GSG-WAVEFRONT

SOFTWARE-DEFINED GNSS CRPA ANTENNA SIMULATION

A Powerful and Field-Proven Platform

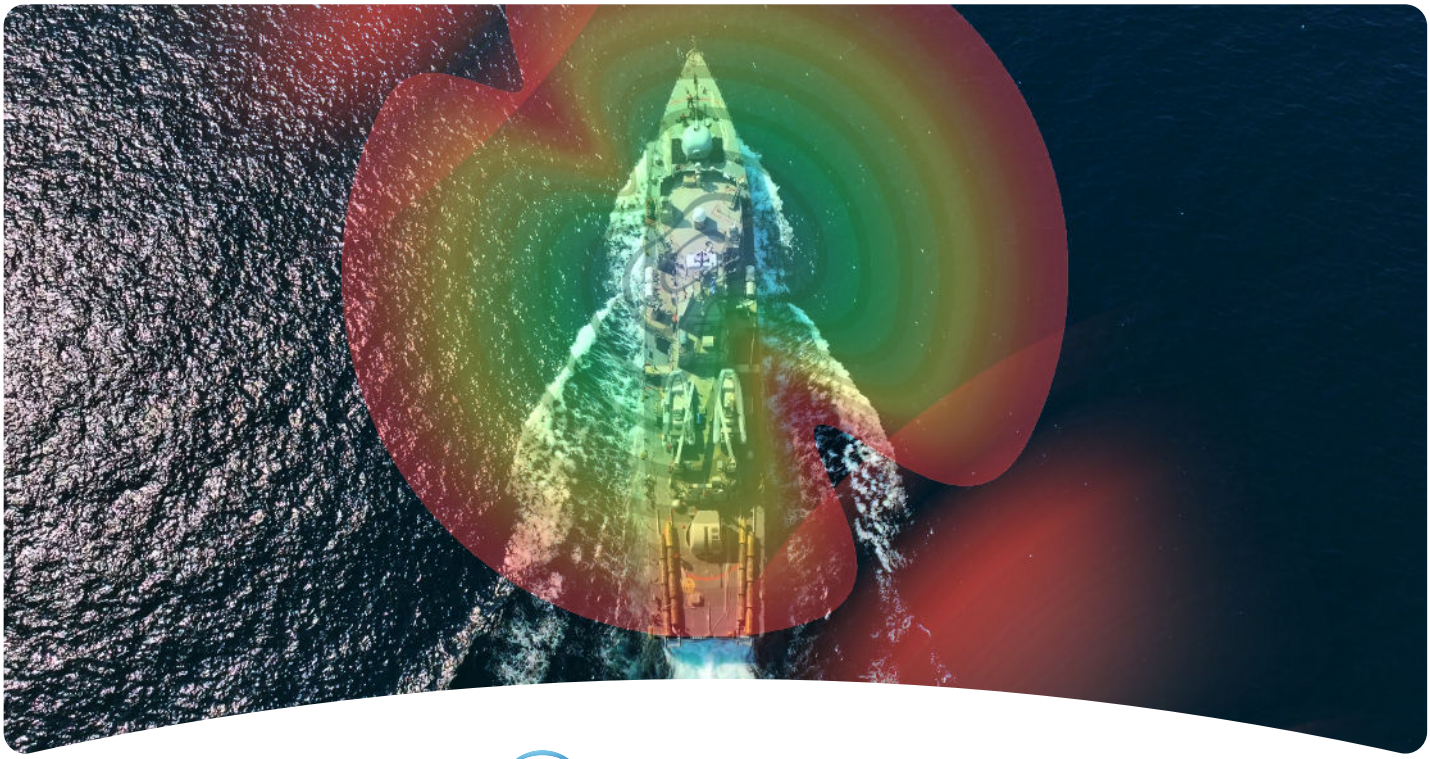
Protecting your GNSS systems from jamming and spoofing is more critical now than ever. This type of resilience is accomplished with an advanced GNSS Simulator capable of generating dedicated RF signals to test CRPA (Controlled Reception Pattern Antenna) architecture.

Leveraging its field-proven software-defined architecture, Safran has developed GSG-Wavefront, an affordable, “off-the-shelf”, and easy-to-use CRPA receiver testing platform.

What is a Wavefront simulator?

GSG-Wavefront simulators emulate and generate the GNSS and interference signals as outputs of the antennas elements.

The GSG-Wavefront approach is different from classical anechoic CRPA Tester systems: it simulates multi-element antennas by providing as many RF outputs as antenna elements – all phase-aligned, consistent and synchronized, to test the CRPA unit.



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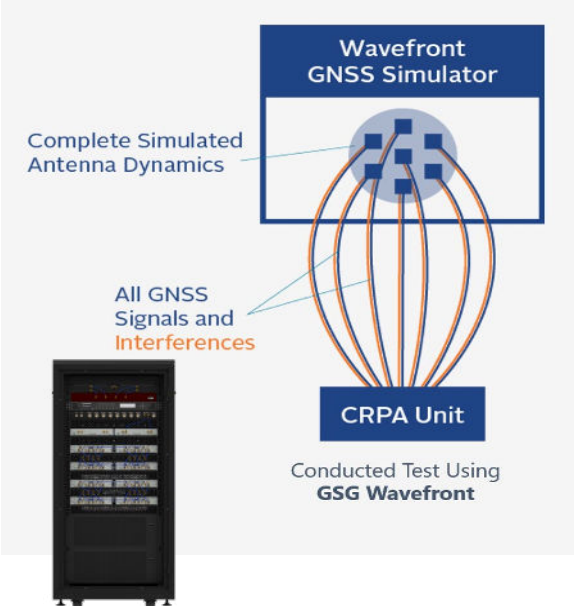


Safran GSG Wavefront GNSS simulator CRPA test scenario

GSG-Wavefront Features*

- Scalable antenna configuration, supporting 2 to 16 multi-frequency antenna elements.
- Up to 800 signals per element (accurate and complex use cases).
- Capable of supporting up to 4 GNSS bands simultaneously.
- All GNSS bands: L1, L2, L5, E6, S band.
- Interference: Jamming, spoofing, and meaconing.
- Simultaneously simulate multiple threats.
- High dynamics to adapt every type of vehicle.

High performances

- High phase alignment and stability (due to shared LO, RF chain quality and Safran timing server and distribution experience).
- High power accuracy and alignment
- Equipped with Safran's SecureSync 2400 time server.
- Automatic Phase Alignment

Modular

- Highly configurable product.
- Possibility to add elements / signals during the lifecycle.

Easy to use

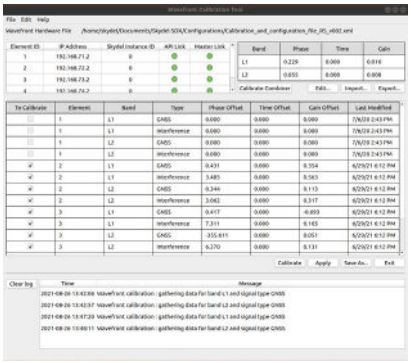
- Powered by user-friendly Skydel software simulation engine.
- On-site annual calibration by end-user.
- No specific calibration needed after power cycle.
- Quiet operation during simulation.
- Simulation from cold start time: <90 seconds.

Reduced form factor & price

- Single 24U unit rack for a typical system with up to 8 elements including interference generation.
- Leverages COTS hardware and Safran components.

Technical Specifications

RF Performance
Typical phase alignment bias : $<\pm 1^{0}$
Typical phase alignment deviation : 0.5^{0} (1σ)
Power accuracy on each element: ±0.5 dB
Power alignment between elements : ±0,5 dB
Signal purity • Spurious : - 65 dBc • Harmonics : - 80 dBc • Phase noise : < 0.002 rad (RMS)
Power management • GNSS power level range : -175dbm to -100dbm • Jamming default maximum power : -10dbm. Optional: separate GNSS and interference outputs and add extra amplifier on the interference RF chain. • Jamming to GNSS Signal ratio : up to + 130dB



GSG Wavefront includes a calibration tool as well as continuous monitoring capabilities.

*: Specific requirements are possible and available upon request, e.g.: five frequencies, additional signals, etc.

Scenarios
800 signals / element
1kHz iteration
Dynamics* • Maximum velocity : 1500 km/s • Acceleration : no limits • Jerk: no limits *This velocity requires the SKY-EXLI license in order to exceed 600 m/s
HIL latency under 10 ms
Multipaths

Signals
GPS open services: L1-C/A, L1C, L1-P, L2-P, L2C, L5;
GPS-AES restricted signals: M-code (L1, L2) ; Y-code (L1, L2) (on Broadsim hardware)
GLONASS: G1, G2
Galileo open services: E1, E5a, E5b, E5AltBOC, E6 HAS, OSNMA
Galileo restricted signals: PRS (E1, E6)
BeiDou: B1, B2, B1C, B2A, B3I
QZSS: L1-C/A, L2C, L5, L6
Navic : L1, L5, S-band
SBAS: WAAS, EGNOS, MSAS, GAGAN, SDCM
Xona : PULSAR XL
Custom Signals
IQ reader

Interferences
Integrated into the software (GUI and API) and hardware
Simultaneously simulate multiple threats with different positions and/or trajectories (Optional: customized number of jammers or spoofers)
Dynamic transmitters, user-defined waveforms
Jamming, spoofing, meaconing

Interfaces
One combined RF output / element (Customizable : N-type or SMA connectors)
Timing : • PPS out : BNC • PPN In : BNC • 10MHz out : BNC • 10MHz in : BNC • GPS connector for clock calibration
Interfaces for monitor, keyboard, USB, and ethernet. Option to include monitor and keyboard.

Timing Specifications

Internal Oscillator	LPN OCXO	LPN Rubidium (option)
Accuracy (average over 24 hours when GPS locked)	$3x10^{-12}$	$1x10^{-12}$
Medium Term Stability (without GPS after 2 weeks of GPS lock)	$2x10^{-10}$/day	$5x10^{-11}$/month ($3x10^{-11}$/month typ)
Short Term Stability (Allan Deviation)		
1 sec	$1x10^{-11}$	$1x10^{-11}$
10 sec	$9x10^{-12}$	$1x10^{-11}$
100 sec	$8x10^{-12}$	$5x10^{-12}$
Temperature Stability (peak-to-peak)	$2x10^{-9}$	$1x10^{-10}$
Phase Noise (dBc/Hz)		
@1 Hz	-100	-100
@10 Hz	-128	-128
@100 Hz	-148	-148
@1 KHz	-150	-150
@10 KHz	-150	-150
Signal Waveform & Levels: +13 dBm ±3 dB into 50 ohm, BNC		

1 PPS Timing Output	LPN OCXO	LPN Rubidium (option)
Accuracy to UTC (locked to GPS @ 1 sigma)	±50 ns	±50 ns
Holdover (constant temp after 2 weeks GPS lock)		
After 4 hours	12 µs	3 µs
After 24 hours	450 µs	100 µs
Signal Waveform & Levels: TTL (5 V_{P-P}), into 50 ohm, BNC		

Full timing specifications from Safran Securesync 2400 data-sheet.

Possibility to use and external clock, distribute the clock and PPS outside of the system and calibrateclock.

Common CRPA Simulator Challenges	With GSG Wavefront
• Calibration takes hours and is not automated. • Physically large and not scalable. • Custom one-off solutions. • Limited spoofing and repeating capabilities. • Limited number of signals. • Lack of phase synchronization monitoring during simulation.	• Automated calibration process takes minutes and is not required after each power cycle. • GSG Wavefront system simulates in less than 90 seconds from cold start. • Modular design: Safran can perform a quick on-site upgrade without changing entire rack. • A typical 8 element systems fits into a single 24U unit rack. • Jamming, spoofing, and meaconing: software-defined architecture allows the simulation of many offensive systems. • Ability to perform increased number of signals per element (more satellites simulated, ready for LEO PNT, ability to simulate complex use cases with multipaths, and more...). • Integrated phase continuous synchronization and monitoring graphs

Pictured top: 5-Element GSG Wavefront System.
Pictured Above: Wavefront Node, generates IQ data per each element.

Images shown in this document may differ from final product and are not considered binding.

Best in Class Support

All Safran systems are provided with an extendable one-year hardware warranty and an extendable one-year software support which includes:

- Expert training
- On-site installation
- Software updates
- Engineering support
- Email support
- Phone support
- Self-paced online certification course
- Access to User Forums: (https://learn.safran-navigation-timing.com/)

Resources

To learn more about Safran's CRPA-related products, here are some useful resources:

- Article: What is CRPA, and how to test it?
- White paper: Engineer's Guide to CRPA Testing

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