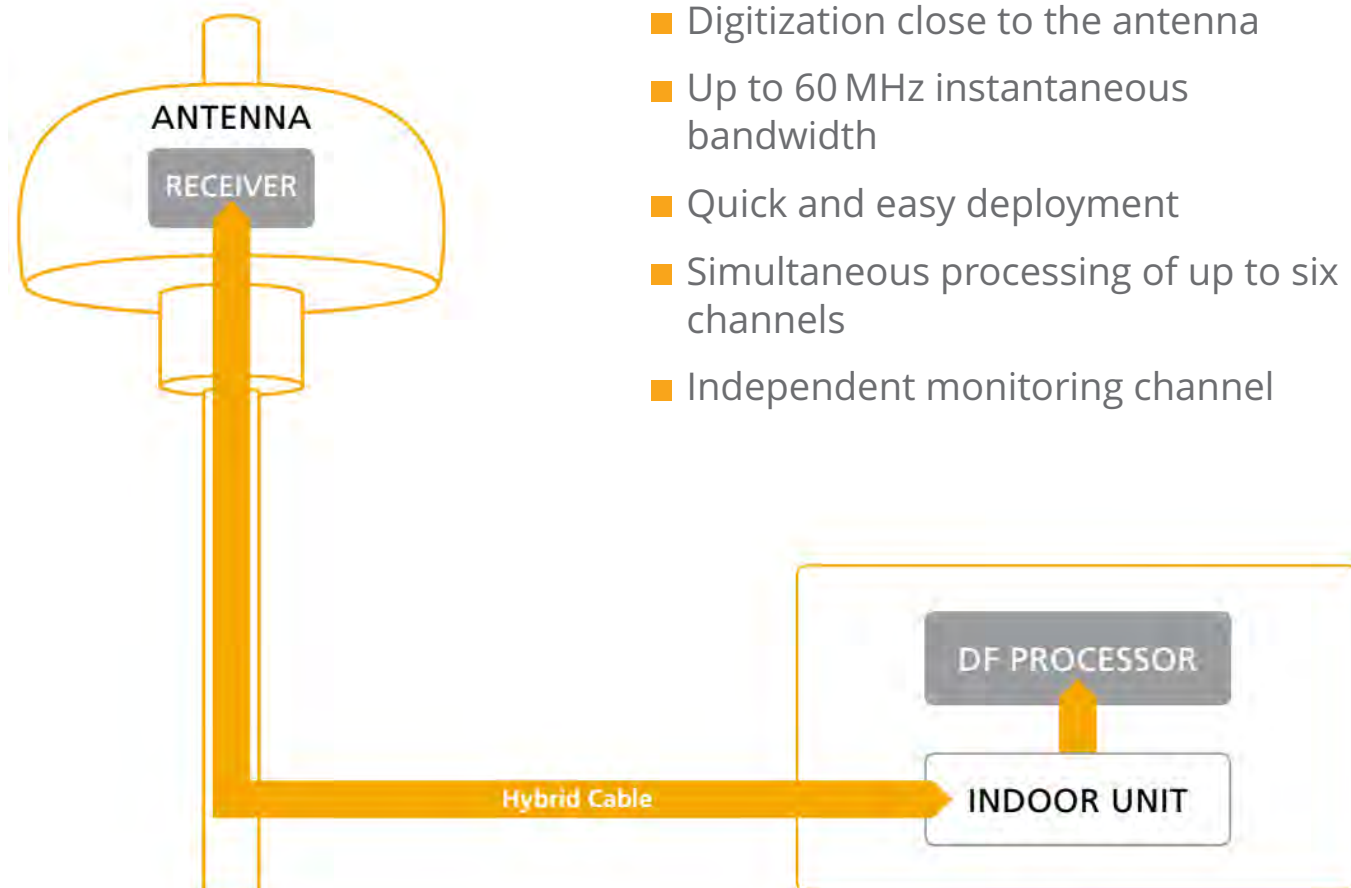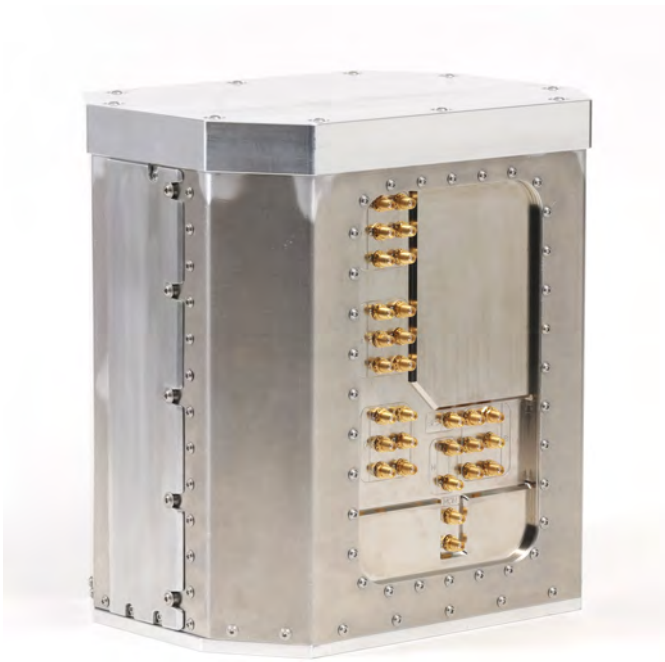# Radio Direction Finder
IZT R5506

- Highest signal quality in the frequency range up to 6 GHz

- Digitization close to the antenna

- Up to 60 MHz instantaneous bandwidth

- Quick and easy deployment

- Simultaneous processing of up to six channels

- Independent monitoring channel

ANTENNA

RECEIVER

DF PROCESSOR

Hybrid Cable

INDOOR UNIT

Overview

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".

Key Features

Close Integration with the Antenna

■ Close integration for exceptional sensitivity
■ RF signals are directly digitized at the antenna
  ≫ page 4

Quick and Easy Deployment

■ Hybrid cable for power and data allows quick and easy deployment
■ Integration into DF antenna results in compact design
  ≫ page 5

High Reception Quality

■ 6 coherent receive channels with instantaneous bandwidth of 60 MHz for maximum probability of intercept, or
■ 5 coherent receive channels and one independent monitoring channel
■ Fast DF scan mode, that is allows highly flexible configuration of scan jobs
■ Internal phase calibration
■ GPS-synchronized reference clock
■ Sub-octave preselection filters
  ≫ page 6

Signal Processing

■ Streaming of 6 simultaneous channels with full rate over optical link
■ A multitude of out data types is available: IQ data, PSD and overlapping complex FFT data
  ≫ page 7

Powerful DF Processing

■ Broadband sampling and modular design allows for DF of multiple signals over a large bandwidth
■ DF processor available separately
  ≫ page 8

Super-resolution DF

■ Superior resolution compared to conventional DF techniques, e.g., interferometer
■ Resolution of multiple signal on the same frequency, e.g., single frequency DVB networks or jammed radio services
  ≫ page 9

Advanced Signal Analysis

■ Advanced signal analysis in parallel with exceptional direction finding
 ≫ page 9

Your Benefits

CLOSE INTEGRATION WITH THE ANTENNA

The IZT R5506 is closely integrated with the antenna system. The receiver unit is stored inside a cavity of the array antenna. Figure 1 shows the IZT R5506 in combination with the Alaris DF-0095A. This five channel antenna covers the frequency range of 1 MHz to 6000 MHz in four bands. Optionally the antenna can be equipped with an omnidirectional monitoring channel. The antenna is radomized and suitable for fixed or mobile use. The power dissipated by the electronics is conducted to a passive cooler below the radome. The antenna can be easily lifted and removed for maintenance of the IZT R5506. The mechanical dimensions are shown in Figure 2 Since only a hybrid cable has to be connected to the antenna system, the IZT R5506 installation is quick and simple.

FIGURE 1: IZT R5506 RECEIVER WITH LIFTED ANTENNA, E.G., FOR MAINTENANCE AND CABLING.
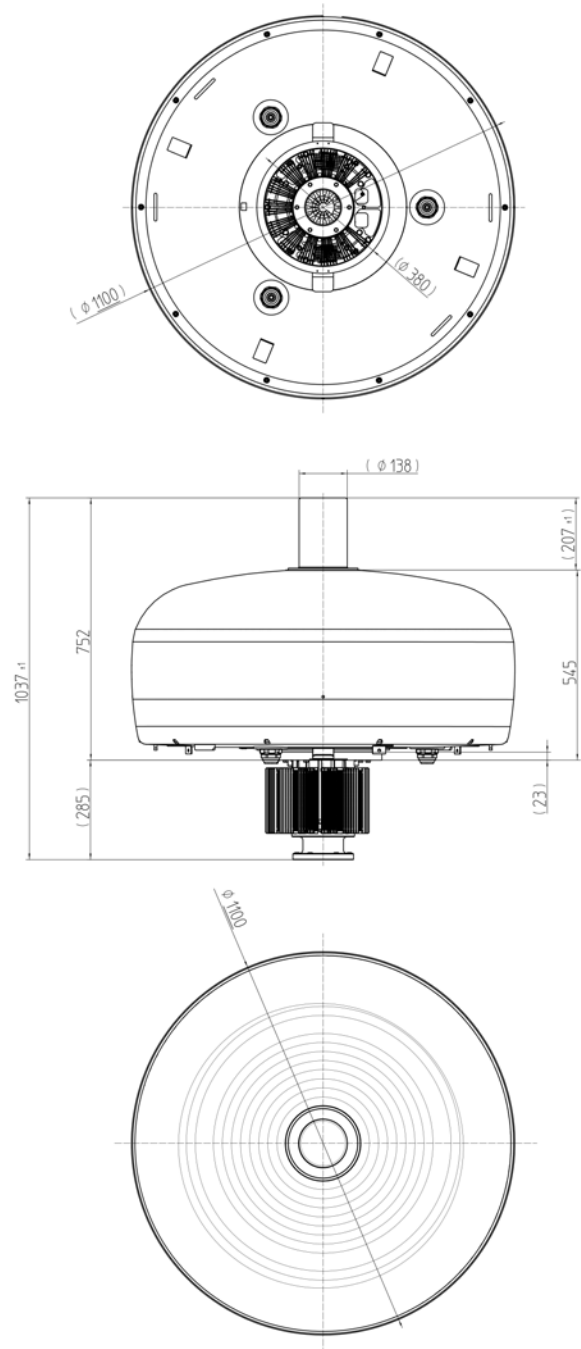
FIGURE 2: DIMENSIONS OF THE IZT R5506 ANTENNA INCLUDING THE RECEIVER UNIT AND COOLING.

QUICK AND EASY DEPLOYMENT

A key feature of the IZT R5506 is the single connection between the receiver and the DF processor. This is sketched in Figure 4. A hybrid cable provides power to the IZT R5506 in the antenna and transports the digitized data from the receiver to the DF processor. This enables quick deployment in the field. Two persons are adequate to mount the antenna system on a transportable mast. Figure 5 shows the IZT R5506 deployed in a measurement campaign. The optional magnetic compass allows for a quick, initial alignment with magnetic north. The IZT R5506 receiver with its housing including the hybrid cable is depicted in Figure 3.

FIGURE 3: IZT R5506 ELECTRONICS WITH HYBRID CABLE.
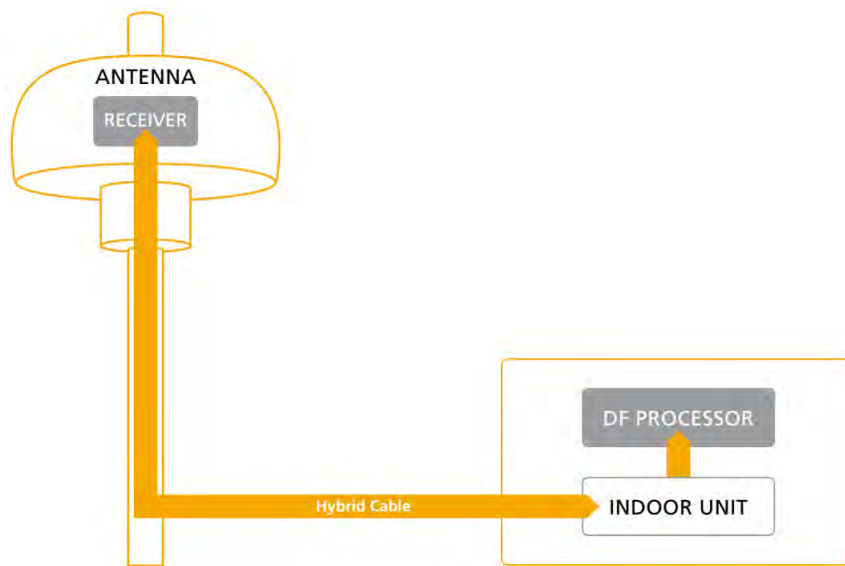
FIGURE 4: BLOCK DIAGRAM OF IZT R5506 WITH ANTENNA, INDOOR UNIT AND DF PROCESSOR.

FIGURE 5: IZT R5506 RECEIVER IN A MEASUREMENT CAMPAIGN.

HIGH RECEPTION QUALITY

The IZT R5506 contains up to six high-performance receivers up to 6 GHz with sub-octave preselector filters. For each antenna element of the 4 RF bands a dedicated RF input is provided. All up to 24 antenna inputs are protected against excessive input power by fast limiters.

An internal calibration source ensures optimum phase and amplitude matching between the channels. One of the six channels can be factory configured with a separate local oscillator (LO) to work as an independent monitoring channel. The IZT R5506 features a high stability internal reference clock and an integrated Global Positioning System (GPS) receiver for synchronization.

Flexible Scan Schemes

Via a flexible job control scheme, the user can define complex scan jobs that will be automatically and synchronously executed by the receiver. All data is tagged with accurate time stamps to support also hybrid (AOA/TDOA) location finding schemes. The data rate generated by the IZT R5506 can be controlled over a wide range. This is realized by introducing gaps and adjusting the bandwidths to adapt to the processing speed of the DF Processor software.

Non-switching Design

Due its non-switching design the IZT R5506 allows for direction finding of extremely fast frequency agile signals with high probability of intercept. The IZT R5506 samples signals synchronously from all antenna elements in a specific frequency band eliminating the need for additional radio frequency (RF) switches. If supported by the DF Processor Software, this feature allows short detection times, beamforming and maximum sensitivity.

Hybrid Cable

Optical fiber replaces long RF cables from the antenna tower to the shelter or vehicle. This makes the installation much simpler and completely eliminates problems with losses or parameter variations in the antenna cables of traditional DF systems. The same hybrid cable also supplies a galvanically isolated DC voltage to the IZT R5506 electronics. The IZT R5506 Indoor Unit contains the power supply, surge protection and access to the data for the DF processor server. All the sensor's functions are remote controlled via the optical interface.
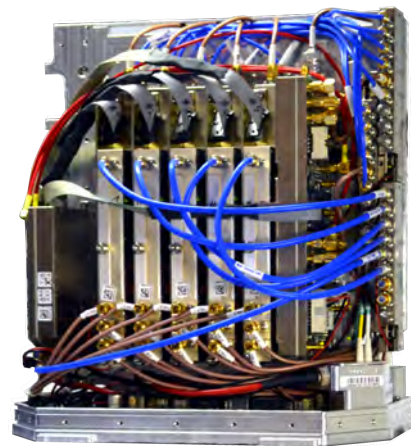
FIGURE 6: IZT R5506 RECEIVER UNIT WITHOUT HOUSING.

SIGNAL PROCESSING

IZT R5506 uses latest FPGA technology for signal processing. Up to six channels with 60 MHz instantaneous bandwidth are continuously sampled, filtered and decimated. The main signal processing board is depicted in Figure 7. Together with meta data and highly accurate time stamps the data is sent to the DF processor server via optical LAN with a maximum capacity of 20 Gigabit per second. A flexible job control allows the user to define complex scan scenarios to be executed by the receiver. Different data formats are available.

IQ Data

IQ Data from the DF channels are available with variable sample rate and an instantaneous bandwidth of up to 60 MHz.

Power Spectrum

The data from the DF channels can be added with weighting coefficients and converted into a power spectrum (PSD) with 4096 frequency bins, which will be sent to the DF processor.

Complex FFT Data

As an option, the IZT R5506 can convert up to six DF channels into an overlapping WOLA-3 16384-point complex FFT. The sample rate going into the FFT is continuously settable by the user, for example to cover typical channel spacings. In this configuration, the capability for processing the PSD is not available, but the overall system performance will be greatly enhanced by reducing the processing power requirements in the DF processor.

Monitoring Channel

If fitted with the optional monitoring channel, the IQ data is available with a variable sample rate and bandwidth up to 60 MHz as well as PSD with 4096 points. Center frequency and the bandwidth of the monitoring channel can be configured completely independent from the DF channels.


**FIGURE 7:** IZT R5506 SIGNAL PROCESSING BOARD.

POWERFUL DF PROCESSOR

The IZT R5506 requires a DF processing software which usually runs on a server, that receives data from the DF receiver located in the antenna assembly via the hybrid cable. For customers who wish to adapt or design their own DF processor software, IZT will provide interface control documents and technical support. IZT also offers DF processor software (available separately), please contact IZT for further information. The IZT DF processor software is based on state-of-the-art super-resolution techniques for accurate direction finding. Results are shown in Figure 8 and Figure 9.
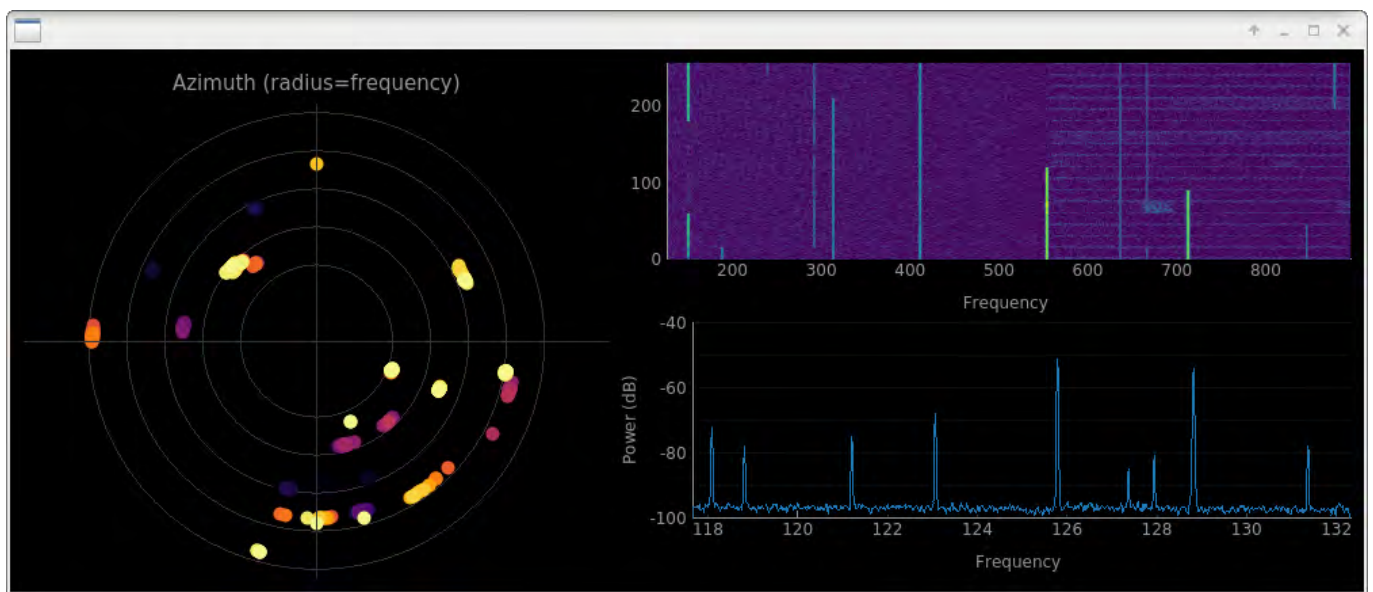
FIGURE 8: SUPER-RESOLUTION DF OF MULTIPLE CHANNELS IN AIR TRAFFIC CONTROL
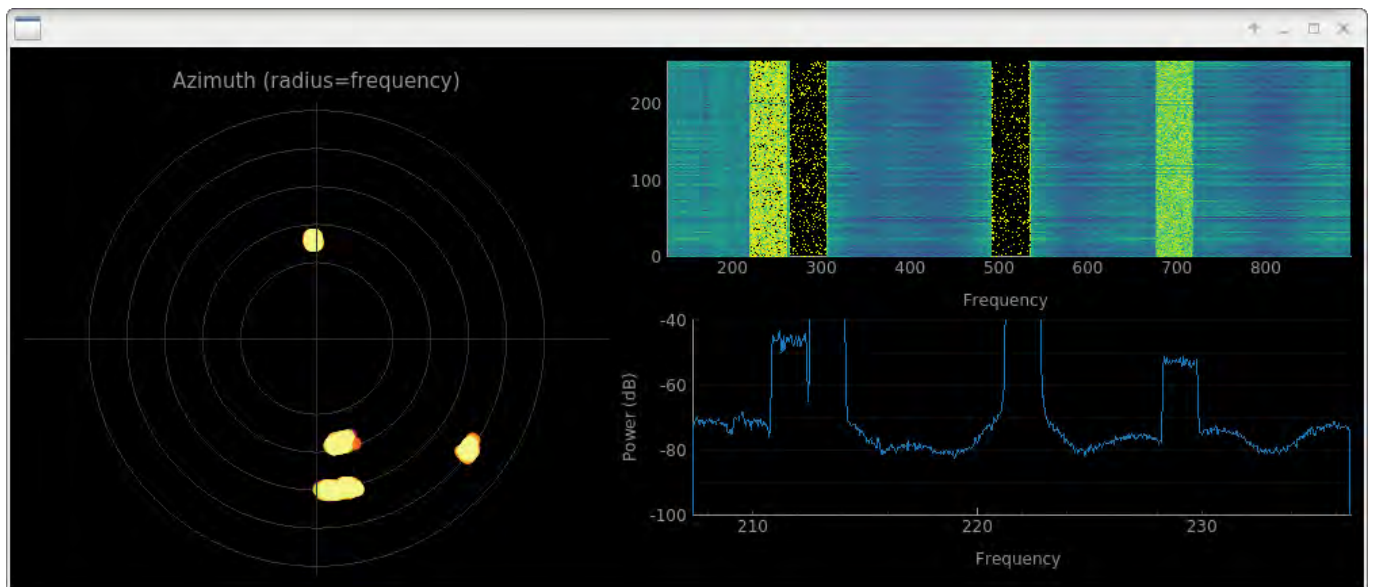

FIGURE 9: SUPER-RESOLUTION DF OF MULTIPLE DAB SIGNALS

SUPER-RESOLUTION DF

In conventional DF methods, for example correlative interferometer, it is assumed to only have a single signal source occupying a specific frequency. However, in real-world application scenarios multiple signal sources might be present on the same frequency. This fact, referred as co-channel interference, impairs the DF results when applying conventional DF methods. One might think of single-frequency DAB/DVB networks or intentional jamming as examples for multiple signal sources on the same frequency.

Super-resolution DF techniques overcome this restriction. Applying super-resolution techniques, the IZT direction finders can resolve multiple signals emitted on the same frequency. The DF processor provides the number of signals present along with their respective incident signal directions.
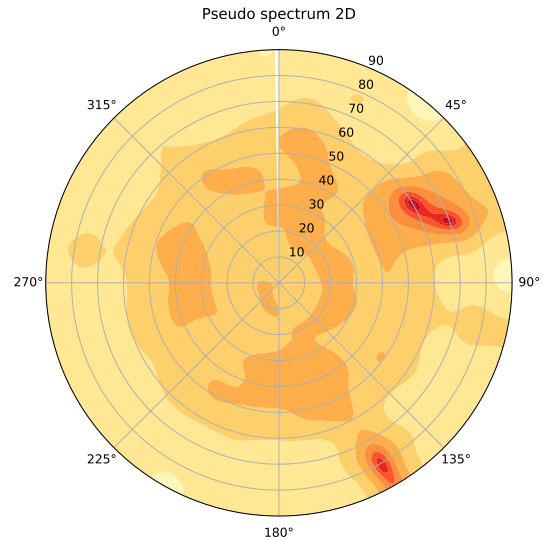

FIGURE 10: 2D MUSIC SPECTRUM FOR 3 SIGNAL SOURCES ON THE SAME FREQUENCY AT AZIMUTHS AND ELEVATIONS OF 60°, 70°, 150° AND 30°, 20°, 10°, RESPECTIVELY

ADVANCED SIGNAL ANALYSIS

Next to simply demodulating signals of certain modulation types, advanced signal analysis can be carried out utilizing the IZT Signal Suite. The IZT Signal Suite modulation recognition function is useful in a number of communications satellite monitoring (CSM) applications such as automated monitoring of satellite transponders, verifying the correct usage of terrestrial bands, characterizing the RF environment, and identifying unauthorized signals in certain frequency bands.

In radio monitoring and intelligence there is a demand for sophisticated signal analysis techniques in order to detect, classify or demodulate radio signals. To achieve this goal, IZT ModRec provides powerful signal analysis for detecting and classifying known and unknown signals which is perfectly combined with the DF capabilities of the IZT R5506. See https://www.izt-labs.de/detecting-and-classifying-signals-with-izt-signal-suite/ for details.
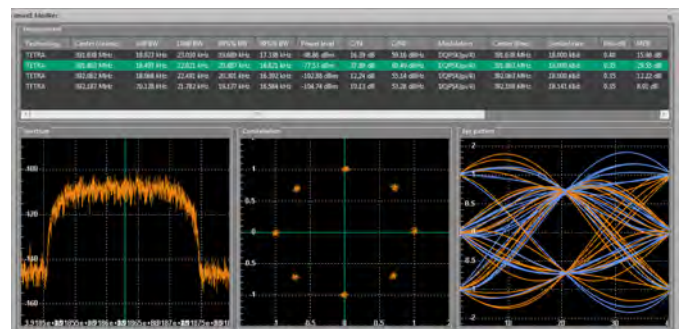
FIGURE 11: MODULATION ANALYZER RESULTS WITH CONSTELLATION AND EYE DIAGRAM

Specifications

Specifications	IZT R5506
Frequency range	1 MHz to 6000 MHz
Number of DF channels	Up to six [1] [2]
Number of monitoring channels	Up to one [3]
Instantaneous bandwidth	60 MHz
Minimum signal duration	Dependent on DF processing software
DF technique	Correlative vector interferometry (CVI), super-resolution (MUSIC)
Instrumental DF accuracy	< 0.5° RMS
DF accuracy with DF0095 antenna	< 2° RMS (90 MHz to 3000 MHz)
	< 3° RMS (1 MHz to 90 MHz and 3000 MHz to 6000 MHz)
Frequency bands for DF	Four
Number of RF inputs	24
Preselector	14 bands, electronic switching
Conversion scheme	Dual conversion with variable 1st IF
I/Q sample rate	Up to 78.125 megasamples per second
FFT	16384 points
PSD	4096 points
Synchronization	Internal GPS receiver
Monitor & Control	From DF processor software via optical link
Power consumption[4]	Approx. 200 W to 250 W

TABLE 1: IZT R5506 SPECIFICATIONS

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[1] simultaneous sampling
[2] up to five if equipped with monitoring channel
[3] optional
[4] depends on number of channels and options

Ordering Guide

Option	Description
IZT R5506-DSP	DSP Unit and framework
IZT R5506-DC6	Analog Tuner Channel up to 6000 MHz
IZT R5506-MON6	Monitoring Channel independently tuneable up to 6000 MHz
IZT R5506-IDU	Indoor Unit
IZT R5506-MNT1	Mechanical Adapter and cooler for DF-0095A
IZT R5506-MNT2	Mechanical Adapter and cooler for DF-0095A, heavy load
IZT R5506 DF0095	5 Element Wideband Portable DF-Antenna 1 MHz to 6000 MHz
IZT R5506-DF0095 OMNI	OMNI Channel for DF0095
IZT R5506-CMP	Built-in Magnetic Compass
IZT R5506-100	I/Q Data
IZT R5506-200	PSD Data
IZT R5506-300	Complex FFT Data

TABLE 2: IZT R5506 ORDERING GUIDE

Radio Direction Finder
IZT R5506

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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