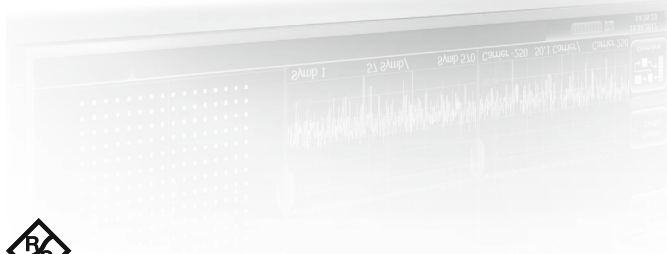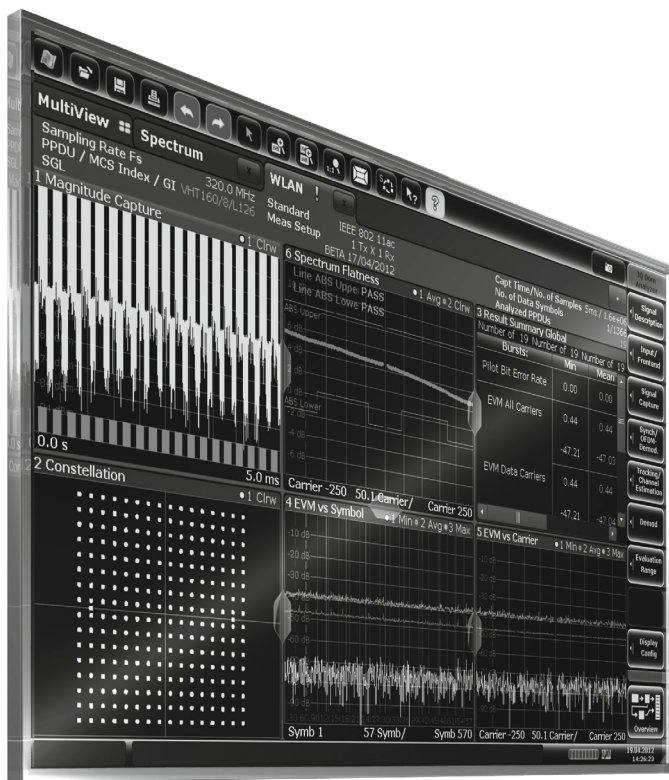# WLAN
Specifications

R&S®FSW-K91 IEEE 802.11a/b/g measurements
R&S®FSW-K91p IEEE 802.11p measurements
R&S®FSW-K91n IEEE 802.11n measurements
R&S®FSW-K91ac IEEE 802.11ac measurements


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.
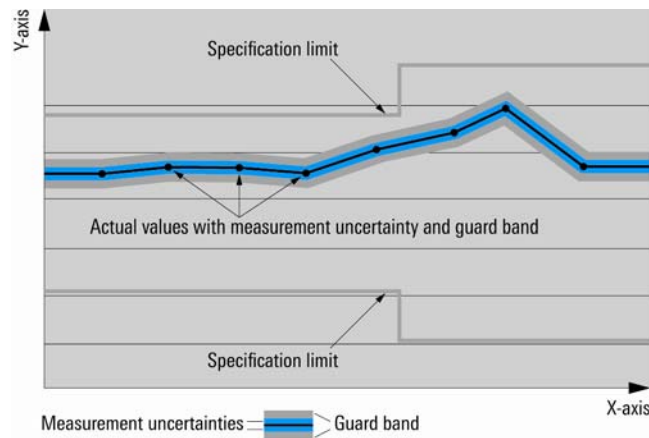
Specifications without limits

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 designated with the format "parameter: value".

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

Specifications

The specifications of the R&S®FSW-K91 IEEE802.11a/b/g measurements, R&S®FSW-K91p IEEE 802.11p measurements, R&S®FSW-K91n IEEE 802.11n measurements and R&S®FSW-K91ac IEEE 802.11ac measurements are based on the specifications in the data sheet for the R&S®FSW signal and spectrum analyzer. They have not been checked separately and are not verified during instrument calibration. Measurement uncertainties are given as 95 % confidence intervals. They apply to the specified symbol rates. The specified level measurement errors do not take into account systematic errors due to reduced signal-to-noise ratio (S/N).

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

IEEE 802.11a and IEEE 802.11g-OFDM modulation analysis requires:
- R&S®FSW-B28 28 MHz analysis bandwidth option or higher

IEEE 802.11p modulation analysis requires:
- Upgrade of R&S®FSW-K91 to R&S®FSW-K91p
- R&S®FSW-B28 28 MHz analysis bandwidth option or higher

IEEE 802.11n modulation analysis requires:
- Upgrade of R&S®FSW-K91 to R&S®FSW-K91n
- R&S®FSW-B40 40 MHz analysis bandwidth option or higher

IEEE 802.11ac modulation analysis requires:
- Upgrade of R&S®FSW-K91 to R&S®FSW-K91ac
- R&S®FSW-B160 160 MHz analysis bandwidth option

Frequency

Frequency range	frequency range same as R&S®FSW [1]

Level

Level range	RF input	−70 dBm [2] to +30 dBm
Level setting		auto level
		manual

Signal acquisition

Supported standards		IEEE 802.11a, IEEE 802.11g-OFDM
		IEEE 802.11p
		IEEE 802.11n
		IEEE 802.11ac
Input		RF
SISO	IEEE 802.11n, IEEE 802.11ac	
	number of TX antennas that can be analyzed	1
Result length	center frequency error, symbol clock error, EVM all carriers, EVM pilots, EVM payload, I/Q offset, gain imbalance, quadrature offset, mean PPDU power, crest factor	capture length, 1 PPDU to 10922 PPDUs
	EVM versus carrier, spectrum flatness, group delay	capture length, 1 PPDU to 10922 PPDUs
	magnitude capture, EVM versus symbol, constellation, constellation versus carrier, bit stream, signal field	capture length, 1 PPDU to 10922 PPDUs up to the maximum number of PPDUs that fit into one capture memory
	FFT spectrum	capture length
Sweep time	spectrum mask	100 ms
	ACPR	300 ms
PPDU length	automatic detection of number of data symbols, manual	1 data symbol to 1366 data symbols
Triggering	RF input	free run, IF power, RF power, external

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[1] 5 MHz to 90 MHz with restricted functionality, depends on bandwidth (IF power trigger, auto level, IF overload).

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

Result display

Result list	min./mean/max. IEEE 802.11n, IEEE 802.11ac result dimensions [3]	center frequency error
		symbol clock error
		EVM all carriers
		EVM pilots
		EVM payload
		I/Q offset
		gain imbalance
		quadrature error
		mean PPDU power
		crest factor
Power versus time	IEEE 802.11n, IEEE 802.11ac result dimensions [3]	magnitude capture
EVM	IEEE 802.11n, IEEE 802.11ac result dimensions [3]	EVM versus symbol
		EVM versus carrier
Spectrum	IEEE 802.11n, IEEE 802.11ac result dimensions [3]	spectrum mask (IEEE and ETSI)
		ACP
		FFT spectrum
		spectrum flatness
		group delay
Constellation	IEEE 802.11n, IEEE 802.11ac result dimensions [3]	constellation diagram
		constellation versus carrier
Signal content and statistics	IEEE 802.11n, IEEE 802.11ac result dimensions [3]	signal field
		bit stream
Limit check	values according to standard	result summary
		EVM
		center frequency error
		symbol clock error
		I/Q offset
		spectrum flatness
		spectrum mask
		ACP

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[3] For the other WLAN standards and if not stated otherwise, the result dimension is SISO, i.e. 1 TX x 1 RX.

Measurement parameters

Data capture settings	capture time IEEE 802.11a/g-OFDM/p	24 µs to 200 ms
	capture time IEEE 802.11n	24 µs to 200 ms
	capture time IEEE 802.11ac	24 µs to 200 ms
	PPDU statistic count	on/off
	number of PPDUs to analyze	
	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
	IEEE 802.11n	CBW20, CBW40 [4]
	IEEE 802.11ac	CBW20, CBW40 [4], CBW80 [5], CBW80+80 [5, 6], CBW160 [7]
PPDU format	IEEE 802.11n	auto, HT-MF, HT-GF
	IEEE 802.11ac	auto, VHT
Guard interval	IEEE 802.11n, IEEE 802.11ac	auto, short, long
Modulation format	IEEE 802.11a/g-OFDM/p/n/ac	BPSK, QPSK, 16QAM, 64QAM
	IEEE 802.11ac	256QAM
Demodulator setting		auto
		manual with/without using the signal field
Source of payload length	IEEE 802.11a/g-OFDM/p/n/ac	estimate from signal
		take from signal field
Pilot tracking		phase on/off
		timing on/off
		level on/off
Channel estimation		preamble and data
		preamble
I/Q mismatch compensation	IEEE 802.11a/g-OFDM/p/n/ac	on/off

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[4]   Requires R&S®FSW-B40 40 MHz analysis bandwidth option or higher.

[5]   Requires R&S®FSW-B80 80 MHz analysis bandwidth option or higher.

[6]   Measure each 80 MHz frequency segment as single CBW80 signal.

[7]   Requires R&S®FSW-B160 160 MHz analysis bandwidth option.

Measurement uncertainty (nominal)

Residual EVM in dB	level −30 dBm [8] to +30 dBm average of 20 PPDUs	IEEE 802.11a/p signal			IEEE 802.11n signal		IEEE 802.11ac signal			
		5 MHz	10 MHz	20 MHz	20 MHz	40 MHz	20 MHz	40 MHz	80 MHz	160 MHz [9]
	input = RF, f_{center} = 2.4 GHz									
	channel estimation = preamble and data	−54	−53	−51	−49	−48	n/a	n/a	n/a	n/a
	channel estimation = preamble	−51	−50	−49	−46	−45	n/a	n/a	n/a	n/a
	input = RF, f_{center} = 5 GHz									
	channel estimation = preamble and data	−49	−49	−50	−48	−48	−48	−48	−45	−43
	channel estimation = preamble	−48	−48	−48	−46	−45	−46	−45	−42	−40

Frequency error		
Lock range		40 ppm [10]
Uncertainty		1 Hz + reference frequency uncertainty
Level uncertainty	test of spectrum mask	0.1 dB
	power	
	10 MHz < f_{center} ≤ 3.6 GHz	±0.27 dB
	3.6 GHz < f_{center} ≤ 8 GHz	±0.37 dB
	ACPR	0.3 dB
Spectrum flatness	signal analysis bandwidth ≤ 80 MHz	
	1.25 × signal analysis bandwidth ≤ f_{center} < 8 GHz	±0.3 dB (nom.)
	signal analysis bandwidth 80 MHz to 160 MHz	
	150 MHz ≤ f_{center} < 4 GHz	±0.5 dB (nom.)
	4 GHz ≤ f_{center} < 8 GHz	±0.7 dB (nom.)

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

[9] IEEE 802.11ac CBW160 signal results apply to the level range from −25 dBm to +30 dBm.

[10] 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.

Frequency

Frequency range	frequency range same as R&S®FSW [11]

Level

Level range	RF input	−70 dBm [12] to +30 dBm
Level setting		auto level
		manual

Signal acquisition

Supported standards		IEEE 802.11b, IEEE 802.11g-DSSS
Input		RF
Result length	center frequency error, chip clock error, peak vector error, PPDU EVM, I/Q offset, gain imbalance, quadrature error, rise time, fall time, mean power, peak power, crest factor	capture length, 1 PPDU to 10922 PPDUs
	magnitude capture, EVM versus chip, vector error IEEE, constellation, bit stream, PLCP header	capture length, 1 PPDU to 10922 PPDUs up to the maximum number of PPDUs that fit into one capture memory
	FFT spectrum	capture length
Sweep time	spectrum mask	250 ms
	ACPR	200 ms
PPDU length	automatic detection of number of data symbols	1 byte to 4095 bytes
Triggering	RF input	free run, IF power, RF power, external

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[11] 5 MHz to 90 MHz with restricted functionality depends on bandwidth (IF power trigger, auto level, IF overload).

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

Result display

Result list	min./mean/max.	center frequency error
		chip clock error
		peak vector error
		PPDU EVM
		I/Q offset
		gain imbalance
		quadrature error
		rise time
		fall time
		mean power
		peak power
		crest factor
Power versus time	clear/write	magnitude capture
	min./average/max.	PVT full PPDU
EVM	clear/write	vector error IEEE
		EVM versus chip
Spectrum	clear/write	spectrum mask
		ACP
		FFT spectrum
Constellation	clear/write	constellation diagram
Signal content and statistics	clear/write	bit stream
		PLCP header
Limit check	values in line with standard	result summary
		peak vector error
		center frequency error
		chip clock error
		spectrum mask
		ACP

Measurement parameters

Data capture settings	capture time	24 µs to 100 ms
	PPDU statistic count	on/off
	number of PPDUs to analyze	
	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 [13]		DBPSK, DQPSK, CCK, PBCC
Demodulator setting		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

Measurement uncertainty (nominal)

Residual PPDU EVM	level −30 dBm [14] to +30 dBm average of 20 PPDUs	IEEE 802.11b signal [15]
	input = RF, f_{center} = 2.442 GHz	0.45 %
Frequency error		
Lock range		1.3 MHz
Uncertainty		1 Hz + reference frequency uncertainty
Level uncertainty	test of spectrum mask	0.1 dB
	power	
	10 MHz < f_{center} ≤ 3.6 GHz	±0.27 dB
	3.6 GHz < f_{center} ≤ 8 GHz	±0.37 dB
	ACPR	0.3 dB

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[13] Corresponds to the data rates 1 Mbps, 2 Mbps, 5.5 Mbps and 11 Mbps.

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

[15] 11 Mbps CCK with short PLCP.

Ordering information

Designation	Type	Order No.	Retrofittable	Remarks
IEEE 802.11a/b/g Measurements	R&S®FSW-K91	1313.1500.02	yes	user-retrofittable
IEEE 802.11p Measurements	R&S®FSW-K91p	1321.5646.02	yes	user-retrofittable, R&S®FSW-K91 required
IEEE 802.11n Measurements	R&S®FSW-K91n	1313.1516.02	yes	user-retrofittable, R&S®FSW-K91 required
IEEE 802.11ac Measurements	R&S®FSW-K91ac	1313.4209.02	yes	user-retrofittable, R&S®FSW-K91 required
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		
Recommended options and extras				
RF Preamplifier, 100 kHz to 13.6 GHz	R&S®FSW-B24	1313.0832.13	yes	contact service center
RF Preamplifier, 100 kHz to 26.5 GHz	R&S®FSW-B24	1313.0832.26	yes	contact service center
28 MHz Analysis Bandwidth [16]	R&S®FSW-B28	1313.1645.02	yes	user-retrofittable
40 MHz Analysis Bandwidth [16]	R&S®FSW-B40	1313.0861.02	yes	user-retrofittable
80 MHz Analysis Bandwidth [16]	R&S®FSW-B80	1313.0878.02	yes	user-retrofittable
160 MHz Analysis Bandwidth [16]	R&S®FSW-B160	1313.1668.02	yes	contact service center
R&S®OSP Open Switch and Control Platform	R&S®OSP120	1505.3009K02		
	R&S®OSP130	1505.3009K03		
RF Switch Module for R&S®OSP open switch and control platform	R&S®OSP-B101	1505.5101.02		
	R&S®OSP-B111	1505.4605.02		
	R&S®OSP-B107	1505.5901.02		

Upgrades

Designation	Type	Order No.	Retrofittable	Remarks
Analysis Bandwidth Upgrade from 28 MHz to 40 MHz [16]	R&S®FSW-U40	1313.5205.02	yes	user-retrofittable, R&S®FSW-B28 required
Analysis Bandwidth Upgrade from 40 MHz to 80 MHz [16]	R&S®FSW-U80	1313.5211.02	yes	user-retrofittable, R&S®FSW-B40 or R&S®FSW-U40 required
Analysis Bandwidth Upgrade from 80 MHz to 160 MHz [16]	R&S®FSW-U160	1313.5754.02	yes	contact service center, R&S®FSW-B80 or R&S®FSW-U80 required

See also R&S®FSW signal and spectrum analyzer data sheet (PD 5214.5984.22).

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

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

About Rohde & Schwarz

Rohde & Schwarz is an independent group of companies specializing in electronics. It is a leading supplier of solutions in the fields of test and measurement, broadcasting, radiomonitoring and radiolocation, as well as secure communications. Established more than 75 years ago, Rohde & Schwarz has a global presence and a dedicated service network in over 70 countries. Company headquarters are in Munich, Germany.

Environmental commitment

◾ Energy-efficient products
◾ Continuous improvement in environmental sustainability
◾ ISO 14001-certified environmental management system

Certified Quality System
ISO 9001

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