Pulse Measurement Application
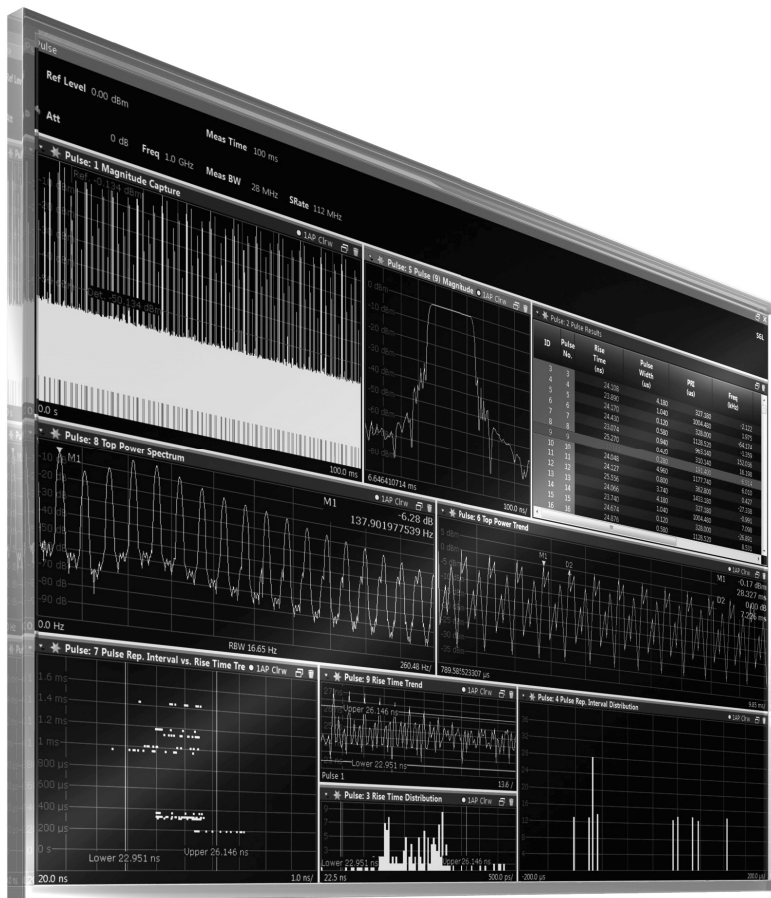
Specifications

R&S®VSE-K6
R&S®FSW-K6/-K6S
R&S®FSWP-K6/-K6S/-K6P
R&S®FPS-K6

ROHDE&SCHWARZ

CONTENTS

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 <, ≤, >, ≥, ±, 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.
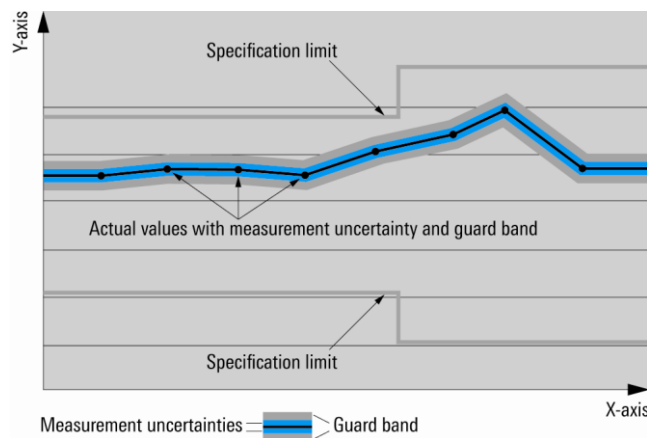
Specifications without limits

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.

In line with the 3GPP/3GPP2 standard, chip rates are specified in Mcps (million chips per second), whereas bit rates and symbol rates are specified in Mbps (million bits per second), kbps (thousand bits per second) or ksps (thousand symbols per second), and sample rates are specified in Msample/s (million samples per second). Mcps, Mbps, kbps, ksps and Msample/s are not SI units.

Specifications

The specifications of the R&S®VSE-K6/R&S®FSx-K6 pulse measurements and R&S®FSx-K6S time sidelobe measurements are based on the data sheet specifications of the R&S®FSW, R&S®FSWP, R&S®FSV/FSVA and R&S®FPS signal and spectrum analyzers and the R&S®RTO oscilloscope. They have not been checked separately and are not verified during instrument calibration. Measurement uncertainties are given as 95 % confidence intervals. The specified level measurement errors do not take into account systematic errors due to reduced signal-to-noise ratio (S/N).

General remarks

This data sheet covers the R&S®FSW-K6, R&S®FSW-K6S, R&S®FSWP-K6, the R&S®FSWP-K6S, the R&S®FPS-K6 and the R&S®VSE-K6. The R&S®FSW-K6, the R&S®FSWP-K6 and the R&S®FPS-K6 are summarized with the term R&S®FSx-K6. The R&S®FSW-K6S and the R&S®FSWP-K6S are summarized with the term R&S®FSx-K6S. The R&S®FSx-K6 and the R&S®FSx-K6S are summarized with the term R&S®FSx-K6/S. The R&S®FSWP-K6, the R&S®FSWP-K6S and the R&S®FSWP-K6P are summarized with the term R&S®FSWP-K6/S/P.

The R&S®FSx-K6S time sidelobe measurements are provided as an upgrade to the R&S®FSx-K6 pulse measurements. The R&S®FSx-K6S option therefore requires the corresponding R&S®FSx-K6 option.

The R&S®FSWP-K6P pulse stability measurements are provided as an upgrade to R&S®FSWP-K6 pulse measurement application. The R&S®FSWP-K6P option therefore requires the corresponding R&S®FSWP-K6 option.

The R&S®FSx-K6/S runs on the device itself.

The R&S®VSE-K6 runs on a PC that can be connected to the R&S®RTO oscilloscope and the following analyzers: R&S®FSW, R&S®FSV/A and R&S®FPS.

If not stated otherwise, the data sheet values are device-specific, e.g. the same value applies to R&S®FSW-K6 and R&S®VSE-K6 with connected R&S®FSW.

For feature tables the following convention applies:

•	Feature always supported i.e. with the R&S®VSE-K6 connected to the device and with the corresponding R&S®FSx-K6 option when running directly on the device.
• (VSE)	Feature supported only with the R&S®VSE-K6 connected to the device. Not with the corresponding R&S®FSx-K6 option when running directly on the device.
• (FSx-K6/S)	Feature supported only when running directly on the device with the corresponding R&S®FSx-K6/S option. Not supported in the R&S®VSE-K6.
–	Feature not supported with this device.

Overview

		R&S®FSW	R&S®FSWP	R&S®FSV/A	R&S®FPS	R&S®RTO
R&S®FSx-K6/S/P	software that runs on device	• R&S®FSW-K6/S	• R&S®FSWP-K6/S/P	–	• R&S®FPS-K6	–
R&S®VSE-K6	PC software that can be connected to device	•	–	•	•	•

Pulse measurement

Frequency

Frequency range	RF input	same as supported instrument

Level

Level range	RF input	same as supported instrument

Signal acquisition

		R&S®FSW	R&S®FSWP (R&S®FSWP-K6)	R&S®FSV/FSVA (R&S®VSE)	R&S®FPS	R&S®RTO (R&S®VSE)
Inputs	RF input	●	●	●	●	●
	digital baseband input	● (FSW-K6) [1]	–	–	–	–
	analog baseband input	● (FSW-K6) [2]	–	–	–	–
	file	●	●	●	●	●
	MSRA I/Q data capture	● (FSW-K6)	● (FSWP-K6)	–	● (FPS-K6)	–
	MSRT I/Q data capture	● (FSW-K6)	–	–	–	–
	external mixer	● (FSW-K6)	–	–	–	–
Usable I/Q bandwidth	standard	10 MHz	10 MHz	28 MHz	28 MHz	600 MHz
	up to [3]	2000 MHz	320 MHz	160 MHz	160 MHz	4 GHz
Max. measurement time	flat filter	same as for the R&S®VSE base system or R&S®FSx I/Q analyzer [4]				
	Gauss filter	up to the max. capture time for the corresponding flat filter bandwidth divided by 3.2				
Gauss filter bandwidths [5]	standard	100/200/400/800 Hz, 1.6/3.2/6.4/12.5/25/50/100/200/400/800 kHz, 1.6/3/5/8/10 MHz				
	18 MHz	● [6]	● [11]	●	●	●
	28 MHz	● [7]	● [11]	● [8]	● [9]	●
	40 MHz	● [10]	● [11]	● [12]	● [13]	●
	50/80/100 MHz	● [14]	● [15]	● [12]	● [16]	●
	160 MHz	● [17]	● [15]	–	● [18]	●
	200/250 MHz	● [19]	● [15]	–	–	●
	320 MHz	● [20]	–	–	–	●
	500 MHz	● [21]	–	–	–	●
	1 GHz	● [21]	–	–	–	● [22]

[1] Only with R&S®FSW-B17 option.

[2] Only with R&S®FSW-B71 option.

[3] Depends on the hardware configuration. For details, see R&S®FSW/FSWP/FSV/FPS and R&S®RTO data sheets.

[4] Maximum measurement time will be reduced with multiple measurement application channels opened simultaneously.

[5] 3 dB bandwidth given. All Gaussian filters are limited to the usable I/Q bandwidth. For certain bandwidths this can result in a "Gaussian top" filter shape as described in the user manual.

[6] Bandwidth option R&S®FSW-B28 or higher required.

[7] Bandwidth option R&S®FSW-B28 or higher required on device (R&S®FSW-K6/S), R&S®FSW-B40 option or higher required with PC software (R&S®VSE-K6).

[8] Bandwidth option R&S®FSV-B70 or higher required for R&S®FSV. Bandwidth option R&S®FSVA-B40 or higher required for R&S®FSVA.

[9] Bandwidth option R&S®FPS-B40 or higher required.

[10] Bandwidth option R&S®FSW-B40 or higher required on device (R&S®FSW-K6/S), R&S®FSW-B80 option or higher required with PC software (R&S®VSE-K6).

[11] Bandwidth option R&S®FSWP-B80 required.

[12] Bandwidth option R&S®FSV-B160 required.

[13] Bandwidth option R&S®FPS-B40 or higher required on device (R&S®FPS-K6), R&S®FPS-B160 option or higher required with PC software (R&S®VSE-K6).

[14] Bandwidth option R&S®FSW-B160 or higher required.

[15] Bandwidth option R&S®FSWP-B320 required.

[16] Bandwidth option R&S®FPS-B160 required.

[17] Bandwidth option R&S®FSW-B160 or higher required on device (FSW-K6/S), R&S®FSW-B320 option or higher required with PC software (VSE-K6).

[18] Bandwidth option R&S®FPS-B160 option required on device (R&S®FPS-K6), not available with PC software (R&S®VSE-K6).

[19] Bandwidth option R&S®FSW-B320 required.

[20] Bandwidth option R&S®FSW-B500 or higher required.

[21] Bandwidth option R&S®FSW-B2000 and corresponding R&S®RTO device as external digitizer are required.

[22] R&S®RTO with 2 GHz bandwidth or higher required.

Triggering

		R&S®FSW	R&S®FSWP (R&S®FSWP-K6)	R&S®FSV/FSVA (R&S®VSE)	R&S®FPS	R&S®RTO (R&S®VSE)
RF input [23]		same as supported instrument				only external trigger
	frequency mask [24]	● (FSW-K6)	–	–	–	–
Baseband input	baseband power	● (FSW-K6)	–	–	–	–
File input	magnitude	● (VSE)				

Signal acquisition (segmented)

		R&S®FSW (R&S®FSW-K6)		R&S®FSWP (R&S®FSWP-K6) [25]
No. of segments	maximum	100 000		100 000
Usable I/Q bandwidth	standard	10 MHz		10 MHz
	up to [26]	2000 MHz		80 MHz
Max. measurement time (compressed) using internal digitizer	flat filter	10 MHz	30.8 s	30.8 s
		40 MHz	7.7 s	7.7 s
		80 MHz	3.85 s	3.85 s
		160 MHz	1.92 s	1.92 s
		500 MHz	641.7 ms	–
	Gauss filter		at least max. measurement time (compressed) for the corresponding flat filter bandwidth divided by 3.2	
Max. measurement time (compressed) using R&S®FSW-B2000 option and corresponding R&S®RTO device	trigger mode	IF power	external	–
	flat filter	80 MHz to 2 GHz	< 100 ms	< 100 ms
	Gauss filter	80 MHz to 1 GHz	< 50 ms	< 50 ms
	the maximum measurement time (compressed) depends on the oscilloscope model, memory configuration and the number of segments. See user manual R&S®FSW-K6 for more detailed information.			
Supported Gauss filter bandwidths [27]	standard		100/200/400/800 Hz, 1.6/3.2/6.4/12.5/25/50/100/200/400/800 kHz, 1.6/3/5/8/10 MHz	
	18 MHz		● [28]	● [29]
	28 MHz		● [28]	● [29]
	40 MHz		● [30]	● [29]
	50/80/100/160 MHz		● [31]	● [32]
	200/250/320 MHz		● [33]	–
	500/1000 MHz		● [34]	–
Trigger modes	RF input	external	●	●
		RF power	●	●

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[23] Trigger availability depends on the instrument used.

[24] Using MSRT I/Q data capture; R&S®FSW-K160R option and one of the options R&S®FSW-B160/-B320 is required, not available for R&S®FSW-B500.

[25] Segmented acquisition is not supported in R&S®FSWP-K6P option when using the "low noise" digitizer mode.

[26] Depends on the hardware configuration. For details, see R&S®FSW/FSWP data sheets. Segmented capture not supported with R&S®FSW-B320 option above 160 MHz I/Q bandwidth.

[27] 3 dB bandwidth given. All Gaussian filters are limited to the usable I/Q bandwidth. For certain bandwidths this can result in a "Gaussian top" filter shape as described in the user manual.

[28] Bandwidth option R&S®FSW-B28 or higher required.

[29] Bandwidth option R&S®FSWP-B80 or higher required.

[30] Bandwidth option R&S®FSW-B40 or higher required.

[31] Bandwidth option R&S®FSW-B160 or higher required.

[32] Bandwidth option R&S®FSWP-B320 or higher required.

[33] Bandwidth option R&S®FSW-B500 or higher required.

[34] Bandwidth option R&S®FSW-B2000 and corresponding R&S®RTO device as external digitizer are required.

Signal acquisition (low-noise)

		R&S®FSWP (R&S®FSW-K6P)
Usable I/Q bandwidth	standard	10 MHz
	up to [29]	80 MHz
Max. measurement time	flat filter — 10 MHz	36.6 s
	flat filter — 80 MHz	4.6 s
	Gauss filter	at least max. measurement time for the corresponding flat filter bandwidth divided by 3.2
Supported Gauss filter bandwidths [35]	standard	100/200/400/800 Hz, 1.6/3.2/6.4/12.5/25/50/100/200/400/800 kHz, 1.6/3/5/8/10 MHz
	18 MHz	18/28/40 MHz [29]
Acquisition modes	absolute	RF input
	additive	RF input with internal or external source [36], supported for center frequency from 1.025 GHz to 18 GHz.
Signal source	pulse mode	user configurable constant pulse width and pulse period
	burst mode	sequence of pulse "bursts", each containing a configurable number of pulses, pulse width, pulse period and burst length.
	level settings and accuracy	see R&S®FSWP data sheet, chapter "Signal source"
Trigger modes	RF input	external, internal (each pulse, each burst, specific burst, entire sequence), IF power

Measurement capability (nom.)

Pulse detection	measured pulses	1 to 100 000
	min. pulse width for measurement bandwidth (flat acquisition filter) [37]	
	10 MHz	400 ns
	28 MHz	150 ns
	40 MHz	100 ns
	80 MHz	50 ns
	160 MHz	25 ns
	320 MHz	12.5 ns
	500 MHz	8 ns
	2000 MHz	2 ns
System rise time	measurement bandwidth (flat acquisition filter) [37]	
	10 MHz	< 110 ns
	28 MHz	< 40 ns
	40 MHz	< 28 ns
	80 MHz	< 14 ns
	160 MHz	< 7 ns
	320 MHz	< 3.5 ns
	500 MHz	< 2.2 ns
	2000 MHz	< 0.6 ns
	measurement bandwidth (Gauss acquisition filter) [38]	
	10 MHz	< 73 ns
	28 MHz	< 26 ns
	40 MHz	< 23 ns
	80 MHz	< 12 ns
	160 MHz	< 6 ns
	250 MHz	< 4 ns
	320 MHz	< 3 ns
	500 MHz	< 2 ns
	1000 MHz	< 1 ns

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[35] 3 dB bandwidth given. All Gaussian filters are limited to the usable I/Q bandwidth. For certain bandwidths this can result in a "Gaussian top" filter shape as described in the user manual.

[36] Use of external source requires option R&S®FSWP-B21.

[37] Available bandwidths depend on the hardware configuration. For details, see R&S®FSW/FSWP/FSV/FPS and R&S®RTO data sheets.

[38] Available Gaussian filter bandwidths depend on the hardware configuration and are listed in the section signal acquisition of this data sheet.

Pulse parameters	timing	timestamp, settling time, rise time, fall time, pulse width, off time, duty ratio, duty cycle, pulse repetition interval, pulse repetition frequency
	amplitude	top power, base power, average on power, average transmitted power, minimum power, peak power, peak-to-average on power ratio, peak-to-average transmitted power ratio, peak-to-min power ratio, droop, ripple, overshoot, power (at point), pulse-to-pulse power ratio (at point), in-phase amplitude, quadrature amplitude
	frequency	frequency (at point), pulse-to-pulse frequency difference (at point), frequency deviation, frequency error (peak), frequency error (RMS), chirp rate
	phase	phase (at point), pulse-to-pulse phase difference (at point), phase deviation, phase error (peak), phase error (RMS)
	envelope model	rise/fall base-point time, rise/fall low-point time, rise/fall mid-point time, rise/fall high-point time, rise/fall top-point time, rise/fall low-point level, rise/fall mid-point level, rise/fall high-point level, rise/fall top-point level
	time sidelobe [39]	peak-to-sidelobe level, integrated sidelobe level, mainlobe 3 dB width, sidelobe delay, compression ratio, mainlobe power (integrated) mainlobe power (average), peak correlation, mainlobe phase, mainlobe frequency
	stability [40]	burst number, position in burst, pulse phase stability, pulse amplitude stability, total pulse stability
Result displays	inter-pulse analysis	table with numeric values per pulse, table with statistics (average, standard deviation, max., min.), trend plot of parameter versus time, scatter plot of parameter versus parameter, spectrum of parameter versus time, histogram of parameter distribution, stability waterfall [40]
	intra-pulse analysis	traces aligned to pulse for magnitude versus time, frequency versus time, phase (wrapped or unwrapped) versus time, pulse I and Q versus time, power spectrum, correlated magnitude [39], frequency error [39], phase error [39], pulse stability [40]

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[39] Requires the R&S®FSx-K6S time sidelobe measurement upgrade option, not available in the R&S®VSE-K6 application.

[40] Requires the R&S®FSWP-K6P pulse stability measurements upgrade option, not available in the R&S®VSE-K6 application.

Measurement uncertainty (nominal)

Specifications apply under the following conditions: temperature from +20 °C to +30 °C; signal level ≥ –10 dBm unless otherwise stated; properly adjusted reference level and attenuation.

Frequency and phase parameters (CW pulse modulation)

The total frequency accuracy is comprised of absolute frequency accuracy and a statistical uncertainty due to measurement noise. The absolute frequency accuracy is given in the corresponding R&S®FSx data sheet.

The statistical measurement uncertainty is given below as a 95 % confidence interval at stated center frequencies and measurement bandwidths (flat acquisition filter) for a pulse modulated CW carrier.

	Meas. bandwidth [41]	R&S®FSW [42]	R&S®FSWP [42]	R&S®FPS [43]
Residual frequency error (RMS)	CF = 2 GHz			
	10 MHz	< 1.5 kHz	< 1.0 kHz	< 2 kHz
Measurement range: 50 % of pulse top, pulse width ≥ 100/measurement bandwidth	28 MHz	< 5.5 kHz	< 4.5 kHz	< 6.5 kHz
	40 MHz	< 9.5 kHz	< 8.0 kHz	< 13.5 kHz
	80 MHz	< 43 kHz	< 40 kHz	< 47 kHz
	160 MHz	< 85 kHz	–	< 130 kHz
	320 MHz	< 260 kHz	–	–
	500 MHz	< 430 kHz	–	–
	CF = 8 GHz			
	10 MHz	< 2 kHz	< 1 kHz	< 2.5 kHz
	28 MHz	< 5 kHz	< 4.5 kHz	< 5.5 kHz
	40 MHz	< 8.5 kHz	< 8.0 kHz	< 10.5 kHz
	80 MHz	< 40 kHz	< 30 kHz	< 40 kHz
	160 MHz	< 80 kHz	–	< 80 kHz
	320 MHz	< 230 kHz	–	–
	500 MHz	< 370 kHz	–	–
	CF = 20 GHz			
	10 MHz	< 3 kHz	< 2 kHz	< 3 kHz
	28 MHz	< 8.5 kHz	< 8.5 kHz	< 8.5 kHz
	40 MHz	< 14.5 kHz	< 14 kHz	< 14.5 kHz
	80 MHz	< 60 kHz	< 45 kHz	< 60 kHz
	160 MHz	< 100 kHz	–	< 105 kHz
	320 MHz	< 300 kHz	–	–
	500 MHz	< 500 kHz	–	–
Pulse-to-pulse frequency	CF = 2 GHz			
	10 MHz	±2.5 kHz	±2.0 kHz	±4.5 kHz
Pulse-to-pulse measurement point occurs at least 10/measurement bandwidth after the rising edge (i.e. 50 % level crossing) and 10/measurement bandwidth before the falling edge (i.e. 50 % level crossing)	28 MHz	±12 kHz	±10 kHz	±15 kHz
	40 MHz	±22 kHz	±18 kHz	±30 kHz
	80 MHz	±90 kHz	±80 kHz	±105 kHz
	160 MHz	±200 kHz	–	±320 kHz
	320 MHz	±650 kHz	–	–
	500 MHz	±1100 kHz	–	–
	CF = 8 GHz			
	10 MHz	±3 kHz	±2.5 kHz	±5 kHz
	28 MHz	±11.5 kHz	±10.5 kHz	±11.5 kHz
	40 MHz	±21 kHz	±18 kHz	±21.5 kHz
	80 MHz	±70 kHz	±60 kHz	±70 kHz
	160 MHz	±190 kHz	–	±195 kHz
	320 MHz	±625 kHz	–	–
	500 MHz	±900 kHz	–	–
	CF = 20 GHz			
	10 MHz	±6 kHz	±5 kHz	±6 kHz
	28 MHz	±20 kHz	±19.5 kHz	±20 kHz
	40 MHz	±35 kHz	±33.5 kHz	±35 kHz
	80 MHz	±130 kHz	±90 kHz	±130 kHz
	160 MHz	±230 kHz	–	±240 kHz
	320 MHz	±750 kHz	–	–
	500 MHz	±1325 kHz	–	–

[41] Available bandwidths depend on the hardware configuration. For details, see R&S®FSW/FSWP/FSV/FPS and R&S®RTO data sheets.

[42] 100 MHz external reference locked to sender, PRI ≤ 10 ms.

[43] 10 MHz external reference locked to sender, PRI ≤ 1 ms.

Pulse-to-pulse phase	CF = 2 GHz			
	10 MHz	±0.11°	±0.08°	±0.44°
Pulse-to-pulse measurement point occurs at least 10/measurement bandwidth after the rising edge (i.e. 50 % level crossing) and 10/measurement bandwidth before the falling edge (i.e. 50 % level crossing)	28 MHz	±0.13°	±0.09°	±0.86°
	40 MHz	±0.15°	±0.10°	±0.87°
	80 MHz	±0.20°	±0.14°	±0.55°
	160 MHz	±0.29°	–	±0.60°
	320 MHz	±0.39°	–	–
	500 MHz	±0.45°	–	–
	CF = 8 GHz			
	10 MHz	±0.15°	±0.12°	±0.64°
	28 MHz	±0.18°	±0.13°	±0.67°
	40 MHz	±0.18°	±0.15°	±0.69°
	80 MHz	±0.20°	±0.18°	±0.72°
	160 MHz	±0.30°	–	±0.65°
	320 MHz	±0.36°	–	–
	500 MHz	±0.43°	–	–
	CF = 20 GHz			
	10 MHz	±0.35°	±0.28°	±2°
	28 MHz	±0.40°	±0.30°	±3.9°
	40 MHz	±0.40°	±0.30°	±3.7°
	80 MHz	±0.45°	±0.36°	±1.6°
	160 MHz	±0.55°	–	±1.6°
	320 MHz	±0.70°	–	–
	500 MHz	±0.90°	–	–

Frequency and phase parameters (linear FM pulse modulation)

The total frequency 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®FSx data sheet.

The statistical measurement uncertainty is given below as a 95 % confidence interval at stated center frequencies and measurement bandwidths (flat acquisition filter) for a pulsed and linearly frequency modulated carrier.

	Meas. bandwidth [44]	R&S®FSW [45]	R&S®FSWP [45]	R&S®FPS [46]
Residual frequency error (RMS) Measurement range: 50 % of pulse top, pulse width ≥ 1000/measurement bandwidth.	CF = 2 GHz			
	10 MHz	< 2 kHz	< 1.5 kHz	< 3 kHz
	28 MHz	< 6 kHz	< 4 kHz	< 12.5 kHz
	40 MHz	< 8 kHz	< 7 kHz	< 20 kHz
	80 MHz	< 29 kHz	< 25 kHz	< 52 kHz
	160 MHz	< 75 kHz	–	< 140 kHz
	320 MHz	< 230 kHz	–	–
	500 MHz	< 390 kHz	–	–
	CF = 8 GHz			
	10 MHz	< 2.5 kHz	< 1.2 kHz	< 2.5 kHz
	28 MHz	< 6 kHz	< 5.5 kHz	< 6 kHz
	40 MHz	< 9 kHz	< 9 kHz	< 11 kHz
	80 MHz	< 36 kHz	< 30 kHz	< 36 kHz
	160 MHz	< 85 kHz	–	< 85 kHz
	320 MHz	< 250 kHz	–	–
	500 MHz	< 410 kHz	–	–
	CF = 20 GHz			
	10 MHz	< 3 kHz	< 2 kHz	< 3 kHz
	28 MHz	< 10 kHz	< 7.5 kHz	< 10 kHz
	40 MHz	< 16 kHz	< 13 kHz	< 16 kHz
	80 MHz	< 50 kHz	< 40 kHz	< 50 kHz
	160 MHz	< 120 kHz	–	< 120 kHz
	320 MHz	< 370 kHz	–	–
	500 MHz	< 675 kHz	–	–
Pulse-to-pulse frequency Pulse-to-pulse measurement point occurs at least 10/measurement bandwidth after the rising edge (i.e. 50 % level crossing) and 10/measurement bandwidth before the falling edge (i.e. 50 % level crossing)	CF = 2 GHz			
	10 MHz	±5 kHz	±3.5 kHz	±9 kHz
	28 MHz	±21 kHz	±15 kHz	±36 kHz
	40 MHz	±28 kHz	±20 kHz	±64 kHz
	80 MHz	±110 kHz	±65 kHz	±150 kHz
	160 MHz	±190 kHz	–	±410 kHz
	320 MHz	±625 kHz	–	–
	500 MHz	±1100 kHz	–	–
	CF = 8 GHz			
	10 MHz	±6.5 kHz	±10 kHz	±6.5 kHz
	28 MHz	±28 kHz	±28 kHz	±28 kHz
	40 MHz	±31 kHz	±35 kHz	±37 kHz
	80 MHz	±110 kHz	±90 kHz	±110 kHz
	160 MHz	±230 kHz	–	±240 kHz
	320 MHz	±725 kHz	–	–
	500 MHz	±1075 kHz	–	–
	CF = 20 GHz			
	10 MHz	±8.5 kHz	±8.5 kHz	±8.5 kHz
	28 MHz	±31 kHz	±31 kHz	±31 kHz
	40 MHz	±49 kHz	±49 kHz	±49 kHz
	80 MHz	±160 kHz	±145 kHz	±160 kHz
	160 MHz	±1175 kHz	–	±1175 kHz
	320 MHz	±1100 kHz	–	–
	500 MHz	±1975 kHz	–	–

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[44] Available bandwidths depend on the hardware configuration. For details, see R&S®FSW/FSWP/FSV/FPS and R&S®RTO data sheets.

[45] 10 MHz external reference locked to sender, PRI ≤ 10 ms.

[46] 10 MHz external reference locked to sender, PRI ≤ 1 ms.

Pulse stability trace

The pulse stability is given below for an example with an acquisition of 100 pulses having constant pulse repetition interval (PRI).

The pulse-pulse average trace stability is specified for a pulse width of 5 µs generated using the R&S®FSWP internal signal source and DUT bypass: on. The signal source level is +10 dBm. The option R&S®FSWP-B61 cross-correlation (low phase noise) is assumed.

The digitizer configuration is "low noise" with filter type "flat" and bandwidth 10 MHz. In general, the additive stability values for phase or amplitude will increase with 3 dB every time the bandwidth doubles. I.e. add $10 \cdot \log_{10}(\text{Meas BW} / 10 \text{ MHz})$ each for amplitude and phase stability. The "low noise" configuration supports up to 80 MHz of I/Q bandwidth.

The stability values specified below are median values and the 95 % confidence intervals on the pulse-phase stability trace results for the given measurement configuration, which apply to the center 75 % of the pulse width.

For phase, the RMS stability in radians (δ_{rad}) can be calculated from the values below (δ_{dB}) using the formula $\delta_{\text{rad}} = 10^{\delta_{\text{dB}}/20}$. E.g. "–60 dB" implies 1 mrad RMS phase stability.

For amplitude, the RMS stability as a percentage ($\delta_{\%}$) of the average amplitude, can be calculated from the values below (δ_{dB}) using the formula $\delta_{\%} = 100 \cdot 10^{\delta_{\text{dB}}/20}$. E.g. "–60 dB" implies 0.1 % RMS amplitude stability.

For more details on the calculation of stability, please consult the user manual of the R&S®FSWP-K6 pulse measurement application.

Specification for R&S®FSWP26 with option R&S®FSWP-B61						
Meas. bandwidth 10 MHz	PRI	Center frequency				
		2 GHz	4 GHz	8 GHz	12 GHz	18 GHz
Pulse-to-pulse phase stability in dB, values given as median value and with 95 % confidence interval in brackets						
Absolute	10 µs	< –73.5 (–72.5)	< –70.0 (–69.0)	< –65.5 (–64.5)	< –63.5 (–62.5)	< –61.5 (–60.0)
	100 µs	< –73.5 (–72.5)	< –70.0 (–69.0)	< –65.5 (–64.5)	< –63.5 (–62.5)	< –61.5 (–60.0)
	1 ms	< –73.0 (–71.5)	< –68.5 (–67.5)	< –63.5 (–62.5)	< –61.0 (–59.5)	< –58.0 (–57.0)
	10 ms	< –65.5 (–64.0)	< –59.5 (–58.0)	< –53.5 (–51.5)	< –50.0 (–48.0)	< –46.5 (–45.0)
Additive	10 ms	< –80.0 (–79.0)	< –80.5 (–79.0)	< –77.0 (–75.0)	< –72.5 (–71.5)	< –69.0 (–67.5)
Pulse-to-pulse amplitude stability in dB						
Absolute, additive	10 ms	< –80.0 (–78.5)	< –82.0 (–80.5)	< –74.0 (–72.5)	< –74.0 (–72.5)	< –70.5 (–69.0)

Specification for R&S®FSWP50 with option R&S®FSWP-B61						
Meas. bandwidth 10 MHz	PRI	Center frequency				
		2 GHz	4 GHz	8 GHz	12 GHz	18 GHz
Pulse-to-pulse phase stability in dB, values given as median value and with 95 % confidence interval in brackets						
Absolute	10 µs	< –71.0 (–70.0)	< –65.5 (–64.5)	< –60.0 (–59.5)	< –57.0 (–56.5)	< –54.0 (–53.0)
	100 µs	< –70.0 (–69.0)	< –64.5 (–63.5)	< –58.5 (–57.5)	< –55.5 (–55.0)	< –52.0 (–51.5)
	1 ms	< –69.5 (–68.5)	< –64.0 (–63.0)	< –58.0 (–57.5)	< –55.0 (–54.0)	< –52.0 (–49.5)
	10 ms	< –68.0 (–66.0)	< –62.0 (–60.0)	< –55.5 (–54.0)	< –52.5 (–51.0)	< –49.0 (–47.5)
Additive	10 ms	< –81.5 (–80.5)	< –81.5 (–80.0)	< –78.0 (–77.0)	< –72.0 (–71.0)	< –71.0 (–69.5)
Pulse-to-pulse amplitude stability in dB						
Absolute, additive	10 ms	< –81.5 (–80.5)	< –83.5 (–82.5)	< –75.0 (–73.5)	< –73.5 (–72.5)	< –71.0 (–69.5)

Ordering information

Designation	Type	Order No.
Pulse Measurement Application (requires R&S®VSE and R&S®FSPC)	R&S®VSE-K6	1320.7516.06
Pulse Measurement Application	R&S®FSW-K6	1313.1322.02
Time Sidelobe Measurements (requires R&S®FSW-K6)	R&S®FSW-K6S	1325.3783.02
Pulse Measurement Application (requires R&S®FSWP-B1)	R&S®FSWP-K6	1325.4421.02
Time Sidelobe Measurements (requires R&S®FSWP-K6)	R&S®FSWP-K6S	1325.5363.02
Pulse Stability Measurements (requires R&S®FSWP-K6, R&S®FSWP-B60 or R&S®FSWP-B61 and R&S®FSWP-B64)	R&S®FSWP-K6P	1338.3106.02
Pulse Measurement Application	R&S®FPS-K6	1331.3169.02
Vector signal explorer		
Vector Signal Explorer Base Software	R&S®VSE	1320.7500.06
License Dongle	R&S®FSPC	1310.0090.03
Software Maintenance	R&S®VSE-SWM	1320.7622.81
R&S®FSW [47]		
Signal and Spectrum Analyzer, 2 Hz to 8 GHz	R&S®FSW8	1312.8000.08
Signal and Spectrum Analyzer, 2 Hz to 13.6 GHz	R&S®FSW13	1312.8000.13
Signal and Spectrum Analyzer, 2 Hz to 26.5 GHz	R&S®FSW26	1312.8000.26
Signal and Spectrum Analyzer, 2 Hz to 43.5 GHz	R&S®FSW43	1312.8000.43
Signal and Spectrum Analyzer, 2 Hz to 50 GHz	R&S®FSW50	1312.8000.50
Signal and Spectrum Analyzer, 2 Hz to 67 GHz	R&S®FSW67	1312.8000.67
Signal and Spectrum Analyzer, 2 Hz to 85 GHz	R&S®FSW85	1312.8000.85
R&S®FSWP		
Phase Noise Analyzer, 1 MHz to 8 GHz	R&S®FSWP8	1322.8003.08
Phase Noise Analyzer, 1 MHz to 26.5 GHz	R&S®FSWP26	1322.8003.26
Phase Noise Analyzer, 1 MHz to 50 GHz	R&S®FSWP50	1322.8003.50
Spectrum Analyzer, 10 Hz to 8 GHz	R&S®FSWP-B1	1322.9997.08
Spectrum Analyzer, 10 Hz to 26 GHz	R&S®FSWP-B1	1322.9997.26
Spectrum Analyzer, 10 Hz to 50 GHz	R&S®FSWP-B1	1322.9997.50
R&S®FSV [48]		
Signal and Spectrum Analyzer, 10 Hz to 4 GHz	R&S®FSV4	1321.3008.04
Signal and Spectrum Analyzer, 10 Hz to 7 GHz	R&S®FSV7	1321.3008.07
Signal and Spectrum Analyzer, 10 Hz to 13.6 GHz	R&S®FSV13	1321.3008.13
Signal and Spectrum Analyzer, 10 Hz to 30 GHz	R&S®FSV30	1321.3008.30
Signal and Spectrum Analyzer, 10 Hz to 40 GHz [49]	R&S®FSV40	1321.3008.39
Signal and Spectrum Analyzer, 10 Hz to 40 GHz	R&S®FSV40	1321.3008.40
R&S®FSVA		
Signal and Spectrum Analyzer, 10 Hz to 4 GHz	R&S®FSVA4	1321.3008.05
Signal and Spectrum Analyzer, 10 Hz to 7 GHz	R&S®FSVA7	1321.3008.08
Signal and Spectrum Analyzer, 10 Hz to 13.6 GHz	R&S®FSVA13	1321.3008.14
Signal and Spectrum Analyzer, 10 Hz to 30 GHz	R&S®FSVA30	1321.3008.31
Signal and Spectrum Analyzer, 10 Hz to 40 GHz	R&S®FSVA40	1321.3008.41
R&S®FPS [50]		
Signal and Spectrum Analyzer 10 Hz to 4 GHz	R&S®FPS4	1319.2008.04
Signal and Spectrum Analyzer 10 Hz to 7 GHz	R&S®FPS7	1319.2008.07
Signal and Spectrum Analyzer 10 Hz to 13.6 GHz	R&S®FPS13	1319.2008.13
Signal and Spectrum Analyzer 10 Hz to 30 GHz	R&S®FPS30	1319.2008.30
Signal and Spectrum Analyzer 10 Hz to 40 GHz	R&S®FPS40	1319.2008.40
R&S®RTO 1000 [51], [52]		
Oscilloscope, 600 MHz, 10 Gsample/s, 20/40 Msample, 2 channels	R&S®RTO1002	1316.1000.02
Oscilloscope, 600 MHz, 10 Gsample/s, 20/80 Msample, 4 channels	R&S®RTO1004	1316.1000.04
Oscilloscope, 1 GHz, 10 Gsample/s, 20/40 Msample, 2 channels	R&S®RTO1012	1316.1000.12
Oscilloscope, 1 GHz, 10 Gsample/s, 20/80 Msample, 4 channels	R&S®RTO1014	1316.1000.14
Oscilloscope, 2 GHz, 10 Gsample/s, 20/40 Msample, 2 channels	R&S®RTO1022	1316.1000.22
Oscilloscope, 2 GHz, 10 Gsample/s, 20/80 Msample, 4 channels	R&S®RTO1024	1316.1000.24
Oscilloscope, 4 GHz, 20 Gsample/s, 20/80 Msample, 4 channels	R&S®RTO1044	1316.1000.44

[47] Firmware version 2.21 or higher required for use with R&S®VSE-K6.

[48] Firmware version 2.30 or higher required for use with R&S®VSE-K6.

[49] Max. bandwidth 10 MHz.

[50] Firmware version 1.30 or higher required for use with R&S®VSE-K6. Firmware version 1.40 or higher required for the R&S®FPS-K6 option.

[51] Firmware version 2.51.1.0 or higher required for use with R&S®VSE-K6.

[52] R&S®RTO-K11 required for use with R&S®VSE-K6.

Designation	Type	Order No.
R&S®RTO 2000		
Oscilloscope, 600 MHz, 2 channels	R&S®RTO2002	1329.7002.02
Oscilloscope, 600 MHz, 4 channels	R&S®RTO2004	1329.7002.04
Oscilloscope, 1 GHz, 4 channels	R&S®RTO2012	1329.7002.12
Oscilloscope, 1 GHz, 2 channels	R&S®RTO2014	1329.7002.14
Oscilloscope, 2 GHz, 4 channels	R&S®RTO2022	1329.7002.22
Oscilloscope, 2 GHz, 2 channels	R&S®RTO2024	1329.7002.24
Oscilloscope, 3 GHz, 4 channels	R&S®RTO2034	1329.7002.32
Oscilloscope, 3 GHz, 2 channels	R&S®RTO2034	1329.7002.34
Oscilloscope, 4 GHz, 4 channels	R&S®RTO2044	1329.7002.44

Hardware options required for R&S®FSWP-K6P pulse stability measurements

The R&S®FSWP-K6P pulse stability measurements option requires one of R&S®FSWP-B60 or R&S®FSWP-B61 as well as R&S®FSWP-B64.

Designation	Type	Order No.
Cross-Correlation, 8 GHz	R&S®FSWP-B60	1322.9800.08
Cross-Correlation, 26 GHz	R&S®FSWP-B60	1322.9800.26
Cross-Correlation, 50 GHz	R&S®FSWP-B60	1322.9800.50
Cross-Correlation (low phase noise), 8 GHz	R&S®FSWP-B61	1325.3719.08
Cross-Correlation (low phase noise), 26 GHz	R&S®FSWP-B61	1325.3719.26
Cross-Correlation (low phase noise), 50 GHz	R&S®FSWP-B61	1325.3719.50
Additive Phase Noise Measurements	R&S®FSWP-B64	1322.9900.26

Oscilloscopes supported by R&S®FSW-B2000 option

Designation	Type	Order No.
Oscilloscope, 4 GHz, 20 Gsample/s, 20/80 Msample, 4 channels	R&S®RTO1044	1316.1000.44
OCXO 10 MHz	R&S®RTO-B4	1304.8305.02
Memory Upgrade, 50 Msample per channel	R&S®RTO-B101	1304.8428.02
Memory Upgrade, 100 Msample per channel	R&S®RTO-B102	1304.8434.02
Memory Upgrade, 200 Msample per channel	R&S®RTO-B103	1304.8440.02
Memory Upgrade, 400 Msample per channel	R&S®RTO-B104	1304.8457.02

Designation	Type	Order No.
Oscilloscope, 4 GHz, 20 Gsample/s, 20/80 Msample, 4 channels	R&S®RTO2044	1329.7002.44
OCXO 10 MHz	R&S®RTO-B4	1304.8305.02
Memory Upgrade, 100 Msample per channel	R&S®RTO-B101	1329.7060.02
Memory Upgrade, 200 Msample per channel	R&S®RTO-B102	1329.7077.02
Memory Upgrade, 400 Msample per channel	R&S®RTO-B104	1329.7083.02
Memory Upgrade, 1 Gsample per channel	R&S®RTO-B110	1329.7090.04

Recommended extras

Designation	Type	Order No.
R&S®FSW		
Real-Time Spectrum Analyzer, 160 MHz [53]	R&S®FSW-K160R	1313.5340.02
OCXO Precision Frequency Reference	R&S®FSW-B4	1313.0703.02
RF Preamplifier, 100 kHz to 13.6 GHz	R&S®FSW-B24	1313.0832.13
RF Preamplifier, 100 kHz to 26.5 GHz	R&S®FSW-B24	1313.0832.26
RF Preamplifier, 100 kHz to 43.5 GHz	R&S®FSW-B24	1313.0832.43
RF Preamplifier, 100 kHz to 50 GHz	R&S®FSW-B24	1313.0832.50
RF Preamplifier, 100 kHz to 67 GHz	R&S®FSW-B24	1313.0832.67
28 MHz Analysis Bandwidth	R&S®FSW-B28	1313.1645.02
40 MHz Analysis Bandwidth	R&S®FSW-B40	1313.0861.02
80 MHz Analysis Bandwidth	R&S®FSW-B80	1313.0878.02
160 MHz Analysis Bandwidth	R&S®FSW-B160	1313.1668.02
320 MHz Analysis Bandwidth	R&S®FSW-B320	1313.7172.02
500 MHz Analysis Bandwidth	R&S®FSW-B500	1313.4296.02
2 GHz Analysis Bandwidth [54]	R&S®FSW-B2000	1325.4750.26
2 GHz Analysis Bandwidth [55]	R&S®FSW-B2000	1325.4750.02
Digital Baseband Interface	R&S®FSW-B17	1313.0784.02
Analog Baseband Inputs for R&S®FSW8/13, 40 MHz analysis bandwidth	R&S®FSW-B71	1313.1651.13
Analog Baseband Inputs for R&S®FSW26/43/50, 40 MHz analysis bandwidth	R&S®FSW-B71	1313.1651.26
Analog Baseband Inputs for R&S®FSW67, 40 MHz analysis bandwidth	R&S®FSW-B71	1313.1651.67
Analog Baseband Inputs for R&S®FSW85, 40 MHz analysis bandwidth	R&S®FSW-B71	1313.1651.85
Analog Baseband Inputs, 80 MHz analysis bandwidth	R&S®FSW-B71E	1313.6547.02
Highpass Filter for Harmonic Measurements [56]	R&S®FSW-B13	1313.0761.02
LO/IF Connections for external mixers	R&S®FSW-B21	1313.1100.26
LO/IF Connections for external mixers	R&S®FSW-B21	1313.1100.43
Harmonic Mixer, 40 GHz to 60 GHz	R&S®FS-Z60	1089.0799.02
Harmonic Mixer, 50 GHz to 75 GHz	R&S®FS-Z75	1048.0271.02
Harmonic Mixer, 60 GHz to 90 GHz	R&S®FS-Z90	1048.0371.02
Harmonic Mixer, 75 GHz to 110 GHz	R&S®FS-Z110	1048.0471.02
R&S®FSWP		
High Stability OCXO	R&S®FSWP-B4	1325.3890.02
RF Preamplifier, 100 kHz to 8 GHz	R&S®FSWP-B24	1325.3725.08
RF Preamplifier, 100 kHz to 26.5 GHz	R&S®FSWP-B24	1325.3725.26
RF Preamplifier, 100 kHz to 50 GHz	R&S®FSWP-B24	1325.3725.50
LO/IF Connections for external mixers	R&S®FSWP-B21	1325.3848.02
80 MHz Analysis Bandwidth	R&S®FSWP-B80	1325.4338.02
320 MHz Analysis Bandwidth	R&S®FSWP-B320	1338.3235.04

[53] One of the options R&S®FSW-B160/-B320 is required, not available for R&S®FSW-B500.

[54] For R&S®FSW26 ex-factory; for later upgrade of R&S®FSW26 instruments use R&S®FSW-U2000.

[55] For R&S®FSW43/50/67/85; contact service center.

[56] R&S®FSW71 required; user-retrofittable.

R&S®FSV/FSVA		
OCXO Reference Frequency	R&S®FSV-B4	1310.9522.02
OCXO Extended Frequency Stability	R&S®FSV-B4	1310.9522.03
Ultra-High Precision Frequency Reference	R&S®FSV-B14	1310.9980.02
RF Preamplifier, 9 kHz to 7 GHz	R&S®FSV-B22	1310.9600.02
RF Preamplifier, 9 kHz to 13.6 GHz	R&S®FSV-B24	1310.9616.13
RF Preamplifier, 9 kHz to 30 GHz	R&S®FSV-B24	1310.9616.30
RF Preamplifier, 9 kHz to 40 GHz	R&S®FSV-B24	1310.9616.40
Electronic Attenuator, 1 dB steps	R&S®FSV-B25	1310.9622.02
YIG Preselector Bypass for R&S®FSVA13 (not retrofittable)	R&S®FSVA-B11	1321.3714.13
YIG Preselector Bypass for R&S®FSVA30 (not retrofittable)	R&S®FSVA-B11	1321.3714.30
YIG Preselector Bypass for R&S®FSVA40 (not retrofittable)	R&S®FSVA-B11	1321.3714.40
40 MHz Analysis Bandwidth [57]	R&S®FSV-B70	1310.9645.02
40 MHz Analysis Bandwidth [58]	R&S®FSVA-B40	1329.0214.02
160 MHz Analysis Bandwidth [59, 60]	R&S®FSV-B160	1311.2015.02
160 MHz Analysis Bandwidth [61, 62]	R&S®FSV-B160	1311.2015.13
160 MHz Analysis Bandwidth [63, 64]	R&S®FSV-B160	1311.2015.40
R&S®FPS		
OCXO Reference Frequency	R&S®FPS-B4	1321.4291.02
YIG Preselector Bypass [65]	R&S®FPS-B11	1326.5467.30
YIG Preselector Bypass [66]	R&S®FPS-B11	1326.5467.40
RF Preamplifier, 9 kHz to 7 GHz	R&S®FPS-B22	1321.4027.02
Electronic Attenuator, 1 dB steps	R&S®FPS-B25	1321.4033.02
RF Preamplifier, 9 kHz to 13.6 GHz	R&S®FPS-B24	1321.4279.13
RF Preamplifier, 9 kHz to 30 GHz	R&S®FPS-B24	1321.4279.30
RF Preamplifier, 9 kHz to 40 GHz	R&S®FPS-B24	1321.4279.40
40 MHz Analysis Bandwidth	R&S®FPS-B40	1321.4040.02
160 MHz Analysis Bandwidth [67]	R&S®FPS-B160	1321.4285.02
160 MHz Analysis Bandwidth [68]	R&S®FPS-B160	1321.4285.13
160 MHz Analysis Bandwidth [69]	R&S®FPS-B160	1321.4285.40

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[57] User-retrofittable, for frequencies ≤ 7 GHz, not available for R&S®FSV40, model .39.

[58] User-retrofittable, for frequencies ≤ 7 GHz, with option R&S®FSVA-B11 also for f > 7 GHz.

[59] For R&S®FSVA4 and R&S®FSVA7, excludes R&S®FSV-B10 and R&S®FSV-B14.

[60] For R&S®FSV4 and R&S®FSV7, R&S®FSVA4 and R&S®FSVA7, excludes R&S®FSV-B10 and R&S®FSV-B14.

[61] For R&S®FSV13 for frequencies ≤ 7 GHz, excludes R&S®FSV-B10 and R&S®FSV-B14.

[62] For R&S®FSVA13 for frequencies ≤ 7 GHz, with option R&S®FSVA-B11 (not retrofittable) also for f > 7 GHz, excludes R&S®FSV-B10 and R&S®FSV-B14.

[63] For R&S®FSV30 and R&S®FSV40 for frequencies ≤ 7 GHz, excludes R&S®FSV-B10 and R&S®FSV-B14. Not available for R&S®FSV40, model .39.

[64] For R&S®FSVA30 and R&S®FSVA40 for frequencies ≤ 7 GHz, with option R&S®FSVA-B11 (not retrofittable) also for f > 7 GHz, excludes R&S®FSV-B10 and R&S®FSV-B14.

[65] For R&S®FPS30.

[66] For R&S®FPS40.

[67] For R&S®FPS4 and R&S®FPS7; retrofit in service center.

[68] For R&S®FPS13 for frequencies ≤ 7 GHz.

[69] For R&S®FPS30 and R&S®FPS40; for f > 7 GHz: R&S®FPS-B11 option required.

Rohde & Schwarz

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