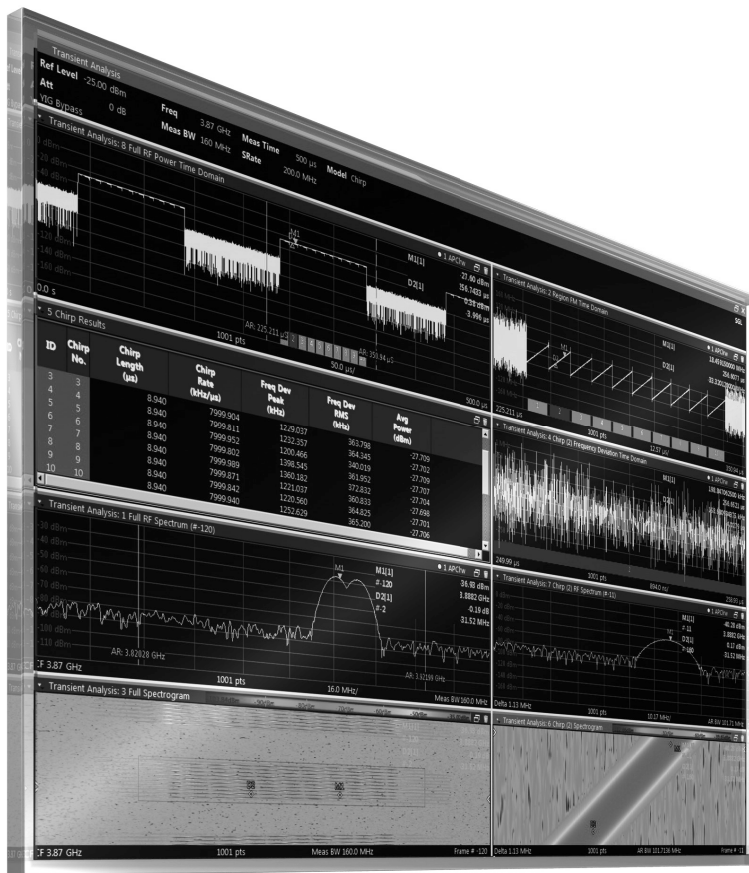


# Transient measurement application, transient hop measurements, transient chirp measurements Specifications

R&S®VSE-K60 | R&S®VSE-K60C | R&S®VSE-K60H  
R&S®FSW-K60 | R&S®FSW-K60C | R&S®FSW-K60H  
R&S®FSWP-K60 | R&S®FSWP-K60C | R&S®FSWP-K60H



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# Definitions

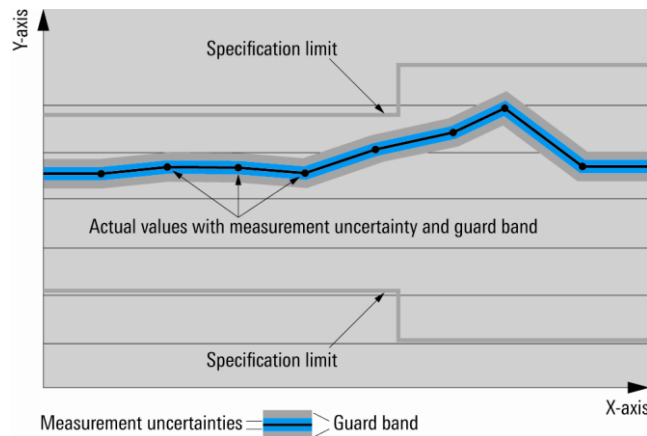
## General

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.

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), Msps (million symbols per second) or ksps (thousand symbols per second), and sample rates are specified in Msample/s (million samples per second). Mcps, Mbps, Msps, kbps, ksps and Msample/s are not SI units.

# Specifications

The specifications of the R&S®VSE-K60/R&S®FSx-K60 transient measurement application, R&S®VSE-K60H/R&S®FSx-K60H transient hop measurements and the R&S®VSE-K60C/R&S®FSx-K60C transient chirp measurements are based on the specifications in the data sheet for the R&S®FSW and R&S®FSWP 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).

## General remarks

This data sheet covers the R&S®FSW-K60, R&S®FSWP-K60 and the R&S®VSE-K60, the R&S®FSW-K60C, R&S®FSWP-K60C and the R&S®VSE-K60C, the R&S®FSW-K60H, R&S®FSWP-K60H and the R&S®VSE-K60H. The R&S®FSW-K60 and R&S®FSWP-K60 are summarized with the term R&S®FSx-K60. The R&S®FSW-K60C and R&S®FSWP-K60C are summarized with the term R&S®FSx-K60C. The R&S®FSW-K60H and R&S®FSWP-K60H are summarized with the term R&S®FSx-K60H. The R&S®FSx-K60, R&S®FSx-K60C and R&S®FSx-K60H are summarized with the term R&S®FSx-K60/C/H. The R&S®VSE-K60, R&S®VSE-K60C and R&S®VSE-K60H are summarized with the term R&S®VSE-K60/C/H.

The R&S®FSx-K60C transient chirp measurements and R&S®FSx-K60H transient hop measurements are provided as an upgrade to the R&S®FSx-K60 transient measurements. The R&S®FSx-K60C and R&S®FSx-K60H options therefore require the corresponding R&S®FSx-K60 option.

The R&S®VSE-K60C transient chirp measurements and R&S®VSE-K60H transient hop measurements are provided as an upgrade to the R&S®VSE-K60 transient measurements. The R&S®VSE-K60C and R&S®VSE-K60H options therefore require R&S®VSE-K60 option.

The R&S®FSx-K60 runs on the device itself.

The R&S®VSE-K60 runs on a PC connected to an R&S®FSW or R&S®FSWP.

If not stated otherwise, the data sheet values are device-specific, e.g. the same value applies to R&S®FSW-K60 and R&S®VSE-K60 with connected R&S®FSx.

For feature tables the following convention applies:

•	Feature always supported i.e. with the R&S®VSE-K60 connected to the device and with the corresponding R&S®FSx-K60 option when running directly on the device.
• (R&S®VSE)	Feature supported only with the R&S®VSE-K60 connected to the device. Not with the corresponding R&S®FSx-K60 option when running directly on the device.
• (R&S®FSx-K60)	Feature supported only when running directly on the device with the corresponding R&S®FSx-K60/C/H option. Not supported in the R&S®VSE-K60.
–	Feature not supported with this device.

## Overview

		R&S®FSW	R&S®FSWP
R&S®FSx-K60/C/H	software that runs on device	•	•
R&S®VSE-K60/C/H	PC software that can be connected to device	•	•

## Transient measurement

### Frequency

		<b>R&amp;S®FSW</b>	<b>R&amp;S®FSWP</b>
Frequency range	RF input	same as supported instrument	

### Level

		<b>R&amp;S®FSW</b>	<b>R&amp;S®FSWP</b>
Level range	RF input	same as supported instrument	

### Signal acquisition

		<b>R&amp;S®FSW</b>	<b>R&amp;S®FSWP</b>
Input	RF input	•	•
	file	•	•
	external mixer	• (R&S®FSW-K60)	• (R&S®FSWP-K60)
	MSRA I/Q data capture	• (R&S®FSW-K60)	• (R&S®FSWP-K60)
	MSRT I/Q data capture	• (R&S®FSW-K60)	–
Measurement bandwidth	standard	10 MHz	10 MHz
	up to <sup>1</sup>	5000 MHz (FSW-K60), 2000 MHz (VSE-K60) <sup>2</sup>	320 MHz
Measurement time		same as for the R&S®VSE base system or R&S®FSx I/Q analyzer <sup>3</sup>	

### Measurement capability (nom.)

Analysis region	time gate length	101 sample up to max. measurement time
	time gate start	0 to measurement time - time gate length
	bandwidth	1 % to 100 % of measurement bandwidth
	delta frequency	$\pm (\text{measurement bandwidth} - \text{bandwidth})/2$
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	32, 64, 128, 256, 512, 1024, 2048, 4096
	history depth	up to 20 000 frames
Hop detection <sup>4</sup>	nominal hop states	up to 1000 states
	measured hops	up to 100 000 hops
	min. dwell time for measurement bandwidth <sup>1</sup> = 3 × FM settling time (see FM step response table for settling times), example for FM video filter: none	
	10 MHz	2.2 µs
	28 MHz	800 ns
	40 MHz	600 ns
	80 MHz	300 ns
	160 MHz	150 ns
	320 MHz	75 ns
	500 MHz	50 ns
	1200 MHz	20 ns
	2000 MHz	13 ns
	5000 MHz	5 ns

<sup>1</sup> Available measurement bandwidths depend on the hardware configuration. For details, see R&S®FSW and R&S®FSWP data sheets.

<sup>2</sup> R&S®VSE-K60 does not support R&S®FSW-B5000.

<sup>3</sup> Maximum measurement time will reduce with multiple measurement application channels opened simultaneously.

<sup>4</sup> Requires R&S®FSx-K60H/R&S®VSE-K60H transient hop measurements upgrade option.

Chirp detection <sup>5</sup>	nominal chirp states	up to 1000 states
	measured chirps	up to 100 000 chirps
	min. chirp length for measurement bandwidth <sup>6</sup> = 3 × chirp rate settling time (see chirp rate step response table for settling times), example for FM video filter: none	
	10 MHz	24 µs
	28 MHz	9 µs
	40 MHz	6 µs
	80 MHz	3 µs
	160 MHz	1.5 µs
	320 MHz	750 ns
	500 MHz	500 ns
	1200 MHz	200 ns
	2000 MHz	125 ns
	5000 MHz	50 ns

## Measurement results

Signal characteristic	Analysis range	Result display
I/Q signal	full capture, analysis region, hop <sup>7</sup> or chirp <sup>5</sup>	I/Q time domain
Amplitude modulation	full capture, analysis region, hop <sup>7</sup> or chirp <sup>5</sup>	RF power time domain
Frequency modulation	full capture, analysis region, hop <sup>7</sup> or chirp <sup>5</sup>	FM time domain chirp rate time domain
Frequency modulation error	full capture, analysis region, hop <sup>7</sup> or chirp <sup>5</sup>	frequency deviation time domain
Phase modulation	full capture, analysis region, hop <sup>7</sup> or chirp <sup>5</sup>	PM time domain PM time domain (wrapped)
Phase modulation error	full capture, analysis region, hop <sup>7</sup> or chirp <sup>5</sup>	phase deviation time domain
Spectrum	full capture, analysis region, hop <sup>7</sup> or chirp <sup>5</sup>	frame power spectrum spectrogram
Frequency hopping <sup>7</sup>	analysis region	results table, statistics table state index hop begin dwell time switching time state frequency (nominal) average frequency hop state deviation relative frequency (hop-to-hop) frequency deviation (peak) frequency deviation (RMS) frequency deviation (average) FM settling point FM settling time FM settled length phase deviation (peak) phase deviation (RMS) phase deviation (average) PM settling point PM settling time PM settled length minimum power maximum power average power power ripple

<sup>5</sup> Requires R&S®FSx-K60C/R&S®VSE-K60C transient chirp measurements upgrade option.

<sup>6</sup> Available measurement bandwidths depend on the hardware configuration. For details, see R&S®FSW and R&S®FSWP data sheets.

<sup>7</sup> Requires R&S®FSx-K60H/R&S®VSE-K60H transient hop measurements upgrade option.

Chirped (linear) FM <sup>8</sup>	analysis region	results table, statistics table
		state index
		chirp begin
		chirp length
		chirp rate
		chirp state deviation
		average frequency
		nominal bandwidth
		frequency deviation (peak)
		frequency deviation (RMS)
		frequency deviation (average)
		frequency INL (peak)
		frequency INL (RMS)
		frequency INL (average)
		FM settling point
		FM settling time
		FM settled length
		phase deviation (peak)
		phase deviation (RMS)
		phase deviation (average)
		PM settling point
		PM settling time
		PM settled length
		minimum power
		maximum power
		average power
		power ripple
Hop <sup>9</sup> or chirp <sup>8</sup> parameter visualization	analysis region	parameter trend
		trend plot of parameter versus time
		scatter plot of parameter versus parameter
		parameter distribution
		histogram of parameter distribution

### FM step response (nom.)

The nominal FM step response is calculated for the internal R&S®FSx-K60/R&S®VSE-K60 frequency demodulator assuming an ideal input FM “step” signal, which transitions within one sample from one frequency state to another. This represents the “worst-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 <sup>10</sup> for measurement bandwidth <sup>11</sup>	
	10 MHz	< 730 ns
	28 MHz	< 260 ns
	40 MHz	< 200 ns
	80 MHz	< 100 ns
	160 MHz	< 50 ns
	320 MHz	< 25 ns
	500 MHz	< 17 ns
	1200 MHz	< 7 ns
	2000 MHz	< 5 ns
	5000 MHz	< 2 ns

<sup>8</sup> Requires R&S®FSx-K60C/R&S®VSE-K60C transient chirp measurements upgrade option.

<sup>9</sup> Requires R&S®FSx-K60H/R&S®VSE-K60H transient hop measurements upgrade option.

<sup>10</sup> 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.

<sup>11</sup> Available measurement bandwidths depend on the hardware configuration. For details, see R&S®FSW and R&S®FSWP data sheets.

FM video filter: 25 % of FM bandwidth	overshoot	< 17 % of FM step size
	frequency settling time <sup>12</sup> for measurement bandwidth <sup>13</sup>	
	10 MHz	< 1.6 $\mu$ s
	28 MHz	< 570 ns
	40 MHz	< 400 ns
	80 MHz	< 200 ns
	160 MHz	< 100 ns
	320 MHz	< 50 ns
	500 MHz	< 35 ns
	1200 MHz	< 14 ns
	2000 MHz	< 9 ns
	5000 MHz	< 4 ns
FM video filter: 10 % of FM bandwidth	overshoot	< 16 % of FM step size
	frequency settling time <sup>12</sup> for measurement bandwidth <sup>13</sup>	
	10 MHz	< 3.8 $\mu$ s
	28 MHz	< 1.4 $\mu$ s
	40 MHz	< 1 $\mu$ s
	80 MHz	< 500 ns
	160 MHz	< 250 ns
	320 MHz	< 125 ns
	500 MHz	< 80 ns
	1200 MHz	< 34 ns
	2000 MHz	< 20 ns
	5000 MHz	< 8 ns
FM video filter: 5 % of FM bandwidth	overshoot	< 15 % of FM step size
	frequency settling time <sup>12</sup> for measurement bandwidth <sup>13</sup>	
	10 MHz	< 7.5 $\mu$ s
	28 MHz	< 2.7 $\mu$ s
	40 MHz	< 1.9 $\mu$ s
	80 MHz	< 960 ns
	160 MHz	< 480 ns
	320 MHz	< 240 ns
	500 MHz	< 160 ns
	1200 MHz	< 64 ns
	2000 MHz	< 40 ns
	5000 MHz	< 16 ns
FM video filter: 1 % of FM bandwidth	overshoot	< 15 % of FM step size
	frequency settling time <sup>12</sup> for measurement bandwidth <sup>13</sup>	
	10 MHz	< 37 $\mu$ s
	28 MHz	< 13 $\mu$ s
	40 MHz	< 9.2 $\mu$ s
	80 MHz	< 4.6 $\mu$ s
	160 MHz	< 2.3 $\mu$ s
	320 MHz	< 1.1 $\mu$ s
	500 MHz	< 800 ns
	1200 MHz	< 320 ns
	2000 MHz	< 200 ns
	5000 MHz	< 80 ns
FM video filter: 0.1 % of FM bandwidth	overshoot	< 14 % of FM step size
	frequency settling time <sup>12</sup> for measurement bandwidth <sup>13</sup>	
	10 MHz	< 255 $\mu$ s
	28 MHz	< 90 $\mu$ s
	40 MHz	< 64 $\mu$ s
	80 MHz	< 32 $\mu$ s
	160 MHz	< 16 $\mu$ s
	320 MHz	< 8 $\mu$ s
	500 MHz	< 5.5 $\mu$ s
	1200 MHz	< 2.2 $\mu$ s
	2000 MHz	< 1.5 $\mu$ s
	5000 MHz	< 600 ns

<sup>12</sup> 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.

<sup>13</sup> Available measurement bandwidths depend on the hardware configuration. For details, see R&S®FSW and R&S®FSWP data sheets.



## Chirp rate step response (nom.)

The nominal chirp rate step response is calculated for the internal R&S®FSx-K60/R&S®VSE-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 “worst-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 <sup>14</sup> for measurement bandwidth <sup>15</sup>	
	10 MHz	< 8 µs
	28 MHz	< 2.9 µs
	40 MHz	< 2 µs
	80 MHz	< 1 µs
	160 MHz	< 500 ns
	320 MHz	< 250 ns
	500 MHz	< 170 ns
	1200 MHz	< 70 ns
	2000 MHz	< 45 ns
	5000 MHz	< 18 ns
FM video filter: 1 % of FM bandwidth	overshoot	< 9 % of chirp rate step size
	chirp rate settling time <sup>14</sup> for measurement bandwidth <sup>15</sup>	
	10 MHz	< 28 µs
	28 MHz	< 10 µs
	40 MHz	< 7 µs
	80 MHz	< 3.6 µs
	160 MHz	< 1.8 µs
	320 MHz	< 900 ns
	500 MHz	< 600 ns
	1200 MHz	< 250 ns
	2000 MHz	< 150 ns
	5000 MHz	< 60 ns
FM video filter: 0.1 % of FM bandwidth	overshoot	< 11 % of chirp rate step size
	chirp rate settling time <sup>14</sup> for measurement bandwidth <sup>15</sup>	
	10 MHz	< 256 µs
	28 MHz	< 92 µs
	40 MHz	< 64 µs
	80 MHz	< 32 µs
	160 MHz	< 16 µs
	320 MHz	< 8 µs
	500 MHz	< 5.5 µs
	1200 MHz	< 2.2 µs
	2000 MHz	< 1.5 µs
	5000 MHz	< 600 ns

<sup>14</sup> 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, the chirp rate “step size” is 2 MHz/µs.

<sup>15</sup> Available measurement bandwidths depend on the hardware configuration. For details, see R&S®FSW and R&S®FSWP data sheets.

## FM measurement uncertainty (nom.)

The total FM measurement uncertainty is comprised of absolute frequency uncertainty and a statistical uncertainty due to measurement noise. The absolute frequency uncertainty is given in the R&S®FSW and R&S®FSWP data sheets. 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 <sup>16</sup>.

### R&S®FSW signal and spectrum analyzer

<b>2 GHz center frequency</b>						
Measurement bandwidth <sup>17</sup>	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	± 8 kHz	± 1.5 kHz	± 500 Hz	± 350 Hz	± 40 Hz	± 2 Hz
40 MHz	± 13 kHz	± 2 kHz	± 700 Hz	± 450 Hz	± 75 Hz	± 3 Hz
80 MHz	± 55 kHz	± 5 kHz	± 1.5 kHz	± 700 Hz	± 250 Hz	± 7 Hz
160 MHz	± 140 kHz	± 25 kHz	± 5 kHz	± 2 kHz	± 400 Hz	± 35 Hz
320 MHz	± 450 kHz	± 45 kHz	± 15 kHz	± 5 kHz	± 700 Hz	± 70 Hz
500 MHz	± 900 kHz	± 90 kHz	± 30 kHz	± 11 kHz	± 1.4 kHz	± 140 Hz
<b>8 GHz center frequency</b>						
Measurement bandwidth <sup>17</sup>	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	± 9 kHz	± 1.5 kHz	± 650 Hz	± 500 Hz	± 70 Hz	± 3 Hz
40 MHz	± 15 kHz	± 2 kHz	± 800 Hz	± 600 Hz	± 120 Hz	± 5 Hz
80 MHz	± 60 kHz	± 5 kHz	± 2 kHz	± 800 Hz	± 350 Hz	± 12 Hz
160 MHz	± 140 kHz	± 20 kHz	± 5 kHz	± 2 kHz	± 550 Hz	± 32 Hz
320 MHz	± 450 kHz	± 55 kHz	± 15 kHz	± 5 kHz	± 1 kHz	± 100 Hz
500 MHz	± 900 kHz	± 110 kHz	± 30 kHz	± 11 kHz	± 2 kHz	± 200 Hz
<b>26 GHz center frequency</b>						
Measurement bandwidth <sup>17</sup>	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	± 26 kHz	± 4 kHz	± 1.5 kHz	± 1 kHz	± 200 Hz	± 8 Hz
40 MHz	± 50 kHz	± 6 kHz	± 2 kHz	± 1.5 kHz	± 300 Hz	± 10 Hz
80 MHz	± 160 kHz	± 16 kHz	± 5 kHz	± 2 kHz	± 700 Hz	± 25 Hz
160 MHz	± 360 kHz	± 45 kHz	± 12 kHz	± 5 kHz	± 1.5 kHz	± 80 Hz
320 MHz	± 1 MHz	± 120 kHz	± 35 kHz	± 12 kHz	± 2 kHz	± 220 Hz
500 MHz	± 2 MHz	± 240 kHz	± 70 kHz	± 24 kHz	± 4 kHz	± 440 Hz
<b>43 GHz center frequency</b>						
Measurement bandwidth <sup>17</sup>	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	± 80 kHz	± 10 kHz	± 3 kHz	± 2 kHz	± 300 Hz	± 12 Hz
40 MHz	± 150 kHz	± 16 kHz	± 5 kHz	± 3 kHz	± 500 Hz	± 20 Hz
80 MHz	± 500 kHz	± 45 kHz	± 15 kHz	± 5 kHz	± 1.5 kHz	± 50 Hz
160 MHz	± 1.2 MHz	± 150 kHz	± 40 kHz	± 15 kHz	± 2.5 kHz	± 150 Hz
320 MHz	± 3.4 MHz	± 400 kHz	± 110 kHz	± 40 kHz	± 4 kHz	± 400 Hz
500 MHz	± 6 MHz	± 800 kHz	± 220 kHz	± 80 kHz	± 8 kHz	± 800 Hz

<sup>16</sup> Signal level ≥ 0 dBm, RF level and attenuator: auto, 10 MHz external reference locked to sender, measurement time ≤ 10 ms.

<sup>17</sup> Available measurement bandwidths depend on the hardware configuration. For details, see R&S®FSW data sheet.

**R&S®FSWP phase noise analyzer and VCO tester**

<b>2 GHz center frequency</b>						
Measurement bandwidth <sup>18</sup>	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	± 1.4 kHz	± 240 Hz	± 110 Hz	± 55 Hz	± 5 Hz	± 0.3 Hz
28 MHz	± 6 kHz	± 800 Hz	± 280 Hz	± 150 Hz	± 25 Hz	± 0.8 Hz
40 MHz	± 10 kHz	± 1.3 kHz	± 400 Hz	± 210 Hz	± 40 Hz	± 1.4 Hz
80 MHz	± 32 kHz	± 3.5 kHz	± 1 kHz	± 400 Hz	± 90 Hz	± 4 Hz
160 MHz	± 90 kHz	± 10 kHz	± 3 kHz	± 1 kHz	± 180 Hz	± 12 Hz
320 MHz	± 300 kHz	± 30 kHz	± 8 kHz	± 3 kHz	± 350 Hz	± 33 Hz
<b>8 GHz center frequency</b>						
Measurement bandwidth <sup>18</sup>	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	± 1.8 kHz	± 600 Hz	± 230 Hz	± 110 Hz	± 8 Hz	± 0.8 Hz
28 MHz	± 8 kHz	± 1.5 kHz	± 430 Hz	± 280 Hz	± 45 Hz	± 1.7 Hz
40 MHz	± 13 kHz	± 2 kHz	± 570 Hz	± 350 Hz	± 80 Hz	± 2.5 Hz
80 MHz	± 40 kHz	± 5 kHz	± 1.2 kHz	± 580 Hz	± 180 Hz	± 7 Hz
160 MHz	± 120 kHz	± 13 kHz	± 4 kHz	± 1.3 kHz	± 300 Hz	± 20 Hz
320 MHz	± 400 kHz	± 40 kHz	± 10 kHz	± 3.5 kHz	± 500 Hz	± 60 Hz
<b>26 GHz center frequency</b>						
Measurement bandwidth <sup>18</sup>	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	± 1.2 kHz	± 600 Hz	± 300 Hz	± 25 Hz	± 2.3 Hz
28 MHz	± 26 kHz	± 3.5 kHz	± 1.3 kHz	± 750 Hz	± 130 Hz	± 5 Hz
40 MHz	± 50 kHz	± 6 kHz	± 1.8 kHz	± 1 kHz	± 230 Hz	± 7 Hz
80 MHz	± 170 kHz	± 16 kHz	± 4.5 kHz	± 1.8 kHz	± 500 Hz	± 20 Hz
160 MHz	± 500 kHz	± 60 kHz	± 15 kHz	± 5 kHz	± 800 Hz	± 60 Hz
320 MHz	± 1.7 MHz	± 170 kHz	± 40 kHz	± 15 kHz	± 1.5 kHz	± 180 Hz

**PM measurement uncertainty (nom.)**

The total PM measurement uncertainty 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 and R&S®FSWP data sheets. 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 <sup>19</sup>.

**R&S®FSW signal and spectrum analyzer**

<b>2 GHz center frequency</b>		measurement bandwidth <sup>20</sup>
	10 MHz	± 0.16°
	28 MHz	± 0.18°
	40 MHz	± 0.18°
	80 MHz	± 0.20°
	160 MHz	± 0.22°
	320 MHz	± 0.28°
	500 MHz	± 0.35°
<b>8 GHz center frequency</b>		measurement bandwidth <sup>20</sup>
	10 MHz	± 0.60°
	28 MHz	± 0.60°
	40 MHz	± 0.63°
	80 MHz	± 0.63°
	160 MHz	± 0.64°
	320 MHz	± 0.66°
	500 MHz	± 0.68°

<sup>18</sup> Available measurement bandwidths depend on the hardware configuration. For details, see R&S®FSWP data sheet.

<sup>19</sup> Signal level ≥ 0 dBm, RF level and attenuator: auto, 10 MHz external reference locked to sender, measurement time ≤ 10 ms.

<sup>20</sup> Available measurement bandwidths depend on the hardware configuration. For details, see R&S®FSW data sheet.

<b>26 GHz center frequency</b>	measurement bandwidth <sup>20</sup>	
	10 MHz	± 2.0°
	28 MHz	± 2.0°
	40 MHz	± 2.0°
	80 MHz	± 2.0°
	160 MHz	± 2.0°
	320 MHz	± 2.1°
	500 MHz	± 2.1°
<b>43 GHz center frequency</b>	measurement bandwidth <sup>20</sup>	
	10 MHz	± 3.3°
	28 MHz	± 3.3°
	40 MHz	± 3.3°
	80 MHz	± 3.4°
	160 MHz	± 3.6°
	320 MHz	± 3.9°
	500 MHz	± 3.9°

### R&S®FSWP phase noise analyzer and VCO tester

<b>2 GHz center frequency</b>	measurement bandwidth <sup>21</sup>	
	10 MHz	± 0.13°
	28 MHz	± 0.13°
	40 MHz	± 0.13°
	80 MHz	± 0.14°
	160 MHz	± 0.16°
	320 MHz	± 0.19°
<b>8 GHz center frequency</b>	measurement bandwidth <sup>21</sup>	
	10 MHz	± 0.45°
	28 MHz	± 0.45°
	40 MHz	± 0.45°
	80 MHz	± 0.45°
	160 MHz	± 0.48°
	320 MHz	± 0.50°
<b>26 GHz center frequency</b>	measurement bandwidth <sup>21</sup>	
	10 MHz	± 1.5°
	28 MHz	± 1.5°
	40 MHz	± 1.5°
	80 MHz	± 1.5°
	160 MHz	± 1.6°
	320 MHz	± 1.7°

<sup>21</sup> Available measurement bandwidths depend on the hardware configuration. For details, see R&S®FSWP data sheet.

## Ordering information

Designation	Type	Order No.
Transient Measurement Application (requires R&S®VSE and R&S®FSPC)	R&S®VSE-K60	1320.7868.02
Transient Hop Measurements (requires R&S®VSE-K60)	R&S®VSE-K60H	1320.7880.02
Transient Chirp Measurements (requires R&S®VSE-K60)	R&S®VSE-K60C	1320.7874.02
Transient Measurement Application	R&S®FSW-K60	1313.7495.02
Transient Hop Measurements (requires R&S®FSW-K60)	R&S®FSW-K60H	1322.9916.02
Transient Chirp Measurements (requires R&S®FSW-K60)	R&S®FSW-K60C	1322.9745.02
Transient Measurement Application (requires R&S®FSWP-B1)	R&S®FSWP-K60	1338.4525.02
Transient Hop Measurements (requires R&S®FSWP-K60)	R&S®FSWP-K60H	1338.4548.02
Transient Chirp Measurements (requires R&S®FSWP-K60)	R&S®FSWP-K60C	1338.4531.02
<b>R&amp;S®VSE vector signal explorer</b>		
Vector Signal Explorer Base Software	R&S®VSE	1320.7500.06
License Dongle	R&S®FSPC	1310.0090.03
R&S®VSE Software Maintenance	R&S®VSE-SWM	1320.7622.81
<b>R&amp;S®FSW signal and spectrum analyzer <sup>22</sup></b>		
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
<b>R&amp;S®FSWP phase noise analyzer and VCO tester <sup>22</sup></b>		
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

## Recommended extras

Designation	Type	Order No.	Retrofittable	Remarks
<b>R&amp;S®FSW signal and spectrum analyzer</b>				
OCXO Precision Frequency Reference	R&S®FSW-B4	1313.0703.02	yes	user-retrofittable
Resolution Bandwidth > 10 MHz	R&S®FSW-B8	1313.2464.26	no	for R&S®FSW8/13/26, with span = 0 Hz; the signal analysis bandwidth is defined by the R&S®FSW-B28/-B40/-B80/-B160/-B160R/-B320/-B512/-B512R/-B2000 options, not by the R&S®FSW-B8 option
Resolution Bandwidth > 10 MHz	R&S®FSW-B8	1313.2464.02	no	for R&S®FSW43/50/67/85, with span = 0 Hz; the signal analysis bandwidth is defined by the R&S®FSW-B28/-B40/-B80/-B160/-B160R/-B320/-B512/-B512R/-B2000 options, not by the R&S®FSW-B8 option; export license required
External Generator Control	R&S®FSW-B10	1313.1622.02	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
LO/IF Connections for external mixers	R&S®FSW-B21	1313.1100.85	yes	for R&S®FSW85; contact service center
RF Preamplifier, 100 kHz to 13.6 GHz	R&S®FSW-B24	1313.0832.13	yes	for R&S®FSW8/13; contact service center

<sup>22</sup> Firmware version 2.21 or higher required for use with R&S®VSE-K60.

Designation	Type	Order No.	Retrofittable	Remarks
RF Preamplifier, 100 kHz to 26.5 GHz	R&S®FSW-B24	1313.0832.26	yes	for R&S®FSW26; contact service center
RF Preamplifier, 100 kHz to 43.5 GHz	R&S®FSW-B24	1313.0832.43	yes	for R&S®FSW43/67; no export license required; contact service center
RF Preamplifier, 100 kHz to 50 GHz	R&S®FSW-B24	1313.0832.49	yes	for R&S®FSW50; no export license required; contact service center
RF Preamplifier, 100 kHz to 50 GHz	R&S®FSW-B24	1313.0832.51	yes	for R&S®FSW50; export license required; contact service center
RF Preamplifier, 100 kHz to 67 GHz	R&S®FSW-B24	1313.0832.66	yes	for R&S®FSW67; no export license required; contact service center
RF Preamplifier, 100 kHz to 67 GHz	R&S®FSW-B24	1313.0832.67	yes	for R&S®FSW67; export license required; contact service center
Electronic Attenuator, 1 dB steps	R&S®FSW-B25	1313.0990.02	yes	for R&S®FSW8/13/26; contact service center
USB Mass Memory Write Protection	R&S®FSW-B33	1313.3602.02	no	pre-installed in factory
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	1325.4850.04	yes	contact service center
320 MHz Analysis Bandwidth	R&S®FSW-B320	1325.4867.04	yes	contact service center
512 MHz Analysis Bandwidth	R&S®FSW-B512	1331.7106.04	yes	includes 200 MHz IF filter; contact service center
1200 MHz Analysis Bandwidth	R&S®FSW-B1200	1331.6400.04	yes	for R&S®FSW43/50 ex-factory; for later upgrade of R&S®FSW43/50 instruments use R&S®FSW-U1200; not available in combination with R&S®FSW-B2000; max. analysis bandwidth 512 MHz in combination with harmonic mixers; contact service center
2000 MHz Analysis Bandwidth	R&S®FSW-B2001	1331.6916.04	yes	for R&S®FSW43/50 ex-factory; for later upgrade of R&S®FSW43/50 instruments use R&S®FSW-U2001; not available in combination with R&S®FSW-B2000; max. analysis bandwidth 512 MHz in combination with harmonic mixers; contact service center
2 GHz Analysis Bandwidth	R&S®FSW-B2000	1325.4750.26	no	for R&S®FSW26 ex-factory; for later upgrade of R&S®FSW26 instruments use R&S®FSW-U2000; uses R&S®RTO oscilloscope as digitizer.
2 GHz Analysis Bandwidth	R&S®FSW-B2000	1325.4750.02	yes	for R&S®FSW43/50/67/85; for R&S®FSW43/50 not available in combination with R&S®FSW-B1200/-B2001; for R&S®FSW85 not available in combination with R&S®FSW-B5000; uses R&S®RTO oscilloscope as digitizer; contact service center
5 GHz Analysis Bandwidth	R&S®FSW-B5000	1331.6997.43	no	for R&S®FSW43 ex-factory; not available in combination with R&S®FSW-B2000; 2 GHz analysis bandwidth supported by option R&S®FSW-B21; uses R&S®RTO oscilloscope as digitizer; for later upgrade use R&S®FSW-U5000

Designation	Type	Order No.	Retrofittable	Remarks
5 GHz Analysis Bandwidth	R&S®FSW-B5000	1331.6997.85	no	for R&S®FSW85 ex-factory; not available in combination with R&S®FSW-B2000; 2 GHz analysis bandwidth supported by option R&S®FSW-B21; uses R&S®RTO oscilloscope as digitizer; for later upgrade use R&S®FSW-U5000
<b>R&amp;S®FSWP phase noise analyzer and VCO tester</b>				
High Stability OCXO	R&S®FSWP-B4	1325.3890.02	yes	user-retrofittable
Spectrum Analyzer, 10 Hz to 8 GHz	R&S®FSWP-B1	1322.9997.08	yes	for R&S®FSWP8; retrofittable in factory
Spectrum Analyzer, 10 Hz to 26 GHz	R&S®FSWP-B1	1322.9997.26	yes	for R&S®FSWP26; retrofittable in factory
Spectrum Analyzer, 10 Hz to 50 GHz	R&S®FSWP-B1	1322.9997.50	yes	for R&S®FSWP50; retrofittable in factory
Resolution Bandwidth > 10 MHz	R&S®FSWP-B8	1325.5028.26	no	for R&S®FSWP8/26 with R&S®FSWP-B1 option; the signal analysis bandwidth is defined by the R&S®FSWP-B80 option, not by the R&S®FSWP-B8 option.
Resolution Bandwidth > 10 MHz	R&S®FSWP-B8	1325.5028.02	no	for R&S®FSWP50 with R&S®FSWP-B1 option; the signal analysis bandwidth is defined by the R&S®FSWP-B80 option, not by the R&S®FSWP-B8 option; export license required
LO/IF Connections for external mixers	R&S®FSWP-B21	1325.3848.02	yes	for R&S®FSWP26/50; contact service center
RF Preamplifier, 100 kHz to 8 GHz	R&S®FSWP-B24	1325.3725.08	yes	for R&S®FSWP8 with R&S®FSWP-B1 option; contact service center
RF Preamplifier, 100 kHz to 26.5 GHz	R&S®FSWP-B24	1325.3725.26	yes	for R&S®FSWP26 with R&S®FSWP-B1 option; contact service center
RF Preamplifier, 100 kHz to 50 GHz	R&S®FSWP-B24	1325.3725.50	yes	for R&S®FSWP50 with R&S®FSWP-B1 option; contact service center
80 MHz Analysis Bandwidth	R&S®FSWP-B80	1325.4338.02	yes	for R&S®FSWP8/26/50 with R&S®FSWP-B1 option; user-retrofittable
320 MHz Analysis Bandwidth	R&S®FSWP-B320	1338.3235.04	yes	for R&S®FSWP8/26/50 with R&S®FSWP-B1 option; contact service center

## 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
Oscilloscope, 4 GHz, 20 Gsample/s, 50/200 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

## Oscilloscopes supported by R&S®FSW-B2000 and R&S®FSW-B5000 option

Designation	Type	Order No.
Oscilloscope, 6 GHz, 20 Gsample/s, 50/200 Msample, 4 channels	R&S®RTO2064	1329.7002.64
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