www.izt-labs.de

IZT
Innovationszentrum
Telekommunikationstechnik

IZT R4000
Monitoring Receiver

- Superior signal quality
- Continuous interception of up to 120 MHz bandwidth
- 4096- or 32768-point FFT processing
- Selective interception of multiple sub-bands
- Memory efficient storage
- Simultaneous distributed post-processing

IZT R4000
Monitoring Receiver

The IZT R4000 is a unique and novel concept for a radio frequency receiving system. It is perfectly adapted to the needs of modern COMINT and ELINT systems, wideband satellite surveillance and continuous broadband radio signal recording, featuring an instantaneous real-time bandwidth of up to 120 MHz and covering the frequency range up to 18 GHz.

The powerful signal processing of the IZT R4000 is combined with adequate RF frontend technology designed for excellent dynamic range even in high bandwidth applications.

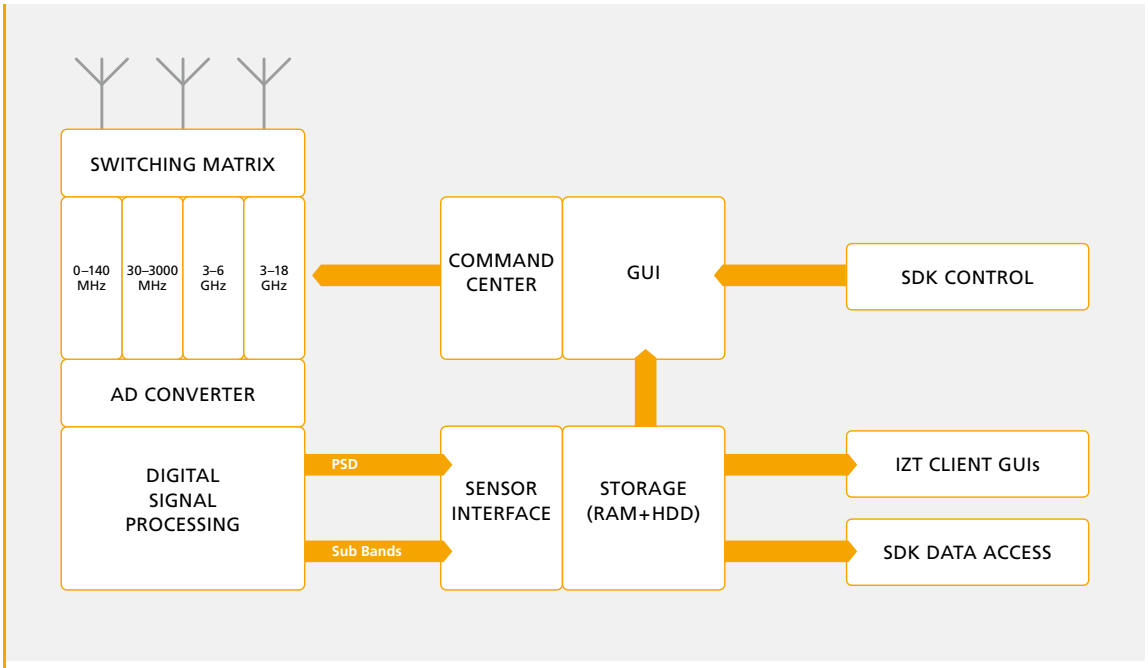

FIGURE 1: IZT R4000 OVERVIEW

Overview

The IZT R4000 digitizes signals up to 140 MHz with a configurable high performance pre-selector. This gives excellent large signal performance without compromising the flexibility of the operator. For higher frequency applications the input frequency range can be extended to 3 GHz, 6 GHz or 18 GHz, using VUHF or SHF frontends.

The IZT R4000's storage system captures every bit of information received from the air for post-processing.

The IZT R4000 backend system allows distributed operation over different locations, supporting multiple sensors and multiple users. The Graphical User Interface is designed for complete control over the many aspects of the system. Utilizing the optional Software Development Kit (SDK), customers can embed the complete functionality into their own user interfaces. Open IZT data formats ensure easy interaction with third party software and system integration.

The highly modular approach of the IZT R4000 makes it a perfect fit for widely differing customer requirements and scenarios while still being cost effective. Additional features can be added later, with growing requirements.

32768-POINT FFT SPECTRUM

Using a 32768-point FFT, the real-time frequency resolution is less than 5 kHz over the full 120 MHz bandwidth.
The transformation is processed in FPGA and continuously without any gaps, making the R4000 also a very powerful real-time signal analyzer.
In parallel to the PSD, I/Q content of sub-bands or even the full bandwidth can be retrieved and forwarded to the sensor controller.
This allows to detect and analyze thousands of signals in parallel.

Utilizing the 4096-point FFT, the time resolution of the spectrum can be as fast as 25.6 µs per spectrum.
This is orders of magnitude faster than swept analysis techniques and meets the demand for systems being able to capture today's hopping, transient signals.
A number of detectors such as RMS, maximum and minimum can simultaneously be used to ensure that short burst signals are identifed.

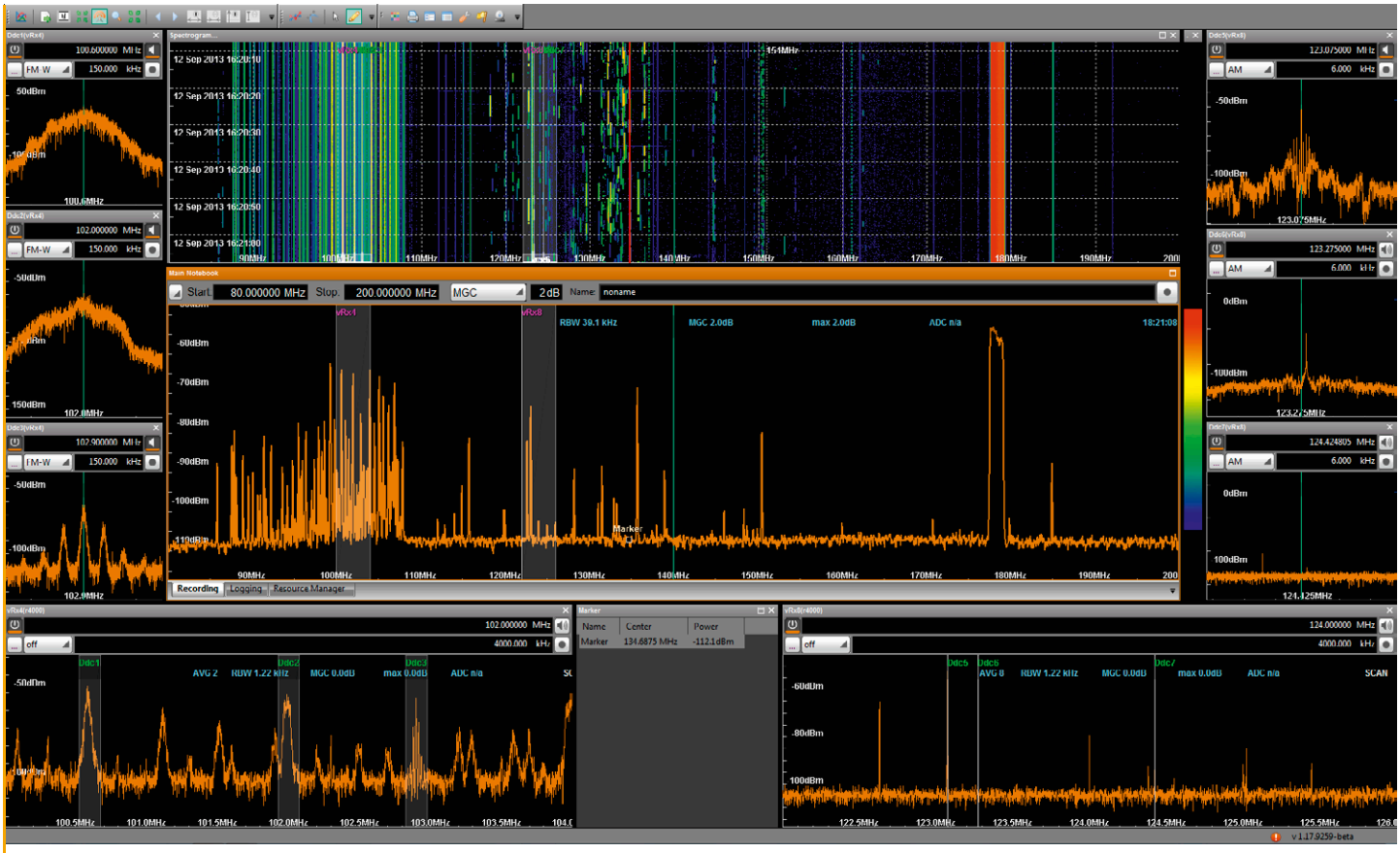

FIGURE 2: IZT SIGNAL SUITE GUI SHOWING TWO VRX SUB-BANDS (2x VRX with 3x DDC each)

RF Sensor

The combination of extensive pre-selection capabilities and exceptional digitization quality makes the IZT R4000 the perfect tool for signal intercept, capture and monitoring. With its high-performance RF frontends, the IZT R4000 sensor is ideally suited for full bandwith signal capture with fixed frequency operation.

The IZT R4000 sensor can also automatically execute complex scan jobs for rapid and effective spectrum surveillance.

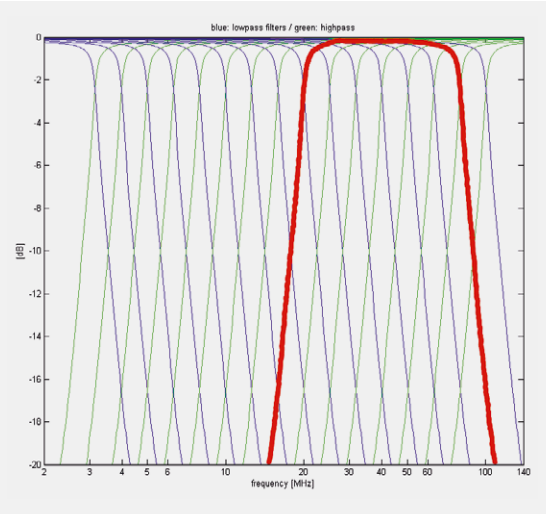

FIGURE 3: SHOWN IN RED: SELECTED LOW- AND HIGH-PASS COMBINATION

HIGH QUALITY RF FRONTENDS

IZT R4000 HVHF

The IZT R4000 digitizes signals up to 140 MHz directly without additional frequency conversion. This results in an exceptional dynamic range. In order to manage the challenging and large VHF band signal environment, the IZT R4000 features a unique configurable, highly linear and highly selective pre-selector.

Low- and high-pass filters with corner frequencies spaced in a ratio of 1:1.26 are available to the user.

This allows to limit the amount of incoming signal energy and provides very effective protection against unwanted IP2 products. The user can freely cascade a combination of one of 16 high-pass and one of 16 low-pass filters. Figure 3 symbolizes the filter curves (green: high-pass, blue: low-pass) with the red curve indicating the selected filter combination.

IZT R4000-RF3

For the frequency band 30 MHz to 3 GHz the IZT R4000-RF3 offers a dual conversion frontend available with a high intermediate frequency. If the HVHF frontend is fitted, the changeover frequency will normally be set to 140 MHz. The frontend features sub-octave preselection filters with an overlap bandwidth of 2 MHz.

IZT R4000-RF3W

Alternative frontend for the VUHF frequency range, filters overlap by 120 MHz, typically. Frequency range 108 MHz to 3 GHz, Option R4000-HVHF is recommended in addition to cover the full VUHF range.

IZT R4000-RF6

The option R4000-RF6 covers the frequency range from 3 GHz to 6 GHz with high performance pre-selector filters and an exceptional phase stability, which makes it ideal for interferometric direction finding and radio monitoring.

IZT R4000-RF18

The frequency extension R4000-RF18 covers the frequency range from 3 GHz to 18 GHz and is perfect for monitoring and recording of microwave or satellite signals. Pre-selection is performed by means of a highly selective tracking bandpass filter.

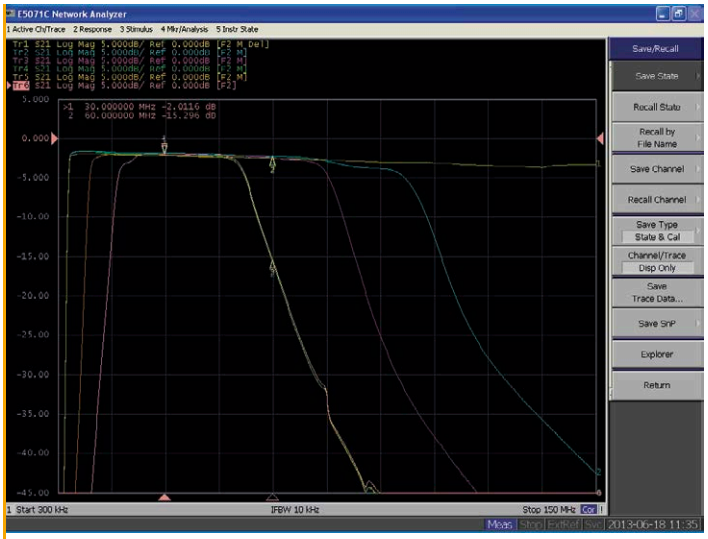

FIGURE 4: EXAMPLE FREQUENCY RESPONSES OF HVHF PRE-SELECTOR COMBINATIONS

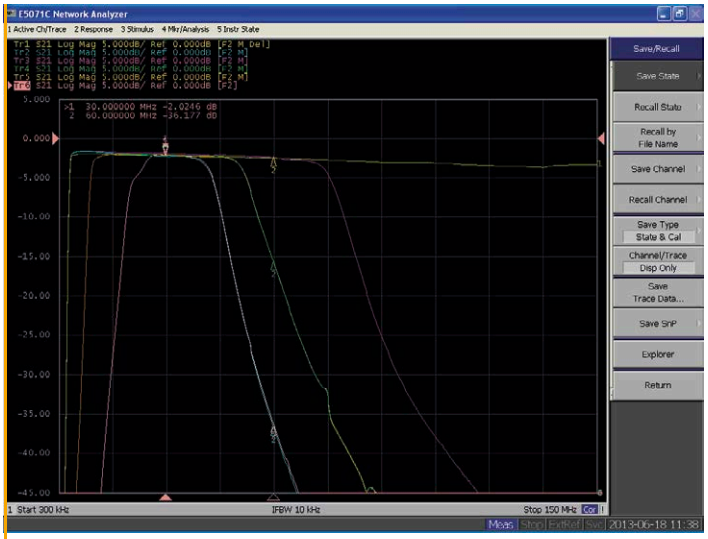

FIGURE 5: EXAMPLE FREQUENCY RESPONSES OF HVHF PRE-SELECTOR COMBINATIONS

Real-time Power Spectrum

SYNCHRONIZATION OF SENSORS

The IZT R4000 features a high stability internal reference clock. The receiver can be synchronized to an external 10 MHz reference source.
The signal processing and all RF local oscillators are fully synchronous and can be locked to an external standard (e.g. GPS). A trigger pulse or 1 PPS signal can be used to synchronize the time base of multiple receivers with sample accuracy.
For phase coherent synchronization of multiple receivers, it is possible to provide a common local oscillator and clock signals, minimizing jitter between receivers to the order of several ten picoseconds.
The time source for synchronization can either be a separate GPS device or the controlling PC time, which itself can be synchronized with external hardware and/or NTP.

After digitization, IZT R4000's DSP section calculates fast, high resolution power spectra (PSD) with configurable parameters and three different detectors (minimum, RMS and maximum) in parallel. Averaging count and time domain window can be selected by the user.
The real-time PSD data gives an overview of the activities in the frequency band and can serve as one trigger source to the IZT R4000 software. While the sub-bands can be delayed in the sensor, the PSD is produced with minimum latency.
Higher frequency resolutions can be calculated in the IZT R4000 software based on sub-band data retrieved by the receiver.

PSD PARAMETERS (OPTION PSD4)

Real-time bandwidth (approx.)	Frequency resolution (approx.)	Time resolution (approx.)
120 MHz	39 kHz	25.6 µs
60 MHz	19.5 kHz	51.2 µs
30 MHz	9.8 kHz	102 µs
15 MHz	4.9 kHz	205 µs
7.5 MHz	2.4 kHz	410 µs

PSD PARAMETERS (OPTION PSD32)

Real-time bandwidth (approx.)	Frequency resolution (approx.)	Time resolution (approx.)
120 MHz	4.9 kHz	205 µs

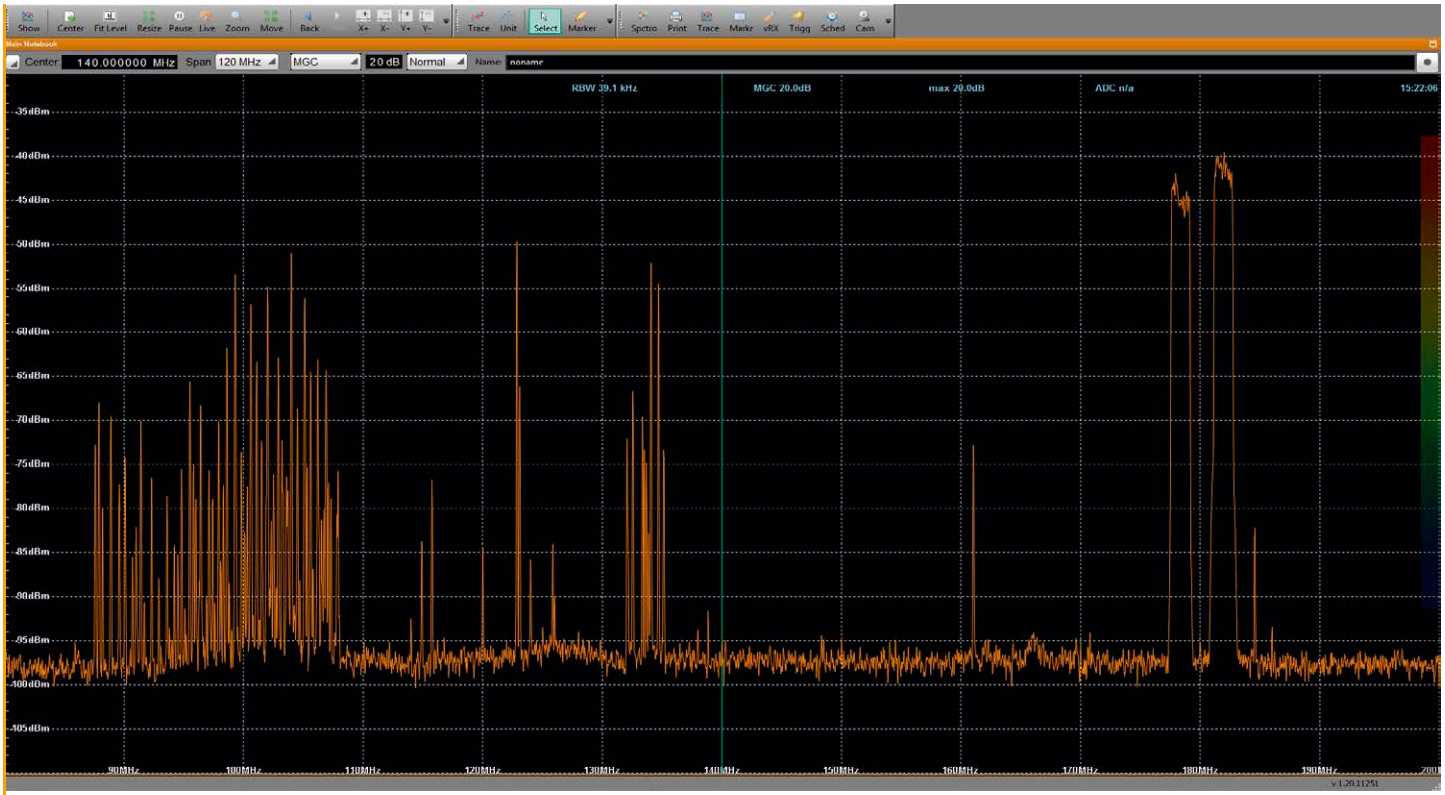

FIGURE 6: SENSOR CONTROL CENTER WITH 120 MHZ REAL-TIME SPECTRUM

Storage System

The IZT R4000 storage system separates signal capture from post-processing and analysis, providing minutes to days of buffering capacity if required.
While new data from the sensors is being recorded, multiple users or post-processing modules can simultaneously access historic data in the storage system as well as "live" streams. The transition from "live" to "recorded" is completely seamless from the users' point of view.

SUB-BAND EXTRACTION

Whenever the software or the user identifies signals of interest in the spectrum or frequency bands are to be recorded continuously, the IZT R4000 extracts independent sub-bands out of the 120 MHz instantaneous bandwidth. Sub-bands may overlap and their center frequencies and bandwidths can be varied dynamically without affecting signal integrity.
A RAM buffer within the sensor stores the entire real-time bandwidth for up to four seconds. This gives detection process time to determine which portions of the total receive bandwidth are active or otherwise of interest.
Commanded by the IZT R4000 Control Center software, the system dynamically extracts sub-bands and sends them to the software storage system. Various trigger functions ensure that no signal of potential interest is lost.
Any signals that have been recorded will be accessible to the clients for detailed analysis, demodulation or data export.

The maximum amount of data that can be stored, the number and bandwidth of separate streams depend on the IZT R4000 configuration. Different configurations and performance levels are available. The table below lists approximate performance parameters and depends on actual stream configuration. Whether HDDs or SSDs should be chosen depends on the expected use case of the system. Please contact IZT for recommendations and storage space requirements.

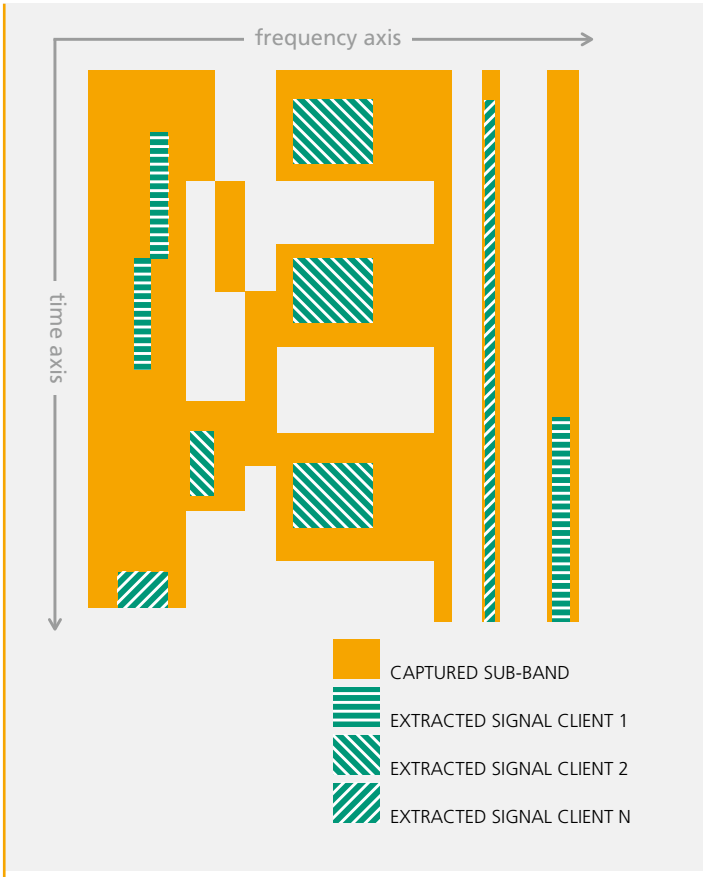

FIGURE 7: CONCEPT OF SELECTIVE RECORDING AND POST-PROCESSING

IZT R4000 STORAGE AND STREAMING CAPABILITIES

IZT R4000 storage configuration	Approx. memory depth (MHz*sec.)	Recording throughput	Real-time streaming throughput	Total number of streams
Standard	RAM: 1800 HDD: 1100000 SSD: 450000	36 MHz (per stream) 72 MHz (total)	36 MHz (per stream) on request	~100
High performance	RAM: 70000 HDD: 5500000 SSD: 2200000	120 MHz (per stream) 160 MHz (total)	120 MHz (per stream) on request	~500

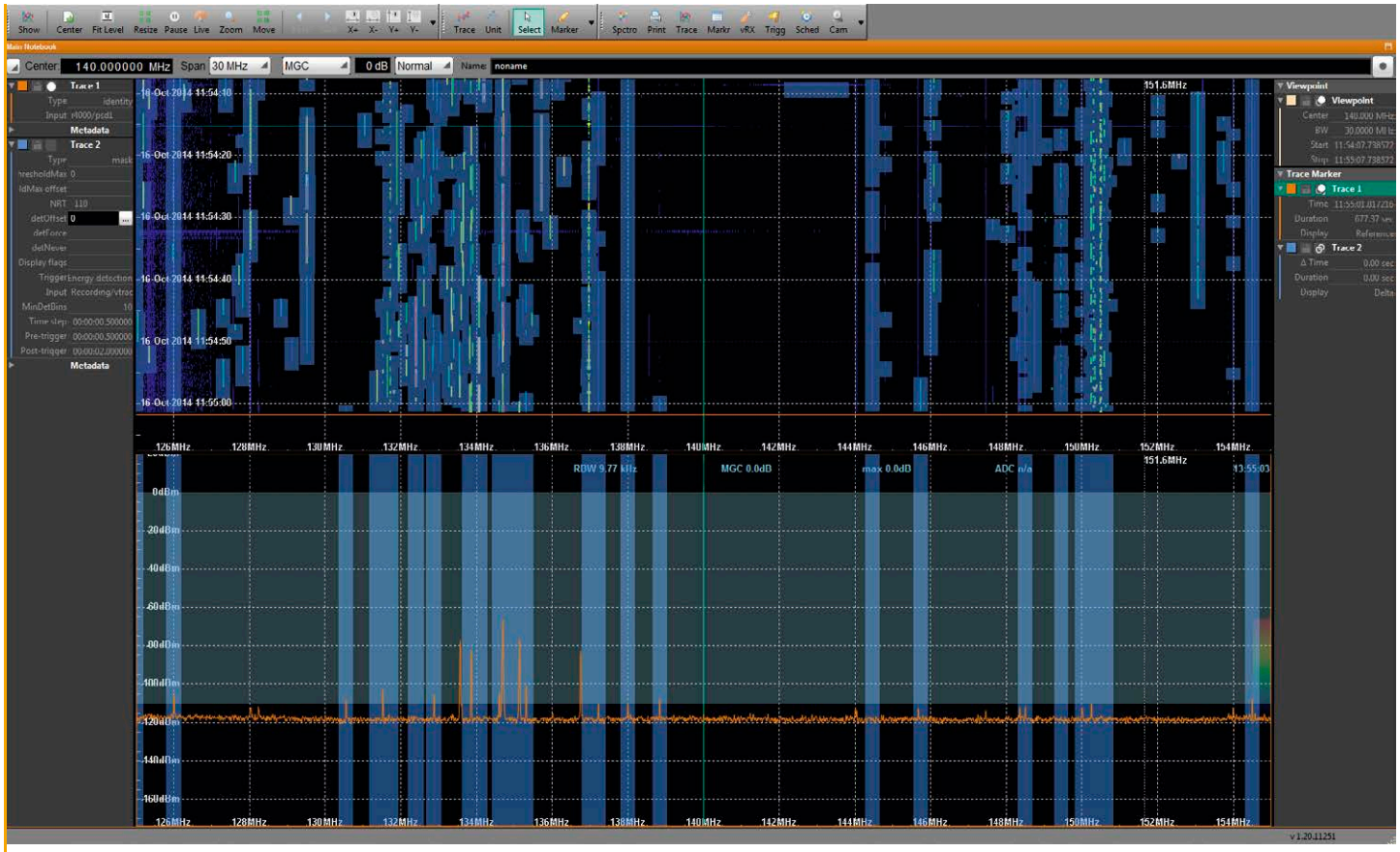

FIGURE 8: ENERGY DETECTION BASED ON PSD DATA

ACCESSING CAPTURED DATA

Once recorded, a signal can be accessed:

- via the Graphical User Interface (GUI)
- with the Software Development Kit (SDK)
- or forwarded via TCP/IP over LAN, WLAN or WAN.

Access does not have to be in strict sequential order. Client applications or users can address and extract any part of the recorded signal with respect to time and frequency.

The IZT SDK and open IZT data formats make integration of the storage system into larger installations easy and flexible.

TIME SHIFTED ACCESS

The IZT R4000 time shift functionality allows users to visualize and extract any signal in the entire memory depth without having to interrupt recording. All signals are continuously recorded, even while users are working with signals, that are minutes, hours or even days old.
Likewise, complex post-processing algorithms also profit from the time shift feature. These algorithms are sometimes too slow to work in real-time, but the time shift function makes it easy to deploy them.

The entire memory depth of the storage system will act as a buffer to slow down data access to the actual speed of the computation – while simultaneously recording all new incoming data.

REMOTE ACCESS

The storage concept and time shift functionality allow for a remote installation of the sensor. Visualization is performed at a central control facility – even with unreliable or slow network connections.
All signals are recorded and cached at the remote location. Users and/or software modules can request a preview of sections defined by time and frequency. Appropriate compression algorithms reduce the amount of data that needs to be transferred to the central command location. Depending on the intended post-processing, the user can influence the tradeoff between quality and speed.
Should the network go down, access to the remote sensor will be temporary unavailable, but the remote storage system will continue recording and store all signals for later analysis.
If the full information of a signal is needed, it can be compressed with configurable quality and transferred to the central location, possibly during times of low network use.

AVAILABILITY MAP

The Availability Map gives the user and clients a quick overview of all areas where signals have been detected and are stored in the storage system for retrieval.
Different color codings represent areas that are available at a remote location and/or have been transferred to the central storage.

DETECTION OF FREQUENCY AGILE SIGNALS

The real-time bandwidth of 120 MHz in combination with the 32768-point FFT resolution of the receiver ensures reliable detection of bursts and frequency-agile signals.

Even the most advanced hoppers with extremely high hop rates are detected under demanding SNR environments.

The burst detector plugin provides real-time information about detected signals containing bandwidth, dwell time and time-of-arrival information.

Further details are available on request.

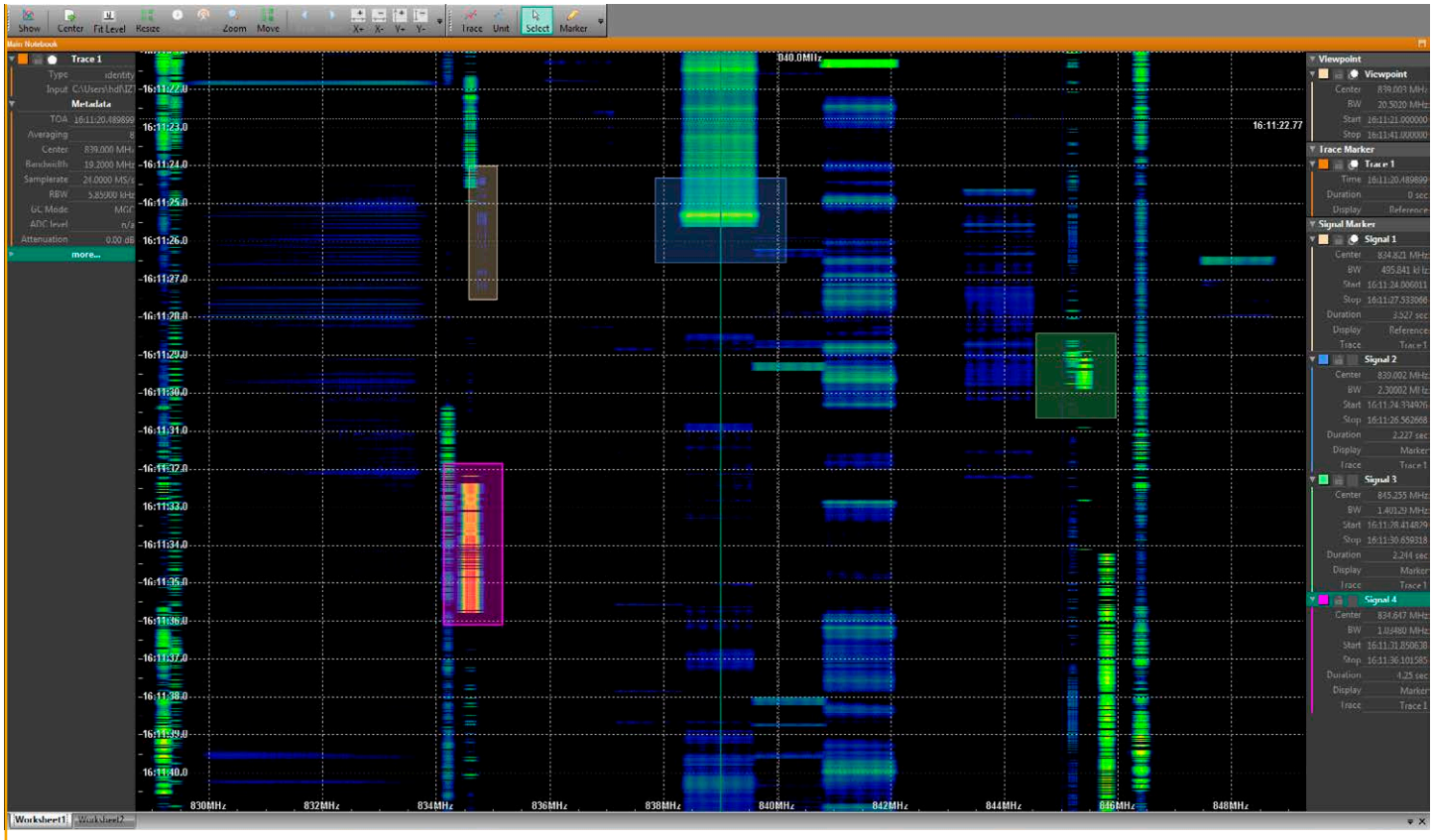

FIGURE 9: AVAILABILITY MAP INDICATING FOUR CAPTURED SIGNALS IN CENTRAL STORAGE

Control Center

The Control Center module is part of the IZT Signal Suite software family. It is the central command hub for all sensors of a setup.
In its smallest configuration it is part of the IZT R4000 base unit and controls one IZT R4000 sensor. But it is also able to handle multiple sensors in local and/or remote locations and can run on a central server system.
The user interface allows users to set center frequencies, bandwidths, synchronize sensors and generally control all operational aspects of the setup.

Setup and Configuration

- Specify the number of sensors and their respective network addresses
- Define antenna and cable setup, load k-factors and frequency-response files
- Prepare project templates for other users

Task-Scheduler

- Create schedules for automated recordings and signal collection

Sensor Synchronization

- Ensure synchronous operation of two or more sensors

Operational Parameters

- Load, save, modify center frequencies, bandwidths, AGCs, attenuation and other parameters
- Create and use presets

REMOTE/LOCAL

The Control Center handles local and remote sensors. The user interface stays the same, regardless of the sensor location. This simplifies the administration and operation of sensors.

DISTRIBUTED CLIENTS

One distinctive feature is the concept of using the IZT R4000 in multi-client applications.

The IZT R4000 can deal with multiple clients at the same time, which can be the workstations of individual operators or a cluster of computers automatically scanning available signals for useful information. Each of the extracted sub-bands can be sent to individual clients. All clients can also configure their active sub-bands dynamically.

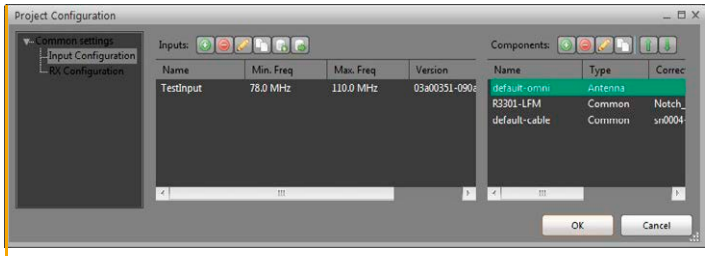

FIGURE 10: ANTENNA INPUT CONFIGURATION

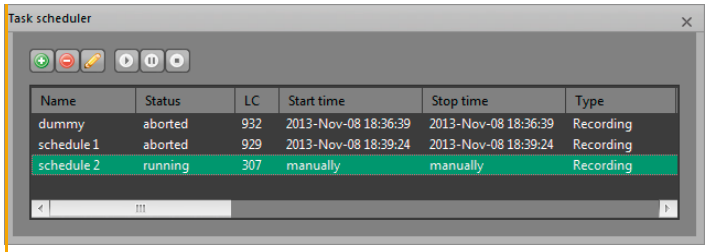

FIGURE 11: LIST OF PLANNED TASKS

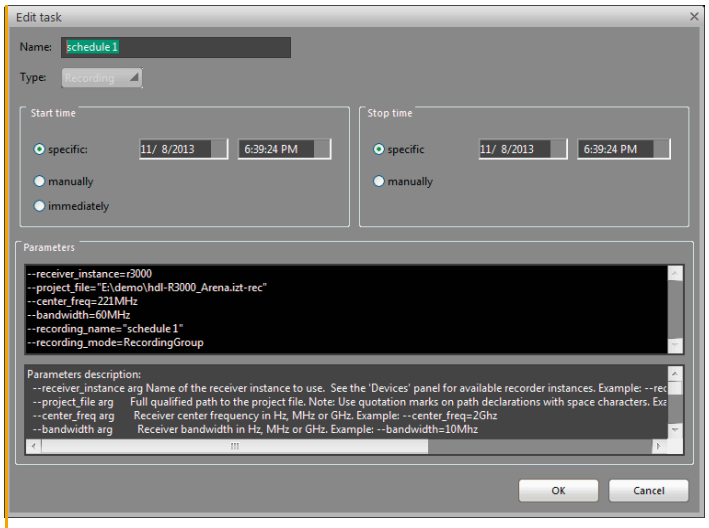

FIGURE 12: SCHEDULER TASK CONFIGURATION

IZT Signal Suite Graphical User Interface

The IZT R4000 Storage System and Control Center provides all the functionality to support semi- or fully-automated monitoring systems. The IZT Signal Suite Graphical User Interface provides additional tools.

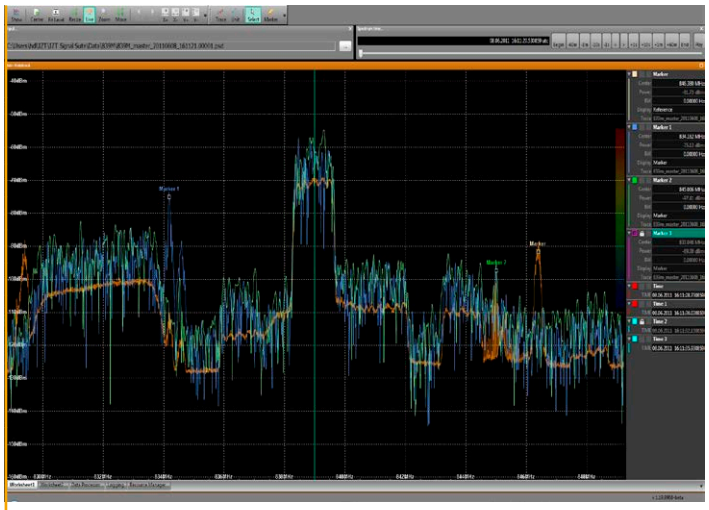

FIGURE 13: MULTIPLE TRACES WITH DIFFERENT PARAMETERS

MODULAR, CUSTOMIZABLE LAYOUT

The IZT R4000 with its 120 MHz real-time bandwidth generates an enormous amount of data in very short time. The GUI's modular concept keeps the user from being overwhelmed by all that information and helps him stay focused on the task at hand.

The customizable layout lets users switch from only a basic overview with minimal information (Figure 13) to a very detailed layout with lots of different tools and several displays on a multi-monitor system (Figure 14).

Workforce managers can create and distribute project templates and restrict the user interface for specific tasks. These templates help prevent users from getting distracted or getting lost in the many possibilities of the software.

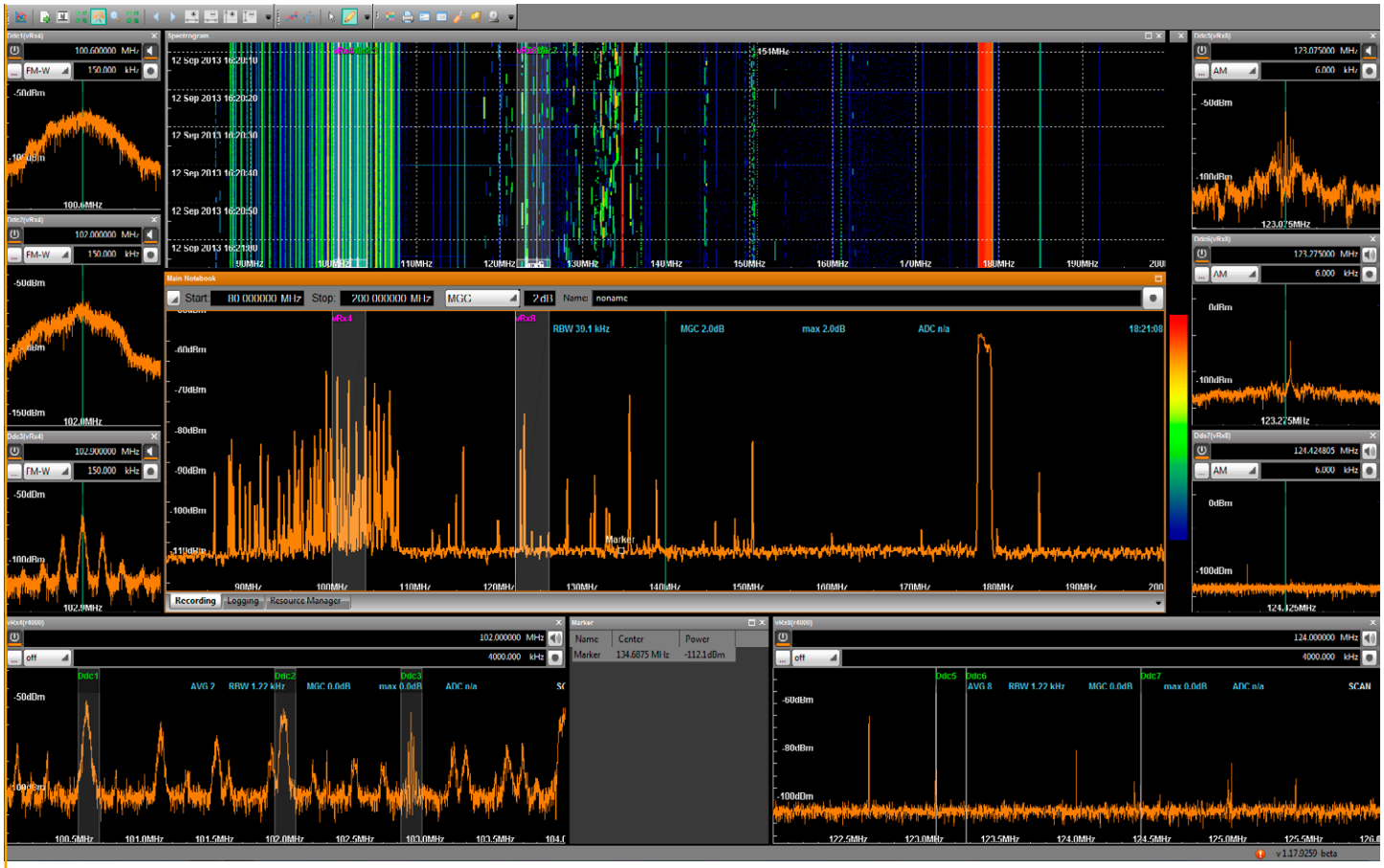

FIGURE 14: COMPLEX SENSOR CONTROL SCREEN WITH MULTIPLE VRX SUB-BANDS

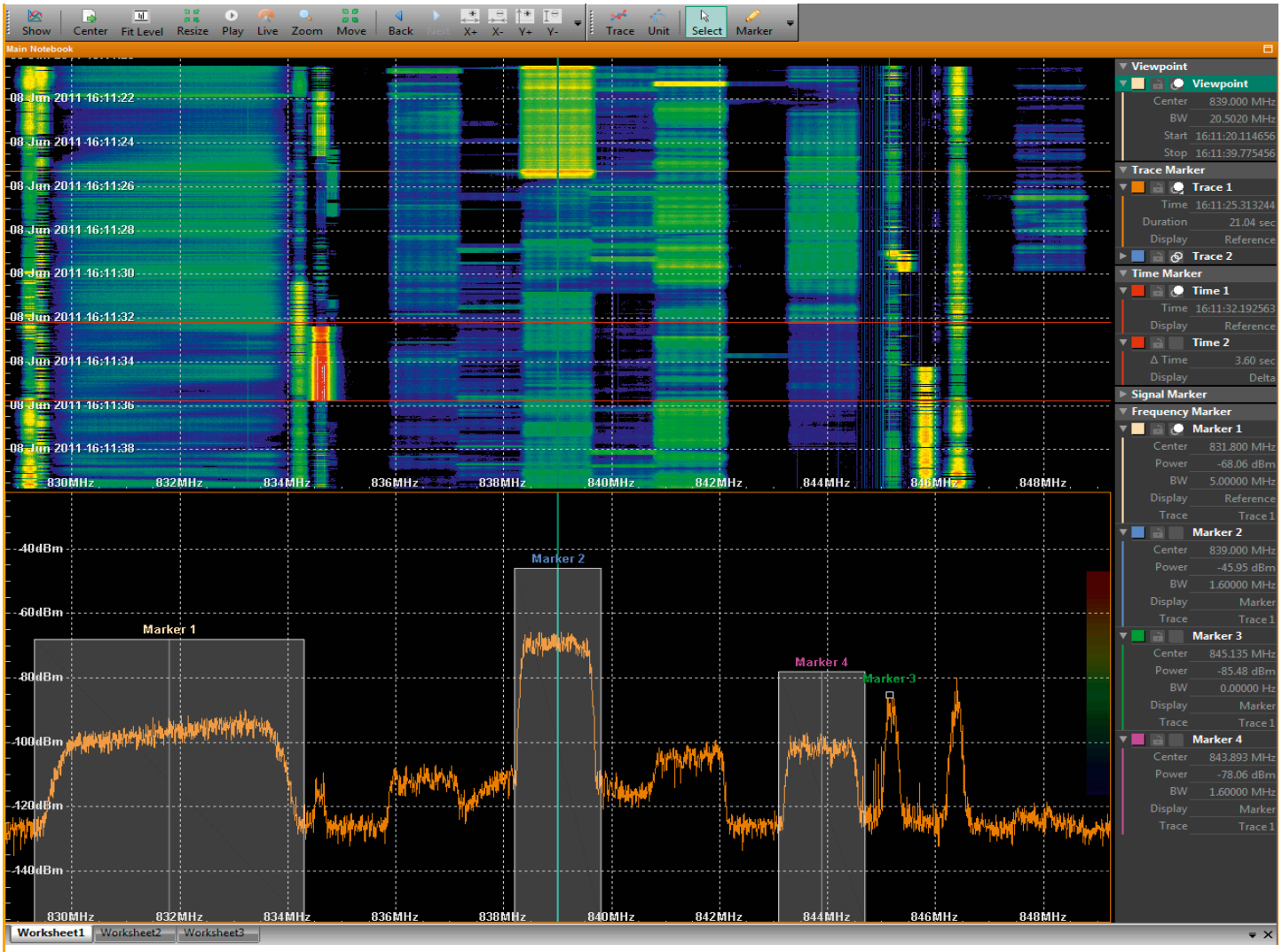

FIGURE 15: WORKSHEET WITH SPECTRUM, SPECTROGRAM AND MARKERS

SPECTRUM, SPECTROGRAM AND MARKERS

The basic package of the Graphical User Interface consists of a spectrum and a spectrogram display. The spectrum shows the current live signal and the spectrogram shows the last 60 seconds of history. A graphical zoom enlarges areas of interest and the marker palette supports various measurements. The spectrogram display is fast enough to update several minutes of spectral data PSD usually within less than a second, depending on the zoom factor.

The optional time shift functionality allows the user to go back to any point in history in the storage system while continuously receiving and storing live signals. To do so, the user simply moves the time slider in the spectrogram display backwards or enters the time of interest in the time field.

The IZT Signal Suite together with the IZT R4000 Storage System keeps response times minimal in order to make this transition as seamless as possible. While the user is looking at the history, the storage system continues to record any new information, never missing an interesting signal.

DEMODULATION

Users can select signals in the spectrum or spectrogram and then choose from a list of demodulators to listen to and extract the signal. The Signal Suite includes several basic demodulators, like AM, FM, SSB and supports a growing number of digital standards. Consult the IZT website for the latest list of supported standards and supported third party products. Expert users can write their own demodulators using the IZT SDK.

LONG TERM SPECTROGRAM

The standard spectrogram is fast enough to show several minutes of PSD data, but users working with long recordings may want an overview over hours, days or even weeks of data in one spectrogram. The long term spectrogram is able to show even these enormous amounts of data and update the display in seconds. By zooming within the spectrogram a user can drill down from a high-level overview, showing one week of data on a single page, to a microsecond display, showing the maximum possible time resolution of the sensor. All this happens seamlessly, within the same display and with update times, that are usually less than one or two seconds.
Spectrogram panels can be chained together in a hierarchy, so that the lower panels act as magnifiers of the higher panel.

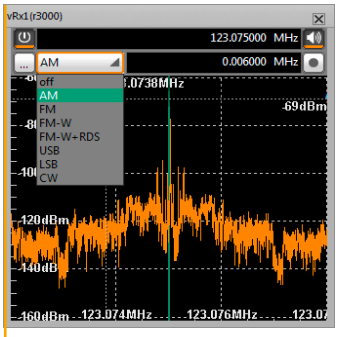

FIG.17: ANALOG DEMODULATION

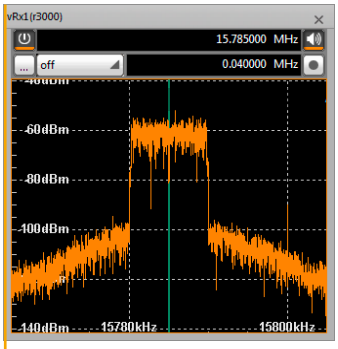

FIG.18: DIGITAL SIGNAL EXTRACTION

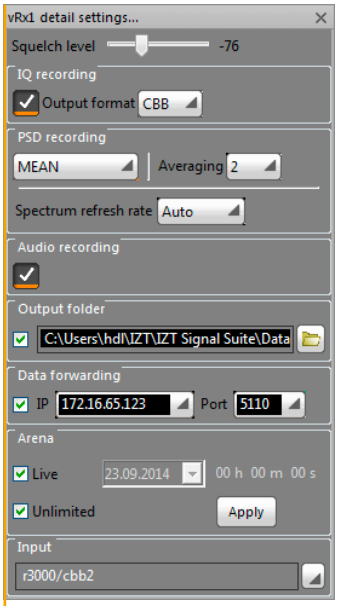

FIG.19: VRX DETAIL SETTINGS

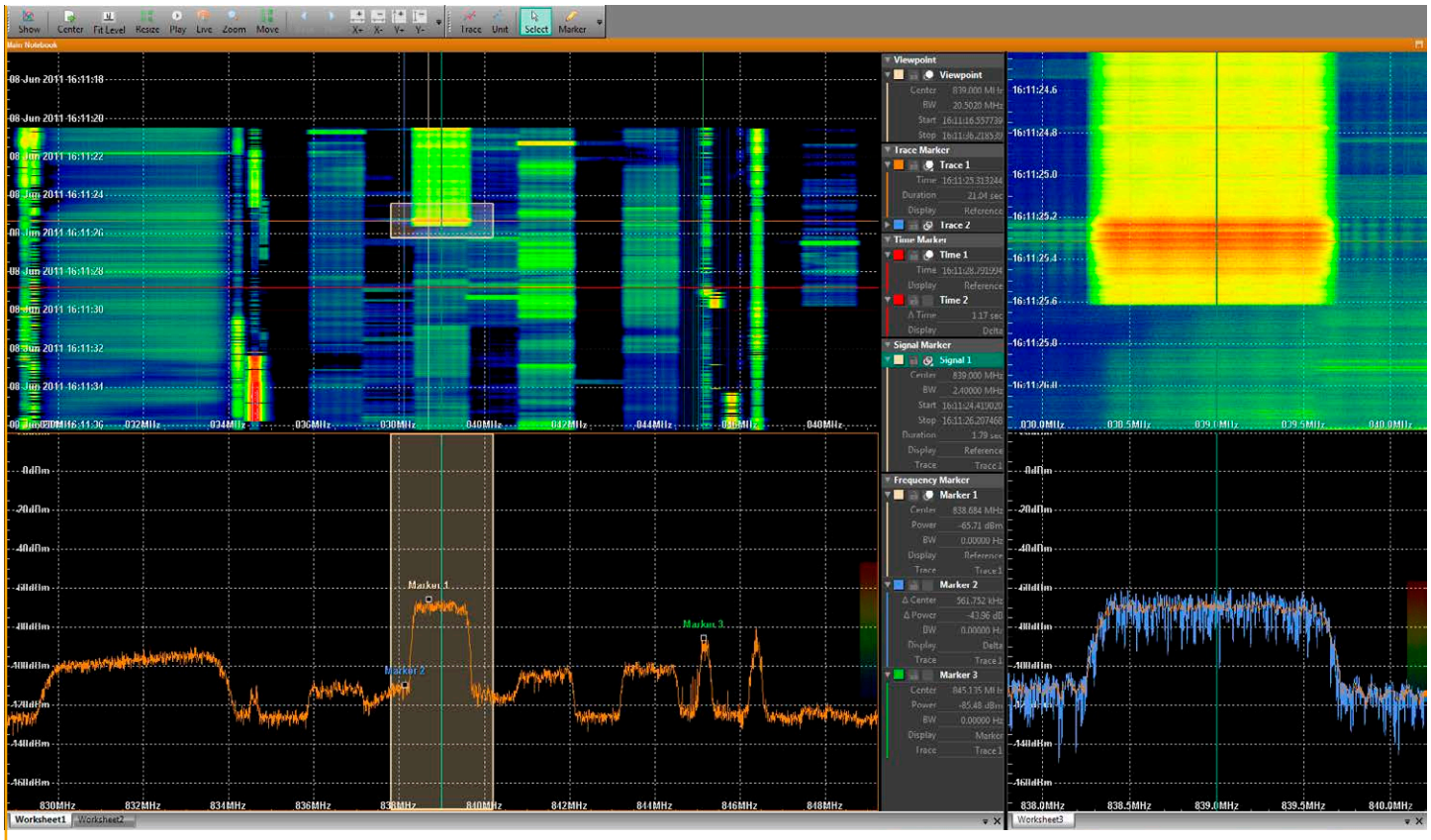

FIGURE 16: MAGNIFIER FUNCTIONALITY SHOWING ZOOMED SIGNAL AT THE RIGHT HAND SIDE

TRIGGERS AND SEARCHING

Triggers help capture signal events that occur only once every few weeks. They are also invaluable for continuous monitoring scenarios, where specific signal parameters must be in compliance with standards.

Users can define trigger conditions from spectrum masks, power levels or signals statistic attributes. These conditions will start or stop recordings, send messages, command other sensors to specific frequencies or run more detailed analysis software on a signal.

The IZT Storage System's continuous recording ability allows pre- and post-trigger times up to the full memory depth.

The search system provides the functionality to define triggers "after the fact" and apply them to recorded data. This is especially useful when it is not possible to define a "good" trigger condition beforehand, because it may be unknown what a "matching" signal would look like.

In this case, users can define a broad trigger condition to record all signals that might be of interest, and then follow up with more specific triggers that work on the recording.

Since the data has already been recorded, a user can change trigger/search conditions and get results almost instantaneously. With this feature, users can continually refine trigger conditions, until the area of interest has been narrowed down. This kind of analysis can also be done completely offline.

DATA EXPORT

Any signal data can be exported to files to be shared with other people or for later analysis with other tools. The IZT Signal Suite export module supports a variety of file formats, such as I/Q, WAV, RAW I/Q and some third party vendor formats.

This feature is commonly used to analyse signals with MATLAB.

A separate IZT Viewer application is also available that allows other people to view exported signal files.

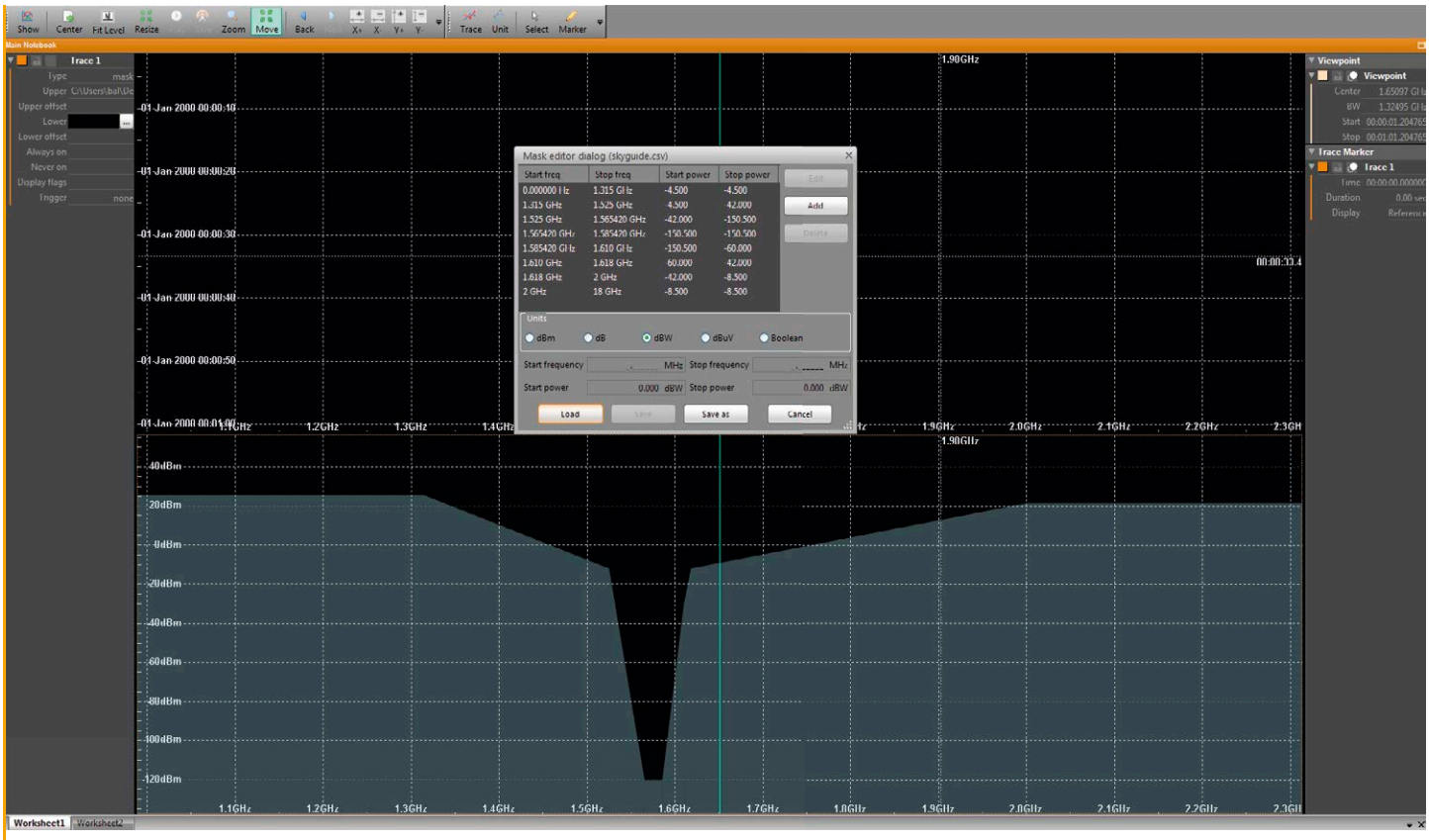

FIGURE 20: TRIGGER CRITERIA DEFINED BY SPECTRUM MASK TABLE

Integration into Customer Systems

IZT SOFTWARE DEVELOPMENT KIT (SDK)

The IZT Signal Suite SDK for system integrators allows customers to integrate IZT receivers into their own software more easily. It provides a unified interface for the entire IZT receiver family. Software written for IZT R3000 receivers will work with the new IZT R4000 receivers out of the box. In addition to basic interface functionality, the SDK allows customers to use advanced powerful features such as time shift functionality, individual access to vRx sub-band channels and industry proven wideband recording within their own software.

The IZT Signal Suite SDK for MATLAB is geared towards the power user who wants to analyze signals received or recorded with the IZT Signal Suite. It eliminates the need for copying files and instead allows MATLAB programs to access I/Q samples directly as they come from the receiver.

Together with the SCPI conforming command language, this allows customers to implement sophisticated analysis algorithms and control complex setups, with sensor data coming either from recordings or live signals. The core IZT SDK functions are a part of every IZT Signal Suite license, including online HTML documentation with sample programs for C++, C#, Visual Basic and MATLAB code.

Multiple advanced functions like spectrum and spectrogram display, time and frequency markers, time scheduled recording, mask triggered recording and data export to other I/Q formats can be purchased separately, either with or without GUI functionality.

Via TCP/IP

- With SCPI commands
- As I/Q streams transmitted with UDP / TCP connections

With Microsoft COM Objects

- For C++
- For C#
- For Visual Basic
- For MATLAB

File based

- Open IZT V4 file format specification

Technical Specifications

R4000-BASE: Digital signal processing			
Analog to digital converter	Sampling rate	320 MSPS	
	SFDR, 9 kHz to 140 MHz	90 dB, typical (referenced to full scale of ADC)	
	SFDR, 120 MHz to 18 GHz	75 dB, typical (referenced to full scale of ADC)	
IF bandwidth		120 MHz	
Spectrum data	Bandwidth	120 MHz to 7.5 MHz 120 MHz	(option PSD4) (option PSD32)
	Frequency resolution	39.0625 kHz to 2.441 kHz 4.882 kHz	(option PSD4) (option PSD32)
	Time resolution	25.6 µs to 409.6 µs 204.8 µs	(option PSD4) (option PSD32)
	FFT width	4096 points 32768 points	(option PSD4) (option PSD32)
	FFT window	Hamming, Hanning, Blackman-Harris	
	Averaging	1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024	
	Detector	Maximum, Minimum, RMS RMS	(option PSD4) (option PSD32)
I/Q data	Number of channels	> 100, independent in bandwidth and center frequency[1]	
	Channel bandwidth	100 Hz to 120 MHz	
	Data buffering	Up to 4 s, with respect to spectrum data	
Interfaces	RF input	N, female, 50 Ω	
	IF input	N, female, 50 Ω	
	External reference input/output	10 MHz, BNC, female, 50 Ω, input 0 to +18dBm, output +7dBm	
	Trigger pulse input	SMA, female, 50 Ω	
	Trigger pulse output	SMA, female, 50 Ω	
	Synchronization input	1PPS BNC, female, 50 Ω	
	External synchronization	up to 12 x SMA, female, 50 Ω	
	LAN (Control)	1 Gbit LAN	
	LAN (Data)	10 Gbit LAN, SFP+ fiber optic 850 nm	
	Additional interfaces	USB 2.0, VGA	

General Data	
Operating temperature	0°C to +50°C
Storage temperature	-40°C to +70°C
Humidity	Max. 85%, non-condensing
EMI / EMC	EN 61010-1:2002; EN 61000-6-2:2002; EN 61000-6-3:2002
Power supply	100 V to 240 V (AC), 50 Hz to 60 Hz
	100 VA to 200 VA (depending on frequency range and options)
Dimensions (WxHxD)	19" x 3 RU x 570 mm
Weight	Approximately 15 kg

[1] NUMBER OF ACTUAL CHANNELS IS DEPENDENT ON SENSOR CONTROLLER

R4000-BASE: IF input		
Frequency range	Baseband input	9 kHz to 140 MHz
Maximum input power		+15 dBm
Tuning resolution		1 Hz
Tuning accuracy		< 0.2 Hz
VSWR		< 1:2
Internal reference stability	Initial tolerance	< +/-1 x 10^{-9}
	Temperature stability	0°C to 50°C < +/-1 x 10^{-8}
	Aging, after 30 days of continuous operation	< +/-5 x 10^{-10} per day; < +/-5 x 10^{-8} per year
Oscillator phase noise		-122 dBc/Hz @ 1 kHz offset, typical
		-140 dBc/Hz @ 10 kHz offset, typical
Sweep time		< 3 ms
Scanning speed	Frequency scan, random	> 40 GHz/s
	Frequency scan within 120 MHz bandwidth	> 4000 GHz/s
Third-order intercept point		+40 dBm, typical
Noise figure		7 dB
Preselector		None

R4000-RF3: 20 MHz to 3 GHz / R4000-RF3W:108 MHz to 3 GHz		
Frequency range	Option R4000-RF3	140 (20) MHz to 3 GHz
	Option R4000-RF3W	108 (20) MHz to 3 GHz
Maximum input power		+15 dBm
Tuning resolution		1 Hz
Tuning accuracy		< 0.2 Hz
VSWR		< 1:2
Internal reference stability	Initial tolerance	< +/-1 x 10^{-9}
	Temperature stability	0°C to 50°C < +/-1 x 10^{-8}
	Aging, after 30 days of continuous operation	< +/-5 x 10^{-10} per day; < +/-5 x 10^{-8} per year
Oscillator phase noise		-115 dBc/Hz @ 10 kHz offset, typical
Sweep time		< 3 ms
Scanning speed	Frequency scan, linear	> 40 GHz/s
	Frequency scan within 120 MHz bandwidth	> 4000 GHz/s
Third-order intercept point	Low distortion mode	+24 dBm, typical
	Normal mode	+13 dBm, typical
Noise figure	Low noise mode	< 10 dB, typical
	Normal mode	14 dB to 15 dB, typical
IF rejection		> 120 dB, typical

Image rejection		> 110 dB, typical	
Oscillator reradiation at antenna output		< -110 dBm, typical	
Preselector	11-band sub-octave filter	Option RF3	Option RF3W
	1	20 MHz to 47 MHz	108 MHz to 174 MHz
	2	45 MHz to 70 MHz	170 MHz to 280 MHz
	3	68 MHz to 87 MHz	225 MHz to 370 MHz
	4	85 MHz to 110 MHz	250 MHz to 420 MHz
	5	108 MHz to 172 MHz	300 MHz to 520 MHz
	6	170 MHz to 242 MHz	400 MHz to 670 MHz
	7	240 MHz to 470 MHz	550 MHz to 870 MHz
	8	468 MHz to 962 MHz	750 MHz to 1220 MHz
	9	960 MHz to 1710 MHz	1100 MHz to 1720 MHz
	10	1708 MHz to 2202 MHz	1600 MHz to 2400 MHz
	11	2200 MHz to 3000 MHz	2200 MHz to 3000 MHz

R4000-HVHF: 9 kHz to 140 MHz			
Frequency range		9 kHz to 140 MHz	
Maximum input power		+15 dBm	
Tuning resolution		1 Hz	
Tuning accuracy		< 0.2 Hz	
VSWR		< 1:2	
Internal reference stability	Initial tolerance	< +/-1 x 10^{-9}	
	Temperature stability	0°C to 50°C < +/-1 x 10^{-8}	
	Aging, after 30 days of continuous operation	< +/-5 x 10^{-10} per day; < +/-5 x 10^{-8} per year	
Oscillator phase noise		-120 dBc/Hz @ 1 kHz offset, typical	
		-140 dBc/Hz @ 10 kHz offset, typical	
Sweep time		< 3 ms	
Scanning speed	Frequency scan, linear	> 40 GHz/s	
	Frequency scan within 120 MHz bandwidth	> 4000 GHz/s	
Third-order intercept point		+40 dBm, typical	
Noise figure		10 dB, typical	
IF rejection		> 120 dB, typical	
Image rejection		> 110 dB, typical	
Oscillator reradiation at antenna output		< -110 dBm, typical	
Preselector		Any combination of high- and low-pass filters with the following corner frequencies (total of 153) 9 kHz, 3.15 MHz, 4 MHz, 5 MHz, 6.3 MHz, 8 MHz, 10 MHz, 12.6 MHz, 16 MHz, 20 MHz, 25 MHz, 32 MHz, 40 MHz, 50 MHz, 63.5 MHz, 80 MHz, 100 MHz, 140 MHz	

Frequency extension R4000-RF6: 3 GHz to 6 GHz		
Frequency range		3 GHz to 6 GHz
Maximum input power		+15 dBm
Tuning resolution		1 Hz
Tuning accuracy		< 0.2 Hz
VSWR		< 1:2
Internal reference stability	Initial tolerance	< +/-1 x 10^{-9}
	Temperature stability	0°C to 50°C < +/-1 x 10^{-8}
	Aging, after 30 days of continuous operation	< +/-5 x 10^{-10} per day; < +/-5 x 10^{-8} per year
Oscillator phase noise		-115 dBc/Hz @ 10 kHz offset, typical
Sweep time		< 3 ms
Scanning speed	Frequency scan, random	> 40 GHz/s
	Frequency scan within 120 MHz bandwidth	> 4000 GHz/s
Third-order intercept point	Normal mode	+18 dBm, typical
	Low noise mode	+2 dBm, typical
Noise figure	Low noise mode	7 dB, typical
	Normal mode	17 dB, typical
IF rejection		> 120 dB, typical
Image rejection		> 110 dB, typical
Oscillator reradiation at antenna output		< -110 dBm, typical
Preselector filter	8-band sub-octave filter	Bands overlap by 120 MHz
	1	2800 MHz to 3320 MHz
	2	3200 MHz to 3720 MHz
	3	3600 MHz to 4120 MHz
	4	4000 MHz to 4520 MHz
	5	4400 MHz to 4920 MHz
	6	4800 MHz to 5320 MHz
	7	5200 MHz to 5720 MHz
	8	5600 MHz to 6120 MHz

Frequency extension R4000-RF18: 3 GHz to 18 GHz		
Frequency range		3 GHz to 18 GHz
Maximum input power	f < 6 GHz	+15 dBm
	f > 6 GHz	+10 dBm
Tuning resolution		1 Hz
Tuning accuracy		< 0.2 Hz
VSWR		< 1:2
Internal reference stability	Initial tolerance	< +/-1 x 10^{-9}
	Temperature stability	0°C to 50°C < +/-1 x 10^{-8}
	Aging, after 30 days of continuous operation	< +/-5 x 10^{-10} per day; < +/-5 x 10^{-8} per year
Oscillator phase noise	f < 6 GHz	-115 dBc/Hz @ 10 kHz offset, typical
	f > 6 GHz	-114 dBc/Hz @ 10 kHz offset, typical
Sweep time	f < 6 GHz	< 3 ms
	f > 6 GHz	< 10 ms
Scanning speed	Frequency scan, random, f < 6 GHz	> 40 GHz/s
	Frequency scan, random, f > 6 GHz	> 12 GHz/s
	Frequency scan within 120 MHz bandwidth	> 4000 GHz/s
Third-order intercept point	Normal mode, f < 6 GHz	+18 dBm, typical
	Low noise mode, f < 6 GHz	+2 dBm, typical
	Normal mode, f > 6 GHz	+25 dBm, typical
	Low noise mode, f > 6 GHz	+15 dBm, typical
Noise figure	Low noise mode, f < 6 GHz	7 dB, typical
	Normal mode, f < 6 GHz	17 dB, typical
	Low noise mode, f > 6 GHz	15 dB, typical
	Normal mode, f > 6 GHz	23 dB, typical
IF rejection		> 120 dB, typical
Image rejection		> 110 dB, typical
Oscillator reradiation at antenna output		< -110 dBm, typical
Preselector filter	f < 6 GHz	8-band sub-octave filter, bands overlap by 120 MHz
	1	2800 MHz to 3320 MHz
	2	3200 MHz to 3720 MHz
	3	3600 MHz to 4120 MHz
	4	4000 MHz to 4520 MHz
	5	4400 MHz to 4920 MHz
	6	4800 MHz to 5320 MHz
	7	5200 MHz to 5720 MHz
	8	5600 MHz to 6120 MHz
	f > 6 GHz	Tracking bandpass filter

IZT R4000
Monitoring Receiver

Ordering Guide		
Receiver hardware options	**R4000-BASE**	Wideband receiver 120 MHz receiver base configuration; 10 Gbit LAN interface, 4 seconds of internal data buffer, including standard sensor controller & storage configuration IZT P2100 (high performance sensor controller & storage configuration on request)
	R4000-IF	IF input, 9 kHz to 140 MHz, without preselector filter
	R4000-HVHF	RF frontend, 9 kHz to 140 MHz Direct sampling up to 140 MHz with electronically configurable pre-selector filters
	R4000-RF3	RF frontend, 20 MHz to 3 GHz
	R4000-RF3W	RF frontend, 108 MHz to 3 GHz
	R4000-RF6	Frequency range extension 3 GHz to 6 GHz
	R4000-RF18	Frequency range extension 3 GHz to 18 GHz
	R4000-CDS	IZT P2500; high performance IZT Sensor Controller & IZT Data Storage configuration
Receiver software options	**R4000-PSD4**	Real-time 4096-point PSD with configurable center frequency and bandwidth up to 120 MHz, directly calculated in FPGA and streamed to client via the IZT Sensor Controller; minimum, maximum and RMS power calculated in real-time, number of averages can be set by user
	R4000-PSD32	Real-time 32768-point PSD with 120 MHz bandwidth, directly calculated in FPGA and streamed to client via the IZT Sensor Controller; RMS power calculated in real-time, number of averages can be set by user
	R4000-SBC	Continuous sub-band channel access inside 120 MHz real-time bandwidth, sub-bands are streamed to clients as I/Q data via the IZT Sensor Controller
	R4000-SSB	Continuous single channel access with up to 60 MHz inside 120 MHz real-time bandwidth; signal data can be recorded or streamed to clients as I/Q data via the IZT Sensor Controller; (upgrade to option R4000-SBC possible)
	R4000-CBB	Single channel I/Q data stream, up to 120 MHz real-time bandwidth
IZT service	**IZT R4000-CLC**	Factory calibration
	IZT R4000-CAL	Accredited ISO calibration
	IZT WE2	Warranty extension to 2 years
	IZT WE3	Warranty extension to 3 years

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 9001:2000 certified.

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

IZT
Innovationszentrum
Telekommunikationstechnik