Application Note and Technical Datasheet

Using the ThinkRF R5500 as a Downconverter

Wideband Downconverters extending range to 27 GHz

Features and Benefits

- Compact, low-power, portable and cost-effective
- RF Input Frequency Range 9 kHz to 27 GHz
- 100 kHz, 10 MHz, 40 MHz, 50 MHz, 100 MHz and 160MHz (Wideband option, WBIQ) real-time bandwidth with 10 Hz tuning resolution
- Small form-factor, GigE Networked and remote deployable

Applications

- Electronic Warfare Systems
- Frequency Conversion
- Drive Testing
- Transmission Test
- Customer Premise Equipment Test
- Interference Testing
- Spectrum Analysis
- Government Spectrum Licensing and Monitoring

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Extend Your Existing Equipment to 27GHz by using R5500 as an RF Downconverter

The R5500 models feature breakthrough frequency and bandwidth coverage for their size and cost. They are available in three frequency ranges from 100 kHz to 8 GHz, 18 GHz, or 27 GHz.

The ThinkRF R5500 devices are versatile, wide frequency coverage receivers that can be employed as wideband downconverters featuring a single RF input and three standard software selectable IF bandwidths - 10 MHz, 40 MHz, 100 MHz, or three optional software selectable IF bandwidths, - 10 MHz, 80 MHz, 160 MHz. The carrier centre frequencies can be tuned from 50 MHz to 27 GHz, including direct digitization below 50 MHz down to 9 kHz.

The devices feature bandwidths of 100 MHz (standard) or 160 MHz (optional) direct conversion (0 Hz IF) I and Q analogue outputs. The wideband version can be software configured for super-heterodyne (SH) mode with a maximum bandwidth of either 40 MHz (standard) on a single IF output centred at 35 MHz IF, or with a bandwidth of either 80 MHz (optional) on a single IF output centred at 55MHz IF.

These wideband products are engineered for analyzing wideband digital communications – cell phone standards 3G/4G/LTE, WiFi, or general Vector Signal Analysis (VSA) applications involving broadband signals.

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Features and Capabilities

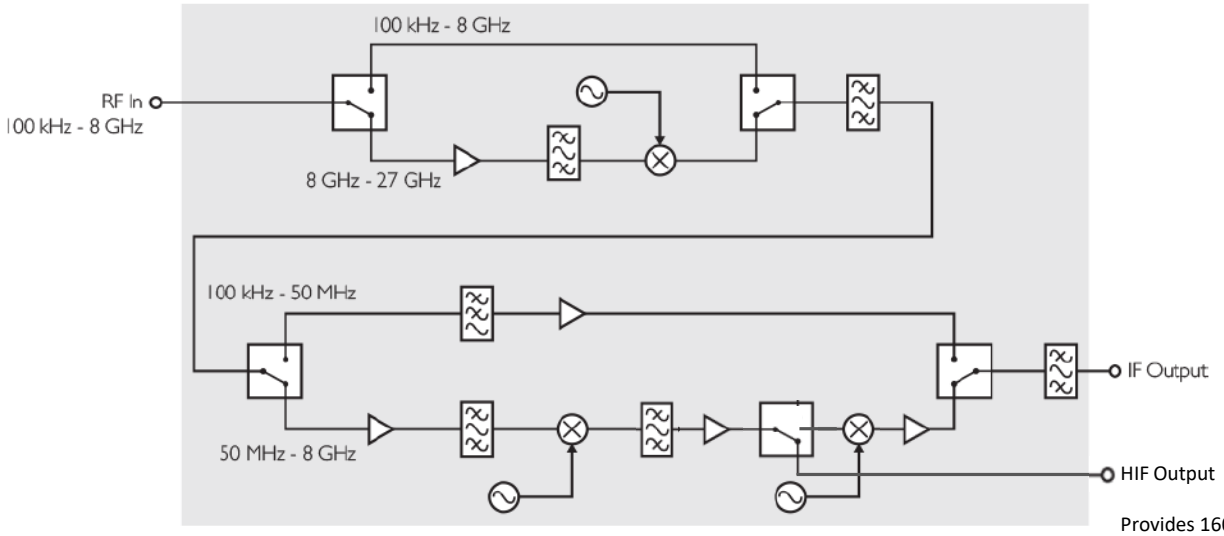
- 10 MHz input and output clock references for multi-unit synchronization
- Analog I/Q and HIF outputs enable OEM high speed digitizers
- GPIO for external trigger.
- 10/100/1G Ethernet port for control and networking
- +12 V DC power input allowing automobile sources and personal mobility with an external battery
- External support for 80 MHz and 160 MHz RTBW (optional)
- 9 kHz – 27 GHz Frequency Coverage
- Three standard selectable IF Bandwidths – 100 MHz, 40 MHz, 10 MHz
- Three Optional Selectable IF Bandwidths – 160 MHz, 80 MHz, 10 MHz

Model	Frequency Range	Standard Bandwidth	Optional Bandwidth (WBIQ – option)
R5500-408	9 kHz – 8 GHz	100 MHz (0 Hz IF) 40 MHz (35 MHz IF) 10 MHz (35 MHz IF)	160 MHz (0 Hz IF) 80 MHz (55 MHz IF) 10 MHz (35 MHz IF)
R5500-418	9 kHz – 18 GHz	100 MHz (0 Hz IF) 40 MHz (35 MHz IF) 10 MHz (35 MHz IF)	160 MHz (0 Hz IF) 80 MHz (55 MHz IF) 10 MHz (35 MHz IF)
R5500-427	9 kHz – 27 GHz	100 MHz (0 Hz IF) 40 MHz (35 MHz IF) 10 MHz (35 MHz IF)	160 MHz (0 Hz IF) 80 MHz (55 MHz IF) 10 MHz (35 MHz IF)

R5500 Block Diagram

The R5500's RF front-end is a unique architecture consisting of both super – heterodyne and direct conversion technologies that are software selectable.

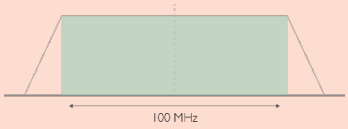
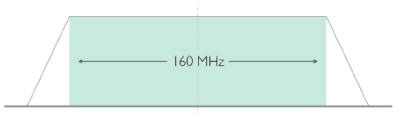
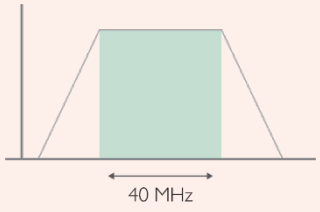
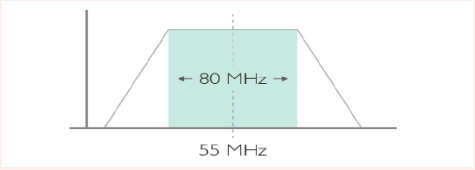
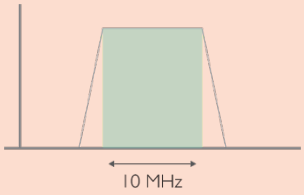
The front-end processing blocks of the R5500 utilize up to 20 pre-select filters to mitigate input-related spurs and image responses. There are three mixing stages and various IF filter banks to further condition the signal. The block diagram for the R5500 RF front-end when operating in super-heterodyne mode, is shown below.



Provides 160 MHz or 100 MHz RTBW when operated in Direct Conversion (ZIF) mode.

R5500 IF Outputs

The R5500 has a single RF input and several software-selectable IF bandwidths of 100 MHz (standard), 160 MHz (optional) , 40 MHz (standard), 80 MHz (optional) and 10 MHz (standard & optional). When the receiver is in direct-conversion mode, the analog signal is present on both the I and Q outputs. In this case, each output is band-limited to 80 MHz. When the receiver is in super-heterodyne mode, the analog output is present on the I output only and centred at either 55 MHz (80 MHz bandwidth) or 35 MHz (10 MHz bandwidth).

Operating Bandwidth	Description	Figures
100 MHz (standard) 160 MHz (optional)	In the widest bandwidth mode of operation, the R5500 is configured as a direct conversion receiver. This mode is well suited for applications such as ISM band signal detection/analysis and RF data acquisition. The final IF signal is centred at DC (0 Hz) and available on both the I and Q connectors. In order to process this signal, a dual-channel digitizer with a sampling rate of at least 250 MS/s is required. Direct conversion receivers typically have artifacts such as DC and IQ offsets. While DC offset correction is to a large extent managed within the hardware, IQ offsets must be corrected in software. ThinkRF provides sample code to accomplish this.	 
40 MHz (standard) Or 80 MHz (optional)	The R5500 has a super-heterodyne mode of operation that allows the processing of signals with a bandwidth of up to 40 MHz. This mode of operation is best suited for signal demodulation and spectrum analysis. The downconverted signal is centred at 35 MHz. The optional wideband super-heterodyne mode of operation that allows the processing of signals with a bandwidth of up to 80 MHz. This mode of operation is best suited for signal demodulation and spectrum analysis. The downconverted wideband signal is centred at 55 MHz. Depending on the roll-off that can can be tolerated by the application, the user may choose to utilize 100 MHz of bandwidth. In this case, the band begins at 5 MHz and ends at 105 MHz. In order to process this signal, a single channel digitizer with a sampling rate of at least 250 MS/s is required.	 
10 MHz (standard) Or 10 MHz (optional)	The R5500 has a narrower 10 MHz super-heterodyne mode of operation. The narrower bandwidth filter centred at 35 MHz offers better rejection of adjacent signals. Also, this mode of operation provides the best spurious performance of all available receiver modes.	

Application Type and Recommended Bandwidth Settings

Application	160 MHz	100 MHz	80 MHz	40 MHz	10 MHz
Processing wideband signals such as LTE and Wi-Fi in the lab or field	●	●	●	●	
Signal demodulation			●	●	●
Signal demodulation of video and audio signals in an interference environment					●
Spectrum analysis			●	●	●
RF measurements of CW signal amplitude in the lab					●
Fast, low-latency spectrum scanning	●	●	●		
Wideband signal detection	●	●			

RF Specifications

Frequency		
Frequency Ranges	9 kHz to 8, 18 or 27 GHz	
Frequency Reference	±1.0 x 10-6 ±1.0 x 10-6 per year ±1.0 x 10-6 0°C to 55°C	Accuracy Aging Stability over temperature
Real-time bandwidth (RTBW)	0.1 / 10 / 40 /100 MHz	
Spurious free dynamic range (SFDR)	60 dBc (typical) 70 dBc (typical) 100 dBc (typical)	100 MHz RTBW 10 / 40 MHz RTBW 0.1 MHz RTBW

Amplitude		
Amplitude Accuracy 25 °C ± 5 °C	± 2.00 dB typical	50 MHz to 27 GHz
	Amplitude Ranges	
Measurement Range	DANL to levels in figure below	R5500-408 (8GHz)
Attenuator Range	0 to 30 dB in 10 dB steps	8 GHz only
Maximum Safe RF Input Level	+10 dBm, 0 V DC	

Displayed Average Noise Level (DANL)			
At 25 °C ± 5 °C, typical			
Frequency (GHz)	8 GHz (typical)	18 GHz (typical)	27 GHz (typical)
1 GHz	- 156 dBm/Hz	- 160 dBm/Hz	- 159 dBm/Hz
Third Order Intercept (TOI) at max gain		+12 dBm, typical	At 1 GHz (R5500-408 only)

Spectral Purity			
SSB Phase noise	With External 10MHz oscillator	Without External 10MHz oscillator	Carrier Offset
25°C ± 5°C	-90 dBc/Hz	-90 dBc/Hz	100 Hz
At 1 GHz	-93 dBc/Hz	-92 dBc/Hz	1 kHz
Measured locked to an external 10MHz oscillator and measured with external oscillator not present	-98 dBc/Hz	-99 dBc/Hz	10 kHz
	-106 dBc/Hz	-109 dBc/Hz	100 kHz
	-120 dBc/Hz	-118 dBc/Hz	1 MHz

General Specifications

Connectors		
RF In	SMA female, 50 Ω	
10 MHz Reference In and Out	SMA female, 50 Ω	
Analog I and Q Out	SMA female, 50 Ω	
HIF Out	SMA female, 50 Ω	
10/100/1000 Ethernet	RJ45	
USB Console	Type B mini	
GPIO	25-pin male D-Subminiature	
Power	Coaxial Type A: 5.5 mm OD, 2.5 mm ID	

Power		
Physical Power Supply	Use AC Wall Power Adaptor provided	Input AC 120V-240V/Output +12V
Power Consumption	25W with Power Adaptor provided	At room temperature

Physical		
Operating Temperature Range	0°C to +50°C	
Storage Temperature Range	-40°C to +85°C	
Warm up time	30 minutes	
Size	269 x 173 x 61 mm (10.58 x 6.81 x 2.40 inches)	With mounting feet (shipped installed on unit)
	269 x 173 x 55 mm (10.58 x 6.81 x 2.15 inches)	Without mounting feet
Weight	2.7 kg (6 lbs.)	
Security	Kensington Security Slot	Located on back end-plate

Regulatory Compliance		
RoHS Compliance	RoHS	
Marks	CE	European Union
EMC Directive 2014/30/EU	EN 61326-1:2013	Electromagnetic Compatibility
Low Voltage Directive 2006/95/EC	EN 61010-1:2010 Class 1	Safety
FCC		

Ordering Information

Base Units	Part Number	Description
8 GHz RTSA	R5500-408	9 kHz to 8 GHz, RTBW up to 100 MHz
18 GHz RTSA	R5500-418	9 kHz to 18 GHz, RTBW up to 100 MHz
27 GHz RTSA	R5500-427	9 kHz to 27 GHz, RTBW up to 100 MHz
8 GHz RTSA	R5500-408-WBIQ	9 kHz to 8 GHz, RTBW up to 160 MHz, Wideband option
18 GHz RTSA	R5500-418-WBIQ	9 kHz to 18 GHz, RTBW up to 160 MHz, Wideband option
27 GHz RTSA	R5500-427-WBIQ	9 kHz to 27 GHz, RTBW up to 160 MHz, Wideband option

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