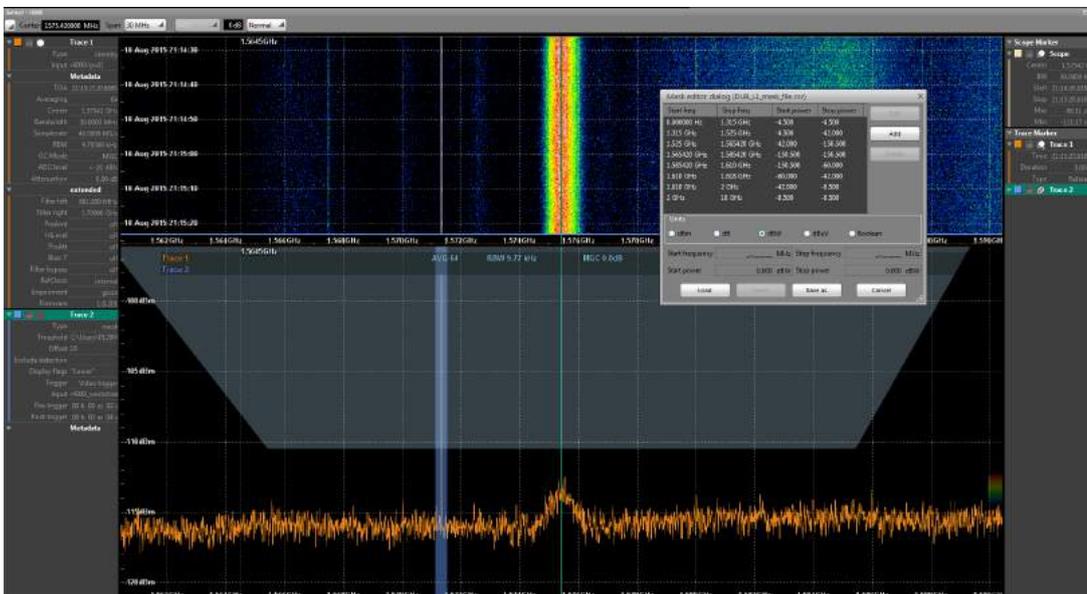


# GNSS Monitoring and Interference Recording



- GNSS monitoring with superior dynamic range
- Covers five GNSS signals simultaneously
- RF recording triggered by interferer events
- Adjustable pre-recording time
- Interference analysis
- Accurate documentation of interference events



## OVERVIEW

Professional receivers for Global Navigation Satellite System (GNSS) like GPS, Galileo and GLONASS are facing multiple threats caused by illegal transmissions, jamming devices and defective RF installations. IZT offers the ideal solution to record, analyze and identify both the interfering signals and the GNSS signal itself – including replay of the RF signal. Accurate and comprehensive documentation supports spectrum policing. The IZT GNSS Monitoring System in its full configuration

can monitor five GNSS bands:

- GPS L5, Galileo E5a at 1176.45 MHz
- GPS L2 at 1227.6 MHz
- GLONASS G2 at 1246 MHz
- GPS L1, Galileo E1 at 1575.42 MHz
- GLONASS G1 at 1602 MHz

An additional scanning receiver detects strong out-of-band interferers.

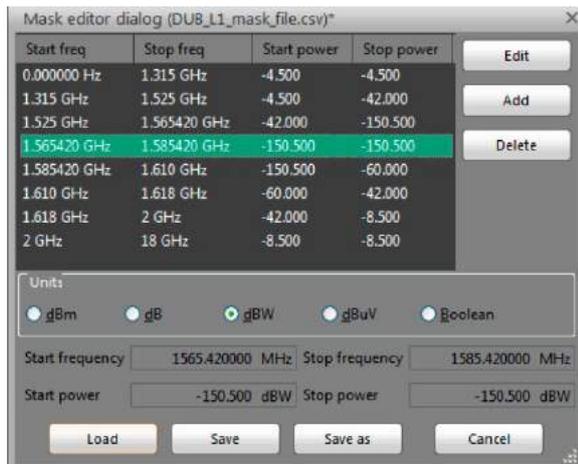


FIGURE 1: SPECTRUM MASK EDITOR

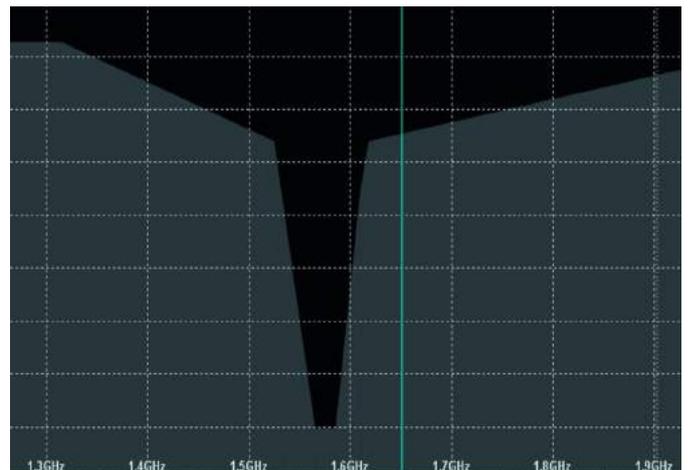


FIGURE 2: ICAO MASK FOR GPS L1



FIGURE 3: ONE INTERFERER MEETING MASK CRITERIA IS DETECTED AND TRIGGERS THE RECORDING TASK

## TECHNICAL BACKGROUND

IZT has a modern portfolio of professional, high dynamic range wideband receivers. Compared to most systems specifically designed for GNSS applications, the IZT receivers work with full 16 bit resolution. This allows capturing GNSS content even under demanding situations when the system has to deal with high levels of interference or strong out-of-band signals.

The IZT Signal Suite software provides RF signal capture in combination with long-term spectrum band monitoring for many days to identify also those interferers which are only rarely in operation. If required, the system can buffer the signals for days.

If a jamming event occurs, the affected RF signal is archived automatically for subsequent analysis in the lab or export to the spectrum regulator. The trigger event can for example be defined by power limits, as a spectrum mask (for example as defined in ICAO annex 10), captured reference traces or by trigger events from external sources. The IZT receiver even has the capability to dynamically enlarge its recording bandwidth up to the full instantaneous bandwidth in order to accurately capture the interference. An adjustable pre-trigger and

selectable follow-up time allows capturing not only the period of time when the interferer is active. It always includes configurable pre- and post-trigger times (up to 30 min or even longer) prior and after the interference event.

In addition to GNSS monitoring and interference detection, this functionality allows verification of professional aeronautic GNSS receivers by replaying the captured GNSS content via the IZT S1000 Signal Generator. The long pre-trigger time of the IZT GNSS Monitoring System allows the 'receiver under test' to acquire a lock sufficiently long before the interference event.

To identify potential sources of interference, the IZT GNSS Monitoring Systems can record video data from a camera with accurate time stamps for later comparison of the video and RF recording. For utmost protection, even a interferometric Radio Direction Finder can be tied into the system to measure the angle of arrival of the interferer.



FIGURE 4: STATUS INFORMATION OF WIDEBAND I/Q RECORDING WITH IZT R3301 RF RECORDER

## KEY FEATURES

### Up to five GNSS bands in one integrated system

Using IZT's high quality monitoring receivers, the IZT GNSS Monitoring System can simultaneously monitor five GNSS bands:

- GPS L5, Galileo E5a at 1176.45 MHz
- GPS L2 at 1227.6 MHz
- GLONASS G2 at 1246 MHz
- GPS L1, Galileo E1 at 1575.42 MHz
- GLONASS G1 at 1602 MHz

An additional scanning receiver detects strong out-of-band interferers.

The RF signals are downconverted with large dynamic range, digitized and processed in FPGAs. Frequency bands meeting defined criteria are extracted and forwarded to the sensor controller for recording and analysis.

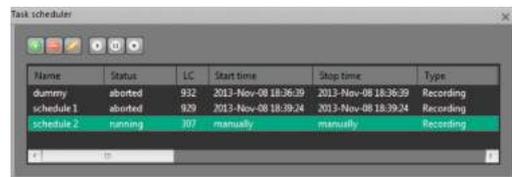
### Recording Signal & Interferers

**Continuous long-term recording** The IZT GNSS Monitoring System has the capability to buffer the five streams containing the GNSS signals as a FIFO. Signals can be buffered for long durations, like for example up to 48h, depending on the installed storage space. All data is complemented with accurate time stamps, allowing to trace back anomalies, which might be reported by GNSS users.

**Archiving of degraded signals** Whenever the software detects interference or degrade signal quality, it will permanently archive the respective part of the data streams. It is possible to set an arbitrarily long per- and post trigger times, only limited by the available storage space. A typical value would be 30 min. In case the recorded data is fed to a reference receiver, the long pre-trigger time allows the receiver to acquire a lock on the signal long before the interference event happens.

**Automatic storage clean-up** Recorded data will be automatically removed from the storage system, once its storage time expires. Recordings containing interference will be permanently archived until deleted by the operator.

**Scheduled recording** The recording task scheduler gives an overview of currently active recording tasks. Here the tasks can be edited.



Name	Status	LC	Start time	Stop time	Type
dummy	aborted	932	2013-Nov-08 18:36:39	2013-Nov-08 18:36:39	Recording
schedule 1	aborted	929	2013-Nov-08 18:39:24	2013-Nov-08 18:39:24	Recording
schedule 2	running	901	manually	manually	Recording

FIGURE 5: SCHEDULE LIST OF RECORDING TASKS

### Trigger Sources

The IZT GNSS Monitoring System uses different trigger sources.

- Mask defined by discrete set of nodes via an editor, for example an ICAO Annex 10 spectrum mask
- An "environmental" threshold defined by a trace, which was generated by "max hold" with an adjustable level offset
- A fixed power level threshold
- A strong out-of-band interferer detected by the scanning receiver

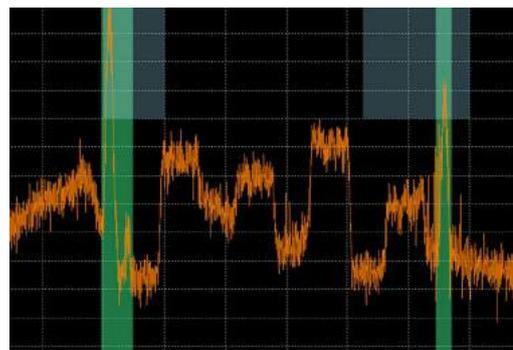


FIGURE 6: SELECTIVE TRIGGER ON SIGNAL EVENTS

## Long-term Spectrogram

The long-term spectrogram function allows the operator to gain a quick overview over hours or even days of recorded spectrum.

## Remote Access and Alarming

The IZT GNSS Monitoring System's graphical user interface can be accessed locally or remotely. It can be configured to alert operators via email or an SNMP trap.

## GNSS INTERFERENCE DETECTION & ANALYSIS SYSTEM (GIDAS®)

The IZT GNSS Monitoring System can feed all or parts of the captured signals to a software package called GIDAS® (GNSS Interference and Analysis System). GIDAS® resides on a separate server and complements the capabilities of the IZT GNSS Monitoring System by detecting and classifying any GNSS interference signals. It reduces the already existing threat of receiving worse GNSS accuracies or even denial of GNSS service. GIDAS® improves save and robust operation of GNSS receivers, terminals, and GNSS-based applications considerably by offering the capabilities for reliably detecting and classifying GNSS jamming attacks.

Apart from jamming interference, GIDAS® is capable of detection of spoofing attacks. These attacks mimic authentic GNSS signal and lead to a navigation solution which can be steered by the attacker. By observation of several GNSS bands, decoding of navigation messages, receiver observations and combination of the accumulated data, GIDAS® uses the information in several detection units, to decide on whether an attack is occurring and also on the severity of an attack.

For documentation purposes, in case of an interference incident in-depth information as well as detection metrics of different detectors are stored within a database and can be easily accessed by the end-user via REST API.

## Supported GNSS Signals

### GNSS Constellations

A supported minimum of GNSS constellations are:

- GPS
- Galileo
- GLONASS
- SBAS (EGNOS, WAAS)

Optional:

- QZSS
- BeiDou

## GIDAS® is licensed by:



## Frequency Bands

The supported frequency bands are:

Option	Band	Center Frequency [MHz]
GIDAS Option A	L1/E1ab	1575.420
	G1	1602.000
GIDAS Option B	L1/E1ab	1575.420
	G1	1602.000
	G2	1246.000
	L2	1227.600
	L5/E5a	1176.450
Optional	E5b	1207.140
	E6	1278.750
	G3	1202.025
	B1	1561.098
	B2	1207.140
	B3	1268.520

## Signal Components

The supported signal components are:

GNSS	Signal Components			
GPS	L1 C/A	L2C	L5-I	L5-Q
SBAS	EGNOS L1			
Galileo	E1 B & C	E5a-I/-Q	E5b-I/-Q*	E6*
GLONASS	G1 C/A*	G2 C/A*		
BeiDou	B1-I*	B2-I*	B3*	

**NOTE:** all variants with \* are optional

All above mentioned signal components are considered for acquisition, tracking and navigation message decoding and included in the PVT solution. The software (especially the navigation message decoding) is designed to allow easy adaptation to new signal definitions and thus easy integration of future signals.

## Interference Detection

GIDAS is capable of the detection of jamming and spoofing attacks. Furthermore, several detection methods are utilized to make a profound assumption of the severity of a possible interference event.

### Jamming Detection Methods

- Power spectral density (threshold for Narrow Band Interference and Wide Band Interference)
- Total received power (threshold)
- Receiver C/N0 monitoring (adaptive threshold)
- Position Velocity Time (PVT) based monitoring (adaptive threshold)
- Pseudorange & Doppler observation monitoring

### Spoofing Detection Methods

- Monitoring of received power (threshold)
- Monitoring of C/N0 (threshold)
- Correlation peak monitoring (number of peaks – separation of multiple peaks)
- Spatial correlation of Doppler observations
- Pseudorange & Doppler observation monitoring
- Position Velocity Time (PVT) based monitoring (static receiver only)
- Monitoring of receiver clock

**Supported interference types** Intentional interference by means of jamming and spoofing are detected by interference types.

**Jammer Types** The system is able to detect pulsed and non-pulsed interference signals of any signal type which are above thermal noise by

- 8 dB for narrowband interference
- 5 dB for wideband interference

in terms of C/N within monitored bandwidth. The following types are able to automatically be classified:

- Amplitude Modulated (AM)
- Frequency Modulated (FM)
- Continuous Wave (CW)
- Swept Continuous Wave (SCW)
- Narrow Band Interference (NBI)

- Wide Band Interference (WBI)
- Spreading signals

### General Specifications

**Real-time operation** Real time operation with constant signal streams (with at least 10 MHz sampling rate).

**Alarm Time** The latency between detection of interference and user notification (depending on software and network latency) is below 10 seconds.

**Continuity of operation** The GIDAS system supports a 24 hours / 7 days a week operation.

**Reliability** The reliability is related to the type of interference signal and interference signal power. An assessment of the reliability has to be performed during performance testing. Expected value > 95% for ICAO thresholds.

**Detection Probability** Detection probability is related to the type of interference signal and interference signal power. An assessment of the detection probability has to be performed during performance testing. Expected value: > 95% for ICAO thresholds.

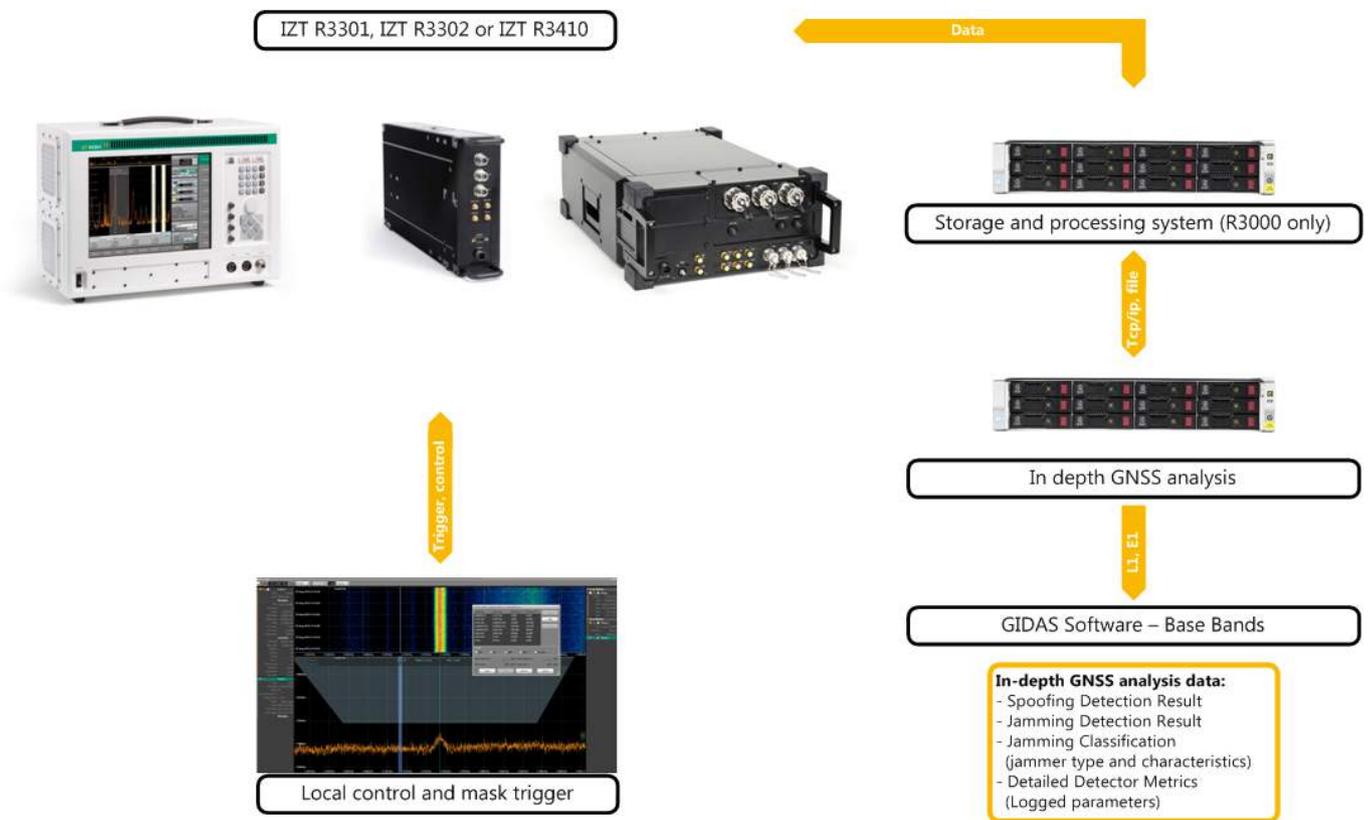
**GIDAS Module Output** The interface to the data generated by GIDAS is accessible by a standardized REST API. The available outputs are listed below:

- Jamming detection and classification results
- Spoofing detection result
- Detailed detector metrics and intermediate detection results:
  - CNR, PVT, Pseudorange, PSD, Doppler, Signal Power, Receiver Clock, Spatial Correlation Algorithm
- Overall system status

## IZT GNSS MONITORING SYSTEM - VARIANTS

### IZT GNSS Monitoring System Configuration “A” - Single Channel

The smallest version of the IZT GNSS Monitoring System is able to monitor one GNSS frequency, typically GPS L1 and Galileo E1 at a time. Depending on the use case of the customer, it can be realized with different hardware. All IZT R3000 series receivers listed below have identical RF performance and processing capabilities. All variants can be combined with a camera for time synchronous recording of RF and video. In case of a later on upgrade to a larger system, the IZT R3000 receiver can be reused as scanning receiver.



**FIGURE 7:** IZT GNSS MONITORING SYSTEM CONFIGURATION “A”

**IZT R3000 and Server** The combination of a rack based IZT R3000-series receiver with a rack based server is suitable for fixed indoor installations. The storage size of the receiver can be configured according to the maximum buffering time required by the customer.



**FIGURE 8:** IZT R3000

**IZT R3301** The IZT R3301 is a receiver with integrated sensor controller with room for four 2.5" HDDs or SSDs - currently 8 TByte total size. It has a built-in display and has been designed for minimum RF emissions. The IZT R3301 is intended for indoor applications. For details see the IZT R3301 data sheet.



**FIGURE 10:** IZT R3301

**IZT R3410 / IZT R3411 and Notebook** If a compact, portable solution for indoor use is desired, the IZT R3411 receiver and a powerful notebook provide a perfect solution.



**FIGURE 9:** IZT R3410 WITH EXTERNAL SENSOR CONTROLLER

**IZT R3302** The IZT R3302 is rated IP54 and therefore suitable for outdoor applications, for example temporary deployments at an airfield. Like the IZT R3301, it has room for four 2.5" HDDs or SSDs. It can be equipped with a wireless modem for remote operation. For details see the IZT R3302 data sheet.



**FIGURE 11:** IZT R3302 WITH EXTERNAL SENSOR CONTROLLER

## Maximum Storage Time

Recording a data stream requires approximately 5 megabyte per megahertz and second. GPS L1, for example, should be recorded with at least 4 MHz bandwidth. The 8 TByte storage space in the IZT R3301 or IZT R3302, would therefore be adequate for over 100 h of stored or buffered signals.

## Multichannel System “B”

The IZT GNSS Monitoring System configuration B uses one IZT R4000 receiver. With its instantaneous bandwidth of 120 MHz it can monitor simultaneously either

- GPS L5, Galileo E5a at 1176.45 MHz
- GPS L2 at 1227.6 MHz

- GLONASS G2 at 1246 MHz

or

- GPS L1, Galileo E1 at 1575.42 MHz
- GLONASS G1 at 1602 MHz

The GNSS signals will be monitored continuously with constant center frequency and bandwidth. The IZT R4000 has the unique capability to quickly adapt its recording bandwidth with a short pretrigger time allowing to capture also broadband interferers once they exceed a level mask, for example the ICAO Annex 10 mask, within the instantaneous bandwidth of the receiver.

All bands are recorded fully synchronous and with accurate time stamps. The data is suitable for triangulation, although triangulation is not a standard feature of the IZT Signal Suite Software yet.

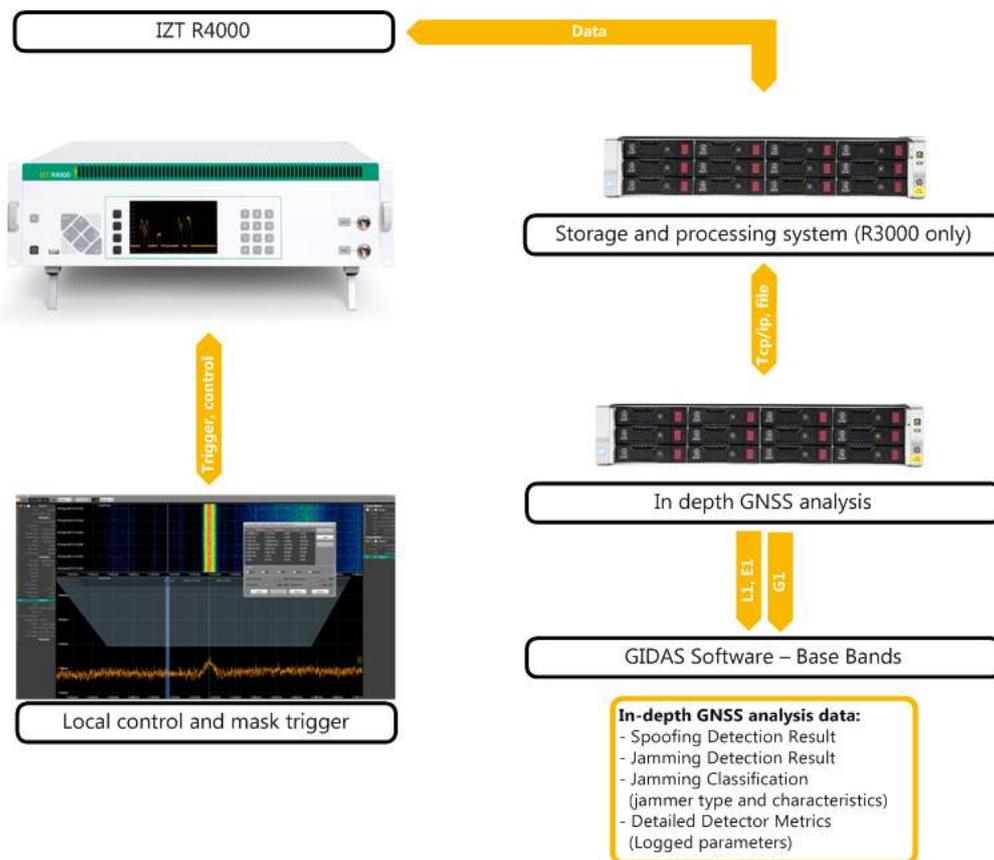


FIGURE 12: IZT GNSS MONITORING SYSTEM CONFIGURATION “B”

### IZT GNSS Monitoring System Configuration “C”

The IZT GNSS Monitoring System configuration C uses two IZT R4000 receivers. With their instantaneous bandwidth of two times 120 MHz and different center frequencies it can monitor simultaneously

- GPS L5, Galileo E5a at 1176.45 MHz
- GPS L2 at 1227.6 MHz
- GLONASS G2 at 1246 MHz
- GPS L1, Galileo E1 at 1575.42 MHz
- GLONASS G1 at 1602 MHz

The GNSS signals will be monitored continuously with constant center frequency and bandwidth. The IZT R4000 has the unique capability to quickly adapt its recording bandwidth with a short pretrigger time allowing to capture also broadband interferers once they exceed a level mask, for example the ICAO Annex 10 mask, within the instantaneous bandwidth of the receiver.

All bands are recorded fully synchronous and with accurate time stamps suitable for triangulation<sup>1</sup>.

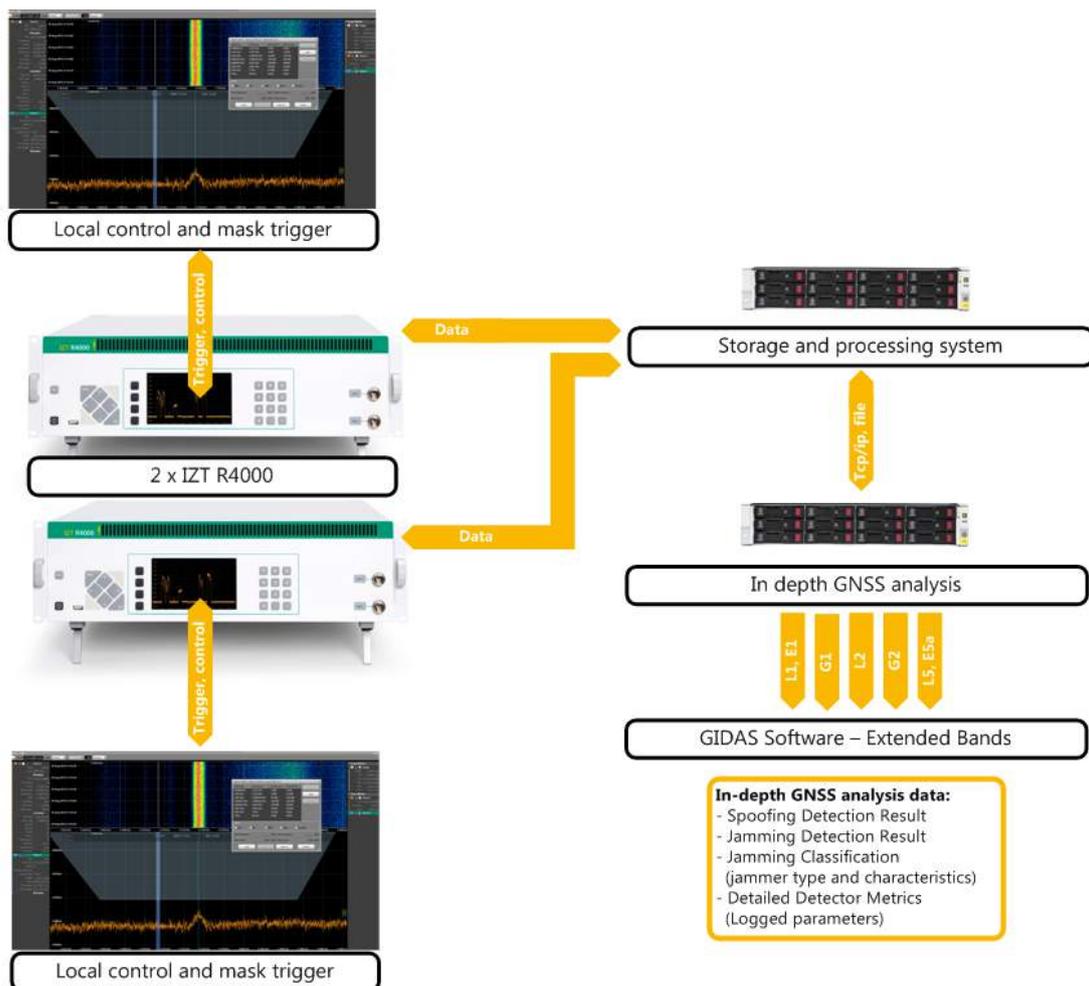


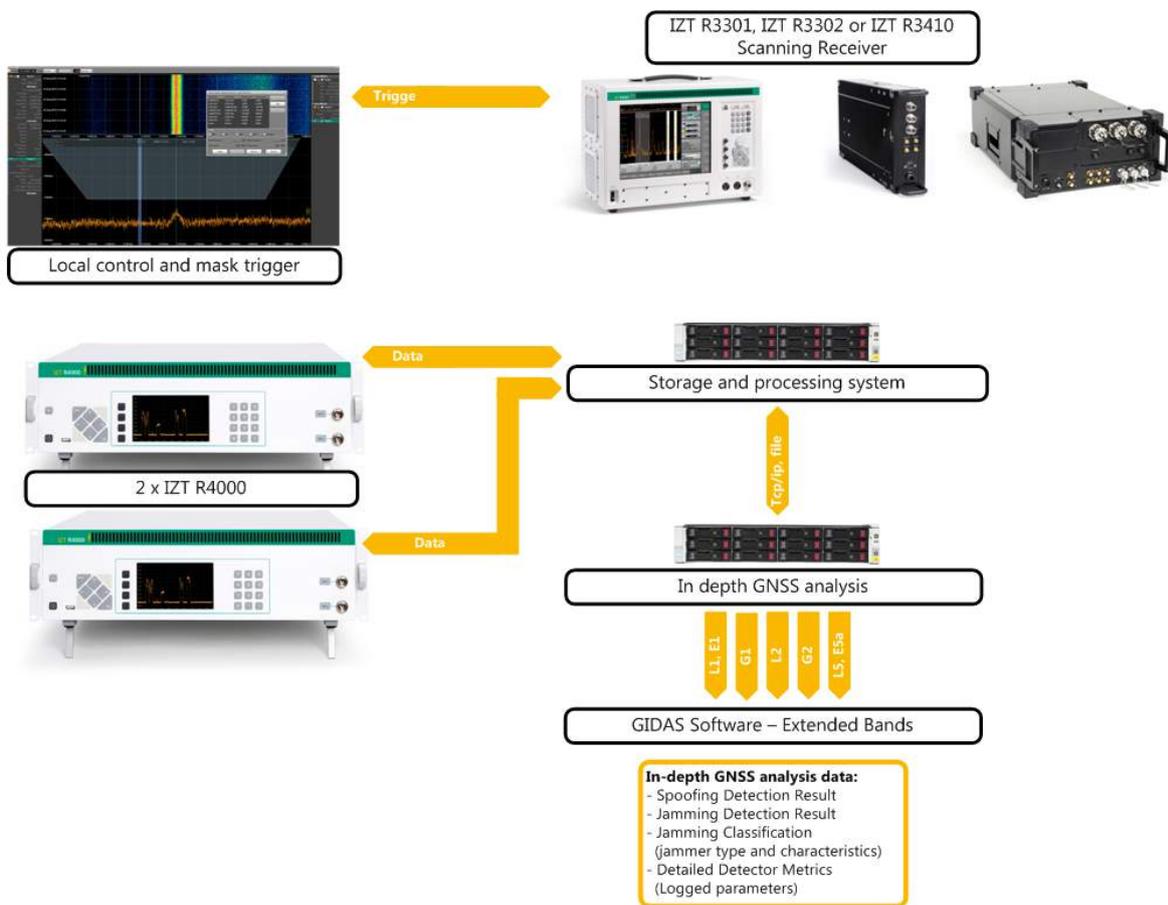
FIGURE 13: IZT GNSS MONITORING SYSTEM CONFIGURATION “C”

<sup>1</sup>The triangulation process itself is not supported by the IZT Signal Suite

## Additional Scanning Receiver “D”

With an additional scanning receiver the system performs continuous scanning to observe spectrum mask compliance. It can detect out of band interferers, generate trigger for the monitoring receivers and it can generate an alarm.

- Ideal suited for IZT R3301, IZT R3302 and IZT R341 1
- Supports IZT R4000 wideband RF recorder
- IZT Sensor Controller



**FIGURE 14:** IZT GNSS MONITORING SYSTEM CONFIGURATION “D”

## Post processing

- Off-line spectrum and spectrogram analysis with IZT Viewer
- I/Q data extraction with IZT Data Processor
- IZT SDK for off-line data access with MATLAB, C# and C++
- RF replay with IZT S1000 Signal Generator

## APPLICATIONS

- Protection of GNSS bands in sensitive areas
- Identifying interferer sources
- Evaluation of receiver performance under real interferer scenarios in the lab
- Providing reliable data to frequency regulators for spectrum policing

## YOUR BENEFITS

- RF recording with high dynamic range preserves GNSS signal in case of interference
- High-fidelity recording of interference event and its history
- Simple, easy to use setup (one click recording)
- Compact, integrated equipment

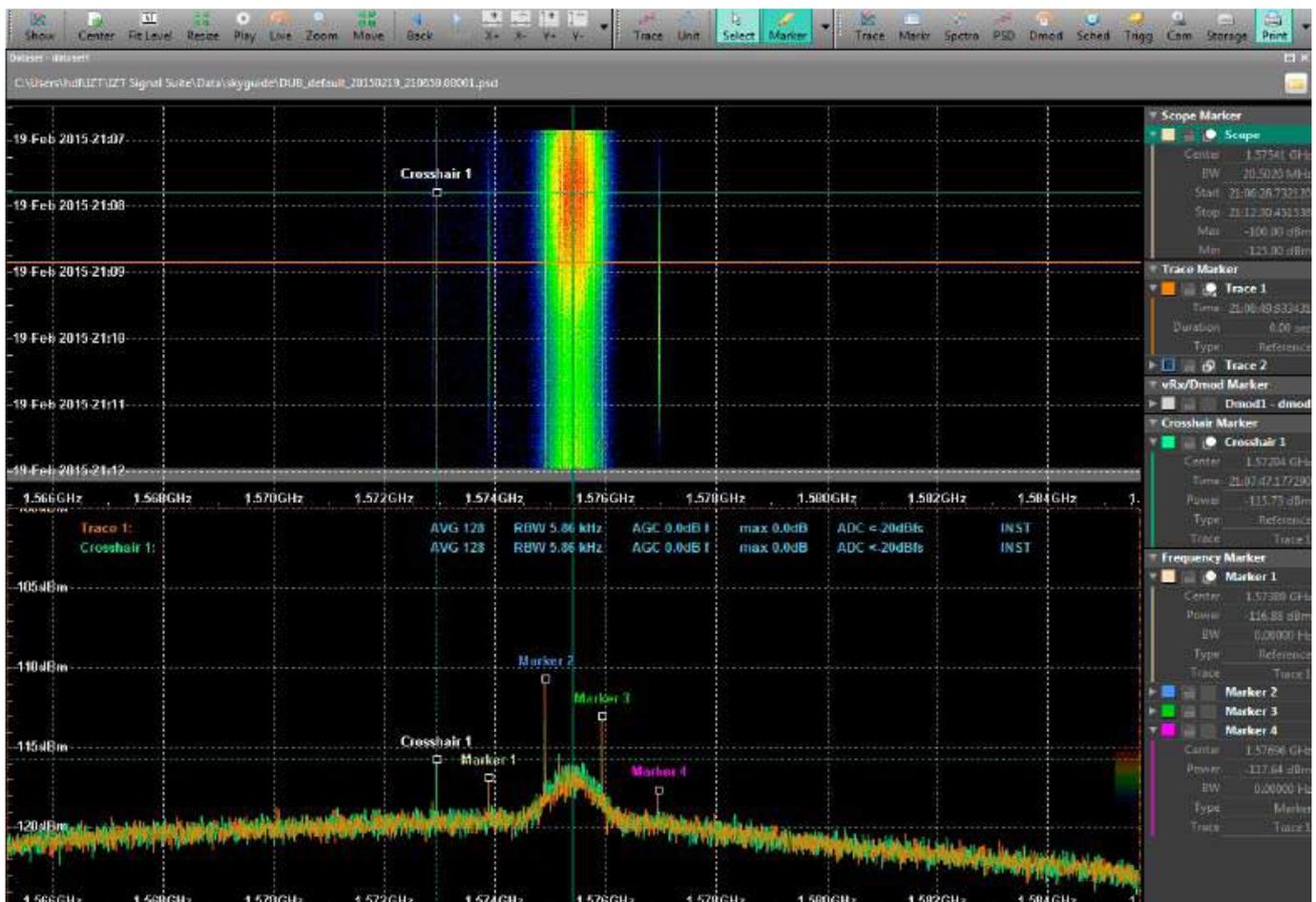


FIGURE 15: GNSS INTERFERER ANALYSIS WITH OFF-LINE APPLICATION IZT VIEWER

## RELATED PRODUCTS

### IZT S1000 Signal Generator and IZT Data Processor

The IZT S1000/S1010 is ideal for replaying a captured signal as live RF signal and feeding it to a GNSS receiver to test the receiver performance under the exact same conditions as if it were connected to the receive antenna in the field during the interference event.

If more complex test scenarios are required, the up to 31 virtual signal generators of the S1000 will make it

very easy to dynamically add signals to the recorded signal and observe the reaction of the GNSS receiver under test. Prior to replaying the signal, the IZT Data Processor Software allows to view and edit the recordings.

More details can be derived from the IZT S1000/IZT S1010 brochure.



FIGURE 16: IZT S1000 SIGNAL GENERATOR



FIGURE 17: IZT S1010 SIGNAL GENERATOR

### IZT R5506 Direction Finder

The IZT R5506 is a compact, high performance radio direction finder for the frequency range of 1 MHz to 6000 MHz with 60 MHz instantaneous bandwidth. The RF and digital processing is closely integrated with the antenna system. The receiver is non-switching to maximize sensitivity and minimize detection times. The digitized signals are sent to the DF processor via a hybrid optical cable to increase operational flexibility and avoid loss of performance due to long coaxial cables. The result is an exceptional dynamic range, sensitivity and DF accuracy within the capabilities of the antenna array. In the IZT R5506 the digitization and digital signal processing are performed before the transmission via the optical link, so it avoids the performance limitations of concepts based on "rf over fiber". The radio direction finder will be controlled by trigger event.



FIGURE 18: INSTALLATION OF IZT R5506 RADIO DIRECTION FINDER

More details can be derived from the IZT R5506 brochure.

## SPECIFICATIONS

### Configuration A/D

Specification	Value	Comment
Frequency Range	30 MHz to 3000 MHz	
Hardware Preselector	11 bands	
Instantaneous Bandwidth	up to 25 MHz	
Gain Control	automatic (fast, medium, slow) or manual	
Number of Hardware DDSs	4	
Phase noise	-120dBc/Hz @ 10kHz	
Dynamic range	>80dB	(@100kHz bandwidth, 1MHz offset)
Receiver noise figure	<10dB	Preamp on (not including active antenna)
IIP3	+15dBm	(at full gain, preamp off)
external preamp	manual control on / off	
antenna pattern GNSS	hemispheric	
high stability reference clock	OCXO	
maximum pre-trigger time	30 min	longer times possible, only limited by size of storage system

### Configuration B/C/D

Specification	Value	Comment
Frequency Range	30 MHz to 3000 MHz	
Hardware Preselector	11 bands	
Instantaneous Bandwidth	up to 120 MHz	
Gain Control	automatic or manual	
Number of Hardware DDSs	16	
Phase noise	-115dBc/Hz @ 10kHz	
Dynamic range	>80dB	(@100kHz bandwidth, 1MHz offset)
Receiver noise figure	<10dB	Preamp on (not including active antenna)
IIP3	+15dBm	(at full gain, preamp off)
external preamp	manual control on / off	
high stability reference clock	OCXO	
antenna pattern GNSS	hemispheric	
antenna pattern scanning receiver	omni	1 GHz to 2 GHz

## ORDERING GUIDE

### Configuration A

Option	Description
IZT R3030	VUHF Receiver <sup>2</sup>
IZT R3301	alternative VUHF Receiver <sup>3</sup>
IZT R3302	alternative VUHF Receiver <sup>4</sup>
IZT R3410	alternative Ruggedized VUHF Receiver <sup>5</sup>
IZT R3411	alternative Ruggedized VUHF Receiver <sup>6</sup>
IZT SignalSuite-510	Sensor Synchronisation
IZT SignalSuite-810	RF Recorder R3000 – 25 MHz
IZT SignalSuite-230	Long-term Spectrogram Recording
IZT SignalSuite-240	Mask Triggered Recording
IZT SignalSuite-242	Pre-Recording
IZT SignalSuite-830	Data Processor
IZT SignalSuite-260	Signal Import/Export
IZT SignalSuite-820	Viewer
IZT A1000-CMB	Metal Case USB Dongle
IZT SignalSuite-310	Time Shift Signal Access
IZT SignalSuite-262	Signal Extraction
IZT P2201	Server for GIDAS®
SPR-GID-0601	GIDAS® Software - Base Bands <sup>7</sup> GPS L1, Galileo E1, GLONASS G1

<sup>2</sup>with options R3000-TRIG and R3000-OCX

<sup>3</sup>with options R3301-CHS, R3000-RF3 and R3300-GSR

<sup>4</sup>with options R3302-CHS, R3000-RF3 and R3300-GSR

<sup>5</sup>with options R3410-CHS, R3000-RF3, R3410-DCW, P1010, R3300-GSR and A1000-GPS

<sup>6</sup>with options R3411-CHS, R3000-RF3, P1010, R3300-GSR and A1000-GPS

<sup>7</sup>The GIDAS® Software is licensed from OHB Digital Solutions.

## Configuration B

Option	Description
IZT R4000	Wideband Receiver <sup>8</sup>
IZT SignalSuite-510	Sensor Synchronization
IZT SignalSuite-812	RF Recorder R4000 – 120 MHz
IZT SignalSuite-230	Long-term Spectrogram Recording
IZT SignalSuite-240	Mask Triggered Recording
IZT SignalSuite-242	Pre-Recording
IZT SignalSuite-830	Data Processor
IZT SignalSuite-260	Signal Import/Export
IZT A1000-CMB	Metal Case USB Dongle
IZT SignalSuite-820	Viewer
IZT SignalSuite-310	Time Shift Signal Access
IZT SignalSuite-262	Signal Extraction
IZT P2201	Server for GIDAS <sup>®</sup>
SPR-GID-0601	GIDAS <sup>®</sup> Software - Base Bands <sup>9</sup> GPS L1, Galileo E1, GLONASS G1

<sup>8</sup>with options R4000-CHS, R4000-RF3W and A1000-RTS

<sup>9</sup>The GIDAS<sup>®</sup> Software is licensed from OHB Digital Solutions.

## Configuration C

Option	Description
2xIZT R4000	Wideband Receiver <sup>10</sup>
IZT SignalSuite-510	Sensor Synchronization
2xIZT SignalSuite-812	RF Recorder R4000 – 120 MHz
IZT SignalSuite-230	Long-term Spectrogram Recording
IZT SignalSuite-240	Mask Triggered Recording
IZT SignalSuite-242	Pre-Recording
IZT SignalSuite-830	Data Processor
IZT SignalSuite-260	Signal Import/Export
IZT A1000-CMB	Metal Case USB Dongle
IZT SignalSuite-820	Viewer
2xIZT SignalSuite-310	Time Shift Signal Access
IZT SignalSuite-262	Signal Extraction
IZT P2202	Server for GIDAS®
SPR-GID-0602	GIDAS® Software - Extended Bands <sup>11</sup> GPS L1/L2/L5, Galileo E1/E5a, GLONASS G1/G2

<sup>10</sup>with options R4000-CHS, R4000-RF3W and A1000-RTS

<sup>11</sup>The GIDAS® Software is licensed from OHB Digital Solutions.

## Configuration D

Option	Description
2xIZT R4000	Wideband Receiver <sup>12</sup>
IZT R3030	VUHF Receiver <sup>13</sup>
IZT SignalSuite-510	Sensor Synchronization
IZT SignalSuite-810	RF Recorder R3000 – 25 MHz
2 x IZT SignalSuite-812	RF Recorder R4000 – 120 MHz
IZT SignalSuite-230	Long-term Spectrogram Recording
IZT SignalSuite-240	Mask Triggered Recording
IZT SignalSuite-242	Pre-Recording
IZT SignalSuite-830	Data Processor
IZT SignalSuite-260	Signal Import/Export
IZT A1000-CMB	Metal Case USB Dongle
IZT SignalSuite-820	Viewer
2xIZT SignalSuite-310	Time Shift Signal Access
IZT SignalSuite-262	Signal Extraction
IZT P2202	Server for GIDAS <sup>®</sup>
SPR-GID-0602	GIDAS <sup>®</sup> Software - Extended Bands <sup>14</sup> GPS L1/L2/L5, Galileo E1/E5a, GLONASS G1/G2

<sup>12</sup>with options R4000-CHS, R4000-RF3W and A1000-RTS4

<sup>13</sup>with option R3000-TRIG

<sup>14</sup>The GIDAS<sup>®</sup> Software is licensed from OHB Digital Solutions.

# GNSS Monitoring and Interference Recording

**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.

*All data provided in this document is non-binding. This data serves informational purposes only and is especially not guaranteed in any way. Depending upon the subsequent specific individual projects, the relevant data may be subject to changes and will be assessed and determined individually for each project. This will depend on the particular characteristics of each individual project, especially specific site and operational conditions.*

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