

WLAN 802.11a Application Firmware R&S® FSQ-K90

Transmitter measurements on WLAN 802.11a OFDM signals with the Signal Analyzer R&S FSQ

- Enhances the signal analyzers of the R&S FSQ family by transmitter measurements in accordance with the IEEE 802.11a standard
- Frequency range from 20 MHz to 3/8/26 GHz, depending on base unit
- Very low residual EVM of below –44 dB/–46 dB
- Automatic or manual setting of modulation format
- Analysis at the RF or in the baseband (optional)
- All measurement functions remotecontrollable via IEC/IEEE bus or LAN
- High measurement rate of >2 measurements/s (54 Mbps, 16 payload symbols)
- Supports 802.11g OFDM



01.00 July 2003

General

Application Firmware R&S FSQ-K90 expands the application range of the Signal Analyzers R&S FSQ by spectrum and modulation measurements on OFDM signals in accordance with the WLAN standard IEEE 802.11a. The measurements specified by this standard can thus be performed at a keystroke, for example:

- Output power (burst power)
- Spectrum mask with limit lines and PASS/FAIL display (FIG 1a +b)

- Spectrum flatness (including display of group delay, FIG 4)
- Constellation error (FIG 2)
- RF carrier leakage (FIG 2)
- Carrier frequency and symbol clock error
- Adjacent channel power

Further analysis and evaluation facilities are often required in the development and verification phase:

- Constellation diagram for all carriers or a single carrier
- Constellation overview of all carriers (FIG 6)
- EVM of single carriers
- EVM versus symbols or time
- Group delay
- Time-gated spectrum (FFT)
- Time-gated CCDF and crest factor
- Bit stream
- Analysis at the RF, IF, inverted IF or in the baseband (option R&S FSQ-B71)
- Selectable tracking (phase, timing, level)

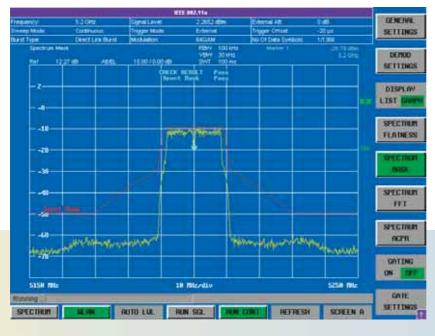


FIG 1a: Spectrum mask with standard-compliant limit lines

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FIG 1b: ACP measurement

The usual spectrum analysis functions of the base unit further expand measurement functionality, making the instrument even more versatile.

Other typical development tasks can be performed with the following measurement functions:

- Channel and user-configurable adjacent channel power measurement
- Multicarrier adjacent channel power measurement
- TOI marker for automatic determination of third-order intercept
- Noise measurements (with R&S FS-K3) or phase noise measurement (with R&S FS-K4)

The Signal Analyzer R&S FSQ26 covers the entire frequency range to be measured for spurious emissions.

		IEEE 002.11s					-
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	Min	Mean	Limit	Max	Limit	Unit	DISPLAY
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	-50.49	-46.47	-25 00	-43.67	-25.00	dB	
EVM Data Carners	0.30	0.48	5.62	0.67	5.62	96	PUT 0
	-50.40	-46.37	-25.00		-25.00	dB	
EVM Pilot Carriers	0.22	0,40	39.81	0.68	39.81	%	
	-53.00		-8.00	-44.66	-8.00	dB	EUN 0
IQ Offset	-50.60	-48.00	-15.00	-46.17	-15.00	dB	
Gain Imbalance	-0.07	-0.01		0.04		%	SPECTRUM 0
	-0.01	-0.00		0.00		dB	(Internet of the local days)
Quadrature Offset	-0.10	-0.04		0.00			CONSTELL @
Center Frequency Error	101,59	117.59	± 40000	131.78	± 40000	Hz	CONSTICUT V
Symbol Clock Error	-1.46	-0.09	± 20	1.40	± 20	ppm	
Burst Power	0.89	0.95		1.19		dBm	STATISTICS
Crest Factor	8.03	9.09		10.36		dB	
Measurement Complete	No.					-	
SPECTRUM	AUTO LUL	RUN SCL	RUN CONT	REFRESH	SCREED	N B	

FIG 2: Display of the main modulation parameters in the Result Summary: The measurement covering 20 bursts shows an EVM of -46.7 dB for the best burst (min. peak) and -45.09 dB for the worst burst (max. peak) as well as an average EVM of -46.09 dB for all bursts. Output power (with regard to burst) and crest factor are also displayed. Quick and easy determination, for example, of the EVM dependence on the output power of an amplifier is thus possible. Owing to its auto level function, the analyzer follows these level changes without requiring any manual settings.

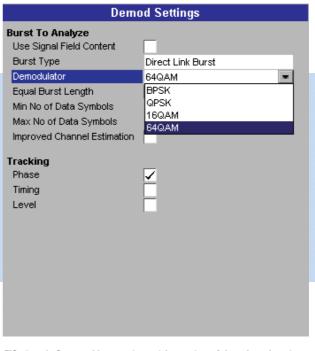
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ner Selection	Carriers .	Signal Level	4.4859 dBm	External Att	0.00	GENERAL
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-38.9036					30.9036	14 B 2
ning						GATE
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FIG 3: Constellation diagram of all or (selectable) single carriers

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tesumer:	52018	Sone Lever	4 4859 dBm	External Alt	0.68	GENERAL
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FIG 4: Group delay and spectrum flatness are determined via the channel estimation of the preamble or (user-selectable) for the entire burst including payload. Frequency responses of filters, distortions due to time offsets or different I and Q signal delays (skew) are clearly visible.

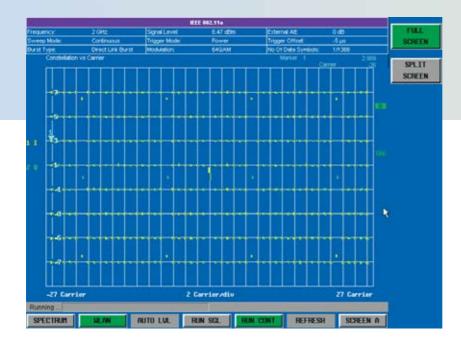
General Settings					
Signal Characteristics					
Standard	IEEE 802.11a				
Frequency	5.2 GHz				
Channel No	40				
Auto Level	\checkmark				
Ext Att	0 dB				
Signal Level (RF)	-30 dBm				
Signal Level (Baseband)	1 V				
Data Capture Settings	1				
Capture Time	1 ms				
Overall Burst Count					
No of Bursts to Analyze	1				
Trigger Settings					
Trigger Mode	Free Run 💌				
Trigger Offset	Free Run				
Power Level (RF)	External				
Power Level (Baseband)	Power				
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Input Settings					
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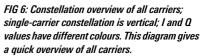


FIGs 5a + b: Setup; tables permit a quick overview of the selected settings and immediate access to the setting parameters The optional Vector Signal Analyzer R&S FSQ-K70 enhances the R&S FSQ by universal demodulation and analysis functions for digitally modulated signals up to a symbol rate of 25 Msps. Thus, the AM/AM and AM/φM distortion curves of an amplifier, for example, can be determined directly from a digitally modulated signal, i.e. very realistically. For analysis down to the chip layer, the option R&S FSQ-B71 has selectable balanced or unbalanced I and Q baseband inputs.

Measurements in the 2.4 GHz range already support 802.11g OFDM.

Specifications for R&S FSQ-K90 see PD 0758.0200.









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WLAN 802.11a Application Firmware R&S[®] FSQ-K90

Specifications



The specifications of R&S FSQ-K90 are based on the data sheet specifications of the Signal Analyzer R&S FSQ and have not been checked separately. They are valid under the following conditions:

15 minutes warm-up time at ambient temperature, specified environmental conditions met, calibration cycle adhered to and internal calibration performed. Data with tolerance limits: measurement uncertainties with a confidence level of 95%. Data without tolerance limits: typical values. The specified level measurement errors do not take into account systematic errors due to reduced S/N ratio.

Frequency

Frequency range	RF input	R&S FSQ3	10 MHz to 3.6 GHz
		R&S FSQ8	10 MHz to 8 GHz
		R&S FSQ26	10 MHz to 26.5 GHz
	I/Q baseband input	(R&S FSQ-B71)	DC to 36 MHz
Frequency setting			frequency
			channel number

Level

Level range	RF input I/Q baseband input (R&S FSQ-B71)	-50 dBm to +30 dBm 31.6 mV to 5.62 V
Level setting		autorange manual

Signal acquisition

Supported standards		802.11a, 802.11g (OFDM)
Modulation format		BPSK, QPSK, 16QAM, 64QAM
Demodulator setting		manual with/without test of signal field
Capture length	continuous	24 μs to 50 ms
Number of bursts that can be analyzed	manual	1 to 10922
Result length	PVT, spectrum FFT, CCDF	capture length, 1 to 10922 bursts or gate length
	EVM vs. symbol and vs. carrier,	capture length, 1 to 10922 bursts
	constellation vs. symbol and vs. carrier	
	spectrum flatness, bit stream	
Sweep time	spectrum mask	100 ms
	ACPR	300 ms
Burst length	automatic detection of number of data symbols manual	1 to 1366 data symbols
Triggering	RF input	free run, IF power, external
	I/Q baseband input	free run, envelope of I/Q voltage, external

Adjustable parameters

Input	R&S FSQ-B71	RF
		I and Q baseband, unbalanced, balanced
Pilot tracking		phase on/off
		timing on/off
		level on/off
Channel estimation		preamble and data
		preamble

Measurement uncertainty

Residual EVM	level –23 dBm to +30 dBm	
	average of 20 bursts	
	input = RF (f = 2.4 GHz or 5 GHz)	
	channel estimation = preamble and data	–46 dB
	channel estimation = preamble	–44 dB
	input = I and Q baseband	
	channel estimation = preamble and data	–47 dB
	channel estimation = preamble	–45 dB
Frequency error		
Lock range		40 ppm
Uncertainty		1 Hz + reference frequency uncertainty
Level uncertainty	test of spectrum mask	0.1 dB
	output power	
	f <3.6 GHz	0.5 dB
	3.6 GHz <=f <=8 GHz	1.5 dB
	ACPR (adjacent channel power ratio)	0.5 dB
Spectrum flatness	f <3.6 GHz	0.3 dB
	f >3.6 GHz	0.5 dB

Ordering information

Application Firmware for WLAN 802.11a TX Measurements with the R&S FSQ	R&S FSQ-K90	1157.3064.02
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 GHz	R&S FSQ26	1155.5001.26
Recommended options and extras	see also data sheet Signal Analyzer R&S	FSQ
I/Q Baseband Inputs for the Signal Analyzer		
R&S FSQ	R&S FSQ-B71	1157.0113.02





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WLAN 802.11a/b/g/j Application Firmware R&S®FSQ-K91

Specifications



The specifications of R&S FSQ-K91 are based on the data sheet specifications of the Signal Analyzer R&S FSQ and have not been checked separately. They are valid under the following conditions:

15 minutes warm-up time at ambient temperature, specified environmental conditions met, calibration cycle adhered to and internal calibration performed. Data with tolerance limits: measurement uncertainties with a confidence level of 95%. Data without tolerance limits: typical values. The specified level measurement errors do not take into account systematic errors due to reduced S/N ratio.

OFDM analysis (802.11a, 802.11g OFDM, 802.11j)

Frequency

Frequency range	RF input	R&S FSQ3	10 MHz to 3.6 GHz
		R&S FSQ8	10 MHz to 8 GHz
		R&S FSQ26	10 MHz to 26.5 GHz
	I/Q baseband input	(R&S FSQ-B71)	DC to 36 MHz
Frequency setting			frequency
			channel number

Level

Level range	-70 dBm to +30 dBm 31.6 mV to 5.62 V
Level setting	autorange manual

Signal acquisition

Supported standards		802.11a, 802.11g (OFDM), 802.11j (10 MHz), 802.11j (20 MHz)
Modulation format		BPSK, QPSK, 16QAM, 64QAM
Demodulator setting		auto
		manual with/without test of signal field
Capture length	continuous	24 µs to 50 ms
Number of bursts that can be analyzed	manual	1 to 10922
Result length	PVT, spectrum FFT, CCDF	capture length, 1 to 10922 bursts or gate length
	EVM versus symbol and versus carrier,	capture length, 1 to 10922 bursts
	constellation versus symbol/versus carrier	
	spectrum flatness, bit stream, signal field	
Sweep time	spectrum mask	100 ms
	ACPR	300 ms
Burst length	automatic detection of number of data symbols	1 to 1366 data symbols
	manual	
Triggering	RF input	free run, IF power, external
	I/Q baseband input	free run, envelope of I/Q voltage, external

Result display

Result list	min/mean/max	EVM all carriers
	min/mean/max	EVM pilots
	min/mean/max	EVM payload
		I/Q offset
		GAIN imbalance
		quadrature error
		center freq error
		symbol clock error
		mean burst power
		crest factor
Power versus time		full burst
		rising/falling edge
EVM		EVM versus symbol
		EVM versus carrier
Spectrum		spectrum mask (IEEE & ETSI)
		ACP (802.11j: abs/rel)
		spectrum FFT
		spectrum flatness

Constellation		constellation diagram constellation versus carrier
Statistics		bit stream
		signal field
		CCDF
Limit check	values according to standard	result list
	_	EVM
		spectrum mask
		ACP

Adjustable parameters

Input	R&S FSQ-B71	RF
		I and Q baseband, unbalanced, balanced
Pilot tracking		phase on/off
		timing on/off
		level on/off
Channel estimation		preamble and data
		preamble

Measurement uncertainty

Residual EVM	level –23 dBm to +30 dBm	
	average of 20 bursts	
	input = RF (f = 2.4 GHz or 5 GHz)	
	channel estimation = preamble and data	-46 dB
	channel estimation = preamble	-44 dB
	input = I and Q baseband	
	channel estimation = preamble and data	–47 dB
	channel estimation = preamble	–45 dB
Frequency error		
Lock range		40 ppm
Uncertainty		1 Hz + reference frequency uncertainty
Level uncertainty	test of spectrum mask	0.1 dB
	output power	
	f < 3.6 GHz	0.5 dB
	3.6 GHz \leq f \leq 8 GHz	1.5 dB
	ACPR	0.5 dB
Spectrum flatness	f < 3.6 GHz	0.3 dB
	f > 3.6 GHz	0.5 dB

DSSS/CCK analysis (802.11b)

Frequency

Frequency range	RF input	R&S FSQ3	20 MHz to 3.6 GHz
		R&S FSQ8	20 MHz to 8 GHz
		R&S FSQ26	20 MHz to 26.5 GHz
	I/Q baseband i	input (R&S FSQ-B71)	DC to 36 MHz
Frequency setting			frequency
			channel number

Level

Level range	-65 dBm to +30 dBm 31.6 mV to 5.62 V
Level setting	autorange manual

Signal acquisition

Supported standards		802.11b
Modulation format		DBPSK, DQPSK, CCK, short PLCP, long PLCP
Demodulator setting		auto manual with/without test of signal field
Capture length	continuous	24 µs to 66 ms
Number of bursts that can be analyzed	manual	1 to 10922
Result length	PVT, spectrum FFT, CCDF	capture length, 1 to 10922 bursts or gate length
	EVM versus symbol and versus carrier, constellation versus symbol bit stream	capture length, 1 to 10922 bursts
	PLCP header	
Sweep time	spectrum mask ACPR	200 ms 200 ms
Burst length	automatic detection of number of data symbols manual	1 to 4095 bytes
Triggering	RF input I/Q baseband input	free run, IF power, external free run, envelope of I/Q voltage, external

Result display

Result list	min/mean/max min/mean/max	peak vector error burst EVM I/Q offset gain imbalance quadrature error center freq error chip clock error rise time fall time mean burst power peak burst power crest factor
Power versus time		up ramp/down ramp
EVM		EVM versus symbol
Spectrum		spectrum mask, ACPR, spectrum FFT
Constellation		constellation diagram
Statistics		bit stream PLCP header CCDF
Limit check	values according to standard	result list, power versus time, EVM, spectrum mask, ACP

Adjustable parameters

Input	R&S FSQ-B71	RF
		I and Q baseband, unbalanced, balanced
Tracking		phase on/off
		timing on/off
		level on/off

Measurement uncertainty

Residual EVM	level -23 dBm to +30 dBm average of 20 bursts, 11 Mbps CCK with short PLCP, burst EVM	
	input = RF (f = 2.442 GHz)	0.7%
	input = I and Q baseband	0.4%
Frequency error		
Lock range		1.3 MHz
Uncertainty		1 Hz + reference frequency uncertainty
Level uncertainty	test of spectrum mask	0.1 dB
	output power	
	f < 3.6 GHz	0.5 dB
	3.6 GHz ≤ f ≤ 8 GHz	1.5 dB
	ACPR	0.5 dB

Ordering information

WLAN 802.11a/b/g/j Application Firmware	R&S FSQ-K91	1157.3129.02
Upgrade from R&S FSQ-K90 to R&S FSQ-K91	R&S FSQ-K90U	1300.8000.02
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 GHz	R&S FSQ26	1155.5001.26
Recommended options and extras	see also data sheet Signal Analyzer R&S FSQ	
I/Q Baseband Inputs for the Signal Analyzer		
R&S FSQ	R&S FSQ-B71	1157.0113.02



Product brochure see PD 0758.0945.12 and at www.rohde-schwarz.com (search term: FSQ)



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