DATASHEET

SimXona

Certified Xona Pulsar demonstration & production signals simulator

spirent
Federal Systems

Spirent SimXona

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Purpose of this Document

This datasheet describes the functionality of Spirent SimXona and also provides technical data and configuration information.

Please speak to your Spirent Federal sales representative before ordering to ensure your specific needs are met.

Introduction

To develop robust positioning, navigation, and timing (PNT) systems, you need comprehensive, highly-sophisticated testing that encompasses all the positioning, navigation, and timing signals that your application requires. In addition to GNSS, complementary alternative navigation signals are increasingly used to ensure the operation of PNT systems in ever more challenging environments.

Spirent SimXona is a powerful and versatile test solution designed to generate Xona PULSAR LEO PNT demonstration and production signals using Spirent PNT simulators. SimXona is compatible with Spirent PNT X, Spirent's revolutionary positioning, navigation, and timing simulation system, as well as the Spirent GSS7000 and GSS9000 simulator platforms. Apart from generating RF signals, SimXona also enables users to produce I/Q files. For the GSS7000 and GSS9000 platforms, a standalone, coupled I/Q generator will generate SimXona I/Q files that can then be replayed in conjunction with GNSS. For the PNT X, the I/Q generator is fully built into the platform, eliminating the interim step of I/Q files being generated.

The content of the user-defined scenarios allows for worldwide coverage within bounded timespans leveraging satellite information available from Xona Space Systems. This testing capability makes SimXona an ideal solution for all applications where accurate and realistic evaluation of GNSS receivers' performance is required.

SimXona is able to support multiple operational configurations as defined by Xona Space Systems. These configurations are representative of distinct phases of Xona's LEO constellation development[1]:

- **Demo Signal - Alpha 0 Configuration** – a two-satellite configuration, matching Xona's Alpha Mission, 2022.
- **Demo Signal - Phase 1 Configuration** – a 32-satellite configuration, in projection of Xona's future Phase 1 orbital deployment, featuring 1-in-view continuous coverage.
- **Demo Signal - Phase 3 Configuration** – a 258-satellite configuration, in projection of Xona's future Phase 3 orbital deployment, featuring at least 4-in-view continuous coverage.
- **Production Signal** – 258 satellite configuration

This enables users to test the benefits of constellation across its different deployment stages ahead of time. Concurrent operation of demo and production signals is not generally foreseen but can be enabled. Please contact your Spirent Federal sales representative.

Spirent Federal recommends that you discuss your current and future needs with your local sales representative. Spirent Federal will provide specific configuration and pricing information to meet your needs.

[1] Xona Space Systems 2023, *Addendum for Specification of Simulator Parameters 1.0*, San Mateo, CA, USA.

SimXona System Overview

This section describes the differences in the SimXona solution for GSS9000/GSS7000 and PNT X users. In all cases, different licenses for XL, X1, or X5 apply.

SimXona for GSS7000 & GSS9000 Users

For GSS7000/GSS9000 users, the SimXona solution consists of two key components:

1. the **SimXona I/Q generator**, which is responsible for generating all of the necessary baseband I/Q files required for the simulation process, and
2. the **SimXona signal generator**, which has the capability to seamlessly replay the I/Q files containing the alternative navigation signals. Xona PULSAR demonstration and production signals can also be generated in conjunction and aligned with all other GNSS signals present within the simulation environment[2].

The SimXona I/Q generator allows users to define their own Xona scenarios within certain time boundaries and generate the corresponding I/Q files. These scenarios can involve static or moving vehicles, providing users with extensive testing capabilities. The SimXona I/Q generator can be accessed from the host controller of the Spirent PNT simulation platform it is integrated with (either the SimXona signal generator or an existing Spirent GNSS simulator). Users can upload Spirent SimGEN® scenarios to the SimXona I/Q generator to generate the corresponding I/Q files for the required Xona PULSAR signals. To deliver RF signals, these I/Q files are transferred to the corresponding Spirent PNT simulation platform.

The SimXona signal generator converts Xona I/Q files into RF, generating the corresponding signals during simulation. This solution is compatible with existing Spirent GSS7000 and GSS9000 GNSS simulators[3]. An optional SimXona signal generator is available for generating the Xona PULSAR signals on a separate chassis. Both options can run the simulation alongside all other GNSS signals present in the scenario.

Figure 1 depicts a GSS9000-based system configuration featuring a SimXona I/Q generator and a SimXona signal generator. This setup allows users to create Xona scenarios utilizing the C50r controller and schedule I/Q-generation tasks through a Spirent SimGEN instance running on the main C50r controller. During simulation execution, the GSS9000 system provides GNSS RF inputs, which may include interference and spoofing signals, to the system under test (SUT)[4]. The SimXona signal generator provides the RF input to the SUT separately from the GNSS RF, thereby facilitating comprehensive testing capabilities for evaluating the performance of Xona-enabled receivers[5].

[2] Due to the inherent difference in power level between standard GNSS and Xona PULSAR signals, a different RF output is required for each solution. This can be achieved by using the SimXona signal generator or upgrading to a 2RF system for your existing GNSS simulator.
[3] Contact your Spirent Federal sales representative for further information.
[4] Dependent on base system capability
[5] If a combiner is required to have the signals on the same SUT input, please contact your Spirent Federal representative to discuss your requirements.

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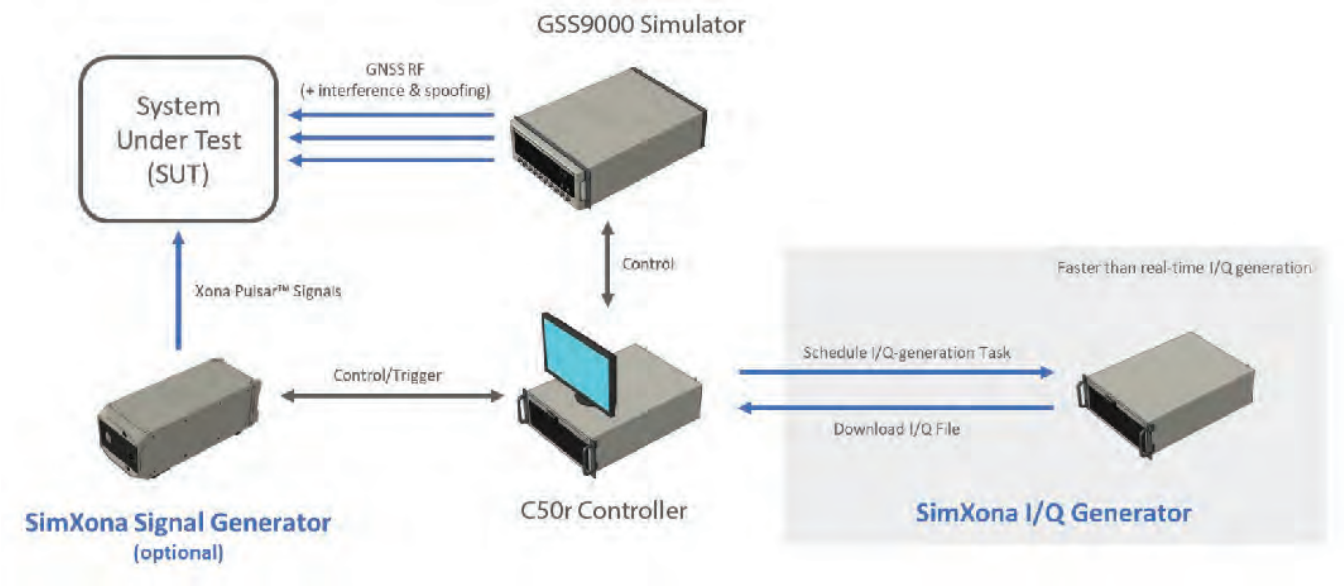

Figure 1: SimXona I/Q generator illustrative setup together with a GSS9000-based system and a SimXona signal generator

Upgrade Your Existing GNSS Simulator with SimXona Signal Generation

It is possible to upgrade your existing Spirent GSS7000 or GSS9000 to incorporate RF generation of Xona signals from I/Q files. This upgrade enables your GNSS simulator to function as a SimXona signal generator, producing both GNSS and Xona PULSAR signals concurrently. For production signals, it is important to note that a 2RF system is necessary to account for the power level difference between the signals. The first port is designated for GNSS signal output, while the second port is designated for Xona PULSAR signal output. For the demo signals, a 1RF system suffices. All SimXona signal generation solutions require an additional channel bank to generate RF.

SimXona for PNT X Users

For PNT X systems, the I/Q generator functionality is fully built into the C50 X, and therefore it is possible to follow the workflow described in the previous GSS7000/GSS9000 section by using the “GPU only” hardware configuration or even directly streaming SimXona signals to the RF outputs of the PNT X by using the combined hardware configuration. The usage of a GPU for the SimXona I/Q generation is part of Spirent’s paradigm of “using the right technology for the right application.” The entire RF chain remains centered on purpose-designed, high-performance, FPGA-based software-defined radios (SDRs).

This new functionality allows scenarios to run in real time together with standard GNSS and further PNT X functionalities. No additional separate chassis is required to add SimXona on PNT X. Depending on baseline PNT X system functionalities, SimXona is either a pure software-only upgrade or requires the in-field upgrade of a further GPU into the C50 X.

The PULSAR RF output will be delivered combined with GNSS RF[6]. Unless specified differently, the radio cards generating PULSAR production signals will be mounted on up to two slots of the PNT X 8/2 split configuration (see MS10000) with an appropriately attenuated loopback cable merging the PULSAR signals into the primary GNSS RF path which then delivers GNSS and PULSAR signals at the appropriate ICD specified power levels. The dynamic range available for the PULSAR production signals is +20dB/-30dB relative to the ICD nominal values. For the demo signals, a loopback cable or 8/2 split is not used. The dynamic range available for the XL signals is +0dB/-40dB relative to the ICD nominal values.

[6] Can be delivered separately. Please contact your Spirent Federal representative if this is a requirement.

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Software Control

SimXona features and capabilities are controlled by Spirent's SimGEN, the world's leading GNSS simulation software for test scenario definition, execution, data management, and GNSS RF constellation simulator command and control. With the fullest capability, features, and performance continuously developed in close consultation with GNSS system authorities over the last 35 years, SimGEN supports all the GNSS test parameters and control capabilities needed for comprehensive GNSS testing for research, development, and design of GNSS systems, services, and devices across any application.

Figure 2: Spirent's SimGEN

Spirent has recently introduced new features to its SimGEN platform for SimXona users. These added functionalities provide users with the ability to access and manage the I/Q-generation service, which operates on either the SimXona I/Q generator or the C50 X. Users can easily upload scenario settings and schedule I/Q-generation tasks to generate the corresponding I/Q signals as well as set up the real-time RF generation, if applicable. Additionally, users can download the files from completed tasks.

I/Q-Generation Tasks and Scenario Generation

Spirent's SimGEN and SimXona empower users to customize their own PNT scenarios, including editing the Xona constellation properties. The satellite orbits are defined using predefined SP3 files provided by Xona, which correspond to specific times (for further details, please refer to Table 2). Both static and moving vehicles are supported with SimXona.

In addition, our sophisticated I/Q-generation task scheduler allows for multiple tasks to be defined and queued up simultaneously. The simulation iteration rate for each task can also be specified, similar to Spirent's SimGEN scenarios. An overview of all tasks, including their status and progress, is readily available to the logged-in user via the monitoring window. This feature also enables users to delete tasks and download I/Q data from completed tasks.

Detailed Performance Specification

Xona I/Q Files / Scenarios

The I/Q files generated are accompanied with a metadata file in the ION SDR metadata format[7]. These metadata files specify center frequency, bit depth, and sample rate. The ION SDR metadata format ensures compatibility with the replay capabilities on the Spirent PNT simulation platform. The supported data formats are listed in Table 1.

Table 1: Supported I/Q file formats

Parameter	Supported Values
Center Frequency	Xona L-band demonstration signal (XL) or production signal X1 and X5
Bit depth	16
I/Q sample rate	30, 60 MHz

The validity of the scenarios is limited by the orbits of the Xona satellites defined in the SP3 files available from Xona Space Systems. The start time of the scenario set, together with the associated limitations, is shown on Table 2. Other scenario sets may be developed in the future.

Table 2: Time boundaries for SimXona scenarios

Description	Start Time [YYYY-MM-DD HH:MM:SS]	Scenario Validity[8]
Scenario Set 1	2022-02-02 00:00:00	24 hours
Scenario Set 2	2023-08-01 00:00:00	24 hours

For each of the scenario sets included, SimXona can generate satellite data (according to the supported ICD specified in ICD Compliance) for the main operational configurations.

[7] See reference: ION SDR Metadata format
[8] I/Q storage supplied limits total scenario duration. Please contact your Spirent Federal representative if support for longer scenarios is required.

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SimXona I/Q Generator Specification – Only for GSS7000/GSS9000 Extensions

Table 3: SimXona I/Q Generator Connectivity

Port	Type	Parameter
USB	I/O	Mouse, keyboard and general file access (2 accessed from front + 2 on rear panel)
VGA	I/O	
Ethernet	I/O	RJ-45 Ethernet interface standard. Used for general network access

Table 4: Physical and Environmental Properties

Part	Parameter	Value
SimXona I/Q Generator	Height	4U 177.8mm / 7”
	Width	426.0mm/16.77” without rack mount installed (fits standard 19” IT rack) 482.0mm/18.98” with rack mount installed
	Depth	600.6mm/23.65” (not including front handles and front bezel door closed)
	Typical Weight	Weight (excluding peripherals) <20kg (44lb)
	Operating Environment	+10 to +40°C (50 to 104°F) (40-90% RH, non-condensing) Altitude restriction of 2000m
	Storage Environment	-40 to +60°C (-90 to 140°F) (20-90% RH, non-condensing)
	Electrical Power	100-240V 15-7 A MAX 50 to 60Hz

Note(s): Physical and environmental properties such as the operating and storage environments apply to the SimXona I/Q generator only. Associated equipment or other Spirent-supplied equipment may not extend to these environmental limits. Optionally, the chassis can be mounted in an equipment rack, details available upon request.

SimXona Signal Generator Specification – Only for GSS7000/GSS9000 Extensions (Optional)

The performance characteristics of the SimXona signal generator are significantly influenced by the I/Q files used for signal generation. Notwithstanding the replayed I/Q files, the SimXona signal generator possesses the following general characteristics. For production signal customers, the signal generator will feature two radio cards. For demo signal customers, there will be only one radio card.

Table 5: Performance Level for the SimXona Signal Generator

Parameter	Description	Units	Notes
RF Signal Level	Nominal RF Power Level XL	As per ICD	9
	Nominal RF Power Level X1	As per ICD	8
	Nominal RF Power Level X5	As per ICD	8
	Carrier Level Control Maximum	0 dB for XL 15 dB for X1 X5	
	Minimum	-40 dB for XL -30 dB for X1 X5	10
	Resolution	0.1 dB	
	Linearity 0 dB to -30 dB	<0.10 dB	
	-30.1 dB to -40 dB	<0.20 dB	
	Absolute Accuracy	±0.5 dB	11
	Run to Run Repeatability	±0.1 dB	
Signal Stability	Internal 10.00MHz OCX Oscillator (after warm up)	$\pm 5 \times 10^{-10}$ per day	

[9] Absolute RF signal power level on the SimXona signal generator is dependent on the power level specified in the I/Q files. The nominal power level for the I/Q files provided with the system is set as per the specified RF signal level.

[10] The control range extends to -99 dB, but performance is unspecified below -30/40dB.

[11] At 21°C ±5°C, 0 to -30dB. ±1.5dB 3-sigma all conditions.

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Table 6: Signal Generator Connectivity

Port	Type	Parameter
Main RF Port	Output	N-type coax female, 50 Ohm, VSWR <1.2:1 AC coupled ±50 V DC, maximum reverse RF 30 dBm
High Level RF Port, Nominal port for Xona Replay	Output	N-type coax female, 50 Ohm, VSWR <1.2:1 AC coupled ±50 V DC, maximum reverse RF 30 dBm
Auxiliary RF	Input	N-type coax female, 50 Ohm, VSWR <1.4:1 0.5 to 2 GHz, Insertion Loss 14.5 dB typical
External Frequency Standard	Input	BNC coax socket, 50 Ohm -5 to +10 dBm at 1 MHz, 5 MHz, 10 MHz
Internal Frequency Standard	Output	BNC coax socket, 50 Ohm 10.00 MHz at +5 dBm nominal
1PPS IN	Input	BNC coax socket, 50 ohm, TTL level compatible
1PPS OUT	Output	BNC coax socket, 50 Ohm, TTL level compatible
Trigger IN	Input	BNC coax socket, 50 ohm, TTL level compatible

Table 7: Optional Monitor

Type	Type	Manufacturer
P2217H	22-inch	Dell

Table 8: Internal Controller Connectivity

Interface	Type	Parameter
USB (x4)	I/O	Mouse, keyboard, and general file access (2 accessed from front + 2 on rear panel)
Ethernet (x2)	I/O	RJ-45 Ethernet interface standard. Used for general network access and available for remote control
DVI	I/O	Video monitor port

Table 9: Physical and Environmental Properties

Part	Parameter	Value
Signal Generator	Approximate Dimensions (H x W x D) (9.25” x 4U chassis)	176.95mm x 235.2mm x 555mm 6.96” x 9.25” x 21.85”
	Typical Weight	<15kg (33lb)
	Operating Environment	0 to +50°C (32 to 122°F) (40-90% RH, non-condensing) Altitude restriction of 2000m
	Storage Environment	-40 to +60°C (-40 to 140°F) (20-90% RH, non-condensing)
	Electrical Power	100-240V 5A Max 50 to 60Hz

Note(s): Physical and environmental properties such as the operating and storage environments apply to the SimXona signal generator only. Associated equipment such as the monitor, keyboard, and mouse or other Spirent-supplied equipment may not extend to these environmental limits. Optionally, the chassis can be mounted in an equipment rack, details available upon request.

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Table 10: Safety and EMC Compliance

Compliance	Applicable Standard
Safety	Low Voltage Directive (LVD) 2014/35/EU IEC 60950-1:2005 (Second Edition) + Am 1:2009 + Am 2:2013 Information technology equipment. Safety. General requirements
EMC	EMC Directive 2014/30/EU EN 61326-1:2013 Electrical equipment for measurement, control and laboratory use. EMC requirements. General requirements

Calibration Requirements

The digital architecture of the signal generator requires only limited annual calibration, for which a detailed procedure is provided.

The SimXona signal generator is calibrated at the time of purchase. This calibration comes with a default 12-month calibration period.

For more information on Spirent's SimXona signal generator calibration service, please contact your Spirent Federal representative.

ICD Compliance

Table 11: SimXona ICD Compliance

Variant	Name	Version	Notes
Demo Signal	DD-PULS-ICD01-Xona-Navigation-Signal-ICD	v1.3.0	Encryption and authentication are not supported. Navigation data from file as per Table 2 Including the Addendum for Specification of Simulator Parameters v1.0
Production Signal	Xona PULSAR Navigation Signal Interface Control Document	V0.5.0	Nav data delivered by Xona from file as per Table 2.

Related Brochures, Data Sheets and Specifications

Table 12: Related Product References

Related Product	Description	Data Sheet / Specification
SimGEN	GNSS Software Suite	MS3008
SimREMOTE	Simulator Remote Control Additional Options	MS3015
SimIQ	Software-In-the-Loop and I/Q File Replay Solution	MS3108
PNT X	PNT X Simulator	MS10000
GSS7000	GSS7000 Constellation Simulator	MS7000
GSS9000	GSS9000 Constellation Simulator	MS9000

Glossary of Terms

1PPS	One pulse per second
EMC	Electromagnetic compatibility
GPS	Global positioning system US GNSS system
GNSS	Global navigation satellite system
GUI	Graphical user interface
ICD	Interface control document
LEO	Low Earth orbit
RF	Radio frequency
SUT	System under yest

Environmental Social & Governance (ESG)

Spirent's Positioning Technology Business Unit has been committed to ESG good practice and improvement since achieving ISO14001:2015 Environmental Managemental System certification in 2004.

We take ESG seriously across all aspects of our business from sustainable buildings, sustainable product design to sustainable supply chain, manufacturing, and shipping/exports.

Our approach is to follow a Continual Improvement process in respect of ESG.

Many of Spirent's Test Solutions rely on physical test equipment used in situ by our customers. We are working to reduce the lifecycle impacts of our products and the environments they are used in through a range of ways:

- Designing for environment and end of life, including compliance with all legal requirements;
- Reducing the size, weight, noise, and power use of our products;
- Virtualization and the development of Test-as-a-Service via PNT Professional Services;
- Improving utilization and automation; and
- In-field servicing and upgrades.

We use formal sustainability metrics in the product development process.

For more specific information on how ESG applies to our PNT Test Solutions, please contact your Spirent Federal representative.

For more information visit, https://corporate.spirent.com/sustainability.

For More Information

For more information on any aspect of SimXona, please contact Spirent Federal directly.

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Why Spirent?

Across five decades Spirent has brought unrivaled power, control, and precision to positioning, navigation, and timing (PNT) simulation. Spirent partners with the leading developers and integrators to consult and deliver on innovative solutions, using the highest-quality hardware and the most flexible and intuitive software on the market.

Spirent delivers

- Simplified testing accelerates the innovation cycle and deployment of robust PNT systems
- Proven track record of being first to market with new signals and ICDs
- Unrivaled investment in customer-focused R&D
- World-leading expertise, redefining industry expectations
- Powerful, flexible, and customizable SDR technology for future-proofed test capabilities
- Signals built from first principles — giving reliable and precise truth data

About Spirent Positioning Technology

Spirent enables innovation and development in the GNSS and additional PNT technologies that are increasingly influencing our lives. Our clients promise superior performance to their customers. By providing comprehensive and tailored test and assurance solutions, Spirent assures that our clients fulfill that promise.

About Spirent Federal Systems

Spirent Federal Systems provides the world's leading PNT test solutions to the US Government and contractors to enable resilient PNT under any conditions and outpace evolving navigation warfare threats. As a US proxy company, Spirent Federal enhances Spirent's commercial offerings with classified and other sensitive military signal emulation capabilities.