Version 01.00

September 2007

# R&S®FSG Spectrum Analyzer

## Spectrum analysis for wideband communication technologies

- Up to 8 GHz and 13 GHz
- 28 MHz I/Q demodulation bandwidth
- 4 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® 1xRTT
  - CDMA2000® 1xEV-DV
  - CDMA2000® 1xEV-DO
  - TD-SCDMA
- Spectrum and modulation measurements for
  - GSM/EDGE
  - WLAN
  - WiMAX
  - LTE 3GPP
  - Bluetooth®
- Fast, fully integrated 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
- Power sensor compatibilty

LXI conformant

ROHDE&SCHWARZ

# Future-proof performance and bandwidth

## Spectrum and signal analysis in a single instrument

Future transmission methods in mobile radio and broadband communication call for wider transmission bandwidths to handle increasing data throughput. Today, multiple carriers of a GSM or 3GPP base station are often boosted in common power output stages to reduce the technical effort and cost. This approach on the other hand increases the bandwidth to be transmitted. In both cases, analysis bandwidths exceeding those provided by most spectrum analyzers are required in development and production, while at the same time the dynamic range must satisfy stringent requirements.

The R&S®FSG is ideal for applications in the development and production of the following:

- 3GPP and GSM-MCPA
- WiMAX
- LTE
- Wireless LAN (WLAN)

It additionally supports measurements on 2G, 2.5G, and 3G mobile radio systems when using application firmware such as:

- GSM/EDGE, R&S®FS-K5
- 3GPP FDD, R&S®FS-K72/-K73
- HSDPA, R&S®FS-K74
- CDMA2000®, R&S®FS-K82/-K83/-K84/-K85
- TD-SCDMA, R&S®FS-K76/-K77

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

**The R&S®FSG family**

| | |
|---|---|
| R&S®FSG 8 | 9 kHz to 8 GHz |
| R&S®FSG 13 | 9 kHz to 13.6 GHz |

## The R&S®FSG has a lot to offer

The R&S®FSG is a full-fledged high-performance spectrum analyzer:

- 84 dB ACLR for 3GPP with noise correction
- 77 dB ACLR for 3GPP multicarrier signals (4 adjacent carriers)
- TOI >+20 dBm, typ. +25 dBm
- 1-dB compression +13 dBm
- Displayed average noise level (DANL) –158 dBm (1 Hz bandwidth)
- Phase noise –150 dBc (1 Hz) at 10 MHz carrier offset
- Phase noise –114 dBc (1 Hz) at 10 kHz carrier offset

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

## Functions at a glance

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

| |
|---|
| GPIB interface, IEEE 488.2 |
| RS-232-C serial interface, 9-pin D-Sub |
| LAN interface 100BaseT |
| USB connector |
| VGA output, 15-pin D-Sub |
| SCPI-compatible GPIB command set |
| R&S®FSE/R&S®FSIQ-compatible GPIB command set |
| Up to 80 measurements/s in manual mode |
| Up to 50/70 measurements/s in GPIB mode |
| Fast FFT filters from 1 Hz to 30 kHz |
| 2.5 ms sweep time in frequency domain |
| 1 µs sweep time in time domain |
| Fast ACP measurement in time domain |
| Harmonic distortion measurement function |
| Statistical signal analysis with CCDF function |
| RMS detector with 100 dB dynamic range |
| Spurious emission measurements with up to 100001 points, in up to 20 segments |
| Number of measurement points/trace selectable between 155 and 30001 |
| Transducer factor for correcting antenna or cable frequency responses |
| Time-selective spectrum analysis with gating function |
| 1 Hz to 10 MHz resolution bandwidth (RBW) |
| Highly selective digital filters from 10 Hz to 100 kHz |
| 4 Msample I and Q memory |
| External reference from 1 MHz to 20 MHz in 1 Hz steps |
| PC-compatible screenshots on USB or hard disk |
| Two-year calibration interval[1)] |

[1)] Except reference frequency.

## Condensed data

| | R&S®FSG8 | R&S®FSG13 |
|---|---|---|
| Frequency range | 9 kHz to 8 GHz | 9 kHz to 13 GHz |
| Reference frequency | aging: $1 \times 10^{-7}$/year | |
| **Spectral purity** | | |
| Phase noise | typ. –114 dBc (1 Hz) at 10 kHz carrier offset | |
| **Sweep time** | | |
| Span >10 Hz | 2.5 ms to 16000 s | |
| Span 0 Hz (zero span) | 1 µs to 16000 s | |
| RBW | 1 Hz to 10 MHz | |
| VBW | 1 Hz to 30 MHz | |
| Display range | DANL to +30 dBm | |
| **DANL (1 Hz RBW)** | | |
| 1 GHz | typ. –155 dBm | typ. –156 dBm |
| 7 GHz | typ. –154 dBm | typ. –155 dBm |
| 13 GHz | – | typ. –151 dBm |
| DANL with preamplifier ON (R&S®FSU-B25), 1 GHz, 1 Hz RBW | –162 dBm | –162 dBm |

# 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®FSG fully meets these requirements.

Full choice of detectors for adaptation to a wide range of signal types:

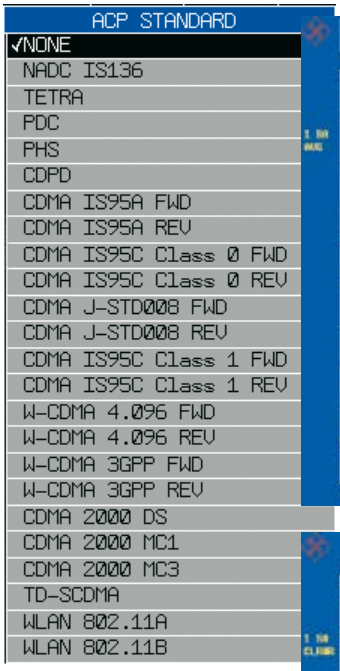
- RMS
- Auto peak
- Max peak
- Min peak
- Sample
- Average

Large range of resolution filters:

- Standard resolution filters from 10 Hz to 10 MHz in 1/2/3/5 sequence
- FFT filters from 1 Hz to 30 kHz
- Five-pole filter in line with GSM specifications

Full range of analysis functions:

- Time domain power turns the R&S®FSG into a full-fledged channel power meter
- TOI marker (Fig. 1)
- Noise/phase-noise marker
- Versatile channel/adjacent-channel power measurement functions with wide selection of standards; user-configurable (Fig. 2)
- Split-screen mode with selectable settings (Fig. 3)
- CCDF measurement function
- Peak list marker for fast search of all peaks in the set frequency range (search for spurious)
- Multicarrier channel/adjacent channel power measurement function

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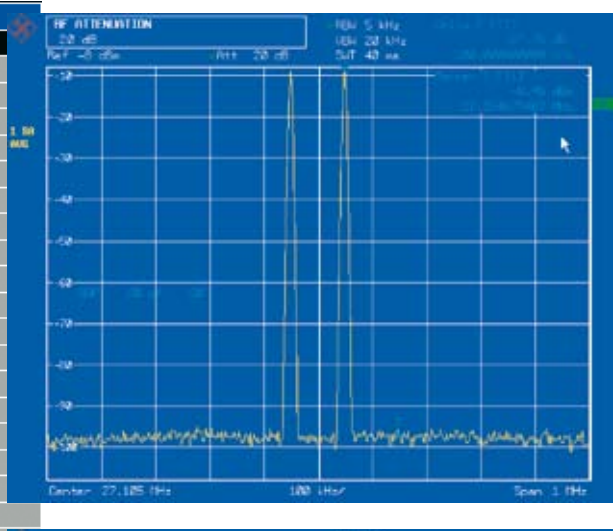

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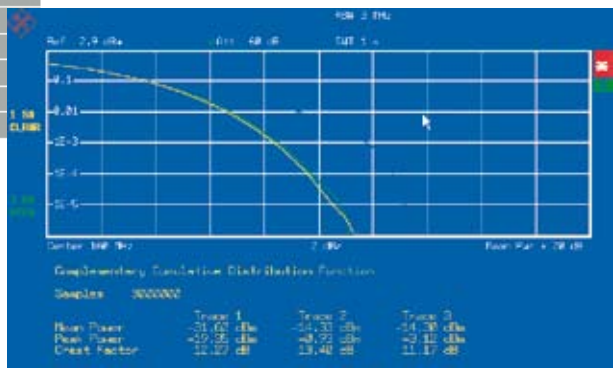
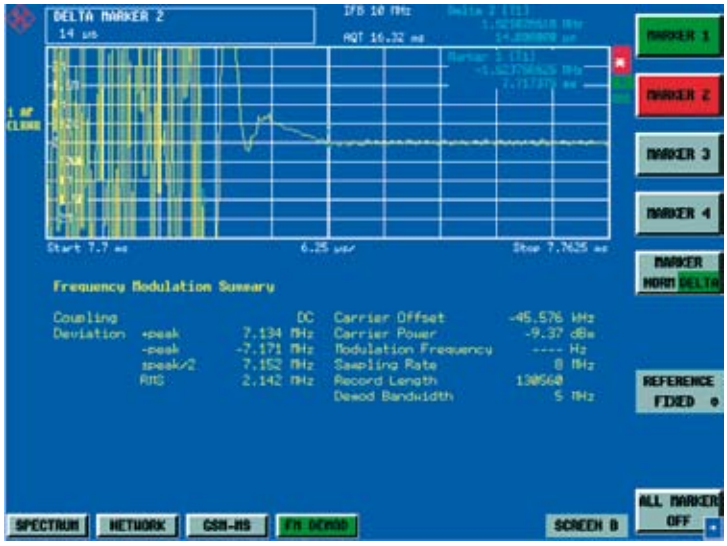


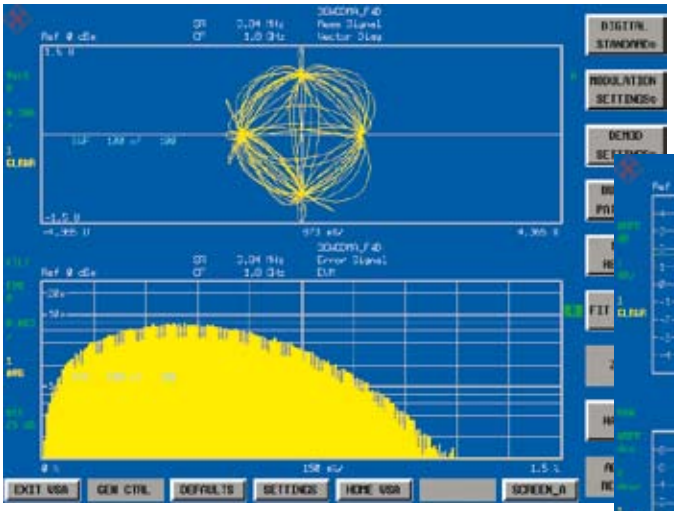
3

## Measuring frequency deviation after settling

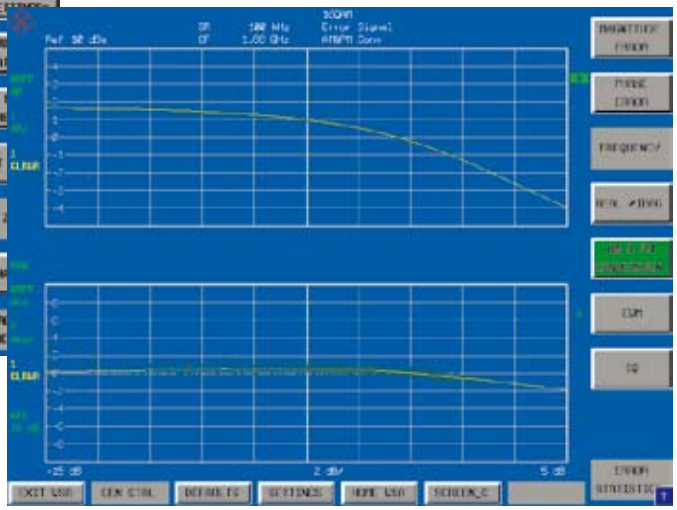
The R&S®FS-K7 option adds a measurement demodulator for analog AM, FM, and φM modulation, allowing not only the frequency deviation but also the frequency settling of oscillators to be determined, for example. Analyzing the demodulated signal is possible with FFT. In addition, THD and SINAD are also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



# … 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).*



*AM/φM and AM/AM distortion example with a 16QAM signal. The picture shows the AM/AM and AM/φM conversion curve of the same signal.*

## Universal analysis of digital radio signals

The optional R&S®FSQ-K70 vector signal analyzer upgrades the high-quality R&S®FSG spectrum analyzers, adding universal demodulation and analysis capability down to bit stream level for digital radio signals.

**For all major mobile radiocommunications standards:**

- GSM and EDGE
- WCDMA-QPSK
- CDMA2000®-QPSK
- Bluetooth®
- TETRA
- PDC
- PHS
- DECT
- NADC
- APCO25

**Ready for wideband communication:**

- 25 MHz symbol rate
- 28 MHz I/Q demodulation bandwidth

**For all common digital modulation modes:**

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

**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

## Software options and function expansions for general applications

| | |
|---|---|
| R&S®FS-K7 | AM/FM/φM measurement demodulator for determining modulation frequency, THD, SINAD, and spectrum (FFT) of the demodulated signal |
| R&S®FS-K9 | Power sensor measurements |
| R&S®FS-K30 | Noise figure and gain measurements |
| R&S®FS-K40 | Phase noise measurements |
| R&S®FSQ-K70 | Universal vector signal analysis, FSK, MSK, BPSK, up to 256QAM, symbol rates up to 25 Msymbol/s |

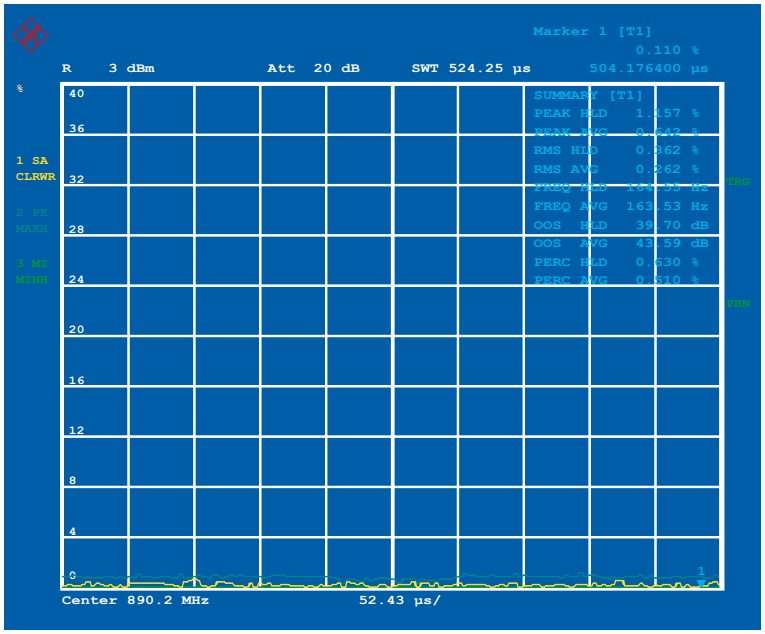
# From GSM to UMTS long term evolution…

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

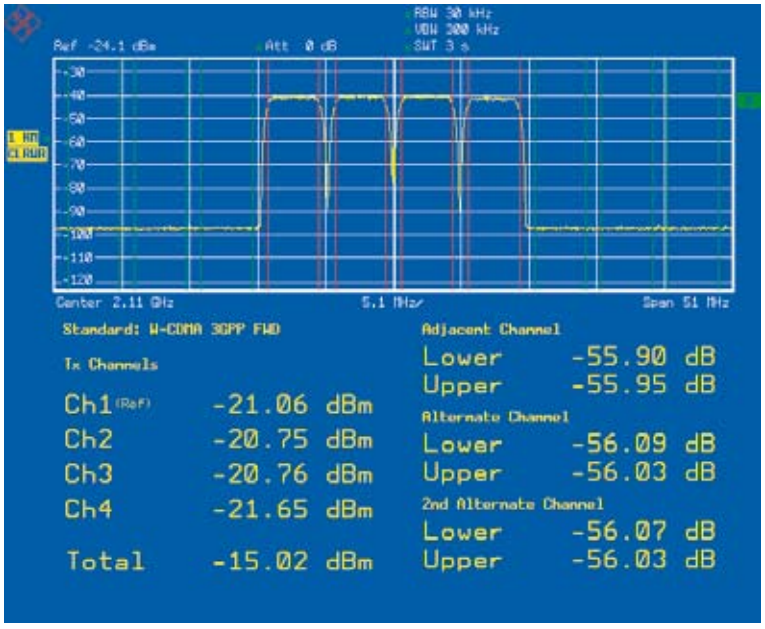
The feature set plus its wide dynamic range make the R&S®FSG an ideal tool in base station development and testing. This is enhanced by the excellent features that are provided by the R&S®FSG as standard, such as <0.3 dB total measurement uncertainty, gated sweep function, and IF power trigger.

Even in its basic version, the R&S®FSG 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-conforming adjacent-channel power measurements with a dynamic range limit of 77 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 clipping of the signal



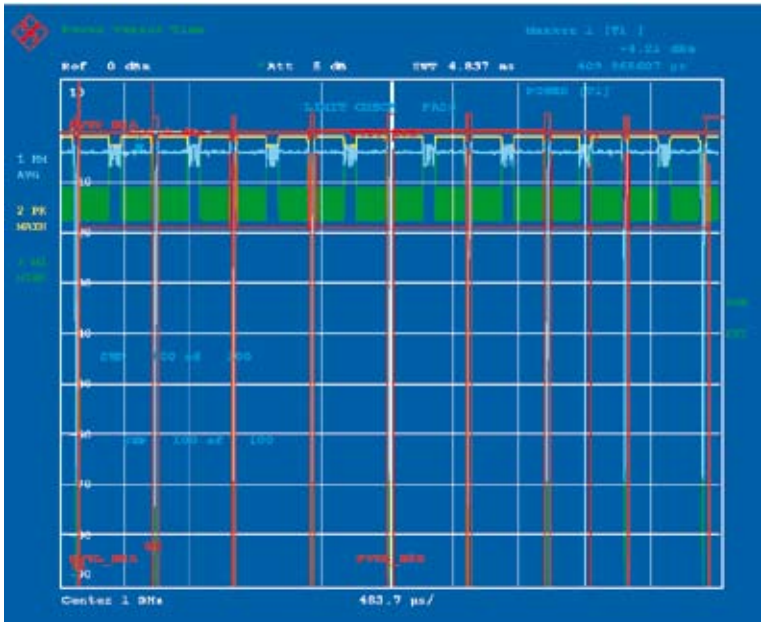

*Measurement of modulation accuracy on EDGE burst.*




*ACP measurement with 4 channels.*

In conjunction with the R&S®FS-K5 GSM/EDGE application firmware, the R&S®FSG 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.

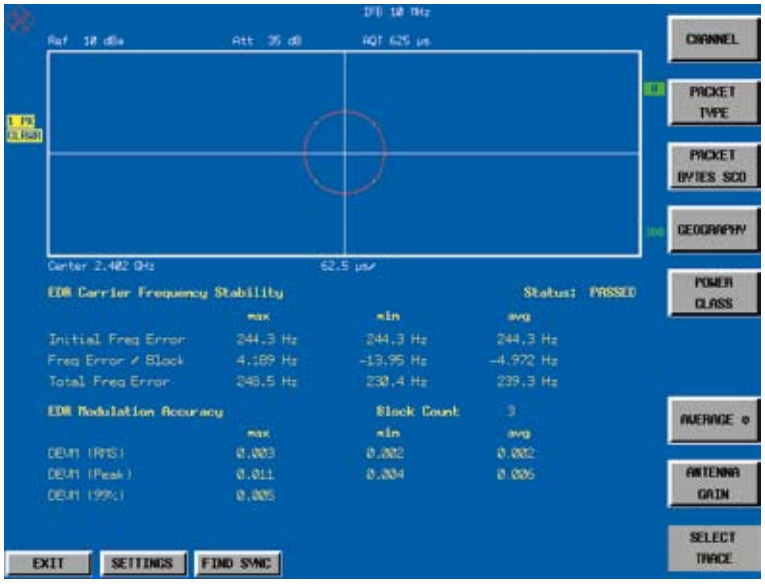
- Phase/frequency error for GSM
- Modulation accuracy for EDGE with:
  - EVM and ETSI-conforming weighting filters
  - OOS
  - 95:th percentile
  - Power versus time with synchronization to midamble
  - Spectrum due to modulation
  - Spectrum due to transients



*Simultaneous measurement of power versus time of an eight-slot EDGE signal.*

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

- Enhanced measurement functionality in line with the Bluetooth® RF Test Specification (Bluetooth® SIG) Rev. 2.0 + EDR
- Measurement functions
  - Output power
  - Adjacent channel power (ACP)
  - Modulation characteristics
  - Initial carrier frequency tolerance (ICFT)
  - Carrier frequency drift
  - Inband spurious emissions, gated
  - Carrier frequency stability and modulation accuracy (DEVM)
  - Differential phase encoding
- Simultaneous display of traces and all numeric measurement results
- Automatic limit value monitoring

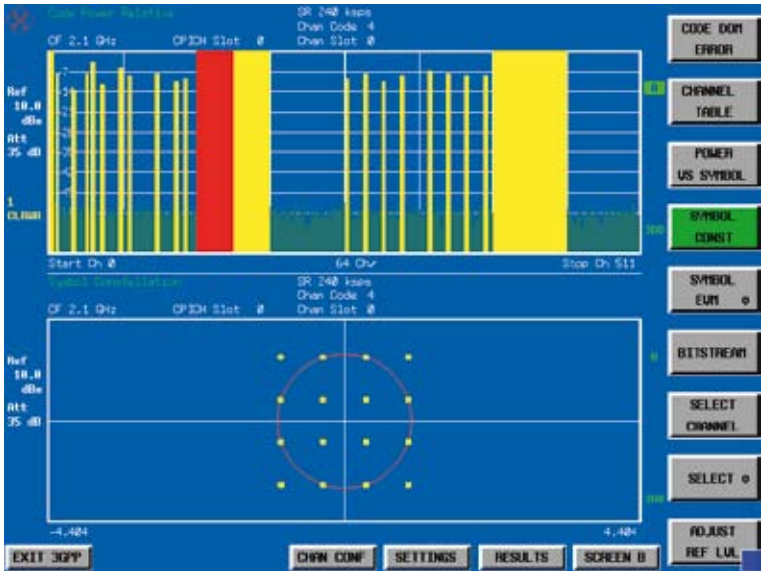



*Measurement of initial carrier frequency tolerance of a Bluetooth® signal with R&S®FS-K8.*

# … 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
- Code domain and CPICH power
- Code domain power and rho (CDMA2000®/3GPP2)
- EVM and PCDE
- Code domain power versus slot
- EVM/code channel
- Spectrum emission mask
- Constellation (symbol, composite)

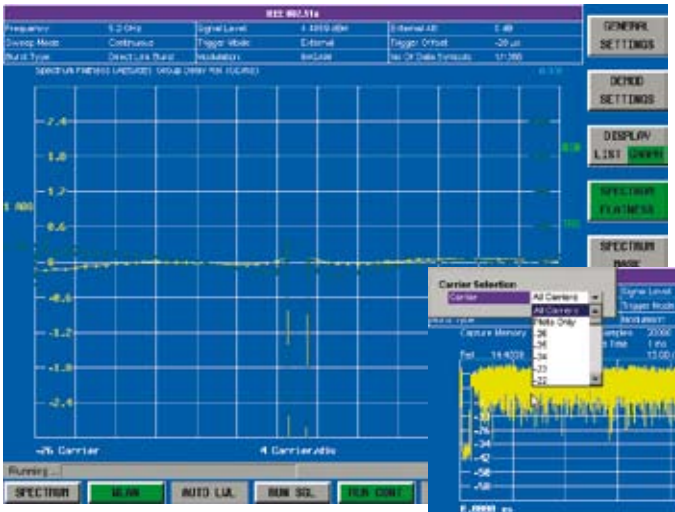



*WCDMA code domain power measurement with the R&S®FSG and R&S®FS-K72.*

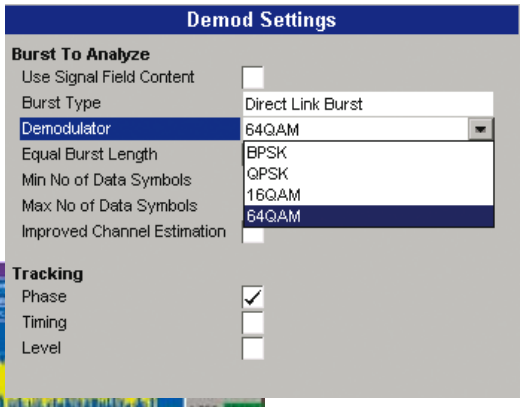
## Firmware options for mobile radio applications

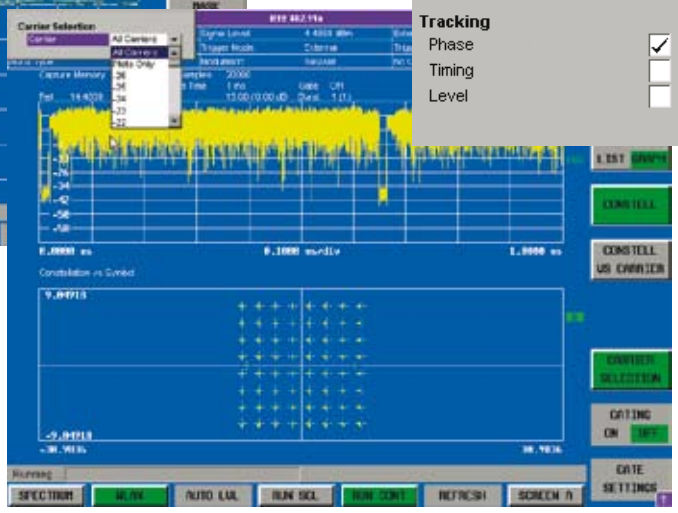
| Type | Designation and/or application |
|---|---|
| R&S®FS-K5 | Modulation and spectrum measurements on GSM/EDGE base station and mobile signals |
| R&S®FS-K8 | Bluetooth® transmitter measurements |
| R&S®FS-K72 | Modulation and code domain power measurements in line with 3GPP TS 24.141 on base station signals (node B) |
| R&S®FS-K73 | Modulation and code domain power measurements in line with 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 in line with 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 in line with CDMA2000®1xEV-DO on base station signals |
| R&S®FS-K85 | Modulation and code domain power measurements on CDMA2000®1xEV-DO mobile station signals (UE) |
| R&S®FSQ-K91 | Modulation and spectrum measurements on WLAN signals in line with IEEE 802.11 a/b/g/j |
| R&S®FSQ-K92 | Modulation and spectrum measurements in line with IEEE 802.16-2005 OFDM |
| R&S®FSQ-K93 | Modulation and spectrum measurements in line with IEEE 802.16-2005 OFDM and OFDMA |
| R&S®FSQ-K100 | Modulation and spectrum measurements on EUTRA/LTE downlink signals |

# 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.*

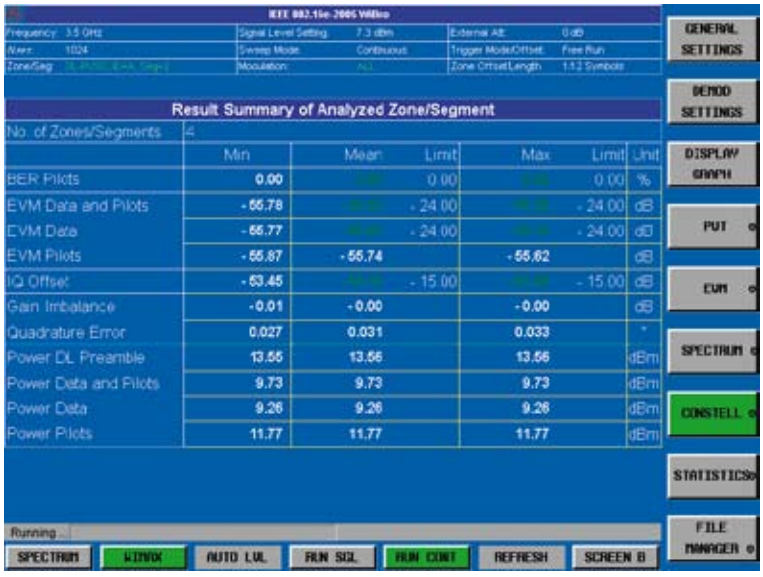
**The R&S®FSQ-K91 application firmware provides the R&S®FSG with modulation and spectrum measurements on WLAN signals in line with IEEE 802.11 a/b/g/j.**

| OFDM (IEEE 802.11a/g/j) | DSSS (IEEE 802.11/b) |
|---|---|
| **Modulation formats** | |
| OFDM with BPSK, QPSK, 16QAM, 64QAM | DBPSK, DQPSK, CCK, short PLCP, long PLCP |
| **Modulation measurements** | |
| 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 |
| **Trigger** | |
| Free run | Free run |
| External | External |
| IF power | IF power |
| **Typical inherent errors for IEEE 802.11a measurements** | **Typical inherent errors for IEEE 802.11b measurements** |
| EVM –45 dB | EVM 0.7 % (RF = 2.4 GHz) |
| Spectral flatness 0.5 dB | – |

# WiMAX measurements

With the R&S®FSQ-K93 application firmware, the R&S®FSG spectrum analyzer can be used for spectrum and modulation measurements on signals in line with the IEEE 802.16e-2005 standard, also known as mobile WiMAX. Its functions cover standard-related tests and more in-depth analysis for troubleshooting WiMAX applications. All functions can be operated manually or programmed via GPIB or LAN.

- Standards: IEEE 802.16e-2005, including WiBro
- Support of OFDM and OFDMA
- Modulation formats for IEEE 802.16: BPSK, QPSK, 16QAM, 64QAM




*WiMAX measurement result summary.*


*Constellation diagram with low signal-to-noise ratio.*


*EVM versus carrier of a PUSC signal.*

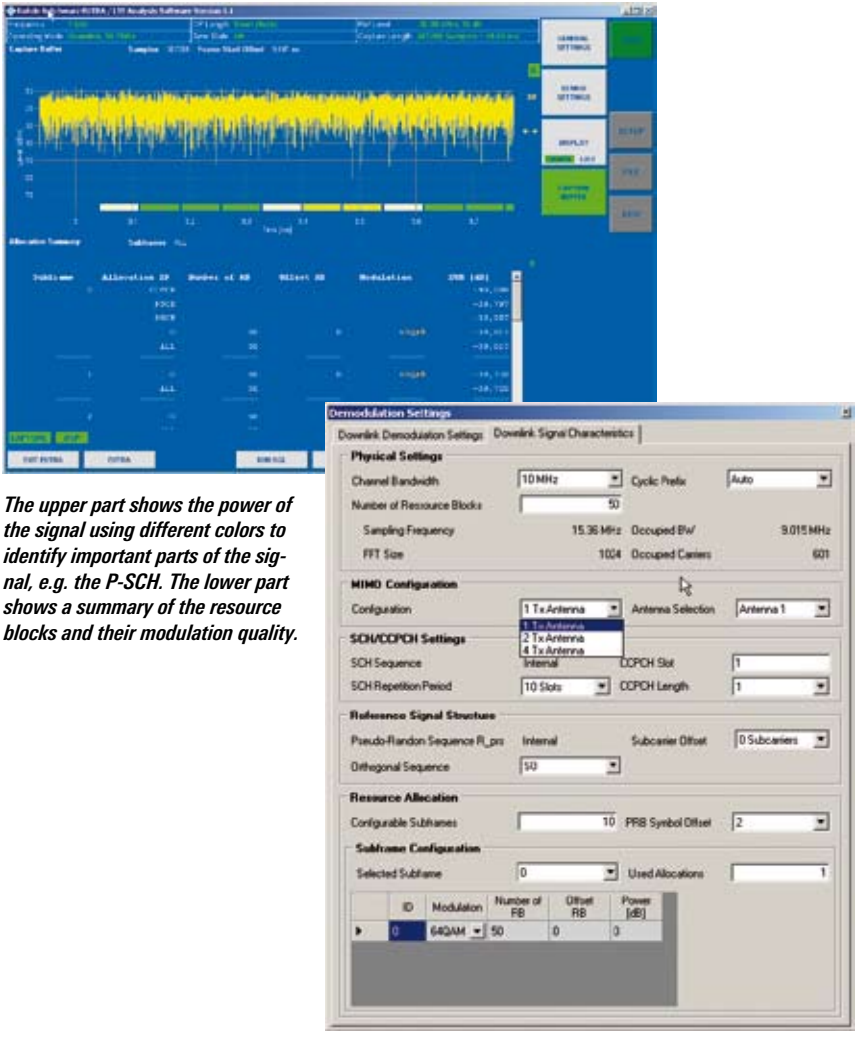
# 3GPP Long term evolution

With the R&S®FSQ-K100 option, the R&S®FSG can be used for analyzing the modulation accuracy of the emerging 3GPP long term evolution standard. The functionality covers all important parameters required to characterize a transmitter:

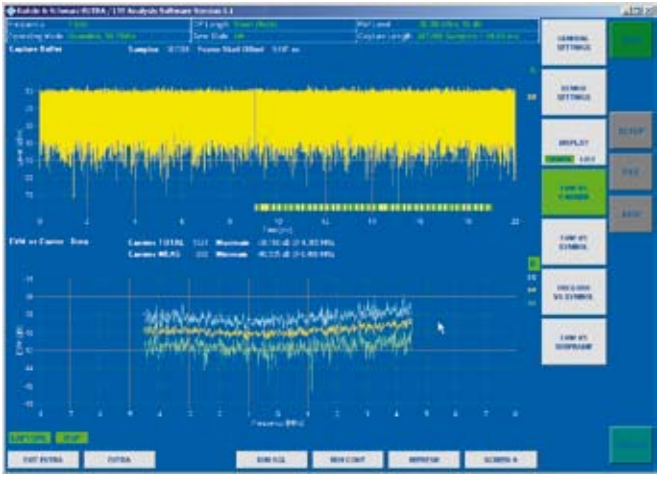
- EVM versus resource block
- EVM versus carriers
- Spectral flatness
- Constellation diagram
- CCDF

For ease of use, the R&S®FSQ-K100 option supports autodemodulation, which minimizes setup time. The following important configuration possibilities are available:

- Demodulation bandwidth – allows the user to flexibly change the maximum number of resource blocks
- Antenna configuration – makes it possible to correctly demodulate MIMO signals




*The upper part shows the power of the signal using different colors to identify important parts of the signal, e.g. the P-SCH. The lower part shows a summary of the resource blocks and their modulation quality.*



*The EVM versus carrier display shows the EVM for each carrier over the frame. As many measurements are performed for each carrier, the maximum, average, and minimum values are displayed for each of the 600 carriers.*

# Benefit from networking

## Versatile documentation and networking capabilities

The Windows XP 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.

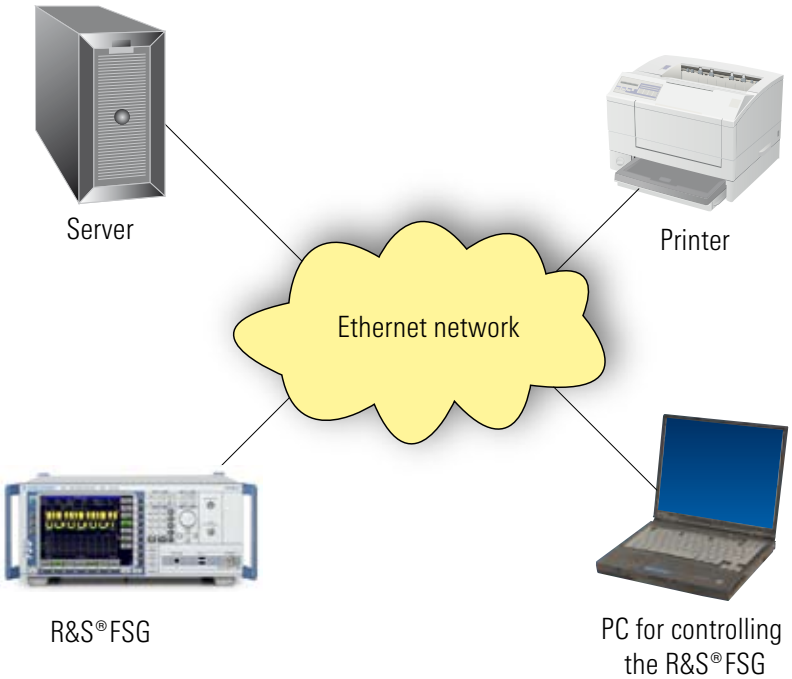
**Advantages of networking**

The standard LAN interface opens up versatile networking capabilities:

- Link to standard network (Ethernet 10/100BaseT)
- Running under Windows XP, the R&S®FSG 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®FSG can thus be optimally matched to your work environment
- Screen contents can be imported directly into Word or, by using an Excel macro, into your documentation programs so that you can immediately create data sheets for your products or documents for quality assurance

Remote control by Ethernet is even simpler:

- The LAN eXtensions for Instrumentation (LXI) standard for controlling T&M equipment combines the advantages of rack and stack instruments, which offer GPIB interfaces and powerful firmware functions, with the benefits of modular, compact VXI/PXI systems




*The R&S®FSG in network operation.*

## Ordering information

| Designation | Type | Order No. |
|---|---|---|
| Spectrum Analyzer, 9 kHz to 8 GHz | R&S®FSG8 | 1309.0002.08 |
| Spectrum Analyzer, 9 kHz to 13 GHz | R&S®FSG13 | 1309.0002.13 |

## Options

| Designation | Type | Order No. |
|---|---|---|
| Digital Baseband Interface | R&S®FSU-B17 | 1163.0063.02 |
| Electronic Attenuator, 0 dB to 30 dB, and 20 dB preamplifier | R&S®FSU-B25 | 1144.9298.02 |



For data sheet, see PD 5213.8721.22
and www.rohde-schwarz.com
(search term: FSG)

ROHDE&SCHWARZ

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