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## Signal Analyzer R&S® FSQ

Signal analysis with the dynamic range of a high-end spectrum analyzer and a demodulation bandwidth of up to 120 MHz

- ◆ Up to 3.6 GHz, 8 GHz, 26.5 GHz and 40 GHz
- ◆ 28 MHz I/Q demodulation bandwidth
- ◆ Optional 60/120 MHz I/Q demodulation bandwidth
- ◆ 16 Msample I and Q memory
- ◆ I/Q data extraction, e.g. for MCPA adjustment
- ◆ Spectrum and code domain power measurements for
  - 3GPP FDD/HSDPA
  - cdma2000
  - cdma2000 1xEV-DV
  - cdma2000 1xEV-DO
  - TD-SCDMA
- ◆ Spectrum and modulation measurements for
  - GSM/EDGE
  - Bluetooth®
  - WLAN
- ◆ General vector signal analysis
- ◆ Dynamic range of a high-end spectrum analyzer
  - TOI: typ. +25 dBm
  - 1 dB compression: +13 dBm
  - 84 dB ACLR/3GPP with noise correction
- ◆ Versatile resolution filters: Gaussian, FFT, channel, RRC
- ◆ Full choice of detectors



**ROHDE & SCHWARZ**

NIST, ISO, IEC, ANSI, NCSL, MIL-STD by [www.raeservices.com](http://www.raeservices.com)

Version  
02.01

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2005

# Future-proof performance and bandwidth

## Spectrum and signal analysis in a single instrument

Future transmission methods in mobile radio and related fields call for wider transmission bandwidths to handle increasing data throughput. Even today, multiple carriers of a GSM or 3GPP base station are often boosted in common power output stages. This reduces the technical effort and costs on the one hand, but increases the bandwidth to be transmitted on the other. In both cases, analysis bandwidths exceeding those provided by present-day spectrum analyzers are required in development and production, while at the same time the dynamic range must satisfy stringent requirements.

The R&S®FSQ combines the outstanding spectrum analyzer features and functions of the R&S®FSU with a demodulation and analysis bandwidth that has been enhanced to 120 MHz. The R&S®FSQ is thus ideal for applications in the development and production of the following:

- ◆ Wireless LAN (WLAN)
- ◆ 3GPP and GSM-MCPA

The R&S®FSQ additionally supports measurements on 2G, 2.5G and 3G mobile radio systems when using application firmware such as:

- ◆ R&S®FS-K5, GSM/EDGE
- ◆ R&S®FS-K72/-K73, 3GPP FDD
- ◆ R&S®FS-K74, HSDPA
- ◆ R&S®FS-K82/-K83/-K84/-K85, cdma2000
- ◆ R&S®FS-K76/-K77, TD-SCDMA

The optional I/Q demodulation bandwidth extension to 60/120 MHz makes the R&S®FSQ fit for future methods requiring high bandwidths.

The operating concept of the R&S®FSQ is identical with that of the Spectrum Analyzers R&S®FSU and R&S®FSP, including the GPIB/IEC commands. These instruments thus offer a uniform platform for a variety of applications.

### The R&S®FSQ family

R&S®FSQ3	20 Hz to 3.6 GHz
R&S®FSQ8	20 Hz to 8 GHz
R&S®FSQ26	20 Hz to 26 GHz
R&S®FSQ40	20 Hz to 40 GHz

### R&S®FSQ – world champion in spectrum analysis

The R&S®FSQ has the same outstanding RF features as the Spectrum Analyzer R&S®FSU:

- ◆ 84 dB ACLR for 3GPP with noise correction
- ◆ 77 dB ACLR for 3GPP multicarrier signals (4 adjacent carriers)
- ◆ TOI > +26 dBm, typ. +25 dBm
- ◆ 1 dB compression +13 dBm
- ◆ Displayed average noise level (DANL) –158 dBm (1 Hz bandwidth)
- ◆ Phase noise –160 dBc (1 Hz) at 10 MHz carrier offset
- ◆ Phase noise –123 dBc (1 Hz) at 10 kHz carrier offset

In addition to broadband demodulation capabilities, the R&S®FSQ provides the dynamic range that is required for multicarrier measurements or the measurement of spurious emissions at base transceiver stations (BTS).

## Functionality

With its wide range of functions, the R&S®FSQ is practically unparalleled on the spectrum analyzer market. Even the base unit comes standard with all important functions.

Highly selective digital filters from 10 Hz to 100 kHz
Fast FFT filters from 1 Hz to 30 kHz
Channel filters from 100 Hz to 8 MHz
BRF filters
1 Hz to 50 MHz resolution bandwidth (RBW)
OR detector and EMI bandwidths 200 Hz, 9 kHz, 120 kHz
2.5 μs sweep time in frequency domain
1 μs sweep time in time domain
Number of measurement points/trace selectable between 155 and 10001
Time-selective spectrum analysis with gating function
GPIB interface, IEEE488.2
RS-232-C serial interface, 9-pin Sub-D
VGA output, 15-pin Sub-D
PC-compatible screenshots on diskette or hard disk
Up to 80 measurements/s in manual mode
Up to 50/70 measurements/s in GPIB mode
SCPI-compatible GPIB command set
R&S®FSE/R&S®FSIQ-compatible GPIB command set
Fast ACP measurement in time domain
Statistical signal analysis with CCDF function
RMS detector with 100 dB dynamic range
Transducer factor for correcting antenna or cable frequency responses
2-year calibration interval <sup>1)</sup>
External reference from 1 MHz to 20 MHz in 1 Hz steps
LAN interface 100BaseT
16 Msample I and Q memory

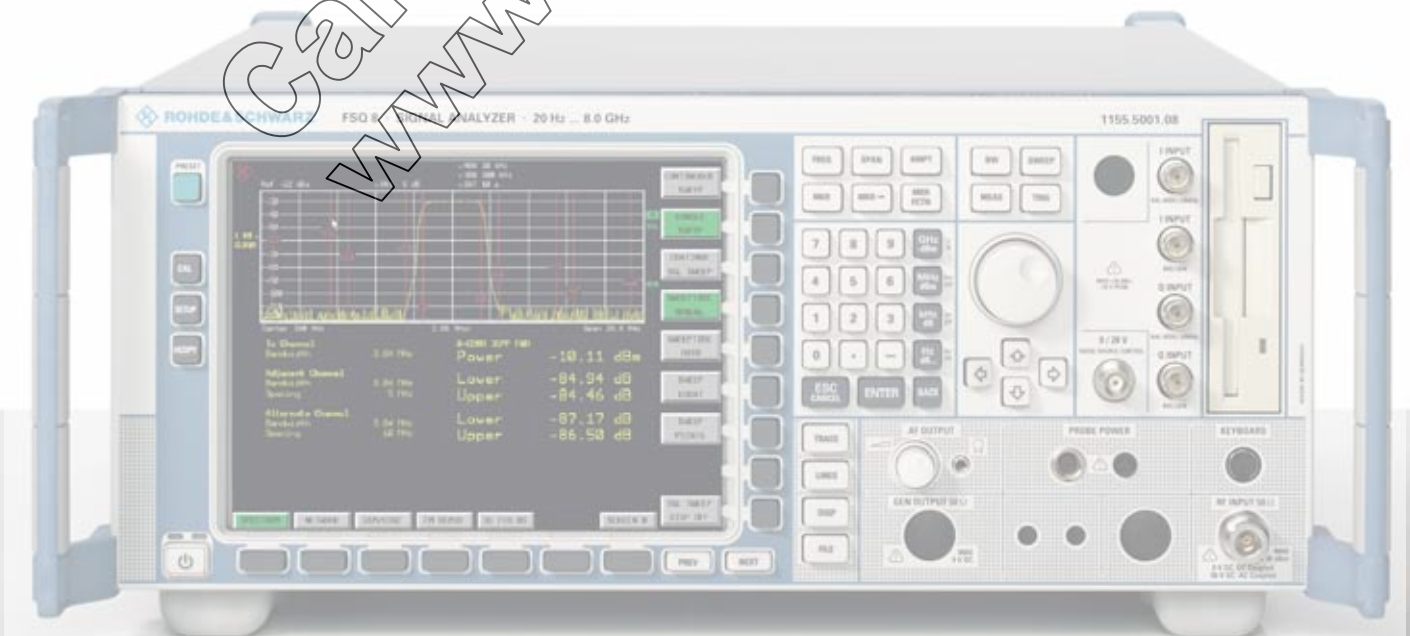
<sup>1)</sup> Except reference frequency.

<sup>2)</sup> Except parts subject to wear and tear (e.g. attenuators).

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## Condensed data

	R&S® FSQ 3	R&S® FSQ 8	R&S® FSQ 26	R&S® FSQ 40
Frequency range	20 Hz to 3.6 GHz	20 Hz to 8 GHz	20 Hz to 26.5 GHz	20 Hz to 40 GHz
Reference frequency	aging $1 \times 10^{-7}$ /year, with option R&S® FSU-B4: $2 \times 10^{-8}$			
<b>Spectral purity</b>				
Phase noise	typ. -123 dBc (1 Hz) at 10 kHz carrier offset			
Distortion	1 Hz			
<b>Sweep time</b>				
Span >10 Hz	2.5 ms to 16000 s			
Span 0 Hz (zero span)	1 $\mu$ s to 16000 s			
RBW	10 Hz to 50 MHz, FFT filter: 1 Hz to 30 kHz, channel filter, EMF bandwidth			
VBW	1 Hz to 10 MHz			
Display range	DANL to +30 dBm			
<b>DANL (10 Hz RBW)</b>				
1 GHz	typ. -148 dBm	typ. -145 dBm	typ. -146 dBm	typ. -145 dBm
7 GHz	-	typ. -144 dBm	typ. -145 dBm	typ. -143 dBm
13 GHz	-	-	typ. -141 dBm	typ. -141 dBm
26 GHz	-	-	typ. -136 dBm	typ. -137 dBm
40 GHz	-	-	-	typ. -131 dBm
DANL with preamplifier ON (R&S® FSU-B25), 1 GHz, 10 Hz RBW	-152 dBm	-152 dBm	-152 dBm	-152 dBm
DANL with preamplifier ON (R&S® FSU-B23), 26 GHz, 10 Hz RBW	-	-	-140 dBm	-
Trace detectors	max peak, min peak, auto peak, sample, rms, average, quasi peak			
Total measurement uncertainty, f < 3.6 GHz	0.3 dB			
Display linearity	0.1 dB (0 dB to -70 dB)			

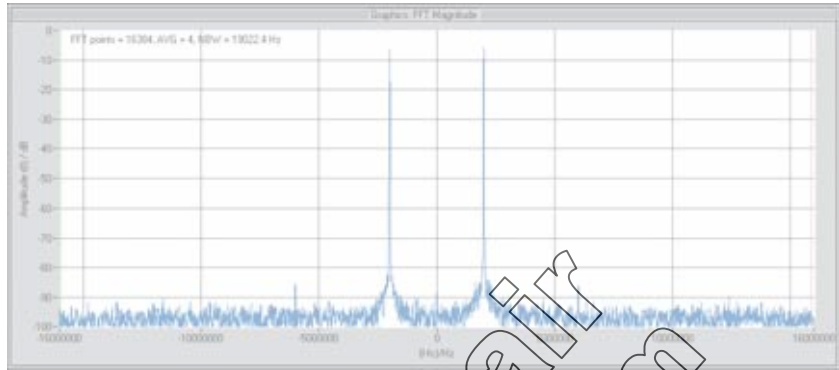


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# Future-proof performance and bandwidth

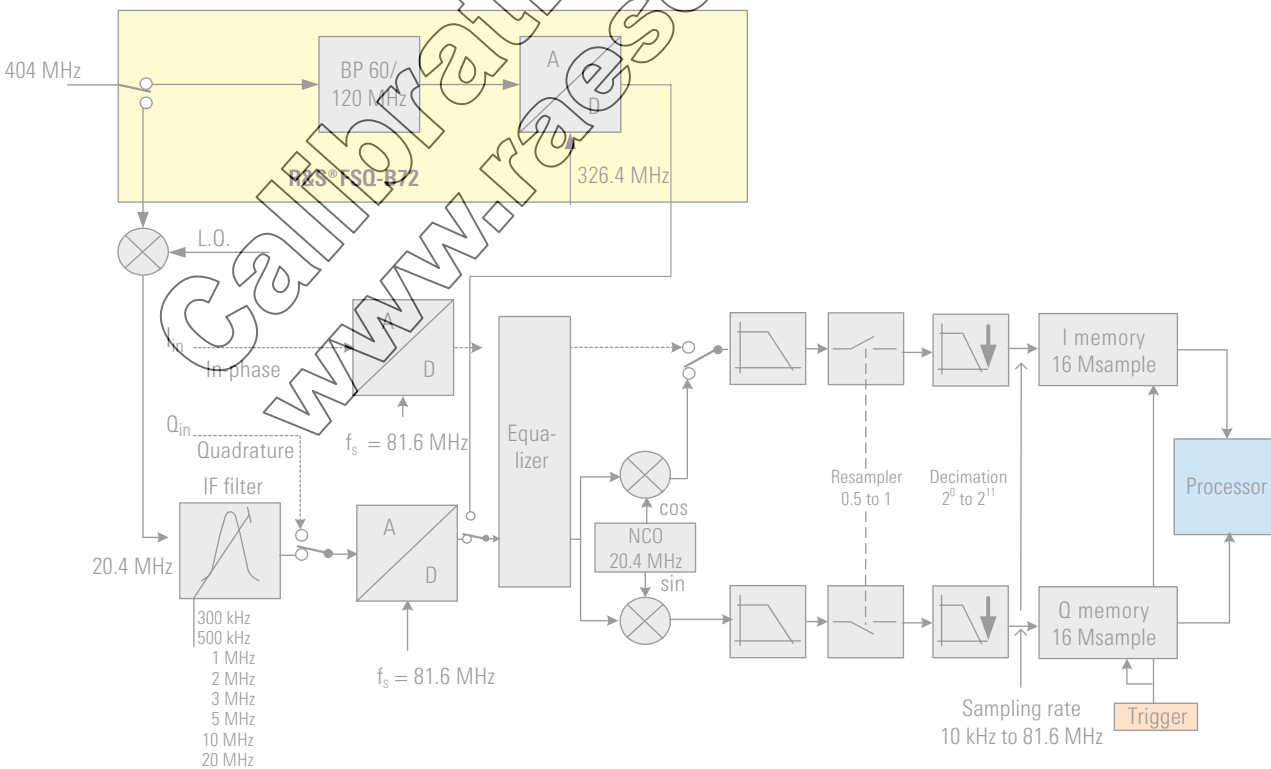
## Signal analysis with up to 120 MHz bandwidth

The R&S®FSQ features a newly developed digital back end that benefits from the progress in ADC and ASIC development. Time-consuming evaluation algorithms can be implemented directly in the hardware – a prerequisite for fast measurements and high accuracy.



Intermodulation distortion of I/Q data: a distortion-free transmission range is particularly important for amplifier measurements; the illustration above shows the intermodulation characteristics of the I/Q data of a two-tone signal.

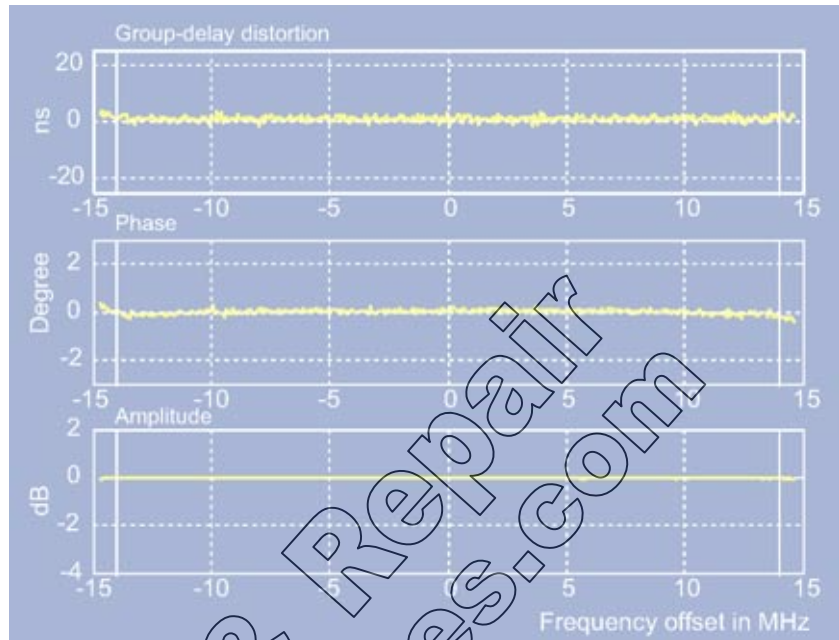
	Standard	With R&S®FSQ-B72
Demodulation bandwidth	28 MHz	60 MHz 120 MHz
ADC resolution	14 bit	8 bit
Sampling rate, selectable	10 kHz to 81.6 MHz	81.6 MHz to 326.4 MHz
Third-order intermodulation	80 dB	typ. 58 dB



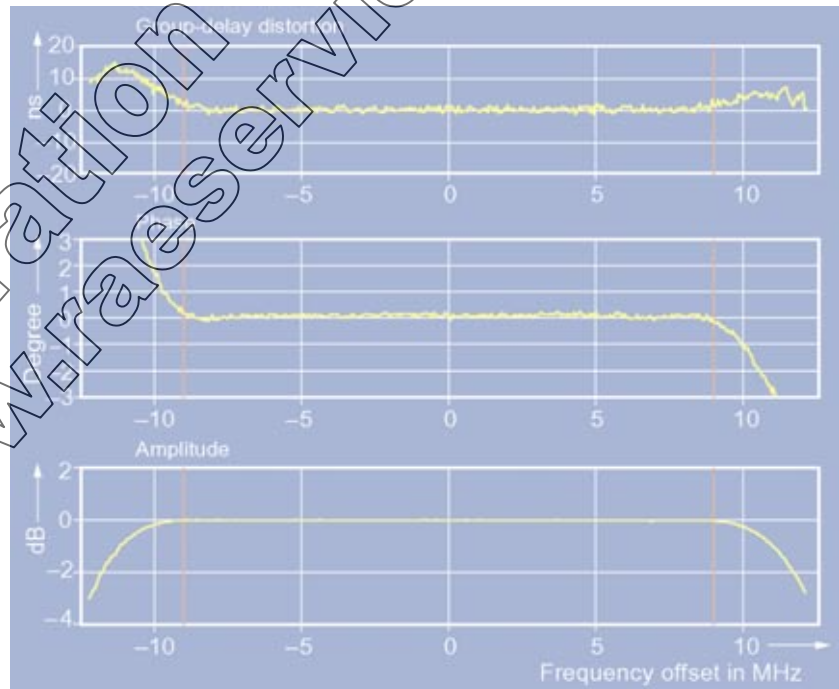
Block diagram of vector signal analysis section in the R&S®FSQ.

The R&S®FSQ determines the linear distortion in the RF and IF paths with the aid of the built-in calibration source and corrects such distortion online using a compensation filter. Moreover, the bandwidth-limiting YIG filter can be switched off in the microwave range at carrier frequencies greater than 3.6 GHz to ensure that even the smallest modulation errors can be measured with high accuracy.

The I/Q data can be transferred to a process controller via either the IEC/IEEE bus interface or the factory-installed LAN interface and then imported into programs such as MatLab for further analysis.



Frequency response and group-delay distortion of 50 MHz resolution filter (example).



Frequency response and group-delay distortion of 20 MHz resolution filter (example).

# Shorter development cycles through versatile functions ...

To handle the wide variety of measurement tasks in product development, an instrument should provide ample functionality and excellent performance in all areas of interest. The R&S®FSQ fully meets these requirements.

Full choice of detectors (Fig. 1) for adaptation a wide range of signal types:

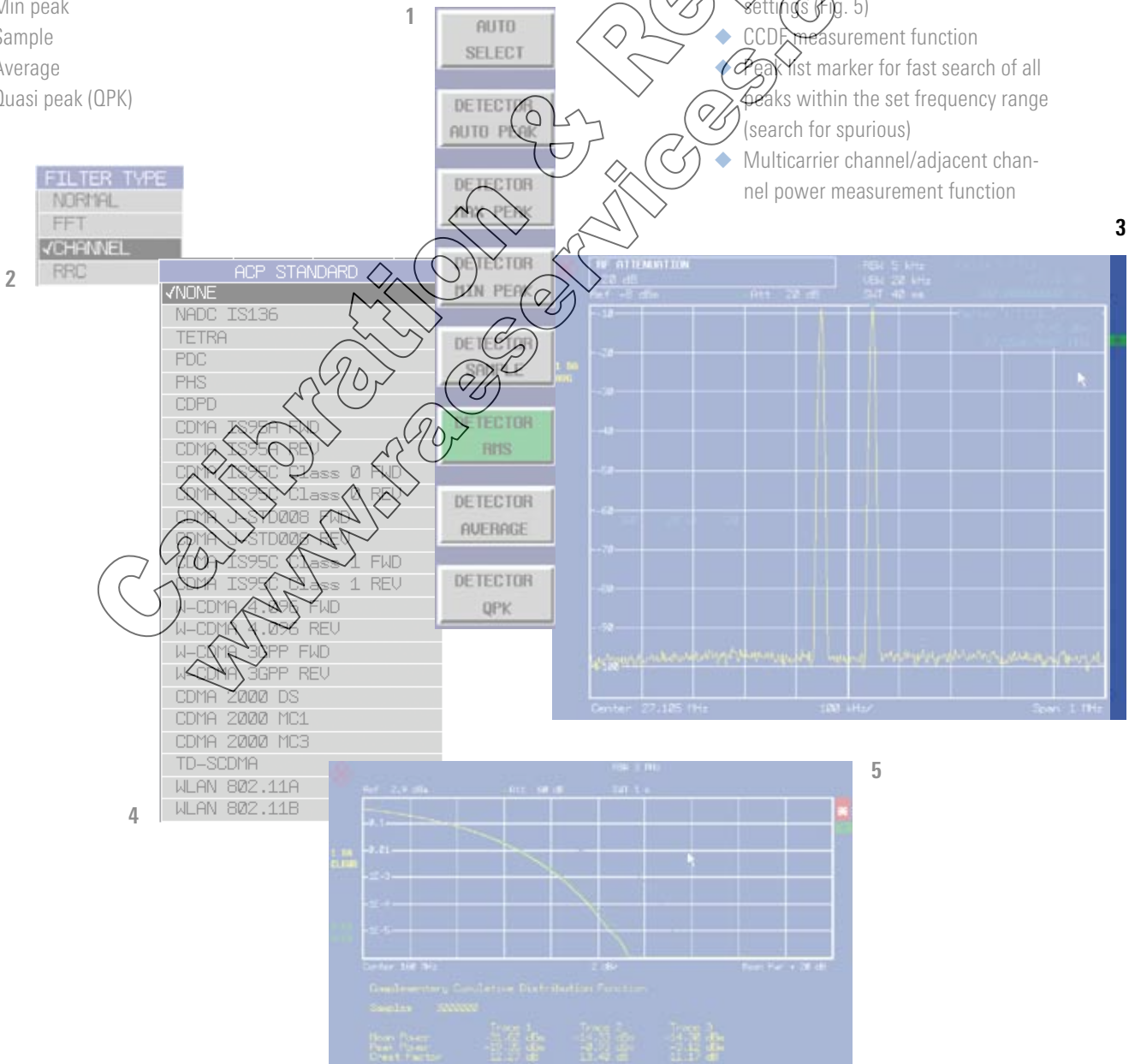
- ◆ RMS
- ◆ Auto peak
- ◆ Max peak
- ◆ Min peak
- ◆ Sample
- ◆ Average
- ◆ Quasi peak (QPK)

The most versatile resolution filter characteristics and largest bandwidth found in a spectrum analyzer:

- ◆ Standard resolution filters from 10 Hz to 50 MHz in steps of 1, 2, 3, 5
- ◆ FFT filters from 1 Hz to 30 kHz
- ◆ 32 channel filters with bandwidths from 100 Hz to 5 MHz
- ◆ RRC filters for NADC, TETRA and 3GPP
- ◆ EMI filters: 200 Hz, 9 kHz, 120 kHz

Full range of analysis functions:

- ◆ Time domain power in conjunction with channel or RRC filters turn the R&S®FSQ into a fully-fledged channel power meter (Fig. 2)
- ◆ TOI marker (Fig. 3)
- ◆ Noise/phase-noise marker
- ◆ Versatile channel/adjacent-channel power measurement functions with wide selection of standards; user-configurable (Fig. 4)
- ◆ Split-screen mode with selectable settings (Fig. 5)
- ◆ CCDF measurement function
- ◆ Peak list marker for fast search of all peaks within the set frequency range (search for spurious)
- ◆ Multicarrier channel/adjacent channel power measurement function



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# ... wide dynamic range and future-proof performance

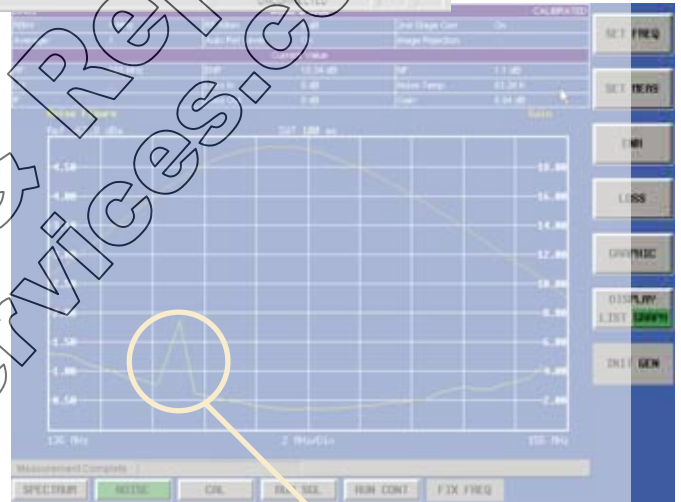
Whether in synthesizer development or front-end design, additional applications expand the R&S®FSQ functionality while ease-of-use is maintained.

Phase Noise Measurement Software **R&S®FS-K4** automates measurement over a complete offset frequency range, and determines residual FM from the phase noise characteristic. In conjunction with the extremely low phase noise of the R&S®FSQ, this eliminates in many cases the need for an extra phase noise measurement system that may even be difficult to operate.

Noise Measurement Application Firmware **R&S®FS-K30** is a convenient tool to determine the noise figure of amplifiers and frequency-converting DUTs throughout the frequency range of the R&S®FSQ, thus enabling complete documentation. The high linearity and extremely accurate power measurement routines of the R&S®FSQ provide precise and reproducible results, making a separate noise figure meter unnecessary.

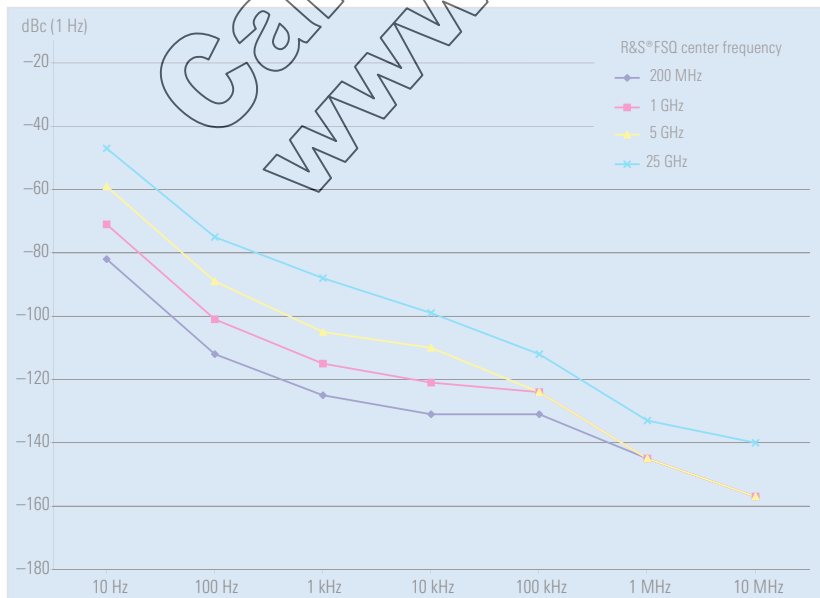


Phase noise measurement using Phase Noise Measurement Software R&S®FS-K4.



Noise figure measurement using Application Firmware R&S®FS-K30.

Fast and simple analysis of anomalies. The cause – spurious or RFI – can easily be traced with the basic analyzer function without additional measuring equipment.



Phase noise of the R&S®FSQ at various center frequencies.

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# Shorter development cycles through versatile functions ...

## Measuring frequency deviation after settling

The option R&S®FS-K7 adds a measurement demodulator for analog AM, FM and  $\phi$ M modulation, allowing not only the frequency deviation but also e.g. the frequency settling of oscillators to be determined. Analyzing the demodulated signal is possible with FFT. In addition, THD and SINAD are also measured.



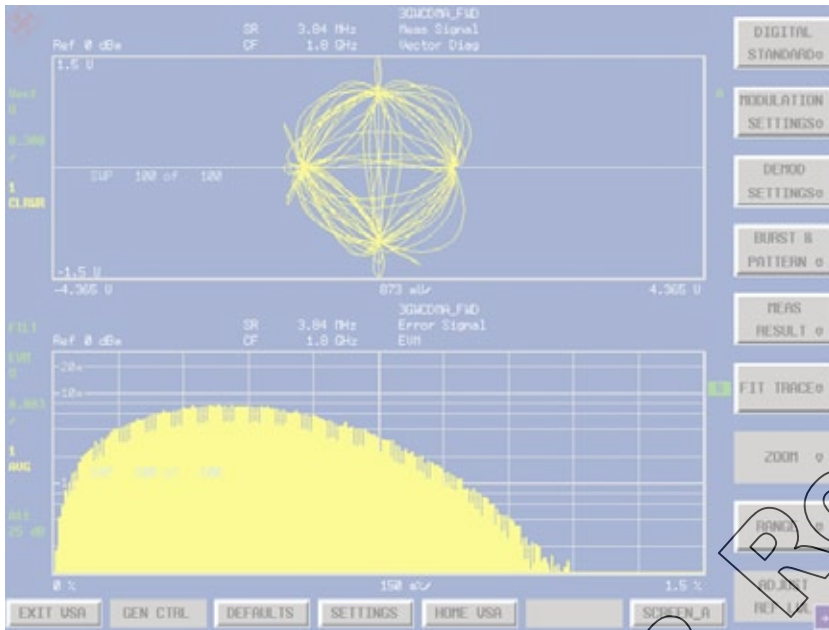
## Software options and function expansions for general applications

R&S®FS-K4	Phase noise measurements (Windows software)
R&S®FS-K7	AM/FM/ $\phi$ M measurement demodulator with measurement of modulation frequency, THD, SINAD and spectrum (FFT) of the demodulated signal
R&S®FS-K9	Power sensor measurements (supports R&S®NRP-211/-221 with R&S®NRP-Z4 USB adapter)
R&S®FS-K30	Noise figure measurements (application firmware), functions similar to R&S®FS-K3, but remote-controllable
R&S®FSQ-K70	Universal vector signal analysis: FSK, MSK, BPSK, up to 256QAM, symbol rates up to 25 Msymbol/s (up to 81.6 Msymbol/s with R&S®FSQ-R72)



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## ... wide dynamic range and future-proof performance



Convenient analysis with vector diagram. The upper screen (A) shows the complete constellation diagram, the lower screen (B) the probability distribution of the error vector magnitude (EVM).

### Universal analysis of digital radio signals

The optional Vector Signal Analyzer **R&S®FSQ-K70** upgrades the high-quality Signal Analyzers R&S®FSQ, adding universal demodulation and analysis capability down to bit stream level for digital radio signals.

#### For all major mobile radio communications standards:

- ◆ GSM and EDGE
- ◆ WCDMA-QPSK
- ◆ cdma2000-QPSK
- ◆ Bluetooth
- ◆ TETRA
- ◆ PDC
- ◆ PHS
- ◆ DECT
- ◆ NADC

#### For all common digital modulation modes:

- ◆ BPSK, QPSK, OQPSK
- ◆  $\pi/4$  DQPSK
- ◆ 8PSK, D8PSK,  $3\pi/8$  8PSK
- ◆ (G)MSK
- ◆ 2, 4, (G)FSK
- ◆ 16, 32, 64, 128, 256 (D)QAM



AM/ $\phi$ M and AM/AM distortion example with a 16QAM signal. The picture shows the AM/AM and AM/ $\phi$ M conversion curve of the same signal.

#### Optimum representation of results:

- ◆ In-phase and quadrature signals versus time
- ◆ Magnitude and phase versus time
- ◆ Eye diagram
- ◆ Vector diagram
- ◆ Constellation diagram
- ◆ Table with modulation errors
- ◆ Demodulated bit stream
- ◆ Spectral evaluation

- ◆ Statistical evaluation of modulation parameters
- ◆ Amplifier distortion measurements

#### 25 MHz symbol rate

- ◆ With R&S®FSQ-B72 up to 81.6 MHz symbol rate

#### 28 MHz I/Q demodulation bandwidth

- ◆ Extendable up to 120 MHz

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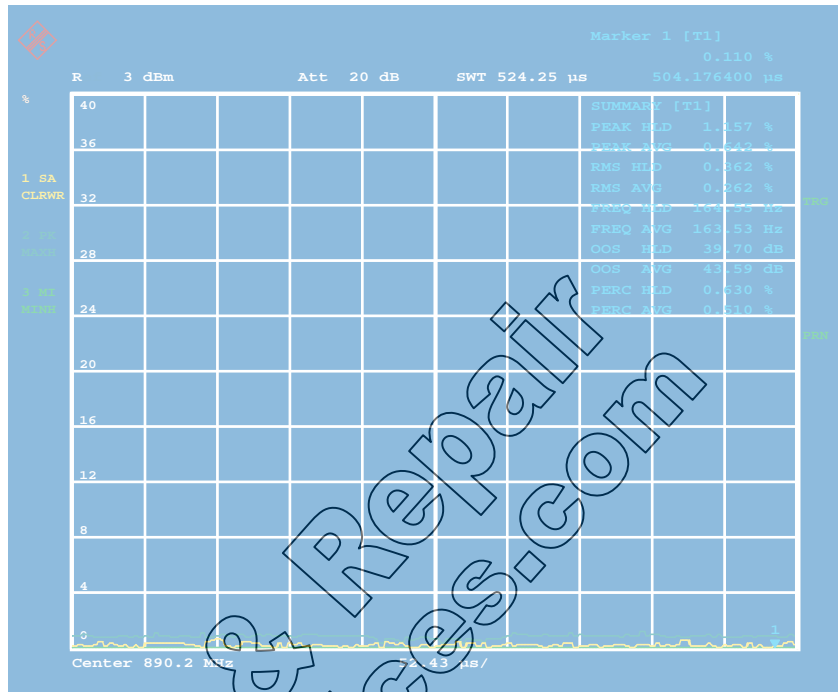
# From GSM to UMTS ...

## From GSM to UMTS – ready for 3G mobile radio

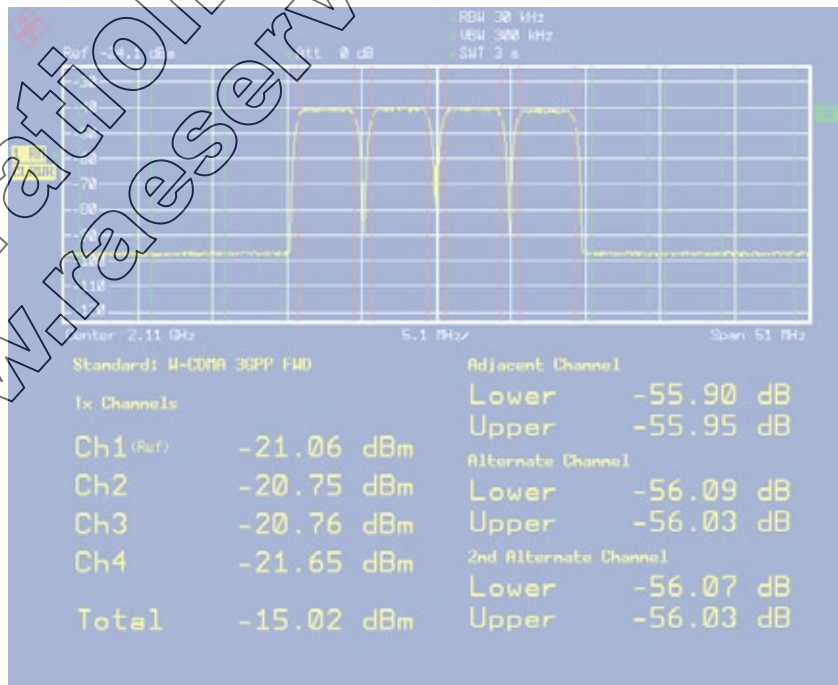
The above features plus its wide dynamic range make the R&S®FSQ an ideal tool in base station development and testing. This is enhanced by the excellent features that are provided by the R&S®FSQ as standard, such as <0.3 dB total measurement uncertainty, gated sweep function and IF power trigger.

Even in its basic version, the R&S®FSQ provides the functionality and characteristics needed to develop, verify and manufacture 3G mobile radio systems:

- ◆ RMS detector, provided as standard in Rohde & Schwarz analyzers for many years and allowing accurate power measurements independently of the waveform. 3GPP specifications stipulate RMS power measurements for most tests
- ◆ ACP measurement function for 3GPP with 3.84 MHz bandwidth RRC filter for standard-conformant adjacent-channel power measurements with a dynamic range limit of 72 dB, or 84 dB with noise correction (one carrier)
- ◆ Dedicated CCDF measurement function that determines the probability of instantaneous signal power exceeding average power. The CCDF measurement is indispensable in determining the optimum transmit power for CDMA signals, assuming that clipping at known, short intervals is tolerable



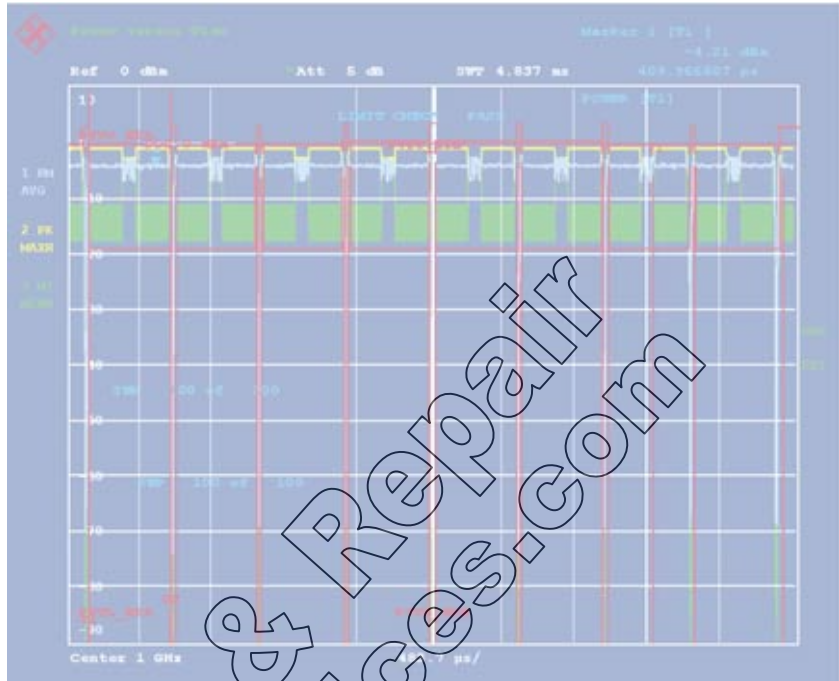
Measurement of modulation accuracy on EDGE burst.



ACP measurement with 4 channels.

In conjunction with GSM/EDGE Application Firmware **R&S®FS-K5**, the R&S®FSQ provides complete functionality for RF and modulation measurements in GSM systems. EDGE (generation 2.5), is already included in the R&S®FS-K5 option.

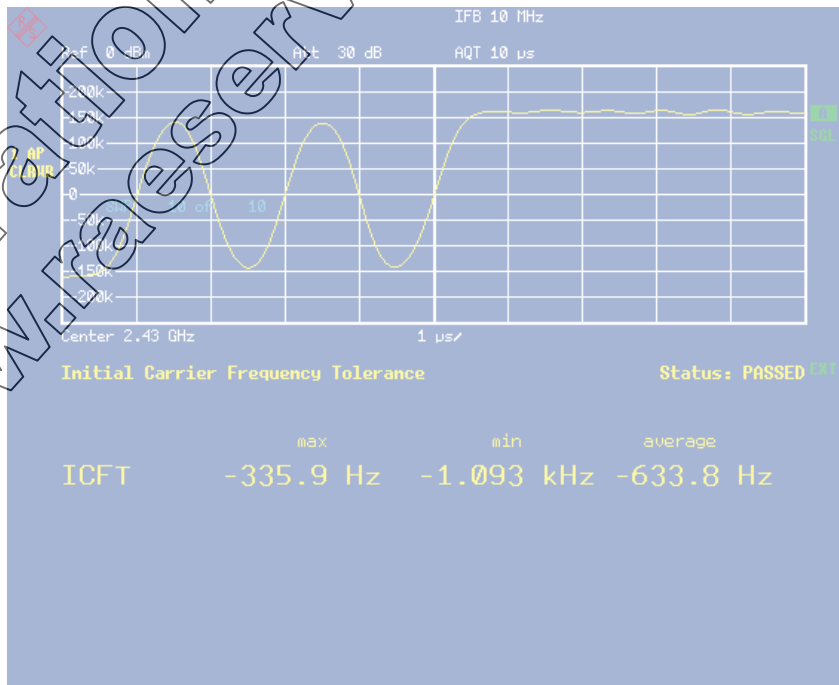
- ◆ Phase/frequency error for GSM
- ◆ Modulation accuracy for EDGE with:
  - EVM and ETSI-conformant weighting filters
  - OOS
  - 95:th percentile
  - Power versus time with synchronization to midamble
  - Spectrum due to modulation
  - Spectrum due to transients



Simultaneous measurement of power vs time of an eight slot EDGE signal.

### Bluetooth® signal measurement (R&S®FS-K8)

- ◆ Enhanced measurement functionality in line with *Bluetooth* RF Test Specification (*Bluetooth* SIG) Rev. 0.91
- ◆ Measurement functions
  - Output power
  - Adjacent channel power (ACP)
  - Modulation characteristics
  - Initial carrier frequency tolerance (ICFT)
  - Carrier frequency drift
- ◆ Simultaneous display of traces and all numerical measurement results
- ◆ Automatic limit value monitoring
- ◆ Ideal for use in development and production of *Bluetooth* modules



Measurement of initial carrier frequency tolerance of a Bluetooth signal with R&S®FS-K8.

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## ... ready for 3G mobile radio

### Standard 3GPP modulation and code domain power measurements

- ◆ Additional measurement functions in line with 3GPP specifications for FDD and TDD LCR modes
- ◆ High measurement speed of 4 s/measurement for 3 GPP BTS signals
- ◆ Code domain and CPICH power
- ◆ Code domain power and rho (cdma2000/3GPP2)
- ◆ EVM and PCDE
- ◆ Code domain power vs slot
- ◆ EVM/code channel
- ◆ Spectrum emission mask
- ◆ Constellation (symbol, composite)



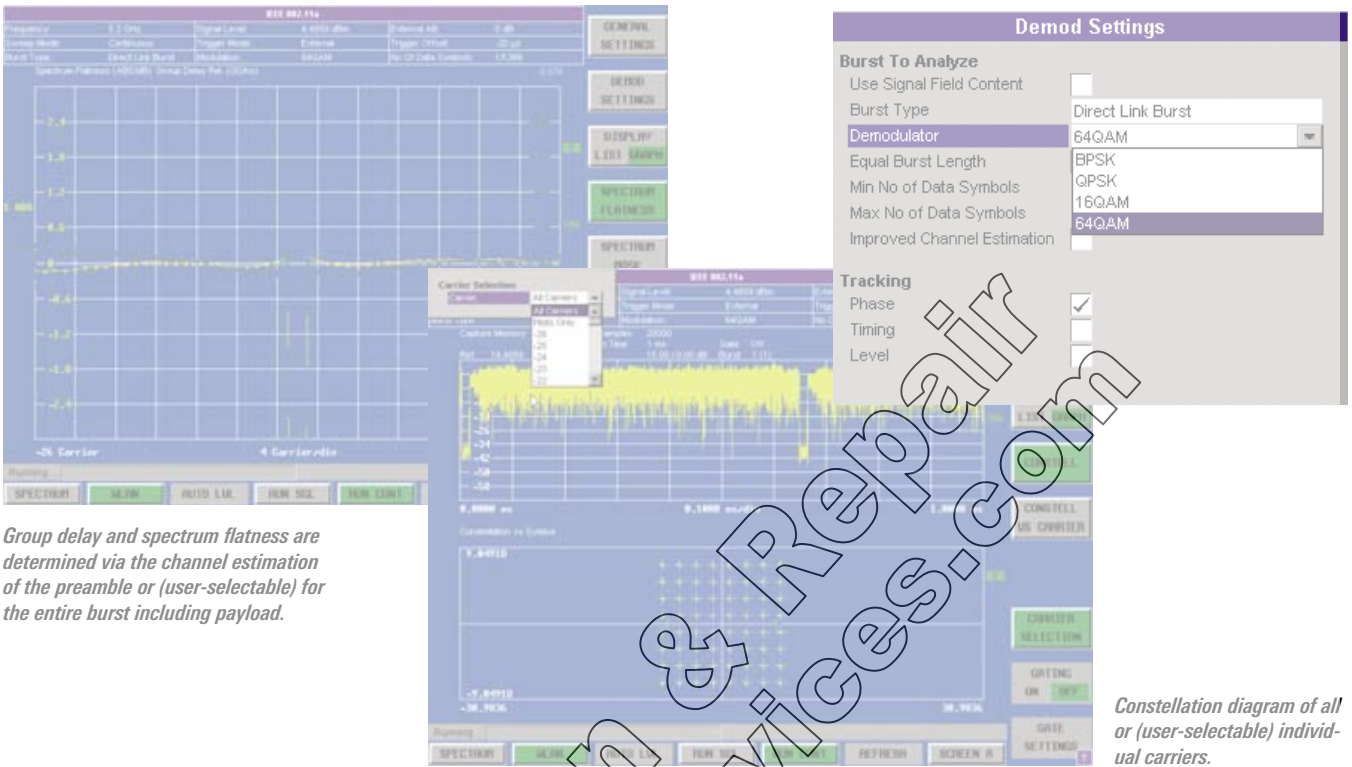
WCDMA code domain power measurement with the R&S® FSQ and R&S® FS-K72.

### Firmware options for mobile radio applications

Type	Designation and/or application
R&S®FS-K5	Modulation and spectrum measurements on GSM/EDGE base station and mobile signals
R&S®FS-K8	Bluetooth transmitter measurements
R&S®FS-K9	Power sensor measurements (supports R&S®NRP-Z11/-Z21 with R&S®NRP-Z4 USB adapter)
R&S®FS-K30	Noise figure measurements (application firmware), functions similar to R&S®FS-K3, but remote-controllable
R&S®FS-K72	Modulation and code domain power measurements to 3GPP TS 24.141 on base station signals (node B)
R&S®FS-K73	Modulation and code domain power measurements to 3GPP TS 25.121 on mobile station signals (UE)
R&S®FS-K74	HSDPA extension for R&S®FS-K72
R&S®FS-K76	Modulation and code domain power measurements on TD-SCDMA base station signals
R&S®FS-K77	Modulation and code domain power measurements on TD-SCDMA mobile station signals (UE)
R&S®FS-K82	Modulation and code domain power measurements to cdma2000/3GPP2 on base station signals (also for measurements on IS-95/cdmaOne signals)
R&S®FS-K83	Modulation and code domain power measurements on cdma2000/1xEV-DV mobile station signals (UE)
R&S®FS-K84	Modulation and code domain power measurements on cdma2000/1xEV-DO mobile station signals (UE)
R&S®FS-K85	Modulation and code domain power measurements to 1xEV-DO on base station signals
R&S®FSQ-K91	Modulation and spectrum measurements on WLAN signals to 802.11 a/b/g/j

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# WLAN measurements



Group delay and spectrum flatness are determined via the channel estimation of the preamble or (user-selectable) for the entire burst including payload.

Constellation diagram of all or (user-selectable) individual carriers.

Application Firmware R&S® FSQ-K91 provides the R&S® FSQ with modulation and spectrum measurements on WLAN signals according to 802.11 a/b/g/j.

OFDM (802.11a/g/j)	DSSS (802.11/b)
<b>Modulation formats</b>	
OFDM with BPSK, QPSK, 16QAM, 64QAM	DBPSK, DQPSK, CCK, short PLCP, long PLCP
<b>Modulation measurements</b>	
Constellation diagram	Constellation diagram
Constellation diagram per OFDM carrier	–
I/Q offset and I/Q imbalance	I/Q offset and I/Q imbalance
Carrier and symbol frequency error	Carrier and symbol frequency error
Modulation error (EVM) per OFDM carrier or symbol	Modulation error (EVM)
Amplitude flatness and spectral flatness	–
CCDF and crest factor	CCDF and crest factor
Transmit spectrum mask	Spectrum mask (IEEE and ETSI)
FFT, also across a selected part of the signal, e.g. preamble	FFT
Payload bit information	Payload bit information header
Sample size selectable up to 50 ms	Sample size selectable up to 50 ms
<b>Trigger</b>	
Free run	Free run
External	External
IF power	IF power
<b>Typical inherent errors for 802.11a measurements</b>	<b>Typical inherent errors for 802.11b measurements</b>
EVM –45 dB	EVM 0.7% (RF = 2.4 GHz)
Spectral flatness 0.5 dB	–

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## Benefit from networking

### Versatile documentation and networking capabilities

The Windows XP Embedded operating system coupled with a wide variety of interfaces makes it easy to insert measurement results into documentation. Simply save the screen contents as a BMP or WMF file and import them into your word processing system. To process trace data, save the data as an ASCII file (CSV format), which not only documents trace data but also the main instrument settings.

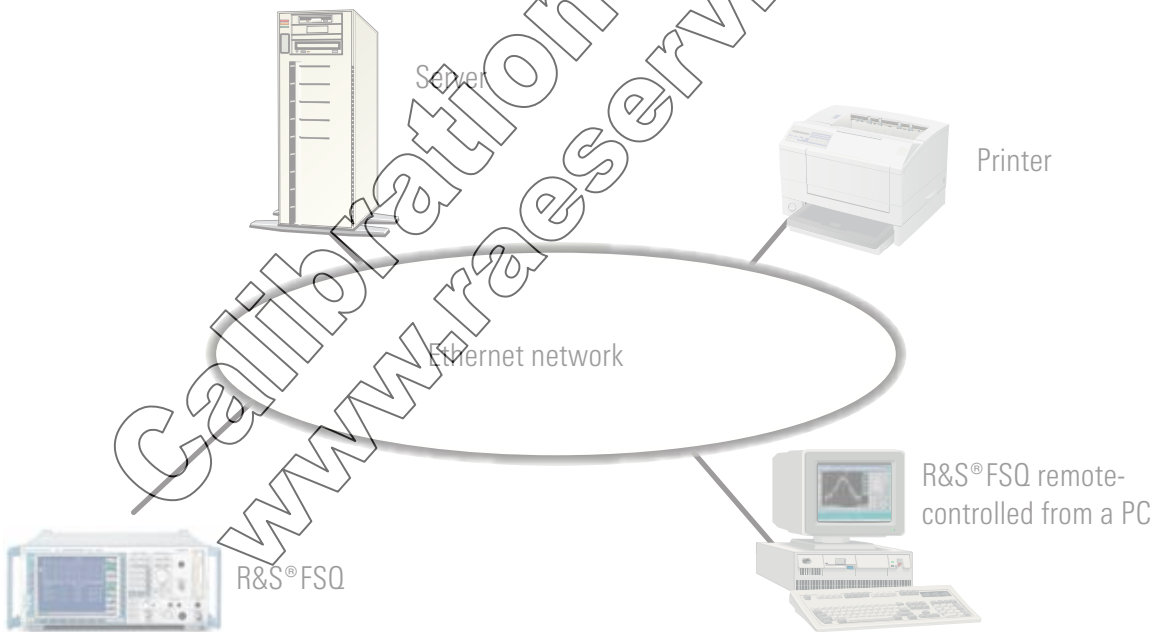
### Advantages of networking

The standard LAN interface opens up versatile networking capabilities:

- ◆ Link to standard network (Ethernet 10/100 BaseT)
- ◆ Running under Windows XP Embedded, the R&S®FSQ can be configured for network operation. Applications such as data output to a central network printer or saving results on a central server can easily be implemented. The R&S®FSQ can thus be optimally matched to your work environment

- ◆ Screen contents can be imported directly into Word for Windows or, by using an Excel macro, into your documentation programs and thus immediately create data sheets for your products or documents for quality assurance

Remote control via Ethernet is simple. The special RSIB software links your application to the TCP/IP protocol and acts like an IEC/IEEE bus driver. The RSIB software is available for Windows and the UNIX world. The R&S®FSQ can be programmed via this interface just like on the familiar IEC/IEEE bus.



*The R&S®FSQ in network operation.*

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## Ordering information

Designation	Type	Order No.
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

## Options

Designation	Type	Order No.
Low-Aging OXCO	R&S®FSU-B4	1144.9000.02
Tracking Generator, 100 kHz to 3.6 GHz	R&S®FSU-B9	1142.8994.02
External Generator Control	R&S®FSU-B11	1129.7246.02
Attenuator for Tracking Generator R&S®FSU-B9	R&S®FSU-B12	1142.9349.02
Removable Hard Disk	R&S®FSU-B18	1145.0242.05
Second Hard Disk for R&S®FSQ-B18	R&S®FSU-B19	1145.0394.05
LO/IF Ports for External Mixers	R&S®FSU-B21	1157.1090.02
RF Preamp, 3.6 GHz to 26 GHz, for R&S®FSQ26	R&S®FSU-B23	1157.0907.03
Electronic Attenuator, 0 dB to 30 dB, and 20 dB preamplifier	R&S®FSU-B25	1144.9298.02
Analog Baseband Inputs	R&S®FSQ-B71	1157.0113.02
I/Q Bandwidth Extension to 60 MHz/120 MHz	R&S®FSQ-B72	1157.0336.02

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