Spectrum Analyzers R&S FSU / R&S FSP

Firmware for 3G code domain measurements

Owing to their flexible design, the Spectrum Analyzers R&S FSU [1] und R&S FSP [2] are developing into powerful 3G signal analyzers. Current add-ons are the WCDMA code domain analyzer for base stations (R&S FS-K72) and user equipment (R&S FS-K73) as well as the code domain analyzer for base stations (R&S FS-K82) for the competing 3G technology CDMA2000.

Important new measurements

The R&S FS-K72/-K73/-K82 firmware packages offer all important transmitter measurements in one menu and expand the spectrum analyzers for code domain measurements:

- Peak code domain error
- Composite EVM
- EVM vs slot
- Channel table
- Rho (only CDMA2000)

The table on page 17 (FIG 5) shows the key specifications at a glance.

Evaluating CDMA signals

Code division multiple access (CDMA) systems use different codes, instead of separate frequencies or times as do frequency division duplexing (FDD) or time division duplexing (TDD) systems. The signals of each subscriber are transmitted on the same frequency.

The quality of the transmitted signal cannot be evaluated purely by spectrum analysis. For a detailed analysis of the CDMA signal power, the signal must be despread before the quality of every individual code can be evaluated.

Code domain analysis

The R&S FS-K72/-K73/-K82 firmware packages are primarily used to determine the code domain power for the different physical channels. The power ratios between the individual channels can be checked for compliance with the nominal values, for example. This measurement is also a highly efficient tool for detecting impairments such as clipping or intermodulation effects.

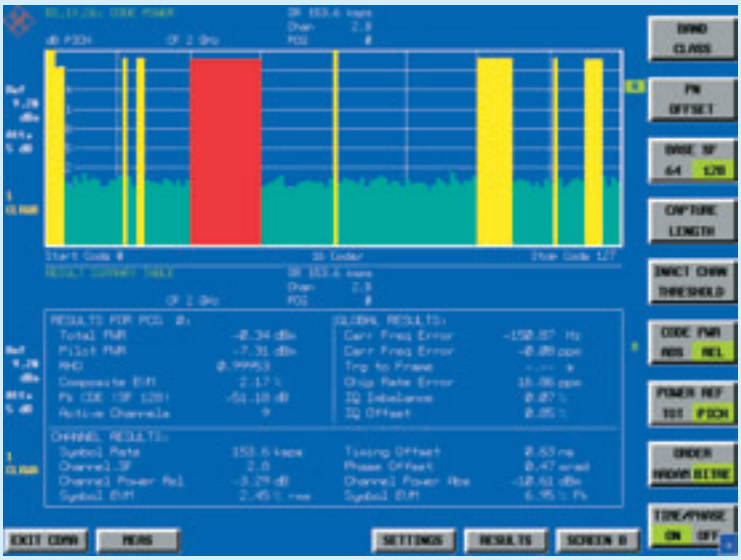

FIG 1
Code power of a CDMA2000 signal which is displayed in reversed bit order.

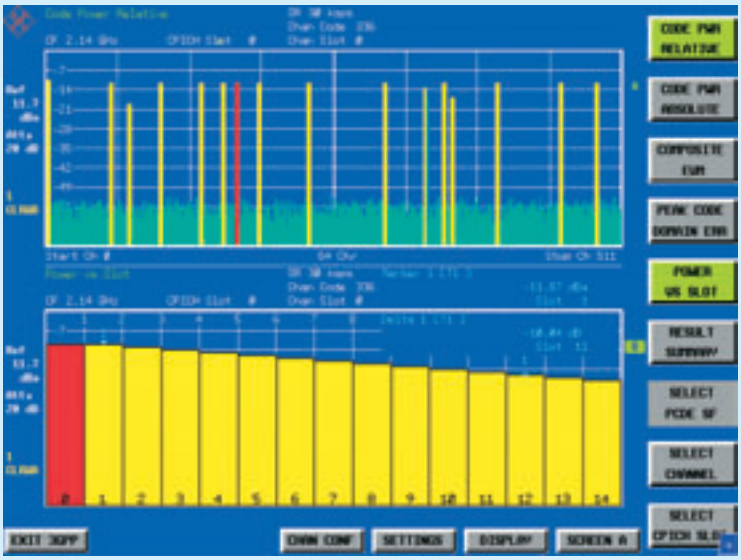

FIG 2
Example of the power control of a WCDMA base station signal. The power difference of a code (highlighted in red in the code domain overview) is measured.

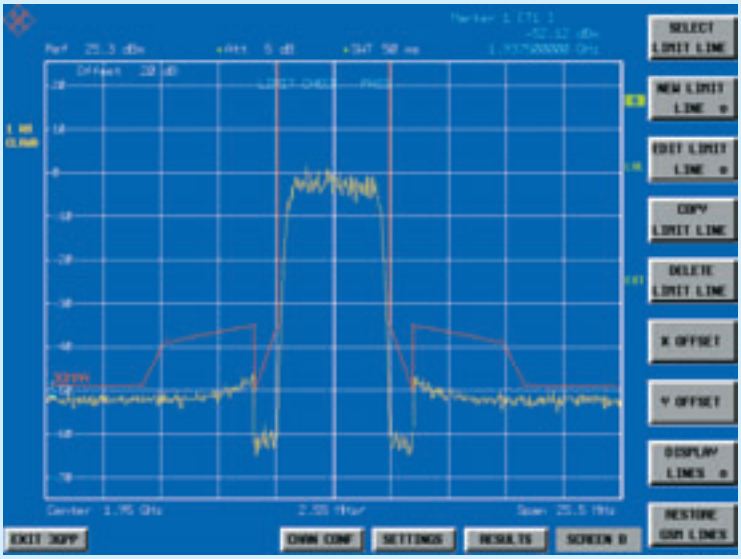

FIG 3
Spectrum emission mask measurement of a WCDMA terminal with automatic PASS/FAIL evaluation in accordance with 3GPP specifications.

WCDMA and CDMA2000 – similar, yet different

The two key 3G technologies resemble each other in many aspects since both use the fundamental CDMA technology. However, coding, modulation and bandwidth differ. The CDMA2000 standard is backwards-compatible with the related 2G IS-95, whereas WCDMA is not compatible with any other 2G system.

The channelization codes fulfill the same basic functions in both systems, i.e. to separate the subscribers from each other in a cell, but they are designed differently. WCDMA uses the orthogonal variable spreading factor (OVSF), CDMA2000 Walch-Hadamard codes. Furthermore, CDMA2000 is a synchronous system that must consequently comply with stringent timing requirements, whereas WCDMA is an asynchronous system.

Differences between the uplink and downlink signals also exist even within the systems. Those of a mobile phone (uplink) on a spectrum analyzer strongly resemble the signals of a base station (downlink), but their code domains are completely different.

FIG 4
Band class selection for CDMA2000 ACLR measurements.

BAND CLASS SELECTION
✓Band Class 0 (800 MHz Band)
Band Class 1 (1900 MHz Band)
Band Class 2 (TACS Band)
Band Class 3 (JTACS Band)
Band Class 4 (Korean PCS Band)
Band Class 5 (450 MHz Band)
Band Class 6 (2 GHz Band)
Band Class 7 (700 MHz Band)
Band Class 8 (1800 MHz Band)
Band Class 9 (900 MHz Band)

Measure-ments	WCDMA base stations (R&S FS-K72)		WCDMA user equipment (R&S FS-K73)		CDMA2000 base stations (R&S FS-K82)	
	R&S FSU	R&S FSP	R&S FSU	R&S FSP	R&S FSU	R&S FSP
Code domain power measurement uncertainty	<0.4 dB	<0.6 dB	<0.4 dB	<0.6 dB	<0.4 dB	<0.6 dB
EVM	<1.5%	<2%	<1.5%	<2%	<1%	<1.5%
Peak code domain error	−50 dB	−60 dB	−50 dB	−60 dB	−50 dB	−60 dB

FIG 5 Key specifications at a glance.

Automatic code determination

The firmware automatically determines the data rates of each code by searching through all possible combinations; the subscriber does not need to know them. Higher data rates in CDMA systems occupy the major part of the code domain. Due to the coding scheme used with CDMA2000, a high data rate is spread across the code domain (Hadamard sequence). It can be difficult to assign the different codes to the respective users of high data rates. If the reversed bit sorting order is selected, the firmware automatically collects the codes of the individual subscribers (FIG 1).

Power control is an essential feature of CDMA systems. Since all subscribers use the same frequency, they interfere with each other. To reduce this interference to a minimum, the power of each mobile and each base station is continuously controlled: with WCDMA 1500 times per second, while the power control rate for CDMA2000 is 800 Hz.

A code domain analyzer is used to measure the power of each individual code in the code domain and determine the accuracy of the power control levels. FIG 2 shows an example of a WCDMA base station signal.

Adjacent channel leakage power ratio

The ACLR is an important design parameter in CDMA systems. It affects the system performance and defines the transmitter linearity for the design engineer. The Spectrum Analyzers R&S FSU and R&S FSP come with default settings for this measurement.

Since CDMA2000 systems are used worldwide in different frequency bands, the standard defines different ACLR requirements for the different regions. The R&S FS-K82 allows the subscriber to define the band class; the limits are then set accordingly (FIG 4). They can, of course, be changed, or new limits can be specified.

Spectrum emission mask

The 3GPP standard defines a spectrum emission mask to ensure coexistence of the different systems (FIG 3). The measurement bandwidth must accordingly be changed from 30 kHz at 3.5 MHz offset from carrier to 1 MHz. The usual Gaussian filters of the spectrum analyzers do not provide the required selectivity; the standard enables the use of more narrowband filters which in turn increase the measurement time.

By using special channel filters, the R&S FSP and R&S FSU can utilize a 1 MHz filter instead of the often used 30 kHz filters and so perform the measurement in record time.

Multistandard platforms for 3G

With the optional R&S FS-K5 application firmware, the spectrum analyzers also support GSM and EDGE. All applications can be installed together to form versatile multistandard platforms.

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More information and data sheets at www.rohde-schwarz.com (search terms: K72 / K73 / K82)

Data sheet
R&S FS-K72 /-K73 /-K82

REFERENCES
[1] Spectrum Analyzer R&S FSU – Best RF performance: third generation of high-end analyzers. News from Rohde & Schwarz (2001) No. 171, pp 20–25
[2] Spectrum Analyzer R&S FSP – Medium class aspiring to high end. News from Rohde & Schwarz (2000) No. 166, pp 4–7