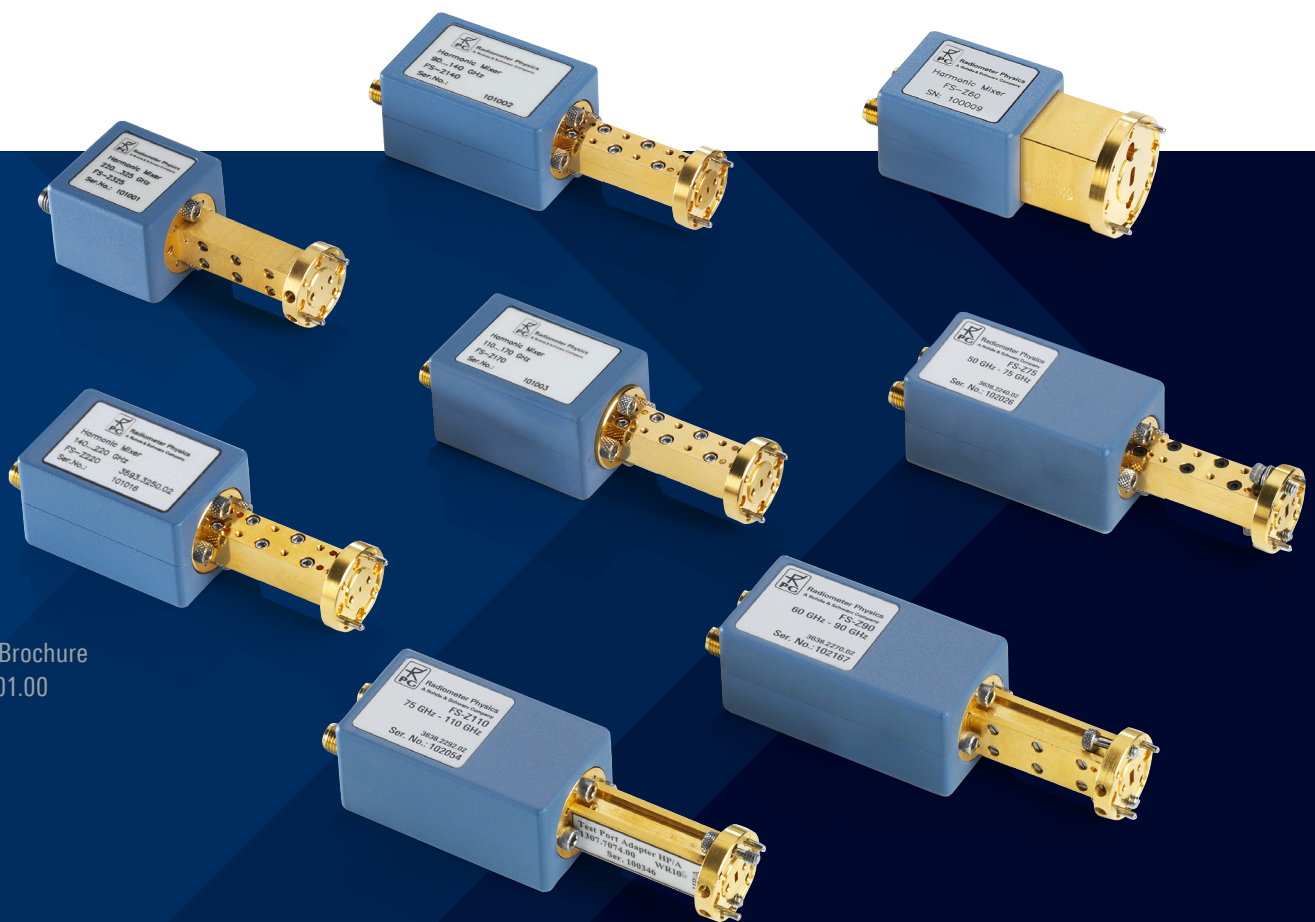


RPG FS-Zxxx HARMONIC MIXERS

Discover mmWave frequencies



Product Brochure
Version 01.00

ROHDE & SCHWARZ

Make ideas real



AT A GLANCE

RPG FS-Zxxx harmonic mixers are a simple way to increase the usable frequency ranges up to 325 GHz for Rohde & Schwarz signal and spectrum analyzers as well as phase noise analyzers and VCO testers.

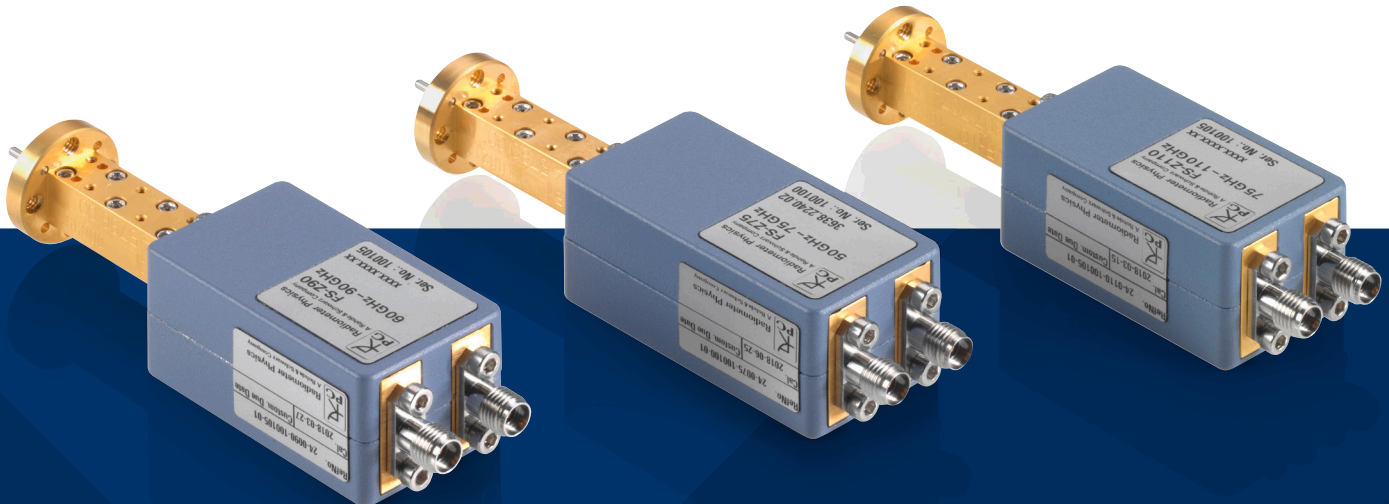
Frequency range extension

Current signal and spectrum analyzers can do far more than classical swept spectrum analysis. Extensive in-depth signal analysis and device characterization are possible with the right measurement applications.

5G and 6G technology is expanding and automotive radars are becoming more common, making mmWave and sub-THz frequency ranges ever more important. The demand for test and measurement solutions in these frequency ranges is also growing. This applies to swept measurements for conformance testing, device characterization and in-depth I/Q-based signal analysis. The RPG FS-Zxxx harmonic mixers from RPG-Radiometer Physics GmbH can easily and affordably help meet these demands by extending the frequency ranges of several Rohde & Schwarz instruments.

Key facts

- ▶ Frequency range extension up to 325 GHz
- ▶ Supported by R&S®FSW, R&S®FSVA3000 and R&S®FSV3000 signal and spectrum analyzers and the R&S®FSWP phase noise analyzer and VCO tester
- ▶ Up to 4.4 GHz analysis bandwidth with the R&S®FSW
- ▶ Up to 1 GHz analysis bandwidth with the R&S®FSVA3000
- ▶ Low conversion loss with reduced inband ripple
- ▶ Excellent VSWR with isolated input port



Swept spectrum measurements

RPG FS-Zxxx harmonic mixers allow swept spectrum measurements up to 325 GHz. The low conversion loss provides an excellent displayed average noise level (DANL) while still providing sufficient dynamic range to detect small spurs even in the presence of a strong carrier signal.

The theory states that image-free spans depend on the intermediate frequency. Combining the R&S®FSW with the RPG FS-Zxxx harmonic mixers uses relatively high intermediate frequencies in the range from 1.3 GHz to 3.5 GHz for an image-free frequency span of > 2.6 GHz for swept spectrum measurements, and an image-free frequency range of up to 7 GHz for modulation analysis, based on the mixer model and selected analysis bandwidth. A signal identification algorithm is applied to wider spans. The analyzer performs two sweeps to suppress the image and unwanted mixing products on the displayed trace. This allows spectrum measurements across the full span of the mixer.

Noise figure and gain measurements

Noise figure and gain is one of the most common measurements on two-port devices such as low noise amplifiers. An R&S®SNS smart noise source and an analyzer with the R&S®FSx-K30 option makes such measurements very simple. R&S®SNS smart noise sources are available for up to 67 GHz and enable noise figure measurements in mmWave frequency with RPG FS-Zxxx harmonic mixers.

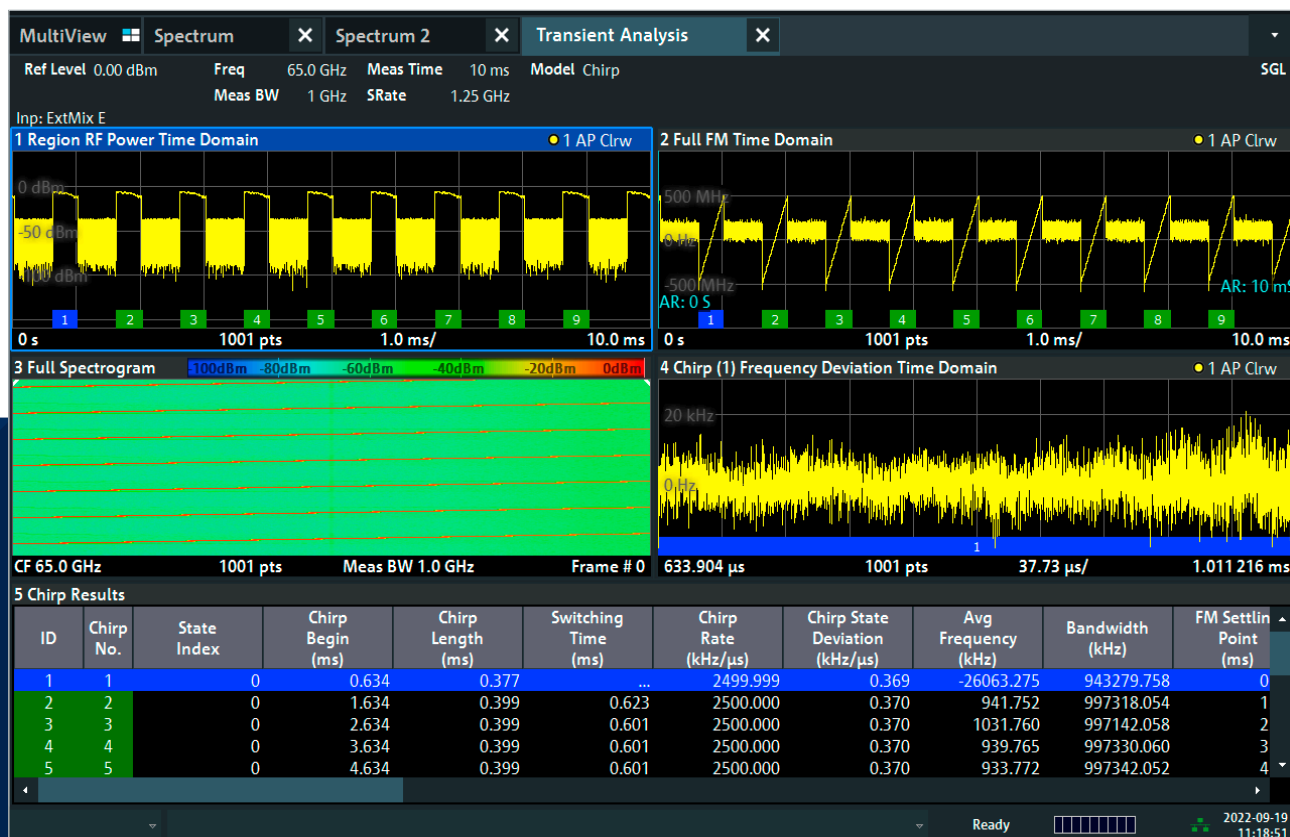
The low conversion loss of the RPG FS-Zxxx mixers means noise figure measurements are possible without a preamplifier. Only the R&S®FSx-B21 and R&S®FSx-K30 options are required on the analyzer side.

Phase noise analysis

Fast and easy phase noise testing in frequencies beyond an analyzer's inherent frequency range are possible with an R&S®FSx-K40 phase noise measurement application and an RPG FS-Zxxx harmonic mixer. The additive phase noise of the mixer is negligible for most measurements, since the sensitivity of the phase noise test is mainly limited by the local oscillator in the analyzer. Phase noise sensitivity scales at $20 \times \log(n)$ when using external harmonic mixers, where n is the order of the local oscillator harmonic.

High precision phase noise testing in mmWave frequencies are possible with an R&S®FSWP phase noise analyzer and VCO tester. A waveguide splitter and two RPG FS-Zxxx harmonic mixers can take advantage of R&S®FSWP cross-correlation capabilities to reduce the phase noise contribution from non-correlated noise signals, such as the additive phase noise from the mixers and the phase noise of local oscillators. Phase noise testing is possible even at sub 1 Hz offsets to the carrier and below the DANL that the conversion loss of the mixers would imply.

Signal analysis of a 1 GHz wide FMCW radar signal at 65 GHz with an R&S®FSA3044 plus R&S®FSV3-B21, R&S®FSV3-B1000 and R&S®FSV3-K60C options.



I/Q-based signal analysis

RPG FS-Zxxx harmonic mixers have up to 4.4 GHz analysis bandwidth depending on their model and analysis bandwidth option.

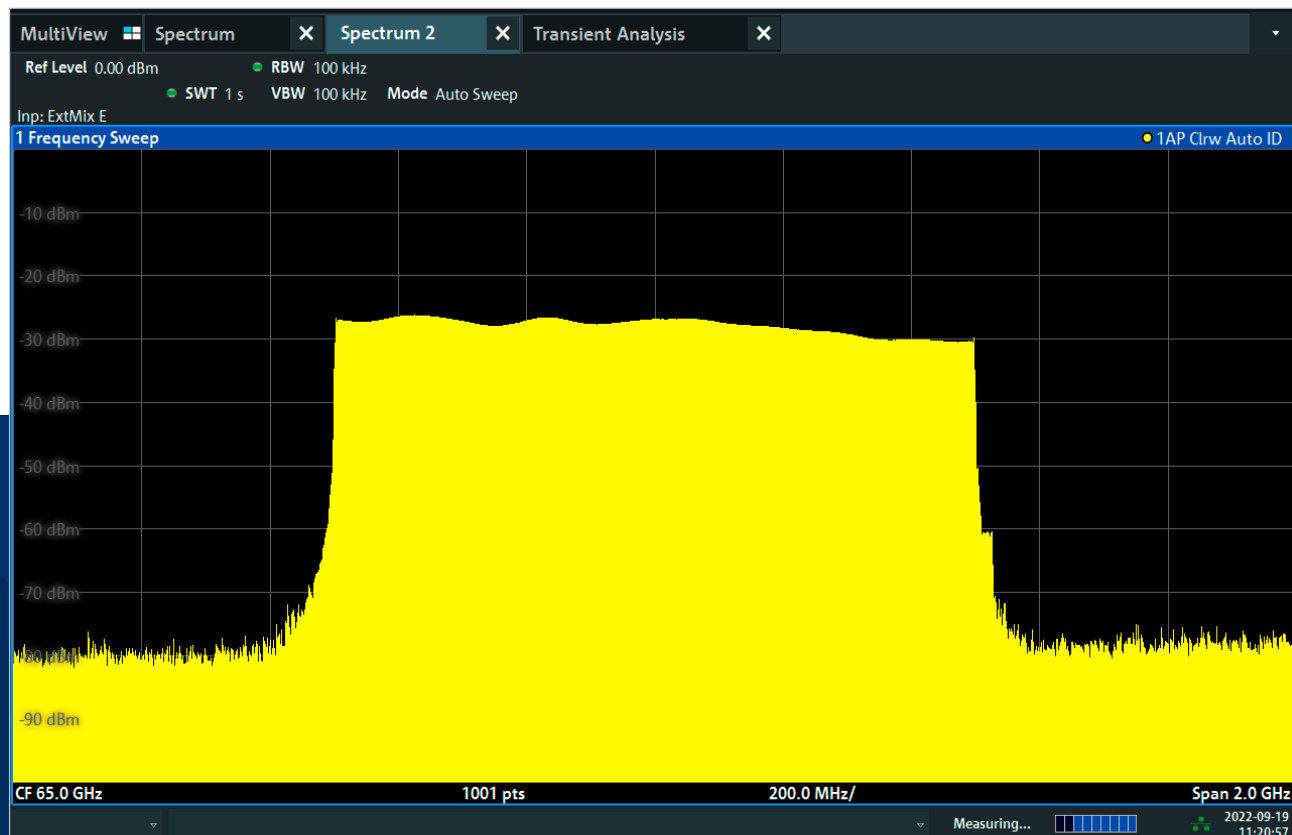
Low conversion loss and strong signal immunity provide sufficient dynamic range for demodulation and EVM measurements of communications signals with high crest factors such as 5G NR.

The mixer frequency response is described by correction files across the full analysis bandwidth, enabling the analyzer to equalize both LO/IF port frequency response and across the full signal path including the mixer itself.

The following I/Q-based measurement options utilize the wide analysis bandwidth and high dynamic range of the mixers:

- ▶ R&S®FSx-K6 pulse measurements
- ▶ R&S®FSx-K7 AM/FM/PM modulation analysis
- ▶ R&S®FSx-K18(D/F/M) amplifier measurements
- ▶ R&S®FSx-K60(H/C) transient measurements
- ▶ R&S®FSx-K70(M/P) vector signal analysis
- ▶ R&S®FSW-K95 WLAN 802.11ad measurements
- ▶ R&S®FSW-K97 WLAN 802.11ay measurements
- ▶ R&S®FSW-K96 OFDM signal analysis
- ▶ R&S®FSx-K144/-K145/-K147/-K148 5G NR measurements

Spectrum measurement of the same signal with 2 GHz span. The images from the lower 732 MHz IF in swept spectrum mode are effectively suppressed by the signal identification algorithm.



SPECIFICATIONS IN BRIEF

Type (RPG)	FS-Z60	FS-Z75	FS-Z90	FS-Z110	FS-Z140	FS-Z170	FS-Z220	FS-Z325
Order number	1048.0171.02	3638.2240.02	3638.2270.02	3638.2292.02	3622.0708.02	3622.0714.02	3593.3250.02	3593.3267.02
Frequency range	40 GHz to 60 GHz	50 GHz to 75 GHz	60 GHz to 90 GHz	75 GHz to 110 GHz	90 GHz to 140 GHz	110 GHz to 170 GHz	140 GHz to 220 GHz	220 GHz to 325 GHz
1 dB compression	0 dBm (typ.)	-5 dBm (typ.)	-6 dBm (typ.)	-6 dBm (typ.)	-3 dBm (typ.)	-3 dBm (typ.)	-5 dBm (typ.)	-5 dBm (typ.)
Conversion loss	max. 20 dB, 15 dB (typ.)	max. 24 dB, 18 dB (typ.)	max. 25 dB, 18 dB (typ.)	max. 30 dB, 23 dB (typ.)	max. 43 dB	max. 40 dB	max. 48 dB, 32 dB (typ.)	max. 50 dB
RF port	WR19 (UG383/UM)	WR15 (UG385/U)	WR12 (UG387/UM)	WR10 (UG387/UM)	WR08 (UG387/UM)	WR06 (UG387/UM)	WR5.1 (UG387/UM)	WR3.4 (UG387/UM)
LO input frequency	8.6 GHz to 15.4 GHz	8 GHz to 12.84 GHz	7.44 GHz to 15.34 GHz	7.75 GHz to 13.99 GHz	9 GHz to 14 GHz	9.13 GHz to 14.13 GHz	8.72 GHz to 13.72 GHz	10 GHz to 14.77 GHz
LO harmonic number	4	6	6	8	10	12	16	18
LO power	+13.0 dBm	+14.0 dBm	+14.0 dBm	+15.5 dBm	+14.0 dBm	+15.5 dBm	+13.0 dBm	+16.0 dBm
VSWR	1.3:1 (typ.)	1.4:1 (typ.)	1.4:1 (typ.)	1.4:1 (typ.)	1.5:1 (typ.)	1.6:1 (typ.)	1.7:1 (typ.)	3:1 (typ.)

Intermediate frequencies (IF) in swept spectrum mode

Rohde & Schwarz analyzer	IF in swept spectrum mode
R&S®FSW	1310 MHz to 1330 MHz
R&S®FSWP	1310 MHz to 1330 MHz (with R&S®FSWP-B1 option) and phase noise measurements < 50 MHz offset
R&S®FSA3000	732 MHz
R&S®FSV3000	732 MHz

Maximum signal analysis bandwidth (BW), intermediate frequencies and frequency response correction

Mixer type (RPG)		FS-Z60	FS-Z75	FS-Z90	FS-Z110	FS-Z140	FS-Z170	FS-Z220	FS-Z325
	Analysis bandwidth	Intermediate frequency							
R&S®FSW bandwidth options									
Any bandwidth option ¹⁾	≤ 80 MHz	1310 MHz to 1330 MHz (bandwidth dependent)							
R&S®FSW-B160/-B320 ¹⁾	80 MHz to 160 MHz/320 MHz	1530 MHz							
R&S®FSW-B512/-B512R/-B1200/-B2001/-B800R ¹⁾	80 MHz to 512 MHz	1580 MHz							
R&S®FSW-B1200/-B2001/-B800R ²⁾	> 512 MHz	–	3290 MHz			–	–	–	–
R&S®FSW-B4001/-B6001/-B8001 ²⁾	80 MHz to 4400 MHz	–	2660 MHz			–	–	–	–
R&S®FSW-B2000 ²⁾	80 MHz to 2000 MHz	2000 MHz							
R&S®FSW-B5000 ²⁾	80 MHz to 4400 MHz	–	2800 MHz			–	–	–	–
	4400 MHz to 5000 MHz	–	3500 MHz			–	–	–	–
R&S®FSV(A)3000 bandwidth options									
Any bandwidth option ¹⁾	≤ 40 MHz	732 MHz							
	40 MHz to 400 MHz	768 MHz							
R&S®FSV3-B600/-B1000 ²⁾	400 MHz to 600 MHz/1000 MHz	1536 MHz							

¹⁾ The *.acl files provide conversion loss tables for swept spectrum measurements and narrow band I/Q analysis, where the frequency response of the mixer is negligible.

²⁾ The *.b2g and *.b5g files enable equalization of the RPG FS-Zxxx harmonic mixers frequency response for wideband I/Q-based measurements.

ORDERING INFORMATION

Designation	Type	Order No.	Remarks
Harmonic mixers			
40 GHz to 60 GHz	RPG FS-Z60	1048.0171.02	
50 GHz to 75 GHz	RPG FS-Z75	3638.2240.02	
60 GHz to 90 GHz	RPG FS-Z90	3638.2270.02	
75 GHz to 110 GHz	RPG FS-Z110	3638.2292.02	
90 GHz to 140 GHz	RPG FS-Z140	3622.0708.02	
110 GHz to 170 GHz	RPG FS-Z170	3622.0714.02	
140 GHz to 220 GHz	RPG FS-Z220	3593.3250.02	
220 GHz to 325 GHz	RPG FS-Z325	3593.3267.02	
Analyzers LO/IF ports			
LO/IF connections for external mixers	R&S®FSW-B21	1313.1100.86	for R&S®FSW85
LO/IF connections for external mixers	R&S®FSW-B21	1313.1100.28	for R&S®FSW26/43/67
LO/IF connections for external mixers	R&S®FSWP-B21	1325.3848.02	for R&S®FSWP26/50
LO/IF connections for external mixers	R&S®FSV3-B21	1330.4010.02	for R&S®FSVA3030/3044, R&S®FSV3030/3044
Recommended extras			
Cables			
Cable extension	R&S®HA-Z5M	1350.6660.02	
Waveguide power splitters/combiners – refer to: www.radiometer-physics.de/products/mmwave-and-terahertz-products/passive-waveguide-components/splitter-combiner/waveguide-power-splitters/			
50 GHz to 75 GHz	WPS 50-75	3656.9408.02	
60 GHz to 90 GHz	WPS 60-90	3656.9489.02	
Waveguide fixed attenuators – refer to: www.radiometer-physics.de/products/mmwave-and-terahertz-products/passive-waveguide-components/attenuators/waveguide-fixed-attenuators/			
Waveguide tunable attenuators – refer to: www.radiometer-physics.de/products/mmwave-and-terahertz-products/passive-waveguide-components/attenuators/waveguide-tunable-attenuators/			
60 GHz to 90 GHz	WTA 60-90	3624.4475.02	
110 GHz to 170 GHz	WTA 110-170	3660.9667.02	
140 GHz to 220 GHz	WTA 140-220	3593.3996.02	
220 GHz to 325 GHz	WTA 220-330	3593.4005.02	
260 GHz to 400 GHz	WTA 260-400	3665.7356.02	
Waveguide to coaxial adapters – refer to: www.radiometer-physics.de/products/mmwave-and-terahertz-products/passive-waveguide-components/waveguide-to-coax-adaptors/			
50 GHz to 75 GHz			
WR15 to 1 mm (f)	WCA75	3626.1044.02	
WR15 to 1 mm (m)	WCA75	3626.1044.03	
60 GHz to 90 GHz			
WR12 to 1 mm (f)	WCA90	3626.1050.02	
WR12 to 1 mm (m)	WCA90	3626.1050.03	
75 GHz to 110 GHz			
WR10 to 1 mm (f)	WCA110	3626.1067.02	
WR10 to 1 mm (m)	WCA110	3626.1067.03	
Waveguide Faraday isolators – refer to: www.radiometer-physics.de/products/mmwave-and-terahertz-products/passive-waveguide-components/waveguide-faraday-isolators/			
50 GHz to 75 GHz	WFI 50-75	3660.4865.02	
75 GHz to 110 GHz	WFI 75-110	3660.5384.02	
Accredited calibration	R&S®ACAFS-Z90	3598.1340.03	for R&S®FS-Z60, R&S®FS-Z75, R&S®FS-Z90, R&S®FS-Z110

Service options		
Extended warranty, one year	R&S®WE1	Please contact your local Rohde & Schwarz sales office.
Extended warranty, two years	R&S®WE2	
Extended warranty, three years	R&S®WE3	
Extended warranty, four years	R&S®WE4	
Extended warranty with calibration coverage, one year	R&S®CW1	
Extended warranty with calibration coverage, two years	R&S®CW2	
Extended warranty with calibration coverage, three years	R&S®CW3	
Extended warranty with calibration coverage, four years	R&S®CW4	
Extended warranty with accredited calibration coverage, one year	R&S®AW1	
Extended warranty with accredited calibration coverage, two years	R&S®AW2	
Extended warranty with accredited calibration coverage, three years	R&S®AW3	
Extended warranty with accredited calibration coverage, four years	R&S®AW4	

The RPG FS-Z60/-Z75/-Z90/-Z110 harmonic mixers are manufactured by Rohde & Schwarz GmbH & Co KG, Mühlendorfstraße 15, 81671 Munich, Germany

The RPG FS-Z140/-Z170/-Z220/-Z325 harmonic mixers are manufactured for Rohde & Schwarz by: RPG-Radiometer Physics GmbH, Werner-von-Siemens-Str. 4, 53340 Meckenheim, Germany

Service that adds value

- ▶ Worldwide
- ▶ Local and personalized
- ▶ Customized and flexible
- ▶ Uncompromising quality
- ▶ Long-term dependability

Rohde & Schwarz

The Rohde & Schwarz technology group is among the trailblazers when it comes to paving the way for a safer and connected world with its leading solutions in test & measurement, technology systems and networks & cybersecurity. Founded more than 85 years ago, the group is a reliable partner for industry and government customers around the globe. The independent company is headquartered in Munich, Germany and has an extensive sales and service network with locations in more than 70 countries.

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- ▶ Environmental compatibility and eco-footprint
- ▶ Energy efficiency and low emissions
- ▶ Longevity and optimized total cost of ownership

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