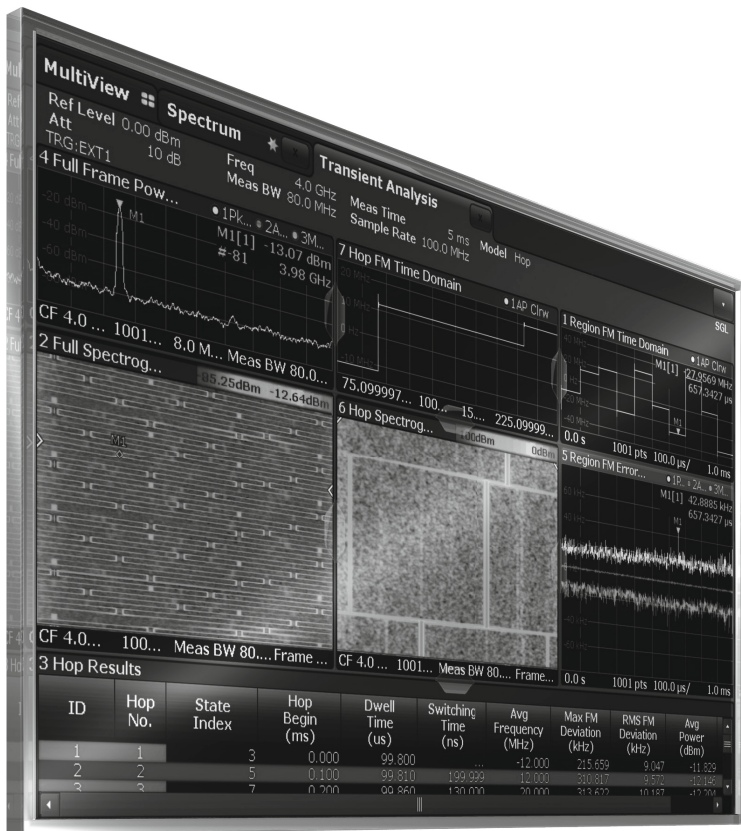


R&S®FSW-K60/-K60H/-K60C

Transient Measurement

Application

Specifications



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Definitions

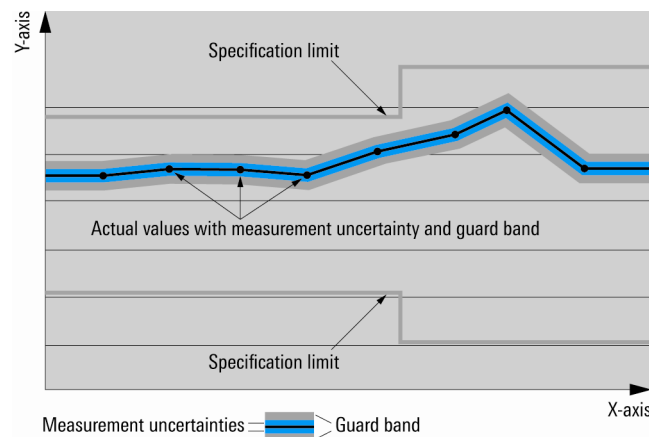
General

Product data applies under the following conditions:

- Three hours storage at ambient temperature followed by 30 minutes warm-up operation
- Specified environmental conditions met
- Recommended calibration interval adhered to
- All internal automatic adjustments performed, if applicable

Specifications with limits

Represent warranted product performance by means of a range of values for the specified parameter. These specifications are marked with limiting symbols such as $<$, \leq , $>$, \geq , \pm , or descriptions such as maximum, limit of, minimum. Compliance is ensured by testing or is derived from the design. Test limits are narrowed by guard bands to take into account measurement uncertainties, drift and aging, if applicable.



Specifications without limits

Represent warranted product performance for the specified parameter. These specifications are not specially marked and represent values with no or negligible deviations from the given value (e.g. dimensions or resolution of a setting parameter). Compliance is ensured by design.

Typical data (typ.)

Characterizes product performance by means of representative information for the given parameter. When marked with $<$, $>$ or as a range, it represents the performance met by approximately 80 % of the instruments at production time. Otherwise, it represents the mean value.

Nominal values (nom.)

Characterize product performance by means of a representative value for the given parameter (e.g. nominal impedance). In contrast to typical data, a statistical evaluation does not take place and the parameter is not tested during production.

Measured values (meas.)

Characterize expected product performance by means of measurement results gained from individual samples.

Uncertainties

Represent limits of measurement uncertainty for a given measurand. Uncertainty is defined with a coverage factor of 2 and has been calculated in line with the rules of the Guide to the Expression of Uncertainty in Measurement (GUM), taking into account environmental conditions, aging, wear and tear.

Device settings and GUI parameters are indicated as follows: "parameter: value".

Typical data as well as nominal and measured values are not warranted by Rohde & Schwarz.

Specifications

The specifications of the R&S®FSW-K60 transient measurement application, R&S®FSW-K60H transient hop measurements and the R&S®FSW-K60C transient chirp measurements are based on the specifications in the data sheet for the R&S®FSW signal and spectrum analyzer. They have not been checked separately and are not verified during instrument calibration. Measurement uncertainties are given as 95 % confidence intervals. They apply to the specified center frequencies and measurement bandwidths. The specified measurement uncertainties do not take into account systematic errors due to reduced signal-to-noise ratio (S/N).

Frequency

Frequency range	frequency range same as R&S®FSW
-----------------	---------------------------------

Level

Level range	RF input	-70 dBm ¹ to +30 dBm
Level setting		auto level manual

Signal acquisition

Input		RF
Measurement bandwidth	standard	100 Hz to 10 MHz
	with R&S®FSW-B28 option	100 Hz to 28 MHz (nom.) ²
	with R&S®FSW-B40 option	100 Hz to 40 MHz (nom.) ²
	with R&S®FSW-B80 option	100 Hz to 80 MHz (nom.) ²
	with R&S®FSW-B160 option	100 Hz to 160 MHz (nom.) ²
	with R&S®FSW-B320 option	100 Hz to 320 MHz (nom.) ²
Measurement time	maximum for measurement bandwidth	
	10 MHz	36.9 s
	28 MHz (R&S®FSW-B28 option)	13.1 s
	40 MHz (R&S®FSW-B40 option)	8.92 s
	80 MHz (R&S®FSW-B80 option)	4.6 s
	160 MHz (R&S®FSW-B160 option)	2.3 s
	320 MHz (R&S®FSW-B320 option)	492.8 ms
Triggering	RF input	free run, external, I/Q power, IF power, RF power

¹ Requires R&S®FSW-B24 RF preamplifier option.

² YIG preselector off for $f \geq 8$ GHz.

Measurement parameters (nom.)

Analysis region	time gate length	101 samples up to max. measurement time
	time gate start	0 to measurement time – time gate length
	frequency range	1 % to 100 % of measurement bandwidth
	frequency offset	\pm (measurement bandwidth– frequency bandwidth)/2
FM video filter	FM bandwidth	0.1 %, 1 %, 5 %, 10 %, 25 %
Spectrogram	detector	sum, average, RMS, maximum, minimum, sample
	window	rectangular, Gauss, Chebyshev, Flattop, Hamming, Hanning, Blackman-Harris
	FFT length	1024, 2048, 4096
	history depth	up to 20 000 frames
Hop detection ³	nominal hop states	up to 1000 states
	measured hops	up to 100 000 hops
	min. dwell time for measurement bandwidth = 3 × FM settling time (see FM step response table for settling times), example for FM video filter: none	
	10 MHz	2.2 μ s
	28 MHz (R&S [®] FSW-B28 option)	800 ns
	40 MHz (R&S [®] FSW-B40 option)	600 ns
	80 MHz (R&S [®] FSW-B80 option)	300 ns
	160 MHz (R&S [®] FSW-B160 option)	150 ns
	320 MHz (R&S [®] FSW-B320 option)	75 ns
	Chirp detection ⁴	nominal chirp states
measured chirps		up to 100,000 chirps
min. chirp length for measurement bandwidth = 3 × chirp rate settling time (see chirp rate step response table for settling times), example for FM video filter: none		
10 MHz		22 μ s
28 MHz (R&S [®] FSW-B28 option)		7.8 μ s
40 MHz (R&S [®] FSW-B40 option)		5.4 μ s
80 MHz (R&S [®] FSW-B80 option)		2.7 μ s
160 MHz (R&S [®] FSW-B160 option)		1.4 μ s
320 MHz (R&S [®] FSW-B320 option)		700 ns

³ R&S[®]FSW-K60H required.

⁴ R&S[®]FSW-K60C required.

Measurement results

Signal characteristic	Analysis range	Result display
Amplitude modulation	full capture, analysis region, hop ⁵ or chirp ⁶	RF power time domain
Frequency modulation	full capture, analysis region, hop ⁵ or chirp ⁶	FM time domain chirp rate time domain
Frequency modulation error	analysis region, hop ⁵ or chirp ⁶	FM deviation time domain
Phase modulation	full capture, analysis region, hop ⁵ or chirp ⁶	PM time domain PM time domain (wrapped)
Spectrum	full capture, analysis region, hop ⁵ or chirp ⁶	frame power spectrum spectrogram
Frequency hopping ⁵	analysis region	results table, statistics table state index hop begin dwell time switching time average frequency frequency deviation max. FM deviation RMS FM deviation average FM deviation average power
Chirped (linear) FM ⁶	analysis region	results table, statistics table state index chirp begin chirp length chirp rate chirp rate deviation average frequency max. FM deviation RMS FM deviation average FM deviation average power

⁵ Requires R&S®FSW-K60H transient hop measurements upgrade option.

⁶ Requires R&S®FSW-K60C transient chirp measurements upgrade option.

FM step response (nom.)

The nominal FM step response is calculated for the internal FSW-K60 frequency demodulator assuming an ideal input FM "step" signal, which transitions within one sample from one frequency state to another. This represents the "worse-case" overshoot and settling time given an ideal step input signal (for a smoother step transition the overshoot and settling time will typically be lower).

FM video filter: none	overshoot	< 20 % of FM step size
	frequency settling time ⁷ for measurement bandwidth	
	10 MHz	< 730 ns
	28 MHz (R&S [®] FSW-B28 option)	< 260 ns
	40 MHz (R&S [®] FSW-B40 option)	< 200 ns
	80 MHz (R&S [®] FSW-B80 option)	< 100 ns
	160 MHz (R&S [®] FSW-B160 option)	< 50 ns
FM video filter: 25 % of FM bandwidth	overshoot	< 17 % of FM step size
	frequency settling time ⁷ for measurement bandwidth	
	10 MHz	< 1.6 μ s
	28 MHz (R&S [®] FSW-B28 option)	< 570 ns
	40 MHz (R&S [®] FSW-B40 option)	< 400 ns
	80 MHz (R&S [®] FSW-B80 option)	< 200 ns
	160 MHz (R&S [®] FSW-B160 option)	< 100 ns
FM video filter: 10 % of FM bandwidth	overshoot	< 16 % of FM step size
	frequency settling time ⁷ for measurement bandwidth	
	10 MHz	< 3.8 μ s
	28 MHz (R&S [®] FSW-B28 option)	< 1.4 μ s
	40 MHz (R&S [®] FSW-B40 option)	< 1 μ s
	80 MHz (R&S [®] FSW-B80 option)	< 500 ns
	160 MHz (R&S [®] FSW-B160 option)	< 250 ns
FM video filter: 5 % of FM bandwidth	overshoot	< 15 % of FM step size
	frequency settling time ⁷ for measurement bandwidth	
	10 MHz	< 7.5 μ s
	28 MHz (R&S [®] FSW-B28 option)	< 2.7 μ s
	40 MHz (R&S [®] FSW-B40 option)	< 1.9 μ s
	80 MHz (R&S [®] FSW-B80 option)	< 960 ns
	160 MHz (R&S [®] FSW-B160 option)	< 480 ns
FM video filter: 1 % of FM bandwidth	overshoot	< 15 % of FM step size
	frequency settling time ⁷ for measurement bandwidth	
	10 MHz	< 37 μ s
	28 MHz (R&S [®] FSW-B28 option)	< 13 μ s
	40 MHz (R&S [®] FSW-B40 option)	< 9.2 μ s
	80 MHz (R&S [®] FSW-B80 option)	< 4.6 μ s
	160 MHz (R&S [®] FSW-B160 option)	< 2.3 μ s
FM video filter: 0.1 % of FM bandwidth	overshoot	< 14 % of FM step size
	frequency settling time ⁷ for measurement bandwidth	
	10 MHz	< 255 μ s
	28 MHz (R&S [®] FSW-B28 option)	< 90 μ s
	40 MHz (R&S [®] FSW-B40 option)	< 64 μ s
	80 MHz (R&S [®] FSW-B80 option)	< 32 μ s
	160 MHz (R&S [®] FSW-B160 option)	< 16 μ s
320 MHz (R&S [®] FSW-B320 option)	< 8 μ s	

⁷ Time from crossing 50 % of FM step transition until remaining within 1 % of FM step size for a total FM step size of less than 80 % of the measurement bandwidth.

Chirp rate step response (nom.)

The nominal chirp rate step response is calculated for the internal R&S®FSW-K60 chirp rate demodulator assuming an ideal input chirp rate “step” signal, which transitions within one sample from one chirp rate state to another. This represents the “worse-case” overshoot and settling time given an ideal step input signal (for a smoother step transition the overshoot and settling time will typically be lower).

FM video filter: none 25 % of FM bandwidth, 10 % of FM bandwidth, 5 % of FM bandwidth	overshoot	< 3 % of chirp rate step size
	chirp rate settling time ⁸ for measurement bandwidth	
	10 MHz	< 8 µs
	28 MHz (R&S®FSW-B28 option)	< 2.9 µs
	40 MHz (R&S®FSW-B40 option)	< 2 µs
	80 MHz (R&S®FSW-B80 option)	< 1 µs
	160 MHz (R&S®FSW-B160 option)	< 500 ns
FM video filter: 1 % of FM bandwidth	overshoot	< 9 % of chirp rate step size
	chirp rate settling time ⁸ for measurement bandwidth	
	10 MHz	< 28 µs
	28 MHz (R&S®FSW-B28 option)	< 10 µs
	40 MHz (R&S®FSW-B40 option)	< 7 µs
	80 MHz (R&S®FSW-B80 option)	< 3.6 µs
	160 MHz (R&S®FSW-B160 option)	< 1.8 µs
FM video filter: 0.1 % of FM bandwidth	overshoot	< 11 % of chirp rate step size
	chirp rate settling time ⁸ for measurement bandwidth	
	10 MHz	< 256 µs
	28 MHz (R&S®FSW-B28 option)	< 92 µs
	40 MHz (R&S®FSW-B40 option)	< 64 µs
	80 MHz (R&S®FSW-B80 option)	< 32 µs
	160 MHz (R&S®FSW-B160 option)	< 16 µs
	320 MHz (R&S®FSW-B320 option)	< 8 µs

⁸ Time from crossing 50 % of chirp rate step transition until remaining within 1 % of chirp rate step size.
For example if the chirp rate transitions from -1 MHz/µs to +1 MHz/µs, then the chirp rate “step size” is 2 MHz/µs.

FM measurement uncertainty (nom.)

FM time domain						
The total FM accuracy is comprised of absolute frequency accuracy and a statistical uncertainty due to measurement noise.						
The absolute frequency accuracy is given in the R&S®FSW datasheet. The statistical measurement uncertainty is given below as a 95 % confidence interval at stated center frequencies and video and measurement bandwidths for a CW carrier ⁹ .						
2 GHz center frequency						
Measurement bandwidth	FM video filter					
	none	25 % of FM bandwidth	10 % of FM bandwidth	5 % of FM bandwidth	1 % of FM bandwidth	0.1 % of FM bandwidth
10 MHz	± 1.5 kHz	± 500 Hz	± 300 Hz	± 150 Hz	± 8 Hz	± 0.5 Hz
28 MHz (R&S®FSW-B28)	± 8 kHz	± 1.5 kHz	± 500 Hz	± 350 Hz	± 40 Hz	± 2 Hz
40 MHz (R&S®FSW-B40)	± 13 kHz	± 2 kHz	± 700 Hz	± 450 Hz	± 75 Hz	± 3 Hz
80 MHz (R&S®FSW-B80)	± 55 kHz	± 5 kHz	± 1.5 kHz	± 700 Hz	± 250 Hz	± 7 Hz
160 MHz (R&S®FSW-B160)	± 140 kHz	± 25 kHz	± 5 kHz	± 2 kHz	± 400 Hz	± 35 Hz
320 MHz (R&S®FSW-B320)	± 450 kHz	± 45 kHz	± 15 kHz	± 5 kHz	± 700 Hz	± 70 Hz
8 GHz center frequency						
Measurement bandwidth	FM video filter					
	none	25 % of FM bandwidth	10 % of FM bandwidth	5 % of FM bandwidth	1 % of FM bandwidth	0.1 % of FM bandwidth
10 MHz	± 2 kHz	± 600 Hz	± 400 Hz	± 180 Hz	± 15 Hz	± 1 Hz
28 MHz (R&S®FSW-B28)	± 9 kHz	± 1.5 kHz	± 650 Hz	± 500 Hz	± 70 Hz	± 3 Hz
40 MHz (R&S®FSW-B40)	± 15 kHz	± 2 kHz	± 800 Hz	± 600 Hz	± 120 Hz	± 5 Hz
80 MHz (R&S®FSW-B80)	± 60 kHz	± 5 kHz	± 2 kHz	± 800 Hz	± 350 Hz	± 12 Hz
160 MHz (R&S®FSW-B160)	± 140 kHz	± 20 kHz	± 5 kHz	± 2 kHz	± 550 Hz	± 32 Hz
320 MHz (R&S®FSW-B320)	± 450 kHz	± 55 kHz	± 15 kHz	± 5 kHz	± 1 kHz	± 100 Hz
26 GHz center frequency						
Measurement bandwidth	FM video filter					
	none	25 % of FM bandwidth	10 % of FM bandwidth	5 % of FM bandwidth	1 % of FM bandwidth	0.1 % of FM bandwidth
10 MHz	± 6 kHz	± 1.5 kHz	± 1 kHz	± 500 Hz	± 50 Hz	± 3 Hz
28 MHz (R&S®FSW-B28)	± 26 kHz	± 4 kHz	± 1.5 kHz	± 1 kHz	± 200 Hz	± 8 Hz
40 MHz (R&S®FSW-B40)	± 50 kHz	± 6 kHz	± 2 kHz	± 1.5 kHz	± 300 Hz	± 10 Hz
80 MHz (R&S®FSW-B80)	± 160 kHz	± 16 kHz	± 5 kHz	± 2 kHz	± 700 Hz	± 25 Hz
160 MHz (R&S®FSW-B160)	± 360 kHz	± 45 kHz	± 12 kHz	± 5 kHz	± 1.5 kHz	± 80 Hz
320 MHz (R&S®FSW-B320)	± 1 MHz	± 120 kHz	± 35 kHz	± 12 kHz	± 2 kHz	± 220 Hz
43 GHz center frequency						
Measurement bandwidth	FM video filter					
	none	25 % of FM bandwidth	10 % of FM bandwidth	5 % of FM bandwidth	1 % of FM bandwidth	0.1 % of FM bandwidth
10 MHz	± 20 kHz	± 3 kHz	± 1.5 kHz	± 700 Hz	± 50 Hz	± 5 Hz
28 MHz (R&S®FSW-B28)	± 80 kHz	± 10 kHz	± 3 kHz	± 2 kHz	± 300 Hz	± 12 Hz
40 MHz (R&S®FSW-B40)	± 50 kHz	± 16 kHz	± 5 kHz	± 3 kHz	± 500 Hz	± 20 Hz
80 MHz (R&S®FSW-B80)	± 150 kHz	± 45 kHz	± 15 kHz	± 5 kHz	± 1.5 kHz	± 50 Hz
160 MHz (R&S®FSW-B160)	± 1.2 MHz	± 150 kHz	± 40 kHz	± 15 kHz	± 2.5 kHz	± 150 Hz
320 MHz (R&S®FSW-B320)	± 3.4 MHz	± 400 kHz	± 110 kHz	± 40 kHz	± 4 kHz	± 400 Hz

⁹ Signal level ≥ 0 dBm, RF level and attenuator: auto, 10 MHz external reference locked to sender, measurement time ≤ 10 ms.

PM measurement uncertainty (nom.)

PM time domain

The total PM accuracy is comprised of deviation from linear phase and a statistical uncertainty due to measurement noise. The deviation from linear phase is given in the R&S®FSW datasheet. The statistical measurement uncertainty is given below as a 95 % confidence interval at stated center frequencies and video and measurement bandwidths for a CW carrier.¹⁰

2 GHz center frequency	measurement bandwidth	
	10 MHz	± 0.16 °
	28 MHz (R&S®FSW-B28 option)	± 0.18 °
	40 MHz (R&S®FSW-B40 option)	± 0.18 °
	80 MHz (R&S®FSW-B80 option)	± 0.20 °
	160 MHz (R&S®FSW-B160 option)	± 0.22 °
	320 MHz (R&S®FSW-B320 option)	± 0.28 °
8 GHz center frequency	measurement bandwidth	
	10 MHz	± 0.60 °
	28 MHz (R&S®FSW-B28 option)	± 0.60 °
	40 MHz (R&S®FSW-B40 option)	± 0.63 °
	80 MHz (R&S®FSW-B80 option)	± 0.63 °
	160 MHz (R&S®FSW-B160 option)	± 0.64 °
	320 MHz (R&S®FSW-B320 option)	± 0.66 °
26 GHz center frequency	measurement bandwidth	
	10 MHz	± 2.0 °
	28 MHz (R&S®FSW-B28 option)	± 2.0 °
	40 MHz (R&S®FSW-B40 option)	± 2.0 °
	80 MHz (R&S®FSW-B80 option)	± 2.0 °
	160 MHz (R&S®FSW-B160 option)	± 2.0 °
	320 MHz (R&S®FSW-B320 option)	± 2.1 °
43 GHz center frequency	measurement bandwidth	
	10 MHz	± 3.3 °
	28 MHz (R&S®FSW-B28 option)	± 3.3 °
	40 MHz (R&S®FSW-B40 option)	± 3.3 °
	80 MHz (R&S®FSW-B80 option)	± 3.4 °
	160 MHz (R&S®FSW-B160 option)	± 3.6 °
	320 MHz (R&S®FSW-B320 option)	± 3.9 °

¹⁰ Signal level ≥ 0 dBm, RF level and attenuator: auto, 10 MHz external reference locked to sender, measurement time ≤ 10 ms.

Ordering information

Designation	Type	Order No.	Retrofittable	Remarks
Transient Measurements	R&S®FSW-K60	1313.7495.02	yes	user-retrofittable
Transient Hop Measurements	R&S®FSW-K60H	1322.9916.02	yes	user-retrofittable, R&S®FSW-K60 required
Transient Chirp Measurements	R&S®FSW-K60C	1322.9745.02	yes	user-retrofittable, R&S®FSW-K60 required
Recommended options and extras				
RF Preamp, 100 kHz to 13.6 GHz	R&S®FSW-B24	1313.0832.13	yes	contact service center
RF Preamp, 100 kHz to 26.5 GHz	R&S®FSW-B24	1313.0832.26	yes	contact service center
RF Preamp, 100 kHz to 43.5 GHz	R&S®FSW-B24	1313.0832.43	yes	contact service center
RF Preamp, 100 kHz to 50 GHz	R&S®FSW-B24	1313.0832.50	yes	contact service center
RF Preamp, 100 kHz to 67 GHz	R&S®FSW-B24	1313.0832.67	yes	contact service center
28 MHz Analysis Bandwidth	R&S®FSW-B28	1313.1645.02	yes	user-retrofittable
40 MHz Analysis Bandwidth	R&S®FSW-B40	1313.0861.02	yes	user-retrofittable
80 MHz Analysis Bandwidth	R&S®FSW-B80	1313.0878.02	yes	user-retrofittable
160 MHz Analysis Bandwidth	R&S®FSW-B160	1313.1668.02	yes	contact service center
320 MHz Analysis Bandwidth	R&S®FSW-B320	1313.7172.02	yes	contact service center
Highpass Filter for Harmonic Measurements	R&S®FSW-B13	1313.0761.02	yes	user-retrofittable
LO/IF Connections for external mixers	R&S®FSW-B21	1313.1100.26	yes	for R&S®FSW26; contact service center
LO/IF Connections for external mixers	R&S®FSW-B21	1313.1100.43	yes	for R&S®FSW43/50/67; contact service center
Harmonic Mixer, 40 GHz to 60 GHz	R&S®FS-Z60	1089.0799.02	yes	user-retrofittable, R&S®FSW-B21 required
Harmonic Mixer, 50 GHz to 75 GHz	R&S®FS-Z75	1048.0271.02	yes	user-retrofittable, R&S®FSW-B21 required
Harmonic Mixer, 60 GHz to 90 GHz	R&S®FS-Z90	1048.0371.02	yes	user-retrofittable, R&S®FSW-B21 required
Harmonic Mixer, 75 GHz to 110 GHz	R&S®FS-Z110	1048.0471.02	yes	user-retrofittable, R&S®FSW-B21 required

Upgrades

Designation	Type	Order No.	Retrofittable	Remarks
Analysis Bandwidth Upgrade from 28 MHz to 40 MHz	R&S®FSW-U40	1313.5205.02	yes	user-retrofittable, R&S®FSW-B28 required
Analysis Bandwidth Upgrade from 40 MHz to 80 MHz	R&S®FSW-U80	1313.5211.02	yes	user-retrofittable, R&S®FSW-B40 or R&S®FSW-U40 required
Analysis Bandwidth Upgrade from 80 MHz to 160 MHz	R&S®FSW-U160	1313.5754.02	yes	contact service center, R&S®FSW-B80 or R&S®FSW-U80 required
Analysis Bandwidth Upgrade from 160 MHz to 320 MHz	R&S®FSW-U320	1313.7189.02	yes	contact service center, R&S®FSW-B160 or R&S®FSW-U160 required

For R&S®FSW signal and spectrum analyzer data sheet, see PD 5214.5984.22.

For R&S®FSW product brochure, see PD 5214.5984.12 and www.rohde-schwarz.com

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Sustainable product design

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- | Longevity and optimized total cost of ownership

Certified Quality Management

ISO 9001

Certified Environmental Management

ISO 14001

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