Analyzers R&S®FSP/FSU/FSQ

Test of HSDPA base stations

The new R&S®FS-K74 application firmware expands the test functionality of the Spectrum Analyzers R&S®FSP and R&S®FSU and the Signal Analyzer R&S®FSQ to include code domain analysis of HSDPA signals for WCDMA 3GPP FDD – at the highest speed currently available on the market.

HSDPA – an extension of the 3GPP standard

HSDPA (high speed downlink packet access) is part of Release 5 of the 3GPP WCDMA specifications. HSDPA, which is an extension of the 3GPP standard, has been specified for the three transmission modes FDD, TDD and TD-SCDMA, which is the low chip rate option of TDD. The new data service boosts data throughput in mobile radio systems, offering a maximum data rate of 14.4 Mbit/s for a 3.84 MHz HSDPA channel. For mobile radio systems using several transmit and receive antennas, data rates of more than 20 Mbit/s have been reported to be possible. Network operators will thus be able to include high-speed services where needed, for example at hot spots such as airports, without any impact on the rest of the 3GPP network.

Principles of HSDPA

In cellular communication systems, the quality of a signal received by a mobile phone depends on a number of factors: the distance between the mobile phone and the base station, as well as fading, noise and interference. To maximize system capacity, peak data rate and coverage, the base station initially transmits the signal to a particular user at maximum power and subsequently varies the signal power according to the quality of the transmission link.

With HSDPA, the power of the transmitted signal is kept constant, and the modulation and the coding scheme are adapted optimally to match current signal quality and channel status. Normally, subscribers close to the base station are assigned modulation of higher order and coding of lower redundancy than more distant users. The parameter values are varied as signal quality deteriorates. To ensure high efficiency, the system must be able to respond quickly to fast or slow fading. Thus, the mobile phone continuously signals channel quality to the base station, and the base station adapts the signal as required.

Characteristics of HSDPA signals

HSDPA signals are fully integrated into WCDMA signals, and HSDPA users coexist with non-HSDPA users on the same frequency. HSDPA signals cannot be identified solely by examining the spectrum. Instead, code domain analysis is required.

HSDPA uses codes with a spreading factor of 16. A maximum of 15 different codes are available, which can be assigned to a single user or distributed among up to 15 users. The number of codes assigned to a user depends on propagation conditions and the capabilities of the mobile phone. Either QAM or 16QAM is used with each code.

More information and R&S®FS-K72 data sheet at www.rohde-schwarz.com (search term: FS-K72)

REFERENCE
[*] Spectrum Analyzers R&S®FSU/R&S®FSP: Firmware for 3G code domain measurements. News from Rohde&Schwarz (2002) No. 175, pp 15–17

Type	Number of channels
P-CCPCH+SCH	1
Primary CPICH	1
PICH	1
S-CCPCH containing PCH (SF=256)	1
DPCH (SF=128)	30/14/6
HS-SCCH	2
HS-PDSCH (16QAM)	8/4/2

FIG 1
Test model 5 specified in 3GPP TS25.141.

Measurements on HSDPA base station transmitters

For tests on HSDPA base stations, the 3GPP TS 25.141 standard has specified a new measurement for determining modulation accuracy. The test signal to be used is described in test model 5, which specifies control channels, traffic channels and two, four or eight 16QAM HSDPA channels (FIG 1). This signal is used to measure the error vector magnitude (EVM).

Using test model 5 to measure modulation accuracy means placing considerably more stringent requirements on base stations. In accordance with Release 99, the modulation quality is determined from two parameters: EVM and the peak code domain error (PCDE). EVM is measured with one or optionally two active codes. Meeting PCDE specifications is a demanding task for transmitter designers, because the signal used in the PCDE test has a higher crest factor and places more stress on the transmitter. The PCDE requirement of approx. –33 dB corresponds to a composite EVM of 30%. Modulation error requirements are likewise more exacting in the case of HSDPA, with a specified value of <12.5%.

The fast measurement solution from Rohde & Schwarz

The R&S®FS-K74 firmware option provides up to 1.5 code domain measurements per second, including EVM and PCDE calculation – the fastest measurement currently available on the market. The option seamlessly integrates into the R&S®FS-K72 option [*]. The measurement and result displays are identical, with the only difference being that any HSDPA signal that is present is automatically identified and included in all calculations. All measurements provided by R&S®FS-K72 – e.g. EVM versus chip, power versus timeslots – are also available with R&S®FS-K74.

The code domain display in the upper part of FIG 2 does not reveal that several 16QAM signals are present in the spectrum. In the lower part of FIG 2, the parameter values of the selected signal (marked red) are displayed, with 16QAM being indicated as the modulation format. The 16QAM modulation format can also be recognized from the symbol constellation diagram (FIG 3).

With the new application firmware options described in this issue, the Analyzers R&S®FSP, FSU and FSQ support numerous 2G, 2.5G and 3G standards and thus become true multistandard platforms.

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Additional articles on the R&S®FSP/FSU/FSQ are found on pages 18, 27, 30 and 36.

FIG 2
Code domain spectrum and overview of main modulation parameters.

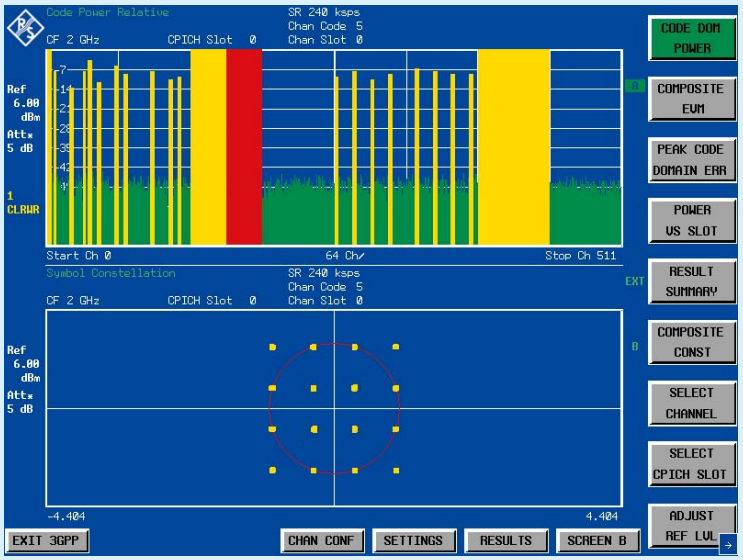


FIG 3
Constellation diagram of HSDPA code (marked red) using 16QAM.

Analyzers R&S®FSP/FSU/FSQ

Test of TD-SCDMA base stations

The new R&S®FS-K76 application firmware enhances the test functionality of the Spectrum Analyzers R&S®FSP and R&S®FSU and the Signal Analyzer R&S®FSQ. For the first time worldwide, R&S®FS-K76 now makes it possible to perform TD-SCDMA code domain measurements with a spectrum analyzer. TD-SCDMA (time division synchronized code division multiple access) is a new standard mainly endorsed by China. R&S®FS-K76 enables the peak code domain power and modulation accuracy of TD-SCDMA signals to be measured in the same manner as for WCDMA and cdma2000 signals.

TD-SCDMA – a new standard in two versions

TD-SCDMA has been specified by two different standardization organizations: 3GPP[1] and the China Wireless Telecommunication Standard group (CWTS). The 3GPP TD-SCDMA standard is also known as the low chip rate (LCR) option of TDD, and the CWTS standard is also referred to as TD-SCDMA system for mobile communication (TSM). The main difference between the two standards is that TSM is intended for use with GSM core networks and LCR with UTRAN[2]. The signals and measurements for physical layer tests are identical, with minor differences existing with respect to requirements.

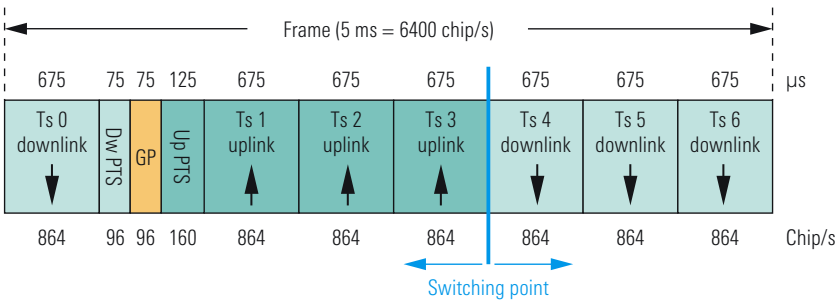
CDMA systems differentiate between users by codes and not by frequencies. TD-SCDMA employs a chip rate of 1.28 Mchip/s and a bandwidth of 1.6 MHz. TDD systems operate on the same frequency in the uplink and the downlink, and differentiate between users by time division duplex (TDD). To avoid interference in the network, it is mandatory that the base station and the mobile phone do not transmit at the same time. To synchronize transmission of the mobile phones, the signal from the base station contains a downlink pilot timeslot (DwPTS).

FIG 1 shows the timeslot structure of a TD-SCDMA frame. The first timeslot (Ts0) of the frame is always used for transmission in the downlink, the second one (Ts1) in the uplink. The remaining timeslots can be configured by the network for either uplink or downlink transmission by moving the switching point. Either QPSK or – if very high data rates are to be achieved – 8PSK modulation is used for the different codes.

For a detailed analysis of the performance of a CDMA transmitter, looking at the spectrum alone is not sufficient, since CDMA systems differentiate between users by codes. It is therefore necessary for the analyzer to despread the signal and measure the power and quality of each individual code.

Code domain analysis

The main application of the new R&S®FS-K76 firmware is to determine the code domain power of the individual physical channels and to check each one for compliance with specified nominal values. Moreover, this measurement is ideally suited for detecting impairments in the transmitter.



1) Third Generation Partnership Project
2) UTRAN – UMTS Terrestrial Radio Access Network
UMTS – Universal Mobile Telecommunications System

FIG 1
Time domain structure of TD-SCDMA signal.

The firmware automatically detects data rates and modulation formats, freeing the user from having to do so. All important modulation accuracy parameters, e.g. error vector magnitude (EVM), peak code domain error (PCDE) and frequency error, are available at a glance (FIG 2). Detailed analysis of all parameters can be performed very conveniently. An example of this is shown in FIG 3, where the EVM across all captured timeslots is displayed and can be checked for compliance with standard requirements.

Spectrum measurements

R&S®FS-K76 offers ready-to-run functions for the most common spectrum measurements, such as code domain power versus time, transmit power, adjacent channel power, as well as spectrum emission mask. The integrated RMS detector allows accurate transmitter power measurements irrespective of the modulation mode.

Multistandard platforms for 3G

With the new application firmware options described in this issue, the Analyzers R&S®FSP, FSU and FSQ support numerous 2G, 2.5G and 3G standards (FIG 4). All applications can be installed together, making the analyzers versatile multistandard platforms.

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FIG 2
Code domain spectrum and overview of main modulation parameters.

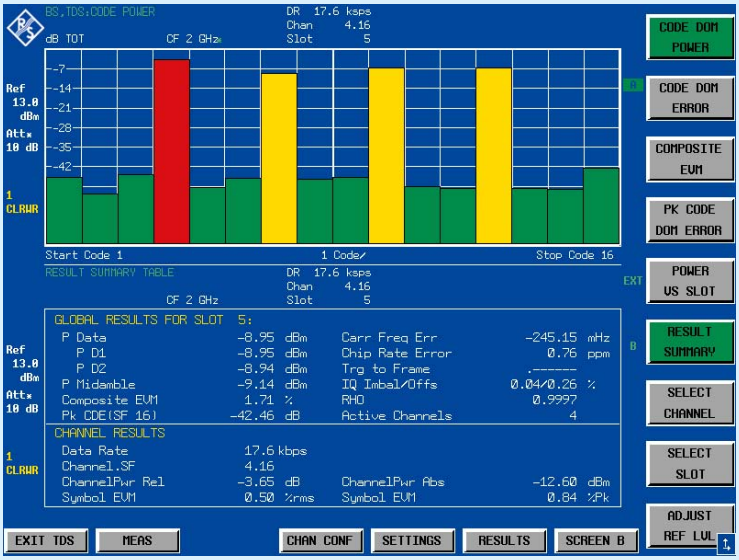

FIG 3
Composite EVM versus timeslots.

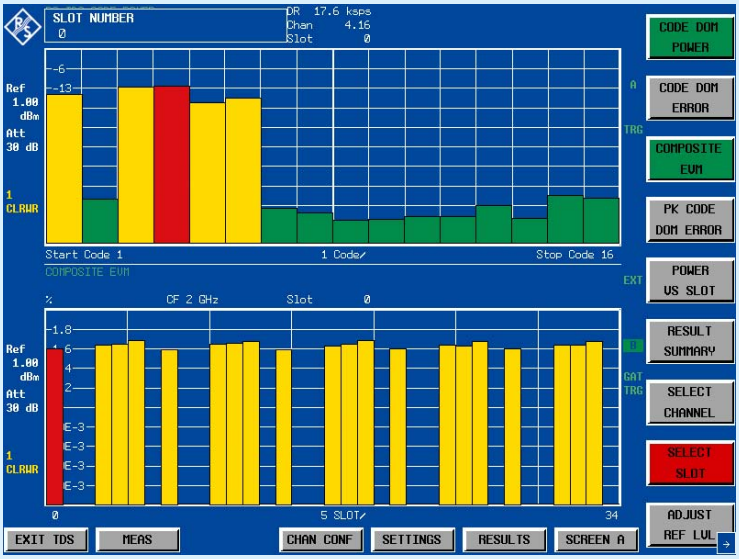

FIG 4
The analyzers support measurements to a variety of standards.

Option	Standard
R&S®FS-K5	GSM/EDGE
R&S®FS-K72	3GPP FDD base stations
R&S®FS-K73	3GPP FDD user equipment
R&S®FS-K74	3GPP HSDPA base stations
R&S®FS-K76	TD-SCDMA base stations
R&S®FS-K82	cdma2000 base stations
R&S®FS-K83	cdma2000 and 1xEV-DV mobile stations
R&S®FS-K84	cdma2000 and 1xEV-DO base stations

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More information and data sheets for the analyzers and options at www.rohde-schwarz.com