Ospirent™
Federal Systems

SimIQ Datasheet

Software-In-the-Loop and I/Q File
Replay Solution

Spirent SimIQ Datasheet

Purpose of this Document

This datasheet describes the functionality of Spirent SimIQ, a software solution that will capture and/or replay I/Q data files using Spirent GSS7000 and Spirent GSS9000 GNSS simulators.

This datasheet also provides technical product specification data and configuration information. Please speak to your Spirent sales representative to discuss your requirements.

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Glossary

AGC	Automatic Gain Control
ASIC	Application-Specific Integrated Circuit
COTS	Commercial Off-The-Self
DMA	Direct Memory Access
DUT	Device Under Test
FPGA	Field Programmable Gate Arrays
GA	General Availability
GNSS	Global Navigation Satellite Systems
HW	Hardware
Hz	Hertz
IF	Intermediate Frequency
ION	Institute Of Navigation
I/Q	In-phase and Quadrature
MB	MegaByte
MHz	MegaHertz
MIL	Model-In-the-Loop
OS	Operating System
PCIe	Peripheral Component Interconnect express
PosApp	Positioning Application
RAID	Redundant Array of Independent Disks
RF	Radio-Frequency
SIL	Software-In-the-Loop
SIR	Simulation Iteration Rate
SSD	Solid-State Drive
TB	TeraByte
USB	Universal Serial Bus

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Definitions

Capture

Licensable SimIQ mode of operation in which I/Q data is generated by a designated radio card and stored in a user specified file (DMA'ed over PCIe), at a given bit-depth and sample rate on the host PC. In this mode of operation, no RF is generated.

Replay

Licensable SimIQ mode of operation in which an I/Q data file generated by the user (external to our system), with a user specified bit-depth and sample rate residing on the host PC is streamed to a designated radio card (DMA's over PCIe). The I/Q data from the file can also be mixed with I/Q data generated natively by Spirent's simulator hardware for upconversion to RF.

Introduction

SimIQ is a software feature available on Spirent GNSS simulators, GSS7000 and GSS9000, which enables the capture and replay of I/Q data files. SimIQ has 3 variants: **SimIQ Capture**, **SimIQ Replay** and **SimIQ Replay Interference,** each of them enabled by their respective license keys.

SimIQ Capture allows the recording of I/Q data into a file stored in the host PC. RF is disabled during the simulation and, instead, the generated I/Q data by the signal generators is saved as a binary file into an internal or external SSD (see Figure 1). In this mode of operation, the user can create and run scenarios with the different constellations and frequencies specified in the SimIQ license feature, regardless of the RF licencing.
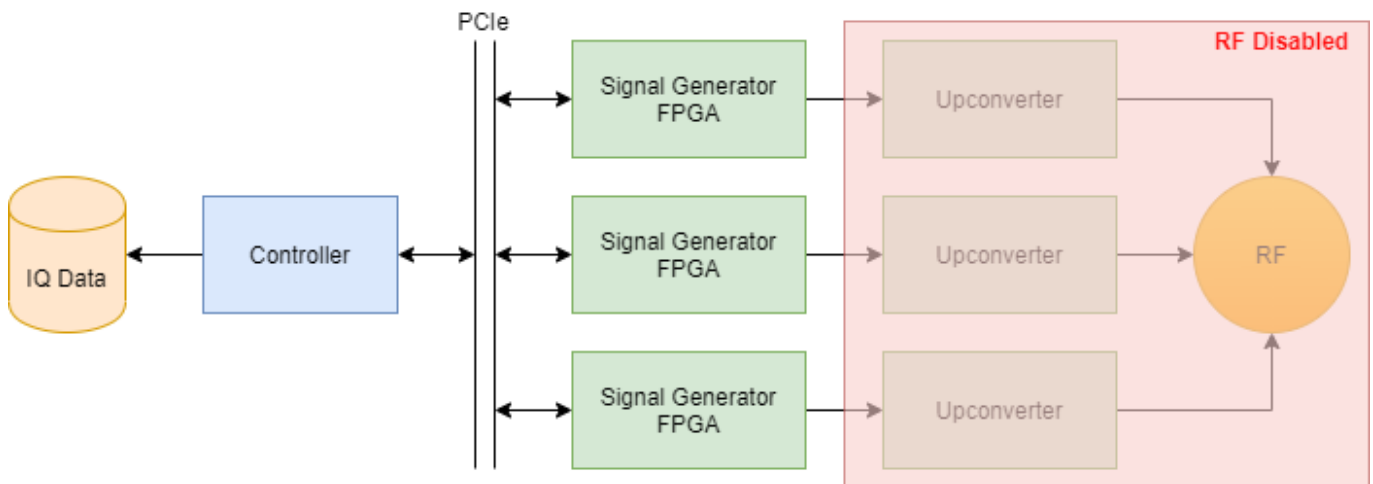
Figure 1: SimIQ Capture – Overview

SimIQ Replay allows customers to read I/Q data from a file stored in the host PC and generate the corresponding RF at GNSS nominal power levels. In this mode of operation, **SimGEN** streams I/Q data from the SSD controllers to the signal generators over the PCIe bus. The streamed I/Q data is mixed with all the other standard **SimGEN** scenario signals generated by the FPGAs (see Figure 2).
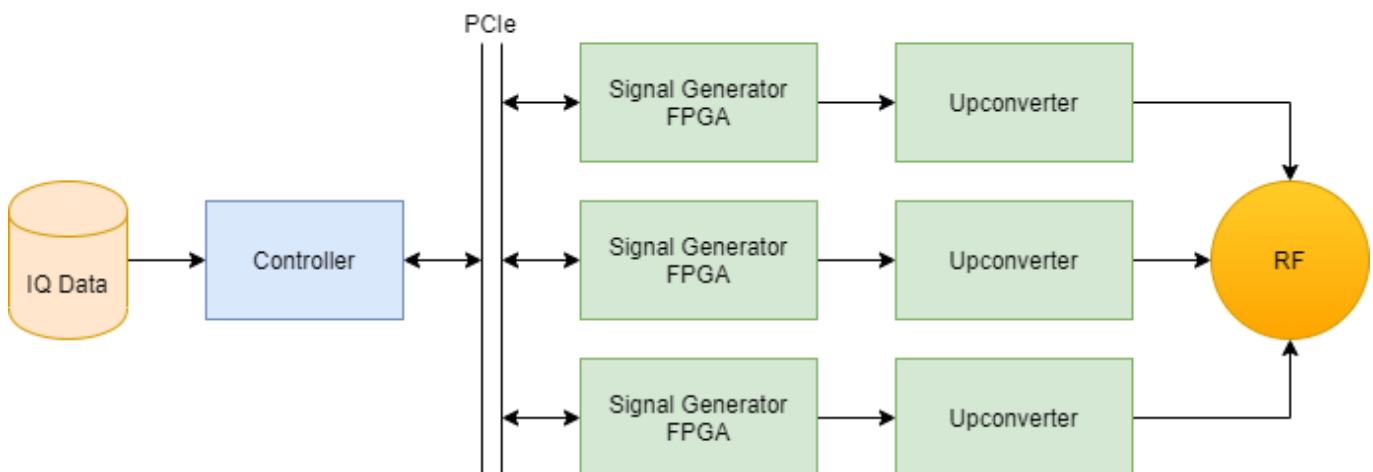
Figure 2: SimIQ Replay - Overview

SimIQ Replay Interference makes use of the 2RF chassis with interference capabilities (available on the GSS7000 and GSS9000 platforms), to generate high power interference signals from I/Q data files alongside other standard **SimGEN** scenario signals generated by the FPGAs (see Figure 3).

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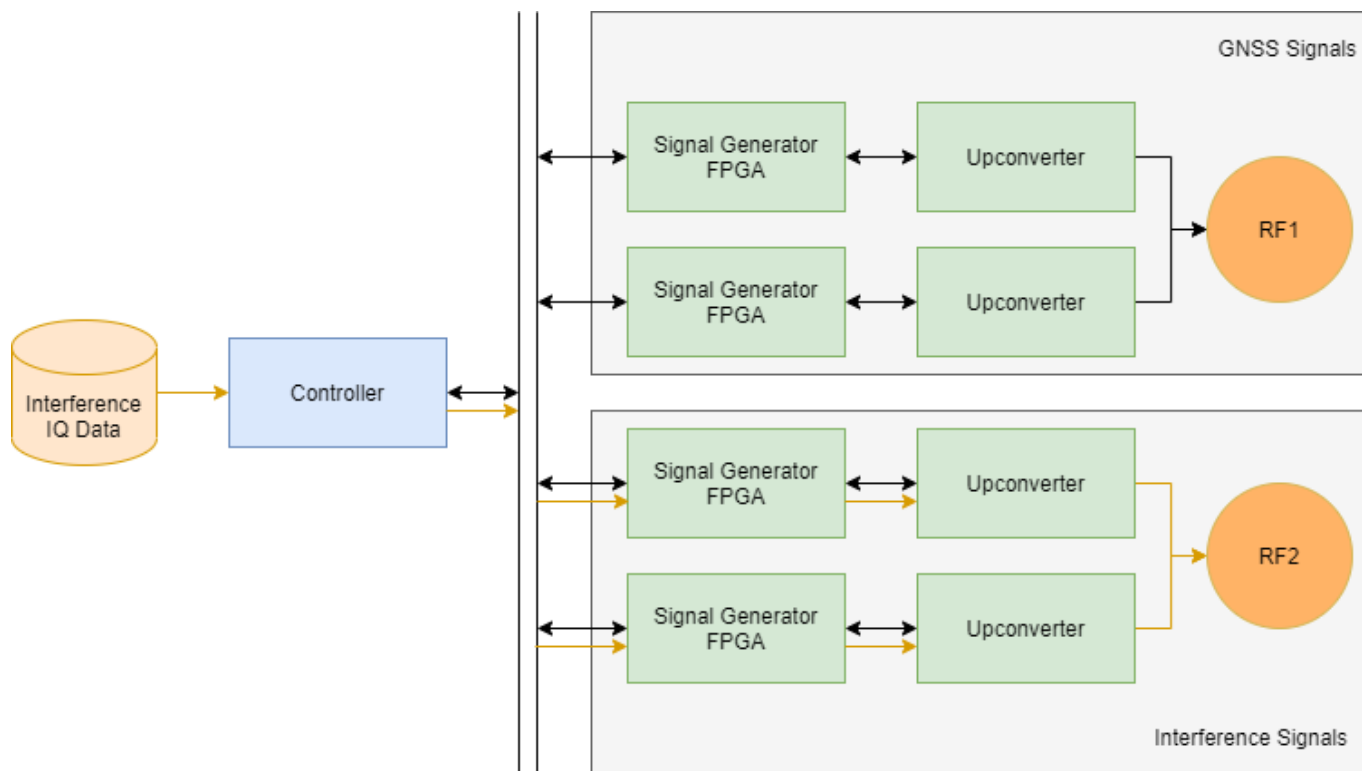
Figure 3: SimIQ Replay Interference – Overview

As **SimIQ Capture** does not generate RF, these modes of operation are mutually exclusive (see Table 1). However, all features (i.e., **SimIQ Capture**, **SimIQ Replay** and **SimIQ Replay Interference**) can be licenced together under the same **SimGEN** or **SimREPLAY+** license.

Table 1: SimIQ Runtime Compatibility

SimIQ Runtime Compatibility	SimIQ Capture (e.g. GPS L1)	SimIQ Replay (e.g. GPS L1)	SimIQ Replay Interference (e.g. GPS L1)	Standard GNSS RF Generation
SimIQ Capture (e.g. GPS L2)	✓	✗	✗	✗
SimIQ Replay (e.g. GPS L2)	✗	✓	✓	✓
SimIQ Replay Interference (e.g. GPS L2)	✗	✓	✓	✓
Standard GNSS RF Generation	✗	✓	✓	✓

Features and Benefits

SimIQ Capture

Spirent GNSS simulators can now generate I/Q files with **SimIQ Capture** containing all the GNSS signal data required to test the algorithms, conformance, and performance of software receivers. This allows Spirent to support its customers with their testing needs across the whole product development cycle, including MIL, SIL, HIL and VIL testing.

Validation of receiver algorithms (MIL)

As GNSS receivers become more complex early testing is essential to avoid expensive errors and delays, being able to identify inaccuracies or issues in their receiver models prior to ASIC design and hardware implementation may help reduce development cost and potential delays. **SimIQ Capture** helps developers and testers to validate their models and software before hardware is involved, with the same realistic scenarios that they use to validate their hardware receivers in a later stage of their design cycle.

Testing GNSS software receivers (SIL)

Certain applications, such as autonomous vehicles, require an extensive amount of testing to ensure the robustness and reliability of the proposed solution. To optimize their time for testing and ensure a timely release in the market, developers are including virtual testing into their product roadmap. Some of them are keen to reduce the amount of hardware required for their virtual tests using software models instead. **SimIQ Capture** enables the possibility to test GNSS software receivers by injecting the generated I/Q data, removing RF real-time constraints while allowing massive parallel simulation.

SimIQ Replay

Spirent GNSS simulators can now generate RF from I/Q files using **SimIQ Replay**. The flexibility and reliability of the hardware enables the generation of RF signals from I/Q files while maintaining the fidelity and quality of the solution, thanks to Spirent's unrivaled signal generation architecture.

Injection of externals signals

SimIQ Replay can generate any RF signals given a center-frequency (L1, L2, L5 or L6) and bandwidth within spec. This enables our customers to not only generate the well-known GNSS signals, but also custom waveforms, custom noise, or even interference and jamming events. In addition to the replay of the I/Q files, users can still generate, simultaneously, GNSS signals as usual with Spirent GSS7000 and GSS9000.

Compatibility with Spirent GSS6450

I/Q files are compliant with the ION metadata standard and are compatible among Spirent GNSS products. Files recorded with Spirent GSS6450 Record & Playback system can be used to generate RF using our GSS7000 and GSS9000, and vice versa.[1]

SimIQ Replay Interference

SimIQ Replay Interference has been specifically designed to offer interference testing capabilities on Spirent's GSS7000 and GSS9000 using I/Q files. This solution allows the generation of high power interference alongside standard **SimGEN** GNSS signals using the 2RF interference-capable chassis architecture of Spirent's signal generators.

High power, high realism

SimIQ Replay Interference allows the definition of transmitter objects within **SimGEN** that can generate interference signals from I/Q files. Transmitters can have an absolute or relative position to the vehicle under test, applying in both cases the corresponding attenuation power levels to the signals contained in the I/Q file based on the distance travelled from the transmitter to the antenna. Moreover, a I/Q file can be looped to fit scenario duration or a list of I/Q files can used – either in a predefined order or randomized.

Subscription Model

SimIQ introduces a new and flexible subscription model[2] for **SimIQ Capture** and **SimIQ Replay**.

SimIQ Capture customers can generate I/Q files from all available constellations and frequencies with the corresponding license (see Table 2) over the subscribed period of time.

SimIQ Replay customers only need to purchase a license to replay I/Q data from any frequency available (i.e. L1, L2, L5 and L6) with their system. This license enables the replay of a single I/Q file with a compatible I/Q radio card. To simultaneously replay several I/Q files, customers can subscribe to up to 3 **SimIQ Replay** licences per system depending on hardware compatibility.

SimIQ Replay Interference is only available through perpetual licensing. Up to 3 **SimIQ Replay Interference** licences can be licensed per system, depending on hardware compatibility, to generate RF from their owned frequency interference feature keys.

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[1] Support for Spirent GSS6450 is available for 4 and 8 bits, and 30.69 and 51.15 MHz of bandwidth.
[2] Perpetual licenses also available for all SimIQ features.

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SimIQ Contents

Table 2: SimIQ Capture – Licensable Constellations and Frequency

Constellation	Frequency	SimGEN Version Supported
GPS	GPS L1	
	GPS L2	
	GPS L5	
GALILEO	GAL E1	
	GAL E5	
	GAL E6	
GLONASS	GLO L1	
	GLO L2	
	GLO CDMA L1	
	GLO CDMA L2	
	GLO CDMA L3	
BEIDOU	BD B1I	SimTEST, SimREPLAY+, SimGEN
	BD B1C	
	BD B2I	
	BD B2A	
	BD B2B	
	BD B3I	
SBAS	SBAS L1	
	SBAS L5	
QZSS	QZSS L1	
	QZSS L2	
	QZSS L5	
	QZSS L6	
IRNSS	IRNSS L5	

Table 3: SimIQ Replay – License Contents

Description	Content	SimGEN Version Supported
SimIQ Replay	Software license that enables the generation of RF from I/Q files that contain L-band custom waveforms that meet users' sample rate and bit-depth requirements.	SimGEN, SimREPLAY+

Table 4: SimIQ Replay Interference – Licensable Contents

Description	Content	SimGEN Version Supported
SimIQ Replay Interference	Software license that enables the generation of RF from I/Q files that contain L-band custom interference waveforms that meet users' sample rate and bit-depth requirements.	SimGEN, SimREPLAY+

Operation

SimIQ Capture, **SimIQ Replay** and **SimIQ Replay Interference** features are editable from SimGEN's scenario tree (see Figure 4). From the scenario tree, the user can enable the modes by selecting an I/Q file and ticking the corresponding box.
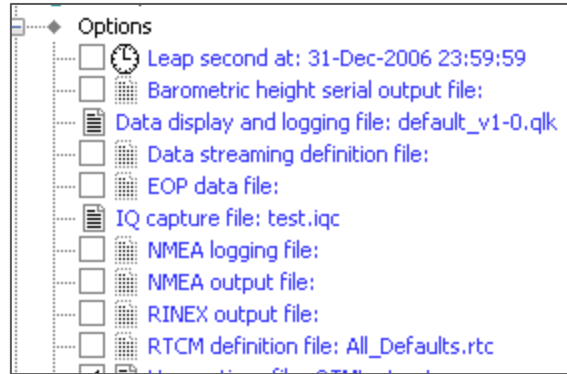
Figure 4: SimIQ Scenario Tree

SimIQ Capture

SimIQ Capture is supported by all SimGEN versions, i.e. SimTEST, SimREPLAY+ and SimGEN. When this mode is selected by the user, a compatible hardware configuration will be automatically selected by SimGEN (see Figure 5). The compatible hardware configuration automatically enables the appropriate constellations and frequencies, these being dependent upon the user's license.

Figure 5: SimIQ Capture Hardware Configuration

User can configure certain parameters of the I/Q file before capturing the data. These are: frequency band or radio card assigned, file format, sample rate and bit-depth. SimGEN can also display instant feedback in order to optimize the simulation parameters (see Figure 6).

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Figure 6: SimIQ Capture Edit Window

SimIQ Capture allows the configuration per frequency band and per radio card:
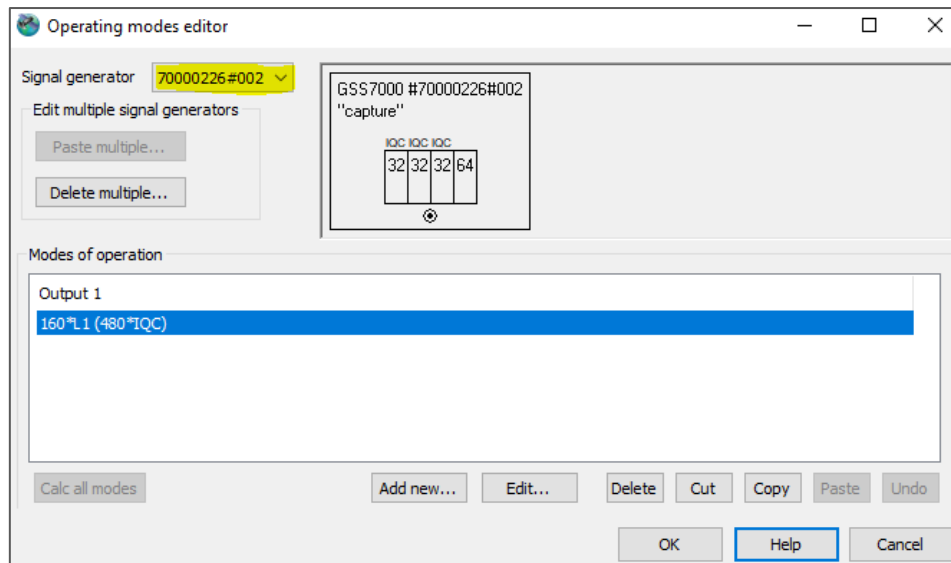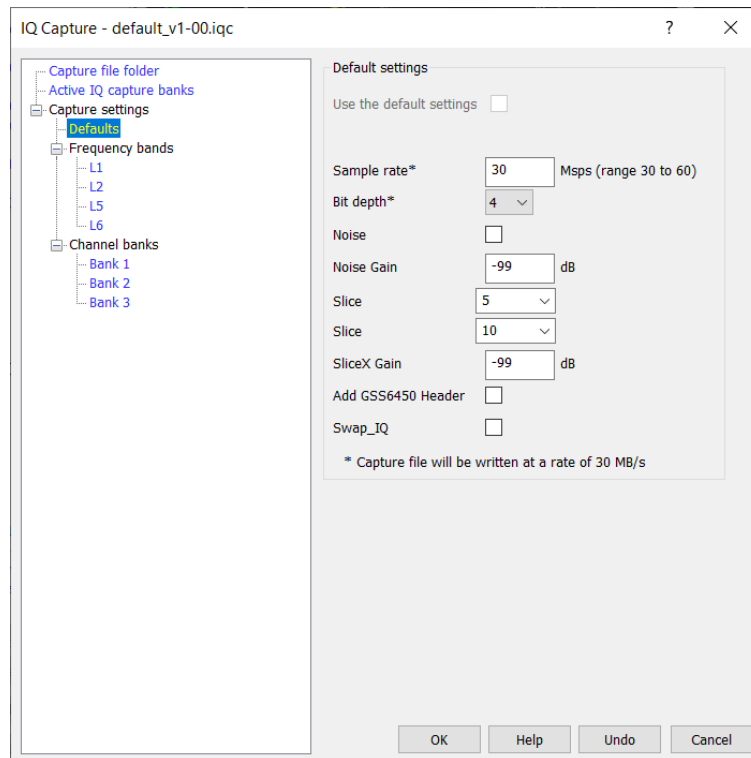
- Per frequency band (default): configuration can be different for each frequency band, e.g. L5 files could require a larger bandwidth than L1.

- Per radio card: Finer control as user can have two L1 radio cards with different configurations.

SimIQ Replay

SimIQ Replay is supported by SimGEN and SimREPLAY+ software levels. When this mode is selected by the user, SimGEN can read I/Q files and generate the corresponding RF. SimGEN has no knowledge of the signals, modulation, channels or waveforms that are defined within the I/Q file. The only knowledge SimGEN has is the information contained in the associated metadata file. This file contains information regarding the center frequency of the I/Q data, which is used by the system to automatically select the right radio card to output the I/Q file. **SimIQ Replay** can be thought of as an extra channel that can replay I/Q data within spec.

User definable settings can be set per radio card and include the following:

- IQ file selection – either single file or a sequence of them.

- Loop option - allows IQ file or IQ file sequence to loop when playback has completed.

- Randomize option – allows IQ file sequence order to be randomized rather than in the defined sequence order.

- Frequency offset (±40MHz for SimIQ Replay and SimIQ Replay Interference[3].

- Gain (-99 to 0 dB)[4] – overall power offset applied in addition to any modeled power.

- Swap IQ (reverse order of I & Q samples)

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[3] Careful consideration is required on the frequency offset selected to ensure that all signal bandwidth is replayed.
[4] Spirent recommends overall power offsets within the range of 0 to -70 dB.
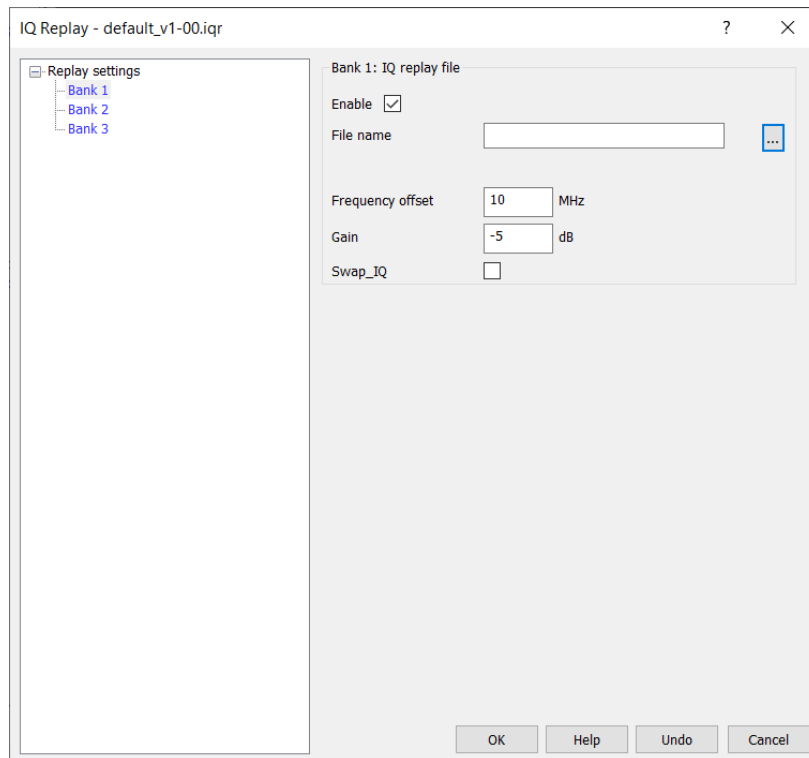
Figure 7: SimIQ Replay Edit Window

SimIQ Replay Interference

SimIQ Replay Interference is supported by SimGEN and SimREPLAY+ software levels. This feature requires a GSS7000 or GSS9000 2RF chassis with interference capabilities and the corresponding interference feature keys to generate RF for a particular center frequency. Both, **SimIQ Replay** and **SimIQ Replay Interference**, share a common dialog within **SimGEN** for the configuration of playback parameters (see Figure 7).

Signals generated from I/Q files can be associated with an I/Q transmitter object that can be displayed on the Ground Track view in **SimGEN** and supports modeled power levels. The user can freely define the transmitter location (either absolute or relative to the vehicle in the **SimGEN** scenario). The scenario based transmitter position is then used to calculate the range between transmitter and the vehicle antenna and the appropriate power level attenuation is applied during the scenario run[5].

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[5] Limited to power level atenuattion only. Other effects such as phase modeling, angle of arrival and doppler effects are not modified when generating RF from an I/Q file.

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Performance Specification

Common Features

Table 5 SimIQ Performance Specifications

Parameter	Value	Note
Supported constellations	GPS L1, L2, L5. GAL E1, E5, E6. GLO L1, L2, CDMA L1, CDMA L2, CDMA L3 BD B1, B2, B3. SBAS L1, L5. QZSS L1, L2, L5, L6. IRNSS L5.	Constellations are available via purchase of appropriate Spirent licensing.
Supported codes	GPS L1: C/A, L1c Pilot, L1c Data, P. GPS L2: L2c or C/A, P. GPS L5: I, Q. GAL E1: E1-A, E1-B, E1-C. GAL E5ab: E5aI + E5aQ + E5bI + E5bQ. GAL E6-A, E6-B, E6-C GLO L1: C/A, P. GLO L2: C/A, P. GLO CDMA L1 GLO CDMA L2 GLO CDMA L3 BD B1: B1I, B1C. BD B2: B2I, B2a, B2b. BD B3: B3I. QZSS L1: C/A, L1S, L1c Data + Pilot. QZSS L2: L2c. QZSS L5: I + Q. QZSS L6: L61/L62. IRNSS L5: C/A	Capture frequencies are available via purchase of appropriate Spirent licensing.
Supported simulator	GSS9000[6] GSS7000[5]	GSS9000: Supported SIR with SimIQ: Up to 1 kHz GSS7000: Supported SIR with SimIQ: Up to 100 Hz

Table 6: SimIQ System Iteration Rate

Parameter	Value	Note
Supported SimGEN Iteration Rate	100 ms - 10Hz 10 ms - 100Hz 1 ms - 1kHz*	The rate at which SimGEN computes the required data and updates the hardware. *GSS7000: Up to 10 ms (100 Hz) *GSS9000: Up to 1 ms (1 kHz)
Supported SimGEN Logging Rate	100 ms - 10Hz 10 ms - 100Hz 1 ms - 1kHz	The rate at which SimGEN logs the data.

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[6] **SimIQ Replay Interference** is only supported by 2RF chassis with interference capabilities.

Supported Third-Party Application Iteration Rate	Up to 1 ms - 1kHz	The rate at which the third-party application computes the vehicles dynamics and sends a vehicle motion message to SimGEN.

SimIQ Capture

Table 7: SimIQ Capture Performance Specifications

Parameter	Value	Note
Software Level	SimTEST SimREPLAY+ SimGEN	**SimIQ Capture** is an editable feature in all software levels.
Configuration Type	Per radio card Per frequency band	
Bit-Depth	4, 8, 16 bits	Please, contact Spirent for other bit-depths.
Sample Rate	30, 60 Msps	Additional sample rates (up to 120 Msps) available as a Tailored Solution.
Optional Noise Generation	Gaussian-like	
No. I/Q radio cards supported	Up to 3[7]	SimIQ Capture is not supported on radio cards with FPGA security modules installed.

SimIQ Replay & SimIQ Replay Interference

Table 8: SimIQ Replay and SimIQ Replay Interference Performance Specifications

Parameter	Value	Note
Software Level	SimGEN SimREPLAY+	
Carrier Offset	±40 MHz	Increments of 100 Hz.
Bit-Depth	4, 8, 16 bits	
Sample Rate	30, 60 Msps[8]	Additional sample rates (up to 120 Msps) available as a Tailored Solution.
No. I/Q files per radio card	1	Each licenced I/Q radio card is able to run an I/Q file and 32 additional channels (if licenced) for a given frequency.
No. I/Q radio cards supported	Up to 3	Depending on the customer's hardware[9].

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[7] Maximum number of radio cards supported depends on the hardware owned. Please, contact Spirent for the most demanding applications (e.g., 3 radio cards, 16 bits, 60 Msps).
[8] 30.69 and 51.15 Msps also supported for GSS6450 compatibility.
[9] Radio cards licensed with the SimIQ Replay feature must be different from those with security modules installed.

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Deliverables

With the purchase of any **SimIQ Capture** part number, the following items are delivered (see Table 9).

Table 9: Delivery Items for SimIQ Capture

Item No.	Quantity	Description	Notes
1	1	Base Image Patch	Upgrade required to use any SimIQ feature.
2	1	I/Q FPGA Image	Upgrade required to use any SimIQ feature.
3	1	SimIQ Capture License	

With the purchase of any **SimIQ Replay** part number, the following items are delivered (see Table 10).

Table 10: Delivery Items for SimIQ Replay

Item No.	Quantity	Description	Notes
1	1	Base Image Patch	Upgrade required to use any SimIQ feature.
2	1	I/Q FPGA Image	Upgrade required to use any SimIQ feature.
3	1	SimIQ Replay License	SimIQ Replay – Up to 3 licences/radio cards per system.

With the purchase of any **SimIQ Replay Interference** part number, the following items are delivered (see Table 11).

Table 11: Delivery Items for SimIQ Replay Interference

Item No.	Quantity	Description	Notes
1	1	Base Image Patch	Upgrade required to use any SimIQ feature.
2	1	I/Q FPGA Image	Upgrade required to use any SimIQ feature.
3	1	SimIQ Replay Interference License	SimIQ Replay Interference – Up to 3 licences/radio cards per system.

A second SSD, with 1TB of storage capacity, can be fitted into the system to save the files used by SimIQ Capture and SimIQ Replay. With the purchase of the SimIQ SSD part number, the following items are delivered (Table 12).

Table 12: Delivery items for SimIQ Hardware

Item No.	Quantity	Description	Notes
1	1	Second Internal 1TB SSD	Return to factory required to perform the internal installation with the purchase of this part number. External support does not require a return to factory.

For more information

For more information on any aspect of SimIQ, please contact your Spirent representative or Spirent directly:

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About Spirent Positioning Technology

Spirent enables innovation and development in the GNSS (global navigation satellite system) and additional PNT (positioning, navigation and timing) technologies that are increasingly influencing our lives.

Our clients promise superior performance to their customers. By providing comprehensive and tailored test solutions, Spirent assures that our clients fulfill that promise.

Why Spirent?

Across five decades Spirent has brought unrivaled power, control and precision to positioning, navigation and timing technology. Spirent is trusted by the leading developers across all segments to consult and deliver on innovative solutions, using the highest quality dedicated hardware and the most flexible and intuitive software on the market.

Spirent delivers

- Ground-breaking features proven to perform
- Flexible and customizable systems for future-proofed test capabilities
- World-leading innovation, redefining industry expectations
- First-to-market with new signals and ICDs
- Signals built from first principles — giving the reliable and precise truth data you need
- Unrivaled investment in customer-focused R&D
- A global customer support network with established experts

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Spirent Communications (LSE: SPT) is a global leader with deep expertise and decades of experience in testing, assurance, analytics and security, serving developers, service providers, and enterprise networks. We help bring clarity to increasingly complex technological and business challenges. Spirent's customers have made a promise to their customers to deliver superior performance. Spirent assures that those promises are fulfilled. For more information visit: www.spirentfederal.com

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