

R&S®FSx-K91/-K91n, R&S®FSQ-K91ac WLAN Application Firmware WLAN TX measurements with Rohde & Schwarz analyzers



R&S®FSx-K91/-K91n R&S®FSQ-K91ac WLAN application firmware At a glance

The R&S®FSx-K91/-K91n and the R&S®FSQ-K91ac application firmware packages expand the application range of the R&S®FSx signal and spectrum analyzers by adding the capability to perform spectrum and modulation measurements on signals in accordance with the WLAN IEEE 802.11a/b/g/j/n/ac standard.

The R&S®FSx-K91 application firmware covers standard-related tests as well as further evaluations for in-depth analysis in development for signals in line with the WLAN IEEE 802.11 a/b/g/j standard. The R&S®FSx-K91n application firmware extends the functionality of R&S®FSx-K91 to include spectrum and modulation measurements in accordance with the IEEE 802.11n standard. For measurements in line with the IEEE 802.11ac standard, the R&S®FSx-K91ac application firmware is needed.

R&S®FSx-K91/-K91n and R&S®FSQ-K91ac are versatile tools for all established WLAN IEEE 802.11 standards.

All WLAN measurement applications are fully remote-controllable via the IEC/IEEE bus or LAN, using SCPI commands. The operating concepts of the different analyzers are largely identical, including the IEC/IEEE bus commands. The analyzers provide a consistent platform for a wide scope of applications. They are ideal for development, design, verification and production applications. Users who are familiar with one of the analyzers can quickly master operation of the other analyzers.

Key facts

- Analysis at the RF or in the analog/digital baseband (optional)
- Demodulation bandwidth of 28 MHz/40 MHz/80 MHz
- Modulation formats for IEEE 802.11a/g/j/n/ac: BPSK, QPSK, 16QAM, 64QAM, 256QAM
- Modulation formats for IEEE 802.11b: DBPSK, DQPSK, CCK, short PLCP, long PLCP
- Very low residual EVM of -44/-46 dB (0.7% at 2.4 GHz)
- Legacy/mixed/Greenfield mode of IEEE 802.11n signals
- Support of very high throughput (VHT)

R&S®FSx-K91/-K91n R&S®FSQ-K91ac WLAN application firmware Benefits and key features

R&S®FSx-K91 WLAN application firmware

- ▮ Expands the R&S®FSQ/FSG/FMU/FSL/FSV signal and spectrum analyzers by adding the capability to perform spectrum and modulation measurements on signals in line with the IEEE 802.11 a/b/g/j standard
- ▮ Provides complex WLAN measurements at a keystroke (automatic setting of modulation format)
- ▮ Performs measurements in the RF/IF range and in the baseband (analog and digital)
- ▮ Offers the ideal solution for a wide scope of WLAN applications
- ▮ Optimally designed for research, design, verification and production applications
- ▮ Allows remote control of all functions via IEC/IEEE bus or LAN

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R&S®FSx-K91n WLAN application firmware

- ▮ Expands the R&S®FSQ/FSG/FSV/FSL signal and spectrum analyzers by adding the capability to perform spectrum and modulation measurements on WLAN IEEE 802.11n signals
- ▮ Maximum analysis bandwidth of 40 MHz with the R&S®FSQ analyzers (equipped with the R&S®FSQ-B72 option) or R&S®FSV analyzers (equipped with the R&S®FSV-B70 option)
- ▮ Support of legacy/mixed/Greenfield mode of IEEE 802.11n signals

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R&S®FSQ-K91ac WLAN application firmware

- ▮ Adds the capability to perform spectrum and modulation measurements on WLAN IEEE 802.11ac signals to the R&S®FSQ signal and spectrum analyzer
- ▮ Maximum analysis bandwidth of 80 MHz with the R&S®FSQ analyzers (equipped with the R&S®FSQ-B72 option)
- ▮ Supports very high throughput (VHT) and 256 QAM

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Analyzers supporting WLAN measurements

Rohde & Schwarz offers a wide range of signal and spectrum analyzers for WLAN measurements:

- ▮ The R&S®FSx-K91 and R&S®FSx-K91n options provide the same user interface for a wide range of different spectrum and signal analyzers, offering optimal solutions for every application. No additional time is needed for transfer of T & M equipment from R & D to production
- ▮ Analyzers equipped with the R&S®FSx-K91/-K91n WLAN options are one-box solutions, which makes remote control easy. Test setups are straightforward and space-saving

▷ [page 8](#)

R&S®FSx-K91

WLAN application firmware

TX measurements on WLAN signals in line with IEEE 802.11a/b/g/j

The WLAN application firmware for the R&S®FSQ, R&S®FSG, R&S®FMU, R&S®FSV and R&S®FSL expands the application range of these analyzers by spectrum and modulation measurements on signals in accordance with the WLAN IEEE 802.11a/b/g/j standards. The R&S®FSQ's and R&S®FSG's outstanding analysis and evaluation facilities, which enable measurements beyond the scope of the standard, make them ideal for applications in development and verification. The R&S®FSV signal and spectrum analyzer with the R&S®FSV-K91 option is a favorably priced mid-range instrument for measurements in development and for production of high-end components. The R&S® FSL spectrum analyzer with its unbeatable price is the optimal solution for production but is also ideal for service and maintenance applications because of its battery option.

Measurement results

IEEE 802.11a/g/j, IEEE 802.11 turbo mode (with the R&S®FSQ only)

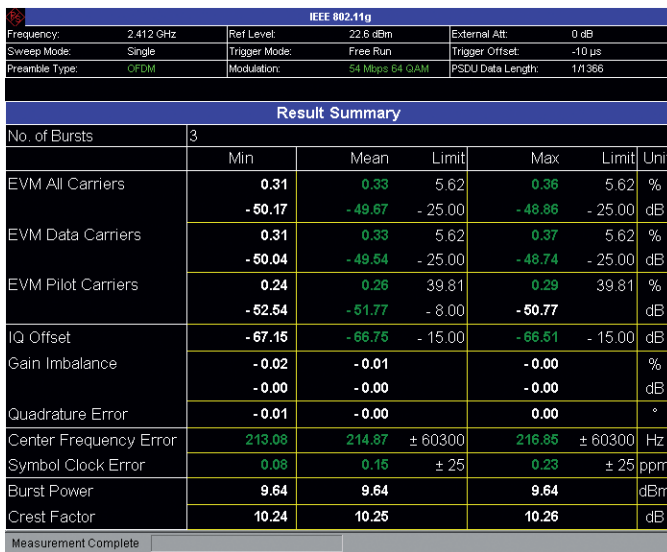
- | Spectrum mask with limit lines and pass/fail (17.3.9.2) and user-editable spectrum mask
- | Spectrum flatness with limit lines and pass/fail (17.3.9.6.2)
- | Constellation error, EVM (17.3.9.6.3)
- | Selectable tracking: phase, level, timing
- | RF carrier leakage (17.3.9.6.1)
- | Carrier frequency and symbol clock error (17.3.9.4, 17.3.9.)
- | Adjacent channel power
- | Constellation diagram for all carriers or a single carrier
- | Constellation overview
- | EVM versus carriers, EVM versus symbols
- | Group delay
- | Time-gated spectrum (FFT)
- | CCDF (also time-gated) and crest factor
- | Bit stream

IEEE 802.11b, IEEE 802.11g-CCK/DSSS

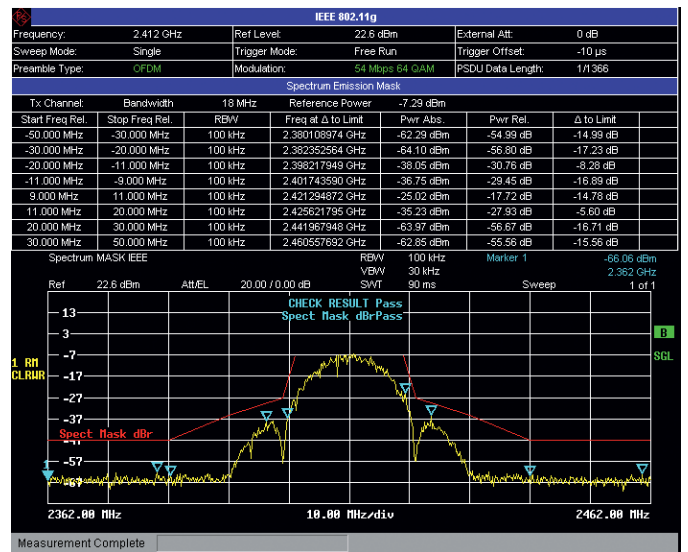
- | TX power level (18.4.7.1)
- | TX spectrum mask with limit lines and pass/fail (18.4.7.3)
- | Transmit power-on and power-down ramp (18.4.7.8)
- | TX modulation accuracy, EVM, EVM versus symbols (18.4.7.8)
- | RF carrier leakage (I/Q offset) (18.4.7.7)
- | Carrier frequency and chip clock error (18.4.7.4, 18.4.7.5)
- | Constellation diagram
- | Gain imbalance, quadrature error
- | CCDF (also time-gated) and crest factor
- | Bit stream
- | Adjacent channel power

General

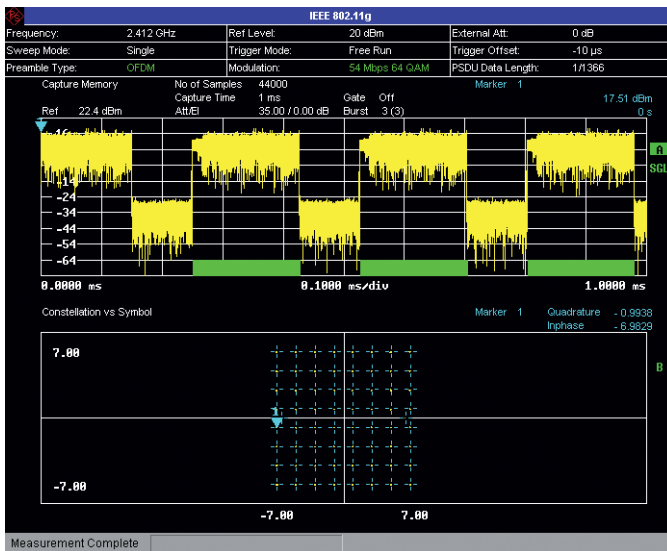
- | Analysis at the RF, IF, inverted IF
- | Analysis in the analog I/Q baseband (requires the R&S®FSQ-B71 option)
- | Analysis in the digital I/Q baseband (requires the R&S®FSx-B17 option)
- | Autoselection of demodulation
- | Display of header information



The result summary displays the most important parameters for characterizing WLAN signals detected within the recording period.



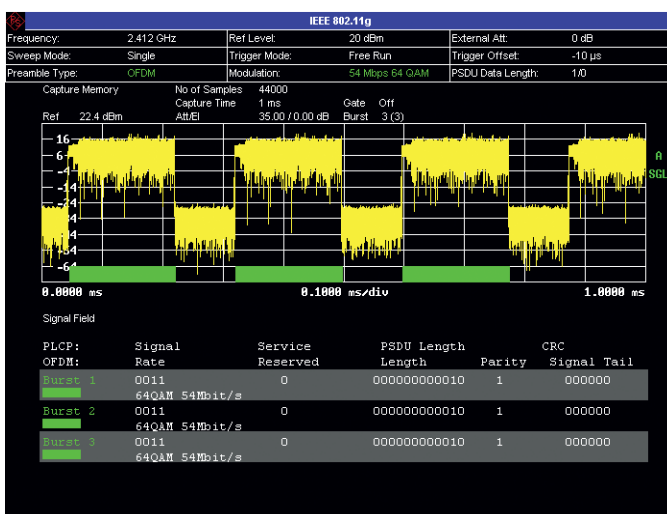
Spectrum emission mask with standard-compliant limit lines for a signal in line with IEEE 802.11b.



Constellation diagram of all or selectable single carriers.

General Settings		
Signal Characteristics	Standard: IEEE 802.11g	Advanced Baseband Settings
Frequency: 2.412 GHz	Channel No: 1	IQ Input: 50 Ohm
Level Settings	Ref. Level (RF): 20 dBm	IQ Path: I/Q
Ext. Att: 0 dB	Full Scale Level: 1 V	Balanced: <input checked="" type="checkbox"/>
Data Capture Settings	Capture Time: 1 ms	Low Pass: <input checked="" type="checkbox"/>
Overall Burst Count: 1	No of Bursts to Analyze: 1	Dither: <input type="checkbox"/>
Trigger Settings	Trigger Mode: Free Run	Dig. Input Data Rate: 81.6 MHz
Trigger Offset: -10 μ s	Ext. Trigger Lvl: 1.4 V	Full Scale Level: 1 V
IQ Settings	Swap IQ: <input type="checkbox"/>	Advanced Settings
Input Settings	Input: RF	Auto Level: <input checked="" type="checkbox"/>
		Auto Level Time: 100 ms
		Ref. Level: 22.4 dBm
		RF Att: 35 dB
		EI Att: ...
		Yig Filter: Auto
		Sample Rate: 44 MHz
		High Dynamic: <input type="checkbox"/>

Setup tables provide a quick overview of the selected settings and quick access to the setting parameters.



Signal field content is used for automatic setting of modulation and can be displayed for further evaluation.

Demod Settings	
Burst To Analyze	<input checked="" type="checkbox"/> Use Header Content
Burst Type	OFDM
Auto Demodulation	<input checked="" type="checkbox"/>
PSDU Mod to Analyze	54 Mbps 64 QAM
Equal Burst Length	<input type="checkbox"/>
Channel Estimation	Preamble
Min Payload Length	1 μ s 1 Symbols
Max Payload Length	66000 μ s ... Symbols
Tracking	
Phase	<input checked="" type="checkbox"/>
Timing	<input checked="" type="checkbox"/>
Level	<input checked="" type="checkbox"/>
Filters	
Transmit Filter	Auto
Receive Filter	Auto

R&S®FSx-K91n

WLAN application firmware

TX measurements on WLAN signals in line with IEEE802.11n

The R&S®FSx-K91n option is a firmware upgrade to the R&S®FSx-K91 option for the R&S®FSQ/FSG/FSV/ FSL signal and spectrum analyzers and enables users of R&S®FSx-K91 to quickly measure signals in line with IEEE802.11n.

WLAN solutions based on the IEEE 802.11 n standard will operate in the 2.4 GHz or 5 GHz radio band, or both bands, offering backward compatibility with existing IEEE 802.11a/b/g deployments.

IEEE802.11n will bring the user the following main benefits:

- ▮ Increased data throughput
- ▮ Increased reliability of the wireless LANs

This has been achieved by three primary innovations:

- ▮ Packet aggregation
- ▮ Channel bonding (40 MHz channels)
- ▮ Multiple input multiple output (MIMO) technology

R&S®FSx-K91n features

The R&S®FSx-K91n option supports modulation measurements on signals in line with the IEEE 802.11n WLAN standard up to a maximum bandwidth of 40 MHz ¹⁾.

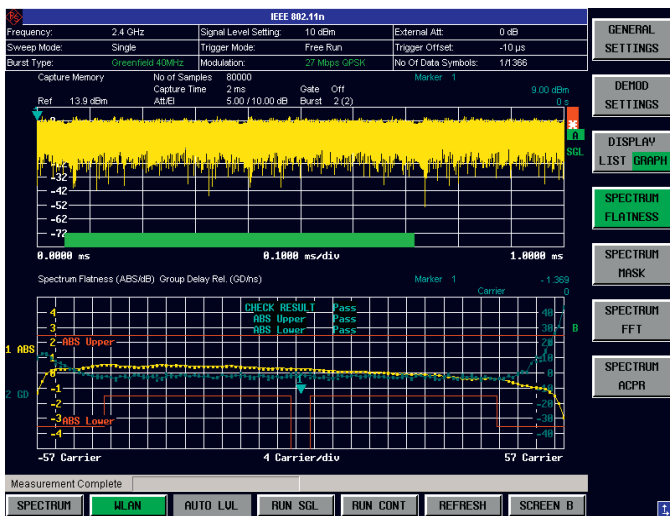
All IEEE802.11n modes are supported:

- ▮ Legacy (support of IEEE 802.11a, g)
- ▮ Mixed mode: high throughput (HT) and legacy
- ▮ Greenfield mode: HT only

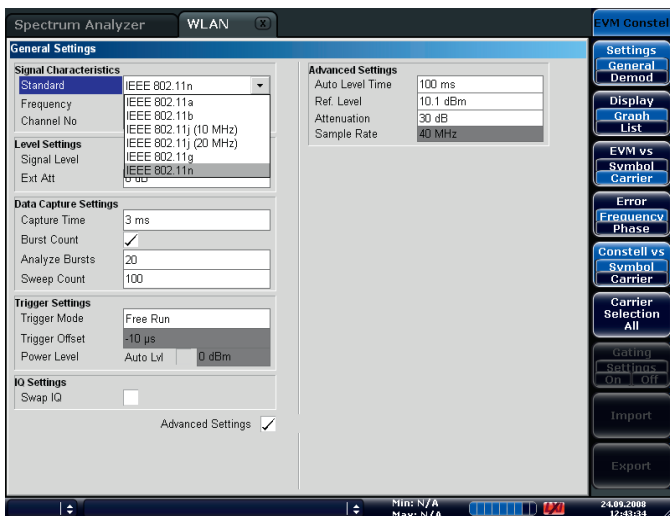
Users of the R&S®FSx-K91n option get the same results as with the R&S®FSx-K91 application firmware and can use the same features.

The R&S®FSx-K91n option makes tests on WLAN signals an easy task because it offers the following advantages:

- ▮ Scalable solution
- ▮ Easy and intuitive user interface



Spectrum flatness and group delay of the 104 occupied carriers of a 40 MHz wide IEEE802.11n signal (Greenfield mode).



In the setup table of the R&S®FSV signal and spectrum analyzer, all relevant WLAN standards can be selected.

¹⁾ For measuring signals with 40 MHz bandwidth, the R&S®FSV-B70 option is required for the R&S®FSV and the R&S®FSQ-B72 option for the R&S®FSQ.

R&S®FSQ-K91ac WLAN application firmware

TX measurements on WLAN signals in line with IEEE 802.11ac

The R&S®FSQ-K91ac option is a firmware upgrade to the R&S®FSx-K91n option for the R&S®FSQ spectrum and signal analyzer. It extends the functionality of R&S®FSx-K91n to include spectrum and modulation measurements in accordance with WLAN IEEE 802.11ac.

The WLAN IEEE 802.11ac physical layer is based on the well-known orthogonal frequency division multiplexing (OFDM) used for IEEE 802.11a and IEEE 802.11n and provides backwards compatibility with IEEE 802.11a and IEEE 802.11n devices operating in the 5 GHz band.

IEEE 802.11ac devices are required to support 20 MHz, 40 MHz and 80 MHz channels and one spatial stream. Several optional features are also defined such as wider channel bandwidth (80 MHz + 80 MHz and 160 MHz), 256QAM and up to eight spatial streams to achieve data rates of 3.5 Gbps.

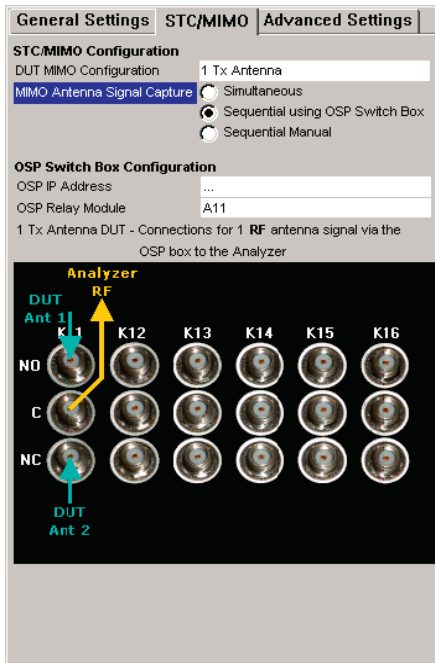
R&S®FSQ-K91ac features

The R&S®FSQ-K91ac application firmware supports modulation measurements on signals in line with the WLAN IEEE 802.11ac standard up to a maximum bandwidth of 80 MHz ²⁾.

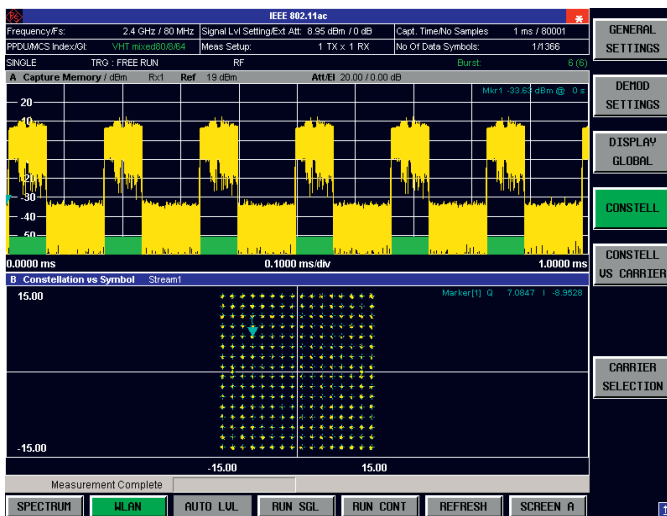
IEEE 802.11ac enhancements are supported:

- Channel bandwidth of 20 MHz, 40 MHz and 80 MHz
- 256 QAM modulation format
- VHT operating mode
- Up to four spatial streams

Users of R&S®FSQ-K91ac get the same results as with the R&S®FSx-K91/-K91n application firmware and can use the same features.



Like with R&S®FSx-K91n option MIMO measurements can be carried out with several R&S®FSQs connected and simultaneous capture of I/Q data. Or, if repetitive signals are available, by capturing the spatial streams sequentially using the OSP box or manually.



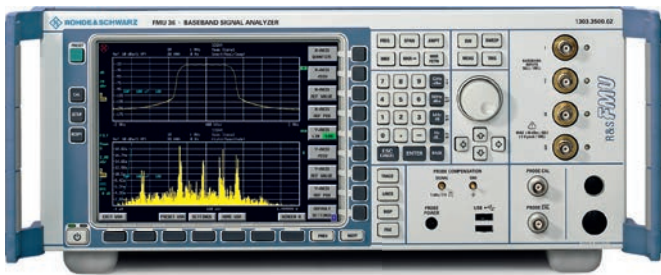
Measurement of a WLAN 802.11ac signal with 256QAM modulation. The capture buffer and the constellation diagram are shown.

²⁾ For measuring signals with 80 MHz bandwidth, the R&S®FSQ-B72 option is required.

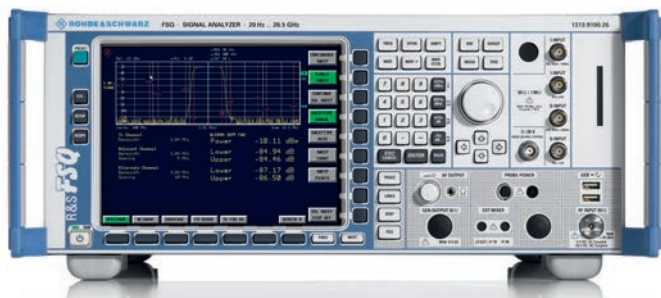
Analyzers supporting WLAN measurements

The uniform operating concept and largely identical functionality of the different analyzers facilitate instrument operation and allow application programs to be transferred.

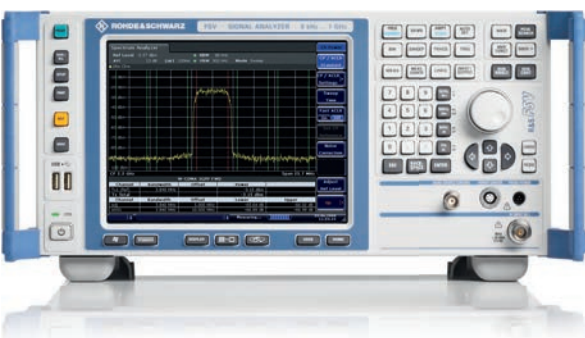
The R&S®FMU – universal baseband analyzer.



The R&S®FSQ – high-end signal analysis.



The R&S®FSV – the new standard in the mid-range class.



The R&S®FSQ signal and spectrum analyzer – high-end signal analysis

The R&S®FSQ combines a spectrum analyzer up to 40 GHz with a signal analyzer in a single box. Equipped with the R&S®FSQ-B71 hardware option, it can also analyze analog baseband signals. The R&S®FSQ-B17 option is required for analyzing digital baseband signals. The R&S®FSQ-B72 broadband option permits the analysis of 40 MHz signals in line with IEEE 802.11n, 80 MHz signals in line with IEEE 802.11ac and of multicarrier scenarios with bandwidths of up to 120 MHz. The R&S®FSQ is a solution for all fields in development and production.

The R&S®FSQ offers extremely low inherent and phase noise, unrivaled low residual EVM, high dynamic range, as well as outstanding accuracy, which makes it the ideal high-end tester for development applications – where tolerances and limit values often have to be narrower than specified in the standard.

The R&S®FMU signal and spectrum analyzer – universal baseband analyzer

The R&S®FMU is a universal analyzer for analog baseband signals. Moreover, it is ideal for applications with low RF that require high sensitivity. The R&S®FMU is equipped with baseband inputs that may either be balanced or unbalanced. The analyzer is equipped as standard with the vector signal analysis application firmware. The R&S®FSQ-K91/-K91n options permit modulation measurements on WLAN OFDM and WLAN DSSS/CCK signals.

The R&S®FSV signal and spectrum analyzer – the new standard in the mid-range class

Featuring a demodulation bandwidth of up to 40 MHz, a measurement uncertainty of less than 0.4 dB up to 7 GHz and a measurement speed that is more than five times faster than that of other analyzers, the R&S®FSV signal and spectrum analyzer is the new industry benchmark in the mid-range class. It is well suited for analysis of all WLAN signals due to the wide demodulation bandwidth of 40 MHz, which is needed for the IEEE 802.11n standard. Its unrivaled speed and its optimal price/performance ratio make it the ideal instrument for production. However, as a multipurpose instrument, the R&S®FSV is the right analyzer for general applications in development and service. The touchscreen and an intuitive user interface make working with the instrument an easy task. Features and functions as well as remote control are compatible with all other Rohde&Schwarz analyzers. Instruments can be changed easily.

R&S®FSL spectrum analyzer – compact spectrum analysis

The R&S®FSL spectrum analyzer is an extremely light-weight and compact analyzer for a wide variety of applications in development, service and production. It offers functions that previously were provided only by high-end spectrum analyzers and has an outstanding price/performance ratio. Featuring a tracking generator and a demodulation bandwidth of 28 MHz, the R&S®FSL is unrivaled in its class. It is the ideal choice for performing spectrum and modulation measurements on every developer's workbench or in production. The optional battery makes it an ideal instrument for service and maintenance as well.

R&S®FSG spectrum analyzer – spectrum analysis for wideband communications technologies

The R&S®FSG spectrum analyzer is ideal for mobile and wireless applications in development and production. It supports frequencies up to 13.6 GHz and features high measurement speed and performance. Owing to its 28 MHz I/Q demodulation bandwidth it is also suitable for wideband standards such as WLAN, WiMAX™ or 3GPP LTE.

The R&S®FSL – compact spectrum analysis.



The R&S®FSG – spectrum analysis for wideband communications technologies.



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Specifications in brief

	R&S®FSQ	R&S®FSG	R&S®FSV	R&S®FSL	R&S®FMU
RF performance					
Frequency range	20 Hz to 3.6/8/26.5/40 GHz	9 kHz to 8/13 GHz	20 Hz to 3/7/13/30 GHz	9 kHz to 3/6/18 GHz	DC to 36 MHz
Resolution bandwidth	1 Hz to 50 MHz	1 Hz to 10 MHz	1 Hz to 40 MHz	1 Hz to 20 MHz	0.5 Hz to 20 MHz
Phase noise at 10 kHz offset	typ. -133 dBc (1 Hz)	typ. -114 dBc (1 Hz)	typ. -106 dBc (1 Hz)	typ. -103 dBc (1 Hz)	typ. -143 dBc (10 MHz)
Overall measurement uncertainty	0.3 dB (f < 3.6 GHz)	0.3 dB (f < 3.6 GHz)	0.4 dB (f < 7 GHz)	0.5 dB (f < 3 GHz)	0.3 dB
DANL	-158 dBm (at 1 GHz, 1 Hz RBW)	-154 dBm	-152 dBm	-117 dBm (at 1 GHz, 300 Hz RBW), -152 dBm (at 1 GHz, 1 Hz RBW, preamplifier)	-151.5 dBm
TOI	typ. 27 dBm	typ. 21 dBm	typ. 17 dBm	typ. 15 dBm	-
I/Q demodulation					
I/Q demodulation bandwidth	28 MHz, 120 MHz (R&S®FSQ-B72 option)	28 MHz	28 MHz, 40 MHz (R&S®FSV-B70 option)	28 MHz	72 MHz
I/Q memory	16 Msample, 235 Msample, 705 Msample	4 Msample	200 Msample	512 ksamples	16 Msample, optionally 235 Msample, 705 Msample
I/Q baseband inputs, analog	• R&S®FSQ-B71	-	-	-	•
I/Q baseband inputs, digital	•	•	•	-	•
LXI Class C conformant	•	•	•	•	•
WLAN					
Residual EVM (averaged over 20 bursts, f = 2.4 GHz or 5 GHz)	-46 dB ¹⁾	-46 dB ¹⁾	-45 dB ¹⁾	-40 dB ¹⁾	-
Measurement speed	typ. 7 frames/s	typ. 7 frames/s	typ. 10 frames/s	typ. 6 frames/s	typ. 7 frames/s
ACLR with noise correction	typ. 80 dB	typ. 80 dB	typ. 70 dB	typ. 58 dB	typ. 69 dB
IEEE 802.11n	•	•	•	•	-
IEEE 802.11ac	•	-	-	-	-

¹⁾ Level: -30 dBm to +15 dBm, channel estimation: preamble und payload.

For data sheet, see PD 0758.1435.22 and www.rohde-schwarz.com

Ordering information

Designation	Type	Order No.
R&S®FSQ		
Signal and Spectrum Analyzer, 20 Hz to 3.6 GHz	R&S®FSQ3	1155.5001.03
Signal and Spectrum Analyzer, 20 Hz to 8 GHz	R&S®FSQ8	1155.5001.08
Signal and Spectrum Analyzer, 20 Hz to 26.5 GHz	R&S®FSQ26	1155.5001.26
Signal and Spectrum Analyzer, 20 Hz to 40 GHz	R&S®FSQ40	1155.5001.40
Recommended options and extras for the R&S®FSQ		
I/Q Baseband Inputs	R&S®FSQ-B71	1157.0113.02
I/Q Bandwidth Extension to 120 MHz	R&S®FSQ-B72	1157.0336.02
Digital Baseband Interface	R&S®FSQ-B17	1163.0063.02
R&S®FSG		
Spectrum Analyzer, 9 kHz to 8 GHz	R&S®FSG8	1309.0002.08
Spectrum Analyzer, 9 kHz to 13.6 GHz	R&S®FSG13	1309.0002.13
Recommended options and extras for the R&S®FSG		
Digital Baseband Interface	R&S®FSQ-B17	1163.0063.02
R&S®FMU		
Baseband Signal and Spectrum Analyzer, DC to 36 MHz	R&S®FMU36	1303.3500.02
Recommended options and extras for the R&S®FMU		
Digital Baseband Interface	R&S®FSQ-B17	1163.0063.02
Firmware/software for the R&S®FSQ, R&S®FSG and R&S®FMU		
WLAN IEEE 802.11 a/b/g/j TX Application Firmware	R&S®FSQ-K91	1157.3129.02
R&S®FSQ-K91 Upgrade to IEEE 802.11n	R&S®FSQ-K91n	1308.9387.02
R&S®FSQ-K91 Upgrade to IEEE 802.11ac ¹⁾	R&S®FSQ-K91ac	1308.9170.02
R&S®FSV		
Signal and Spectrum Analyzer, 9 kHz to 3 GHz	R&S®FSV3	1307.9002.03
Signal and Spectrum Analyzer, 9 kHz to 7 GHz	R&S®FSV7	1307.9002.07
Signal and Spectrum Analyzer, 9 kHz to 13 GHz	R&S®FSV13	1307.9002.13
Signal and Spectrum Analyzer, 9 kHz to 30 GHz	R&S®FSV30	1307.9002.30
Recommended options and extras for the R&S®FSV		
40 MHz Analysis Bandwidth	R&S®FSV-B70	1310.9645.02
Firmware/software for the R&S®FSV		
WLAN IEEE 802.11 a/b/g/j TX Application Firmware	R&S®FSV-K91	1310.8903.02
R&S®FSV-K91 Upgrade to IEEE 802.11n	R&S®FSV-K91n	1310.9468.02
R&S®FSL		
Spectrum Analyzer, 9 kHz to 3 GHz	R&S®FSL3	1300.2502.03
Spectrum Analyzer, 9 kHz to 3 GHz, with tracking generator	R&S®FSL3	1300.2502.13
Spectrum Analyzer, 9 kHz to 6 GHz	R&S®FSL6	1300.2502.06
Spectrum Analyzer, 9 kHz to 6 GHz, with tracking generator	R&S®FSL6	1300.2502.16
Spectrum Analyzer, 9 kHz to 18 GHz	R&S®FSL18	1300.2502.18
Firmware/software for the R&S®FSL		
WLAN IEEE 802.11 a/b/g/j TX Application Firmware	R&S®FSL-K91	1302.0094.02
R&S®FSL-K91 Upgrade to IEEE 802.11n	R&S®FSL-K91n	1308.7903.02

¹⁾ For R&S®FSQ only.

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- | Uncompromising quality
- | Long-term dependability

About Rohde & Schwarz

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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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R&S®FSx-K91/-K91n, R&S®FSQ-K91ac

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