: 15 G 11 ms duration Non-operating: 30 G 11 ms duration

Vibration (according to EN 60068-2-6)	Operating: 10-150 Hz: 1G/3 axis Non-operating: 10-150 Hz: 2G/3 axis
MTBF	> 50.000 hrs

2U	4U
430 x 88 x 510 mm 17 x 3.5 x 20 in	430 x 177 x 472 mm 17 x 7 x 18.5 in
12 kg / 26.5 lb	20 kg / 44 lb

Constellator™

RTGS4 - Configurations

Each configuration comes with 1 Multi RF output and 3 Mono RF outputs, simulating 80, 240, 600 and 1 200+ L1C/A equivalent signals.

More RF outputs can be added to RTGS4-14 and 24 units, up to 6 Mono RF and 2 Multi RF.

Base configurations

PRODUCTION	VALIDATION	HIGH-END R&D	
RTGS4-02	RTGS4-12	RTGS4-14	RTGS4-24
• Standard 2U unit	• Standard 2U unit	• Standard 4U unit	• Standard 4U unit
• 80 signals	• 240+ signals	• 600+ signals	• 1200+ signals
• Constellator Simulation Software	• Constellator Simulation Software	• Constellator Simulation Software	• Constellator Simulation Software
• 2 Constellations, 2 Bands	• (Signals & Bands to be added individually)	• (Signals & Bands to be added individually)	• (Signals & Bands to be added individually)

Constellator's singularity lies in the **Real-time tight coupling of SDR (Software Defined Radio) and state-of-the-art RF Analog front-end**. Top-end processing performance and superior RF quality are met into a COTS solution offering maximum flexibility in simulation control.

Options

Constellations	GPS, Galileo, GLONASS, QZSS, NavIC (IRNSS), BeiDou, SBAS systems
Frequency Bands	L1, L2, L5, L6, S
Specific Signals	GPS L1P, GPS L2P, NavIC L5-RS, NavIC S-RS
RTGS_Trajectory_Replay RTGS_Trajectory_Replay_High_Rate	Replay of user-defined trajectory, from file, up to 100 Hz / 10 000 Hz. Specific file format to configure a specific predefined user-defined trajectory. Conversion tool included.
RTGS_HIL RTGS_HIL_High_Rate	Live feed of user-defined trajectory and orientation, up to 100 Hz / 10 000 Hz. Allows full control of trajectory, in live, with zero-effective latency.
RTGS_Space	Allows altitude above 100 km. Includes interfaces to specify open loop orbital trajectories (Keplerian parameter or initial position & velocity). Trajectory propagation using 40th order gravitational model, atmospheric drag, lunar & solar gravitational perturbation, solar pressure. Space dedicated 3D extensions of all standard ionospheric models.
RTGS_Extended_Dynamics	Allows receiver trajectories with velocity above 600 m/s (requires Export Licence)
RTGS_Jamming	Up to 20 jammers with up to 10 signals each amongst: CW, Pulsed-CW, Spectrum-matching noise & Band-Limited Additional White Gaussian noise. Up to 80 dB J/S with shared RF Output. Up to 115 dB (resp. 130) with 40 dB C/N0 (resp. 25) on GNSS signal with specific RF Output.
RTGS_Spoofing	Up to 20 Spoofers with configurable source positions, spoofing positions, delay, RF power, list of signals, meaconing.
RTGS_Signal_Advanced_File RTGS_Signal_Advanced_Live	Interface to inject low level perturbations to signals (amplitude, delay, drift, phase offset), modelling advanced effects: all sorts of multipath, clock bias, drifts or noise, scintillation, radio occultation, and more. File: Effects are user-defined, and uploaded via a file in a specific format. Live: Effects can be injected in real-time by the user, during a simulation.
RTGS_PRN Link	Input card to inject spreading codes for encrypted signals (L1P(Y), L2P(Y), NavIC RS, or other signals on demand).

The future of navigation is software

Since 2015, Syntony has become a leader in the GNSS industry. Syntony offers unique location solutions allying Software-Defined Radio (SDR) and state-of-the-art RF Analog front-end.

Easy to setup and use, Syntony solutions are built to evolve with the market needs, and inherit from 20 years of R&D and collaboration with high-demanding industries and administrations.

For more information

Visit our website:
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Syntony Offices

TOULOUSE - PARIS - NEW YORK

Safety Certifications	Emissions
EN/IEC 61010-1:2010	EN 61326-1:2013
ROHS, 2011/65/EU	FCC Part 15 : 2016 – Verification
NRTL UL 62368-1	(Section 2.902 47 CFR)
CB IEC 62368-1	