IZT R5020
HF Receiver

- Highest signal quality up to 30 MHz
- Ultimate linearity at full HF coverage
- Passive input channelizer for best IP2/IP3
- Twelve A/D converters
- Sum data stream or 12 single streams

The IZT R5020 is a broadband receiver with a patented preselector filter bank. It is designed to digitize the complete HF band from 50 kHz to 30 MHz with an exceptional dynamic range.

The IZT R5020 can be used with the IZT Signal Suite GUI applications, through an IZT SDK or with 3rd party software.

Figure 1: IZT R5020 DSP SECTION

Key Features

FULL HF COVERAGE WITH ULTIMATE LINEARITY

The IZT R5020 is a broadband receiver designed to digitize the whole HF band from 50 kHz to 30 MHz in very high quality. Key components of the IZT R5020 are a multichannel digitizer from IZT's R5000 receiver series and a very high-performance, analog channelizer with overlapping bandpass filters.

IZT's patented design outperforms conventional receivers by using a passive, low-loss channelizing filter with 12 overlapping frequency bands in front of any active electronics. Each output channel has a dedicated A/D converter preceded by an electronic attenuator and subsequent low noise high linearity amplifier. Automatic gain control is performed independently for each channel.

The receiver is still sensitive enough to be operated without a preamplifier.

The IZT R5020 design overcomes typical limitations of legacy receivers: Especially when large receive antenna systems are used, the power of the input signal can be very high. In consequence, limiting the receiver bandwidth by preselection filters becomes essential. The biggest concern are second order intermodulation products which require preselection filters with less than one octave relative bandwidth.

With conventional receivers, it is not possible to monitor the whole HF frequency band at a time. Most receivers will allow bypassing the preselector filters, but usually this will require a reduced gain to avoid clipping due to strong signals and the strongest signal or the sheer amount of incoming energy will force the receiver gain control to reduce its sensitivity over the whole instantaneous bandwidth.
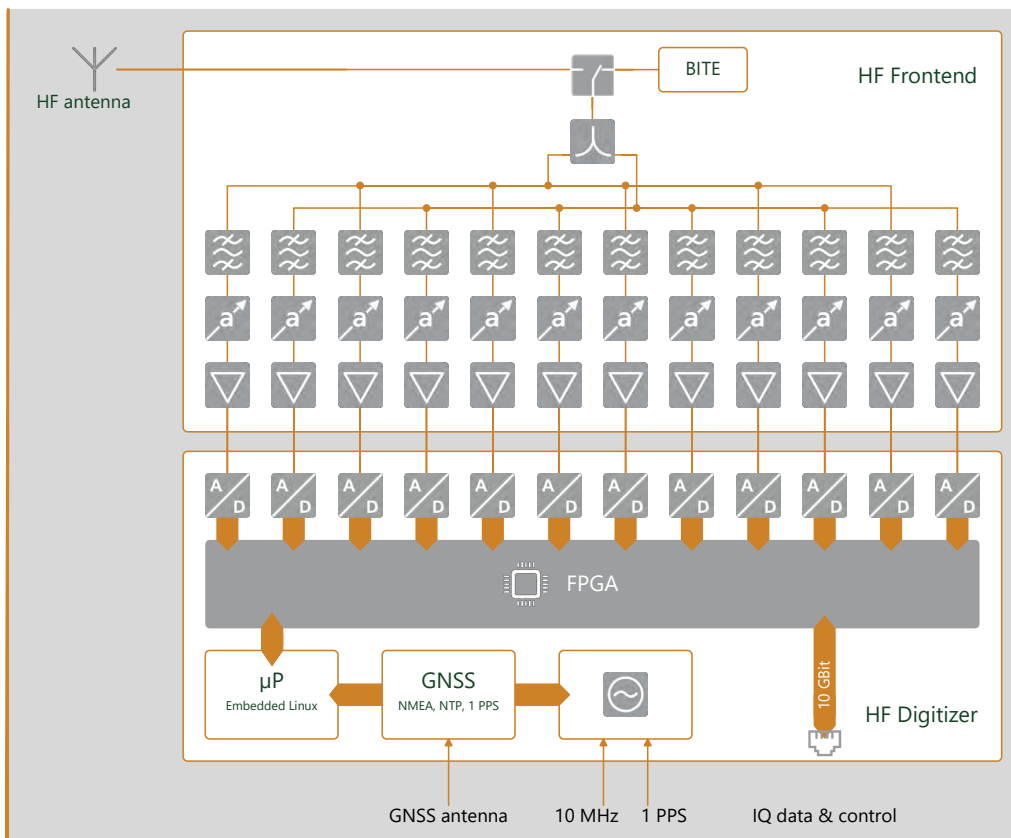

Figure 2: IZT R5020 BLOCK DIAGRAM

ANALOG CHANNELIZER

Two banks of overlapping, passive bandpass filters channelize the whole HF spectrum into 12 bands. Mechanically large inductors ensure minimum intermodulation.

The filter corner frequencies from 50 kHz to 30 MHz are shown in Table 1. The filters are grouped into two banks A and B (refer to Figure 2 and Table 1). Only the first filter is a lowpass, while all other filters are bandpass filters with a relative bandwidth of approx. 1:1.6. These filters therefore meet the sub-octave criterion and improve the second-order intercept point. The center frequencies of the filters increase by approximately 1:1.3, ensuring adequate overlap at the corner frequencies. The filters within one bank do not overlap and therefore can be coupled with minimum loss.

A reactive power divider with high interport isolation allows for coupling banks A and B. Only behind the filters, each channel has a highly linear electronic attenuator and a subsequent amplifier with a large dynamic range. This technique avoids second-order intermodulations in the active stages up to the A/D converter. In addition, it allows for individual gain adjustment in each channel. Only the channels loaded with very strong input signals have to reduce their gain while quieter channels can still operate with maximum sensitivity.

A built-in test source is available enabling the receiver software to estimate and thereafter equalize the frequency responses of the analog filters so that they can be combined into a broadband data stream by the post processing software if necessary.

POWERFUL DIGITAL PROCESSING

Each of the 12 channels is digitized with 16 bit resolution and processed in an FPGA. For full simultaneous coverage of the HF band, one DDC is assigned to one A/D converter. For special scenarios it is possible to concentrate the available pool of DDCs at a single A/D converter. The DDCs support an arbitrary user-defined sample rate and up to 40 MHz bandwidth.

The output data is provided via UDP/IP as complex I/Q data with embedded meta data compatible to the IZT R5000 receiver series. Accurate time stamps allow for calculating the reception time for each sample down to sub-nanosecond accuracy.

The IZT R5020 contains an ovenized crystal oscillator as timing reference. Multiple IZT R5020 can be accurately synchronized with respect to time and frequency.

TIME REFERENCE SOURCE

With option IZT R5020-REF, the IZT R5020 contains a GNSS receiver module serving as highly accurate time reference source to discipline the OCXO via 1PPS signal derived from the GNSS satellites. It also provides an NMEA data stream via UDP with location information and an integrated NTP server. Both are sent in parallel to the IQ data stream over the same 10Gbit interface.

Filter No.	Bank	Frequency
1	A	0 to 1.2 MHz
2	B	1.1 to 1.6 MHz
3	A	1.4 to 2.1 MHz
4	B	1.9 to 2.9 MHz
5	A	2.6 to 3.8 MHz
6	B	3.4 to 5.1 MHz
7	A	4.6 to 6.9 MHz
8	B	6.2 to 9.3 MHz
9	A	8.3 to 12.4 MHz
10	B	12.2 to 16.1 MHz
11	A	14.9 to 22.4 MHz
12	B	21.5 to 30 MHz

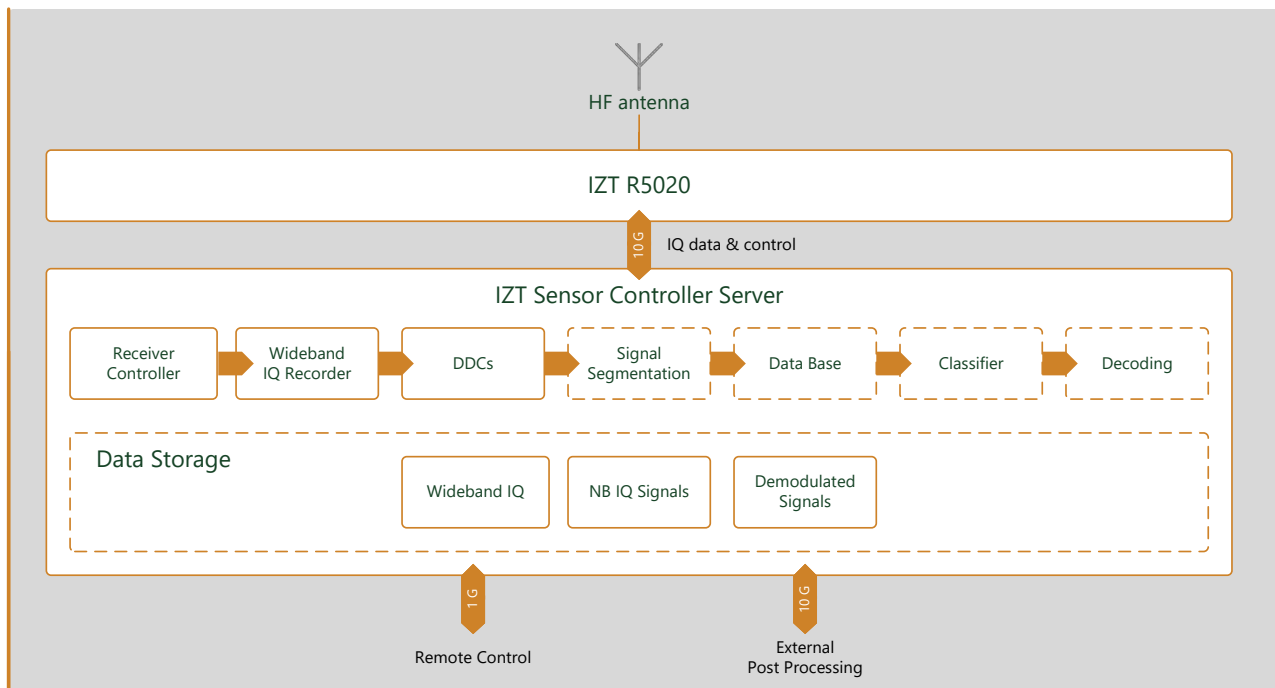**Table 1:** CORNER FREQUENCIES OF THE BAND-PASS FILTERS

Figure 3: IZT R5020 WITH IZT SENSOR CONTROLLER PC

Key Features

SOFTWARE PROCESSING

IZT R5020 is primarily designed to interface with the IZT Signal Suite software running on a sensor controller server. The processing chain is shown in figure 3. The IZT Signal Suite performs the following functions:

- Controlling the IZT R5020
- Wideband IQ recording
- Narrow-band DDCs

If required, the IZT Signal Suite can perform additional functions:

- Signal Segmentation
- Data Base
- Classifier
- Decoding
- Interfacing with a large storage system

MECHANICAL DESIGN

IZT R5020 comes in a 19'/1U' enclosure with 500 mm depth. All interfaces like LAN connectors for control and data as well as RF and synchronization interfaces are placed on the rear panel.

Interfaces

The intake for cooling air is located on the front side, where an indicator LED shows the summery status.

Figure 4: IZT R5020 FRONT PANEL

All electrical interfaces of the IZT R5020 are located on the rear panel. Interfaces which are reserved for future use are not populated and covered with blind panels.

Figure 5: IZT R5020 REAR PANEL

Interfaces

Label	Specification	Description
POWER	IEC 320	AC power supply
CLK IN	SMA, female, 50 Ohm	Internal, synchronization of multiple units
CLK OUT	SMA, female, 50 Ohm	Internal, synchronization of multiple units
TRIG IN	SMA, female, 50 Ohm	External trigger input
TRIG OUT	SMA, female, 50 Ohm	External trigger output
PPS IN	SMA, female, 50 Ohm	PPS input for synchronization [1]
PPS IN	D38999/24WA98PN	PPS input for synchronization [2]
BLNK IN	SMA, female, 50 Ohm	Blanking input[1]
BLNK IN	D38999/24WA98PN	Blanking input[2]
GPS IN	SMA, female, 50 Ohm	GPS antenna input and bias voltage output
REF IN/OUT	SMA, female, 50 Ohms	10 MHz reference input / output
AUX 1, AUX 2	SMA, female, 50 Ohm	*reserved for future use*
RF1	N, female, 50 Ohms	Antenna input
USB	USB 2.0	Service interface
SERVICE	USB 2.0	Low level service interface
LAN	1 GBit, RJ45	Optional web interface
SFP+ 1	10 GBit optical, multimode, SFP +	Data and configuration
SFP+ 2	10 GBit optical, multimode, SFP +	*reserved for future use*

[1]standard version
[2]with option R5020-SYM

Performance Characteristics

Parameter	Value
Frequency range	50 kHz to 30 MHz
Instantaneous bandwidth	30 MHz
RF input	50 Ω, VSWR <1:2.5
Maximum input level	+20 dBm, +30 dBm with attenuator active
Noise figure	10dB typ. [1]
Third order intercept point	+40 dBm typ.
Second order intercept point	+100 dBm typ. [1]
Spurious	<-120dBm (max. 5 spurs @ -120 to 110dBm)
ADC SFDR	95 dBc typ. @ 10 MHz
Gain control	AGC fast/medium/slow and MGC, for
	sum data stream or individually for 12 single data streams
Gain control range	0 to 44dB, in 3dB steps
Preselector	12 bands, sub-octave, organized in two filter banks
Phase noise	< -110 dBc/Hz @ 100 Hz
	< -140 dBc/Hz @ 1 kHz
Reference frequency	10 MHz
	AVAR < 1 x 10^{-11}, τ = 1 s
	Long term per day < 1 x 10^{-9}
	Temperature drift < 3 x 10^{-8}
Signal processing	16bit, IQ-CBB data format
Sum data stream:	39.0625000 MSps
Single data streams:	Band 1 to 6: 4.8828125 MSps
	Band 7 to 10: 9.7656250 MSps
	Band 11 to 12: 19.5312500 MSps
Data output	UDP via one 10 Gbps SFP+ fiber Ethernet
Mechancial size	19"/1U, approx. 500 mm depth (over all depth: 550 mm)
Power supply	AC: 90 to 264 V, 47 to 63 Hz
Power consumption	approx. 90 W
MTBF	53 500 h
Operating temperature	−10 °C to 50 °C
Storage temperature	−25 °C to 70 °C

[1]degraded performance below 1.2 MHz

Ordering Guide

Option	Description
IZT R5020	Broadband HF Receiver
IZT R5020-REF	Internal GNSS receiver for synchronization
IZT R5020-SYM	Symmetric inputs for 1PPS and blanking signals

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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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