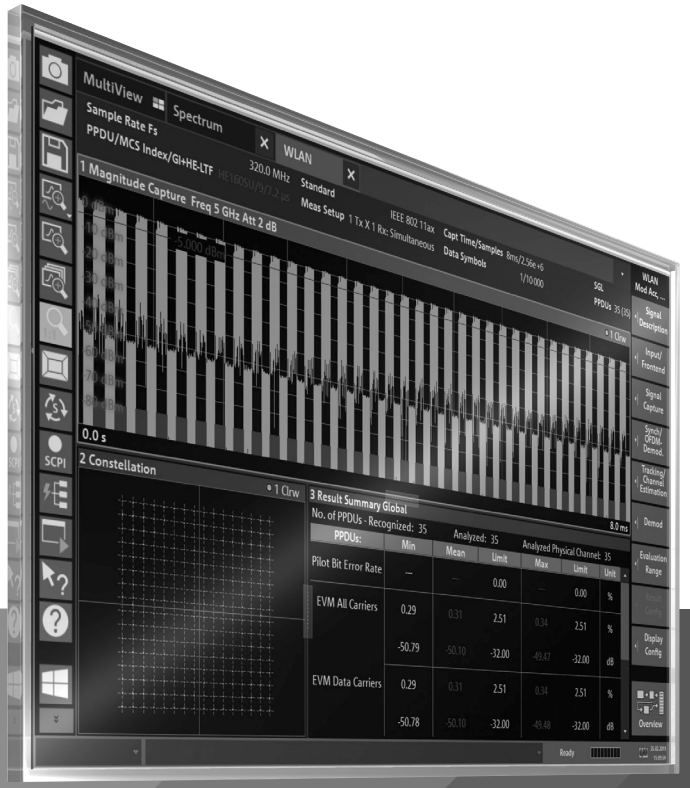
WLAN IEEE 802.11a/b/g/j/p/n/ac/ax/be MEASUREMENT APPLICATION

Specifications

R&S®FSW-K91/K91p/K91n/K91ac/K91ax/K91be
R&S®FSV3-K91/K91p/K91n/K91ac/K91ax/K91be
R&S®FPS-K91/K91p/K91n/K91ac
R&S®VSE-K91/K91p/K91n/K91ac/K91ax/K91be



Specifications
Version 09.00

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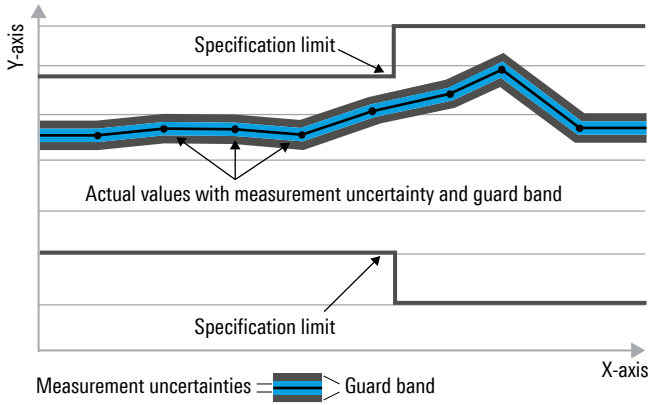
CONTENTS

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.



Non-traceable specifications with limits (n. trc.)
Represent product performance that is specified and tested as described under “Specifications with limits” above. However, product performance in this case cannot be warranted due to the lack of measuring equipment traceable to national metrology standards. In this case, measurements are referenced to standards used in the Rohde & Schwarz laboratories.

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 designated with the format “parameter: value”.

Non-traceable specifications with limits, typical data as well as nominal and measured values are not warranted by Rohde & Schwarz.

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

Specifications

The specifications of the R&S®FSx-K91/p/n/ac/ax/be, R&S®FPS-K91/p/n/ac and R&S®VSE-K91/p/n/ac/ax/be WLAN measurement applications are based on the data sheet specifications of the R&S®FSW, R&S®FSVA3000, R&S®FSV3000 and R&S®FPS signal and spectrum analyzers. 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 (SNR).

General data

This data sheet covers the R&S®FSW-K91/p/n/ac/ax/be, the R&S®FSV3-K91/p/n/ac/ax/be, the R&S®FPS-K91/p/n/ac and the R&S®VSE-K91/p/n/ac/ax/be.

The R&S®FSW-K91/p/n/ac/ax/be, R&S®FSV3-K91/p/n/ac/ax/be and R&S®FPS-K91/p/n/ac are summarized with the term R&S®FSx-K91/p/n/ac/ax/be.

The R&S®FSx-K91/p/n/ac/ax/be runs on the device itself.

The R&S®VSE-K91/p/n/ac/ax/be runs on a PC that can be connected to the analyzers and oscilloscopes as specified below.

If not stated otherwise, the data sheet values are device-specific, e.g. the same value applies to the R&S®FSW-K91/p/n/ac/ax/be and the R&S®VSE-K91/p/n/ac/ax/be with connected R&S®FSW.

For feature tables the following convention applies:

•	Feature always supported, i.e. with the R&S®VSE-K91/p/n/ac/ax/be connected to the device and with the corresponding R&S®FSx-K91/p/n/ac/ax/be option when running directly on the device.
• (VSE)	Feature supported only with the R&S®VSE-K91/p/n/ac/ax/be connected to the device. Not with the corresponding R&S®FSx-K91/p/n/ac/ax/be option when running directly on the device.
• (FSx-K91/p/n/ac/ax/be)	Feature supported only when running directly on the device with the corresponding R&S®FSx-K91/p/n/ac/ax/be option. Not supported in the R&S®VSE-K91/p/n/ac/ax/be.
–	Feature not supported with this device.

Overview

	R&S®FSW	**R&S®FSVA3000/R&S®FSV3000**	**R&S®FPS**
R&S®FSx-K91/p/n/ac/ax/be, software that runs on device	• (FSW-K91/p/n/ac/ax/be)	• (FSV3-K91/p/n/ac/ax/be)	• (FPS-K91/p/n/ac)
R&S®VSE-K91/p/n/ac/ax/be, PC software that can be connected to a device	•	• R&S®VSE firmware version 1.62 or higher required	•

OFDM analysis (IEEE 802.11a, IEEE 802.11g-OFDM, IEEE 802.11j, IEEE 802.11p, IEEE 802.11n, IEEE 802.11ac, IEEE 802.11ax, IEEE 802.11be)

Level

		R&S®FSW	R&S®FSVA3000/R&S®FSV3000	R&S®FPS
Level range	RF input	–70 dBm [1] to +30 dBm	–70 dBm [2] to +30 dBm	–70 dBm [3] to +30 dBm
Level setting	auto level	• (FSW-K91/p/n/ac/ax/be)	• (FSV3-K91/p/n/ac/ax/be)	• (FPS-K91/p/n/ac)
	manual	•	•	•

Inputs

	R&S®FSW	R&S®FSVA3000/R&S®FSV3000	R&S®FPS
RF input	•	•	•
Digital baseband input	• (FSW-K91/p/n/ac/ax/be) [4]	–	–
Analog baseband input	• (FSW-K91/p/n/ac/ax/be) [5]	• (FSV3-K91/p/n/ac/ax/be) [6]	–
File	•	•	•

Signal acquisition

		R&S®FSW	R&S®FSVA3000/R&S®FSV3000	R&S®FPS
Supported standards		IEEE 802.11a, IEEE 802.11g-OFDM, IEEE 802.11j [7], IEEE 802.11p, IEEE 802.11n, IEEE 802.11ac		
		IEEE 802.11ax	IEEE 802.11ax	IEEE 802.11ax (VSE-K91ax)
		IEEE 802.11be	IEEE 802.11be	IEEE 802.11be (VSE-K91be)
Capture length	IEEE 802.11a/j/g-OFDM/p	24 µs to 200 ms (FSW-K91/p)	24 µs to 200 ms (FSV3-K91/p)	24 µs to 200 ms (FPS-K91/p)
	IEEE 802.11n	24 µs to 200 ms (FSW-K91n)	24 µs to 200 ms (FSV3-K91n)	24 µs to 200 ms (FPS-K91n)
	IEEE 802.11ac	24 µs to 200 ms [8] (FSW-K91ac)	24 µs to 200 ms [8] (FSV3-K91ac)	24 µs to 200 ms [8] (FPS-K91ac)
	IEEE 802.11ax	24 µs to 200 ms [8] (FSW-K91ax)	24 µs to 200 ms [8] (FSV3-K91ax)	–

[1] Requires R&S®FSW-B24 RF preamplifier option.
[2] Requires R&S®FSV3-B24 RF preamplifier option.
[3] Requires R&S®FPS-B22 or R&S®FPS-B24 RF preamplifier option.
[4] Requires R&S®FSW-B17 option.
[5] Requires R&S®FSW-B71/-B71E option.
[6] Requires R&S®FSV3-B271 option.
[7] Supported for R&S®FSW-K91, R&S®FSV3-K91 and R&S®FPS-K91 options.
[8] One RX antenna analysis allows up to 200 ms capture time. In case of MIMO analysis, the maximum capture time scales reciprocally proportional to the number of RX antennas and the channel bandwidth (CBW) of the signal to be analyzed. For example, CBW160 signal analysis: two RX antenna analysis up to 100.0 ms capture time; three RX antenna analysis up to 66.66 ms capture time; four RX antenna analysis up to 50.0 ms capture time. For example, CBW80 signal analysis: two RX antenna analysis up to 200.0 ms capture time; three RX antenna analysis up to 133.33 ms capture time; four RX antenna analysis up to 100.0 ms capture time.

			R&S®FSW	R&S®FSVA3000/R&S®FSV3000	R&S®FPS
	IEEE 802.11be		24 µs to 100 ms [8] (FSW-K91be)	24 µs to 100 ms [8] (FSV3-K91be)	–
Sample rate	IEEE 802.11a/g-OFDM/p		5/10/20/40 MHz	5/10/20/40 MHz	5/10/20/40 MHz
	IEEE 802.11n		10/20/40/80 MHz	10/20/40/80 MHz	20/40/80 MHz
	IEEE 802.11ac		10/20/40/80/160/320 MHz	10/20/40/80/160/320 MHz	20/40/80/160/320 MHz
	IEEE 802.11ax		20/40/80/160/320 MHz	20/40/80/160/320 MHz	20/40/80/160/320 MHz (VSE-K91ax)
	IEEE 802.11be		20/40/80/160/320/640 MHz	20/40/80/160/320/640 MHz	20/40/80/160/320 MHz (VSE-K91be)
Usable I/Q bandwidth	IEEE 802.11a/g-OFDM/p		5/10/20 MHz	5/10/20 MHz	5/10/20 MHz
	IEEE 802.11n		5/10/20/40 [9] MHz	5/10/20/40 [10] MHz	20/40 [11] MHz
	IEEE 802.11ac		5/10/20/40 [9]/80 [12]/160 [13] MHz	5/10/20/40 [10]/80 [14]/160 [14] MHz	20/40 [11]/80 [15]/160 [15] MHz
	IEEE 802.11ax		20/40 [9]/80 [12]/160 [13] MHz	20/40 [10]/80 [14]/160 [14] MHz	20/40 [11]/80 [15]/160 [15] MHz (VSE-K91ax)
	IEEE 802.11be		20/40 [9]/80 [12]/160 [13]/320 [16] MHz	20/40 [10]/80 [14]/160 [14]/320 [17] MHz	20/40 [11]/80 [15]/160 [15] MHz (VSE-K91be)
Trigger modes	RF input	free run	•	•	•
		external	•	•	•
		IF power [18]	•	•	•
		I/Q power	•	•	–

[9] Requires R&S®FSW-B40 40 MHz analysis bandwidth option or higher.
[10] Requires R&S®FSV3-B40 40 MHz analysis bandwidth option or higher.
[11] Requires R&S®FPS-B40 40 MHz analysis bandwidth option or higher.
[12] Requires R&S®FSW-B80 80 MHz analysis bandwidth option or higher.
[13] Requires R&S®FSW-B160 160 MHz analysis bandwidth option or higher.
[14] Requires R&S®FSV3-B200 200 MHz analysis bandwidth option or higher.
[15] Requires R&S®FPS-B160 160 MHz analysis bandwidth option.
[16] Requires R&S®FSW-B320 320 MHz analysis bandwidth option or higher.
[17] Requires R&S®FSV3-B400 400 MHz analysis bandwidth option or higher.
[18] Restricted functionality at carrier frequencies < 50 MHz.

Measurement parameters

	R&S®FSW	R&S®FSVA3000/R&S®FSV3000	R&S®FPS
PPDU statistic count	on/off		
Number of PPDUs to analyze	1 to 10922		
PPDU statistic count off	all PPDUs to be analyzed in one capture memory		
PPDU statistic count on	1 PPDU to 10922 PPDUs		
Channel bandwidth (CBW)	sample rate (F_s) and N_{FFT} are set depending on the channel bandwidth		
IEEE 802.11a/g-OFDM/p	CBW5, CBW10, CBW20	CBW5, CBW10, CBW20	CBW5, CBW10, CBW20
IEEE 802.11n	CBW20, CBW40 [9]	CBW20, CBW40 [10]	CBW20, CBW40 [11]
IEEE 802.11ac	CBW20, CBW40 [9], CBW80 [12], CBW80+80 [12], CBW160 [13]	CBW20, CBW40 [10], CBW80 [14], CBW80+80 [14], CBW160 [14]	CBW20, CBW40 [11], CBW80 [15], CBW80+80 [15], CBW160 [15]
IEEE 802.11ax	CBW20, CBW40 [9], CBW80 [12], CBW80+80 [12], CBW160 [13]	CBW20, CBW40 [10], CBW80 [14], CBW80+80 [14], CBW160 [14]	CBW20, CBW40 [11], CBW80 [15], CBW80+80 [15], CBW160 [15] (VSE-K91ax)
IEEE 802.11be	CBW20, CBW40 [9], CBW80 [12], CBW160 [13], CBW320 [16]	CBW20, CBW40 [10], CBW80 [14], CBW160 [14], CBW320 [17]	CBW20, CBW40 [11], CBW80 [15], CBW160 [15] (VSE-K91be)
Filter out adjacent channels [19]	on/off		
PPDU format			
IEEE 802.11n	auto, HT-MF, HT-GF		
IEEE 802.11ac	auto, VHT		
IEEE 802.11ax	auto, HE SU, HE MU, HE trigger-based, HE extended range	auto, HE SU, HE MU, HE trigger-based, HE extended range	auto, HE SU, HE MU, HE trigger-based, HE extended range (VSE-K91ax)
IEEE 802.11be	auto, EHT MU, EHT non-OFDMA SU, EHT TB	auto, EHT MU, EHT non-OFDMA SU, EHT TB	auto, EHT MU, EHT non-OFDMA SU, EHT TB (VSE-K91be)
Guard interval			
IEEE 802.11n/ac	auto, short, long		
IEEE 802.11ax	auto, 0.8 µs, 1.6 µs, 3.2 µs	auto, 0.8 µs, 1.6 µs, 3.2 µs	auto, 0.8 µs, 1.6 µs, 3.2 µs (VSE-K91ax)
IEEE 802.11be	auto, 0.8 µs, 1.6 µs, 3.2 µs	auto, 0.8 µs, 1.6 µs, 3.2 µs	auto, 0.8 µs, 1.6 µs, 3.2 µs (VSE-K91be)
HE-LTF, EHT-LTF size			
IEEE 802.11ax	auto, 3.2 µs, 6.4 µs, 12.8 µs	auto, 3.2 µs, 6.4 µs, 12.8 µs	auto, 3.2 µs, 6.4 µs, 12.8 µs (VSE-K91ax)
IEEE 802.11be	auto, 3.2 µs, 6.4 µs, 12.8 µs	auto, 3.2 µs, 6.4 µs, 12.8 µs	auto, 3.2 µs, 6.4 µs, 12.8 µs (VSE-K91be)
Modulation format			
IEEE 802.11a/g-OFDM/p/n/ac	BPSK, QPSK, 16QAM, 64QAM		
IEEE 802.11ac	256QAM, 1024QAM		

[19] Not supported for R&S®FSW-K91b/g-DSSS, R&S®FSV3-K91b/g-DSSS, R&S®FPS-K91b/g-DSSS and R&S®VSE-K91b/g-DSSS.

	R&S®FSW	**R&S®FSVA3000/R&S®FSV3000**	**R&S®FPS**
IEEE 802.11ax	BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM, 4096QAM	BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM, 4096QAM	BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM, 4096QAM (VSE-K91ax)
IEEE 802.11be	BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM, 4096QAM	BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM, 4096QAM	BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM, 4096QAM (VSE-K91be)
Demodulator setting	auto, manual with/without using the signal field		
MIMO	• (FSW-K91n/ac/ax/be, VSE-K91n/ac/ax/be)	• (FSV3-K91n/ac/ax/be, VSE-K91n/ac/ax/be)	• (FPS-K91n/ac, VSE-K91n/ac/ax/be)
Configuration			
IEEE 802.11n	1 to 4 TX antennas	1 to 4 TX antennas	1 to 4 TX antennas
IEEE 802.11ac	1 to 8 TX antennas	1 to 8 TX antennas	1 to 8 TX antennas
IEEE 802.11ax	1 to 8 TX antennas	1 to 8 TX antennas	1 to 8 TX antennas (VSE-K91ax)
IEEE 802.11be	1 to 8 TX antennas	1 to 8 TX antennas	1 to 8 TX antennas (VSE-K91be)
MIMO antenna signal capture setup	simultaneous [20], sequential		simultaneous [20], sequential (FPS-K91n/ac, VSE-K91n/ac/ax/be)
	Sequential, using R&S®OSP open switch and control platform [21] (FSW-K91n/ac/ax/be, FSV3-K91n/ac/ax/be)		–
Spatial mapping	direct, spatial expansion, user defined		
Source of payload length	estimate from signal, take from signal field	estimate from signal, take from signal field	estimate from signal, take from signal field (FPS-K91a/g-OFDM/p/n/ac, VSE-K91a/g-OFDM/p/n/ac/ax/be)
Pilot tracking	phase on/off, timing on/off, level on/off		
Channel estimation	preamble, preamble and data		
Interpolation [22]	none/linear, Wiener		none/linear, Wiener (VSE-K91n/ac/ax/be)
I/Q mismatch compensation [19]	per subcarrier, average subcarrier, off		on/off

[20] Requires an R&S®FSW/FSVA3000/FSV3000/FPS for each DUT TX antenna to be measured. In case of R&S®VSE-K91n/ac/ax, the DUT TX antennas can be connected to the input channels of an R&S®RTP oscilloscope.

[21] Requires an R&S®OSP open switch and control platform.

[22] K91n/ac/ax/be

Result display

	R&S®FSW	R&S®FSVA3000/R&S®FSV3000	R&S®FPS
Result summary			
Center frequency error	●	●	●
Symbol clock error	●	●	●
EVM all carriers	●	●	●
EVM pilots	●	●	●
EVM payload	●	●	●
I/Q offset [23]	●	●	●
Gain imbalance [23]	●	●	●
Quadrature offset [23]	●	●	●
Mean PPDU power	●	●	●
Crest factor	●	●	●
Power versus time			
Magnitude capture	●	●	●
Full PPDU	●	●	●
Rising/falling PPDU	●	●	●
EVM			
EVM versus carrier	●	●	●
EVM versus symbol	●	●	●
Spectrum			
Spectrum flatness	●	●	●
Group delay	●	●	●
FFT spectrum	●	●	●
Spectrum mask	● (FSW-K91/n/ac/ax/be)	● (FSV3-K91/n/ac/ax/be)	● (FPS-K91/n/ac)
ACP	● (FSW-K91/n/ac/ax/be)	● (FSV3-K91/n/ac/ax/be)	● (FPS-K91/n/ac)
Constellation			
Constellation diagram	●	●	●
Constellation versus carrier	●	●	●
I/Q [19]			
Gain imbalance versus carrier [23]	●	●	● (VSE-K91/n/ac/ax/be)
Quadrature error versus carrier [23]	●	●	● (VSE-K91/n/ac/ax/be)
Linearity [19]			
AM/AM	●	●	–
AM/PM	●	●	–
AM/EVM	●	●	–
Tracking [19]			
Phase tracking	●	●	● (VSE-K91/n/ac/ax/be)
Amplitude tracking	●	●	–
Statistics/miscellaneous			
CCDF	●	●	●
Signal field	●	●	●
Bit stream	● (FSW-K91/n/ac, VSE-K91/n/ac)	● (FSV3-K91/n/ac, VSE-K91/n/ac)	● (FPS-K91/n/ac, VSE-K91/n/ac)

[23] HE/EHT OFDMA PPDUs require symmetrical subcarrier usage around the DC.

Measurement uncertainty (nominal)

Signal level at –10 dBm

	R&S®FSW8	R&S®FSVA3000	R&S®FSV3000	R&S®FPS
Residual EVM in dB	level –10 dBm [24], average of 20 PPDUs	level –10 dBm [25], average of 20 PPDUs		level –10 dBm [26], average of 20 PPDUs
Input = RF, f_{center} = 2.4 GHz				
Channel estimation = preamble and data				
IEEE 802.11a/g-OFDM/j/p signal				
5 MHz	–56.0	–55.5	–55.0	–55.0
10 MHz	–56.1	–55.6	–55.1	–55.0
20 MHz	–56.1	–55.6	–55.1	–55.0
IEEE 802.11n signal				
20 MHz	–55.5	–55.0	–54.8	–55.0
40 MHz	–54.2	–54.0	–53.8	–53.5
Channel estimation = preamble				
IEEE 802.11a/p signal				
5 MHz	–55.5	–55.3	–55.1	–55.0
10 MHz	–55.6	–55.3	–55.1	–55.0
20 MHz	–55.5	–55.3	–55.1	–55.0
IEEE 802.11n signal				
20 MHz	–53.6	–52.0	–51.8	–53.0
40 MHz	–51.6	–51.2	–51.1	–50.8
Input = RF, f_{center} = 5.8 GHz				
Channel estimation = preamble and data				
IEEE 802.11a/p signal				
5 MHz	–	–	–	–
10 MHz	–	–	–	–
20 MHz	–	–	–	–
IEEE 802.11n signal				
20 MHz	–54.7	–53.2	–52.7	–52.5
40 MHz	–53.8	–53.3	–52.8	–50.9
IEEE 802.11ac signal				
20 MHz	–53.5	–52.1	–51.8	–52.1
40 MHz	–52.4	–51.9	–51.4	–50.0
80 MHz	–53.2	–52.7	–52.2	–45.5
160 MHz	–51.8 [27]	–51.3	–50.8	–44.8

[24] Requires R&S®FSW-B24 RF preamplifier option.

[25] Requires R&S®FSV3-B24 RF preamplifier option.

[26] Requires R&S®FPS-B22 or R&S®FPS-B24 RF preamplifier option and R&S®FPS-B25 electronic attenuator option.

[27] Requires R&S®FSW-B320 320 MHz analysis bandwidth option with order no. 1325.4867.04.

	R&S®FSW8	R&S®FSVA3000	R&S®FSV3000	R&S®FPS
Channel estimation = preamble				
IEEE 802.11a/p signal				
5 MHz	–	–	–	–
10 MHz	–	–	–	–
20 MHz	–	–	–	–
IEEE 802.11n signal				
20 MHz	–52.3	–50.4	–50.4	–50.4
40 MHz	–50.7	–50.7	–50.7	–50.7
IEEE 802.11ac signal				
20 MHz	–51.9	–50.5	–50.2	–50.0
40 MHz	–50.8	–50.3	–50.0	–48.2
80 MHz	–50.5	–50.0	–49.7	–43.3
160 MHz	–49.0 [27]	–48.5	–48.2	–41.5

	R&S®FSW8 [28]	R&S®FSVA3000	R&S®FSV3000	R&S®FPS
Residual EVM in dB	level –10 dBm [29], average of 20 PPDUs	level –10 dBm, average of 20 PPDUs		–
Input = RF, f_{center} = 2.4 GHz				
Channel estimation = preamble and data				
IEEE 802.11ax HE SU signal with MCS 9				
20 MHz	–55.4	–53.0	–52.5	–
40 MHz	–55.3	–54.8	–54.3	–
80 MHz	–54.1	–53.6	–53.1	–
160 MHz	–52.1 [27]	–51.6	–51.1	–
Channel estimation = preamble				
IEEE 802.11ax HE SU signal with MCS 9				
20 MHz	–54.2	–51.5	–51.0	–
40 MHz	–54.3	–53.8	–53.3	–
80 MHz	–53.2	–52.7	–52.2	–
160 MHz	–51.1 [27]	–50.6	–50.1	–
Input = RF, f_{center} = 5.8 GHz				
Channel estimation = preamble and data				
IEEE 802.11ax HE SU signal with MCS 9				
20 MHz	–54.2	–51.5	–51.0	–
40 MHz	–54.1	–53.6	–53.1	–
80 MHz	–53.0	–52.5	–52.0	–
160 MHz	–51.2 [27]	–50.5	–50.0	–
Channel estimation = preamble				
IEEE 802.11ax HE SU signal with MCS 9				
20 MHz	–53.4	–50.2	–49.7	–
40 MHz	–53.1	–52.6	–52.1	–
80 MHz	–52.4	–51.9	–51.4	–
160 MHz	–50.3 [27]	–49.5	–49.0	–

[28] Frontend board order no. 1312.8046 Rev08.26 or newer.

[29] Requires R&S®FSW-B24 RF preamplifier option.

	R&S®FSW8 [30]	R&S®FSVA3000	R&S®FSV3000	R&S®FPS
Residual EVM in dB	level –10 dBm [31], average of 20 PPDUs	level –10 dBm, average of 20 PPDUs		–
Input = RF, f_{center} = 2.4 GHz				
Channel estimation = preamble and data				
IEEE 802.11be EHT non-OFDMA SU signal with MCS 9				
20 MHz	–55.6	–55.0	–	–
40 MHz	–55.6	–55.0	–	–
80 MHz	–55.4	–55.0	–	–
160 MHz	–53.0 [27]	–52.5	–	–
320 MHz	–50.5 [27]	–50.0	–	–
Channel estimation = preamble				
IEEE 802.11be EHT non-OFDMA SU signal with MCS 9				
20 MHz	–54.6	–54.0	–	–
40 MHz	–54.7	–54.0	–	–
80 MHz	–53.0	–52.5	–	–
160 MHz	–51.3 [27]	–50.7	–	–
320 MHz	–49.5 [27]	–49.0	–	–
Input = RF, f_{center} = 5.8 GHz				
Channel estimation = preamble and data				
IEEE 802.11be EHT non-OFDMA SU signal with MCS 9				
20 MHz	–57.6	–57.0	–	–
40 MHz	–56.2	–55.7	–	–
80 MHz	–53.2	–52.8	–	–
160 MHz	–53.0 [27]	–51.7	–	–
320 MHz	–50.3 [27]	–49.0	–	–
Channel estimation = preamble				
IEEE 802.11be EHT non-OFDMA SU signal with MCS 9				
20 MHz	–56.5	–56.0	–	–
40 MHz	–55.0	–54.5	–	–
80 MHz	–53.2	–52.7	–	–
160 MHz	–51.6 [27]	–50.6	–	–
320 MHz	–49.5 [27]	–48.0	–	–

[30] Frontend board order no. 1312.8046 Rev08.26 or newer.

[31] Requires R&S®FSW-B24 RF preamplifier option.

Signal level at –25/–20/–15/–10/–5/0 dBm

	R&S®FSW8/13/26 [32]	R&S®FPS [33]
Residual EVM in dB	average of 20 PPDUs	average of 20 PPDUs
Input = RF, f_{center} = 2.4 GHz		
Channel estimation = preamble and data		
IEEE 802.11a/g-OFDM/j/p signal		
5 MHz	–55.4	–55.0
10 MHz	–55.4	–55.0
20 MHz	–55.2	–54.7
IEEE 802.11n signal		
20 MHz	–54.8	–54.3
40 MHz	–52.0	–51.5
Channel estimation = preamble		
IEEE 802.11a/p signal		
5 MHz	–54.5	–54.0
10 MHz	–54.6	–54.0
20 MHz	–54.5	–54.0
IEEE 802.11n signal		
20 MHz	–52.6	–52.1
40 MHz	–49.2	–48.7
Input = RF, f_{center} = 5 GHz		
Channel estimation = preamble and data		
IEEE 802.11a/p signal		
5 MHz	–52.8	–52.3
10 MHz	–52.5	–52.0
20 MHz	–52.8	–52.3
IEEE 802.11n signal		
20 MHz	–52.3	–52.0
40 MHz	–49.8	–49.0
IEEE 802.11ac signal		
20 MHz	–51.4	–51.0
40 MHz	–48.3	–48.0
80 MHz	–47.0	–45.7
160 MHz	–43.5	–43.0

[32] Requires R&S®FSW-B24 RF preamplifier option.

[33] Requires R&S®FPS-B22 or R&S®FPS-B24 RF preamplifier option and R&S®FPS-B25 electronic attenuator option.

	R&S®FSW8/13/26 [32]	**R&S®FPS** [33]
Channel estimation = preamble		
IEEE 802.11a/p signal		
5 MHz	–51.6	–51.1
10 MHz	–51.8	–51.3
20 MHz	–51.8	–51.3
IEEE 802.11n signal		
20 MHz	–50.4	–49.9
40 MHz	–47.7	–47.2
IEEE 802.11ac signal		
20 MHz	–50.1	–49.5
40 MHz	–47.6	–47.1
80 MHz	–44.9	–43.6
160 MHz	–40.5	–40.0

	R&S®FSW8/13/26	**R&S®FSVA3000/R&S®FSV3000**	**R&S®FPS**
Frequency error			
Lock range	40 ppm [34]		
Uncertainty	1 Hz + R&S®FSx reference frequency uncertainty (see R&S®FSx reference frequency in the respective data sheet)		
Level uncertainty			
Power	same as R&S®FSx (see R&S®FSx total measurement uncertainty in the respective data sheet)		

[34] For IEEE 802.11a CBW5 signals at 5 GHz: 30 ppm.

DSSS analysis (IEEE 802.11b, IEEE 802.11g-DSSS)

IEEE 802.11b and IEEE 802.11g-DSSS modulation analysis requires R&S®FSW-B28 28 MHz analysis bandwidth option or higher.
Note: Exclusively one instance of this measurement option is supported.

Level

		R&S®FSW	R&S®FSVA3000/R&S®FSV3000	R&S®FPS
Level range	RF input	–70 dBm [35] to +30 dBm	–70 dBm [36] to +30 dBm	–70 dBm [37] to +30 dBm
Level setting	auto level	• (FSW-K91)	–	• (FPS-K91)
	manual	•	•	•

Inputs

	R&S®FSW	R&S®FSVA3000/R&S®FSV3000	R&S®FPS
RF input	•	•	•

Signal acquisition

			R&S®FSW	R&S®FSVA3000/R&S®FSV3000	R&S®FPS
Supported standards			IEEE 802.11b, IEEE 802.11g-DSSS		
Capture length	IEEE 802.11b/g-DSSS		24 µs to 100 ms		
Sample rate	IEEE 802.11b/g-DSSS		44 MHz		
Usable I/Q bandwidth	IEEE 802.11b/g-DSSS		35.2 MHz		
Trigger modes	RF input	free run	•	•	•
		external	•	•	•
		IF power [38]	•	•	•
		I/Q power	•	•	–

Measurement parameters

		R&S®FSW	R&S®FSVA3000/R&S®FSV3000	R&S®FPS
Data capture settings				
PPDU statistic count		on/off		
	PPDU statistic count off	all PPDUs to be analyzed in one capture memory		
	PPDU statistic count on	1 PPDU to 10922 PPDUs		
PPDU format		short PPDU, long PPDU		
Modulation format [39]		DBPSK, DQPSK, CCK, PBCC		
Demodulator settings		auto, manual with/without using the PLCP header		
Source of payload length		take from PLCP header		
Tracking		phase on/off, timing on/off, level on/off		

[35] Requires R&S®FSW-B24 RF preamplifier option.
[36] Requires R&S®FSV3-B24 RF preamplifier option.
[37] Requires R&S®FPS-B22 or R&S®FPS-B24 RF preamplifier option.
[38] Restricted functionality at carrier frequencies < 50 MHz.
[39] Corresponds to the data rates: 1 Mbps, 2 Mbps, 5.5 Mbps and 11 Mbps.

Result display

	R&S®FSW	R&S®FSVA3000/R&S®FSV3000	R&S®FPS
Result list			
Center frequency error	●	●	●
Chip clock error	●	●	●
Peak vector error	●	●	●
PPDU EVM	●	●	●
I/Q offset	●	●	●
I/Q gain imbalance	●	●	●
I/Q quadrature error	●	●	●
Rise time	–	–	–
Fall time	–	–	–
Mean power	●	●	●
Peak power	–	–	–
Crest factor	●	●	●
Power versus time			
Magnitude capture	●	●	●
PvT full PPDU	●	●	●
Up ramp/down ramp	–	–	–
EVM			
Vector error IEEE	●	●	●
EVM versus chip	●	●	●
Spectrum			
FFT spectrum	●	●	●
Spectrum mask	● (FSW-K91)	● (FSV3-K91)	● (FPS-K91)
ACP	● (FSW-K91)	● (FSV3-K91)	● (FPS-K91)
Constellation			
Constellation diagram	●	●	●
Statistics/miscellaneous			
PLCP header	●	●	●
Bit stream	●	●	●

Measurement uncertainty (nominal)

	R&S®FSW8/13/26	R&S®FSVA3000	R&S®FSV3000	R&S®FPS
Residual PPDU EVM	f_{center} = 2.442 GHz, level –30 dBm [40] to +30 dBm, average of 20 PPDUs [41]	f_{center} = 2.4 GHz, level –10 dBm [42], average of 20 PPDUs		f_{center} = 2.442 GHz, level –30 dBm [43] to +30 dBm, average of 20 PPDUs [41]
Input = RF	0.45 %	0.45 %	0.47 %	0.6 %
Frequency error				
Lock range	1.3 MHz			
Uncertainty	1 Hz + R&S®FSx reference frequency uncertainty (see R&S®FSx reference frequency in the respective data sheet)			
Level uncertainty				
Power	same as R&S®FSx (see R&S®FSx total measurement uncertainty in the respective data sheet)			

[40] Requires R&S®FSW-B24 RF preamplifier option.

[41] 11 Mbps CCK with short PLCP.

[42] Requires R&S®FSV3-B24 RF preamplifier option.

[43] Requires R&S®FPS-B22 or R&S®FPS-B24 RF preamplifier option and R&S®FPS-B25 electronic attenuator option.

Ordering information

Designation	Type	Order No.
WLAN measurement applications		
R&S®FSW		
IEEE 802.11a/b/g/j measurements	R&S®FSW-K91	1313.1500.02
IEEE 802.11p measurements	R&S®FSW-K91p	1321.5646.02
IEEE 802.11n measurements [44]	R&S®FSW-K91n	1313.1516.02
IEEE 802.11ac measurements [44]	R&S®FSW-K91ac	1313.4209.02
IEEE 802.11ax measurements [44]	R&S®FSW-K91ax	1331.6345.02
IEEE 802.11be measurements [44]	R&S®FSW-K91be	1350.6730.02
R&S®FSVA3000, R&S®FSV3000		
IEEE 802.11a/b/g/j measurements	R&S®FSV3-K91	1330.5100.02
IEEE 802.11p measurements	R&S®FSV3-K91p	1330.5122.02
IEEE 802.11n measurements [44]	R&S®FSV3-K91n	1330.5139.02
IEEE 802.11ac measurements [44]	R&S®FSV3-K91ac	1330.5116.02
IEEE 802.11ax measurements [44]	R&S®FSV3-K91ax	1346.3399.02
IEEE 802.11be measurements [44]	R&S®FSV3-K91be	1346.4966.02
R&S®FPS		
IEEE 802.11a/b/g/j measurements	R&S®FPS-K91	1321.4191.02
IEEE 802.11p measurements	R&S®FPS-K91p	1321.4391.02
IEEE 802.11n measurements [44]	R&S®FPS-K91n	1321.4204.02
IEEE 802.11ac measurements [44]	R&S®FPS-K91ac	1321.4210.02
R&S®VSE		
IEEE 802.11a/b/g measurements	R&S®VSE-K91	1320.7597.06
IEEE 802.11p measurements	R&S®VSE-K91p	1320.7680.06
IEEE 802.11n measurements [44]	R&S®VSE-K91n	1320.7600.06
IEEE 802.11ac measurements [44]	R&S®VSE-K91ac	1320.7616.06
IEEE 802.11ax measurements [44]	R&S®VSE-K91ax	1345.1411.06
IEEE 802.11be measurements [44]	R&S®VSE-K91be	1345.1428.06

[44] In order to measure WLAN signals with a given channel bandwidth (CBW) ∈ {5, 10, 20, 40, 80, 160, 320} MHz, the R&S®FSx requires an analysis bandwidth option greater or equal to this CBW. I.e. the CBW of the WLAN signal to be measured ≤ max. fitted R&S®FSx analysis bandwidth option.

Designation	Type	Order No.
Analyzers		
R&S®FSW		
Signal and spectrum analyzer, 2 Hz to 8 GHz	R&S®FSW8	1331.5003.08
Signal and spectrum analyzer, 2 Hz to 13.6 GHz	R&S®FSW13	1331.5003.13
Signal and spectrum analyzer, 2 Hz to 26.5 GHz	R&S®FSW26	1331.5003.26
Signal and spectrum analyzer, 2 Hz to 43.5 GHz	R&S®FSW43	1331.5003.43
Signal and spectrum analyzer, 2 Hz to 50 GHz	R&S®FSW50	1331.5003.50
Signal and spectrum analyzer, 2 Hz to 67 GHz	R&S®FSW67	1331.5003.67
Signal and spectrum analyzer, 2 Hz to 85 GHz	R&S®FSW85	1331.5003.85
R&S®FSVA3000, R&S®FSV3000		
Signal and spectrum analyzer, 10 Hz to 4 GHz	R&S®FSVA3004	1330.5000.05
Signal and spectrum analyzer, 10 Hz to 7.5 GHz	R&S®FSVA3007	1330.5000.08
Signal and spectrum analyzer, 10 Hz to 13.6 GHz	R&S®FSVA3013	1330.5000.14
Signal and spectrum analyzer, 10 Hz to 30 GHz	R&S®FSVA3030	1330.5000.31
Signal and spectrum analyzer, 10 Hz to 44 GHz	R&S®FSVA3044	1330.5000.44
Signal and spectrum analyzer, 10 Hz to 4 GHz	R&S®FSV3004	1330.5000.04
Signal and spectrum analyzer, 10 Hz to 7.5 GHz	R&S®FSV3007	1330.5000.07
Signal and spectrum analyzer, 10 Hz to 13.6 GHz	R&S®FSV3013	1330.5000.13
Signal and spectrum analyzer, 10 Hz to 30 GHz	R&S®FSV3030	1330.5000.30
Signal and spectrum analyzer, 10 Hz to 44 GHz	R&S®FSV3044	1330.5000.43
R&S®FPS		
Signal and spectrum analyzer, 9 kHz to 4 GHz	R&S®FPS4	1319.2008.04
Signal and spectrum analyzer, 9 kHz to 7 GHz	R&S®FPS7	1319.2008.07
Signal and spectrum analyzer, 9 kHz to 13.6 GHz	R&S®FPS13	1319.2008.13
Signal and spectrum analyzer, 9 kHz to 30 GHz	R&S®FPS30	1319.2008.30
Signal and spectrum analyzer, 9 kHz to 40 GHz	R&S®FPS40	1319.2008.40
Vector signal explorer		
R&S®VSE basic edition	R&S®VSE	1345.1011.06
R&S®VSE enterprise edition	R&S®VSE Enterprise Edition	1345.1105.06
R&S®VSE software maintenance	R&S®VSE-SWM	1320.7622.81

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