VHF Radio Direction Finder
IZT R5509

Product Information

- Accurate VHF Radio Direction Finder
- Simultaneous processing of more than 35 channels
- Frequency range 20 MHz to 520 MHz
- Robust design: up to wind speeds of 200 km/h under icing conditions
- Perfect for applications in air traffic control (ATC)

REV. 1.2 | 07.02.2019

Overview

The IZT R5509 is a highly accurate and reliable radio direction finding (DF) system that is from the ground up designed for high resolution VHF direction estimation. The DF system is intended to support the work of ATC operators by localizing and identifying the transmitting aircraft. Hence, misreading of the aircraft's call-sign are avoided. This improves the situational awareness of the ATC operators and increases the safety level. That in turn, allows to handle more flights per operator for cost-efficient control of the airspace.

The novel DF system IZT R5509 features 10 coherent receive channels and is equipped with a 9-element antenna array to realize accurate and robust direction estimation. The utilized DF antenna with 9 elements provides superior immunity to multipath propagation. An optional center antenna element may be used for even increased spatial resolution. Beyond outstanding radio frequency (RF) characteristics, the antenna is equipped with lightning protection and is verified to withstand wind speeds of 200 km/h even under icing conditions.

In brief: The IZT R5509 is the ideal solution for ATC direction finding to improve situational awareness and reduce the risk of misunderstandings in radio transmissions.

FIGURE 1: DF RECEIVER CHASSIS

FIGURE 2: CUSTOMER INSTALLATION WITH IZT DF ANTENNA AND RECEIVER

Key Features

Exceptional RF Properties

- The IZT 5509 provides 10 coherent receive channels
- Direction conversion design for maximum selectivity
- Full VHF coverage: 20 MHz to 520 MHz
- Instantaneous bandwitdh: 40 MHz
- Preselection filters provide exceptional large-signal immunity

≫ page 4

Robust Design

- Integrated lightning protection
- Wide operating temperature range: -20°C to +55°C
- The IZT R5509 antenna allows wind speeds of up to 200 km/h under icing conditions
- Stand-by power supply (UPS) for continuous operation in case of power outages

≫ page 4

Wide-Aperture Array Antenna

- A wide-aperture array antenna with 9 elements provides excellent DF accuracy and high immunity to reflections

≫ page 5

Powerful DF Processor

- A powerful DF processor is part of the IZT R5509 system
- Broadband sampling and modular design allows for DF of multiple signals over a large bandwidth
- Up to 100 active ATC channels in parallel
- Supports 8.33 kHz and 25 kHz channel spacing

≫ page 5

Super-resolution DF

- Superior resolution and multipath robustness compared to conventional DF techniques, e.g. interferometer
- Resolution of multiple signal on the same frequency, for example single frequency DVB networks or co-channel interference

≫ page 6

Easy Integration

- The IZT R5509 provides system monitoring and built-in self-tests
- Remote control protocol for receiver configuration
- SNMP interface for easy integration into existing monitoring systems
- ASTERIX compliant output data format
- IZT provides full service for ATC DF system including installation support (e.g. building antenna masts), training and maintenance as well as geo-location solutions

FIGURE 3: ANTENNA WITH IZT R5509 RECEIVER CABINET

Your Benefits

EXCEPTIONAL RF PROPERTIES

The IZT R5509 is a high-speed, ultra-wideband direction finder designed for the VHF band. With an instantaneous bandwidth of 40 MHz, the IZT R5509 allows continuous direction finding in the full VHF airband from 118 MHz to 137 MHz. Continuous sampling of the complete band ensures high probability of intercept. Besides the VHF airband, the IZT R5509 provides a frequency range from 20 MHz to 520 MHz. Hence, the IZT R5509 also provides DF capabilities in the UHF airband between 225 MHz and 400 MHz.

Exceptional large-signal immunity is achieved by high-grade preselection filters. The following filters are available:

- Band 1: 20 MHz to 108 MHz
- Band 2: 108 MHz to 144 MHz
- Band 3: 144 MHz to 225 MHz
- Band 4: 225 MHz to 400 MHz
- Band 5: 400 MHz to 520 MHz

Each of the filters features its individual amplifier stage, optimized for this frequency range. This ensures maximum linearity and large signal performance.

ROBUST DESIGN

With the receiver cabinet located directly below the antenna, the RF and digital processing is closely integrated with the antenna system. 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 optimal dynamic range, sensitivity and DF accuracy within the capabilities of the antenna array.

The IZT R5509 antenna is designed for wind speeds of up to 200 km/h even under icing conditions.

The system can be extended with a uninterruptible power supply (UPS) for continuous operation in case of power outages.

FIGURE 4: INSTALLATION OF THE IZT R5509 WITH IZT ANTENNA

WIDE-APERTURE ANTENNA

The antenna of the IZT R5509 has been designed and is manufactured by IZT. Apart from generic requirements, like adequate bandwidth, the main objective in the design was to use antenna elements with robust and low impedance connection to the ground.

Compared to dipoles or variants thereof, which are commonly used in the industry, the design of the IZT R5509 antenna provides an additional layer of protection against surges and lightning strikes.

The large aperture size of the IZT R5509 antenna array provides excellent sensitivity and superior DF accuracy even in multipath environments.

Due to its large aperture size and thorough design, the IZT R5509 antenna array is capable of resolving closely spaced sources as shown on page 6.

The antenna array has nine elements and a diameter of 2.17 meter. Together with Fraunhofer Institute, the antenna pattern of the antenna was measured at a facility of TU Ilmenau, Germany, and found to be suitable to achieve the required DF accuracy.

POWERFUL DF PROCESSOR

The IZT R5509 requires a DF processing software which usually runs on a server. The server 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.

The IZT DF processor software is based on state-of-the-art super-resolution techniques for accurate direction finding. Within the VHF aviation band of 117.975 MHz to 137 MHz all up to 2283 channels (at 8.33 kHz channel spacing) can be monitored for activity at the same time.

Results are shown in Figure 7.

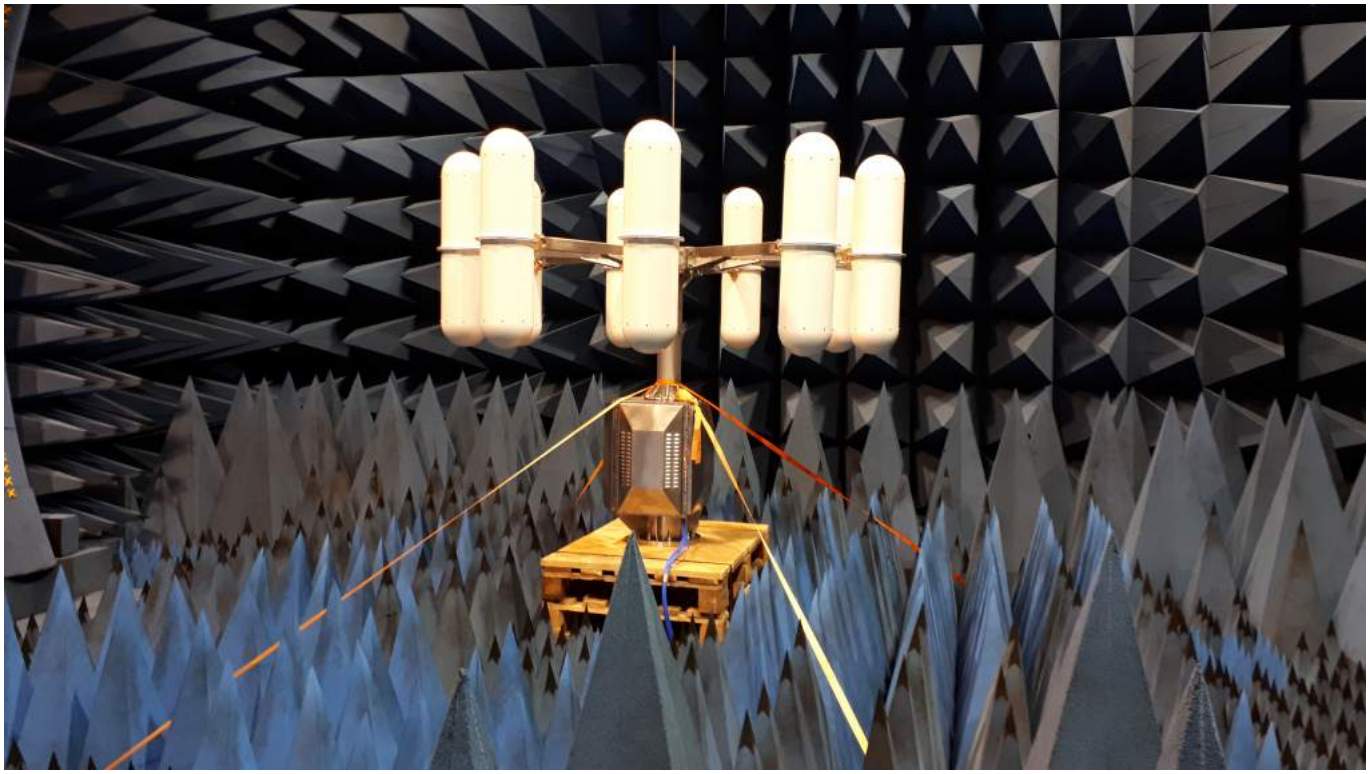

FIGURE 5: MEASUREMENT OF THE 9-ELEMENT PROTOTYPE ANTENNA

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.

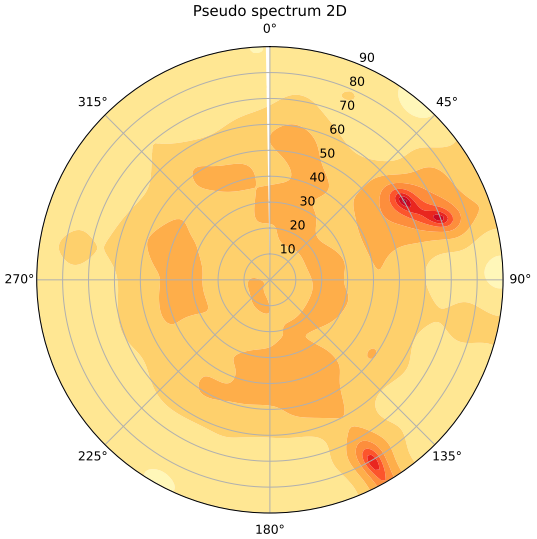

FIGURE 6: 2D MUSIC SPECTRUM FOR 3 SIGNAL SOURCES ON THE SAME FREQUENCY AT AZIMUTHS AND ELEVATIONS OF 60°, 70°, 150° AND 30°, 20°, 10°, RESPECTIVELY

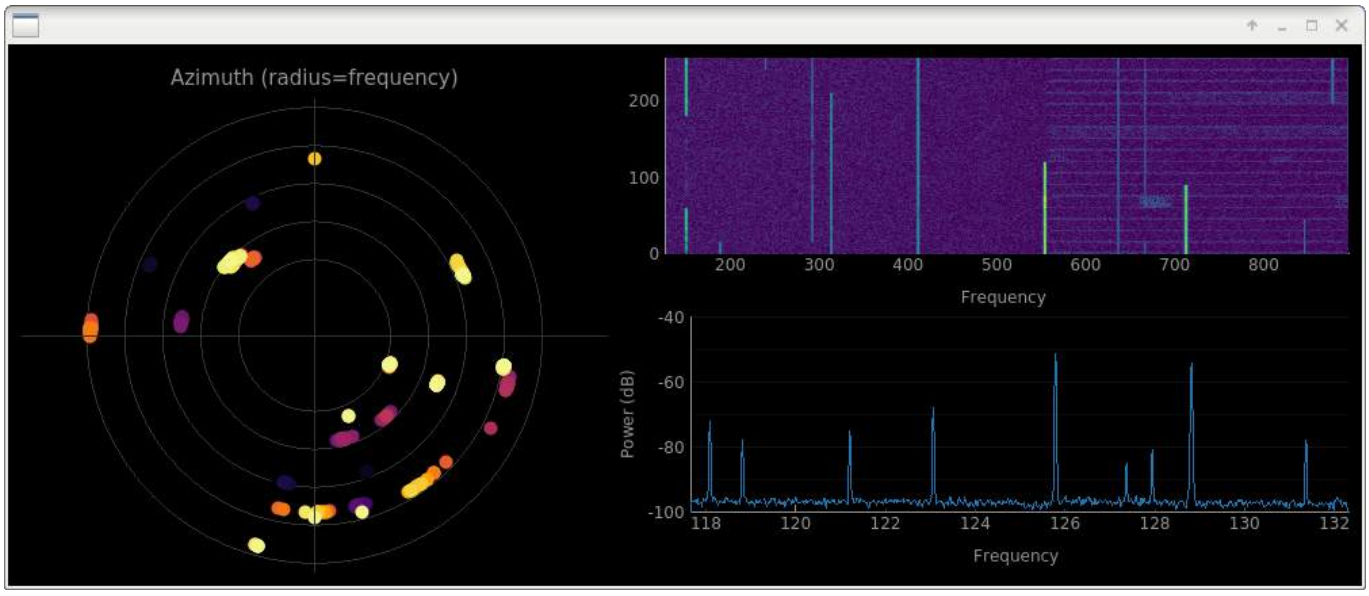

FIGURE 7: SUPER-RESOLUTION DF OF MULTIPLE CHANNELS IN AIR TRAFFIC CONTROL

Applications

AIR TRAFFIC CONTROL

Up to 25 aircraft are often in the responsibility of a single air traffic controller in Europe's densely packed airspace. Using a DF system can significantly improve the situational awareness of the controller. Bearing measurements from VHF DF system help the controller to quickly locate the transmitting aircraft on the ATC screen. On the ATC screen a circle indicates the position of the aircraft, as depicted in Figure 8. Beyond quick and unambiguous localization of the communicating aircraft, the risk of misunderstanding and call-sign confusion is significantly reduced. As read-backs from wrong aircraft or crossed transmissions are avoided, safety and productivity are substantially increased.

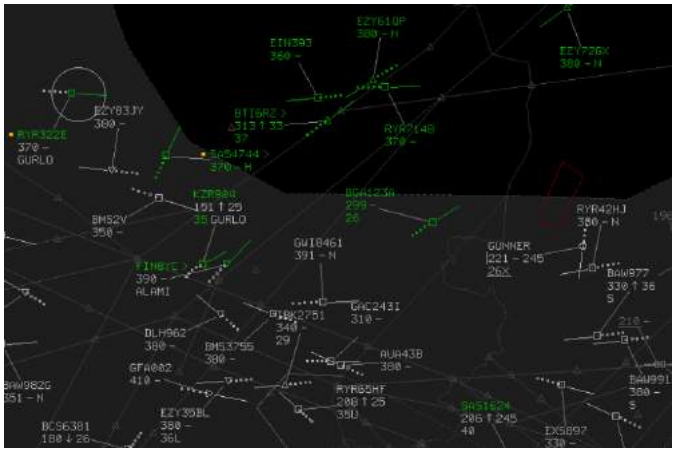

FIGURE 8: DETAIL OF A CONTROLLER'S SCREEN WITH A CIRCLE INDICATING THE LOCATION OF THE TRANSMITTING AIRCRAFT
©EUROCONTROL

FULL SYSTEM SOLUTION

Figure 9 shows the high level architecture of a full VHF Positioning System (VPS) which includes multiple VHF Direction Finder (VDF) sites based on the IZT R5509 and a VPS center.

The DF results from multiple IZT R5509 sites are fused to aircraft positions in the VPS center. The VPS center provides DF data accumulation and sensor data fusion as well as consistent data storage. Furthermore, the VPS center allows replay of recorded data at arbitrary time intervals and at various speeds for investigation and training purposes.

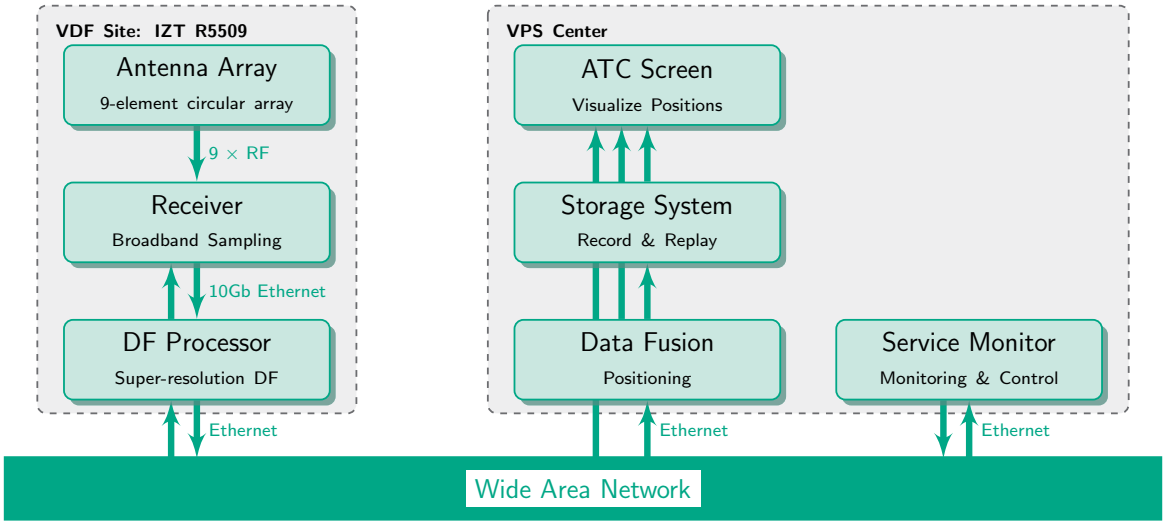

FIGURE 9: HIGH LEVEL ARCHITECTURE OF A VPS SYSTEM

Specifications

Specification	IZT R5509 receiver
Frequency range	20 MHz to 520 MHz
Number of DF channels	9 (optional 10)
DF technique	Correlative Vector Interferometry (CVI), super-resolution (MUSIC)
Instrumental DF accuracy	< 0.5° RMS
Tuning resolution	1 Hz
Conversion scheme	Direct sampling
Instantaneous bandwidth	40 MHz
Sampling rate	50 MSPS
Minimum signal duration	100 µs
SFDR, ADC	75 dB
Tuning speed	< 1 ms
Tuning resolution	1 Hz
Oscillator phase noise	−120 dBc/Hz @ 1 kHz
	−130 dBc/Hz @ 10 kHz
IP3	+15 dBm
IP2	+70 dBm
Noise figure	10 dB
Preselector	5 bands, electronic switching
	20 MHz to 108 MHz
	108 MHz to 144 MHz
	144 MHz to 225 MHz
	225 MHz to 400 MHz
	400 MHz to 520 MHz
Monitoring and control	From DF processor software via ethernet link
Power consumption	Approx. 200 W to 250 W
Operating temperature	−20 °C to 55 °C
Storage temperature	−40 °C to 70 °C

Specification	IZT R5509 antenna
Antenna type	Circular array, fully grounded structure
Polarization	Vertical
Diameter	2.17 m
Permissible wind speed	200 km/h, also under icing conditions

Ordering Guide

Option	Description
IZT R5509	VHF Radio Direction Finder

VHF Radio Direction Finder
IZT R5509

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.

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.

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

Quality Management ISO 9001 DEKRA certified

IZT Innovationszentrum Telekommunikationstechnik

REV. 1.2 | 07.02.2019