Signal Analyzer FSIQ

The ideal analyzer for the third mobile-radio generation

The decision to implement digital wideband CDMA for the third generation of mobile radio – following analog FM and GSM – represents a milestone not only in transmission technology but also in the related measurement technology because of the larger bandwidth available for transmitting data and graphics. The FSIQ signal analyzer family was developed specially for examining the physical parameters of wideband CDMA signals, besides supporting the measurements used for previous transmission modes.

FIG 1 Signal Analyzer FSIQ7 for 20 Hz to 7 GHz Photo 43 185/2

The **FSIQ family** comprises **three models** with different frequency ranges:

- FSIQ3 20 Hz to 3.5 GHz
- FSIQ7 20 Hz to 7 GHz
- FSIQ26 20 Hz to 26.5 GHz

The instruments are follow-on developments of Spectrum Analyzers FSEA30, FSEB30 and FSEM30 [1; 2; 3]. These analyzers provide the ideal basis in terms of bandwidth and dynamic range to meet the requirements of W-CDMA standards (ARIB and ETSI). Signal Analyzer FSIQ (FIG 1) analyzes W-CDMA (wideband code-division multiple access) signals in frequency, time and modulation domains, meeting needs not normally fulfilled by previous instruments at the RF interface. Essential parameters of the analyzer are resolution bandwidths up to 10 MHz, wide dynamic range, fast sampling in the time domain and capability for processing high chip rates. The superior characteristics of the FSIQ family become evident when looking at the most important measurements, for example at the RF output of a W-CDMA base station.

W-CDMA measurements

For high-accuracy **power measurements,** FSIQ incorporates an rms detector that determines power within the measurement bandwidth over a wide dynamic range irrespective of waveform. No software correction factors are needed since FSIQ measures the power correctly from the start. It determines the power of a signal spectrum at each test point of a trace. The user can define the duration of power measurement and thus the stability of results by selecting the appropriate sweep time.

To make measured power comparable with results produced by a thermal power meter, special importance is attached to measurement accuracy. Up to 2.2 GHz, the guaranteed absolute level measurement uncertainty of FSIQ is max. 1 dB (from reference level to 50 dB below reference level in the display range). Statistical analyses of final production reports of the FSE family (valid also for the FSIQ family) covering over 100 units have revealed a measurement uncertainty of only 0.5 dB (95% confidence level). With option FSE-B22 (Increased Level Accuracy) this value is guaranteed. Fitted with this option, FSIQ can in many cases replace a power meter, thus eliminating the need for complex mechanical switches in automatic test systems for example.

FSIQ features easy-to-operate software routines with presettings for the W-CDMA system for measuring power and occupied bandwidth. It also offers the bandwidths (5 or 10 MHz) and detectors required for measuring the ratio of peak power to average power (crest factor), which is especially important in amplifier design for W-CDMA transmitters and receivers.

A major measurement in the frequency domain is that of **adjacent-channel power** [4]. This makes tough demands on analyzer dynamic range, especially when you are measuring at component or module level, where rated characteristics have to be substantially bettered for the complete transmitter system to meet specifications. In addition, the instrument should have a dynamic range 6 to 10 dB better than the EUT. The excellent dynamic range of the FSE family was improved even more in FSIQ by implementing new circuit concepts. For example, the 3rd-order intercept point for the W-CDMA frequency ranges is typically 18 dBm with FSIQ3, 20 dBm with FSIQ7 and 22 dBm with FSIQ26. The unparalleled noise figure of the FSE family is of course also implemented in FSIQ. The third parameter decisive for dynamic range, ie the phase noise of internal oscillators, was reduced by several dB for carrier offsets starting from 100 kHz (FIG 2).

These three characteristics of FSIQ combine in FSIQ7, for example, to yield a dynamic range for power measurements on W-CDMA signals of approx. 75 dB in the adjacent channel

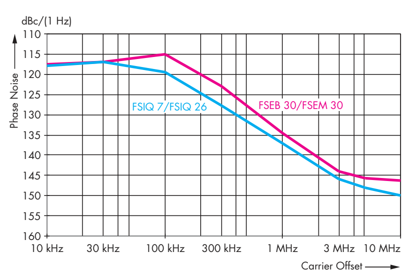

FIG 2 Phase noise of FSIQ7 and FSIQ26 at 500 MHz compared with FSEB30 and FSEM30

(4.096 MHz channel bandwidth, 5 MHz channel spacing) and approx. 81 dB in the alternate channel. FIG 3 shows the dynamic range achievable with FSIQ7. This range is determined by the inherent thermal noise power, the power of adjacent-channel intermodulation products and by the SSB phase noise power of the internal oscillators in the adjacent channel. The measurable adjacent-channel power is

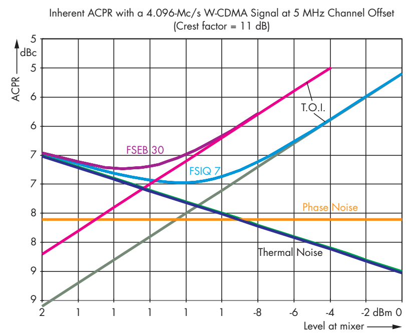

FIG 3 Comparison of achievable inherent adjacent-channel power ratio (ACPR) of FSIQ7 and FSEB30 as function of level at input mixer

largely influenced by the sum of these three power components.

With a level of approx. –12 dBm at the input mixer and an 11 dB crest factor of the W-CDMA signal, FSIQ7 attains an inherent adjacent-channel power ratio (ACPR) of about 75 dBc. This not only meets current standard requirements for mobile and base stations with a comfortable margin but also allows measurements on submodules. The routines offered for adjacent-channel power measurements on W-CDMA signals allow up to seven channels to be covered in a single sweep (power of transmit channel and power of three adjacent channels above and below transmit channel).

Measurement of spurious emissions makes exacting demands on analyzer dynamic range in any type of transmission system. High power levels have to be handled (eg 20 W of a base station), plus very low spurious emission levels are specified to avoid interference to other radio services. A special feature of third-generation mobile radio is its large transmission bandwidth. To measure spurious emission levels correctly, you need resolution bandwidth of 5 MHz for example, corresponding to the transmission bandwidth of the useful signal (5 MHz at 4.096 Mchip/s transmission rate). FSIQ not only offers the right resolution bandwidth but, thanks to its low noise figure, also the dynamic range necessary for measuring spurious emissions without any additional equipment. Only harmonics measurements require a simple highpass filter. The rms detector ensures accurate, fast and stable measurements of spurious emissions (FIG 4).

To achieve optimum capacity in a CDMA radio network, it is essential to regulate the transmit levels of all subscribers to the lowest possible value to avoid interference to other subscribers, since they all operate on the same channel. A base station, for example, is capable of readjusting the transmit power every 625 μs in steps of 1 dB. Specified power levels are to be ob-

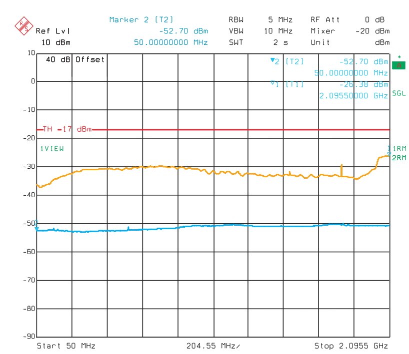

FIG 4 Measurement of spurious emissions from 50 MHz to 2 GHz with rms detector at assumed 20 W power of base station. Red line: 60 dBc limit value; yellow trace: spurious emissions of transmitter; blue trace: noise floor of FSIQ7 without input signal

served with close tolerances. To verify compliance, a signal analyzer must offer large bandwidth, highly linear level display and **fast power measurement in the time domain.** The FSIQ family is well prepared to handle these measurements on all three counts. With measurement bandwidth of 10 MHz and a 20 MHz A/D converter for digitization of the video voltage, level steps are easily followed and displayed. Display linearity is so high that tolerance margins can be allowed practically exclusively for the EUT. The

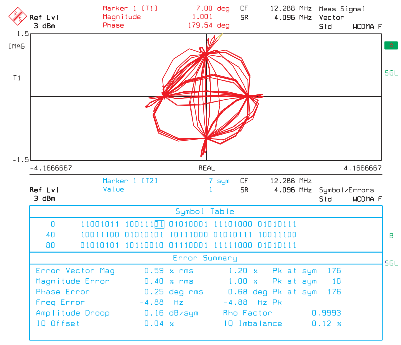

FIG 5 Measurement of modulation errors of W-CDMA signal. Top: vector diagram; bottom: list of modulation errors

rms detector measures power with high precision, and timeslot measurements are supported by software routines for power measurements over definable time intervals.

Modulation error measurements on broadband signals place very high demands on the analyzer's amplitude and phase distortion on the entire signal path from RF connector through to A/D converter. A new method for correcting both the inherent amplitude and phase response of the analyzer makes for extremely low total distortion of FSIQ across a bandwidth of 8 MHz about the receive frequency. This results in a very low instrument error in signal demodulation measurements. For W-CDMA signals (QPSK, 4.096 Mchip/s), the typical error vector magnitude (EVM) of less than 1% is low enough to allow even transmitter submodules with their stringent specifications to be measured with high accuracy (FIG 5). All errors relevant to modulation such as EVM, magnitude error, phase error, frequency error, waveform quality factor, I/Q offset and I/Q imbalance are tabulated for the operator to see all information at a glance.

The FSIQ family not only demodulates W-CDMA signals but also general digital modulation formats such as BPSK, QPSK, offset QPSK, DQPSK, π/4DQPSK, 8PSK, 16QAM, MSK, GMSK, 2FSK, 2GFSK and 4FSK as well as analog modulation like AM, FM and PM. The maximum symbol rate for digital modulation is 6.4 Msymbol/s or 8 MHz signal bandwidth. In addition, FSIQ offers presettings for the main standards such as IS95 CDMA, GSM, NADC, TETRA, PDC, PHS, CDPD, DECT, PWT, APCO25, CT2, ERMES, FLEX, MODACOM and TFTS. This makes FSIQ suitable for multistandard applications.

General applications, remote control

Apart from its use for the third mobile-radio generation, the FSIQ family is also an ideal choice for measurements in general applications. Application software is available, for example, for measurement of noise figure (FSE-K3) or phase noise (FSE-K4).

High internal computing power (233 MHz Pentium processor, transputer and DSP network) not only results in high display update rates but also makes for extremely fast response in automatic IEC/IEEE-bus operation.

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[4] Wolf, J.: Measurement of Adjacent-Channel Power on Wideband CDMA Signals. R&S Application Note 1EF04_0E (1998)

Condensed data of Signal Analyzer FSIQ

Frequency range	20 Hz to 3.5 / 7 / 26.5 GHz
Amplitude measurement range	–155 to 30 dBm
Amplitude display range	1 to 200 dB, linear
Amplitude measurement error	<1 dB up to 2.2 GHz, <1.5 dB from 2.2 to 7 GHz, <2 dB from 7 to 26.5 GHz
Modulation measurement error	EVM <1% rms (typ.) for 4.096 Mchip/s (W-CDMA)
Resolution bandwidths	1 Hz to 10 MHz in steps of 1, 2, 3, 5
Calibration	autocalibration by internal routines
Display	24 cm colour TFT LC display, VGA resolution
Remote control	IEC 625-2 (SCPI 1994.0) or RS-232-C

Reader service card 160/01