

R&S®FSx-K92/-K93, R&S®FSQ-K94 WiMAX™/MIMO Application Firmware WiMAX™ TX measure- ments with analyzers from Rohde & Schwarz



75 Years of
Driving
Innovation



R&S®FSx-K92/-K93, R&S®FSQ-K94 WiMAX™/MIMO Application Firmware At a glance

R&S®FSx-K92 and R&S®FSx-K93 add WiMAX™ options to the scope of functions provided by the R&S®FSQ, R&S®FSV, R&S®FSL, R&S®FMU, and R&S®FSG analyzers. The R&S®FSx-K92 and R&S®FSx-K93 application firmware allows TX measurements on OFDM and OFDMA signals in line with the WiMAX™ IEEE 802.16-2004 and IEEE 802.16e-2005 standards. The R&S®FSQ-K94 application firmware enhances the capability of R&S®FSQ-K93 to include analysis of WiMAX™ MIMO signals for the R&S®FSQ and R&S®FSG. Numerous measurements as specified by the standards and a wide range of functions are therefore available at a keystroke.

All WiMAX™ 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, reducing the time to market.



The upper part of the screen shows a typical WiMAX™ signal in the time domain. The analyzed frames are marked by the green bar. The lower part shows the EVM versus carrier. The gaps in the traces indicate that not all carriers are used (PUSC zone).

R&S®FSx-K92/-K93, R&S®FSQ-K94 WiMAX™/MIMO Application Firmware Key features

R&S®FSx-K92/-K93

- ▀ Expands the R&S®FSQ, R&S®FMU, R&S®FSL, R&S®FSV, and R&S®FSG analyzers by adding the capability to perform spectrum and modulation measurements on signals in line with the IEEE 802.16-2004 and IEEE 802.16e-2005 standards
- ▀ Supports OFDM and OFDMA
- ▀ Provides complex WiMAX™ measurements at a keystroke
- ▀ Performs measurements in the RF/IF range and in the baseband
- ▀ Offers the ideal solution for a wide scope of WiMAX™ applications
- ▀ Optimally designed for research, design, verification, and production applications
- ▀ Allows remote control of all functions via IEC/IEEE bus or LAN

R&S®FSQ-K94

- ▀ Expands the R&S®FSQ and R&S®FSG signal analyzers (when equipped with the R&S®FSQ-K93 application firmware) by adding the capability to perform spectrum and modulation measurements on WiMAX™ MIMO signals
- ▀ Offers a very flexible solution by providing SISO measurements on antenna 0 and 1 (matrix A and B) or measurement of both antennas (MISO) at the same time (matrix A)

Analzers supporting WiMAX™ measurements

Rohde & Schwarz offers a wide range of signal and spectrum analyzers for WiMAX™ measurements. The R&S®FSx-K92/-K93 and R&S®FSQ-K94 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-K92/-K93 and R&S®FSQ-K94 WiMAX™ options are one-box solutions, which makes remote control easy. Test setups are straightforward and space-saving.

R&S®FSx-K92 Application Firmware

TX measurements on OFDM signals in line with IEEE 802.16-2004

The R&S®FSx-K92 application firmware allows the analysis of WiMAX™ signals in line with the IEEE 802.16-2004 standard. The option offers a wide range of possible settings so that the user can optimally adapt the measurement to the signal to be analyzed. In addition to frequency, bandwidth, and sample rate, the guard interval length of the WiMAX™ signal can be defined. A wide range of other parameters such as memory depth or trigger settings can be adapted as needed. The main parameters and results of the measurements are listed in a numeric table:

- EVM results (averaged)
 - EVM (all carriers)
 - EVM (data carriers only)
 - EVM (pilot carriers only)
- I/Q constellation
 - I/Q offset
 - Gain imbalance
 - Quadrature offset
- Power measurement
 - In time and frequency domain
 - Crest factor
 - Radio signal strength indicator (RSSI) measurement
- Carrier frequency error and symbol clock error
- Carrier to interference and noise ratio (CINR) measurement

Plus, equipped with the R&S®FSx-K92 option, the R&S®FSQ, R&S®FSG, R&S®FSL, and R&S®FMU analyzers can graphically display the following measurement results:

- Error vector magnitude (EVM) measurements
 - EVM versus symbols
 - EVM versus carriers
- Frequency error and phase error during preamble
- Spectrum flatness
- Adjacent carrier power difference
- Group delay
- Constellation diagram (color-coded according to modulation)
- Spectrum mask with limit lines and pass/fail indication
- Adjacent channel power (absolute and relative) with noise correction (up to five adjacent channels can be defined)
- FFT spectrum
- CCDF and crest factor
- Overview of all bursts with burst summary list
- Bit stream (color-coded according to modulation)

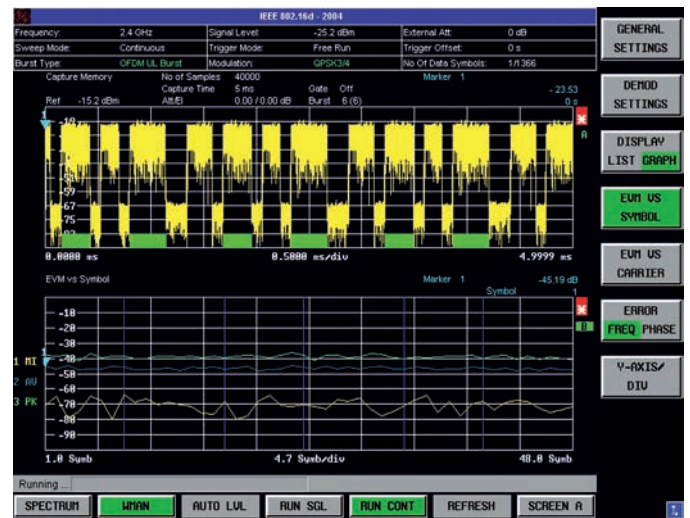
R&S®FSx-K92 offers the following additional features:

- Automatic demodulation
- Remote control via GPIB or LAN
- Import and export of I/Q data

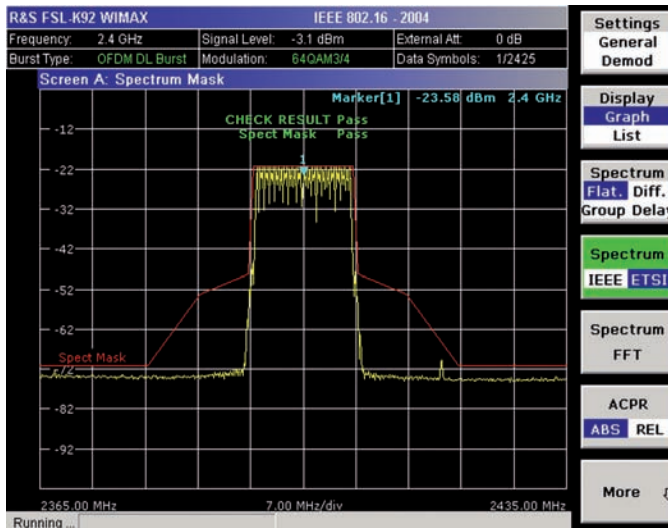
The result summary displays the most important parameters for characterizing WiMAX™ signals detected within the period of recording.



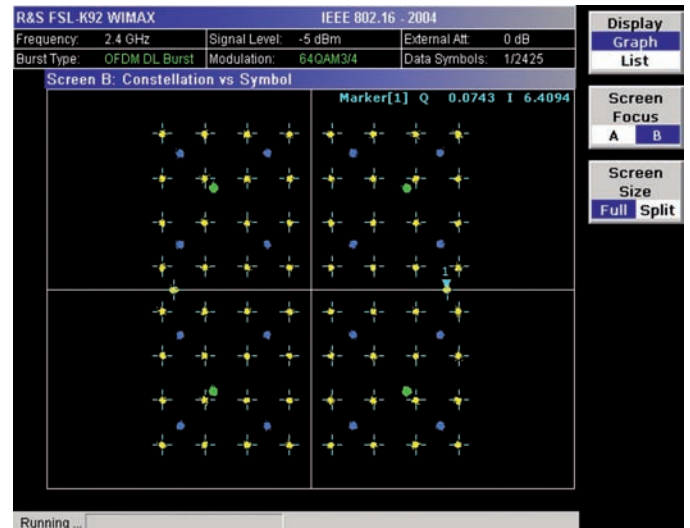
The upper part of the screen shows the recorded WiMAX™ signal in the time domain. The lower part displays the minimum, average, and maximum EVM values versus the physical carriers. The blue lines mark the limits of each burst.



The analyzers can be used for measuring both the adjacent channel power and the spectrum mask in line with the IEC/IEEE and ETSI standards. Using predefined limit lines with pass/fail indication, the analyzer determines at a keystroke whether the spectrum conforms to specified requirements.



The constellation diagram of WiMAX™ signals is color-coded according to the modulation. Either the entire zone or individual modulation modes are displayed. The constellation diagram can be displayed either for all carriers or for selected carriers.



R&S®FSx-K93 Application Firmware

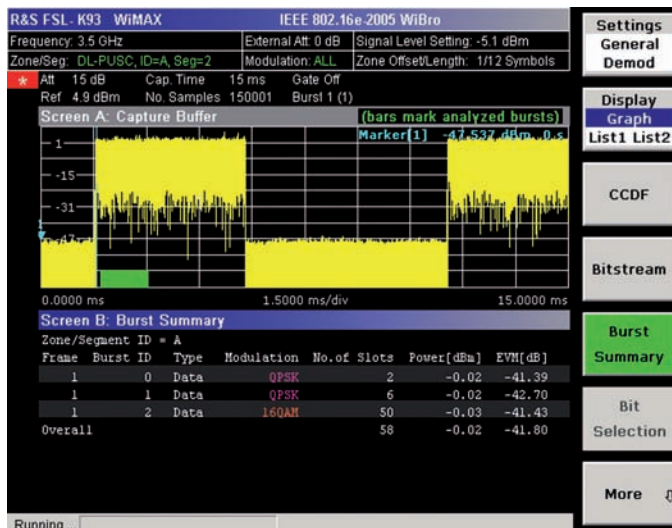
TX measurements on OFDMA signals in line with IEEE 802.16-2004, IEEE 802.16e-2005

The R&S®FSx-K93 option includes all functions of the R&S®FSx-K92 option. Results and graphical display are identical in both options. In addition, R&S®FSx-K93 supports the IEEE 802.16e-2005 standard for Mobile WiMAX™ signals, and therefore expands the R&S®FSx-K92 option to measurements on OFDMA signals. R&S®FSx-K92 can be upgraded to R&S®FSx-K93 in all of the analyzers.

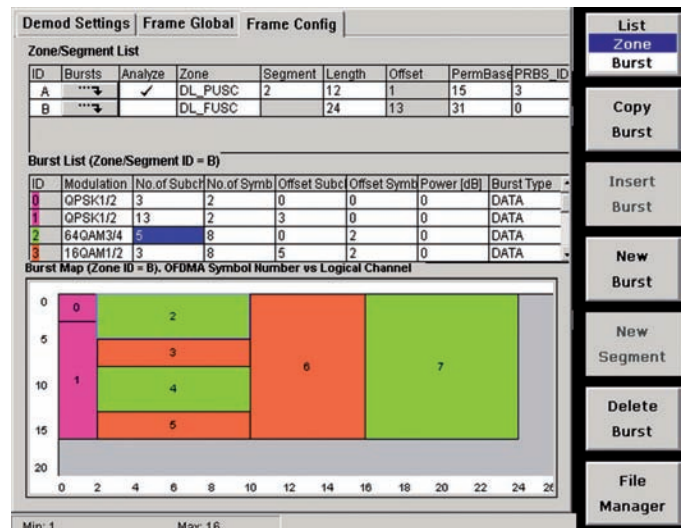
The R&S®FSx-K93 option includes automatic demodulation based on the DL map. The analyzer reads the DL map and demodulates the OFDMA signal in line with the map. This feature enables the user to measure WiMAX™ OFDMA signals without defining the DL map and the modulation formats. In addition, it provides information about the detected map (allocation of the bursts), which is the first step in evaluating the MAC layer. Moreover, the user can test whether the signals comply with the standard, which is a prerequisite for interoperability tests.

The user can also define the DL map manually. For this purpose, the R&S®FSx-K93 option provides a user-friendly DL map editor, where the number of subscribers, the assignment of subchannels, and the modulation modes are defined. Moreover, the user can specify the number of active subchannels as well as the type and number of permutation zones. Furthermore, the DL map or setting files can be directly loaded from an R&S®SMU200A vector signal generator connected via LAN.

The subranges of the WiMAX™ signal in the time domain (highlighted in green) are demodulated. The burst summary provides information about the bursts of the analyzed zone, e.g. modulation mode and EVM. The raw data bit stream can be displayed for all bursts, including the FCH field.



In the Frame Configuration menu, the UL and DL map as well as the individual zones of the OFDMA signal can be defined by means of a table. This WiMAX™ signal consists of two zones, i.e. a PUSC zone, which is analyzed (see check mark in first table), and an FUSC zone. The second table shows the burst configuration. All settings can be graphically displayed in the Burst map or Zone map.



R&S®FSQ-K94 Application Firmware

TX measurements on WiMAX™ MIMO signals in line with IEEE 802.16e-2005

The R&S®FSQ-K94 option for the R&S®FSQ or R&S®FSG high-end signal and spectrum analyzers expands the R&S®FSQ-K93 application firmware to support MIMO measurements. The objective of MIMO (multiple input multiple output) is to increase the data rate in wireless communications systems such as WiMAX™. The different modes, defined in the IEEE 802.16e-2005 standard, are supported by the R&S®FSQ-K94 application firmware:

- TX diversity (matrix A)
- Spatial multiplexing (matrix B)

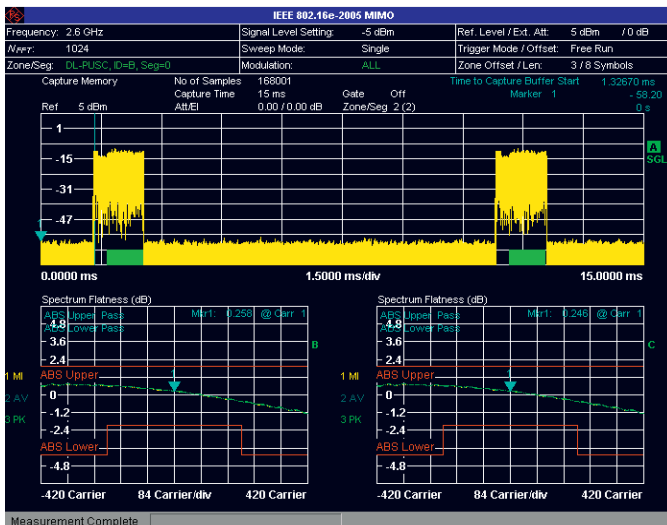
The R&S®FSQ-K94 option in combination with the R&S®FSQ or R&S®FSG high-end signal and spectrum analyzers offers a flexible and scalable solution for TX measurements.

Most applications do not require that both antennas be measured at the same time. Therefore, only one analyzer is needed in order to measure antenna 0 or antenna 1, which can easily be done with R&S®FSQ-K94 installed on the R&S®FSQ or R&S®FSG.

When matrix A is used, the same information is sent on both antennas with different coding (Alamouti coding). TX measurements of both antennas at the same time, if needed, can also be performed by using only one R&S®FSQ or R&S®FSG. With matrix B, both antennas transmit different data streams, which doubles the data rate. For full characterization of the RF transmission, it is necessary to receive both transmit paths simultaneously. For this purpose, two analyzers are needed, one acting as the master and the other one as the slave. The application firmware is required on the master only. This mode is currently implemented.

Using the R&S®FSQ-K94 option, all the features, that are familiar from the R&S®FSQ-K93 WiMAX™ application firmware are supported such as user-editable SEM or autodemodulation, and users get the same results. In addition, the different channels can be displayed, and additional MIMO-related results such as power of unmodulated pilots are listed.

The screenshot shows the spectrum flatness of both channels of a WiMAX™ signal in line with IEEE 802.16e-2005, matrix A. Only one analyzer is required to characterize both channels.



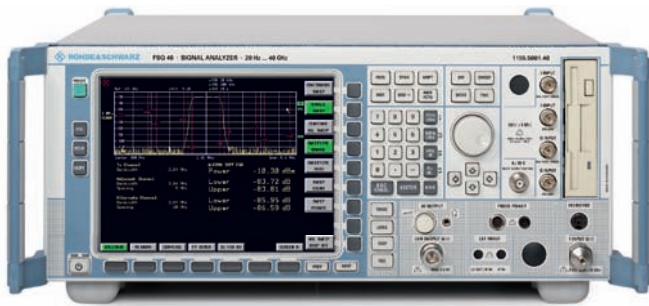
A: Result Overview of Analyzed Zone/Segment Tx0			A: Result Overview of Analyzed Zone/Segment Rx0		
BER Pilots	0.00	0.00 %	Center Frequency Error	222.75 ± 5200	Hz
Center Frequency Error	222.75 ± 5200	Hz	Clock Error	0.08 ± 2	ppm
Clock Error	0.08 ± 2	ppm	EVM Data and Pilots	-52.29	-15.00 dB
IQ Offset	...	-15.00 dB	Power Data and Pilots	-44.93	dBm
B: Result Overview of Analyzed Zone/Segment Tx1					
BER Pilots	0.00	0.00 %			
Center Frequency Error	222.75 ± 5200	Hz			
Clock Error	0.08 ± 2	ppm			
IQ Offset	...	-15.00 dB			

The EVM values or frequency offset etc. are listed in the table. The user gets different tables for the different TX streams that have been analyzed.

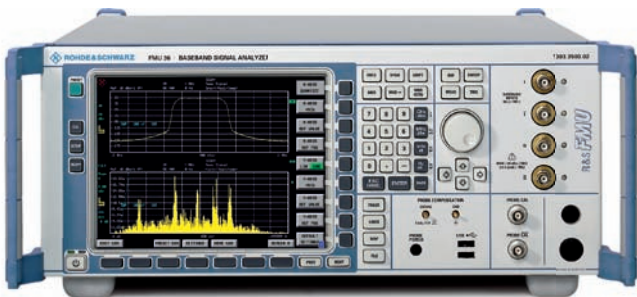
Analyzers supporting WiMAX™ measurements

Rohde & Schwarz offers a wide range of signal and spectrum analyzers for WiMAX™ measurements – an appropriate instrument is available for nearly every application. Analyzers from Rohde & Schwarz cover virtually all requirements placed on class, frequency range, and function.

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



The R&S®FMU – universal baseband analyzer.



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

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

The R&S®FSQ analyzer 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 signals in the baseband. The R&S®FSQ-B72 broadband option permits the analysis 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.

R&S®FMU signal 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-K92/-K93 options permit modulation measurements on WiMAX™ OFDM and WiMAX™ OFDMA signals.

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The R&S®FSL – compact spectrum analysis.

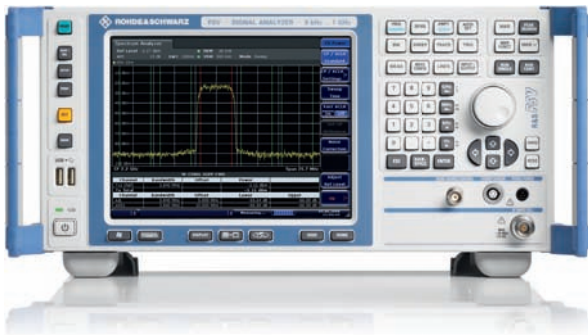


R&S®FSL spectrum analyzer – compact spectrum analysis

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.

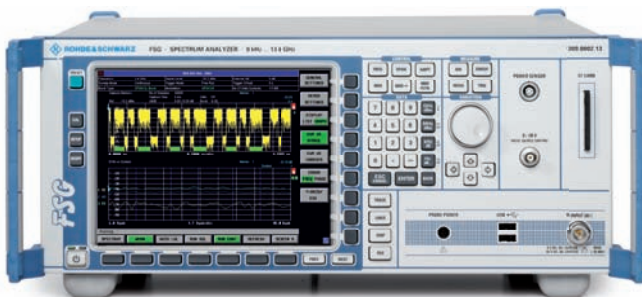
The R&S®FSV – the new standard in the mid-range class.



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 5 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 WiMAX™ signals due to the wide demodulation bandwidth of 40 MHz. 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 touch screen 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.

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



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 WiMAX™ or 3GPP LTE.

Specifications in brief

	R&S®FSQ	R&S®FMU	R&S®FSL	R&S®FSV	R&S®FSG
RF performance					
Frequency range	20 Hz to 3.6/8/26.5/40 GHz	DC to 36 MHz	9 kHz to 3/6/18 GHz	20 Hz to 3/7/13/30 GHz	9 kHz to 8/13.6 GHz
Resolution bandwidth	1 Hz to 50 MHz	0.5 Hz to 20 MHz	1 Hz to 20 MHz	1 Hz to 40 MHz	1 Hz to 10 MHz
Phase noise at 10 kHz offset, 1 GHz input frequency	typ. -129 dBc (1 Hz)	typ. -143 dBc (1 Hz), (10 MHz input frequency)	typ. -97 dBc (1 Hz)	typ. -106 dBc (1 Hz)	typ. -114 dBc (1 Hz)
Overall measurement uncertainty	0.3 dB (f < 3.6 GHz)	0.3 dB	0.5 dB (f < 3 GHz)	0.4 dB (f < 7 GHz)	0.3 dB (f < 3.6 GHz)
DANL	typ. -156 dBm (at 1 GHz, 1 Hz RBW)	typ. -151.5 dBm	typ. -142 dBm (at 1 GHz, 1 Hz RBW), typ. -152 dBm (at 1 GHz, 1 Hz RBW, with preamplifier ON)	-152 dBm	typ. -155 dBm (at 1 GHz, 1 Hz RBW), typ. -162 dBm (at 1 GHz, 1 Hz RBW, with preamplifier ON)
TOI	typ. 27 dBm	-	typ. 15 dBm	typ. 17 dBm	typ. 25 dBm
I/Q demodulation					
I/Q demodulation bandwidth	28 MHz, optionally 120 MHz (R&S®FSQ-B72)	72 MHz	28 MHz ¹⁾	28 MHz, 40 MHz (R&S®FSV-B70 option)	28 MHz
I/Q memory	16 Msample, optionally 235/705 Msample	16 Msample, optionally 235/705 Msample	512 ksample	200 Msample	4 Msample
I/Q baseband inputs	optional, 50 Ω/1 MΩ (R&S®FSQ-B71)	50 Ω/1 MΩ (balanced, unbalanced)	-	-	-
LXI Class C compliant	✓	✓	✓	✓	✓
Digital baseband interface	✓	✓	-	-	✓
WiMAX™					
Residual EVM (f = 3.5 GHz, 0 dBm, typical values of WiBro signal)	typ. -52 dB	typ. -52 dB (baseband)	typ. -40 dB	typ. -45 dB	typ. -49 dB
ACLR with noise correction	typ. 80 dB	typ. 69 dB (without noise correction)	typ. 58 dB	typ. 70 dB	typ. 80 dB
Measurement speed (bandwidth 8.75 MHz, six data symbols)	typ. 7 frames/s	-	typ. 6 frames/s	typ. 6 frames/s	typ. 7.0 frames/s
MIMO	✓	-	-	-	✓

¹⁾ R&S®ZVL: 20 MHz.

Ordering information

Designation	Type	Order No.
R&S®FSQ		
Signal Analyzer, 20 Hz to 3.6 GHz	R&S®FSQ3	1155.5001.03
Signal Analyzer, 20 Hz to 8 GHz	R&S®FSQ8	1155.5001.08
Signal Analyzer, 20 Hz to 26.5 GHz	R&S®FSQ26	1155.5001.26
Signal 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
R&S®FMU		
Baseband Signal Analyzer, DC to 36 MHz	R&S®FMU36	1303.3500.02
Firmware/software for the R&S®FSQ, R&S®FSG, and R&S®FMU		
IEEE802.16-2004 OFDM WiMAX™ Application Firmware	R&S®FSQ-K92	1300.7410.02
R&S®FSQ-K92 to R&S®FSQ-K93 Upgrade	R&S®FSQ-K92U ¹⁾	1300.8500.02
IEEE802.16e-2005 OFDMA WiMAX™ Application Firmware	R&S®FSQ-K93	1300.8600.02
IEEE802.16e-2005 MIMO Application Firmware	R&S®FSQ-K94 ²⁾	1308.9770.02
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
Firmware/software for the R&S®FSL		
IEEE802.16-2004 OFDM WiMAX™ Application Firmware	R&S®FSL-K92	1302.0236.02
R&S®FSL-K92 to R&S®FSL-K93 Upgrade	R&S®FSL-K92U ¹⁾	1302.0307.02
IEEE802.16e-2005 OFDMA WiMAX™ Application Firmware	R&S®FSL-K93	1302.0736.02
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
Firmware/software for the R&S®FSV		
IEEE802.16e-2005 OFDMA WiMAX™ Application Firmware	R&S®FSV-K93	1310.9416.02

¹⁾ R&S®FSx-K92 required.

²⁾ R&S®FSQ-K93 required

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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 75 years ago, Rohde & Schwarz has a global presence and a dedicated service network in over 70 countries. Company headquarters are in Munich, Germany.

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