FIG 1 The new R&S FSQ-K70 application software enhances the Signal Analyzer R&S FSQ for high-precision measurements of modulation parameters of digitally modulated signals.

Signal Analyzer R&S FSQ

Application software for precise vector signal analysis

The new R&S FSQ-K70 software package expands the application range of the Signal Analyzer R&S FSQ (FIG 1) for high-precision measurements of the modulation parameters of digitally modulated signals. With its large bandwidth of 28 MHz and user-configurable demodulators for all common modulation modes, the enhanced R&S FSQ is an extremely flexible tool for vector signal analysis.

Low inherent error, precise demodulation

With a wide dynamic range and low phase noise, the Signal Analyzer R&S FSQ [1] converts the RF input signal to the last IF, digitizes it with 14-bit resolution and then converts it to the I/Q baseband. Using a patented method, it corrects the I/Q data stream by taking into account the amplitude and delay distortions of the entire RF receive path, minimizing the path's influence on the measurement signal. It thus ensures a very low inherent error when measuring modulation errors such as the error vector magnitude (EVM), even with transmission methods using high symbol rates. In the case of a 64QAM signal with a 10 MHz symbol rate, for example, the inherent error is only 1% (FIG 2).

Presettings for standard-compliant measurements

R&S FSQ-K70 [2] provides defined default settings for the vector measurement of modulation parameters of common digital radio transmission standards such as WCDMA 3GPP, cdma2000, GSM, EDGE, NADC, PDC, PHS, *Bluetooth*™ and TETRA. After selecting the desired standard from a table, the instrument is configured with the stored setting and instantly permits standard-compliant measurements (FIG 3).

The predefined settings include not only the modulation mode (PSK, MSK, QAM, FSK), filtering (raised cosine, root raised cosine, Gaussian), symbol rate and the specification of the signal ranges to be analyzed, but also the presentation of results.

Frequently needed settings can be defined as a standard and stored under any user-selectable name, allowing the analyzer to switch very quickly between different test scenarios. Complicated manual reconfiguring of the instrument is thus a thing of the past. This possibility is especially advantageous when standards are changed or a new digital standard is issued. Users can make the required modifications or create a new standard immediately on site without having to load new instrument firmware. Needless to say, factory-set standards deleted by mistake can be restored.

Loadable mapping files

The development of new transmission methods often requires symbol constellations that are not yet included in analyzers currently available on the market. With R&S FSQ-K70, this is no longer a problem. The MAPWIZ program – which can be downloaded for free from the Rohde & Schwarz website – allows users for the first time to create their own constellations, transfer them to the measuring instrument and thus respond to new standards at an early stage. The only other software needed is the widely used MATLAB™ simulation program. FIGs 4 and 5 show a constellation created in this way.

Enhanced trigger and measurement capabilities

R&S FSQ-K70 allows triggering to external trigger events, bursts and synchronization patterns contained in the data stream. Triggering can be either to one synchronization pattern at a time or even to several patterns simultaneously. For GSM, this means that the analyzer searches for all training sequences (TSC 0 to TSC 7) and, without knowing the pattern actually transmitted, reliably demodulates the signal. Triggering to burst signals can be very finely parameterized. The analyzer normally determines the level threshold values automatically; as an alternative, they can also be specified manually.

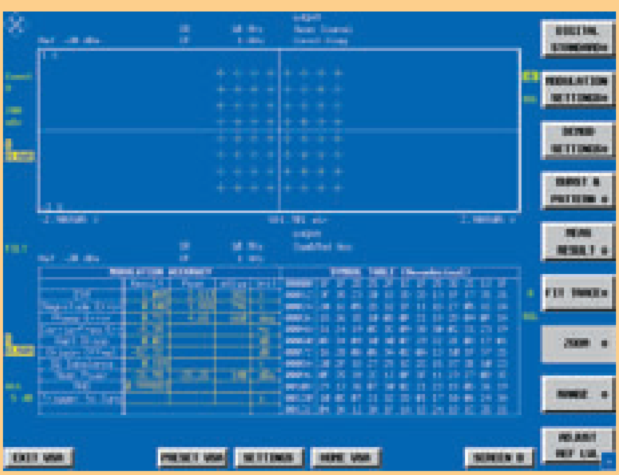
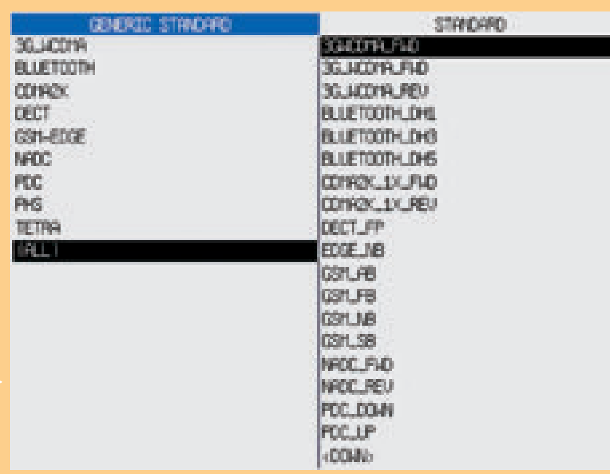


FIG 2
Constellation diagram, numeric result display and decoded symbols of a 64 QAM measurement signal.

FIG 3
Selecting a standard from a table.



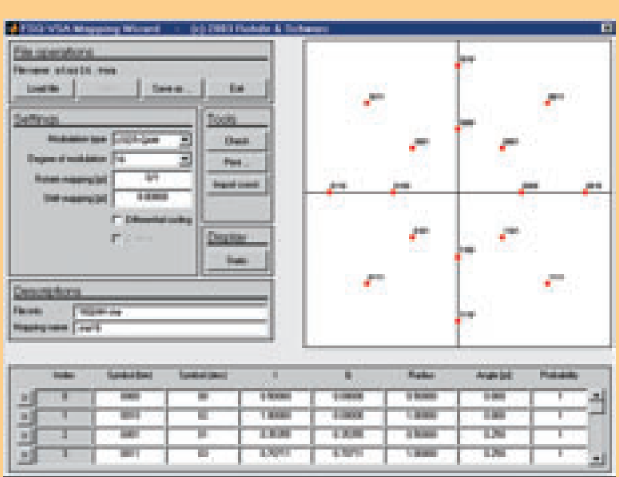
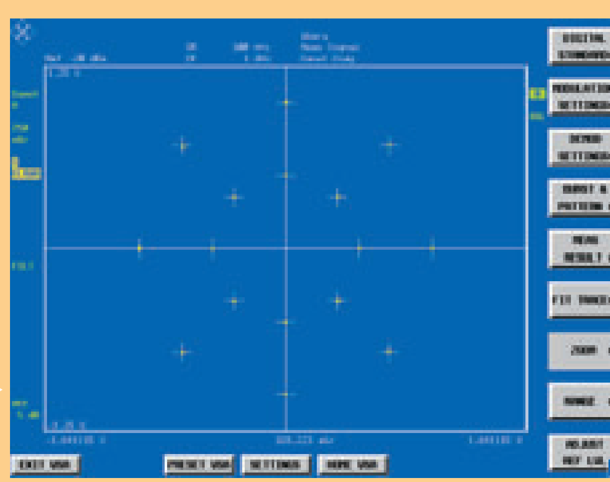


FIG 4
Creating a user-defined constellation.

FIG 5
Constellation diagram of a measurement signal with user-specific constellation.



Unique is the easy way of measuring bursts that contain different modulation modes. An IEEE 802.11b burst, for example, contains a BPSK-modulated synchronization component at the beginning, followed by a QPSK-modulated payload component. FIGs 6 and 7 show the constellation diagrams of the components and the amplitude characteristic of the entire burst.

Measurement on filtered and unfiltered signals

The new vector signal analysis software already provides the receive and measurement filters prescribed by the standards for error measurement. In many cases, however, it is necessary to determine the modulation errors for unfiltered signals. It is possible to switch between the analysis of unfiltered and filtered signals at the press of a button. FIG 8 shows the vector diagram of an unfiltered $3\pi/8$-8PSK signal (EDGE).

This function provides completely new analysis capabilities:

- Power measurements on burst signals without switching to the spectrum analyzer mode
- Measurements of nonlinear signal distortions
- Statistical evaluations

Statistical analysis, distribution and standard deviation

Each of the above-mentioned signal or error displays versus time can be switched to a statistical display simply by a keystroke. The statistical distribution of the measurement or error signal allows conclusions to be drawn about the type of modulation error (e.g. noise, sinusoidal interference or signal compression; FIGs 9 and 10). Determining statistical parameters in the measuring instrument makes complicated and time-consuming post-processing of measurement data in an external controller unnecessary.

The result table for modulation accuracy contains numeric results of the most important signal and error parameters (FIG 11). This table can also be easily expanded to include statistical evaluations. The results of the current measurement are listed on the left, while the quadratic and linear average and the standard deviation are listed on the right. In addition, the 95% probability factor ("95:th percentile") is calculated for the EVM measurement parameter.

Nonlinear distortions

An interesting innovation in R&S FSQ-K70, and one that is very useful for the development of amplifiers, is the measurement and display of nonlinear characteristics. From the demodulated bit stream, the software generates the ideal transmit signal with selectable oversampling. The analyzer compares the measurement signal with the ideal transmit signal at all sampling times and subsequently displays the level and phase errors versus the level of the ideal signal. Averaged over many measured values, this yields the display of the AM/AM and AM/φM conversion – key parameters primarily for dimensioning and optimizing power amplifiers. This distortion measurement is not restricted to continuous signals but can also be applied to TDMA signals as are used with EDGE, for example.

FIG 12 shows AM/AM conversion (top) and AM/φM conversion (bottom) for a distorted 16QAM signal (FIG 13).

Maximum measurement speed

The vector signal analysis in the R&S FSQ is unique in terms of measurement speed and accuracy. The reason is that LSI ASICs are used for signal processing (frequency response correction, clock rate conversion and digital mixing), a powerful floating-point signal processor for demodulation and a Pentium® processor for sequence control, evaluation and display of measurement results.

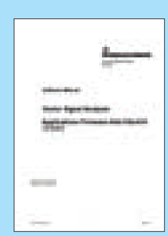
With measurements on GSM or EDGE signals, for example, the R&S FSQ can achieve measurement rates of up to 40 measurements/s. Not only does this allow adjustments to be made without waiting for the measurement result but also makes it possible to perform a series of statistical measurements in very short time. The high measurement speed ensures a high throughput and, together with the low measurement uncertainty, a high yield in production.

Hagen Eckert

More information and data sheets at www.rohde-schwarz.com (search term: FSQ-K70)

Data sheet R&S FSQ

Data sheet R&S FSQ-K70



R&S FSQ-K70 manual

REFERENCES

[1] Signal Analyzers R&S FSQ – Bandwidth and dynamic range for future systems and technologies. News from Rohde&Schwarz (2002) No. 74, pp 17–21

[2] Operating manual for R&S FSQ-K70 (can be downloaded from the Rohde&Schwarz website)

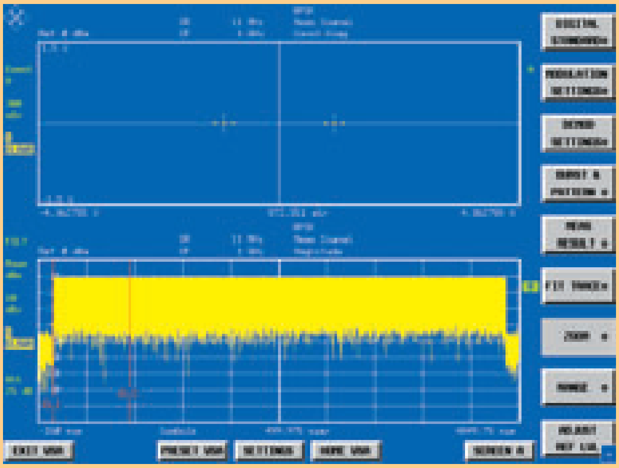


FIG 6
IEEE 802.11b burst; BPSK component.

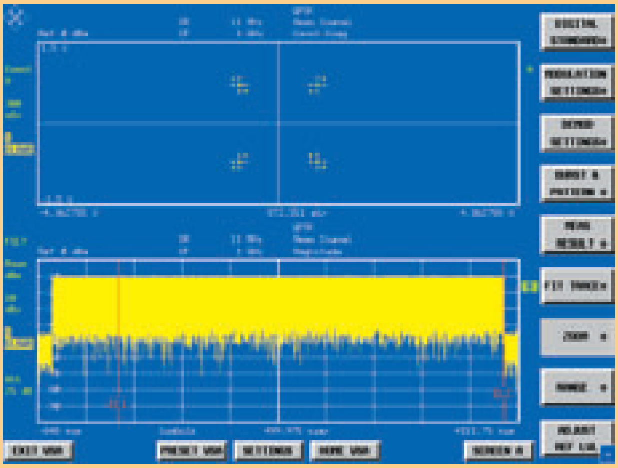


FIG 7
IEEE 802.11b burst; QPSK component.

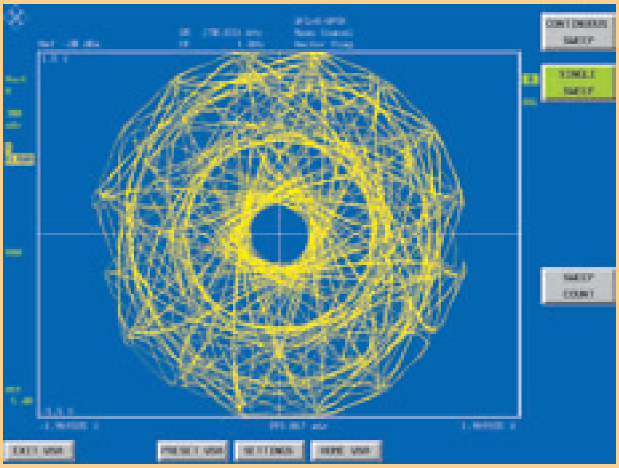


FIG 8
Unfiltered $3\pi/8$-8PSK signal (EDGE).

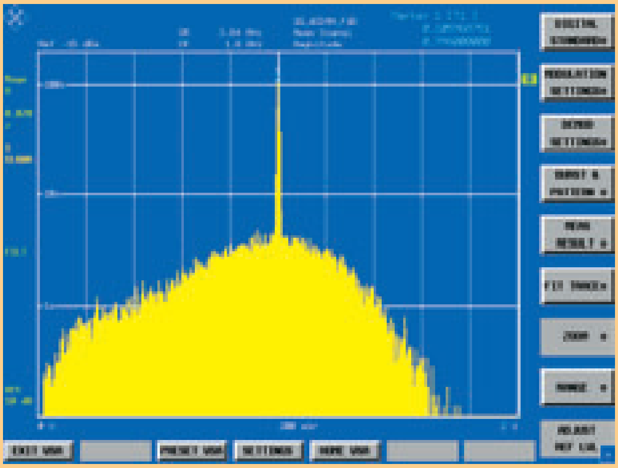


FIG 9
Probability density function (PDF) of a WCDMA measurement signal without superimposed sinusoidal interference.

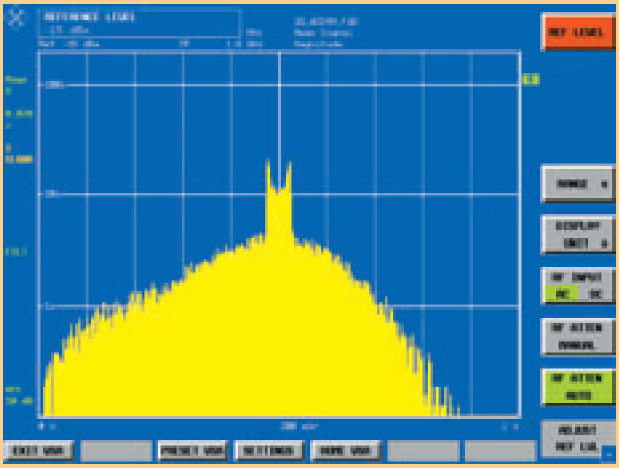


FIG 10
Probability density function (PDF) of a WCDMA measurement signal with superimposed sinusoidal interference.

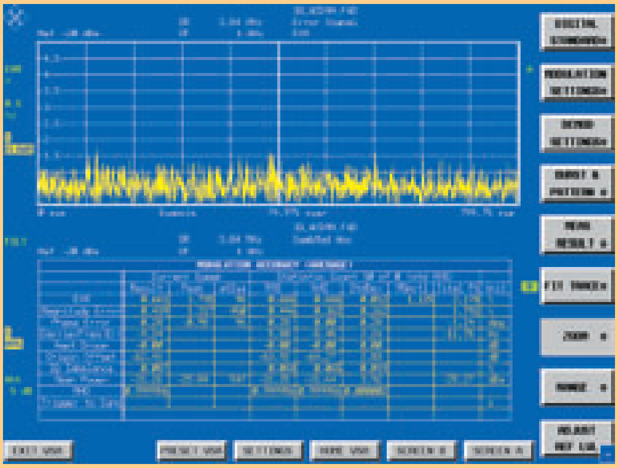


FIG 11
Bottom table: statistical evaluations over several measurements.

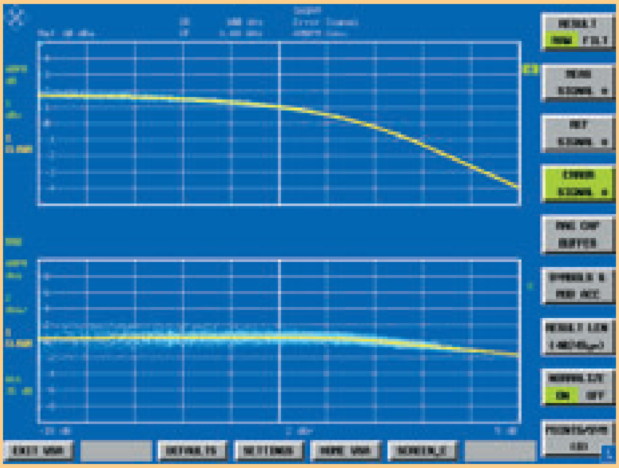


FIG 12
Distortion characteristics of AM/AM and AM/φM conversion. Blue: discrete measurement points; yellow: interpolated conversion curve.

FIG 13
Nonlinear distortions, 16QAM constellation diagram.