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## Spectrum Analyzers R&S®FSP/R&S®FSU

# Analyzing HSDPA and HSUPA signals

### Using firmware options

**R&S®FS-K73 / -K74, the Spectrum Analyzers R&S®FSP and R&S®FSU and the Signal Analyzer R&S®FSQ can perform code domain measurements on HSDPA and HSUPA signals for WCDMA FDD transmissions.**

### High-speed packet access

One of the objectives of the 3G system was to significantly increase data transmission speed as compared with 2G systems. Even the first releases of the 3GPP WCDMA standard provided for a maximum transfer rate of 384 kbit/s – an impressive increase that made it possible for subscribers to download e-mails or make video phone calls. Network providers were able to offer new services such as mobile TV and the capability to download video clips. The new functions met with a positive response, but this also caused the demand for transmission capacities to grow further.

The first release included a limitation that was due to the use of circuit-switched links, which meant that system resources were dedicated to subscrib-

ers who might not even need them, thus wasting valuable capacities.

These circumstances and the need to hold ground against competing radio technologies such as Wi-Fi and WiMAX prompted the 3GPP standardization body to further improve the radio standard. The objectives were to boost data throughput and reduce access times.

Enhancement was implemented in two steps, always bearing in mind compatibility with existing networks. The first step – high-speed downlink packet access (HSDPA) – has yielded transfer rates up to 14 Mbit/s. Rohde & Schwarz provided T&M technology for this enhancement at an early stage [\*].

High-speed uplink packet access (HSUPA) – the second and lat-

► est enhancement of the standard – has increased uplink transfer rates to 5.76 Mbit/s. HSDPA and HSUPA together are referred to as HSPA (high-speed packet access). HSPA transfer rates by far exceed the rate of 2 Mbit/s specified by ITU for 3G systems. HSPA-compatible WCDMA networks are therefore also called 3.5G systems.

### HSPA measurements using R&S® FSx analyzers

Rohde&Schwarz has already adapted part of its T&M product portfolio to meet the new requirements of the standard, thus supporting manufacturers of terminal equipment and network components in designing their HSPA solutions.

Rohde&Schwarz has added HSUPA capability to the R&S®FS-K72/ -K73/ -K74 application firmware packages for its R&S®FSQ, R&S®FSP and R&S®FSU signal and spectrum analyzers. Thus, besides HSDPA functionality, the firmware now also includes extensive functions for transmitter measurements on HSUPA base stations and modules. R&S®FS-K74 is integrated into R&S®FS-K72 and provides modulation test capabilities for HSDPA and HSUPA signals in the downlink. The R&S®FS-K73 option provides HSDPA and HSUPA measurements in the uplink.

#### Higher-order modulation

A very common method of increasing data throughput is to adapt the modulation to the current propagation conditions. This method is used by several standards such as GSM/EDGE, 1xEV-DO or Wi-Fi.

In accordance with the first WCDMA release, a specific code in the code domain was assigned to each subscriber in the downlink for their payload. This code is referred to as DPCH and is always QPSK-modulated. With HSDPA,

each subscriber is also assigned a DPCH for the payload and control information. In addition, each mobile terminal shares one or more high-speed channels (HS-PDSCH) with other subscribers for data reception. Via one or more HS-SCCHs, the base station signals which terminal it will send data to. QPSK or 16QAM modulation is used, depending on the propagation conditions.

The analyzer firmware must be able to identify the modulation type in order to demodulate signals correctly. The R&S®FS-K74 option performs this task automatically (FIG 1).

For HSDPA base station tests, the 3GPP TS 25.141 standard specifies a new measurement for determining modulation quality. Test model 5 contains the signals for this measurement. The signals include control channels, traffic channels and two, four or eight 16QAM HSDPA channels and are used to determine the error vector magnitude (EVM). The new measurement using test model 5 places substantially higher demands on base stations.

Previous releases provided for two measurements for determining modulation quality; these covered the peak code domain error (PCDE) and the EVM. The EVM is measured using one or optionally two active codes. The PCDE measurement is a highly demanding task for developers of transmitters because the test signal has a higher crest factor, which means correspondingly greater stress for the transmitter. The stipulated PCDE of approx. –33 dB corresponds to a composite EVM of 30%.

Requirements for HSDPA are even more stringent, stipulating an EVM of <12.5% as well as the use of a considerably more complex signal. This makes EVM measurements very demanding. Using the R&S®FS-K74 option, these measurements pose no problems. Featuring

an internal EVM as low as <1.5%, the option has virtually no effect on measurement results.

HPSK modulation, which may also be understood to be “scrambled dual BPSK”, is used in the uplink. HSPA is a multicode transmission method, with the peak value of the signal increasing from approx. 3.5 dB to approx. 6.5 dB relative to the average value. This means greater stress for the modulator and the power amplifier in the terminal. New test procedures defining the signal structure are currently under development. An EVM of 12.5% is allowed; however, a signal with a higher crest factor must be used for measuring the EVM. The R&S®FS-K73 option supports multicode EVM measurements (FIG 2).

### Abbreviations

BPSK	Binary phase shift keying
CPICH	Common pilot channel
DPCH	Dedicated physical channel
E-DPDCH	Enhanced dedicated physical data channel
HPSK	Hybrid phase shift keying
HS-PDSCH	High-speed physical downlink shared channel
HS-SCCH	High-speed shared control channel
PCDE	Peak code domain error
P-CCPCH	Primary common control physical channel
PICH	Pilot channel
QPSK	Quadrature phase-shift keying
S-CCPCH	Secondary common control physical channel

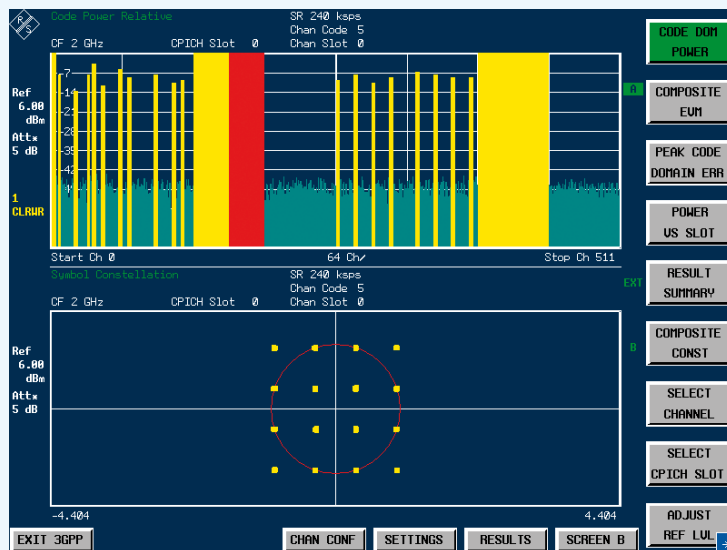
### Full demodulation down to bit level

To be able to adapt modulation and coding appropriately, the base station and the mobile terminal continuously monitor propagation conditions and signal current conditions to each other. Moreover, they exchange information as to whether demodulation was successful or transmission has to be repeated.

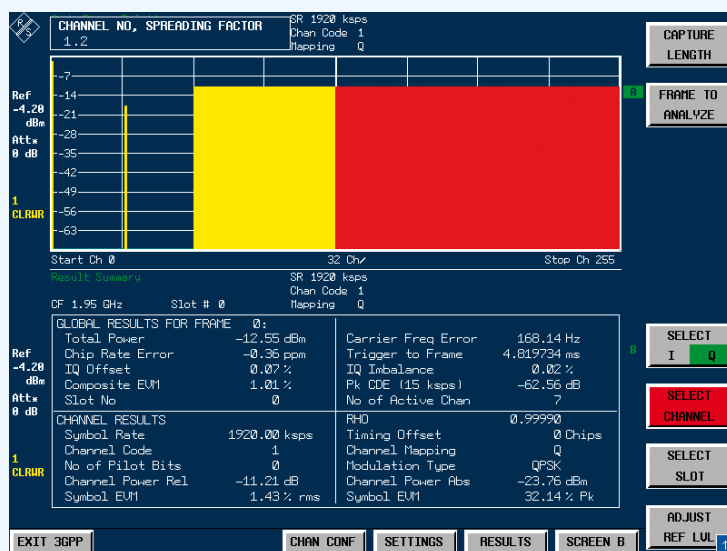
The analysis firmware demodulates signals down to bit level (FIG 3). In conjunction with the R&S®FSQ's large memory capable of saving up to 100 frames, the firmware is an excellent tool for analyzing the signaling procedures described above.

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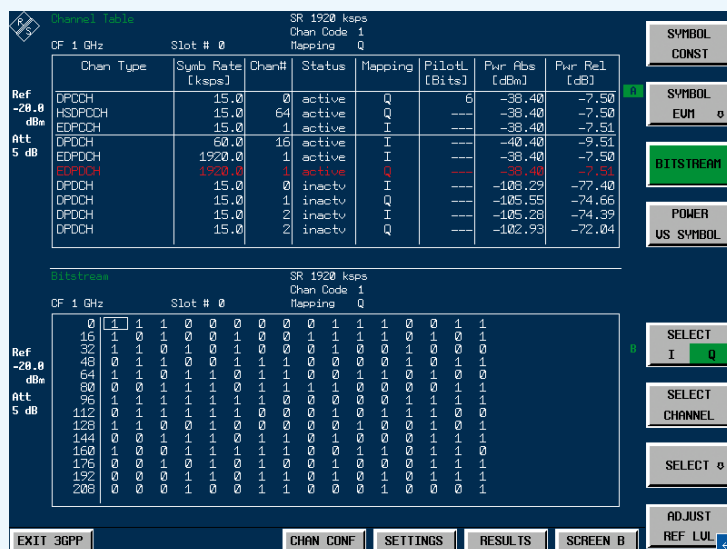
**FIG 1**  
Shown in red:  
16QAM modulation automatically detected by the software.



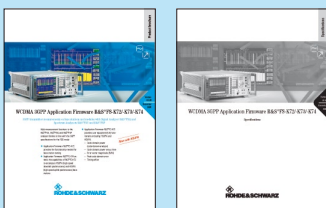
**FIG 2**  
The upper half of the screen shows the code domain in the Q component of the signal. The signal contains various codes; the code marked red represents an E-DPDCH with 1920 kbit/s.



**FIG 3**  
Demodulation down to bit level.



More information, data sheet and brochure at [www.rohde-schwarz.com](http://www.rohde-schwarz.com) (search term: FS-K73 / -K74)



#### REFERENCES

[\*] Analyzers R&S®FSP/FSU/FSQ: Test of HSDPA base stations. News from Rohde & Schwarz (2004) No. 181, pp 16–17