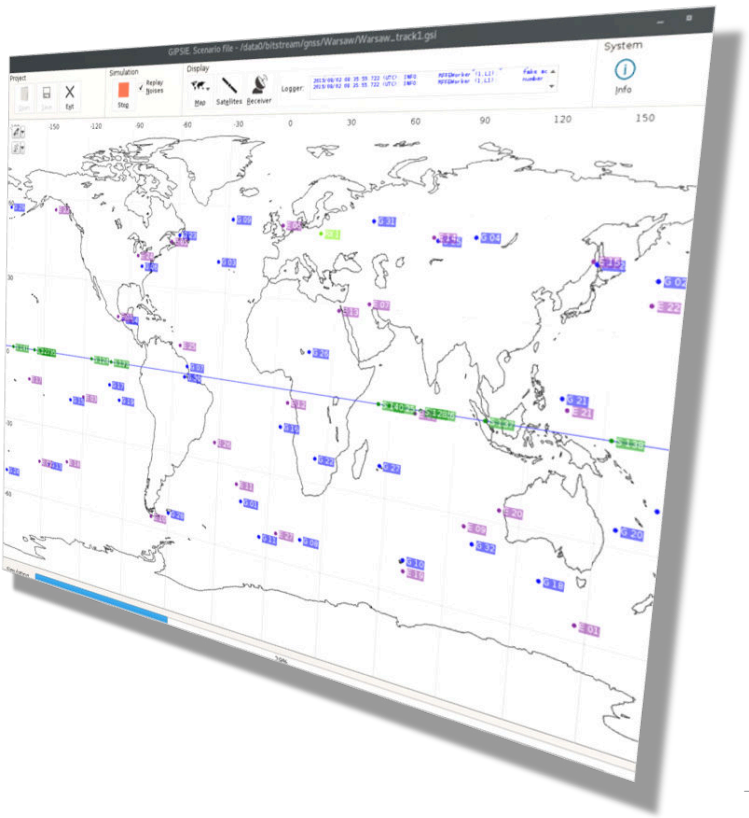
IZT S1000 GNSS
Realtime Signal Generator

Product Information

- Multi-standard GNSS constellation simulator
- All civil GNSS constellations (including NavIC and QZSS)
- Up to 208 simultaneous GNSS signals
- Combination of GNSS and other RF Signals
- Hardware-in-the-loop (HIL)
- Testing of infotainment systems
- Synchronization of multiple units
- Automated testing for development and production



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Overview

The IZT S1000 GNSS Realtime Simulator is a compact multi-channel high-performance platform for complex and versatile GNSS testing in one device.

Its multi-channel, multi-standard functionality enables the generation, encoding and modulation of RF signals for important global digital standards and simulates real-time impairments. It can be used to meet a wide range of challenging test requirements as well as to perform integrated automated sequences to reduce time to market.

The IZT S1000 GNSS is complemented by a software-based Satellite Constellation Simulator, which simulates the satellite orbits by using a sophisticated orbit integrator including modeling of environmental parameters such as satellite clocks, transmit power, antenna patterns, ionosphere and troposphere. The GNSS signal modulation is performed by the IZT S1000 GNSS firmware in real-time with extremely low latency.

Optional software modules can be used for the sophisticated simulation of interference signals on top of the GNSS signals including realistic simulation of channel power variations.

The real-time RF signal generation is enabled by an FPGA implementation and a real-time interface between the IZT S1000 GNSS software and firmware. An additional real-time input interface is available in the software to offer HIL scenarios.

Key Features

OUTSTANDING TECHNOLOGY FOR SIGNAL PROCESSING

State-of-the-art digital processing

High-performance test equipment has to be designed for today's exceptionally complex testing environment. Due to IZT's patented approach for signal synthesis, the IZT S1000 GNSS is capable of processing and combining a high number of signals in a very efficient manner. The cumulative bandwidth of these signals can go up to 320 MS/s.

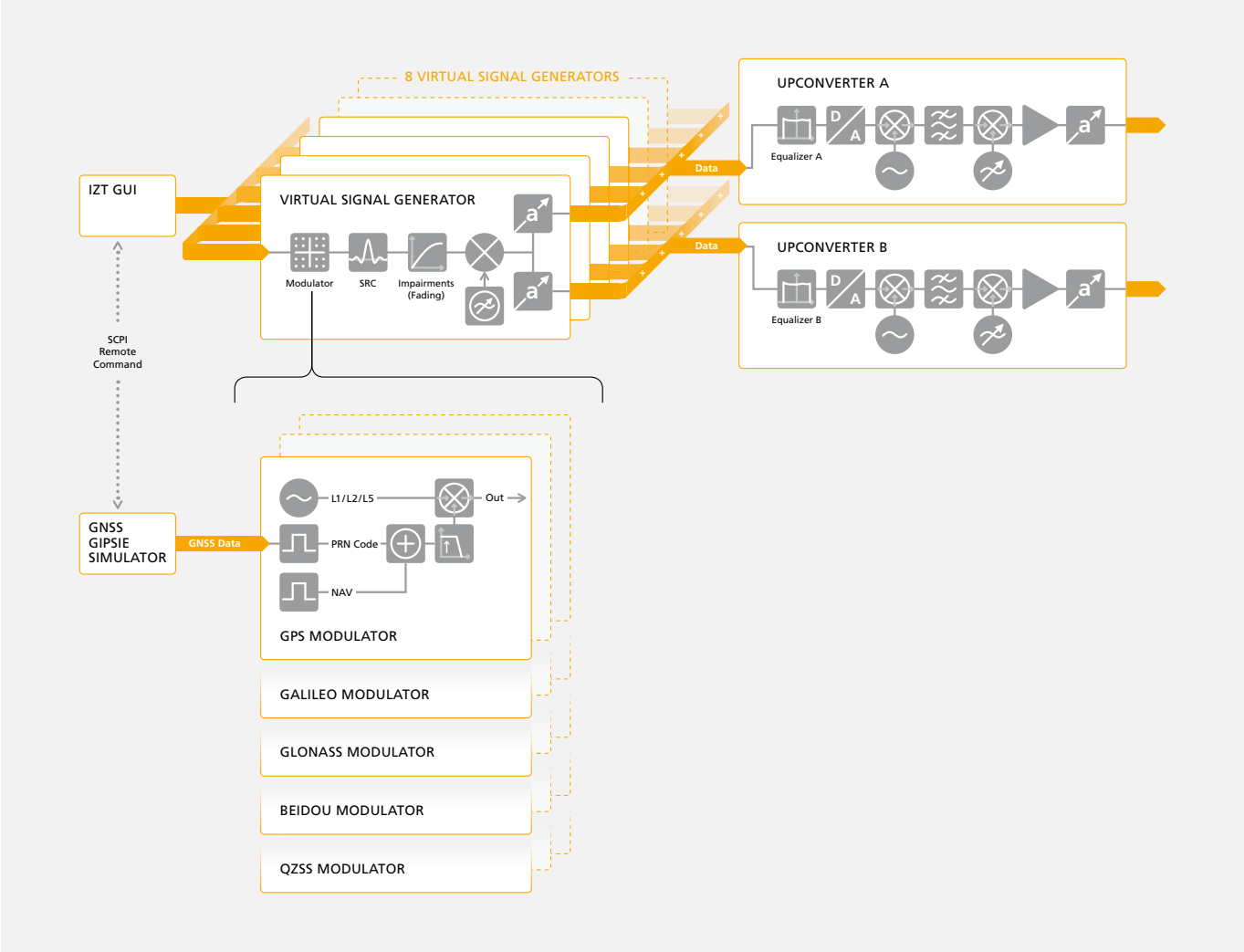

FIGURE 1: IZT S1000 GNSS BLOCK DIAGRAM

S1000 GNSS CONSTELLATION SIMULATOR

GNSS receivers need to be tested during development as not all GNSS signals (e.g. Galileo) are transmitted in full operational constellation. The software provides the possibility to generate simulated GNSS constellations for various user-defined scenarios including complex trajectories and environments. All settings can be made within an easy-to-read configuration file or within the user-friendly and simple graphical user interface.

The system is composed of the following software modules:

- Orbit integration module based on earth gravitational model including gravitational effects of sun and moon
- Simulation of complete GNSS constellations including all satellites based on default almanac or accurate ephemeris information and clock parameters
- Simulation of accurate atmospheric models for ionospheric and tropospheric delays
- Simulation of user-defined receiver antenna characteristics including reception gain patterns and multipath effects
- Navigation message simulation based on GNSS ICDs or customized user-defined message formats
- IF signal simulation based on the constellation updates with user-defined update rate and bandwidth
- Reproducible noise and signal degradation simulations
- Graphical user interface
- Comprehensive data logging of all intermediate results for detailed analyses and debugging support

S1000 GNSS key performance characteristics:

- 64 GPS/QZSS C/A, SBAS, GPS/QZSS L2
- 32 GLONASS L1OF, L2OF
- 32 BeiDou B1-1, B1-2
- 24 GPD/QZSS L1C, Galileo E1 OS
- 24 GPS/QZSS L5, Galileo E5A, Galileo E5B, BeiDouB3-I
- 16 Galileo E6 CS
- Continuous operation, additional interferers
- Constellation Update Rate: up to 100 (250) Hz
- Resolution: up to 2x16 bit I/Q for storage

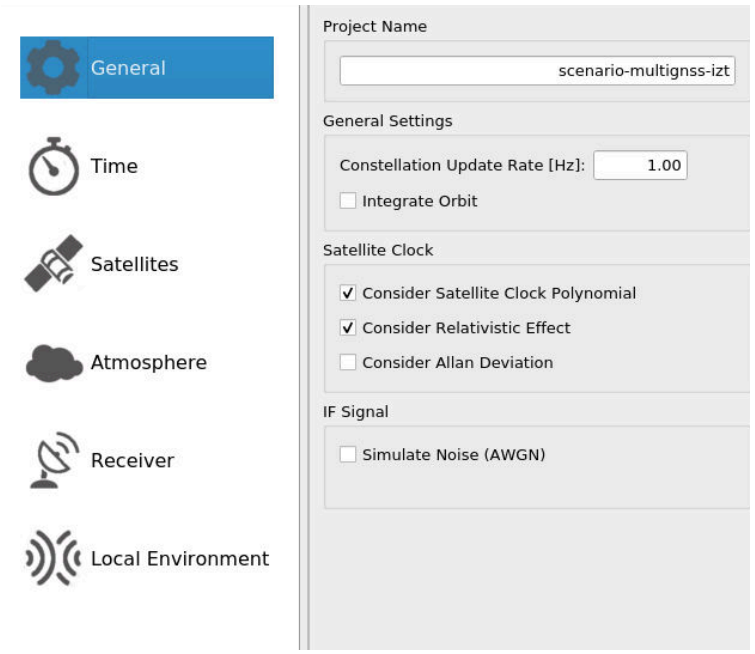

FIGURE 2: GNSS SIMULATOR CONFIGURATION

One device – 8 Virtual Signal Generators (VSG) and complex full GNSS orbit

The IZT S1000 GNSS generates a 120 MHz wide composite output signal from up to 8 individual signal carriers. Each signal can be set within two independent 120 MHz blocks within the frequency range up to 3 GHz. Figure 1 shows the block diagram of the IZT S1000. Additionally to the 8 individual carriers the S1000 GNSS can generate hundreds of GNSS signals.

For each Virtual Signal Generator, the user assigns:

- IQ content streamed from harddisk or memory
- Interferer signals
- Interpolation rate
- Launch delay
- Impairments
- Center frequency
- RF power

All active Virtual Signal Generators are combined and distributed to two RF outputs.

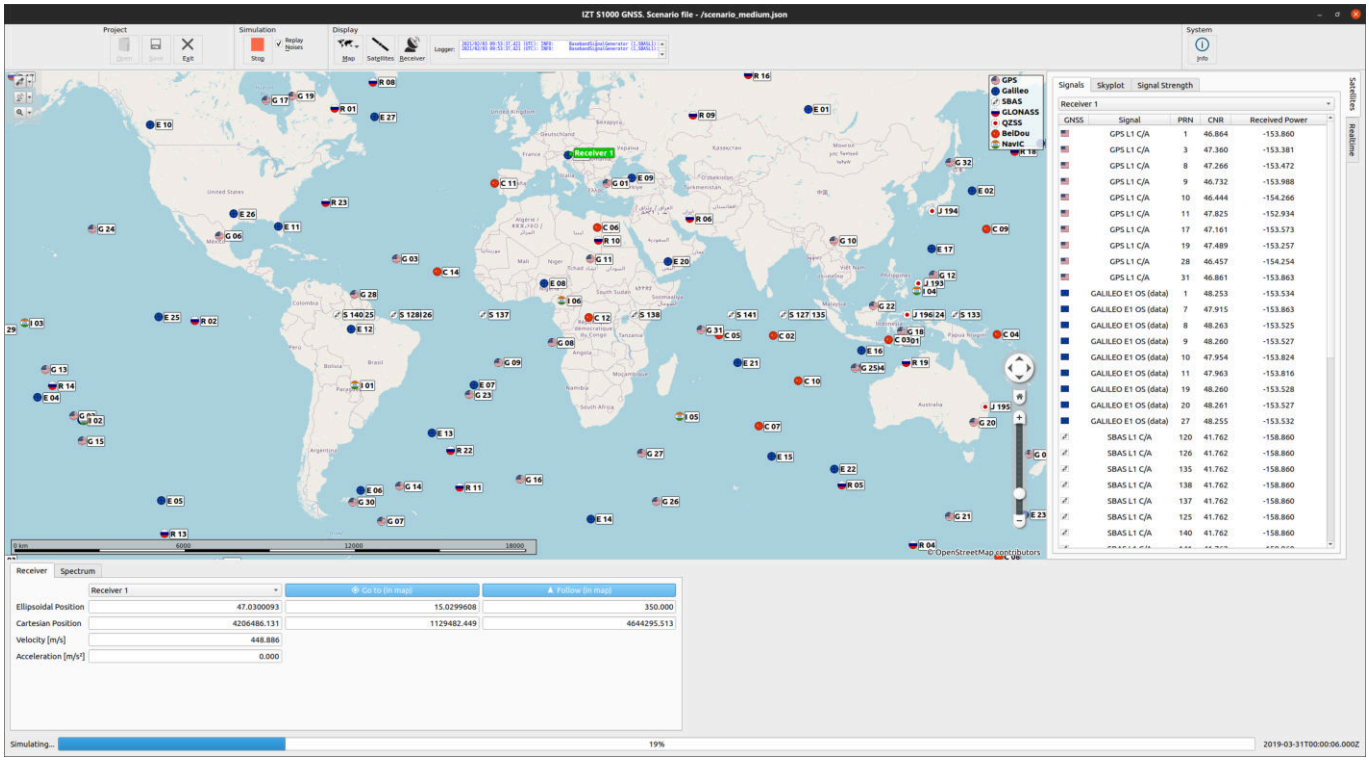

FIGURE 3: REALTIME GNSS SIMULATOR

Acknowledgement: The GNSS Real-time Modulation and Interface was carried out under a programme of and funded by the European Space Agency. The view expressed herein can in no way be taken to reflect the official opinion of the European Space Agency.

receivers at multiple frequencies or superimposing an interferer moving over a frequency span of 3 GHz. In GNSS test setups it saves an additional signal generator. It allows easy testing of various interferer scenarios.

When equipped with dual synthesizers, the center frequencies of the outputs can be tuned independently over the entire frequency band.

TWO INDEPENDENT RF OUTPUTS

The IZT S1000 GNSS contains two independent RF sections (Figure 4), each of which can be set within 9 kHz to 3 GHz with an instantaneous bandwidth of 120 MHz. Their linearity and dynamic range are designed to meet the demanding operating conditions created by multiple RF signals.

The center frequencies can be modified during signal generation. This allows the user to move the signals seamlessly in the 3 GHz span. This feature enables a broad range of additional applications such as testing

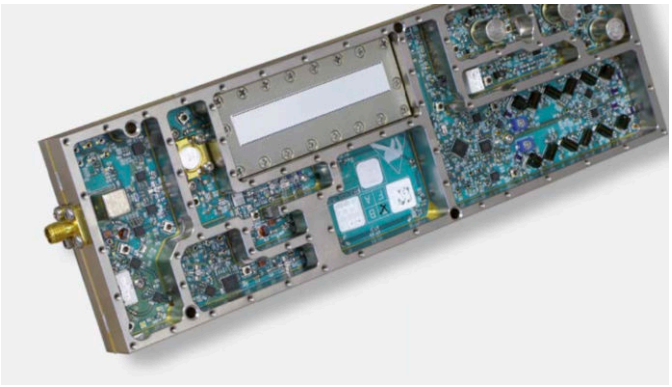

FIGURE 4: RF SECTION OF THE IZT S1000

Applications

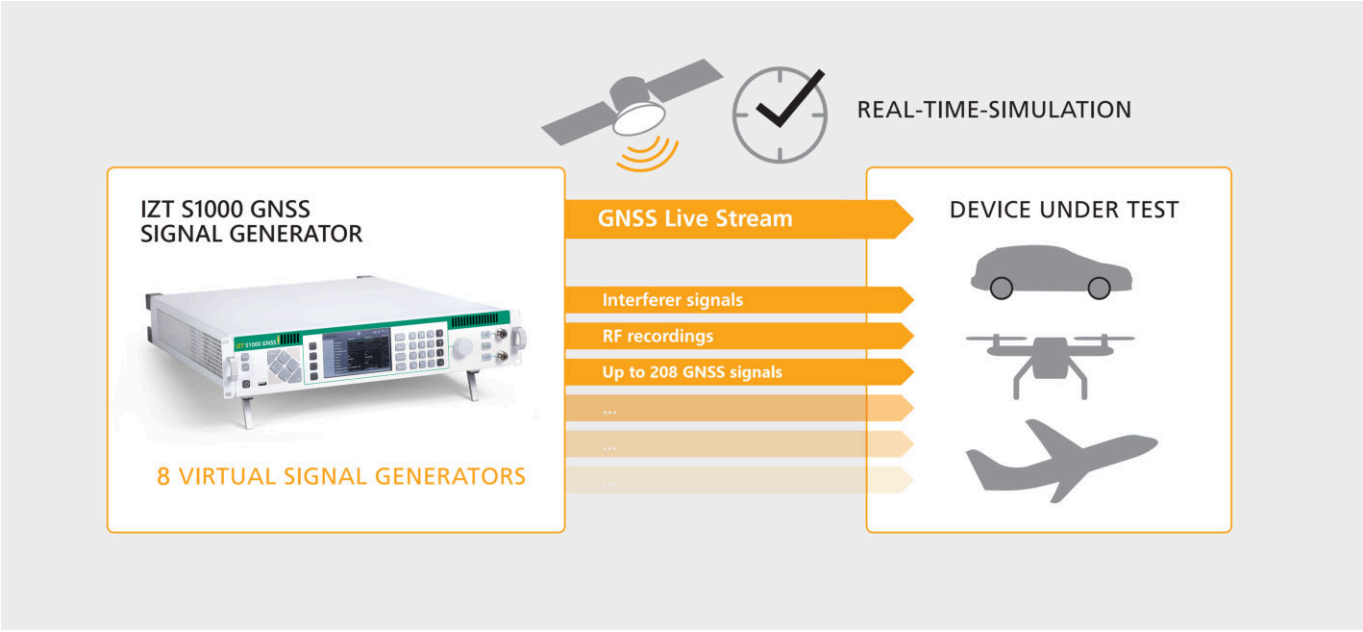

FIGURE 5: TESTING SCENARIOS

GNSS TESTING

The IZT S1000 GNSS can be used in conducted environments using two RF outputs for testing the DUTs. But it is also possible to transmit the GNSS signals digitally to the IZT C7000 Channel Emulator (Figure 7). The IZT C7000 WFS allows to build a model with the correct position and orientation. I.e. the simulation don't just emulate a correct sum signal (for the correct position for the GNSS receiver), but also the correct position (of antenna arrays, relative to the satellites) in addition to the interference signals. This way it is possible to test interferer effects and signal capturing effects on the DUT. [1]

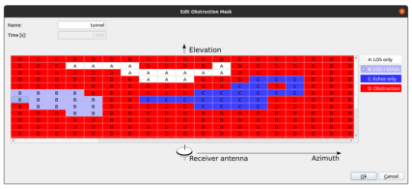

FIGURE 6: OBSTRUCTION MASK CONFIGURATION

The obstacle obstruction mask allows the user to configure objects between the satellite and the receiver. This obstruction mask can also be used in a timed way.

RECEIVER TESTING

The entire supply chain of radio receivers can benefit from testing scenarios. This includes product development, validation and production line testing. Chip set manufacturers, suppliers and car manufacturers need to cover a variety of testing scenarios as automotive radio receivers are becoming more and more complex, and user experience increasingly important.

When testing car infotainment systems, it is important to cover the whole range of DAB functionality. On one side, encoding and signaling needs to be tested in compliance with the DAB specification, while on the other hand, reception conditions also need to be considered. Finally, the relation between DAB services and other bearers such as FM needs to be taken into account. In particular, traffic information received from TPEG

[1] https://www.izt-labs.de/izt/media/IZT-C7000-OTA-Over-the-Air-Research-and-Testing.pdf

or TMC services have to be related to the positional information of the vehicle.

The IZT S1000 GNSS and IZT ContentServer form a comprehensive test setup covering these combined requirements.

Further information about receiver testing can be found in our application note[2] and our technical article[3].

TESTING ECALL SYSTEMS

The IZT S1000 GNSS can be used for testing emergency call (eCall) systems. The solution offers a compact multi-channel high performance platform for complex and versatile testing in one device.

Further information about testing eCall systems can be found in our application note[4].

RECORD AND PLAYBACK

The ability to record RF signals during test drives and to reproduce them in the laboratory can significantly reduce time-to-market and cost when developing radio receivers. Take a look in our Brochure about IZT RecPlay[5] and our technical article[6].

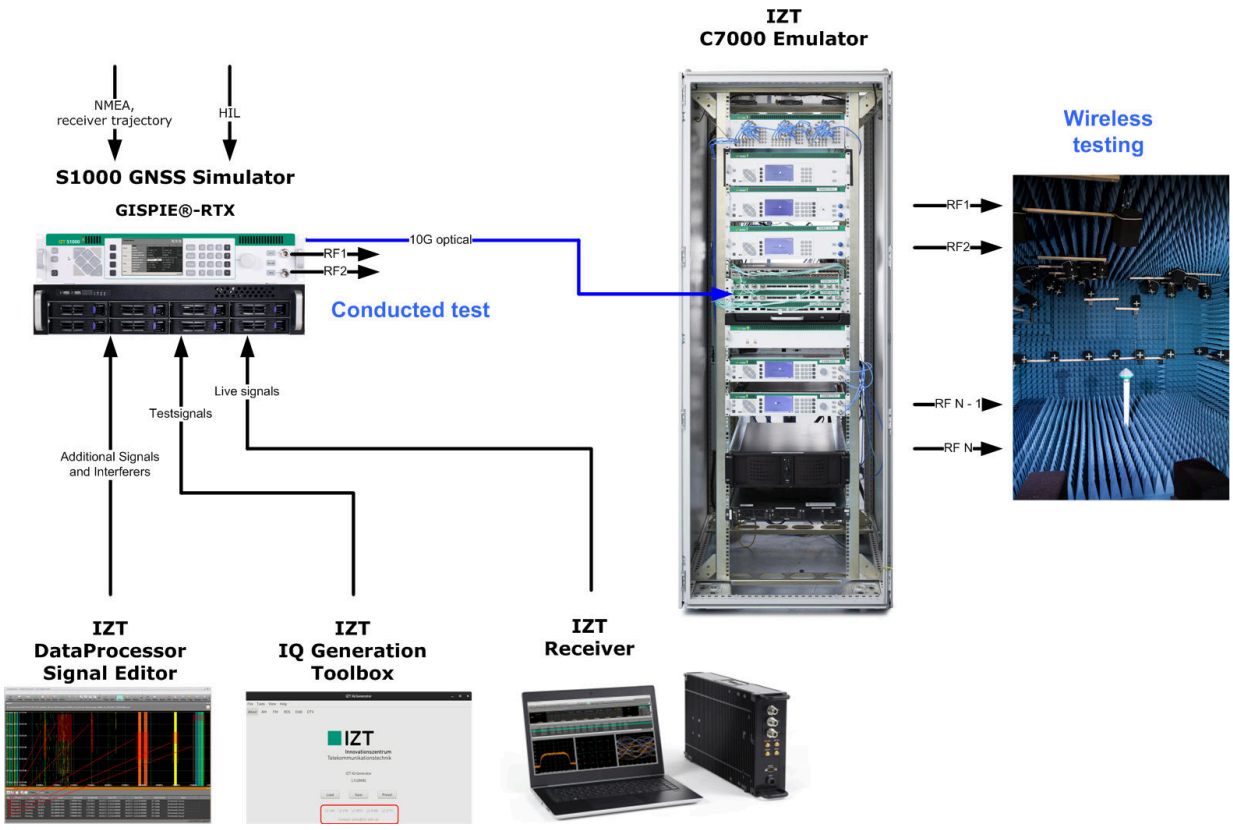

FIGURE 7: GNSS TESTSOLUTIONS

[2] https://www.izt-labs.de/izt/media/Testing-DAB-Receivers-with-the-DAB-ContentServer-and-the-S1000-Signal-Generator.pdf
[3] https://www.izt-labs.de/izt/media/Digital-Broadcasting-IZT-Solutions.pdf
[4] https://www.izt-labs.de/izt/media/IZT-S1000-IZT-S1010-testing-eCall-systems.pdf
[5] https://www.izt-labs.de/record-playback-izt-recplay/
[6] https://www.izt-labs.de/izt/media/Technical-Article-Virtual-Field-Tests-IZT-Record-and-Playback-System.pdf

Features

SYNCHRONIZATION OF MULTIPLE IZT S1000 GNSS SIMULATORS

It is easily possible to synchronize multiple IZT S1000 GNSS units in a phase coherent way. One of the IZT S1000 GNSS will take the role of the Master and the other IZT S1000 GNSS will be a Slave unit. This enables the possibility to generate multistandard constellations like L1, L2, E5, L5 ... at the same time.

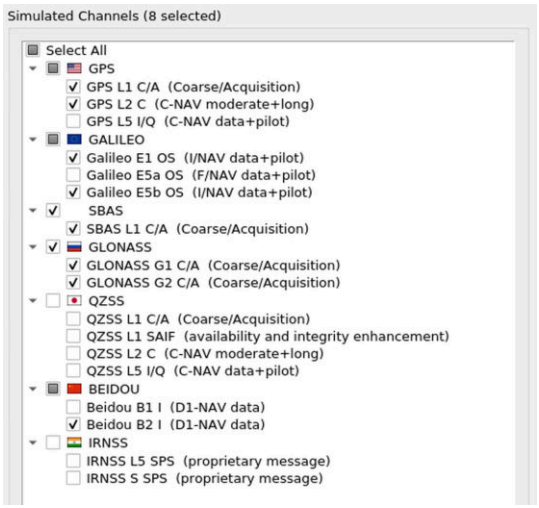

FIGURE 8: MULTIPLE S1000 GNSS BANDS

VARIABLE SAMPLE RATE CONVERTERS

Each of the 8 Virtual Signal Generators [7] contains independent variable sample rate converters with 120 dB SFDR and sub-Hertz frequency resolution. They allow the user to easily combine signals from different standards and origin with their specific sample rate without time-consuming pre-processing.

REPLAYING RF SIGNALS

The IZT S1000 replays recorded or simulated signals with up to 40 MS/s at 12- or 16-bit complex resolution. This sample rate is sufficient for an individual signal bandwidth of 34.4 MHz.

The internal memory supports sequences with more than one minute duration before they loop at the highest bandwidth. When using lower bandwidths, this looping length is scaled up linearly. When used with an external Memory Extension (Figure 9), which is available in two hardware configurations, hours of recorded signals can be replayed continuously.

Signal sequences can be recorded with IZT receivers. This can be done for a single antenna, whereas when using the IZT receiver family, diversity setups with multiple antennas are also supported.

Instead of recording a signal, the user can generate test signals using the IZT IQ Generator or derived from system simulations from Matlab, Phyton, GnuRadio etc. The variable sample rate converters built into the IZT S1000 avoid time-consuming offline re-sampling of the test data.

Due to its multi-channel functionality, IZT S1000 is able to replay or simulate complex signal environments with uncorrelated or identical content. A specific signal power and center frequency can be assigned to each VSG in real-time via the GUI or remote control.

[7] S1000 GNSS firmware and software differs from the functionality of the standard S1000 functionality. Please consult sales@izt-labs.de for further information

FIGURE 9: IZT S1000 WITH EXTERNAL MEMORY EXTENSION

SIMULATION OF ANTENNA CHARACTERISTICS

With the GNSS Simulator antenna characteristics can be simulated. The antenna patterns are loadable and are applied according to the direction of the receiver and transmitter.

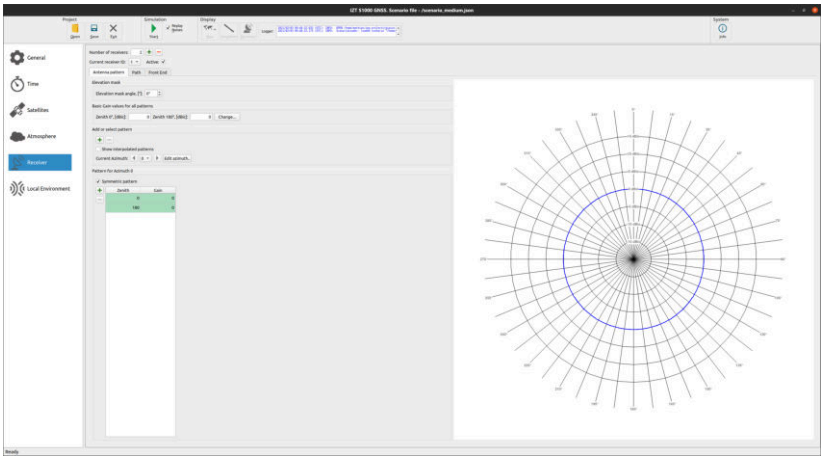

FIGURE 10: SIMULATION OF ANTENNA CHARACTERISTICS

VARIABLE SIGNAL EMISSION AT DEFINED TIMESLOTS

For more flexibility in testing, IZT S1000 supports "advanced streaming", which allows individual emissions to be sent at defined time slots (Figure 11). In each emission, the most important signal parameters can be configured even during run-time:

- Start/stop time
- Frequency
- Bandwidth
- Source (I/Q File, IZT R3000, NI)
- Time-variant profiles
- Hopping sequence
- Up to 8 signal streams from the IZT S1000 Memory Extension

SMOOTH EXTERNAL SYNCHRONIZATION

If a setup with several signal generators is necessary, an option for external synchronization is available. IZT S1000 GNSS is prepared such that the IZT devices can be used absolutely phase-synchronously together. One of the devices will take the role of the master and the other will take the role of the slave. A central clock and LO signals are distributed among the signal generators. If there are more than two signal generators, an additional clock/LO distribution unit is available.

FIGURE 11: SCENARIO SIMULATION WITH CHANGING CONTENT OVER TIME

SIMULATION OF PPD JAMMING EFFECTS

To test receivers for robustness against jamming signals as they are produced by PPD (Personal Privacy Devices) the sophisticated capabilities of the S1000 GNSS can be used. Most PPDs generate continuous wave (CW) or chirp signal or frequency hopping signals. Any kind of these signals can configured and superimposed to the GNSS signal. This gives a huge advantage in comparison to other GNSS generators.

REAL-TIME IMPAIRMENT SIMULATION

As a versatile and comprehensive testing platform, IZT S1000 can be equipped with a wide range of simulation tools. Many configurations are possible – the specific application will be customized with the exact software option as required. Most of the software options can be easily upgraded by option keys.

Fading Channel Simulation

Figure 12 shows the fading channel simulation of the IZT S1000, which offers a pool of up to 8 fading paths that can be allocated freely to the VSGs and the RF outputs. The user takes advantage of the full flexibility at both ends of the channel simulator block. For GNSS fading simulations there are sophisticated resources available to simulate complex fading scenarios.

All paths can simulate a “moving path”, that is the support of a time-variant delay. The Doppler spread can be as high as 10 kHz. The complex gains of all paths are either streamed from a file or calculated in real-time by the IZT S1000 GNSS software. The fading channel simulation has the ability to generate scenarios for testing receivers with antenna diversity. Each scenario is reproducible in a perfectly controlled way.

Different fading models such as Rayleigh, Rice (Figure 13), LOS, GAUSS are supported to easily simulate scenarios as defined in receiver test procedures.

Fading models like TU4 / RA6 / TU6 / SFN are provided as predefined scenarios, which can be recalled. During product support, these fading models will be continuously enhanced and upgraded.

The IZT S1000 can be used for Maximal Ratio Combining (MRC) receiver testing. The powerful fading simulation and two RF outputs provide a simple and effective way to test MRC. MRC is a variant of diversity combining, that is a method to combine two or more received signals in order to improve the quality of the resulting signal.

FIGURE 12: FADING CHANNEL SIMULATION

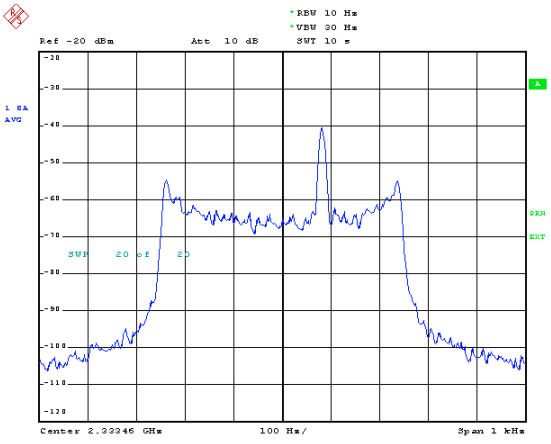

FIGURE 13: RICE FADING WITH LOS COMPONENT

Time Variant Signal Profiles

The IZT S1000 supports a number of time-variant signals called “profiles” to simulate large-scale variations of signal properties (Figure 14):

- Propagation delay
- Signal frequency
- Power levels

These parameters can be modified independently for each VSG without affecting signal quality and with a timing resolution as low as 12 µs. Typical applications are large-scale fading or shadowing effects, delay variations caused by moving satellites or emulating a fast frequency hopper.

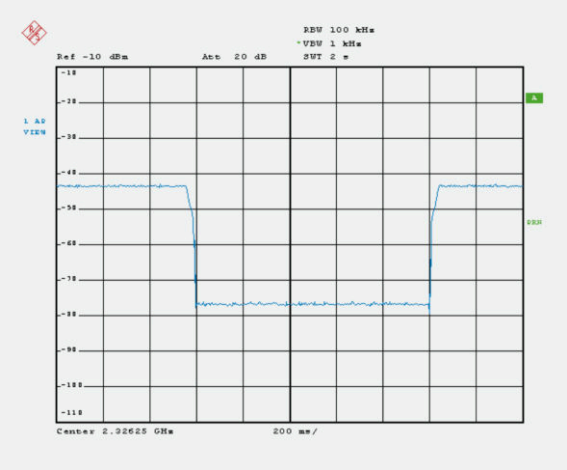

FIGURE 14: POWER LEVEL PROFILE

Shaped Noise Source

The IZT S1000 contains one incoherent noise source per RF output, which sets the carrier to noise ratio to a user-defined level. The individual power of the signals and the noise are controlled and combined digitally. In consequence, the carrier to noise ratio is extremely accurate.

In addition to carrier to noise settings, the IZT S1000 Realtime GNSS Simulator allows the user to shape the noise floor. This is very important for wideband multi-standard signal generation to simulate frequency-dependent background noise, antenna and LNA performance in the different frequency bands. Further, this feature reduces total output power because only bands relevant to the receiver are subject to an elevated noise floor.

Phase Noise Simulation

Simulates phase noise of the transmitter or the receiver, based on a user controllable phase noise mask. The mask can loaded from predefined configurations or can be online edited in the mask editor and is instantly applied. The phase noise simulation can be applied to one VSGs.

Injection	Applied before fading
Profiles	Pre-defined phase noise masks from library User-defined phase noise masks Settable on Graphical User Interface
Format	editable via GUI and ASCII text files
Graphical User Interface	31 independent points 31 independent frequency offset values Internal calculation, instantly applied
Max phase angle	+-180 degree
Distribution function	Gaussian
Phase noise uncertainty	0.5 dBc/Hz typical
Frequency offset range from carrier	1 Hz - 2.5 MHz

Your Benefits

FIGURE 15: IZT S1000 GNSS SIGNAL GENERATOR

UPGRADEABLE HARDWARE FOR POWERFUL TESTING

The IZT S1000 GNSS addresses a wide range of different customer applications. The customer benefits from its compact 2U form factor chassis. The chassis contains all digital processing hardware, synthesizers and RF sections.

As a versatile and comprehensive testing platform it is offered with a broad choice of available hardware options. For a specific customer application, a single device or extensive setup can be equipped with the exact hardware as required.

Internal Memory for Interferers

The internal memory supplies all Virtual Signal Generators with their required inputs:

- Raw I/Q data with 12- or 16-bit resolution for arbitrary or pre-encoded signals
- Data for frequency, delay and power profiles
- RF recordings from R3000 at any sample rate and 16- or 32-bit resolution
- Data from third party measurement equipment

The Virtual Signal Generators share the data of the on-board sample memory. Conventional signal generators, lacking the sophisticated processing of the IZT S1000, hold only a few seconds of content, while the IZT S1000 GNSS can support minutes of continuous signal out of internal memory until the signal wraps. The signals are repeated seamlessly in a loop without interruption.

The IZT S1000 has four GB of fast sample memory available for storing and reading out I/Q data. Eight GB memory is available as an option.

The signals can be loaded from the internal hard drive or streamed from an external IZT Memory Extension unit.

Data Streaming from External Memory Extension

For the most demanding applications, data can be streamed from an external Memory Extension directly into the FPGA via dual Gbit LAN. The 10 Gbit optical LAN interface is reserved for the GNSS (Figure 17).

All kinds of signals for radio testing and any I/Q signals of variable sample rate as well as multiple signals, can be streamed at the same time to the signal source.

Dedicated Ethernet connections via the dual Gbit Ethernet port make it possible to stream up to 225 MB/s. The available streaming resources can be shared among all streamed Virtual Signal Generators. Also the direct replay of recordings of the complete FM broadcast band is possible (Figure 16).

The external Memory Extension is available in two different configurations. See specification for details.

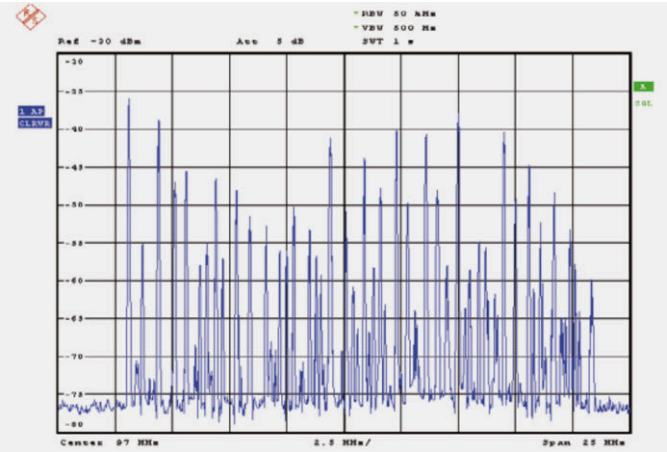

FIGURE 16: RECORDED FM BROADCAST SPECTRUM

FIGURE 17: BACK PLANE OF THE IZT S1000 INCLUDING 10 GBIT INTERFACE

FIGURE 18: S1000 MEMORY EXTENSION

Frequency Hopping Module

The frequency hopping module IZT S1000-FHS utilizes the profile functionality of the IZT S1000 to generate a hopping network in a very efficient manner. The content can be generated by an analogue modulation tool or from the user as narrow band I/Q data. One hopper requires one VSG only (two VSGs with 240 MHz spread). Additional hoppers can be added with the option IZT S1000-FHC.

Spread	Up to 120 MHz / 240 MHz
Hop rate	› 2000 hops/s
Channel spacing	User-settable
Hopper pattern	Regular or random within user defined channel list Regular or random within sequence of channels or user defined frequencies
Number of hoppers	Up to 31; one hopper requires one IZT S1000-110 One hopper requires two IZT S1000-110 with 240 MHz spread
Content	Narrow band I/Q-data ‹ 5 MS/s when number of hoppers is 31

SUPPORT FOR GLOBAL MODULATION FORMATS

The IZT S1000 GNSS supports a number of modulation standards. This enables users to rapidly develop custom applications for research, design, characterization, validation and testing communication systems and components that modulate or demodulate signals.

The supported broadcast standards are AM, FM, FM-RDS, DAB, DAB+, DVB-T, DVB-T2, ISDB-T, HD-Radio, DRM, DRM+. For Details take a look in our Brochure about IZT S1000/S1010[8]

Please keep in mind that the S1000 GNSS firmware has a limited number of VSGs and less modulation resources as the IZT S1000 / S1010 firmware.

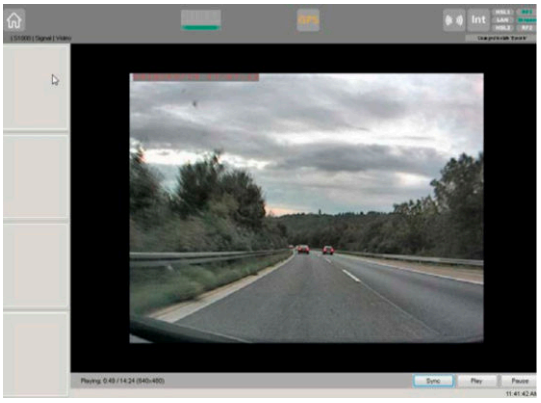

FIGURE 19: VIDEO REPLAY SYNCHRONIZED TO RF SPECTRUM

UDP Data Connection

It is possible to connect external devices like SDR modulators via UDP. This UDP data can be live processed by the IZT S1000 GNSS as input to the Virtual Signal Generators. Each available VSG can have it own UDP port and samplerate. This is a very effective way to connect third party software to the Signal generator.

USER-FRIENDLY OPERATION

The IZT S1000 RT's Graphical User Interface have been specially designed for a rapid and user-friendly control of multiple signals. These support a fast and reliable navigation within the signal generator and enable the user to configure complex scenarios in just a few steps.

Easy Control of Multiple Signals

The parameters of the Virtual Signal Generators are organized in a grid layout with a minimum number of layers (Figure 20). The front panel allows fast navigation through the grid and quick access keys take the user right to those parameters, which are changed most frequently during operation. The GUI provides optimal support for the user by checking settings for inconsistencies and giving hints about how to resolve them.

FIGURE 20: SCREENSHOT OF THE GRAPHICAL USER INTERFACE

[8] https://www.izt-labs.de/izt/media/IZT-S1000-S1010-multi-channel-signal-generator.pdf

Comprehensive Spectrum and Video Visualization

The spectrum visualization provides a very quick overview of all generated signals in the 120 MHz bandwidth. As the IZT S1000 GNSS supports up to 8 additional arbitrary signals and has versatile impairment functionality, it helps to verify and check the configuration.

The IZT S1000 GNSS permits a video visualization of IZT R3000 recordings (Figure 19), which are combined with video content. This helps to acquire additional video information besides the GPS location when replaying recordings. The video is fully synchronous to the start time, duration, length and loop parameters.

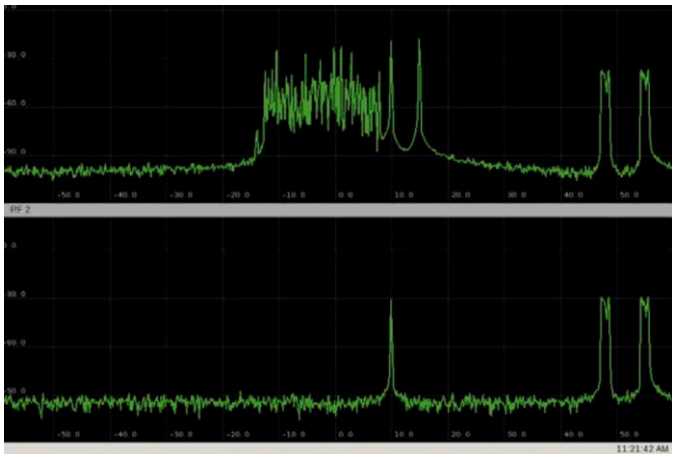

FIGURE 21: EXAMPLE OF INTERNAL SPECTRUM VIEW

Full Remote Control via Ethernet, Serial Port and GPIB

The IZT S1000 is fully remote controlled through SCPI commands received via Ethernet or GPIB. The GUI will automatically reflect the settings received. A convenient XML-based save and recall mechanism simplifies handling of large configuration scenarios. Saved scenarios can be transferred to external devices for documentation purposes and copied to other IZT S1000 Signal Generators to replicate setups.

LabVIEW applications and drivers are available for easy integration of the IZT S1000 into automated test setups (Figure 22). The Single Command Center can operate the IZT S1000 on all interfaces remotely while extracting SCPI command lists. The Multiple Command Center replays the SCPI command lists for automated test routines either in a single loop or continuously in a time controlled way.

FIGURE 22: LABVIEW FOR AUTOMATED TEST SETUPS

GPS Interface

This option enables the GPS extraction of the NMEA Data from IZT R3000 recordings. The embedded GPS meta data inside the I/Q streams is extracted and sent to map visualization software. IZT provides Map Visualization software for showing the replayed route. Additionally it is possible to send the NMEA to a RS232 interface.

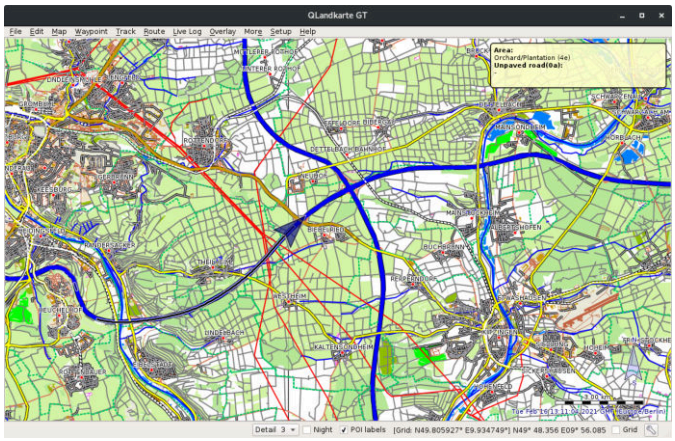

FIGURE 23: MAP VISUALIZATION SHOWS A REPLAYED ROUTE

Specifications IZT S1000 GNSS

Technical specifications	RF Sections	Value
Frequency	Range Resolution	9 kHz to 3 GHz 0.001 Hz
Instantaneous bandwidth	9 kHz to 30 MHz 90 MHz to 2940 MHz	30 MHz 120 MHz
Reference	Accuracy Ageing Temperature stability Signal stability Warm-up time External reference	OCXO ‹ ± 5 x 10^{-8} per year ‹ ± 1 x 10^{-8} (0 to 70 °C) ‹ ± 5 x 10^{-10} per day 10 min can be used
Power level	Maximum output power Resolution Uncertainty Range Dynamic range	+20 dBm typical 0.1 dB ± 0.5 dB: +10 dBm to -50 dBm; ± 1.0 dB: below -50 dBm -134 dBm to +20 dBm (peak) ‹ 75 dB typical
Spectral purity	Harmonics f ‹ 30 MHz Harmonics f ‹ 30 MHz Non harmonics › 30 MHz Non harmonics ‹ 30 MHz	‹ -30 dBc at +10 dBm ‹ -40 dBc at +10 dBm ‹ -75 dBc typical ‹ -80 dBc typical
Output IP3	‹ 30 MHz @ 10 dBm dualtone, 2 MHz spacing 100 MHz @ 10 dBm dualtone, 2 MHz spacing 1575 MHz @ 10 dBm dualtone, 2 MHz spacing 2332.5 MHz @ 10 dBm dualtone, 2 MHz spacing	+35 dBm typical +40 dBm typical +34 dBm typical +32 dBm typical

GNSS Specifications	
Realtime input signals	SCPI, RINEX
Input signals	KML for receiver path
Simultaneously generated Signals	64 GPS/QZSS C/A, SBAS, GPS/QZSS L2 32 GLONASS L1OF, L2OF 32 BeiDou B1-1, B1-2 24 GPS/QZSS L1C, Galileo E1 OS[9] 24 GPS/QZZS L5, Galileo E5A, Galileo E5B, BeiDou B3-I[10] 16 Galileo E6 CS more standards and updates during product updates
Accuracy between RF1,RF2	lower than 100ns
Continuously operation	supported
Simulation iteration rate SIR	250Hz, 100Hz, 50Hz, 10Hz
Simulation update rate of traject.	250Hz, 100Hz, 50Hz, 10Hz, 1Hz

[9] max. 16 can be used for Galileo
[10] E5A and E5B separately

GNSS Specifications	
Simulation of Hardware-in-the-loop (HIL)	250Hz, 100Hz, 50Hz, 10Hz Latency to RF output ‹ 2ms
Simulation of receive Antenna	gain
Simulation of transmit Antenna	gain
Signal dynamics	Relative Velocity : 200,000 m/s Relative Acceleration : 150,000 m/s2 Relative Jerk : 5000 m/s2 Angular Rate (at 1.5m lever arm): $\leq 15\Pi$ rad/s Angular Rate (at 0.05m lever arm): $\leq 60\Pi$ rad/s
Signal accuracy	Pseudorange Accuracy: ‹ 1mm Pseudorange Bias: 0mm [11] Inter-carrier Bias: $\pm$2 ps RMS [12] Inter-frequency Bias: 0.2×10^{-3} ns [13]
Spectral purity	Phase Noise (SSB): ‹ 0.02Rad RMS
Logging capabilities	Time related parameters Simulated receiver(s) trajectory in RINEX, KML Skyplot of each receiver Receive and transmit antenna parameters Satellite orbits Received signal parameters

S1000 GNSS	Parameter	Value
Integrated hard disk	Size	1 TB
Internal memory	Size	4 GB, 8 GB (optional)
External LAN	Connection	3 x 1000 BaseT UDP / TCP / 10 Gbit optical
RF Ports	Number Connector Type	1 or 2 N-Type female
Power supply, nominal values	Input voltage range AC supply frequency Max input current	100 V to 240 V (AC) 50 Hz to 60 Hz 1.4 A (100 V), 0.6 A (240 V)
EMC		Meets EN 55022, classB QP, AV FCC 47 CFR Part 15, Subpart B, Class B
Environmental conditions	Operating temperature Storage temperature	0 °C to 55 °C -40 °C to +70 °C
Dimensions (W x H x D)	Without angles With angles	446 mm x 88 mm x 570 mm 482 mm x 88 mm x 595 mm
Weight		12 kg (including keyboard)

[11] single channel bank - supporting up to 64 channels. When the same signal is generated across multiple channel banks the inter channel bank bias uncertainty is $\pm$ 2 ps

[12] RF1 signal and RF2 signal mixed and filtered and Phasenoise measurement performed. Jitter between two independant RF1+RF2 outputs

[13] The signal generator with its two RF outputs can be phase calibrated which compensates the inter-frequency bias between two RF bands.

DCLK IN	Value
Connector type	SMA, female, 50 Ω
Coupling	AC; DC max 50 V
Center frequency	160 MHz
Impedance	50 Ω
Input level	-25 dBm to +12 dBm, › +4 dBm result in compression
Input reflection |s11|	‹ -15 dB @ 100 MHz to 1000 MHz

DCLK OUT	Value
Connector type	SMA, female
Coupling	AC, DC max. 50 V
Center frequency	160 MHz
Impedance	50 Ω
Output level	+12 dBm (ON) -24 dBm (OFF)
Waveform	Square, Duty-Cycle = 50% ca. +2.0 Vpp @ 50 Ω
Spurs, non harmonic	‹ -90 dBc typical
Phasenoise	-90 dBc/Hz typical @ 10 Hz offset -102 dBc/Hz typical @ 100 Hz offset -128 dBc/Hz typical @ 1 kHz offset -146 dBc/Hz typical @ 10 kHz offset -154 dBc/Hz typical @ 100 kHz offset -155 dBc/Hz typical @ 1 MHz offset -155 dBc/Hz typical @ 10 MHz offset -155 dBc/Hz typical @ 30 MHz offset

Reference IN/OUT	
Connector type	BNC, female, 50 Ω
Coupling	AC; DC max 50 V
Center frequency	10 MHz
Tuning range	± 5 Hz
Input reflection |s11|	‹ -20 dB @ 10 MHz to 200 MHz
Input level max.	+18 dBm
Input level min.	0 dBm
Input leakage	-70 dBm typical
Output impedance	50 Ω
Output level	+6.5 dBm
Output waveform	Square: -0.6 V to +0.6 V Duty-Cycle: 50 % @ 50 Ω

System specification	Memory Extension	Memory Extension+
Operating system	Debian Linux 64 Bit	Windows 10 64 Bit
RAM	16 GB	16 GB
Storage HDD	4 x 3.5” Tray (removable) 2 x 12 TB Raid0 System	8 x 3.5” Tray (removable) 2 x 12 TB Raid0 System 4 x 2.5” Tray (removable)
System HDD	1 TB (removable)	500 GB (removable)
CPU	Intel core i7-4770S 4 x 3,1 GHz	Intel core i7-6700 4 x 4 GHz
Ethernet	4 x Gbit high-speed ports	6 x Gbit high-speed Ports
	2 x optical 10 Gbit (optional)	2 x optical 10 Gbit (optional)
Interfaces	2 x USB 2.0 (front) 4 x USB 2.0 (back) 2 x USB 3.0 (back)	2 x USB 2.0 (front) 4 x USB 2.0 (back) 4 x USB 3.0 (back)
	2 x RS232 Serial Ports (back)	1 x RS232 Serial Ports (back)
Display interface	1 x VGA (up to 1920 x 1200) 1 x HDMI (up to 1920 x 1080) 1 x DVI-D (up to 1920 x 1080)	2 x Display Port (up to 4096 x 2304) 1 x DVI-D (up to 2560 x 1600)
Graphic	Intel HD 4000/5000 Graphics	Intel HD Graphics 530
Display	24” TFT	24” TFT
Input	USB keyboard, USB mouse	USB keyboard, USB mouse
MTBF	› 36,500 h (Telcordia SR-332, Issue 3) @ 35°C environmental temperature	› 45,000 h (Telcordia SR-332, Issue 3) @ 35°C environmental temperature
Input voltage range	100 V - 240 V (AC)	100 V to 240 V (AC)
AC supply frequency	50 Hz - 60 Hz	50 Hz to 60 Hz
Max. input current	1.4 A (100 V) ; 0.58 A (240 V)	2.0 A (100 V) ; 0.83 A (240 V)
Dimensions (W x H x D)	435 mm x 88 mm (2 RU) x 550 mm (+30 mm incl. handles)	426 mm (+52 mm for ears) x 178 mm (4 RU) x 490 mm (+50 mm incl. grips)
Weight	13.5 kg	25.8 kg

Ordering Guide

Hardware IZT S1000 GNSS	Description
IZT S1000-CHS	Chassis and all digital hardware
IZT S1000-10G	10 Gbit option
IZT S1000-TCS	Transport case (for packaging)
IZT S1000-RF3	RF output 9 kHz to 3 GHz [14]
IZT S1000-RFS3	RF synthesizer 3 GHz
IZT S1000-8GB	8 GB high-speed memory (increases the internal memory from 4 GB to 8 GB)
IZT S1000-FHS	Frequency hopping module
IZT S1000-FHC	Additional frequency hopping channel
IZT S1000-EXT_SYNC	External synchronization interface
IZT S1000-Memory-Extension	Enhances the IZT S1000 streaming capabilities to wideband signals
IZT S1000-MemExt 10G	optical 10 GBit LAN

Software	Description
IZT S1000-GUI	Graphical user interface
IZT S1000-LBV	LabVIEW driver
IZT S1000-110	One virtual signal generator VSG [15]
IZT S1000-120	Streaming input (high-speed LAN streaming, 2 Gbit ports for streaming data)
IZT S1000-140	Advanced streaming (enables time controlled streaming)
IZT S1000-203	DAB real-time modulator
IZT S1000-203b	Live EDI input for IZT S1000-203
IZT S1000-220	HD Radio™license to play digital HD AM and FM files [16]
IZT S1000-301	Phase noise simulation
IZT S1000-304	Fading channel simulator with fixed delays
IZT S1000-305	Power level profiles
IZT S1000-306	Frequency profile / delay profile
IZT S1000-307	Shaped noise
IZT S1000-402	FM RDS: Generation of AM and FM signals from audio waveform files [17]
IZT S1000-403	DAB modulator
IZT S1000-407	DAB/DAB+/DMB ContentServer Embedded Edition[18]
IZT S1000-407b	DAB/DAB+/DMB ContentServer Embedded Edition upgrade[19]
IZT S1000-409	DRM30 modulator

[14] IZT S1000 can be equipped with one or two RF outputs; requires at least one synthesizer IZT S1000-RFS3 RF
[15] up to 8 VSGs are possible
[16] Requires at least one IZT S1000-110 VSG
[17] includes RDS encoder
[18] Can be extended by additional options of the IZT DAB ContentServer. Full-featured DAB functionality is available with the IZT DAB ContentServer Developer Edition. For further information, please refer to the IZT DAB ContentServer brochure
[19] Can be extended by additional options of the IZT DAB ContentServer. Full-featured DAB functionality is available with the IZT DAB ContentServer Developer Edition. For further information, please refer to the IZT DAB ContentServer brochure

Software	Description
IZT S1000-409a	DRM30 modulator for MDI input
IZT S1000-410	DRM30/DRM+ modulator
IZT S1000-410a	DRM30/DRM+ modulator for MDI input
IZT S1000-410b	DRM30/DRM+ modulator bundle (IZT S1000-410/-410a)
IZT S1000-412	GPS output
IZT S1000-413	Spectrum display
IZT S1000-414	Video playback
IZT S1000-416	DRM30/DRM+ upgrade xHE-AAC / HE-AAC
IZT S1000-417	DRM30/DRM+ upgrade MDI output streaming
IZT S1000-418	DVB-T modulation toolbox
IZT S1000-419	DVB-T2 modulation toolbox
IZT S1000-420	ISDB-T modulation toolbox

Memory Extension	Description
IZT S1000 Memory Extension	Enhances the IZT S1000 streaming capabilities to wideband signals; provides 2 x 12 TB storage capacity
IZT S1000 Memory Extension+	Enhances the IZT S1000 streaming capabilities to wideband signals; provides 2 x 9 TB storage capacity with fault tolerance

Service	Description
IZT Software Support Contract	Support for IZT software options
IZT WE2	Warranty extension to 2 years
IZT WE3	Warranty extension to 3 years
IZT S1000-CLC	Factory calibration recommended in a 2-year cycle (IZT certificate included)

GNSS Options	Features of Satellite Constellation Simulator
IZT S1000-601	GPS constellation simulator including the following signals: C/A, GPS L1C, GPS L2 C, GPS L5 I/Q (Hardware Modulation) Simulation of the following features: - Satellite orbits based on ephemeris or orbit integration - Satellite clock model - Atmospheric delays - Antenna gain pattern - Statistical multipath model with time-dependant obstruction mask - Realistic and reproducible noise components - User-configurable navigation message contents
IZT S1000-602	Additional GLONASS signals: L1OF, L2OF (Hardware Modulation)

GNSS Options	Features of Satellite Constellation Simulator
IZT S1000-603	Additional Galileo signals: E1 OS, E5 (E5a + E5b), E6 CS (Hardware Modulation)
IZT S1000-604	Additional Beidou signals: B1-1, B1-2, B3-I10 (Hardware Modulation)
IZT S1000-605	Additional NavIC signals: L5 SPS, S SPS (Hardware Modulation)
IZT S1000-606	Additional QZSS signals: C/A, L1C, L2, L5 , L1 SLAS, E6 CLAS (Hardware Modulation)
IZT S1000-607	Additional SBAS signals: SBAS L1 C/A The following SBAS systems are supported: WAAS, EGNOS, SDCM, GAGAN, MSAS
IZT S1000-620	IZT S1000 GNSS Real-time Interface. Requires the Option IZT S1000-10G.
IZT S1000-GNSS-HS	GNSS simulation version which supports moving objects in excess of 600m/s
IZT S1000-GNSS-ECALL-BASE	Predefined eCall Test scenarios: Includes IZT S1000-601, IZT S1000-603 and IZT S1000-607 - Scenarios - Precomputed IF signals - Predefined Configurations

Example Configuration GPS	Number	Remarks
IZT S1000-CHS	1	Chassis and all digital hardware
IZT S1000-10G	1	10 Gbit option
IZT S1000-RF3	2	RF output 9 kHz to 3 GHz
IZT S1000-RFS3	2	RF synthesizer 3 GHz
IZT S1000-GUI	1	Graphical user interface
IZT S1000-110	8	Virtual signal generator VSG
IZT S1000-120	1	Streaming input (high-speed LAN streaming, 2 Gbit ports for streaming data)
IZT S1000-140	1	Advanced streaming (enables time controlled streaming)
IZT S1000-413	1	Spectrum display
IZT S1000-Memory-Extension	1	Enhances the IZT S1000 streaming capabilities to wideband signals. Constellation simulator is also operated here
IZT S1000-MemExt 10G	1	optical 10 GBit LAN
IZT S1000-601	1	GPS constellation simulator including L1, L2, L5

Further configurations on request. Please contact sales@izt-labs.de

IZT S1000 GNSS
Realtime Signal Generator

Product Information

About IZT The Innovationszentrum fuer Telekommunikationstechnik GmbH IZT specializes in the most advanced digital signal processing and field programmable gate array (FPGA) designs in combination with high frequency and microwave technology.

The product portfolio includes equipment for signal generation, receivers for signal monitoring and recording, transmitters for digital broadcast, digital radio systems, and channel simulators. IZT offers powerful platforms and customized solutions for high signal bandwidth and real-time signal processing applications. The product and project business is managed from the principal office located in Erlangen/Germany. IZT distributes its products worldwide together with its international strategic partners. The IZT quality management system is ISO 9001:2015 certified.

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INNOVATIONSZENTRUM FÜR TELEKOMMUNIKATIONSTECHNIK GMBH IZT AM WEICHSELGARTEN 5 · 91058 ERLANGEN, GERMANY
GENERAL MANAGER: RAINER PERTHOLD · TEL: +49 (0)9131 9162-0 · FAX: -190 · SALES@IZT-LABS.DE · WWW.IZT-LABS.DE

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IZT Innovationszentrum Telekommunikationstechnik

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