# News from Rohde & Schwarz


Versatile test solutions for
WPAN, WLAN and WWAN

Fast and convenient testing of
WCDMA base stations

Product life cycle management:
controlling availability and costs

2005/III
187

ROHDE&SCHWARZ

**Rohde&Schwarz offers a wide range of T&M products for all important wireless communications networks. The article on page 33 describes a comprehensive solution for WiMAX applications. The articles on pages 38 and 40 present generators and analyzers that can handle the WLAN 802.11 standard.**


44444

**The new RF Test Chambers R&S®TS7121 permit reliable RF testing of small modules and devices with maximum dimensions of 80 mm × 130 mm × 194 mm (page 6).**

**The WCDMA Base Station Test Set R&S®FSMU-W, which includes the high-end instruments R&S®SMU and R&S®FSQ, is an excellent tool for testing 3GPP base stations in accordance with TS25.141 (page 18).**

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**Broadcasting equipment from Rohde & Schwarz, securely packed for worldwide dispatch. Whether it's TV transmitters for a FLO™ network in the USA (page 48), FM and TV transmitters for a nationwide broadcasting network in Ghana (page 50) or transmitters for the DTV project in Bavaria (page 52) – numerous projects and references are proof of the worldwide success of Rohde & Schwarz transmitters and T&M equipment.**


## BROADCASTING

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## Sound transmitters

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**The digital FM Exciter R&S®SU 800 combines the excellent specifications of the best analog exciters with the reliability of modern digital signal processing. Thus, it is very compact and occupies only one height unit in a rack (page 54).**


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# DARP – new receiver technologies boost network capacity

**With a steadily increasing number of mobile radio subscribers having to share limited frequency resources, operators are looking for economical ways to expand their network capacity. An obvious approach is to use the available frequency spectrum as effectively as possible by employing a reuse factor of 1:1. This, however, involves considerable adjacent-channel interference, which would diminish the desired effect. One solution can be found in a new receiver technology: DARP (downlink advanced receiver performance).**

## Reuse factor 1:1 – pros and cons

Ideally, each cell of a network would transmit at each available frequency, meaning a reuse factor of 1:1. This option would provide maximum network capacity. But there is a drawback: In such a scenario, a mobile phone would receive a number of different signals from neighboring radio cells. These signals would be superimposed on the wanted signal, thus causing interference. A reuse factor of 4:12 is therefore currently employed in many mobile radio networks.

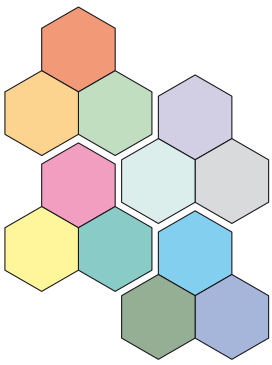
FIG 1 illustrates the scenarios for the reuse factors of 4:12 and 1:1. With a reuse factor of 4:12, the 12 frequencies available for a base station are allocated to the station's four cells, i.e. one frequency to each of the three sectors of a cell. This means that each sector can utilize only 1/12 of the available frequency resources. The reuse pattern repeats after every fourth cell.

With a reuse factor of 1:1, by contrast, all 12 frequencies are available in each cell, i.e. the network provides the maximum capacity.

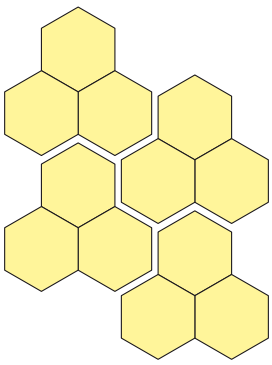
New techniques for expanding network capacity meet with great interest among network operators and mobile radio manufacturers. Initial approaches aimed at handling adjacent-channel interference by implementing appropriate features in the mobile phone led to the use of additional antennas (antenna diversity). However, this solution would have necessitated considerable hardware and software changes in the mobile terminals.

## The solution: DARP

The solution offered by DARP increases network capacity by employing lower reuse factors, and at the same time suppresses interferences. The new technique requires no multiple antennas and works at the chip level (baseband) by



**Reuse factor 4:12**
Four cells with three sectors each and a total of 12 frequencies. Each sector is allocated a separate frequency and can, therefore, use only 1/12 of the available frequency resources.



**Reuse factor 1:1**
The ideal case: Each cell and each sector use the same frequency; the maximum network capacity is available.

**FIG 1**
**Different reuse factors in mobile radio networks and their effect.**

means of signal processing in the mobile phone. It allows network capacity to be expanded and base station transmit power to be reduced at the same time. DARP is used synonymously with the term SAIC (single antenna interference cancelation).

The DARP technique operates with the antenna integrated in the mobile phone and is based on a knowledge of GSM modulation, which makes it possible to suppress as effectively as possible adjacent-channel interference that differs from general noise. Simulations and field trials have shown that optimum interference suppression, and thus maximum increase in performance, are achieved with a synchronous network structure.

The currently relevant DARP algorithms can be divided into two basic categories.

### Joint demodulation (JD)

The JD algorithm is based on a knowledge of the GSM signal structure in adjacent cells in synchronous mobile radio networks. Using this algorithm, one or several interference signals can be demodulated in addition to the wanted signal. This capability of retrieving interference signals allows the suppression of specific adjacent-channel interferers.

Apart from GMSK-modulated signals, JD is also capable of demodulating 8PSK (EDGE) signals. However, the fact that interfering signals are demodulated at the same time makes this technique considerably more complex to implement and thus dramatically increases the required computing power.

### Blind interferer cancelation (BIC)

The BIC algorithm only demodulates the GMSK signal of the wanted carrier; the receiver has no knowledge of the structure of any interfering signals that may be received at the same time. In other words, the receiver is "blind" to any adjacent-channel interferers that may occur, and attempts to suppress the interfering component as a whole. Given this characteristic, BIC is suitable only for GMSK-modulated speech and data services, but can also be used in asynchronous networks.

| Reference test scenario | Interference sources | Relative interference level | Training sequence | Delay of interference signal |
|---|---|---|---|---|
| DTS-5 | Co-channel 1 | 0 dB | None | 74 symbols |
| | Co-channel 2 | –10 dB | None | None |
| | Adjacent channel 1 | 3 dB | None | None |
| | AWGN | –17 dB | – | – |

**FIG 2 Reference test scenario with several asynchronous interference sources.**

| | |
|---|---|
| Speech channels (TCH/FS, TCH/AFSx, TCH/AHSx) | FER ≤1% |
| Signaling channels (FACCH/F, SDCCH) | FER ≤5% |
| Packet-switched channels (PDTCH) | BLER ≤10 |

**FIG 3 Requirements of DARP conformance tests.**

## Status and test strategy of 3GPP specifications

In early 2005, the 3GPP TS 45.005 (Radio Transmission and Reception) and 3GPP TS 51.010-1 (MS Conformance Test Specification) standards were extended to include DARP-compatible mobile phones. The 3GPP standard defines five DARP reference test scenarios (DTS) for synchronous and asynchronous networks and specifies the required performance values in each case.

FIG 2 shows an example of test scenario DTS 5 with four interference sources. The interferers are configured with a different level, delay and training sequence code (TSC). A uniform fading profile (TU 50) is superimposed on all interferers as well as on the carrier signal.

Sixteen new test cases were created on the basis of the DARP reference scenarios. Using these test cases, DARP-compatible mobile phones can be checked for conformance with the requirements listed in FIG 3.

## DARP test solutions from Rohde & Schwarz

The R&S®TS 8950, R&S®TS 8952 and R&S®TS 8955 RF test systems support all currently available DARP test cases. Existing test systems can be upgraded to provide test functionality covering the additional interference signals specified in the test cases.

Siegfried Friesinger

**More information and data sheets for the test systems at www.testsystems.rohde-schwarz.com**

REFERENCES
– 3GPP TS 45.005
– 3GPP TS 51.010-1
– 3GPP TR 45.903


**FIG 1 Automatic RF Test Chamber R&S®TS 7121 A used with Universal Radio Communication Tester R&S®CMU 200.**

**The RF Test Chambers R&S®TS 7121 (FIG 1) complement the Rohde & Schwarz product portfolio for RF tests on small modules and devices with a radio interface. Featuring high shielding effectiveness, the RF chambers perform interference-free and thus reproducible tests on small modules and devices in accordance with a wide variety of standards, including ISM, GSM, CDMA, UMTS, WLAN, *Bluetooth*®, etc.**

Automatic / manual RF Test Chambers R&S®TS 7121

# Reliable RF tests on small modules and devices

## Product spectrum expanded

In the past, Rohde & Schwarz mainly offered manually operated RF chambers such as the Antenna Coupler R&S®CMU-Z10 with the Shielding Cover R&S®CMU-Z11, and the modular universal RF Test Fixture R&S®TS 7110 [1, 2]. The R&S®TS 7110 is remarkable for its wide range of applications, from module tests through to final tests of devices with a radio interface. The manual R&S®CMU-Z10 / -Z11 RF chamber, by contrast, is mainly intended for RF tests on radio interfaces. The new RF Test Chamber R&S®TS 7121 A complements this spectrum by adding test capability for automated production lines (FIG 2).

The R&S®TS 7121 M manual version is intended for use in service and development and also in manual test setups in production.

Used in conjunction with the Universal Radio Communication Tester R&S®CMU 200 or other test equipment as well as suitable antenna couplers for GSM, WCDMA or UMTS, the RF test chambers enable BER, FER and power measurements on mobile phones, for example. They also provide RF tests on other small devices that have a radio interface, e. g. on PDAs, remote keyless entry or cordless phones that operate in the ISM, WLAN, home RF and *Bluetooth*® bands, for example.

## Milled from a single block

The RF Test Chamber R&S®TS7121A has been designed to meet the requirements of automatic production lines. This includes heavy use, rugged design and automatic opening and closing of the RF chamber. To meet these requirements and to attain shielding effectiveness higher than 70 dB, the housing is milled from a solid aluminum block. The housing surfaces are galvanized to prevent the aluminum from oxidizing, thus ensuring continuously high shielding effectiveness (FIG 3).

The RF test chambers consist of a milled base, a slide-in unit and a cover. The lower compartment of the base accommodates the guide rails and, in the case of the R&S®TS7121A, also the pneumatic system including the pressure regulators and valves. The valves are controlled via a 24 V connector or an optional USB control.

The actual RF chamber is located above the chamber that contains the pneumatic system. On the RF chamber rear panel, four RF feedthroughs are provided for connecting antenna couplers or DUT RF interfaces. Moreover, the rear panel contains a D-Sub filter connector for feeding voltages and low-frequency signals to the DUT or to the internal test and control circuitry (FIG 4).

The interior of the RF chamber is lined with absorbent material that attenuates high-frequency electromagnetic waves and thus ensures reproducible and stable measurements. The absorber material also works in the audio range, where it effectively reduces reflections and ambient sound.

The DUT is slid into the RF chamber through the chamber window on the slide-in unit by pneumatic or manual control. The supporting plate which holds the DUT mount or the DUT itself


**FIG 2 RF test chambers available from Rohde & Schwarz.**

**FIG 3**
**Milled from a single block: housing of RF Test Chambers R&S®TS7121 (rear view).**


**FIG 4**
**Interior view of R&S®TS7121A with GSM antenna coupler and supporting plate.**

contains a centering pin and rests on a stable guiding mechanism. This ensures reproducible positioning of the DUT or application-specific DUT mounts.

GSM and *Bluetooth*® antenna couplers in the range 800 MHz to 2.4 GHz are currently available; the couplers can be attached to the side panels or the bottom panel. Moreover, ISM couplers for frequencies <1 GHz and WLAN antenna couplers for 2.4 GHz to 5.8 GHz are available that can be adapted for use with the RF test chamber.

The RF chamber is sealed by means of a milled cover, which is fastened in place with easy-to-lock tension levers. Optionally, elevated covers are available that provide sufficient room for the integration of further test equipment such as CCD cameras or keyboard stimulators.

The R&S®TS 7121 M manual version is equipped with a handle that allows easy closing and locking of the RF chamber (FIG 5). This version is mainly intended for use in service and development. The automatic and the manual version of the RF shielding chamber are basically of the same design, which ensures that the two versions also have the same test functionality.

## Summary

The RF Test Chambers R&S®TS 7121 provide reliable RF tests on small modules and devices, i.e. with dimensions up to 80 mm × 130 mm × 194 mm. Other measurements, e. g. audio tests, can be performed optionally. The RF test chambers are manufactured by Rohde & Schwarz itself. Customized models can, therefore, also be supplied at short notice if larger quantities are ordered. Rohde & Schwarz offers complete customized test solutions based on the RF test chambers described above as well as other test equipment, for example for testing tire pressure sensors, mobile phones, or ISM, *Bluetooth*® or WLAN modules.

Gert Heuer

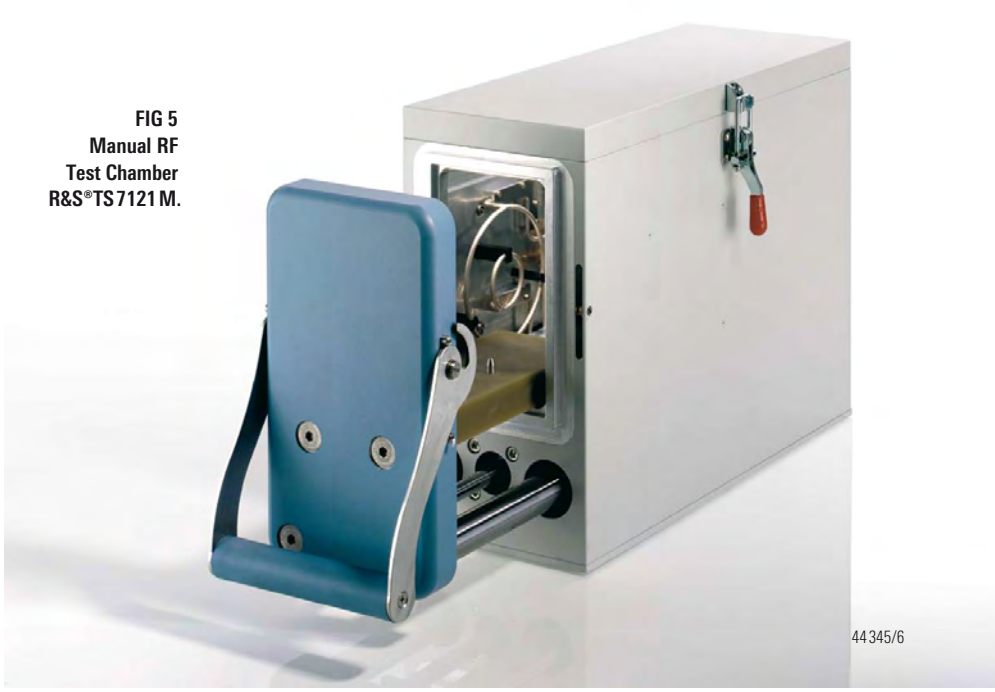



**FIG 5**
**Manual RF Test Chamber R&S®TS 7121 M.**

**More information at**
**www.testsystems.rohde-schwarz.com**
**(search term: TS7121)**
**www.rf-chamber.rohde-schwarz.com**

REFERENCES

[1] Antenna Coupler R&S®CMU-10 / Shielding Cover R&S®CMU-Z11: Practical and indispensable accessories for testing mobile phones. News from Rohde & Schwarz (2002) No. 175, pp 18–19
[2] Versatile Shielded RF Test Fixture R&S®TS 7110: Test fixture for modules and units with radio interface. News from Rohde & Schwarz (2003) No. 179, pp 4–7

### Condensed data of the R&S®TS 7121

| | |
|---|---|
| **Dimensions** (width × height × depth) | |
| Outer dimensions[1] | 155 mm × 305 mm × 428 mm |
| Inner dimensions incl. absorbent material | 87 mm × 130 mm × 354 mm |
| Max. DUT dimensions incl. DUT mount | 80 mm × 130 mm × 194 mm |
| **Connectors** | |
| Compressed air (grease-free) | 4 bar to 8 bar |
| Control of pneumatic system | 25-contact D-Sub (m), 24 V |
| Filter feedthroughs | 25-contact D-Sub (f) |
| **Shielding effectiveness**[2] | >70 dB, 800 MHz to 2.4 GHz |
| | >60 dB, 2.4 GHz to 6 GHz |
| **Options** | |
| Antenna coupler | GSM, *Bluetooth*®, WLAN, ISM |
| Coupling factor, e. g. of GSM antenna module | typ. 10 dB to 20 dB |

1) Without connectors, levers and handle.
2) Standard values without external cables.

Mobile Radio Communications Architecture IpMCA®

# Future-proof IP-based communications architecture

**The IP-based Mobile Radio Communications Architecture IpMCA® is a technical and commercial requirements profile defined by Rohde & Schwarz for digital professional mobile radio (PMR) networks intended for mission-critical applications. Rohde & Schwarz is systematically gearing its *ACCESSNET*®-T TETRA system for compliance with the new profile.**

## Anticipating the future

IpMCA® encompasses all elements of a network's infrastructure, as well as mobile and stationary terminal equipment and all other supplementary equipment and facilities. The definition of the new architecture reflects the many years of experience gained by Rohde & Schwarz in the field of TETRA mobile radio systems as well as customer requirements all over the world as determined from a large number of discussions and invitations to tender.

A criterion of paramount importance for a modern mobile radio communications architecture is its capability to handle future requirements, so as to safeguard customers' investments in the long term. This can be achieved only by employing state-of-the-art telecommunications technology as well as innovative system products that can be expanded or modified with a minimum of effort.

In terms of technology, the key elements of a future-proof mobile radio communications architecture are currently seen to be the Internet protocol (IP), the consistent use of the principles of software-defined radio as well as the deployment of powerful, open operating systems such as Linux. The use of these elements – in conjunction with intelligent system and software structures – will shift the focus of future technological developments from hardware to software. This solution is rounded out by functions for software downloads for network components.

A digital infrastructure based on IpMCA® perfectly takes into account the dynamic nature of mission-critical PMR networks, and is designed to facilitate any modifications that may become necessary during the life of the networks.

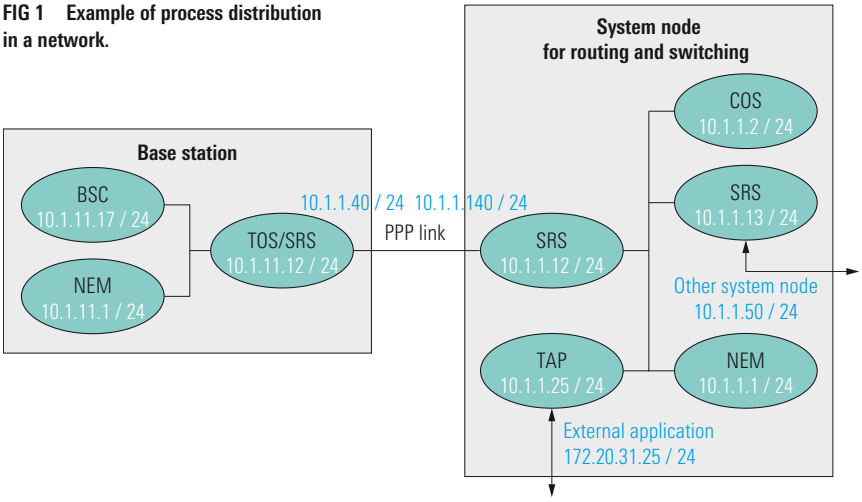
## IpMCA® and *ACCESSNET*®-T

The Internet protocol (IP) has been defined as the binding communication protocol for IpMCA®, together with an underlying point-to-point protocol (PPP).

Rohde & Schwarz decided very early in favor of IP as the binding protocol in its *ACCESSNET*®-T TETRA mobile radio network. The protocol serves as the basis for all communication between network elements such as routers and switches, base stations, the network management system, and communication with databases and applications (FIG 1).

The different software components of a network element also use IP to communicate with each other while carrying out their processes, irrespective of

**FIG 1 Example of process distribution in a network.**



whether these processes are performed on one or multiple processors. Processes can therefore be distributed among several processors to handle increasing capacity requirements. Moreover, IP-based communication is completely independent of the operating systems used.

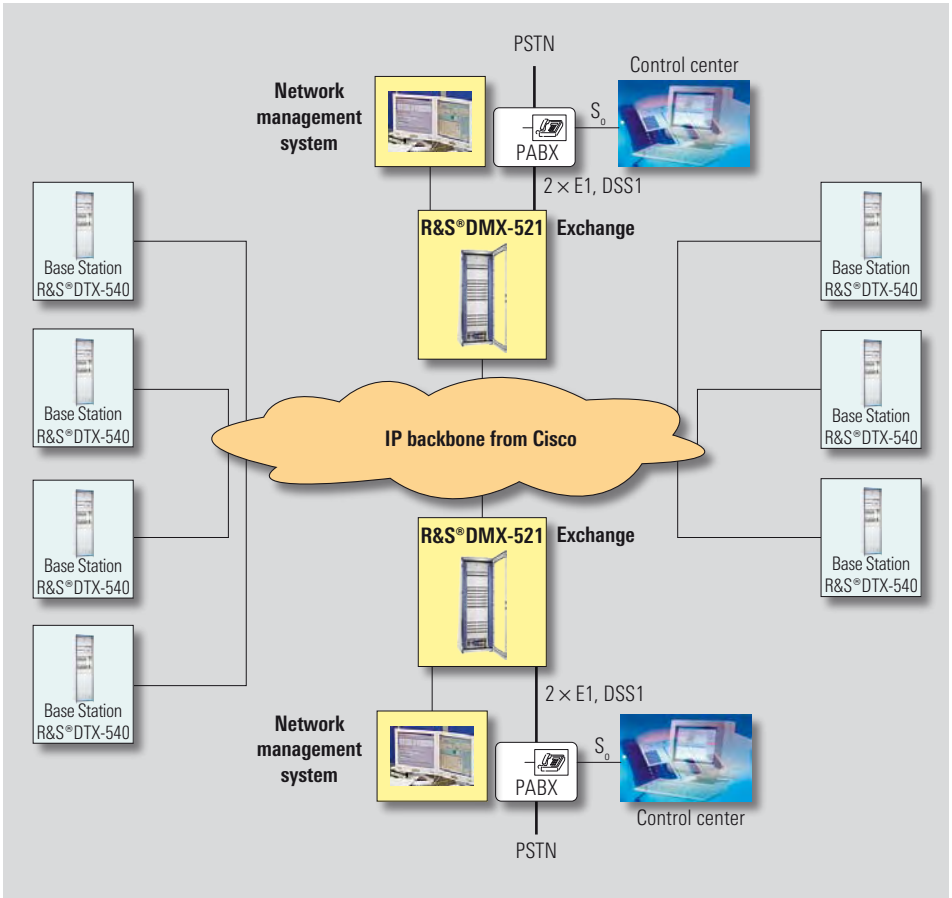
The use of IP-based communication does not relieve operators of mission-critical infrastructure from providing suitable backbone networks. Mission-critical PMR networks, in contrast to in-house Ethernet systems, must cover larger areas. Moreover, base stations are frequently planned for locations where a backbone can usually be established only by means of microwave links or leased lines. IpMCA® therefore also makes it possible to use IP for communication via such links or lines.

| Network element | Designation | Network | Subnet mask |
|---|---|---|---|
| **Exchange** | Ethernet network segment | 10.1.1.0 | 255.255.255.0 / 24 bit |
| | NMS segment | 10.1.3.0 | 255.255.255.0 / 24 bit |
| | Dialup segment to RCS | 10.1.8.0 | 255.255.255.0 / 24 bit |
| **Base station 1** | Ethernet network segment | 10.1.10.0 | 255.255.255.128 / 25 bit |
| | NMS segment | 10.1.10.128 | 255.255.255.128 / 25 bit |
| **Station de base 2** | Ethernet network segment | 10.1.11.0 | 255.255.255.128 / 25 bit |
| | NMS segment | 10.1.11.128 | 255.255.255.128 / 25 bit |

**FIG 3 Example of IP address allocation in an *ACCESSNET*®-T network with two base stations.**

There are also private, large-area IP networks that offer high transmission capacity and sufficient quality of service (QoS), allowing their use as backbone networks for *ACCESSNET*®-T mobile radio networks (FIG 2).

**FIG 2 *ACCESSNET*®-T with IP backbone from Cisco Systems.**




In packet-switched networks, voice information is also transported in the form of IP data packets that are routed through the network using the packet address. Circuit-switched networks, by contrast, transmit voice information via lines, which are switched as dedicated lines between the subscribers for the duration of the communication. IpMCA® supports both transmission modes. However, since circuit-switched transmission observes a stricter time scheme, it will be the preferred solution where minimum call setup times are crucial.

Industry expressly recommends not using the publicly accessible Internet as a backbone network for mission-critical PMR networks. At present, its quality standard does not sufficiently guarantee a defined transmission rate – and thus a defined transmission and response time. While this may be different in the future, the internal IP address allocation of *ACCESSNET*®-T will nevertheless not collide with the Internet address space because the *ACCESSNET*®-T address allocation scheme prevents this (FIG 3).

## TETRA and IP

**IP over TETRA** is a data service described by the TETRA standard (EN 300 392-2, Chapter 28). IpMCA®-compatible networks will have this data service implemented in accordance with the specifications of the TETRA MoU

interoperability profile (TIP). This data service can consequently be used by any TIP-conforming TETRA terminal. The IP packets are routed unchanged through the *ACCESSNET*®-T mobile radio network to an IP access point; the data contents will not become known to the network.

**TETRA over IP (ToIP)**, on the other hand, means that the inner network structure is designed exclusively for packet-switched operation and is based on IP. It should be noted that ToIP is not an established standard in the strict sense of the word; for this reason, binding specifications do not exist. The TETRA standard itself does not contain any references to ToIP; after all, the standard does not define the inner structure of a TETRA network.

Since IpMCA® also supports packet switching, ToIP will be implemented as standard as a proprietary solution in IpMCA®-compatible *ACCESSNET*®-T mobile radio networks.

## First router and switch for IpMCA®

The R&S®IpSN system node from Rohde&Schwarz is the first router and switch for *ACCESSNET*®-T that fully meets IpMCA® requirements (FIG 4). It comes as a stackable 19" standard block and is designed for connecting 36 base stations. The R&S®IpSN contains 38 TETRA vocoders for voice recoding at the junction with PABX and ISDN systems or a control center. It is equipped with $S_0$ and $S_{2m}$ interfaces as standard.

Several R&S®IpSN system nodes can be cascaded to yield capacity to serve up to 100 base stations. In addition to cascading, system nodes can also be interconnected to build very large networks in which hundreds of base stations can be operated. Other remarkable features of the R&S®IpSN LSI system node are its compact size, low weight and low power consumption. Software updates can be performed by software downloading via the network management system.

## Summary

The IP-based IpMCA® is the most modern framework currently available defining all important aspects of a future-oriented mobile radio communications architecture. It describes the impact that IpMCA® will have on the elements of a digital PMR mobile radio network as well as the resulting advantages for network operators and subscribers. The innovative IpMCA® definition is impressive due to its use of state-of-the-art technologies, also taking into account any further developments of such technologies in the foreseeable future.

Max Zerbst

**More information about our comprehensive TETRA program at www.rohde-schwarz.com (Trunked Radio)**

## Abbreviations

| | |
|---|---|
| BSC | Base station controller |
| COS | Core operation server |
| IP | Internet protocol |
| LSI | Large-scale integration |
| NEM | Network element manager |
| NMS | Network management system |
| PABX | Private automatic branch exchange |
| PMR | Professional mobile radio |
| PPP | Point-to-point protocol |
| PSTN | Public switched telephone network |
| RCS | Remote control system |
| TAP | TETRA application platform |
| TOS | TETRA operation server |
| SRS | Switching and routing server |

**FIG 4 The R&S®IpSN system node is a cascadable 19" standard block.**

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**FIG 1 R&S®CRTU-W/-M platform for protocol tests.**

Protocol Testers R&S®CRTU-W/-M

# Layer 1 tests for WCDMA and HSDPA made easy

**The layer 1 test software option for the 3G Protocol Testers R&S®CRTU-W/-M provides extensive test capability for the physical transmission layer of WCDMA and HSDPA terminals. A new integrated scripting interface for the generation of test scenarios helps the user to perform automatic tests.**

## Why layer 1 tests?

The implementation of layer 1 (physical layer) involves major effort on the part of manufacturers of chip sets for WCDMA terminal equipment. Unlike GSM, a high degree of flexibility in layer 1 has been stipulated by the WCDMA standard from the start: Services with different quality requirements can be multiplexed for transmission using the same physical resources. Different channel coding can be selected for each service in order to make the most efficient use of the available bandwidth. Manufacturers and network operators can thus offer a customized range of services as well as optimized transmission quality. This flexible concept, however, makes layer 1 implementation more complex and thus calls for more sophisticated test equipment and concepts for 3G mobile phones.

3GPP Radio Access Network (RAN) specifications stipulate that complex tasks such as power control, compressed mode and transmit diversity be implemented in layer 1. Moreover, the downlink data rate is boosted to as high as 14 Mbit/s by the High Speed Downlink Packet Access (HSDPA) standard defined in 3GPP WCDMA Release 5, which makes layer 1 requirements even more stringent. Extensive tests of 3G layer 1 implementation during the development phase and prior to integration are therefore indispensable for every manufacturer.

## Software concept

The layer 1 test software from Rohde&Schwarz with a Windows®-based GUI (FIG 2) provides a convenient and extremely flexible test environment for layer 1 implementations in WCDMA and HSDPA chip sets and terminals. This test environment is available as a software option not only for the Protocol Tester R&S®CRTU-W, but also for the more economical R&S®CRTU-M platform (FIG 1). The two instruments are based on identical hardware; the R&S®CRTU-W however features software that provides more comprehensive functionality. If necessary, the R&S®CRTU-W and the R&S®CRTU-M can be upgraded to fully configured protocol test environments and are thus ideal for use at all stages of terminal design – from layer 1 development and protocol integration up to conformance tests.

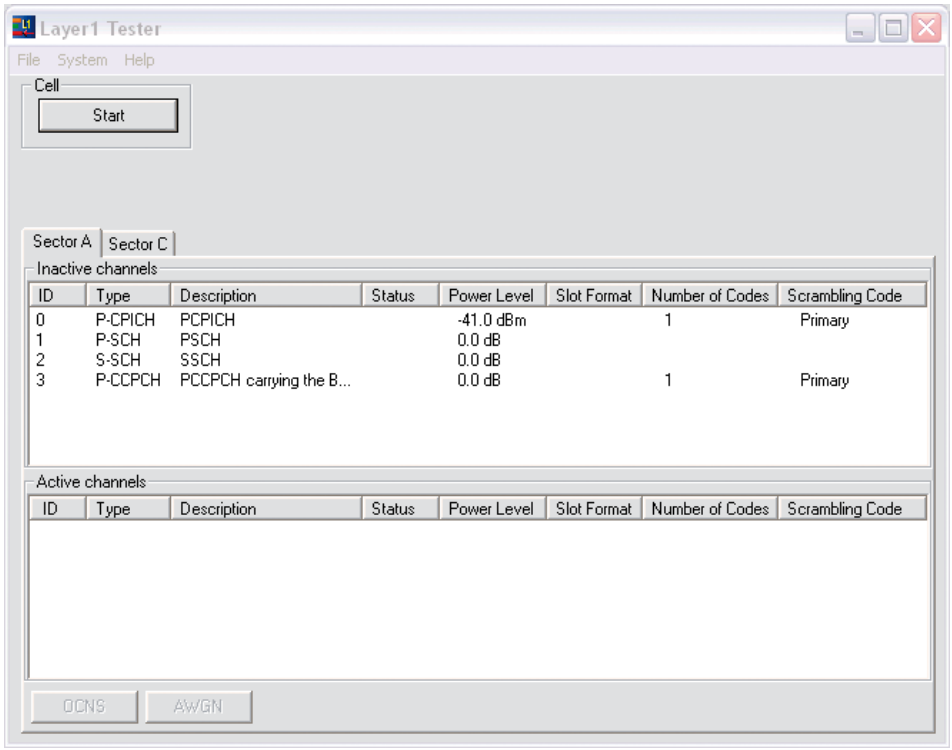



**FIG 2 GUI of layer 1 test software.**

**FIG 3 Physical channels that can be configured using layer 1 test software.**

**3GPP channels defined in Release 99**
P-SCH
S-SCH
P-CPICH
S-CPICH
P-CCPCH
S-CCPCH
PICH
AICH
PRACH
DPDCH (uplink and downlink)
DPCCH (uplink and downlink)

**HSDPA channels defined in 3GPP Release 5**
Max. four HS-SCCH
Max. five HS-PDSCH
HS-DPCCH

**AWGN**

**OCNS (16 channels)**

The software basically acts like a WCDMA or HSDPA base station. It can generate complex downlink signals at layer 1 and test their reception and processing by the implementation under test. In the uplink, the software analyzes the signals received from the DUT. Moreover, the software can test correct interaction between the downlink and the uplink in the DUT, which is indispensable in HSDPA tests, for example. The DUT is operated in the non-signaling mode, where no signaling by higher protocol layers is required.

## Channel configuration

In the downlink, the test software generates all conventional channels defined by 3GPP Release 99 and Release 5 (FIG 3). It offers unique configuration options for the WCDMA transport channels, coded composite transport channels and physical channels (FIG 4). The user can define the transport formats for each transport channel, generate any combinations of transport formats from them (FIG 5) and store these combinations permanently. To develop an efficient layer 1 implementation, it is mandatory that a maximum number of combinations be tested. Otherwise there is the risk that errors will crop up later in development or, even worse, in real operation. The test cases specified by the standard cover only a small number of the permissible configurations, so that manufacturers should in no case rely on the standard test cases alone.

You can choose from among a large number of channel combinations predefined by Rohde&Schwarz. For example, channel combinations for AMR and

ISDN services are available in addition to the reference measurement channels defined by the standard. Plus, the test software can be used for verifying further layer 1 functions such as compressed mode, power control and transmit diversity in addition to configuring channel combinations.

## Reconfiguration during the test

The layer 1 test software allows you to modify the test scenario while the test is in progress. Any parameter changes can immediately be activated via the GUI. This does away with the need for tedious recompilations of test scenarios.

## HSDPA

HSDPA boosts downlink data rates to as high as 14 Mbit/s. In layer 1, the HSDPA standard provides for two new physical channels in the downlink and one new physical channel in the uplink. The modulation and coding of the useful data in the downlink channel are continuously adapted, based on the channel quality information returned by the subscribers. If errored packets are received, subscribers will request their retransmission using the hybrid automatic repeat request (ARQ) protocol. The adaptive modulation and coding as well as the hybrid ARQ, therefore, call for continuous interaction between the downlink and the uplink.

The layer 1 test software allows you to configure the new HSDPA channels as required (FIG 7) and to define the behavior of the tester in terms of adaptive modulation and coding as well as the hybrid ARQ protocol. This enables you to generate practically any test scenario you like. You can extensively test the behavior of your layer 1 implementation both in normal operation and under special conditions.

## Scripting interface

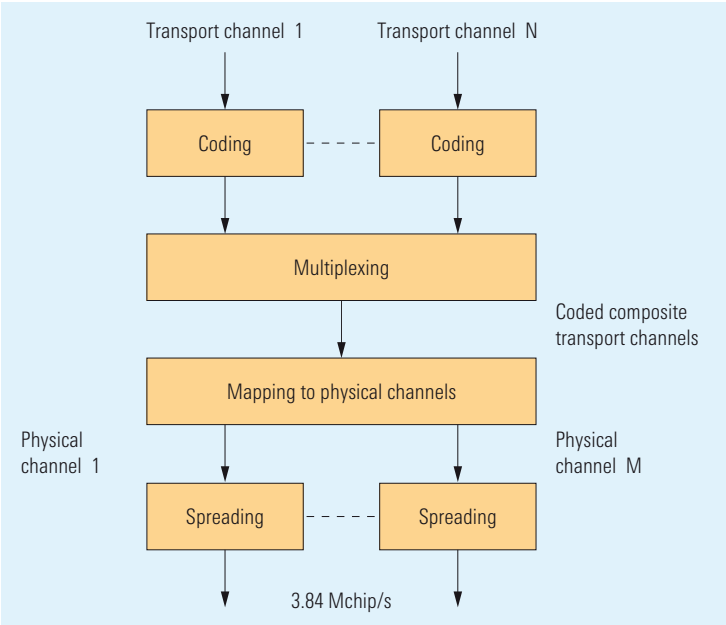
The test software not only allows the manual generation of test scenarios via the graphical Windows GUI. It also features a scripting interface based on the Microsoft COM standard. Test scripts can be generated in Visual Basic, for example, to define the behavior of the layer 1 test software (FIG 6). Previously defined channels can be integrated in scripts. This provides you with a cost- and time-saving means of performing fully automatic regression tests, and thus makes it easier for you to meet the extensive 3G test requirements.

## Summary and future developments

The layer 1 test software offers test functionality indispensable for the development of layer 1 implementations in WCDMA and HSDPA terminals. The demand for test solutions for such applications will continue to grow. For example, Release 6 of the 3GPP WCDMA standard, which will cover High Speed Uplink Packet Access (HSUPA), will include many new requirements with respect to layer 1.

Christina Geßner

**FIG 4 WCDMA model for transport channels, coded composite transport channels and physical channels.**




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

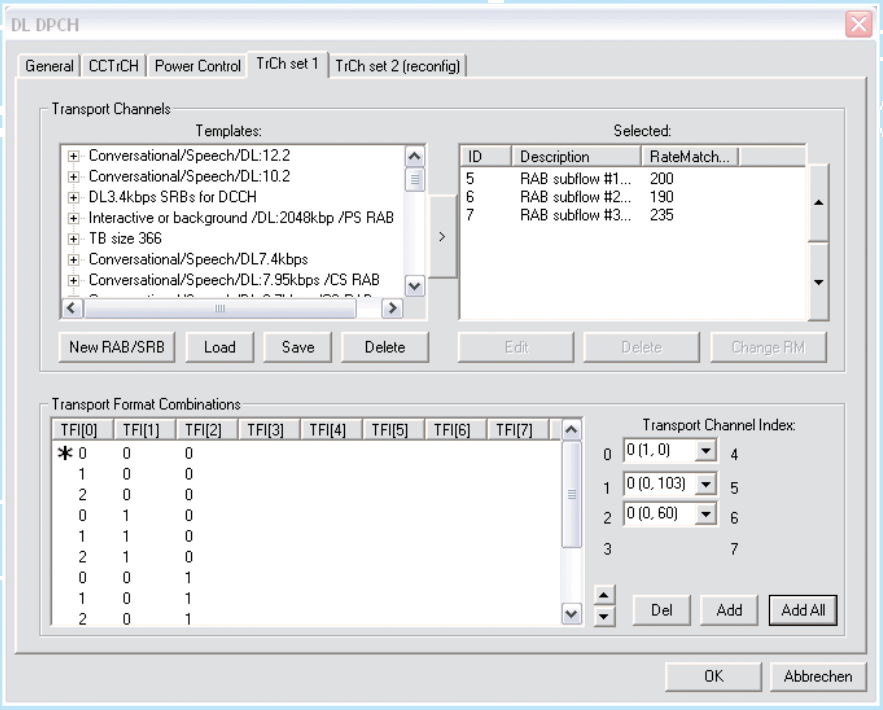



**FIG 5 Definition of permissible transport format combinations.**

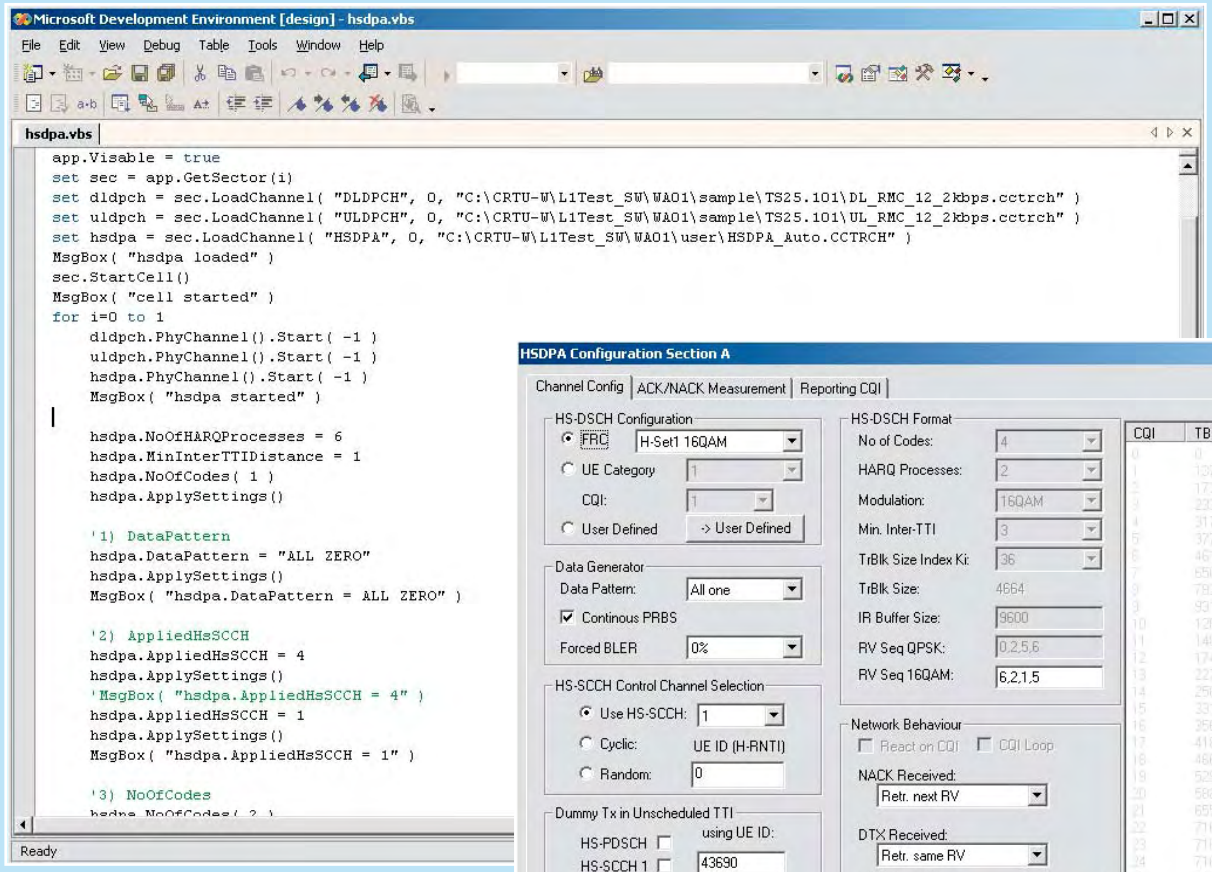



**FIG 6**
**Example of Visual Basic script for performing automatic tests with layer 1 test software.**

**FIG 7 Configuration of HSDPA channels.**

Protocol Tester R&S®CRTU-G

# Convenient version manager helps you keep track

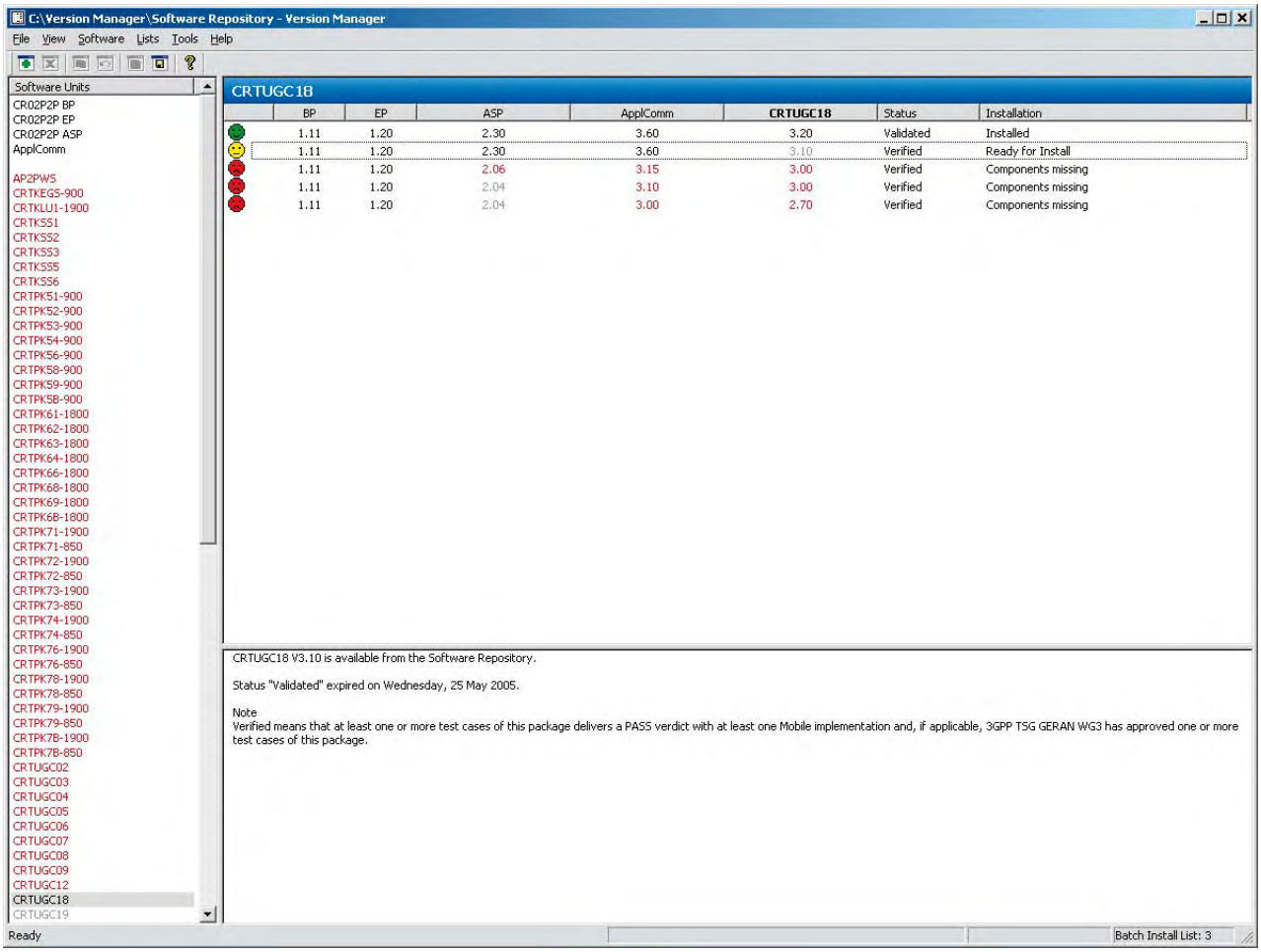
**The new version manager for the Protocol Tester R&S®CRTU-G helps you keep track of the large and steadily increasing number of functions being defined in modern mobile radio standards and the accompanying test cases.**

## Modern mobile radio standards continuously expanding

The Protocol Tester R&S®CRTU-G supports many state-of-the-art mobile radio standards such as GPRS, EGPRS, AMR and DTM. These standards are subject to frequent changes, because new functions are continuously being added, which in turn calls for new test cases. And that is where the problem comes in: As the R&S®CRTU-G always provides state-of-the-art functionality, its protocol stack must be continuously adapted and expanded. In this process it is almost unavoidable that different test cases require different versions of the protocol stack. Moreover, since test cases are always validated using a defined version of the protocol stack, they are usually no longer validated when ported from one stack version to another.

Rohde & Schwarz now offers a version manager for the Protocol Tester R&S®CRTU-G (FIG). This manager will help you keep track of different protocol stack versions and switch between

**The version manager prevents errors due to missing software components, and does away with having to consult compatibility lists.**



versions as desired. All you have to do is choose your test case; the version manager will select the required software components.

## Multiple operational software installation

To provide maximum flexibility, the R&S®CRTU-G operational software was divided into three parts by means of MOPSI (multiple operational software installation): a base part (BP), an automatic switching part (ASP) and an extension part (EP). The BP contains system-specific components such as device drivers, services and system configuration. The EP contains components not relevant to validation, such as the message composer. The ASP, by contrast, is the component relevant to signaling. Depending on the test case, this component is needed in different versions between which dynamic switchover has to be performed. By dividing the operational software in the manner described, it was possible to combine individual components in such a way that the software can now be adapted to changes in specifications within a very short time.

## Installation of the three software components

Only one BP can be installed, which should preferably be the latest version. Installing several BPs would not make sense, since new versions are downward-compatible. With the EP, the situation is similar; only one (the latest) version is to be installed.

For the ASP and the test cases, by contrast, any number of different versions may be installed; these are written to different directories organized in a straightforward manner. During installation, the version manager automatically saves test case packages to the directories of the ASP versions for which they were validated. When a test case is to be compiled, the required components such as the ASP and the application common code are recognized from the directory structure and automatically called during the test run. Deinstalling the operational software is no longer required.

## Complete and intelligent management

The version manager provides you with an intelligent management tool and helps you keep track of the software components installed. The heart of the version manager is a compatibility database, which contains complete information regarding the dependencies of the individual software components. For example, if you install a test case package that requires an ASP version not installed, the version manager signals the absence of that version. This mechanism enables consistent configuration of the R&S®CRTU-G without having to concern yourself with software component dependencies.

The version manager takes the components to be installed from a software repository, which is a directory defined in the version manager. This directory may be located on a network drive or on a CD / DVD or local drive.

The version manager lists components already installed in black font; components not yet installed but available in the repository are shown in grey font. This provides you with a quick overview of installed and/or available components.

When you install test cases, dependencies on other components, e.g. the ASP and the BP, come into play, as mentioned above. The version manager marks test case packages, for which the required ASP and BP versions are already installed and that are thus ready to run, by means of a green smiley. If a required component is not installed but available in the repository – or not available at all –, this is indicated by a yellow or a red smiley, respectively.

The new version manager makes software component management simple and easy. It prevents errors due to missing software components, and does away with having to consult compatibility lists.

Markus Hendeli

**More information and data sheet at www.rohde-schwarz.com (search term: CRTU-G)**


**FIG 1 The most important components in the WCDMA Base Station Test Set R&S®FSMU-W are the Signal Analyzer R&S®FSQ (above) and the Vector Signal Generator R&S®SMU 200 A.**

**The WCDMA Base Station Test Set R&S®FSMU-W can handle all test cases specified in 3GPP TS 25.141 (transmitter, receiver and performance tests). The most important components of the new test set are the two high-end instruments R&S®SMU 200 A and R&S®FSQ.**

WCDMA Base Station Test Set R&S®FSMU-W

# Quick and easy WCDMA base station testing

## Preconfigured all-in-one solutions are in demand

Test specifications such as TS 25.141 (base station conformance testing (FDD)) are a prerequisite in order for the 3GPP WCDMA standard to function properly worldwide and for equipment to be interoperable. Therefore, base station manufacturers must ensure that their equipment complies with these specifications. However, a number of obstacles have to be overcome:

- Compliance with extensive technical specifications must be achieved
- Complex test procedures must be taken into account
- Standardized test software must be developed

This means long periods of training and preparation for setting up test systems and can delay their market introduction. Therefore, the parties involved are not only buying individual measurement instruments – which naturally have to

meet the highest quality standards – but also expect preconfigured all-in-one solutions from test equipment suppliers.

Due to its flexible concept, the WCDMA Base Station Test Set R&S®FSMU-W does a good job of fulfilling these new requirements. It meets the highest quality standards and helps you to set up test systems quickly and to carry out acceptance tests by providing the following:

- Extensive application software with detailed descriptions
- Preconfigured test solutions with PC-based remote control
- Simplified programming due to an integrated wizard
- Measurement programs that can be modified in ANSI-C as required
- Options for expanded measurement procedures

## All essential test cases fully preconfigured

The main components of the R&S®FSMU-W are the Signal Analyzer R&S®FSQ and the Vector Signal Generator R&S®SMU 200 A (FIG 1) as well as a PC-based remote-control software application. This preconfigured all-in-one solution enables you to carry out tests on 3GPP base stations in accordance with TS 25.141 immediately. The customary and time-consuming integration of analyzers and signal generators into test procedures is no longer necessary.

FIG 2 shows an example of a test setup. The remote-control software performs the necessary settings on the generator and analyzer. The base station under test emits a trigger to start signal generation in the R&S®SMU 200 A and responds to the generator's reverse link signal by changing the power in the forward link. The R&S®FSQ measures and evaluates the change in power triggered by the generator.

Due to the expandability of the R&S®SMU 200 A, the test setup is much more compact than previous solutions. For the R&S®FSMU-W, the following options are available: second RF path, second baseband source and fading simulation. They enable you to run all test cases for transmitters and receivers specified in TS 25.141. A detailed overview of the more than 30 test cases and the options they require are listed in the data sheet, which can be downloaded from the Internet.

## Signal Analyzer R&S®FSQ

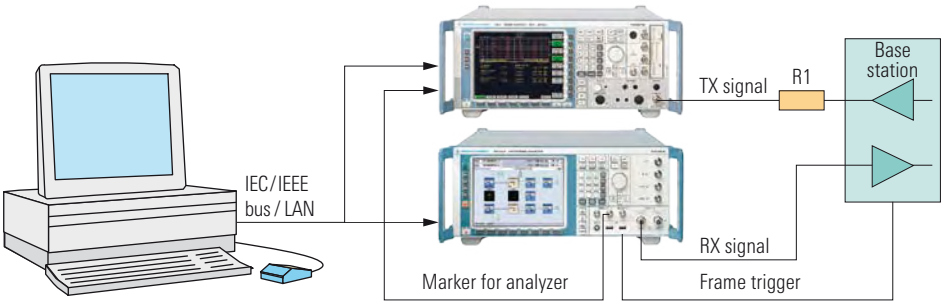
The high-end Signal Analyzer R&S®FSQ [1], which is available in three models up to 3.6 GHz, 8 GHz or 26.5 GHz, has a very wide dynamic range. Its convenient operation and well-organized measurement functions make combining test protocols quick and easy.

High sensitivity, low phase noise and high intermodulation suppression enable the R&S®FSQ to measure the adjacent channel leakage ratio (ACLR) of a 3GPP FDD signal with a dynamic range of up to 77 dB. Its intelligent signal processing improves this value to up to 85 dB and far exceeds the requirements in TS 25.141; the influence of the instrument on the measurement results is therefore negligible.

The R&S®FSQ also offers excellent RF performance and flexible functions when measuring spurious emissions. The analyzer can divide the frequency sweep into as many as 20 different segments, and each segment can be set with different parameters – for example measurement bandwidth, reference level and the number of measurement points (up to 100 001). Nevertheless, the entire measurement of spurious emissions is completed in less than one second. The results can be stored directly as an ASCII file and read out via the IEC/IEEE bus or a LAN.

Measurements in the spectral range alone are not sufficient for determining the characteristics of a WCDMA transmitter. Instead, an in-depth evaluation requires code domain analysis – for example, measuring the modulation accuracy or exact checking of the transmitter's power control. The R&S®FSQ can intercept and analyze up to 100 consecutive frames. It automatically detects the active channels for each of the 15 timeslots in one frame. Likewise, it automatically finds the QPSK and 16QAM modulation formats used with HSDPA.

**FIG 2 Test setup for test case 6.4.2 (power control steps).**



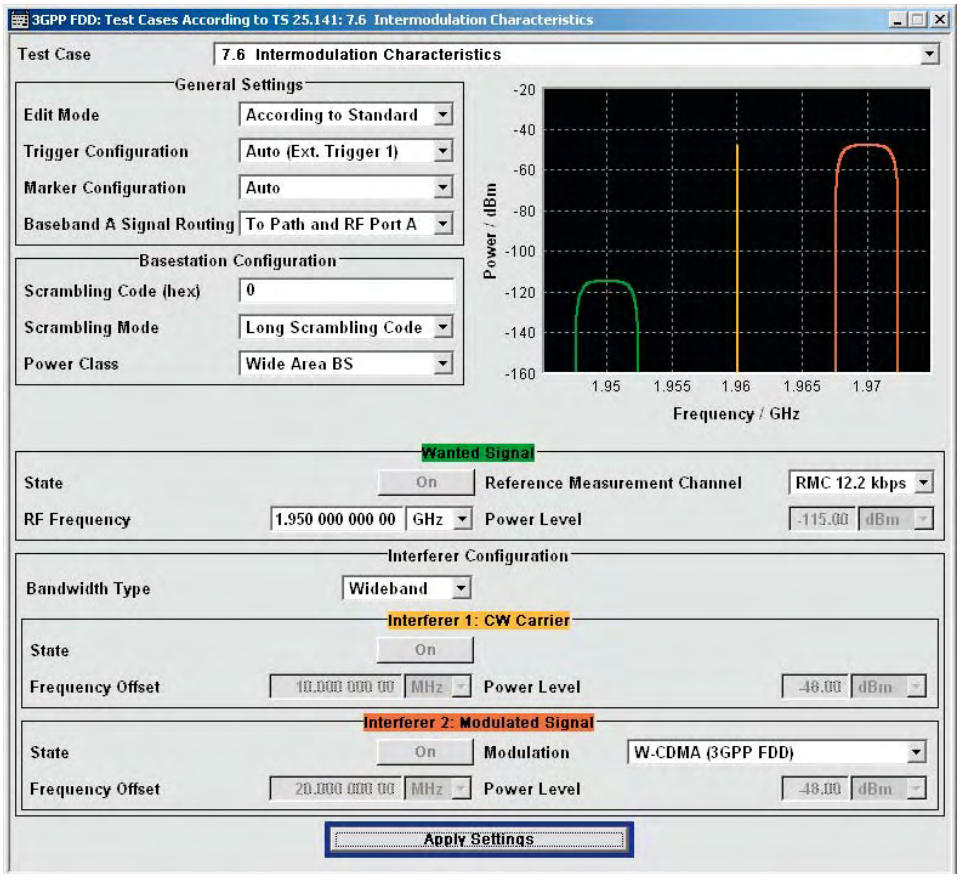



**FIG 3 Wizard menu for test case 7.6 (intermodulation characteristics).**

## Vector Signal Generator R&S®SMU 200 A

The Vector Signal Generator R&S®SMU 200 A [2] provides all test signals specified in TS 25.141. The R&S®SMU 200 A meets the high requirements that development and production place on a state-of-the-art signal generator by providing outstanding RF characteristics (3GPP ACLR of typ. +70 dB , wideband noise of typ. –153 dBc) and unique features such as:

- Two independent signal paths, from the baseband generation (3GPP, HSDPA, etc) to the RF output
- Simulation of real radio propagation conditions (fading, AWGN, CW interferers)

A 3GPP test case wizard that can be started via the 3GPP menu provides a convenient means of operating the generator. The wizard makes all necessary settings, e. g. the signals and markers in the baseband, the injection of interferers, fading simulation, RF power and frequency. This convenient wizard frees you from having to set each and every parameter that is necessary for a test case.

As an example, FIG 3 shows the wizard's menu for test case 7.6 (intermodulation characteristics), which is divided into various sections.

The General Settings section is used to set signal generator parameters such as edit mode, trigger and marker configuration, and signal routing, for example.

The next section is used to configure general base station parameters. The section in the bottom half of the screen contains settings specific to the test case. These settings primarily include frequency and level as well as wanted and unwanted signals to be generated. The graphs show the frequency and level of the signals generated by the R&S®SMU 200 A. In this test case, a base station is being tested to determine whether an unwanted 3GPP signal at 1.97 GHz together with an unwanted CW signal at 1.96 GHz (both have a relatively high transmit level of –48 dBm) impair the reception of a weak wanted signal of only –115 dBm on a reference measurement channel (RMC) at 1.95 GHz.

FIG 4 shows the signal flow in the R&S®SMU 200 A that is necessary for test case 7.6. Upon receiving an external trigger, baseband generator A starts a 3GPP RMC signal which is routed to RF output A as a wanted signal. At the same time, the lower baseband generator B generates an interference reverse link signal that is routed to RF output B as an unwanted signal together with an unwanted CW signal generated in the AWGN/IMP B module. That means that a single R&S®SMU 200 A can simultaneously generate three baseband signals.

A comparison of FIG 3 and FIG 4 makes the main advantage of the test case wizard clear: While the wizard menu in FIG 3 requires only a few settings (power class, bandwidth type, RF frequency), the graphical user interface of the R&S®SMU 200 A (FIG 4) requires that a number of modules be switched on and off to configure the generator correctly for the test specification.

Despite its convenience, the wizard is highly flexible. Experienced users can still depart from the specifications in

TS 25.141 and take full advantage of the generator's capabilities. For example, the edit mode lets you choose whether to strictly comply with the recommendations in TS 25.141 or to determine the performance limits of a base station under more stringent conditions (e. g. under an extremely reduced level of the wanted signal). You can also modify signal generation after you run the test case. In test case 7.6 in FIG 3, for example, you could activate the generator in the AWGN/IMP A module and thus superimpose additional interference on the wanted signal.

## Flexible software control

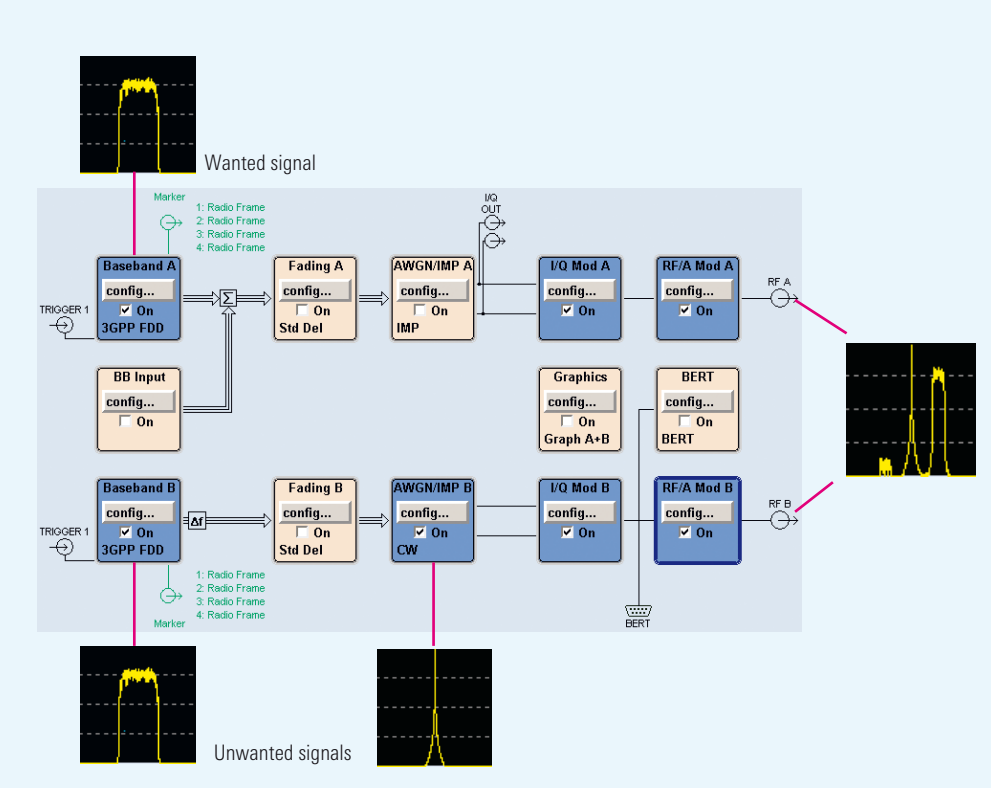
Like the wizard, the PC-based software control that is included offers broad flexibility. It can generate ready-to-run test configurations, but also helps to quickly set up customized measurement procedures. To make this possible, all modules needed for test cases are written in ANSI-C. The modules provide elementary functions – e. g. instrument initialization/reset and writing/reading via the remote-control bus – as well as program examples which can serve as a basis for complex test sequences. A comprehensive operating manual describes the test procedures in detail and provides numerous tips and tricks.

## Summary

Mobile radio manufacturers must comply with test specifications to be successful on the market. The struggle for every tenth of a dB requires highly accurate signal generation and precise analysis functions in the measuring instruments. The WCDMA Base Station Test Set R&S®FSMU-W, which includes the two high-end instruments R&S®SMU 200 A and R&S®FSQ, is an excellent tool for testing base stations in accordance with TS 25.141.

Dr Karlheinz Pensel; Johan Nilsson

**FIG 4 Configuration of the R&S®SMU 200 A for the intermodulation characteristics test in accordance with test case 7.6.**




**More information, data sheets and application notes at www.rohde-schwarz.com (search terms: FSMU-W, SMU200A, FSQ)**

Brochure R&S®FSMU-W

Specifications R&S®FSMU-W


REFERENCES

[1] Spectrum and signal analyzers for every requirement – an overview. News from Rohde & Schwarz (2004) No. 182, pp 30–36

[2] Vector Signal Generator R&S®SMU 200 A: The art of signal generation. News from Rohde & Schwarz (2003) No. 180, pp 21–27

**3G technological leaders have come up with initial UMTS implementations in the megabit range. These implementations, which are being presented at mobile radio fairs, are based on the High Speed Downlink Packet Access (HSDPA) standard. This development is accompanied by major technological progress at laboratories of leading mobile radio chip and terminal manufacturers, where the functionality and quality of initial HSDPA equipment are carefully optimized. With its R&S®CMU 200, Rohde & Schwarz provides the required test capability for HSDPA terminals at an early stage.**

Universal Radio Communication Tester R&S®CMU 200

# HSDPA signaling and extended measurements for 3GPP Release 5

## New test functions

In tests of HSDPA terminals, the mobile radio tester controls the terminals exclusively by means of signaling messages transmitted via the air interface. The first step in an HSDPA test, therefore, is to set up a link between the tester and the terminal, same as in a real network. If the link is set up successfully, a suitable radio bearer is established also by way of signaling. The radio bearer determines the configuration of the desired HSDPA link both in the DUT and the tester. The selection of configuration parameters depends on the type of test the user wishes to carry out. The R&S®CMU 200 supports the following test and measurement functions for HSDPA terminals:

- Testing of basic signaling functionality
- Testing of HSDPA-specific physical baseband and RF parameters
- Expanded / new UMTS RF measurements for determining DUT transmit and receive quality

## HSDPA – the major innovation in 3GPP Release 5

When UMTS was originally defined, nobody anticipated HSDPA. Therefore, many new signaling parameters and procedures had to be added to enable the migration from 3GPP Release 99 to Release 5. When a link is established, the base station and the mobile station signal Release 5 compatibility to each other and agree on whether and how HSDPA is to be activated. The R&S®CMU 200 tests this basic signaling functionality at the press of a button and

**FIG 1** Generator settings.

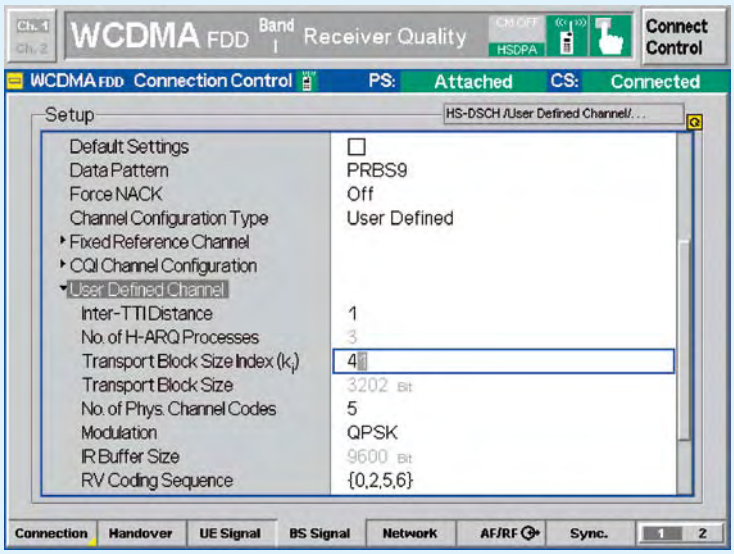
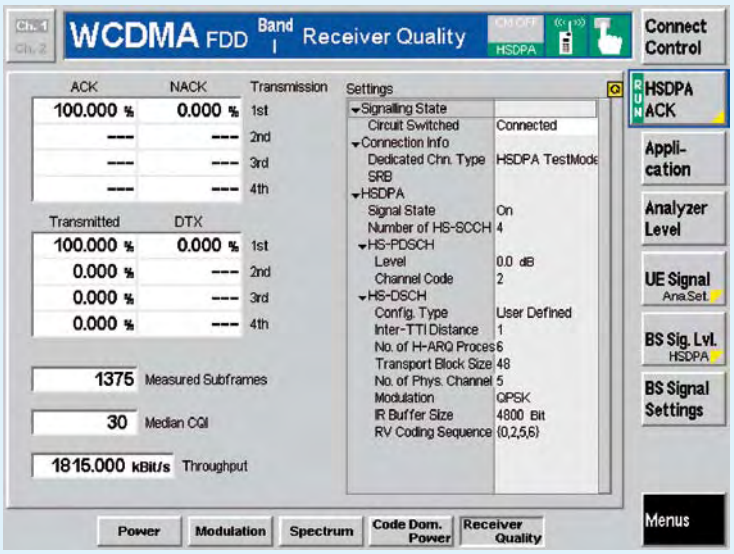



**FIG 2** HSDPA ACK / NACK menu.



handles the procedures required for the following:

- Link setup and cleardown with and without HSDPA
- HSDPA activation / deactivation including the test mode
- More in-depth analyses, e. g. for querying measurement reports generated in the DUT

For more complex signaling scenarios, including detailed result analysis, the Protocol Tester R&S®CRTU-W is available.

## DUT and tester put through their paces

For 3GPP Release 5, the R&S®CMU 200 generates new physical channels in the downlink – currently up to four HS-SCCH and up to five HS-DPDCH channels (suitable for 3.6 Mbit class) – in addition to the existing 3GPP Release 99 channels. You can set the desired levels and physical codes on the mobile radio tester in the same convenient way as known from other physical channels and select further settings such as QPSK or 16QAM modulation for the data channels. The high speed shared control channels (HS-SCCH) transmit control information via subframes every 2 ms. This information is used to address mobile terminals, schedule different hybrid automatic repeat request (HARQ) processes if required, and inform the mobile terminals of the coding and modulation of the HS-DPDCH data that follow the coding and modulation information.

The R&S®CMU 200 offers a selection of basic configurations in the HSDPA generator menu (FIG 1) from which users can choose depending on the intended test purpose and their expertise:

- Fixed reference channel, based on test specification included in 3GPP TS 34.121
- Channel quality indication (CQI) test, based on test specification included in 3GPP TS 34.121
- User-defined configuration and editing of parameters

To appropriately deal with the high complexity of the HSDPA baseband, merely generating predefined signals is not enough. Rather is it necessary to analyze the information transmitted via the HS-DPCCH uplink control channel (CQI report, acknowledge bits) and trigger follow-up activities in the next downlink transmission at a high level of priority – for example a repeat transmission with modified coding. Only through this process of rapid interaction between the transmitter and the receiver can the actual data throughput in the baseband be measured. One of the highlights offered by the R&S®CMU 200 for this measurement is the Follow CQI function. This function causes the downlink configuration of the tester to dynamically follow the CQI proposal of the DUT, which periodically estimates channel quality and reports it to the base station or the tester in its uplink HS-DPCCH.

## HSDPA-specific evaluations

In the ACK / NACK menu (FIG 2), the tester displays the data throughput, the CQI median value and the percentages of the ACK, NACK and DTX values (ACK:

**FIG 3 Code domain power with HS-DPCCH visualization.**

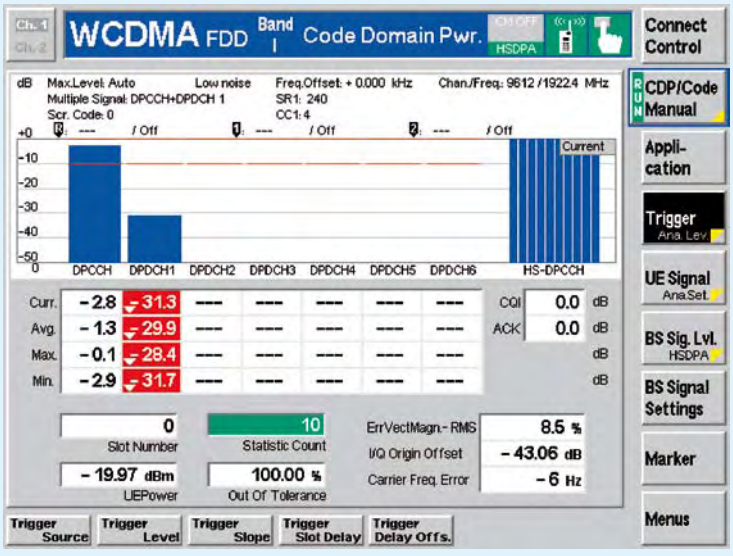
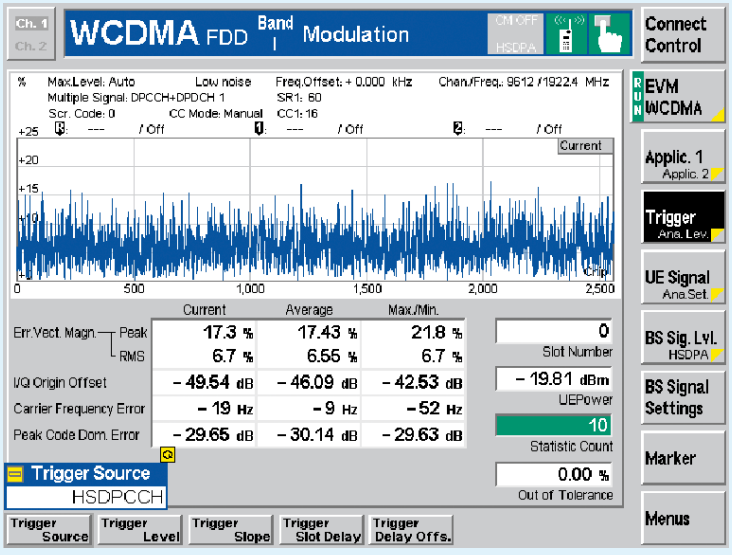



**FIG 4 RF measurement with activated HSDPA trigger.**



- DUT has acknowledged; NACK: DUT has not acknowledged and may request a repeat transmission; DTX: discontinuous transmissions – DUT was expected to respond but did not).

Moreover, the HS-DPCCH log provides you with a readable sequence of successive HS-DPCCH transmissions. The CQI menu visualizes the block error distribution for different CQI ratios, based on the test requirements specified in TS 34.121.

## RF measurements

In UMTS, only one (DPCCH) or two code channels (DPDCH and DPCCH) were previously active in the uplink to handle data rates up to 384 kbit/s. With HSDPA, a new uplink channel (HS-DPCCH) is added, which the R&S®CMU 200 displays both as code domain power and as a function of time (FIG 3). This channel includes the following characteristics:

- The HS-DPCCH channel is switched on and off as a function of the dynamic time scheduling in the downlink, i.e. it is switched on or off each time an HSDPA HARQ process is active and scheduled
- The beginning and the end of the channel are not synchronized with the timeslot pattern of the other uplink channels but may be shifted by n × 256 chips relative to this pattern

These characteristics place new demands on the RF functionality of DUTs, which in turn calls for an extension of 3GPP TS 34.121 RF test definitions. For example, an HS-DPCCH that is out of tolerance may produce undesired spectral components, which may affect results both in modulation and spectral (ACLR, SEM) measurements. The power setting of the mobile terminal in limit ranges and transitional regions, for example at maximum power, must correspond to a predefined nominal behavior. The R&S®CMU 200 can start measurements (modulation, spectrum, power, etc) using a time-variable HS-DPCCH trigger (FIG 4). By means of this trigger, the additional RF component introduced by the HS-DPCCH uplink signal can be included or omitted in measurements. Moreover, nominal beta factors can be set on the R&S®CMU 200 for determining the code power of each uplink code channel (DPCCH, DPDCH and HS-DCCH).

## Supplementary RF measurements

In addition to HSDPA-specific extensions, a number of RF measurements were included in the 3GPP standard to fill some existing gaps:

### Phase discontinuity measurement

Phase discontinuities caused, for example, by amplifier switching in the mobile terminal, may lead to a temporary loss of synchronization of the base station receiver in a network, which means that valuable radio resources are tied up in the network during this period. 3GPP Release 5 specifies limit values as well as a clearly defined test method. With its large memory depth, the R&S®CMU 200 can analyze up to 45 consecutive timeslots in a measurement sequence (FIG 5). The mobile terminal transmit power can be flexibly controlled during the measurement by means of predefined TPC bits.

### Modulation measurement on the preamble

3GPP Release 5 now includes measurement of the modulation quality during link setup, thus filling another gap in the standard specifications.

## Summary

By incorporating state-of-the-art HSDPA functionality and T&M capability in the R&S®CMU 200, Rohde & Schwarz has reinforced the ability of this leading mobile radio tester to meet future challenges. We can already look forward to further extensions of applications and measurements to accommodate data rates in the 10 Mbit range.

Pirmin Seebacher

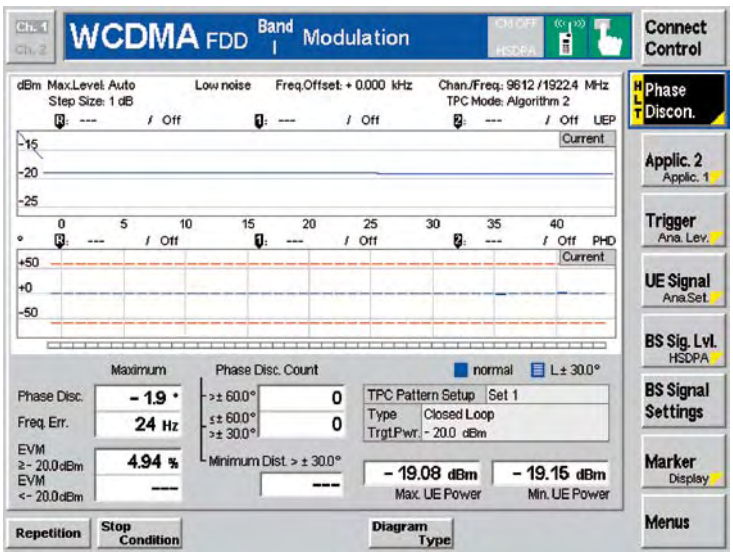



**FIG 5**
**Phase discontinuity measurement.**

# Complex TX measurements due to expanded trigger capabilities

**The mixed modulation modes occurring in 8PSK-EGPRS measurements are a new challenge for mobile terminals and T&M equipment. With firmware version 3.80, the Universal Radio Communication Tester R&S®CMU 200 can now also handle these complex transmitter measurements.**

## Detecting control ACKs

In EGPRS / GPRS networks, mobile phones can request control ACKs in the form of short access bursts or as normal, GMSK-modulated bursts. This can be done both in a GMSK connection and an 8PSK connection. The modulation mode used for the connection depends on the coding scheme. Since the R&S®CMU 200 can request both types of control ACKs, you can choose the one you need.

The control ACKs are generated at a relatively large interval of approx. one second. To detect these events, the measurements are selectively triggered. When multiple uplink timeslots are involved, the multislot power ramp measurement displays control ACK bursts in addition to 8PSK or GMSK bursts. FIGs 1 and 2 show the combination of access burst and 8PSK burst for a connection with two uplink timeslots. You do not have to concern yourself with the special triggering of the measurement since it is adapted by the R&S®CMU 200 as soon as the modulation type you have selected for display corresponds to the control ACK mode. To monitor bursts of different modulation modes simultaneously in a multislot connection, the tester requests the control ACKs at different points in time. On the main timeslot, the control ACKs are received one radio block earlier than on the other active timeslots.

## Access bursts and timing advance

In the packet mode, the R&S®CMU 200 is now an excellent choice for timing advance measurements. During an established connection, you can check

**FIG 1** Multislot power ramp measurement with two uplink timeslots. Triggering occurs in response to the access burst in the first timeslot. The second timeslot is 8PSK-modulated. Timing advance has a value of 0 here.

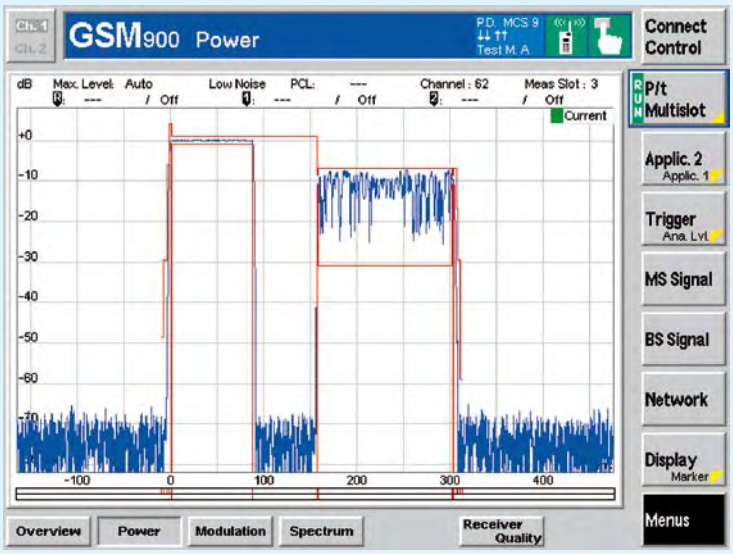
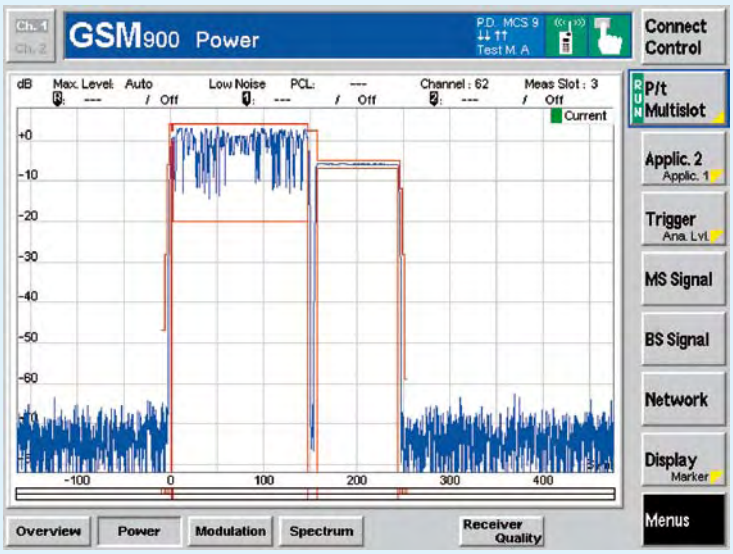



**FIG 2** Triggering in response to access burst in the second timeslot.



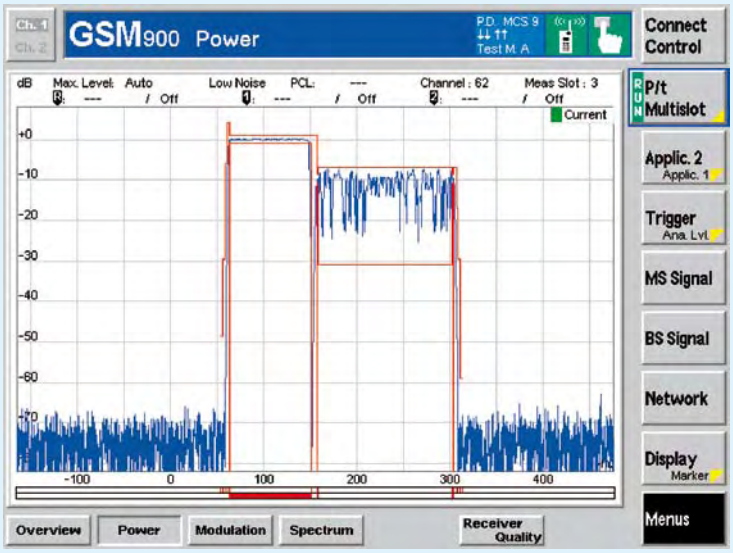



**FIG 3**
**Access burst and 8PSK burst at maximum timing advance of 63 (in the GSM 900 band). The time shift of the access burst compared to FIG 1 is evident.**

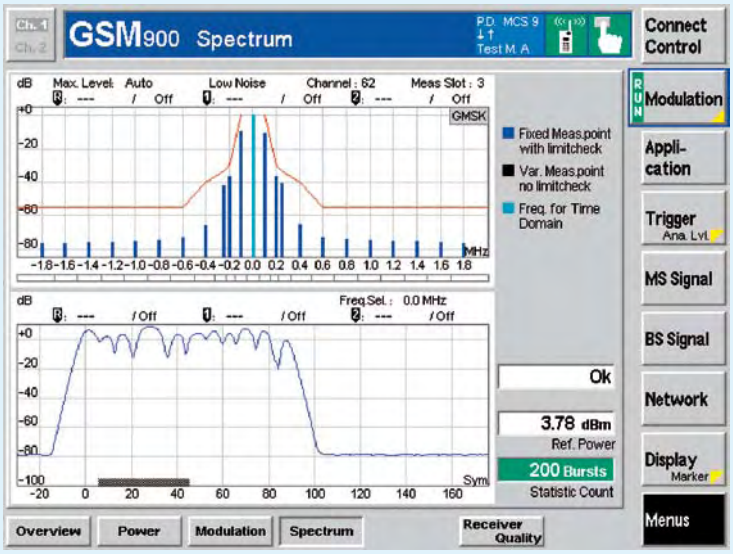



**FIG 4**
**Modulation spectrum of an access burst.**

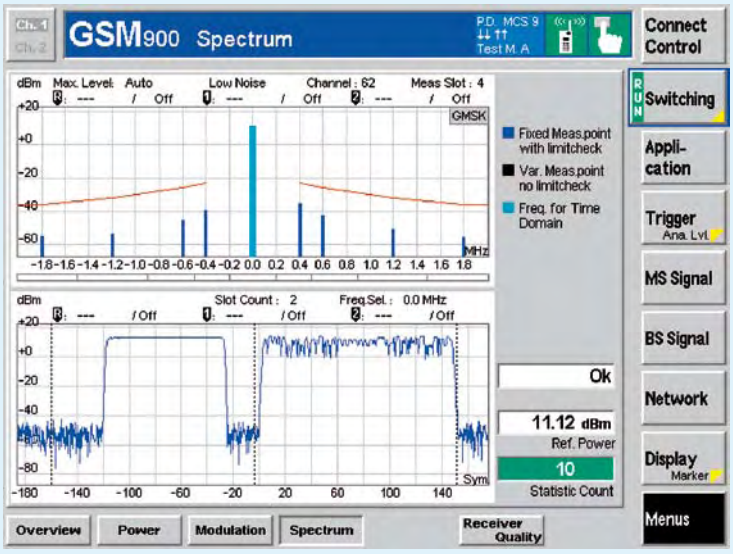



**FIG 5**
**Switching spectrum of access burst and 8PSK burst with timing advance 40.**

the transmit and receive timing adaptation of a mobile terminal, especially the critical case of access bursts in addition to normal bursts. By means of timing advance, you can compensate for the distance-dependent delay of the radio signal between the base station and the mobile terminal. The longer the signal path, the closer together the transmit and receive windows have to move on the mobile terminal end. This prevents connections on adjacent timeslots from being impaired. However, access bursts are not affected by timing advance. Access bursts are so narrow that they can also be transmitted at the maximum distance within an uplink timeslot. They are therefore transmitted at the beginning of a timeslot and arrive at the base station with a time delay. The R&S®CMU 200 displays this clearly in the multislot power ramp measurements. FIGs 1 and 3 show the location of the access burst and 8PSK burst with and without maximum timing advance. FIG 3 clearly shows that the access burst directly approaches the 8PSK burst at maximum timing advance. The measurement is thus an ideal way to also test difficult timing scenarios of several timeslots.

The spectrum measurements now also offer enhanced trigger capabilities. The problem with these measurements is that different modulation modes affect the result. Especially GMSK bursts corrupt the spectrum of an 8PSK measurement. For this reason, the R&S®CMU 200 now only selects bursts of the same modulation, i.e. in a normal measurement the GMSK-modulated control ACKs are not included in the evaluation. The tester also suppresses idle frames. However, the R&S®CMU 200 also offers inverse triggering in the spectrum, allowing you to specifically detect the control ACKs. FIGs 4 and 5 show access burst spectra.

## External triggers

The new trigger capabilities of the R&S®CMU 200 are not restricted solely to the internal transmitter measurements; the R&S®CMU 200 also offers a number of external trigger signals:

- Frame clock trigger
- Ctrl ACK main slot trigger
- Ctrl ACK other slots trigger
- Hopping trigger
- 26, 52, 104 multiframe trigger

The tried-and-tested frame clock trigger is particularly useful for controlling external spectrum analyzers. It blanks out idle frames and control ACKs.

The control ACK triggers enable you to filter all TDMA frames with corresponding bursts and analyze them on the spectrum analyzer, for example. As described above, the control ACKs on the main timeslot are not generated at the same time as on the other timeslots. The two trigger signals allow them to be specifically selected.

The R&S®CMU 200 can synchronize an external signal generator such as the R&S®SMU or the R&S®SMIQ to its own frequency hopping method by means of the hopping trigger. This makes it possible to also simulate an interferer with this method, not just with stationary frequencies.

The multiframe triggers make synchronizing to the BCCH unnecessary. In an active traffic channel (the R&S®CMU 200 also allows connection setup without signaling), a multiframe trigger establishes synchronization with the GSM time grid and thus permits the measurement of the bit error ratio (BER), for example. Triggers for multiframes with 26, 52 and 104 TDMA frames are available.

All external triggers can be delayed on a timeslot basis and thus be adapted to your own needs. The simultaneous output of two different triggers supports parallel measurements.

Jörg Füßle

Universal Radio Communication Tester R&S®CMU 200

# Innovative enhancement of GSM functionality

**The Universal Radio Communication Tester R&S®CMU 200 is one of the most successful mobile radio testers. The latest GSM software adds numerous innovative functions to its scope of capabilities.**

## Dual transfer mode

Mobile phones are evolving more and more into communications centers: In the beginning, you simply used them to make phone calls. Today, mobile data communications via e-mail and Internet are gaining increasing importance. At work, for example, you want to use the time and make a call while data is being downloaded. Until now, however, you could not do both simultaneously with GSM; you had to choose between making a call and setting up a data link.

The standardization committees have now remedied this problem by specifying the dual transfer mode (DTM). This mode allows you to make a call via a circuit-switched connection while simultaneously transmitting data via a packet data connection (GPRS or EGPRS). Leading mobile radio manufacturers are currently implementing the dual transfer mode in their mobile phones. The R&S®CMU 200 will be able to support this undertaking, since the R&S®CMU-K44 option expands the R&S®CMU 200 into a full-fledged DTM tester.

## Complex transmitter measurements

Mobile phone development may confront you with very difficult problems – for example, how to measure the transmission quality of a control ACK burst, which is sometimes transmitted instead of the usual data packets. You can do this only if a trigger signal is generated at the exact time of this burst. However, the comprehensive trigger capabilities of the R&S®CMU 200 make this difficult task mere child's play (see article on page 25).

## Enhanced measurement report

Each GSM phone has to evaluate the quality of a circuit-switched connection and report it to the base station via a measurement report. The standardization committees have since defined three additional performance criteria, expanding the measurement report into the enhanced measurement report (EMR).

The mobile phone needs to determine the mean bit error probability (MEAN_BEP), the coefficient for the variance of the bit error probability (CV_BEP) and the number of data blocks correctly decoded during the measurement period (NBR_RCVD_BLOCKS). The R&S®CMU 200 can request an enhanced measurement report from the mobile phone, evaluate the response and then display it.

## Display of demodulated symbols

The display of the demodulated symbols helps evaluate modulation quality. If you combine the display of the demodulated symbols with a peak search function – via the EVM trace of an 8PSK signal, for example – you will soon identify the critical symbols of the 8PSK modulator of a mobile phone (FIG 1). Both the display of the demodulated signals and the peak search function are implemented in the R&S®CMU 200, allowing conclusive and convenient evaluation of the modulation quality.

## I/Q analyzer

An I/Q analyzer helps evaluate modulation quality, too. The analyzer in the R&S®CMU 200 can be configured for versatile purposes. It can display a constellation diagram or an eye diagram versus the I or Q signal, or versus both signals. Removing the $3\pi/8$ rotation of 8PSK signals is user-selectable, as is the ISI filtering (FIGs 2a to 2e).

## Adjusting the polar modulator

Polar modulators are often used in modern mobile phones. Adjusting these modulators is a difficult and time-consuming task if you use conventional measuring equipment. Again, the R&S®CMU 200 comes up with a solution, the R&S®CMU-K48 option. If a special algorithm is implemented in the mobile phone, the tester can quickly adjust the polar modulator.

## Power-versus-slot measurement with retrigger function

The fast power-versus-slot measurement offered by the R&S®CMU 200 has been expanded by a retrigger function, making it easier to adjust transmitter power in production. As a result, the transmitter no longer needs to transmit its bursts synchronously with the GSM time grid, i.e. it no longer needs to synchronize to the BCCH of the tester to perform the adjustment.

You can also define measurement specifications in this mode. The power of the burst with the maximum power can be specified, as can a reduced power for subsequent bursts, for example. The measurement determines the power of each individual burst versus a settable number of bursts. If you need to quickly terminate the measurement because bursts are missing (e. g. if the phone is faulty), you can specify a point in time after which the measurement will be cancelled if bursts are missing.

## Summary

In addition to these major expansions, the Universal Radio Communication Tester R&S®CMU 200 features a large number of smaller add-ons, which facilitate routine measurement tasks. With these new functions, the R&S®CMU 200 is once again able to prove its leading role in all areas of mobile radio measurement.

Rudolf Schindlmeier

**More information and data sheet at www.rohde-schwarz.com (search term: CMU200)**

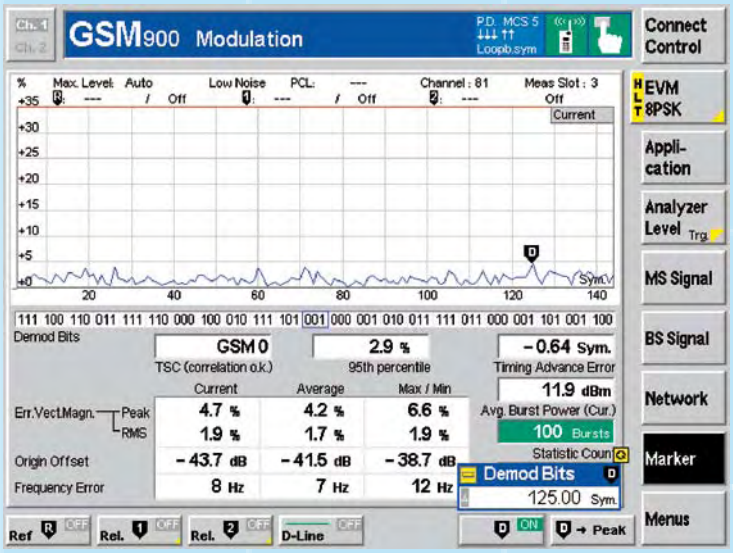



FIG 1 The R&S®CMU200 can also output the demodulated symbols in the modulation measurement. The blue symbol corresponds to the symbol at the marker position in the burst. You can change the marker position via the menu or the rotary knob. The peak search function is particularly useful. It automatically sets the marker to the position of the maximum value of the selected trace, allowing you to quickly find the critical symbols of a modulator.

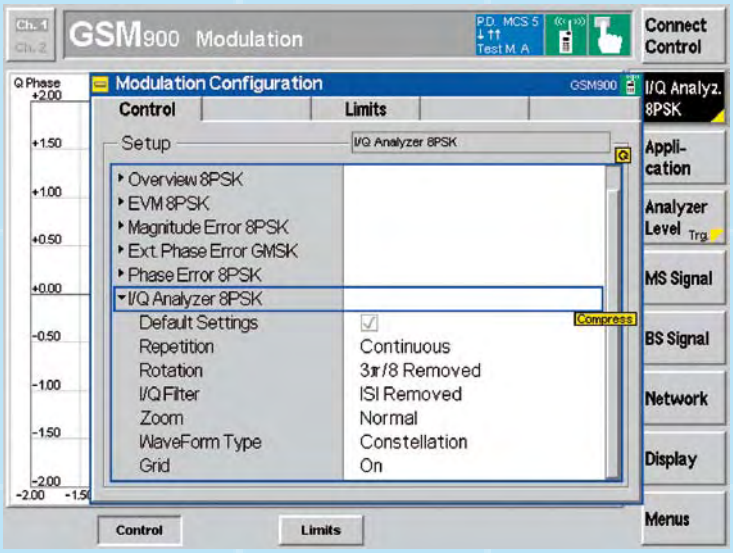



FIG 2a The I/Q analyzer of the R&S®CMU200 allows versatile configuration. The values can be displayed in a constellation diagram (2b) or an eye diagram, either separately for the I and Q signals or for both signals together (2c). If required, the I/Q analyzer can also reverse the 3π/8 rotation of 8PSK signals (2d) or perform ISI filtering (2e), or both (2b).

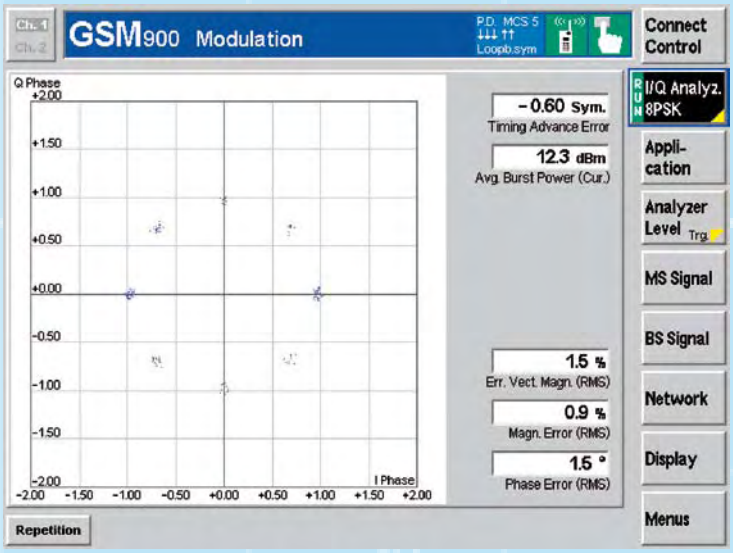



FIG 2b

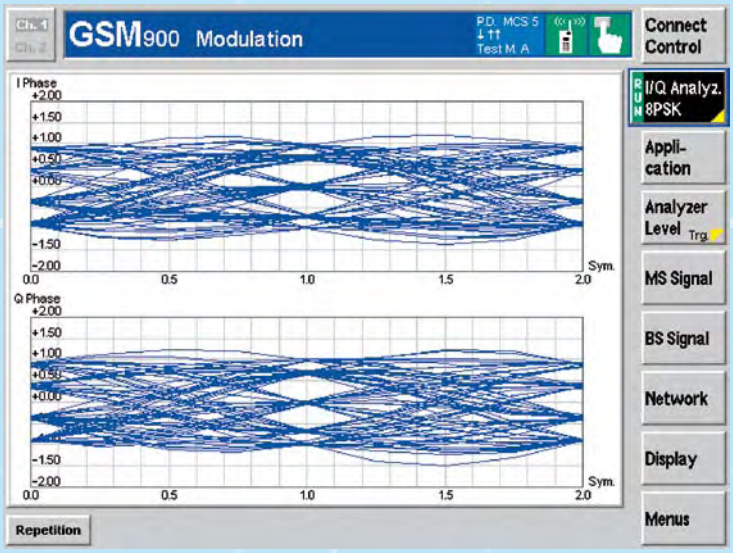



FIG 2c

FIG 2d

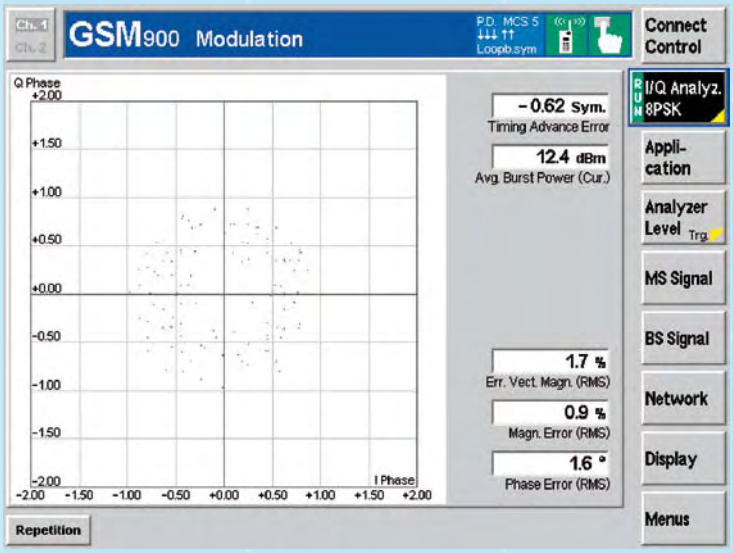
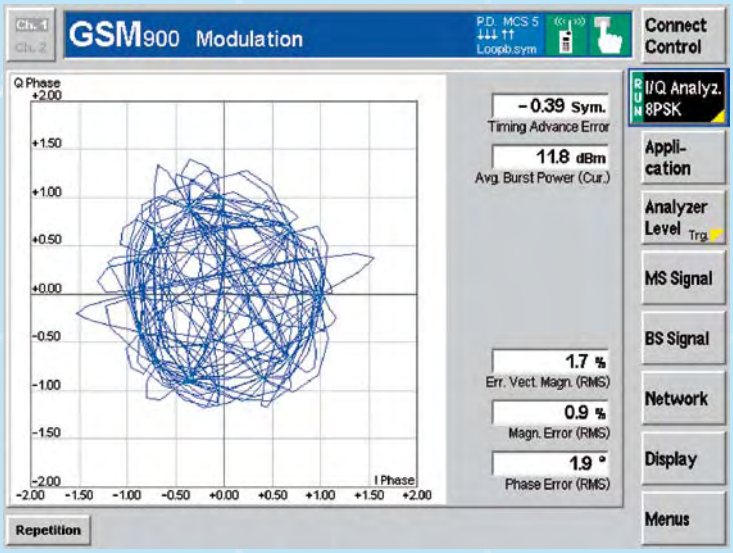



FIG 2e



Universal Radio Communication Tester R&S®CMU 200

# Production test software for GSM reference designs

**With market cycles becoming shorter and the variety of mobile phones steadily increasing, product life cycles have to be optimized at all stages. A critical hurdle is the handover of a product from development to production. To ensure smooth startup of large-scale production after type approval testing, ready-made solutions are required, and a test program has to be created while still in the development phase. Using the R&S®CMU-TSR 10 start-and-go package in conjunction with reference designs puts convenient ready-made solutions at your fingertips.**

## The mobile radio market is rapidly changing

In the past, mobile phones stayed on the market for one or two years. Today, market cycles are often no more than just a few months, depending on customer acceptance. Manufacturers must offer a great variety of designs in order to satisfy specific customer groups. The schedule from start of development to series production must be strictly observed to ensure market success.

Design, development, type approval testing, pilot production, mass production and service are closely interrelated and must be optimally planned. To simplify hardware and software development, the manufacturers of chip sets for mobile phones supply their customers with reference designs, thus providing comprehensive support. Reference designs contain a functional evaluation board, loadable instrument firmware with a protocol stack, as well as software modules. They allow design and development time to be cut by several months, so that mobile phone manufacturers can concentrate on device functions (design, operation, data interfaces, etc). Development costs are also reduced.

## Reference designs simplify development

Evaluation boards of the latest generation are based on an LSI chip set that usually contains only five chips:

- Baseband chip
- Power management and codec chip
- RF transceiver
- RF power amplifier
- Flash memory

The boards normally have the dimensions of the target layout (approx. 35 mm × 60 mm). GSM quadband modules, for example, support the 850 MHz and 1900 MHz bands for the USA and 900 MHz and 1800 MHz for Europe and Asia.

Along with the reference design, chip set manufacturers supply circuit diagrams, parts lists and the layout drawing, which allows the critical RF section to be transferred unchanged to the target layout. An expandable GSM/GPRS protocol stack is also available and can be integrated as the core module into the software of the new mobile phone.

## R&S®CMU-TSR 10 start-and-go package

The R&S®CMU-TSR 10 start-and-go package consists of a cable set and an installation CD. By using a simple test setup that includes the start-and-go package, the Universal Radio Communication Tester R&S®CMU 200 and an evaluation board (FIG 1), you are ready to perform a complete calibration test sequence, typically in the following order:

- Initialize the R&S®CMU 200
- Switch the evaluation board to test mode
- Calibrate the DC offset
- Calibrate the AFC
- Calibrate the power control levels of the RX and TX sections
- Calibrate the RX and TX sections over the channels

- Store the calibration results on the evaluation board
- Set up the connection
- Check the RF calibration including signaling
- Measure the bit error ratio (BER), RF power and spectrum

The limit values for the various measurements as well as the setting parameters for the R&S®CMU 200 are stored in ASCII files and can easily be modified to generate simulation sequences. Results and associated limit values are recorded in a straightforward report file and used in subsequent analysis.

## The crucial step: calibration of the RF section

To perform stable and fast adjustment of a mobile phone's RF section, you require detailed knowledge about the RF transceiver chip. Using the calibration test sequence included in the R&S®CMU-TSR 10 start-and-go package, you can perform an automatic test of your new hardware design to check whether the RF section is functioning properly. Results will be stored for each test sequence and are available for subsequent statistical evaluation. If you need any additional test steps, you can add them quickly and conveniently. The reference design manufacturer and Rohde & Schwarz collaborate closely to make sure that the software libraries work well together (FIG 2).

With the evaluation board, the RF test program for pilot and / or series production can be generated while still in the development phase. The Generic Test Software Library R&S®GTSL from Rohde & Schwarz, which is included in the start-and-go package, provides an optimized solution for the time-critical RF transceiver adjustment: For the transmitter section, individual power control levels (PCL) are measured and intermediate values determined by way of interpolation. At a fixed power control level, the frequency response over the channels is determined also by way of interpolation. Receiver adjustment is performed using the same steps. By applying this solution, you can ensure that scheduled test times will be adhered to in subsequent series production.

## Designed to work together

The R&S®GTSL software library contains ready-to-run setting and measurement functions for all common mobile radio standards; the functions are tailored for use with the R&S®CMU 200 (FIG 3). Tests cover all mobile phone function blocks and include, for example, audio

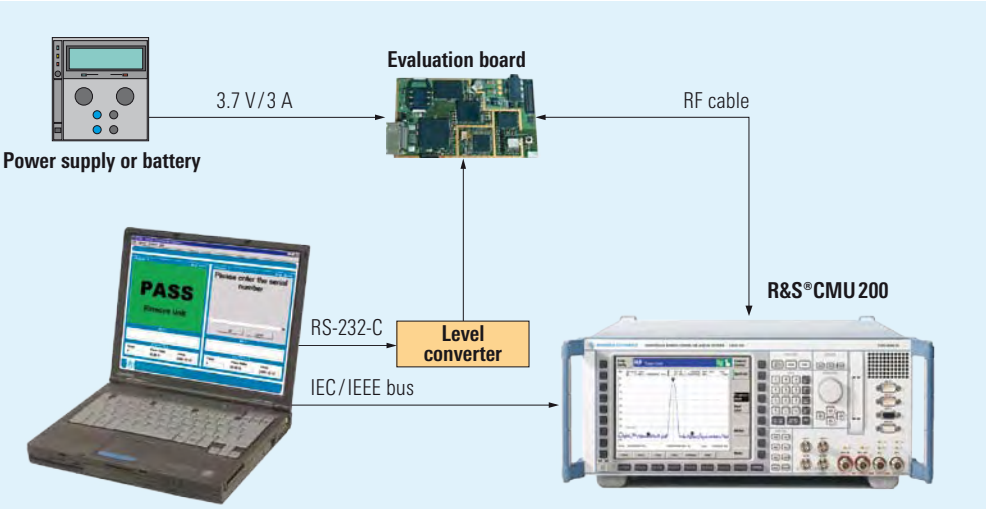



**FIG 1 The R&S®CMU-TSR 10 start-and-go package is ready to run with just a few components.**

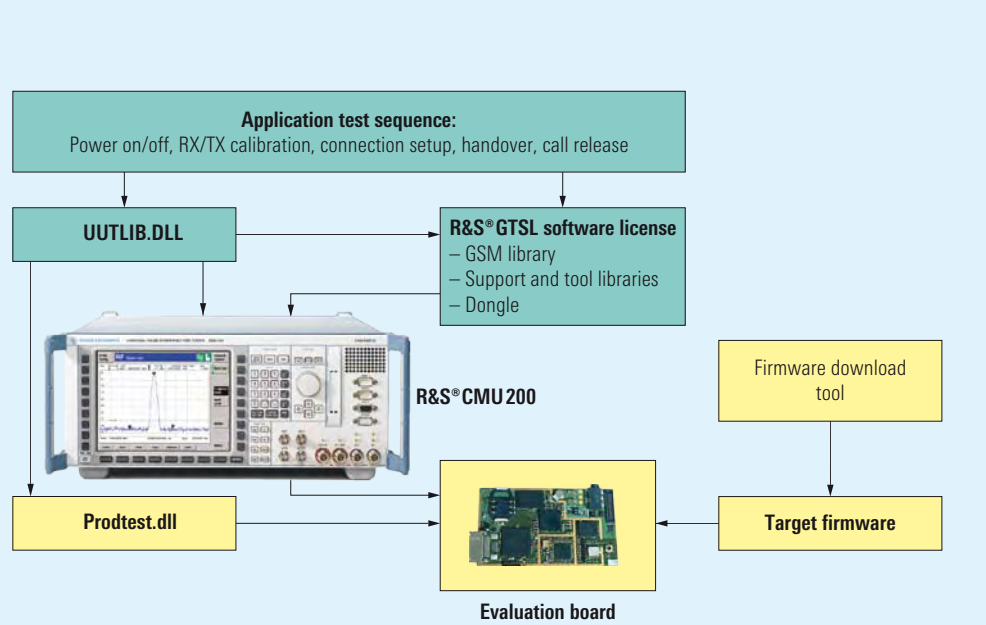



**FIG 2 Joint development of software tools for reference designs (yellow: components from chip set manufacturer; green: components from Rohde & Schwarz).**

and acoustic tests as well as RF tests and signaling tests. Functions are available in the form of dynamic link libraries (DLL) that you can adapt via menus as required. Moreover, you can modify limit values and setting parameters quickly and conveniently using a standard text editor.

R&S®GTSL offers you numerous advantages:

- Simplified programming of the R&S®CMU 200
- Data storage and report generation already available in the TestStand™ sequencer from National Instruments
- Examples of complete test sequences
- Support of all common mobile radio standards such as GSM, GPRS, TDMA (IS-136), AMPS, cdmaOne, CDMA2000®, WCDMA
- Simple user interface for production environments
- Example source code for expansions of R&S®GTSL
- Easy integration of additional system components

## Summary

When used in conjunction with reference designs, the R&S®CMU-TSR 10 start-and-go package helps mobile phone manufacturers reduce development time and limit the risks involved in new developments. Rohde & Schwarz also offers complete turnkey solutions for use in mobile phone production. These solutions are based on the Test Platform R&S®TS 7180 [*], which consists of a test rack with the R&S®CMU 200, the Shielded RF Test Fixture R&S®TS 7110 and the R&S®GTSL system software.

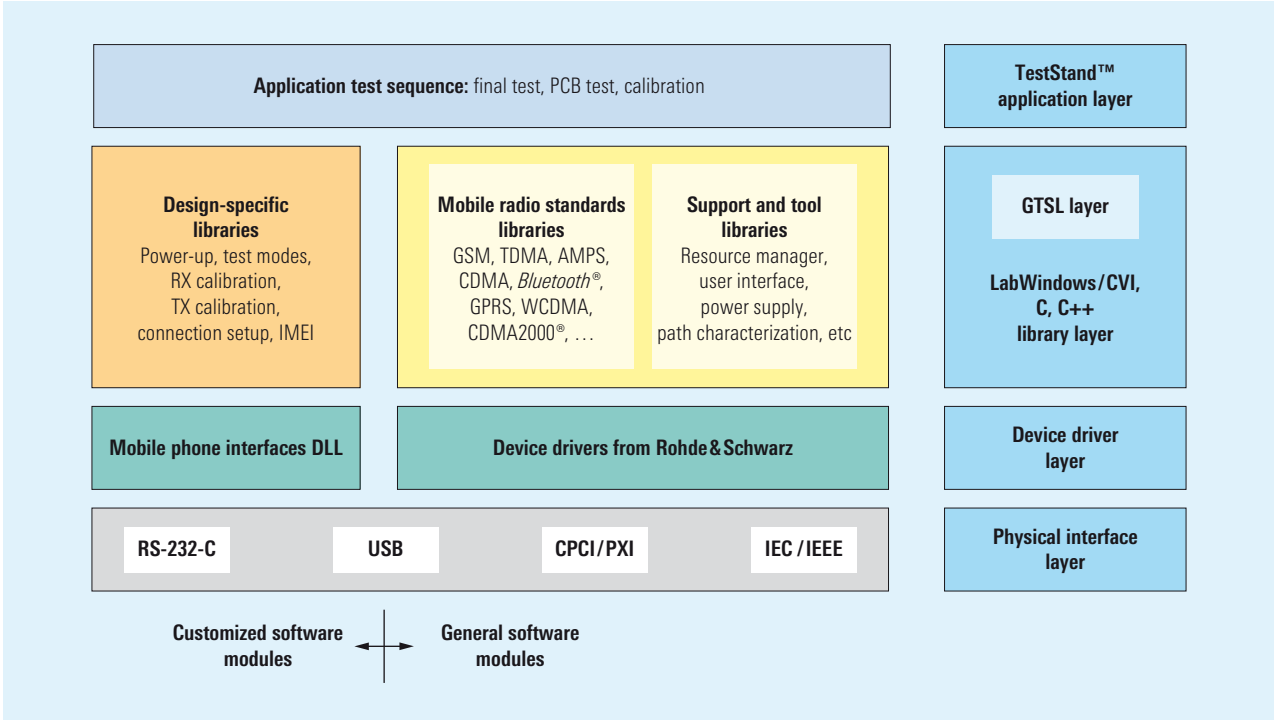
Erwin Böhler

**More information on Rohde & Schwarz test systems at www.testsystems.rohde-schwarz.com**

REFERENCES

[*] Test Platform for Mobile Phone Production R&S®TS 7180: Ready for mass production, incoming goods inspection and service. News from Rohde & Schwarz (2002) No. 176, pp 10–13

**FIG 3 Architecture of R&S®GTSL software library.**



Signal Generator R&S®SMU 200 A / Signal Analyzer R&S®FSQ

# Complete test solution for WiMAX applications

**The new WiMAX radio technology – worldwide interoperability for microwave access – is based on wireless transmission methods defined by the IEEE 802.16 standard. WiMAX has been developed to replace broadband cable networks such as DSL. Rohde & Schwarz offers a complete test solution for WiMAX applications by combining its Signal Generator R&S®SMU 200 A and Signal Analyzer R&S®FSQ plus the appropriate options.**

## WiMAX – a brief introduction

The WiMAX standard is not restricted to defining a single concrete implementation of the transmission method, but rather describes many different solutions. The WiMAX IEEE 802.16 proposal adopted in 2001 deals with line of sight (LOS) transmissions in the frequency range 10 GHz to 66 GHz. The RF carrier is directly modulated using digital phase shift keying (QPSK, 16QAM or 64QAM). This yields transmission rates of up to 134 Mbit/s at a bandwidth of 28 MHz. However, the Los requirement with the outside antennas that are needed makes this implementation somewhat inflexible.

The ratified version IEEE 802.16-2004 adopted in October 2004 defines distinctly more versatile applications that provide end users with attractive broadband access options. Radio transmission is feasible without direct line of sight (non line of sight, NLOS) in the specified frequency range of 2 GHz to 11 GHz. Like the 802.11a / g (WLAN) standard, the IEEE 802.16-2004 version specifies OFDM as the transmission method for NLOS communications.

Unlike the carrier signal in single-carrier transmission, an OFDM signal is made up of many orthogonal carriers, each of them modulated separately. A large number of symbols is transmitted in parallel, which results in a symbol duration many times that encountered in single-carrier transmission, the transmission rate being the same in either case. This has a very beneficial effect in multipath propagation, as the extended symbol duration considerably reduces interference caused by consecutive symbols overlapping each other. Moreover, the detrimental effect of multipath propagation is practically eliminated for another reason: a guard interval is added to each symbol. In addition, the parallel transmission of multiple symbols makes it possible to retrieve the contents of impaired carriers by means of error correction. All these characteristics combine to yield stable connections with very low bit error ratios. Modulation is adapted to match transmission conditions; BPSK, QPSK, 16QAM and 64QAM are used as modulation modes. Thus, transmission rates up to 75 Mbit/s can be attained. In contrast to its "little brother", WLAN, the 2004 WiMAX version does not provide for a constant bandwidth; rather the bandwidth may vary between 1.25 MHz and 28 MHz.

The IEEE 802.16-2004 standard differentiates between the OFDM and the OFDMA mode. In the conventional OFDM mode, 200 carriers are available for data transmission. Both TDD and FDD transmission are used. With the OFDMA method, multiple subscribers can be served simultaneously. This is achieved by assigning each subscriber a defined group of carriers (which is referred to as subchannelization); this carrier group

**High-end Signal Generator R&S®SMU 200 A.**

**For further articles regarding the R&S®SMU 200 A and the R&S®FSQ, see pages 18, 38, 40 and 42.**

**High-end Signal Analyzer R&S®FSQ.**

conveys the information intended for a specific subscriber. The OFDMA mode employs a significantly higher number of carriers, i.e. 1682 to 1729.

A forthcoming expansion of WiMAX is the IEEE 802.16e standard, which enables mobile applications and even roaming. Ratification of this standard is expected in late 2005. The standard specifies transmission rates of up to 15 Mbit/s in a frequency range of up to 6 GHz and employs a variable number of carriers.

## WiMAX calls for high-end measurement technology

To develop and produce complete WiMAX applications or WiMAX components, it is necessary to analyze the corresponding high-frequency characteristics accurately and in detail. Analyzing the modulation quality of a WiMAX OFDM signal is not possible using conventional spectrum analyzers. This task requires a high-end signal analyzer such as the R&S®FSQ, which is capable of demodulating the broadband WiMAX signals (demodulation bandwidth 28 MHz, or 120 MHz with option R&S®FSQ-B72). To measure transmit signals or test receivers with the R&S®FSQ, WiMAX signals of excellent modulation quality are needed. You can generate such signals very conveniently by means of the Signal Generator R&S®SMU 200 A and option R&S®SMU-K49. This option is also available for the Signal Generators R&S®SMJ 100 A and R&S®SMATE 200 A.

## Generating WiMAX signals with the R&S® SMU 200 A

The Signal Generator R&S®SMU 200 A produces test signals for OFDM receiver tests in conformance with IEEE 802.16-2004 (FIG 1), requiring only minimum operating effort. A single-path generator is ideal for testing receiver sensitivity or determining the maximum input level. An R&S®SMU 200 A with two paths can in addition provide an OFDM-modulated interference signal – an optimal condition for measuring adjacent-channel rejection with a single instrument. The AWGN module (option R&S®SMU-K62) superimposes defined channel noise as required for high-accuracy sensitivity measurements. The R&S®SMU-B14 fading simulator option enables tests under fading conditions.

In addition to choosing predefined test signals, you can configure signal scenarios to create any possible situation. Up to eight bursts with user-definable power and payload can be set both in the downlink and the uplink (FIG 2). The payload of the bursts is fully channel-coded during modulation. Moreover, you can define a MAC header and an optional CRC. In the uplink, the time position of each burst in a frame can be varied as desired by introducing gaps, for example to simulate mobile stations operating at various distances. The R&S®SMU 200 A displays the power, duration and position of each burst in a clear-cut table.

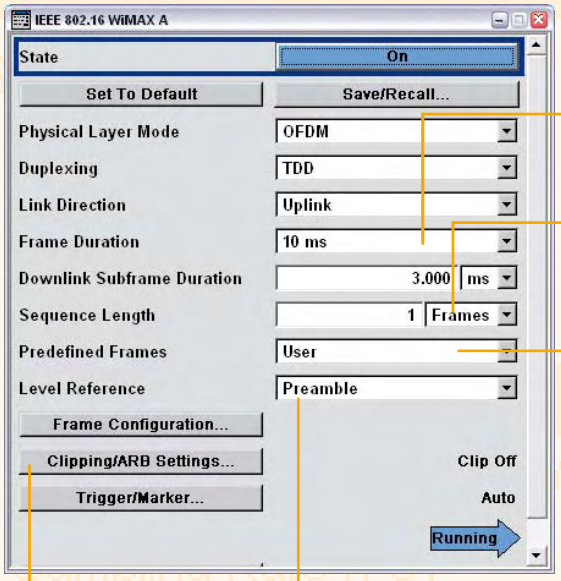
In automatic test systems, it is vital that your test signals can be generated by remote control. All WiMAX signal parameters offered by the R&S®SMU 200 A can be set by means of SCPI commands, i.e. the generator is fully remote-controllable via the IEC / IEEE bus or VXI 11.

With the functions described, the R&S®SMU 200 A provides the complete range of receiver tests, including those currently defined by the WiMAX forum as part of the IEEE 802.16-2004 specification (Radio Conformance Test, RCT). The R&S®SMU 200 A is thus an ideal choice in development, design, verification and production.

## Analyzing WiMAX signals with the R&S® FSQ

The high-end Signal Analyzer R&S®FSQ from Rohde & Schwarz records signals with a bandwidth of up to 28 MHz (120 MHz with option R&S®FSQ-B72). Using WiMAX Application Firmware R&S®FSQ-K92, the R&S®FSQ can analyze WiMAX signals – with the optional R&S®FSQ-B71 baseband inputs even directly in the baseband. The R&S®FSQ-K92 firmware option allows the analysis of WiMAX signals in accordance with standard 802.16-2004 OFDM. Further WiMAX expansions such as 802.16-2004 OFDMA or 802.16e will be supported in forthcoming releases of the firmware. The R&S®FSQ comes in various models up to a maximum frequency of 40 GHz. All WiMAX measurement applications are fully remote-controllable via the IEC / IEEE bus or VXI 11, using SCPI commands.

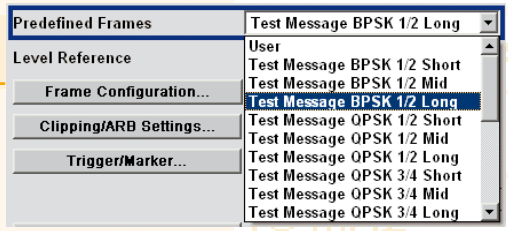
At the beginning of a measurement, you not only have to set the standard parameters such as the frequency, recording length, etc, as would be the case in WLAN, but also the bandwidth and the length of the guard interval, since these parameters are variable in WiMAX (FIG 3). With the R&S®FSQ-B71 option installed, WiMAX signals can be analyzed directly in the baseband, for example to determine any signal degradation originating in the I/Q modulator or during RF transmission.




In addition to choosing predefined frame lengths, you can define your own frame lengths or select the *Continuous* mode. The *Continuous* mode generates a signal without a burst.

Depending on the sample rate and frame duration, a total signal length of up to 511 frames may be attained. This length is ideal for BER tests with PN9 as a data source.

Here, you can choose the *Short*, *Mid* and *Long* test sequences specified in the standard. In the User mode, you can configure any desired signals.




The crest factor of the signal can be reduced by means of scalar or vector clipping.

The generator output power can be referenced to the preamble or to the average power of the overall signal.

**FIG 1 WiMAX main menu of the R&S®SMU200A.**

Predefined frequency bands simplify channel bandwidth setting.

In addition to conventional PN data sources, you can select your own specific data lists.

A MAC header and a CRC can be added to each burst.

The R&S®SMU200A supports channel bandwidths up to 28 MHz.

Up to eight bursts can be configured per frame. BPSK, QPSK, 16QAM or 64QAM modulation can be selected for each burst.

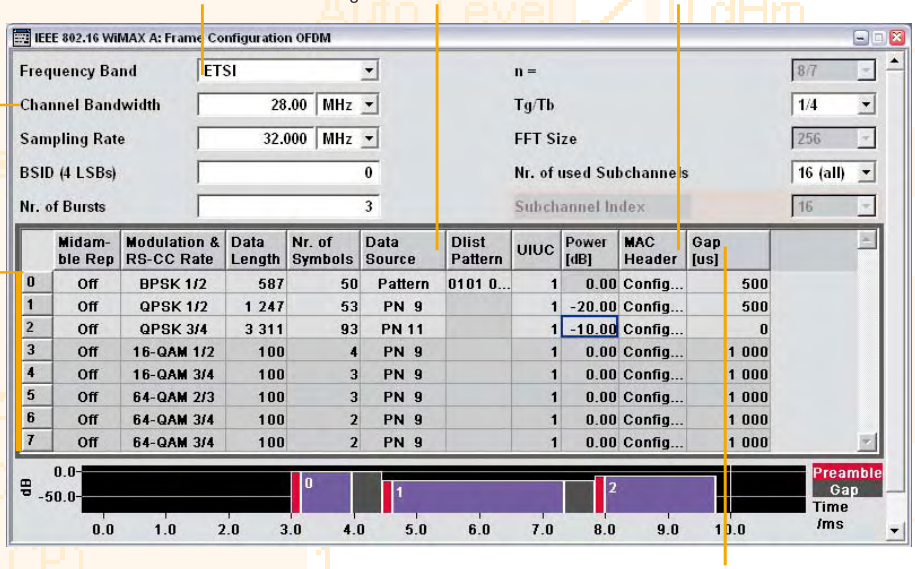



**FIG 2 Typical frame configuration in the uplink mode.**

Gaps can be introduced between bursts to simulate propagation times (round trip delay), for example.

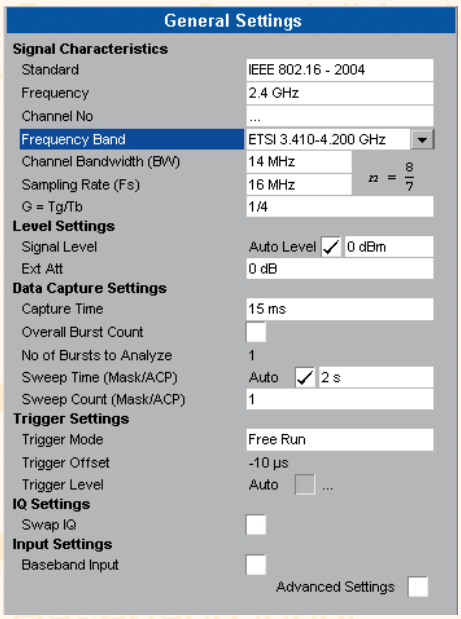
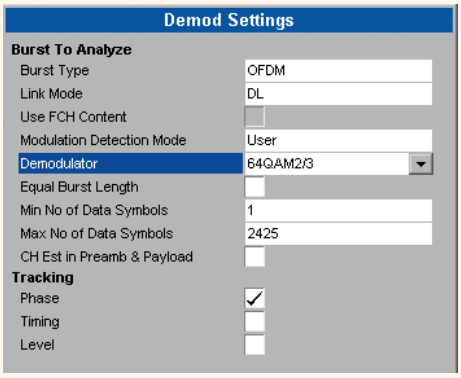



**FIG 3**
**General settings in the WiMAX Application Firmware R&S®FSQ-K92 option.**

**FIG 4**
**Setting of demodulation parameters.**



In accordance with the standard, the bursts allocated to the different subscribers in the downlink path of a WiMAX signal can be differently modulated. Bursts with the same modulation mode are combined in groups, the groups being sent in the order corresponding to the requirements made on transmission reliability, i.e. first BPSK, then QPSK, then 16QAM and finally 64QAM modulated groups. The R&S®FSQ-K92 firmware automatically detects the modulation mode. You can define what modulation mode, or part of the signal, should be analyzed (FIG 4). With the settings shown in FIG 5, for example, only signal parts with 64QAM modulation will be considered. Automatic modulation detection can also be deactivated; in this case, the complete signal will be analyzed applying the preset modulation. The WiMAX signal contains eight pilot carriers to synchronize the 200 carriers of the OFDM signal. The pilot carriers are always BPSK-modulated and transmit a known bit sequence. You can choose whether, in addition to their phase, the amplitude and the timing of the OFDM signal carriers should be synchronized, and whether channel estimation should be performed during the entire signal rather than during the preamble only (the latter being the standard specification).

The signal analyzer measures the parameters relevant to characterizing a WiMAX signal and displays the results in a table (FIG 6). An essential parameter is the error vector magnitude (EVM), which allows assessment of the modulation quality. The EVM indicates the deviation of a measured (actual) point in the constellation diagram from the ideal point, the points representing the I/Q value pairs of the symbols of the OFDM carriers. The bottom half of FIG 5 shows a typical constellation diagram of a 64QAM WiMAX signal. The yellow points indicate the measured values; the blue pattern shows the ideal positions of the constellation points. The R&S®FSQ displays the EVM as an average over all carriers and separately for data carriers and pilot carriers (FIG 6), where the pilot carriers are always BPSK-modulated. Further parameters important for assessing signal quality include I/Q offset, quadrature error, and imbalance between the signal's in-phase and quadrature component. Moreover, the frequency error and the symbol clock error as well as the burst power and the crest factor are displayed. The table shows all important parameters at a glance and thus helps you optimize your system.

In many applications, it is useful to display results in greater detail. The R&S®FSQ shows EVM versus time, for example, thus facilitating the analysis of transient effects. The analyzer also shows EVM versus frequency, or versus the carriers, respectively, thus allowing the detection of frequency-specific problems (FIG 7). Many other quantities can be displayed graphically, e. g. frequency and phase error, frequency response, group delay, etc. Typical conformance tests measuring, for example, adjacent-channel power or spectrum mask (FIG 8), are conveniently performed by means of predefined settings.

## Summary

WiMAX technology appears to be on the road to great economic success for two reasons: First, it can provide greater transmission ranges than possible with WLAN. Second, its ability to support mobile applications (802.16e) is very promising. As a result, even leading chip manufacturers are vigorously driving this technology forward. While the commercial use of the standard is still in its infancy, the T&M equipment that is necessary for development and certification is needed today. Rohde&Schwarz has taken on this challenge and already provides the WiMAX options shown in FIG 9.

Dr Wolfgang Wendler; Gernot Bauer

## Abbreviations

| | |
|---|---|
| AWGN | Additive white Gaussian noise |
| BPSK | Binary phase shift keying |
| CRC | Cyclic redundancy check |
| EVM | Error vector magnitude |
| FDD | Frequency division duplex |
| LOS | Line of sight |
| MAC | Medium access control layer |
| NLOS | Non line of sight |
| OFDM | Orthogonal frequency division multiplexing |
| OFDMA | Orthogonal frequency division multiple access |
| QPSK | Quadrature phase shift keying |
| QAM | Quadrature amplitude modulation |
| TDD | Time division duplex |
| WiMAX | Worldwide interoperability for microwave access |

**More information, data sheets and an article from "Funkschau" (in English and German) at www.rohde-schwarz.com (search terms: SMU200A/FSQ/WiMAX (for "Funkschau" article))**

Brochure R&S®FSQ-K92

Specifications R&S®FSQ-K92

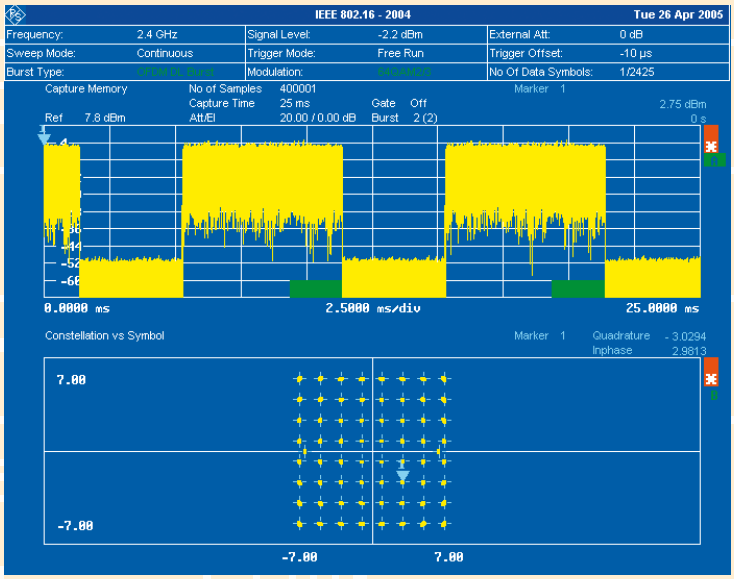
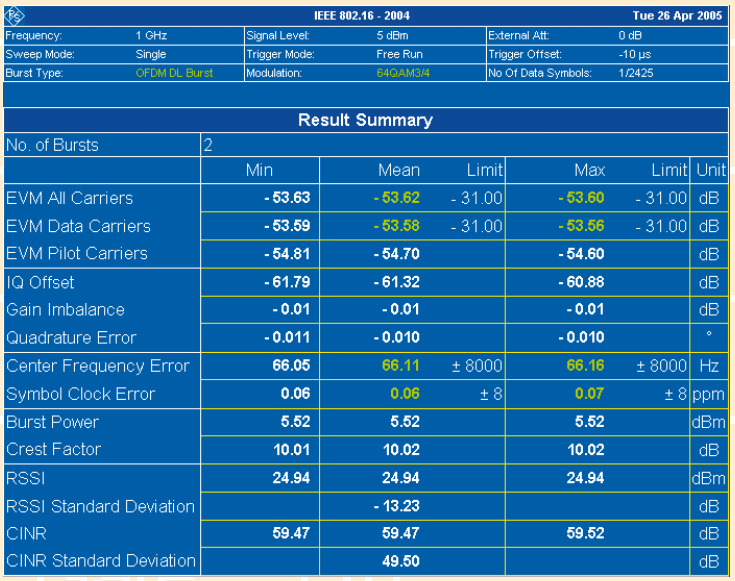



**FIG 5 WiMAX signal with constellation diagram. The 64QAM burst parts highlighted in green are demodulated and results shown in the constellation diagram.**



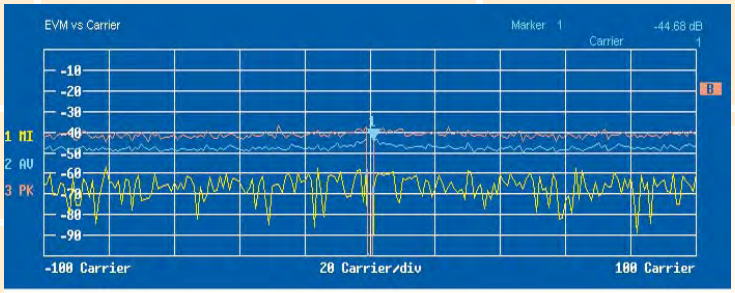

**Result Summary**

| No. of Bursts | 2 | | | | | |
|---|---|---|---|---|---|---|
| | Min | Mean | Limit | Max | Limit | Unit |
| EVM All Carriers | -53.63 | -53.62 | -31.00 | -53.60 | -31.00 | dB |
| EVM Data Carriers | -53.59 | -53.58 | -31.00 | -53.56 | -31.00 | dB |
| EVM Pilot Carriers | -54.81 | -54.70 | | -54.60 | | dB |
| IQ Offset | -61.79 | -61.32 | | -60.88 | | dB |
| Gain Imbalance | -0.01 | -0.01 | | -0.01 | | dB |
| Quadrature Error | -0.011 | -0.010 | | -0.010 | | ° |
| Center Frequency Error | 66.05 | 66.11 | ±8000 | 66.16 | ±8000 | Hz |
| Symbol Clock Error | 0.06 | 0.06 | ±8 | 0.07 | ±8 | ppm |
| Burst Power | 5.52 | 5.52 | | 5.52 | | dBm |
| Crest Factor | 10.01 | 10.02 | | 10.02 | | dB |
| RSSI | 24.94 | 24.94 | | 24.94 | | dBm |
| RSSI Standard Deviation | | -13.23 | | | | dB |
| CINR | 59.47 | 59.47 | | 59.52 | | dB |
| CINR Standard Deviation | | 49.50 | | | | dB |

**FIG 6 List of all parameters important for WiMAX signal characterization.**

**FIG 9 Options for testing WiMAX applications.**

| | |
|---|---|
| **R&S®SMU-K49** | Digital Standard IEEE 802.16 |
| **R&S®SMU-K62** | Additive White Gaussian Noise (AWGN) |
| **R&S®SMU-B14** | Fading Simulator |
| **R&S®SMU-B203** | RF Path B (100 kHz to 3 GHz) |
| **R&S®FSQ-K92** | Application Firmware WiMAX 802.16-2004 |
| **R&S®FSQ-B71** | Analog Baseband Inputs |
| **R&S®FSQ-B72** | I/Q Bandwidth Extension to 120 MHz (f >3.6 GHz) |



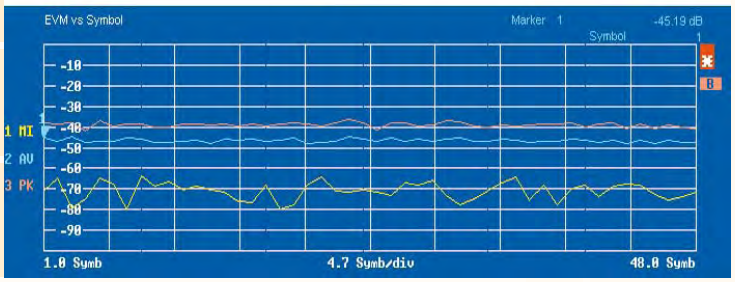




**FIG 7**
**Display of EVM versus carriers (frequency domain, top) and versus symbols (time domain, bottom).**

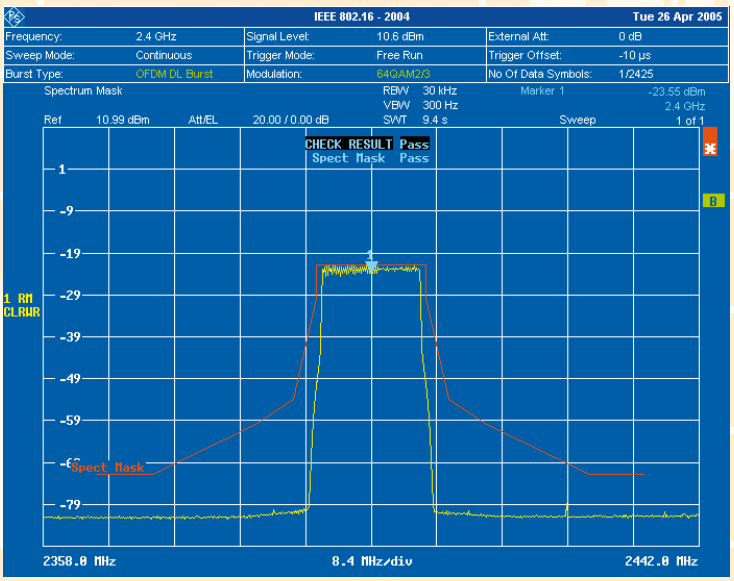



**FIG 8**
**Using predefined limit lines, the analyzer determines, at the press of a button, whether the spectrum conforms to specified requirements.**

Signal Generators R&S®SMx

# WLAN 802.11: Signals for development, production and service

**WLAN is an established radio technology for the wireless networking of computer systems based on the IEEE 802.11 standard. Virtually every modern PC or notebook supports this standard. With the new R&S®SMU-K48 option, signal generators of the R&S®SMx family with firmware version 1.35 or later can generate IEEE 802.11-conforming WLAN signals without requiring an external PC.**

## All-in-one WLAN solutions

Rohde&Schwarz has been offering T&M technology for WLAN applications for some time. In particular, Simulation Software R&S WinIQSIM™ has proven to be a successful tool for generating WLAN signals. The software runs on an external PC, which controls the arbitrary waveform memory of a signal generator, e. g. the R&S®AMIQ or a generator of the R&S®SMx family.

With the new R&S®SMU-K48 option, the Signal Generators R&S®SMU 200 A, R&S®SMJ 100 A and R&S®SMATE 200 A with firmware version 1.35 or later can now generate IEEE 802.11-conforming WLAN signals without requiring any external equipment.

## WLAN tests made easy

With an R&S®SMx generator, you can create WLAN test signals for IEEE 802.11 receiver tests in just a couple of steps. The generators support the standards 802.11a (OFDM with up to 54 Mbit/s) and 802.11b (DSSS CCK / PBCC modulation with up to 11 Mbit/s) in the physical layer (PHY incl. PLCP sublayer) and the MAC layer, and in addition 802.11g, which may be regarded as a combination of the two aforementioned standards.

A two-path R&S®SMU 200 A can also supply OFDM-modulated interference signals, which is vital to determining adjacent-channel rejection by means of only one instrument. An AWGN module (option R&S®SMU-K62) adds channel noise that is as precise as required for this measurement. Moreover, the optional Fading Simulator R&S®SMU-B14 allows you to perform tests under fading conditions.

The generators offer predefined test settings (predefined frames, FIG 1), but also allow you to configure the wide variety of WLAN parameters in as much detail as required for your application. You can set the transmission rate in steps from 1 Mbit/s to 54 Mbit/s, and select a packet size up to 4095 bytes. Moreover, packets can be assigned any desired data contents – from standard pseudo-random sequences and configurable patterns up to user-definable data lists. Scrambler and interleaver stages can also be controlled (FIG 2). You can define a MAC header as well as an optional frame check sequence (FCS) (FIG 3). You can even configure the sequence control parameters to simulate packet retransmission.

## Full remote control capability

With automatic test systems, remote control capability of your signal generator is of vital importance. SCPI commands are available for all WLAN signal parameters; the R&S®SMx generators are, therefore, fully remote-controllable via an IEC bus (IEEE 488) or LAN (VXI-11, TCP/IP) and thus an ideal choice not only for applications in development and service but also for use in production.

Markus Höck

**More information and data sheet at www.rohde-schwarz.com (search term: SMU)**

**The Signal Generators R&S®SMx are ideally complemented by the high-end Signal Analyzer R&S®FSQ including the R&S®FSQ-K90 / -K91 WLAN options (see page 40). Rohde&Schwarz thus offers a single-source, all-in-one solution on the WLAN T&M market.**

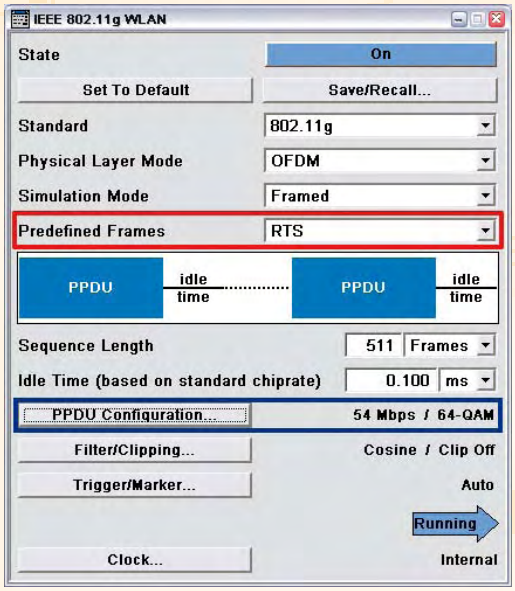
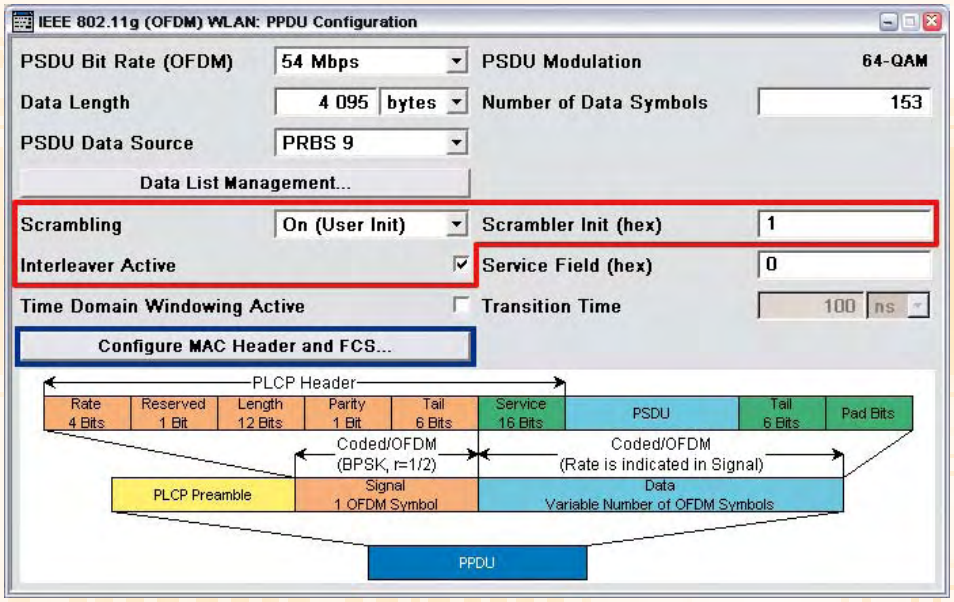



FIG 1 IEEE 802.11 WLAN standard main menu of the R&S®SMU200A.

## Abbreviations

| | |
|---|---|
| AWGN | Additive white Gaussian noise |
| CCK | Complementary code keying |
| DSSS | Direct sequence spread spectrum |
| FCS | Frame check sequence |
| IEEE 802.11a | WLAN specification, OFDM with up to 54 Mbit/s in 5 GHz band |
| IEEE 802.11b | WLAN specification, DSSS CCK/PBCC modulation with up to 11 Mbit/s in 2.4 GHz band |
| IEEE 802.11g | WLAN specification, OFDM and DSSS CCK/PBCC modulation with up to 54 Mbit/s in 2.4 GHz band |
| MAC | Medium access control layer |
| OFDM | Orthogonal frequency division multiplexing |
| PBCC | Packet binary convolutional coding |
| PHY | Physical layer |
| PLCP | Physical layer convergence protocol |
| PPDU | PLCP protocol data unit |

FIG 2 PPDU frame packet configuration menu.




**Options for the R&S®SMx generators for testing WLAN applications.**

| | |
|---|---|
| **R&S®SMU-K48** | Digital Standard IEEE WLAN 802.11 (a/b/g) |
| **R&S®SMU-K62** | Additive White Gaussian Noise (AWGN) |
| **R&S®SMU-B14** | Fading Simulator |
| **R&S®SMU-B203** | RF Path B, 100 kHz to 3 GHz |

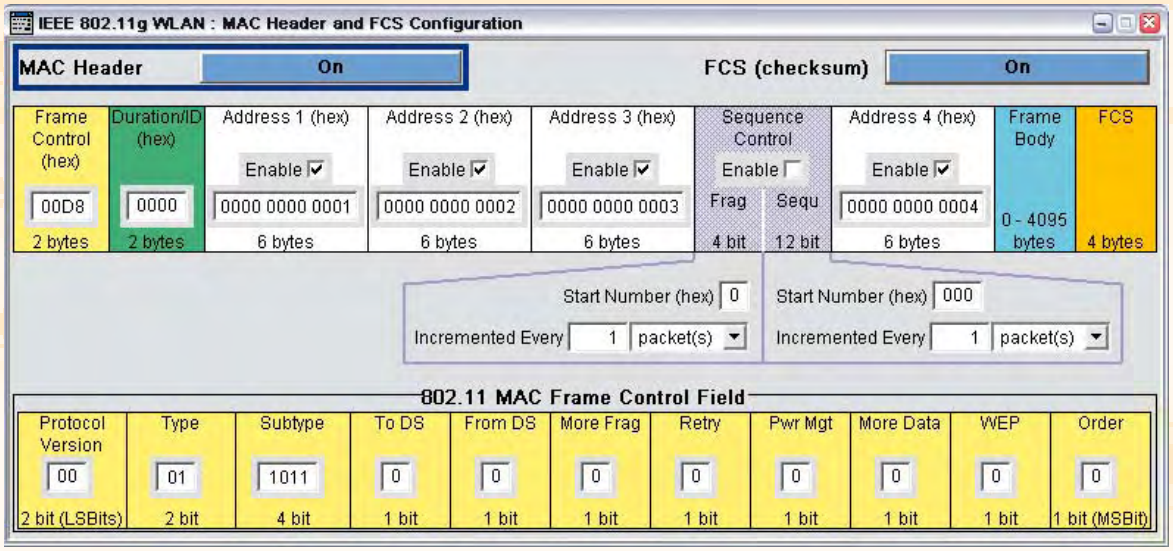



FIG 3 MAC header and FCS configuration menu.

Signal Analyzer R&S®FSQ

# New functions in the WLAN application firmware

**The R&S®FSQ-K91 firmware option has now been on the very vital WLAN market for more than two successful years. During this time, users have provided valuable feedback, the standard has been developed further, and the Vector Signal Analyzer R&S®FSQ has been enhanced. To keep pace, Rohde & Schwarz has developed a number of new functions for the WLAN application firmware that make measurements on OFDM signals even easier and more convenient.**

## Optimized measurement of rise/fall time

The 802.11b standard requires the measurement of the rise and fall times on the modulated signal. The purpose is to ensure that the burst power rises to and falls from the rated value within a defined time. In GSM, for example, a limit value mask is defined that is based on the logarithmized power (in dBm). The 802.11b standard, however, stipulates that the time between 10% and 90% of the non-logarithmized power be measured.

The maximum power (in watts) occurring in the WLAN burst is defined as the 100% reference value. Such a parameterized measurement leads to data-dependent results with modulated signals. Both the 100% reference value and the 10% and 90% values vary significantly. This, in turn, causes the measurement to fail since the rise and fall times are so high. Therefore, the measurement has been optimized in the WLAN application firmware as follows:

- It is now possible to switch between the maximum and average burst power (as a 100% reference value). This makes determining the reference value almost data-independent.
- The firmware offers a sliding averaging filter of variable length, which allows you to determine the average power for the entire WLAN burst. Thus, determining the 10% and 90% reference values becomes less data-dependent as the filter length increases (FIG 1).

## Signal bandwidths up to 120 MHz

A WLAN signal currently occupies max. 20 MHz. However, future standards (802.11n) will use higher bandwidths. For users of the Signal Analyzer R&S®FSQ, this is no problem. By installing the R&S®FSQ-B72 hardware option (I/Q bandwidth extension), users can already develop the modules for such signals, since this option can demodulate signals with RF bandwidths up to 120 MHz.

The WLAN application firmware supports both the R&S®FSQ-B72 option and an adjustable sample rate, so that you can analyze signals with bandwidths up to 120 MHz and sample rates up to 81.6 MHz.

## Full dynamic range up to 32 MHz signal bandwidth

The High Dynamic mode has been added for users who need to analyze bandwidths up to 32 MHz. This feature allows you to analyze signals up to 32 MHz with the full dynamic range of the analyzer (previously up to 28 MHz) even without the R&S®FSQ-B72 bandwidth extension. You can thus perform measurements on turbo mode signals without any restrictions.

**More information and data sheet at www.rohde-schwarz.com (search term: FSQ-K91)**

## Importing and exporting I/Q data

The latest release allows you to store the recorded I/Q data in a file at the press of a button (and via a remote control command) either on the R&S®FSQ or externally. Conversely, you can also load self-generated I/Q data into the WLAN firmware option and analyze it. This allows you to analyze data recorded in an earlier measurement session. It also simplifies interaction with simulation tools (e. g. with MATLAB®) since models that have been generated can be verified with the WLAN firmware in the simulation and can later be compared with the real WLAN instrument.

## Measuring phase and frequency errors

In WLAN, power is present only during data transmission, not at any other time. When the WLAN transmitter is switched on, its power requirements jump dramatically. This can affect its PLL module via the power supply and can cause frequency or phase errors at the beginning of a burst. This makes receiver synchronization more difficult and thus impairs the sensitivity of the entire transmission path.

To enable you to check this behavior, a special frequency / phase error measurement has been implemented that displays the frequency and phase characteristic at the beginning of the burst (in the preamble; FIG 2).

## Signals with high I/Q offsets

Especially in the initial phase of development, measurement values sometimes clearly exceed the permissible limit values. The WLAN application firmware has been expanded so that you can now synchronize even signals with high levels of interference (for example, with an I/Q offset exceeding –3 dB) without any problem. This makes the R&S®FSQ the WLAN development tool of choice – even at the beginning of development.

Starting with version 3.60 SP1, option R&S®FSQ-K91 supports all these features; you can download it from the Rohde & Schwarz website (license key required).

Johannes Steffens

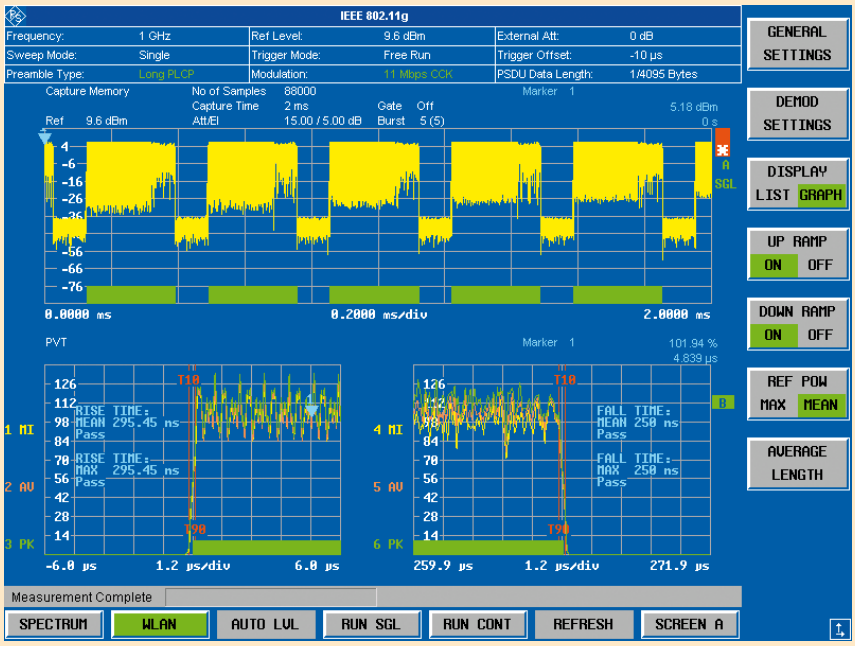



**FIG 1 Power characteristic measurement of a WLAN burst with sliding averaging filter.**


**FIG 2 A special frequency/phase error measurement displays the frequency and phase characteristic at the beginning of the burst (in the preamble).**

Spectrum Analyzers R&S®FSP / FSU / FSQ

# Harmonics and distortion measurements at a keystroke

**The new Harmonic Distortion Measurement function expands the Rohde & Schwarz analyzers by adding the capability of convenient harmonics and THD measurements. The corresponding firmware versions are available free of charge on the Internet.**

## Routine work for the spectrum analyzer

An important criterion for assessing the performance of oscillators, mixers and amplifiers is the spectral purity of the output signal, i.e. the level difference between the harmonic components and the fundamental component, which is the wanted signal. If you use a spectrum analyzer's standard functions to measure the level difference (also referred to as harmonic suppression), this can often be very time-consuming. You have to set the frequency, the level and the bandwidth, position the marker, and read the signal level. And you have to repeat all these steps for each harmonic included (FIG 1). Who wouldn't like to have functionality that eliminates all this work?

The solution to the problem is the new Harmonic Distortion Measurement function for the Analyzers R&S®FSP, R&S®FSU and R&S®FSQ. This function automatically measures the level of each harmonic at a keystroke without requiring any extra configuration.

## What the new function can do

Based on the signal with the highest level in the selected frequency range, the analyzer's level setting is optimized. Then the levels of the selected number of harmonics (up to 26 including the fundamental) are measured in the time domain. You can set the measurement time for each harmonic. This will ensure that the maximum level is reliably determined even in the case of pulsed signals.

The analyzers provide a straightforward, graphical display of results in the upper half of the screen. Each partial measurement, or harmonic, is represented by a division of the x-axis (FIG 3). In the lower half of the screen, the levels of the fundamental and the harmonics are listed; the levels of the harmonics are indicated in dBc relative to the fundamental level. Moreover, total harmonic distortion (THD) is shown in the marker information field (for explanation of THD measurement see FIG 2).

A particular challenge in harmonics measurements are signals with an unstable frequency, where the frequency variation bandwidth of the fundamental is multiplied by the order of the harmonic in each case. To accurately measure the level of such signals, the resolution bandwidth must be adapted for each harmonic. The new Harmonic Distortion Measurement function also performs this task. All you have to do is activate the automatic RBW adjustment function (HARMONIC RBW AUTO).

If harmonic suppression limits are specified for a DUT, you can combine the Harmonic Distortion Measurement function with one or more limit lines. The result tells you at a glance whether the DUT complies with specifications.

## Summary

The new Harmonic Distortion Measurement function turns tedious and complex harmonics measurements into extremely easy tasks. By merely pressing a button, you can determine harmonic suppression for the desired number of harmonics and measure THD. Even comb generator signals can thus be measured easily (FIG 4).

The new function will be implemented as standard in the Analyzers R&S®FSP, R&S®FSU and R&S®FSQ as from firmware version 3.6x. You can download the firmware version required for your analyzer from the Rohde & Schwarz website free of charge.

Jens Franke

**More information and analyzer firmware at www.rohde-schwarz.com (search term: FSP, FSU or FSQ)**

1st harmonic = fundamental

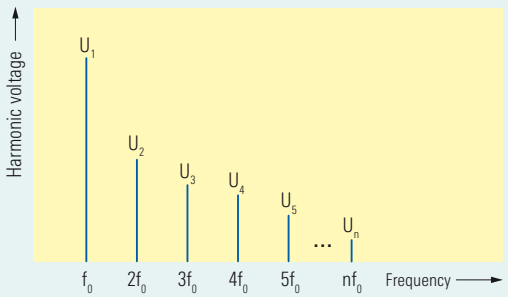
2nd harmonic

3rd harmonic

...

nth harmonic

**FIG 1 Order of harmonics.**




$$THD\,/\,\mathrm{dB} = 20 \times \log \left[ \frac{\sqrt{\sum_{i=2}^{n} U_i^2}}{\sqrt{\sum_{i=1}^{n} U_i^2}} \right]$$

$$THD\,/\,\% = 10^{\frac{THD\,/\,\mathrm{dB}}{20}} \times 100$$

**FIG 2 Determination of total harmonic distortion (THD) in a measurement with n harmonics.**

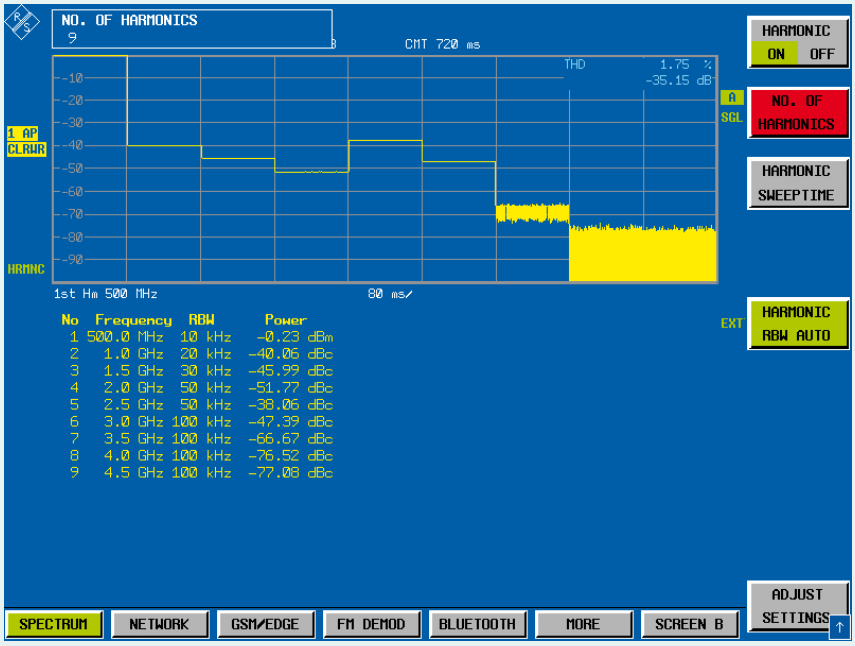



**FIG 3 Harmonics measurement at a keystroke with analyzers from Rohde & Schwarz.**

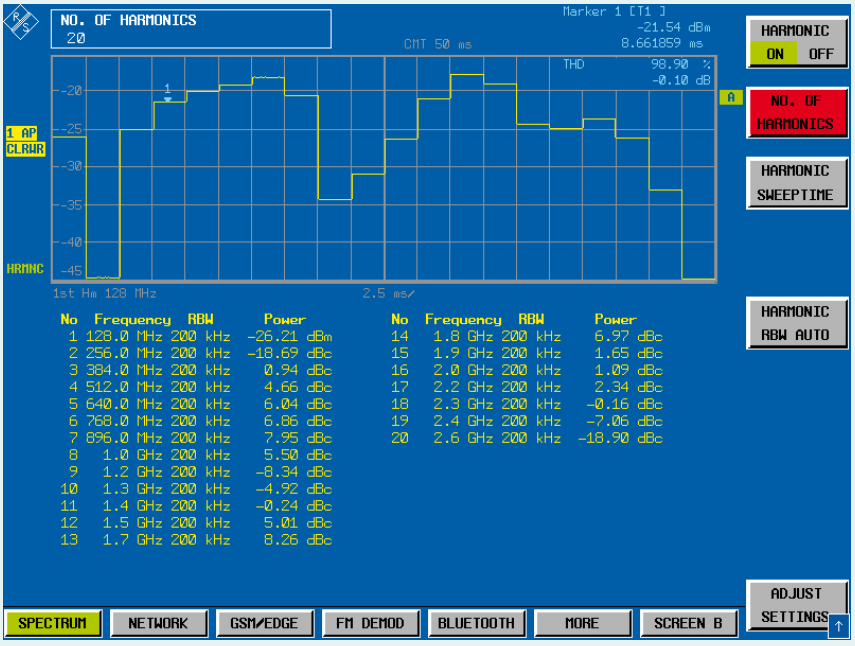



**FIG 4 Even comb generator signals can be measured conveniently with the new Harmonic Distortion Measurement function.**

Audio Analyzer R&S®UPV

# *Record* and *Play* – record signals and analyze them later

**In some cases, you need to record measurement signals at one point in time and analyze them later. The Audio Analyzer R&S®UPV now enables you to do this by providing the new Record and Play functions.**

## Online or offline analysis

Modern audio analyzers such as the R&S®UPV from Rohde & Schwarz – but also its predecessor, the R&S®UPL – feature very short measurement times. Thus, they can perform all important audio measurements in realtime (online) and display the results in graphical and numeric form. This is especially important when you use the R&S®UPV in production and adjustment procedures.

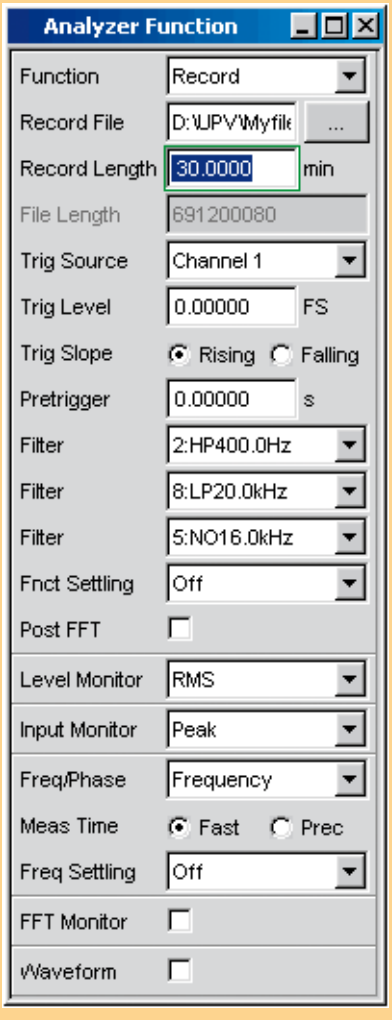
In some cases however, you may need to record a measurement signal at one point in time and analyze it later (offline). Here are just a few examples:

- The signal to be measured does not occur cyclically or occurs only occasionally.
- The same signal is to be used to perform a greater variety of measurements than the audio analyzer can perform simultaneously.
- The signal to be measured is to be analyzed with an external diagnostic program.
- The location and time that the measurement values are recorded are unfavorable for analyzing them.

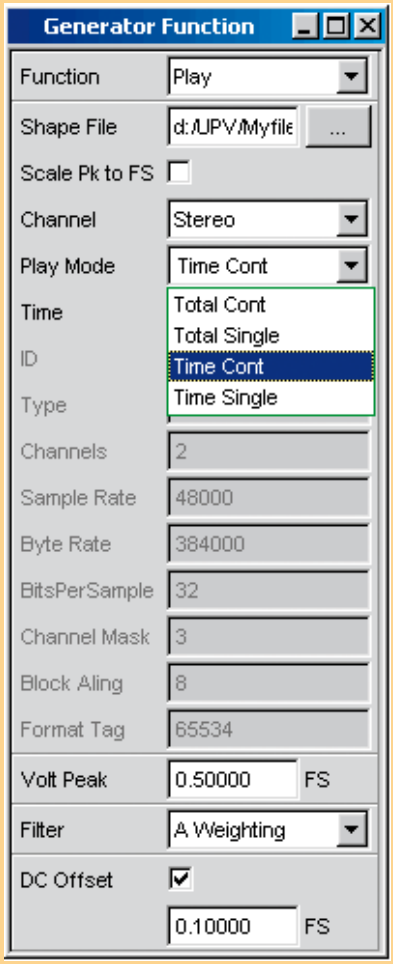
With its new Record and Play functions, the Audio Analyzer R&S®UPV now offers a universal solution for these applications. Every new R&S®UPV includes the Record and Play functions as standard; analyzers already in use can be upgraded by installing free-of-charge software.

You first use the analyzer's Record function to store measurement signals. It has sampling rates up to 192 kHz (digital) or 80 kHz bandwidth (analog) and saves the signals as WAV files in PCM format. When you get ready to analyze the signals, you replay the files by using the generator's Play function. While the files are being replayed, the analyzer, which is internally connected with the generator in the R&S®UPV, performs all desired measurements one after the other.

To measure special signal parameters, you can also use external programs to read and analyze the recorded data stream. By using the WAV format, which is based on the RIFF (resource inter-




**The Record menu.**




**The Play menu.**

change file format) specification developed by Microsoft and IBM in 1991, you can perform a platform-independent external analysis (e. g. under Windows, UNIX/Linux or Mac operating system).

The R&S®UPV also allows you to replay and analyze WAV files not recorded by the analyzer itself. The following applications are possible:

- Replaying of predefined voice and music signals for special measurements in the field of mobile radio or for hearing aids
- Analysis of recordings made earlier
- Analyses of multiple decentrally recorded digital signals using a single R&S®UPV

## Formats

When recording, the R&S®UPV automatically selects the format that requires the least amount of storage space. Digital signals with a maximum of 16 bits are recorded in the standard WAV format. Since the analog analyzer in the R&S®UPV operates internally with a 24-bit A/D converter, the extended format (with 32-bit integer resolution) is always used for analog signals. The same applies to digital signals that are supplied using a word width of 17 bits to 32 bits.

Signals can be replayed using any word length, regardless of which one was used during recording. If the replay word length is larger than the recording word length, the R&S®UPV fills missing bits with 0. Smaller word lengths are rounded. Thus, you can replay and measure recorded analog signals via one of the optional digital interfaces (e.g. via I²S) using a smaller word length in order to analyze the influence of different word lengths.

## Record

Signal recording can be performed for several hours. The WAV files are stored on the hard disk or on a network drive. If files are short, a USB stick can also be used.

The start of the recording can be synchronized to a specific level (e.g. spurious peak). As an option, a pretrigger also records the signals preceding the trigger event.

The audio analyzer can store the signals raw or filtered. A maximum of four filter banks with user-definable filters are available. These filters evaluate and band-limit the signals, for example.

The R&S®UPV displays important signal parameters even during recording, e. g. frequency, peak and rms value. The audio monitor allows additional acoustic monitoring of the recording. To also allow you to perform a graphical assessment of the signal, the beginning of the recording is displayed in the time and frequency domains (FFT) – and you can include the pretrigger if you wish.

Depending on the application, the Record function is triggered or started manually as a continuous or single measurement:

- **Manual single recordings** over a fixed period are recommended if you want to analyze a signal at a later time or with an external analysis program.
- **Triggered single recordings** are useful when searching for an event that occurs very infrequently, provided that this event can be triggered.
- **Triggered continuous recordings** are useful when analyzing triggerable events that occur sporadically. This type of recording generates a separate file for each trigger event. The time stamp of the event is applied to the file.
- **Manual continuous recordings** are useful when searching for interferences that cannot be triggered but that you can detect (acoustically or from the measurement values). To perform these recordings, you select a maximum recording period and stop the recording as soon as the event occurs. The recording start time is retroactively shifted in such a manner that the specified recording period is not exceeded even if you have to wait a very long time before the event occurs.

## Play

As with all other generator signals, you can also filter the signal, adjust the level and add a DC offset. To achieve an adequate level even with WAV files containing a weak value, you can scale the signal to maximum size during replay.

You can replay the WAV file once or repetitively. You can also specify whether to return to the start of the file at the end or after a user-defined amount of time so that you can omit unwanted passages at the end of the file.

Martin Schlechter; Axel Voss

**More information and data sheet at www.rohde-schwarz.com (search term: UPV)**

EMS Test System R&S®TS 9980

# Tried-and-tested compliance test system expanded for DAB

**The R&S®TS 9980 test system for determining electromagnetic susceptibility (EMS) of sound and TV broadcast receivers and associated consumer electronics equipment has established itself as a worldwide standard for compliance measurements [1]. The DAB system expansion now also allows DAB broadcast receivers to be tested for EMS.**

## Fully automated EMS tests

The methods for EMS measurements of digital sound broadcast receivers have been specified in amendment A1:2003 to the EN 55 020:2002 European standard [2]. This standard includes the useful signal definition, test methods, sound evaluation criteria and EMS requirements. These requirements largely correspond to the requirements of analog sound broadcast receivers, i.e. the limit values are identical to those of FM radio receivers with the exception of the input immunity test.

As with analog sound broadcast receivers, sound is evaluated by determining the audio-frequency ratio of useful signals to noise signals. However, with digital sound broadcast receivers, the effects linked to digital transmission such as clicking and disruption have to be determined as well. The Audio Analyzer R&S®UPL, which is integrated in the R&S®TS 9980 test system, can handle this task. A 1 kHz sinusoidal tone serves as the test signal. The DUT level is measured behind a 1 kHz notch filter, which can be set on the audio analyzer. All spectral components, with the exception of the test signal, are thus covered. The analysis is performed with the peak value measurement function, ensuring that each individual digitized measurement value is tested and every noise registered.

The COFDM-modulated (coded orthogonal frequency division multiplex) useful signal is generated in line with the DAB system standard ETS 300 401. To generate such a signal, you need an R&S®DSIP 020 ETI signal source and an R&S®SDB 601 DAB test transmitter. FIG 1 shows how both measuring instruments are integrated in the R&S®TS 9980 test system.

Since it is not possible to change the RF output level with the R&S®SDB 601 DAB test transmitter, it is used only as an I/Q modulator. Thus, the I/Q signal is applied to the digital TV Test Transmitter R&S®SFQ, which is integrated in the test system and which controls the RF frequency and the level.

Amendment A1:2003 does not yet contain any specific requirements for testing the input immunity of digital sound

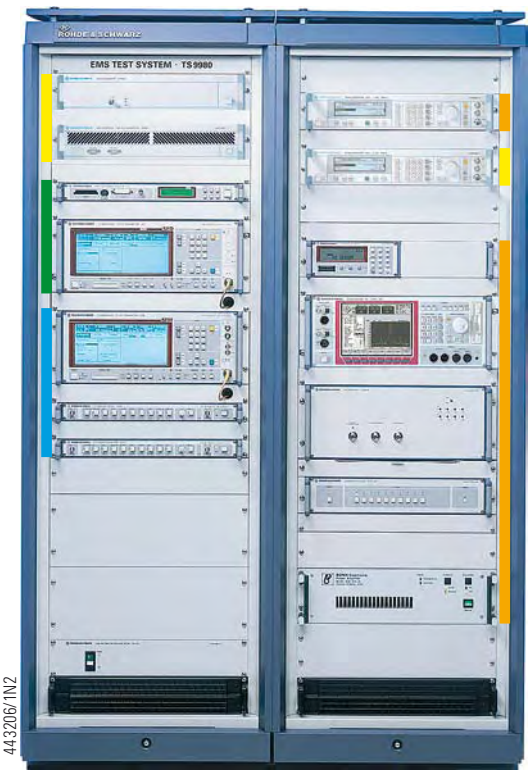



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**FIG 1**
**EMS Test System R&S®TS 9980 expanded for DVB and DAB. The color bars match the colors in the block diagram on the opposite page.**

**More information on Rohde & Schwarz test systems at www.testsystems.rohde-schwarz.com**

REFERENCES
[1] Test System R&S®TS 9980 measures electromagnetic immunity of radio and television receivers. News from Rohde & Schwarz (1990) No. 128, pp 32–33
[2] DIN EN 55 020:2002 + A1:2003 Sound and television broadcast receivers and associated equipment – Immunity characteristics – Limits and methods of measurement (Ton- und Fernseh-Rundfunkempfänger und verwandte Geräte der Unterhaltungselektronik – Störfestigkeitseigenschaften – Grenzwerte und Prüfverfahren); VDE Verlag, 10625 Berlin, October 2003
[3] DIN EN 50 048:2001 DAB characteristics (DAB-Eigenschaften); VDE Verlag, 10625 Berlin, April 2002

broadcast receivers. Therefore, the characteristics for DAB receivers specified in the EN 50 048:2001 European standard are applicable [3]. However, the sound evaluation criteria are applied in accordance with EN 55 020:2002 since a BER measurement is not possible due to the lack of an outer data interface for test house and lab operation.

Providing a DAB-modulated noise signal in the adjacent channel for measuring input immunity is another special feature. For this purpose, the Vector Signal Generator R&S®SMV is integrated in the test system. The digital TV Test Transmitter R&S®SFQ provides the required I/Q signal; using the R&S®SFQ-Z5 option, the R&S®SFQ splits the signal provided by the DAB test transmitter (FIG 2).

## Summary

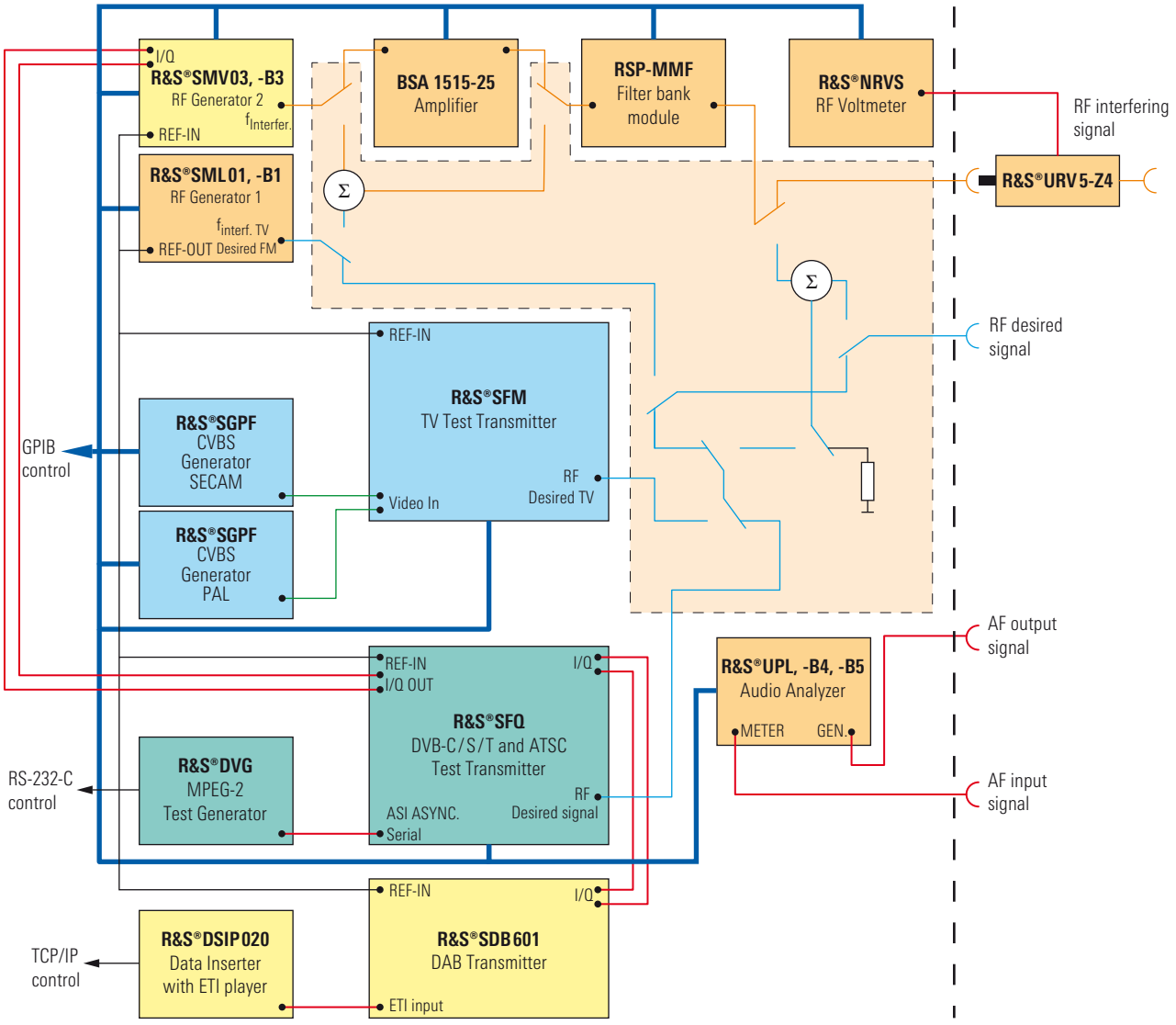
The DAB system expansion now also allows fully automated EMS tests on DAB broadcast receivers. This is a special advantage in the very time-consuming and repetitive procedures that are required for type-approval and quality acceptance testing.

Users will benefit in various ways:

- Fully automated test sequence
- Reproducible measurement results
- Fast training of system operators
- Measurements can be integrated into the production process
- Increased test throughput owing to optimized test sequences

Jens Medler

**FIG 2 Block diagram of the EMS Test System R&S®TS 9980.**



# FLO™ technology brings multimedia content to mobile devices

**Transmitter networks based on new standards such as DVB-H, DMB-T or FLO™ are currently being set up worldwide by combining different technologies from the fields of digital broadcasting, mobile telecommunications and information technology. FLO™ technology effectively transmits multimedia content to mobile devices nationwide, with transmitters from Rohde&Schwarz playing a significant role.**

## TV on your mobile phone

These global activities focus on combining different technologies to economically provide the mobile users' handheld devives with a wide range of multimedia content. The technical development of OFDM-based standards has produced a variety of solutions – DVB-H, DMB-T or FLO™, for example – that make mobile reception of TV / video services possible on battery-operated devices such as mobile phones. The required networks are currently being implemented in different countries.

The conversion from analog to digital TV meets the needs of service providers. In the USA, for example, the TV channels 51 to 69 are being released and auctioned off by the FCC. The usage of the spectrum will largely be left to the new frequency owners.

Technology provider Qualcomm reserved channel 55 (700 MHz) in the USA early on, and created MediaFLO™ USA, a wholly-owned subsidiary. The company will deploy and operate a nationwide wireless media delivery network for the FLO™ standard, delivering up to 100 channels with multimedia content to third-generation mobile phones (see box). The transmission network is scheduled to be launched by the end of 2006.

## Strong partners

In terms of engineering, setting up a network in a short amount of time is an enormous organizational and logistic challenge. Accomplishing this ambitious goal requires cutting-edge technology and quick availability, combined with a consistent logistics concept. Qualcomm therefore is working with Rohde&Schwarz as a transmitter supplier. Both companies as technological pioneers act as catalysts for new trends and technologies in the wireless industry.

With its state-of-the-art exciters, Rohde&Schwarz is the world's only company that can easily integrate new DTV standards into its transmitters. In a joint collaboration, the FLO™ code was implemented in the R&S®SV700 exciter in a very short time. Afterwards a supply contract for 5 kW DTV transmitters of the R&S®NV7500V family was awarded.

The first test transmitter was successfully put into operation in San Diego in November 2004. Two to three transmitters forming a single-frequency network are planned for each city or coverage area. Since cities in the USA are spread out, high transmitter powers between 5 kW and 10 kW are usually preferred.

"One of the key operational factors of utilizing Rohde&Schwarz product is its modularity," states Richard Azer, Director of Operations, for MediaFLO™ USA. "That functionality assists both in the deployment and operational support of the equipment."

## Impressive transmitters

Rohde&Schwarz clearly beat its competitors in the first stage with its R&S®NV7500V transmitters and their excellent price/performance ratio. The liquid-cooled 5 kW TV transmitters with their outstanding features meet the requirements of the described scenario. Low power consumption, easy servicing, effective liquid cooling, high redundancy, simple mechanical concept, state-of-the-art LDMOS amplifier technology

## The most important abbreviations

| | |
|---|---|
| COFDM | Coded orthogonal frequency division multiplexing |
| DMB-T | Digital multimedia broadcast – terrestrial |
| DVB-H | Digital video broadcasting for handheld |
| FCC | Federal Communications Commission |
| LDMOS | Lateral diffused metal oxide silicon |
| FLO™ | Forward link only |
| OFDM | Orthogonal frequency division multiplexing |

that ensures high linearity, best-rated exciters with integrated GPS receiver, and the modern remote-control concept – these were just some of the arguments speaking in favor of Rohde&Schwarz.

Purely practical aspects, which often help considerably to save costs, are also important. The clear, straightforward mechanical structure of the transmitters allows even third-party companies to set up the systems quickly and safely. This is an important prerequisite if you want to work successfully with subcontractors. The compact design with its minimal footprint is another important cost criterion if operating rooms have to be leased.

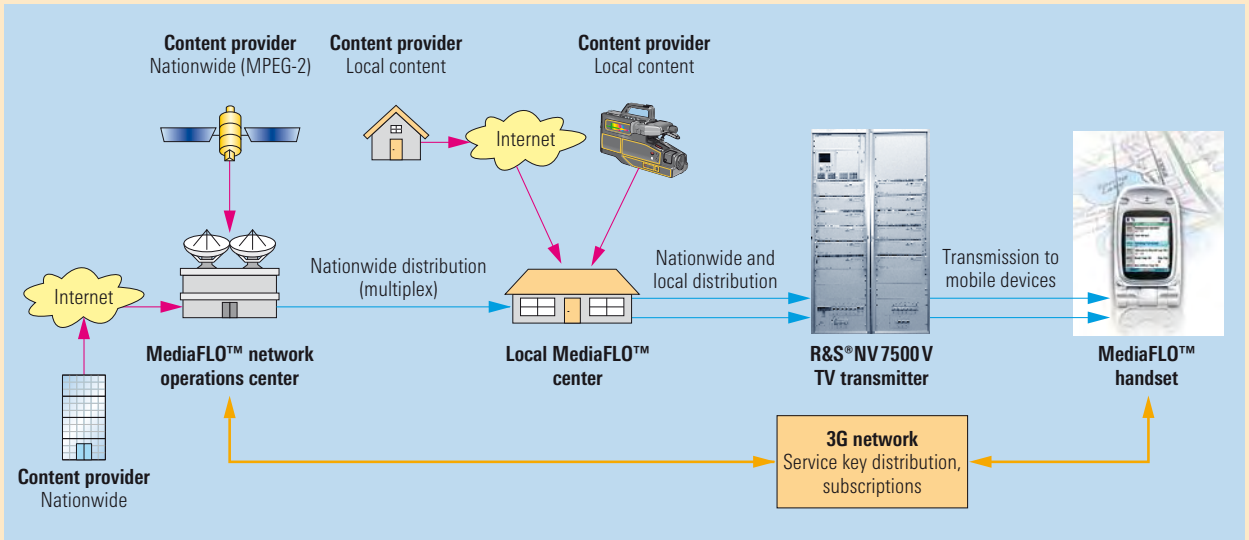
In the USA, fast spare-parts availability and 24-hour service are crucial. The Rohde&Schwarz office in Columbia, Maryland, was able to provide the necessary prerequisites within minimum time.

Reinhard Scheide

## Basic setup of a nationwide network of MediaFLO™

The new FLO™ digital standard from Qualcomm is based on signals with COFDM modulation and 6 MHz bandwidth that can be received by 3rd-generation mobile devices specially developed for this purpose. The MediaFLO™ network operations center receives content in realtime from different content providers via satellite, or terrestrially via transmitters or cable. Other content is fed in via the Internet or from an archive. The signals are multiplexed and converted into a FLO™ data stream. The network operations center passes the data streams on to the local centers, which are also the transmitter locations. The data streams can be fed via satellite, microwave link or optical fiber. The local centers are allowed to insert additional content into the data streams before they are sent to the transmitters. The data streams are subsequently COFDM-modulated with the FLO™ codec and transmitted via a terrestrial single-frequency transmitter network. Users can receive the service on a mobile phone and watch TV on the go.

**National and local centers in a MediaFLO™ network distribute multimedia content to mobile devices.**



# Nationwide transmitter network in Ghana

**In its role as the consortium leader, Rohde & Schwarz FTK GmbH joined forces with T-Systems International GmbH to set up and commission a nationwide TV and sound broadcasting network for the state-owned broadcasting company in Ghana. Transmitter systems including masts, antennas and emergency power supplies were supplied and installed at 30 sites. The German Federal Government stood behind the 17.4 million euro order with a Hermes export credit guarantee.**

The objective of the state-owned Ghana Broadcasting Corporation (GBC) is to broadcast entertainment, information and education programs via sound broadcasting and TV. To do this, it began setting up transmitter networks in Ghana in 1965. Up to now, primarily cities and the surrounding areas have been covered. But the GBC is currently expanding existing TV and FM transmitter networks to also meet the needs of more remote rural areas. Programs are to be specially tailored to help develop the various regions and educate the rural population. Since conclusion of the order, more than 90% of Ghana's population now has access to sound and TV broadcasting.

The first task was to conduct a site survey in Ghana. The resulting data was essential for planning the coverage of the complete GBC sound and TV broadcasting network, taking the available transmitter infrastructure into account. To cover more than 90% of the country, 30 sites were earmarked during the planning phase. At these sites, either new transmitter systems had to be set up or present systems had to be replaced.

FM transmitters of the R&S®SR 500 and R&S®SR 600 families from Rohde & Schwarz were part of the project. Air- and liquid-cooled transmitters of the R&S®NM 7000 series were used for the TV transmitter network. Program input equipment (PIE) racks developed to customer specifications were supplied for each transmitter. These racks make it possible to switch between different FM and TV programs and are equipped with T&M technology for monitoring the quality of the applied modulation signal. The order also included Rohde & Schwarz T&M equipment for the maintenance of the transmitter systems.

Most of the sites were equipped with new antennas. At some sites, new antenna supports between 45 m and 150 m high were also installed. Emergency power generators between 60 kVa and 200 kVA were also part of the project.

A satellite earth station was set up in Accra to provide the satellite-supported modulation feed to the various sites. The DVB-T-compliant satellite uplink supplies GBC's national radio and TV programs to the individual transmitter sites. You can now select between broadcasting national or local program content almost anywhere in Ghana.

Training was also included in the overall package. It took place both in Germany and in Ghana. GBC employees were taught how to operate and maintain the FM and TV transmitter systems, the PIE racks and the satellite stations.

The material required for the project was shipped to the Tema seaport in Ghana in more than 100 containers between December 2003 and September 2004.


The **Republic of Ghana** is situated between the Ivory Coast and Togo in Western Africa. The country is about two thirds of the size of Germany and has a tropical climate since it is located near the equator. Ghana's main exports are gold, cocoa and timber.

From there, the containers had to be transported on trucks to even the northernmost regions of the country. Logistics was a real challenge especially during the rainy season when transportation had to be managed on unpaved and almost impassable roads.

Work at the individual sites was performed by supervisors from the consortium and GBC employees. Since the customer was also deeply involved in project implementation, its employees gained direct knowledge about setting up and commissioning the systems. This now enables GBC to maintain their new transmitter systems on their own. In the main phase of the project, six installation and commissioning teams were simultaneously at work throughout the country and had to be supported and coordinated. The efficient and trusting atmosphere within the consortium made it possible to complete all tasks involved in the expansion and modernization of the transmitter network in early May 2005 – ahead of schedule.

GBC's existing broadcasting infrastructure has now been modernized and expanded. The new transmitter network was planned, installed and put into operation by relying on one main contractor. This will serve as an outstanding reference for Rohde&Schwarz throughout Africa

Dr Wolfram Titze

**New antennas and partly new antenna supports between 45 m and 150 m high were installed at most of the sites (Kissi transmitter site shown here).**

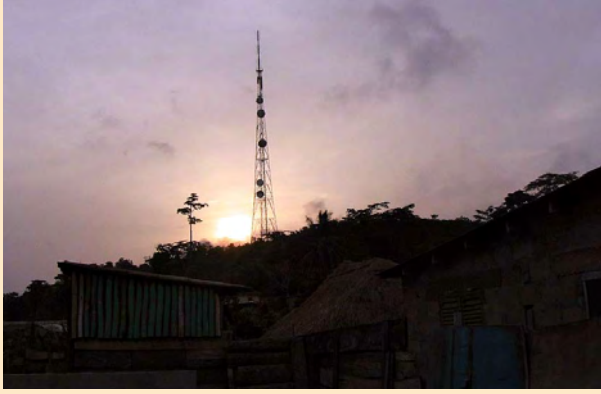


Photo: FTK

**The national GBC radio and TV program is broadcast to the different transmitter sites via satellite. You can then select between national or local program content almost anywhere in Ghana.**

Photo: T-Systems

**New transmitter stations were also set up in some cases, here in Kintampo.**

Photo: T-Systems

**FM transmitters of the R&S®SR500 and R&S®SR600 families as well as air- and liquid-cooled TV transmitters of the R&S®NM7000 series from Rohde&Schwarz now provide 90% of Ghana's population with sound and TV broadcasting. The photograph shows the PIE racks for FM and TV between the two transmitters.**

Photo: FTK

Smooth kick-off with Rohde & Schwarz

# Digital terrestrial TV in Bavaria

**Monday, May 30, 2005 was the big day: In the Munich / Southern Bavaria area and in Greater Nuremberg, DVB-T (digital video broadcasting-terrestrial) TV went on the air. Well over six million viewers can now receive 24 programs of high technical quality with a set-top box via a roof or room antenna.**

## Advantages of digital

DVB-T offers numerous advantages: improved picture and sound quality, more channels, plus appealing auxiliary services. The extra benefit of digital terrestrial transmission is that you can receive programs with a portable TV receiver or via a laptop with a TV receiver card. This provides viewers with new freedom of movement, which has led to the marketing term "TV anywhere".

## High-power DVB-T transmitters from Rohde & Schwarz

Commissioned by the two network operators T-Systems International GmbH and Bayerischer Rundfunk (Bavarian broadcasting corporation), Rohde & Schwarz supplied 21 high-power transmitters from the R&S®NX7000 family for digital TV in Bavaria; their output power ranges from 1.7 kW to 9.3 kW. In all, six multiplexes with four programs each were equipped.

The Munich / Southern Bavaria area is covered by transmitters in the Munich Olympic Tower (FIG 1) and on the Wendelstein mountain in the Alps. Greater Nuremberg is covered by the Dillberg and Nuremberg telecommunications towers. The transmitters function in both cells as single-frequency networks (SFN), ensuring high coverage density and low frequency resource consumption.

**FIG 1** The transmitters in the Munich Olympic Tower cover the Munich / Southern Bavaria area.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## Ingenuity and commitment at work

To enable the conversion from analog to digital TV within the narrow time-frame specified, Rohde & Schwarz and its two customers had to complete enormous tasks. Production at the Rohde & Schwarz Teisnach plant ran at full speed to meet the delivery schedule for the transmitter systems. Setting up the entire network, i. e. planning, delivering, installing and putting it into operation, was accomplished in just four months.

The teams in charge, both from the network operators and from Rohde&Schwarz, had to be extremely creative to meet the special challenges at hand. For example, the exhaust heat from the transmitters' central cooling unit in the Munich Olympic Tower had to be used in an intelligent manner. The operators of the adjacent swimming pool are now benefiting from the teams' good ideas, since the pool will be partially heated using this energy.

For the Wendelstein mountain station, the transmitter systems and cooling units had to be transported under tremendous time pressure and daunting winter conditions. These difficulties were overcome by using a helicopter. Several tons of material were airlifted to 1838 m (FIG 2) in three flights. The Wendelstein station is now Germany's highest digital transmitter site.

To ensure reliable switchover on the scheduled date, an overnight test run was performed several days in advance. The persons in charge noted with satisfaction that everything ran smoothly and that the scheduled switchover could go ahead exactly as planned.

## Further expansion of the DVB-T transmitter networks in Germany

The first DVB-T network in Germany went into operation in Berlin/Brandenburg in November 2002 with transmitters from Rohde&Schwarz. Since then, the network has been rapidly expanded in North Rhine-Westphalia, Lower Saxony, Hesse and now in Bavaria. Thuringia and Saxony-Anhalt will follow later this year.

Further expansion has already been scheduled for Bavaria as well: Bayerischer Rundfunk is planning seven additional sites with the goal of supplying up to 88% of the population with digital terrestrial TV.

It has now become tradition for Rohde&Schwarz to be part of all these projects. The company actively participated in the introduction of the new digital DVB-T standard even during the standard's earliest stages. Moreover, Rohde&Schwarz is Europe's undisputed market leader both in transmitters and the required T&M equipment. In Germany, its market share exceeds 70%.

Friedrich Rottensteiner

**FIG 2 A DVB-T transmitter system was airlifted via helicopter to Germany's highest digital transmitter site, Wendelstein mountain.**

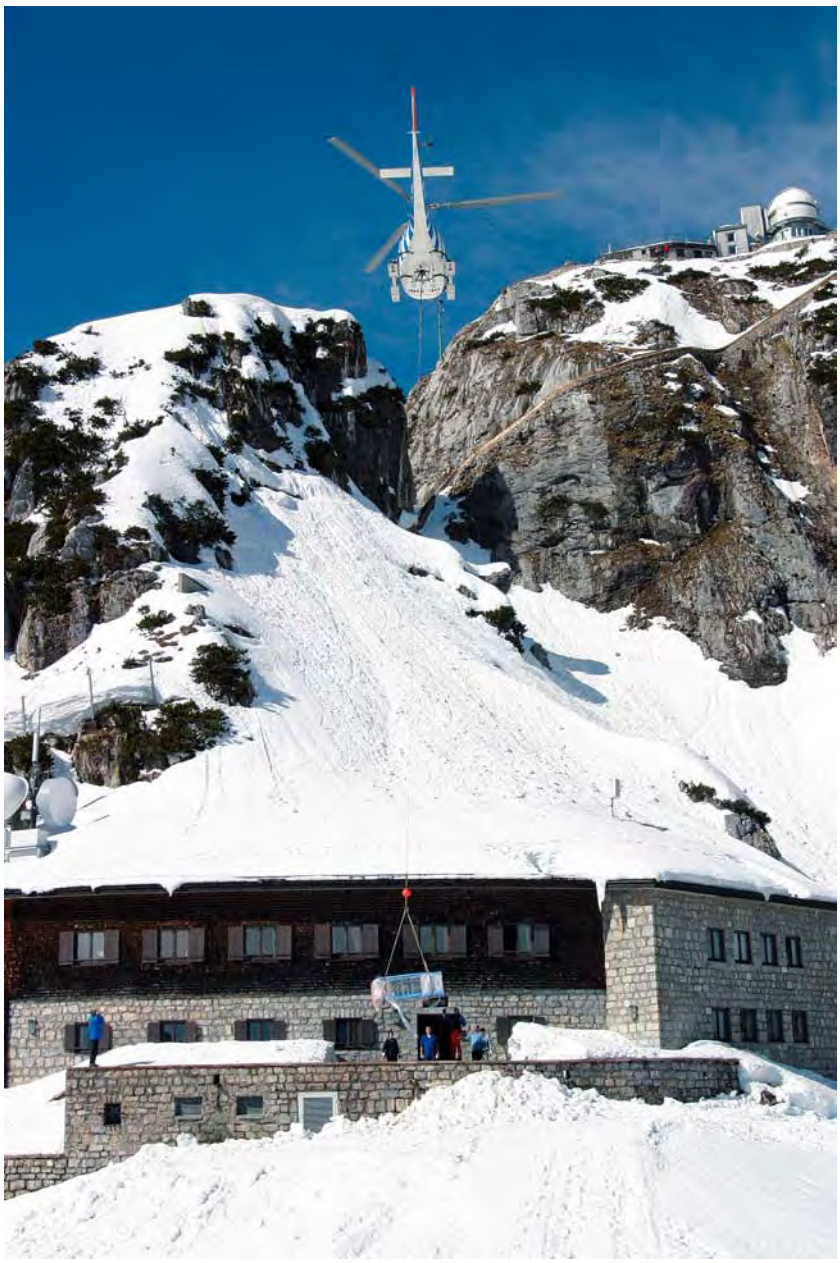


Photo: Bayerischer Rundfunk

Exciter R&S®SU 800

# Digital FM exciter – compact and versatile

**The new Exciter R&S®SU 800* combines the excellent specifications of the best analog exciters with the reliability of modern digital signal processing. Thus, it is very compact and occupies only one height unit in a rack. It provides an integrated digital AES/EBU interface as standard.**

## State-of-the-art technology in only one height unit

The Exciter R&S®SU 800 (FIG 2) is a component of the new VHF FM Transmitter Family R&S®NR 8200 [1]. All signal processing including frequency modulation is performed digitally. By using powerful digital technology and state-of-the-art D/A converters, this exciter meets the high requirements for spurious and spectrum masks.

The R&S®SU 800 is very compact – input interface, digital signal processing, RF section, control and power supply are all integrated on one board.

The exciter provides a built-in AES/EBU interface for direct input of digital audio data and thus makes full use of the advantages offered by digital signal processing. This feature eliminates all analog interferences from the studio up to the output of the frequency modulator.

You can switch the signal feed from analog to digital at any time. Analog audio signals can be applied in parallel, either as AF (left / right) or as multiplex (MPX) signals. You can connect two of the three possible signal feeds simultaneously; this allows you to easily switch to standby feed from a remote location.

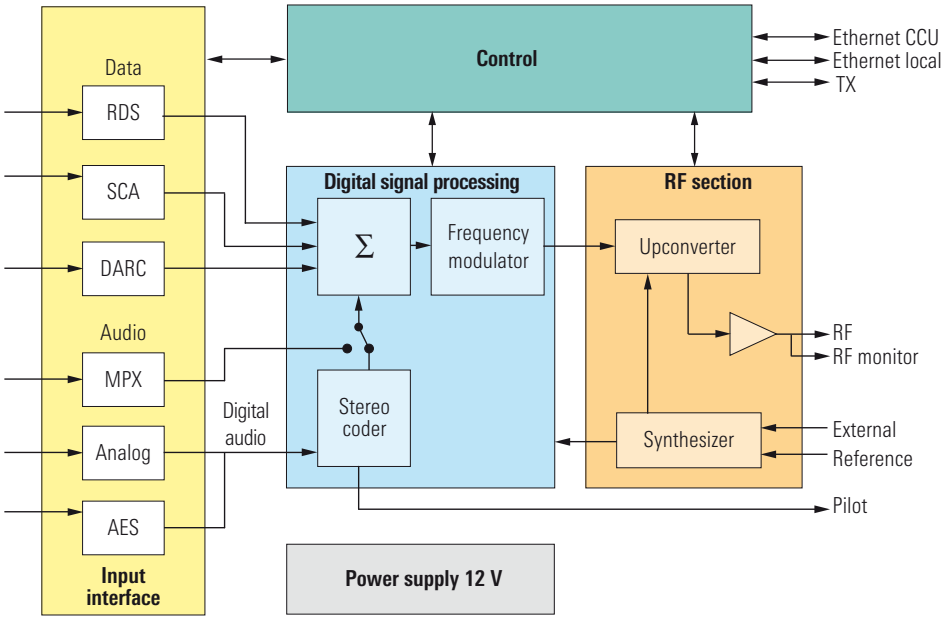
## Input interface

Analog (left / right) and digital audio signals (AES/EBU) are applied separately (FIG 1). Additionally, you can supply an MPX signal which has been generated in an external stereo coder.

The input interface provides three analog inputs for RDS, SCA and DARC signals. The R&S®SU 800 digitizes these signals and adds them to the internal MPX signal. It decodes the AES signal and converts it into a constant sampling rate. This allows you to process input data at different sampling rates up to 192 kHz and to eliminate jitter effects simultaneously.

To suppress interference, all incoming analog data input signals are first routed via analog lowpass filters, their level adjusted, and then separately digitized

**FIG 1 Block diagram of the Exciter R&S®SU 800.**




* The development of this innovative product was co-financed by the European Union.


**FIG 2 The new Exciter R&S®SU800 occupies only one height unit: input interface, digital signal processing, RF section, control and power supply are all integrated on one board.**

and fed to the digital signal processing system. Digitization is handled by high-quality A/D converters – with 24-bit resolution for analog audio signals and with 16-bit resolution for MPX and additional data. You can define a specific level for nominal deviation for each input.

## Digital signal processing

The fully digital signal processing function, which is handled by a powerful field programmable gate array (FPGA), ensures a consistently high level of signal quality, free from random sources of error such as temperature fluctuations or quality variations of the component. Due to the consistent use of digital technology, the entire module needs virtually no adjustment.

The digitized audio signals are routed via a lowpass, and a bandpass suppresses interfering signal components outside the data signal spectrum. The internal stereo coder processes the filtered audio signals to yield a standard-conforming MPX signal. For stereo signals, you can set the level of the pilot tone. The digital MPX signal is used for frequency modulation of a high-precision direct digital synthesizer (DDS).

## RF section

The RF section converts the digital signal into an analog signal by means of a fast 16-bit D/A converter. The signal is then filtered – to meet the requirements for spurious and spectrum masks – and converted to the output frequency. The selected switching concept allows frequency switching without adjustments.

The synthesizer provides all necessary clock and mixer frequencies. If you need exceptionally good frequency stability, the exciter allows you to synchronize the internal clock to an external reference (10 MHz or 1 pps).

## Control

A powerful microcontroller configures and monitors the R&S®SU800. It initializes the hardware from a compact flash memory that contains the complete software and firmware as well as all settings.

The R&S®SU800 concept is based on the R&S®Nx8000 transmitter platform and is also used in the TV Exciter R&S®Sx800 [2]. Important control features are thus uniform, which simplifies maintenance and operation significantly. During operation, for example, the exciter is configured and monitored by the Control Unit R&S NetCCU®800 via the Ethernet interface on the rear panel.

If the control unit is not available, you can also operate the exciter from a local PC via the Ethernet interface on the front panel. To do this, you simply need to open the web browser and establish a connection to the exciter. No special operation software is needed since a web server providing all necessary functions runs on the exciter.

Jan Gulde

**More information and data sheet at www.rohde-schwarz.com (search term: SU800)**

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[1] Family of VHF FM Transmitters R&S®NR8200: Compact, air-cooled transmitters for 2.5 kW to 30 kW. News from Rohde&Schwarz (2005) No. 186, pp 44–45

[2] Exciter R&S®Sx800: Multistandard exciter for ATV and DTV. News from Rohde&Schwarz (2005) No. 186, pp 41–43

Integrated Logistics Support

# Product life cycle management: controlling availability and costs

**Today, a product is expected to meet not only the customer's technical requirements; criteria such as economic viability and availability are increasingly gaining importance. When customers decide to buy a product, it's no longer just the purchasing costs that tip the scale – the costs for operation and use are also becoming more and more decisive. Product and system providers meet these challenges by offering product life cycle management (PLM). The PLM strategy is a conceptual solution that sees a product through all its life cycle phases. Correctly applied, it enhances a company's competitive position while ensuring customer benefit.**

## Services for optimum availability

The Rohde&Schwarz Cologne Service Center has years of experience and extensive know-how in developing PLM strategies and implementing them in civil and military applications. Integrated logistics support (ILS), as this service is referred to, is offered to customers in the capital goods sector and covers a broad scope of services:

- Developing logistics, training, documentation and service concepts
- Performing and implementing life cycle cost analyses and calculations
- Providing suitable IT systems and tools for the interface between R&D / design and customers as well as all associated consultancy, R&D and integration services
- Creating computer-based training courses and simulations
- Providing equipment and system training
- Generating product and systems documentation from databases
- Developing the necessary test and inspection systems
- Installing equipment and putting it into operation
- Providing on-site services
- Ensuring availability of spare parts
- Redeveloping discontinued original components or modules to extend the life of products and systems

These services ensure the availability of systems and products at the best possible cost/benefit ratio, while the developed solutions cover customer-specific requirements.

**Typical PLM process.**

| | | |
|---|---|---|
| **Development phase** | Development of standard logistics for a product or system | **Logistics planning and optimization** |
| **Quotation phase** | Planning of the logistics support at the customer's end and customization | |
| **Procurement** | Logistics implementation at the customer's and manufacturer's end | **Implementation for the customer** |
| **Warranty phase and after-sales support** | Logistics support during the entire service life | |

## A typical process

A product or system design has to be optimized for favorable life cycle costs even during the R&D phase. Reviews during development plus the structured acquisition of basic logistics data help accomplish this objective. Logistics services identified in advance are customized during the quotation phase to meet the specific requirements of customers or of a specific customer target group. Customer sites and, if applicable, their facilities and capabilities are the decisive factors to be taken into account. Once an order has been placed during the procurement phase, logistics plans are executed at the customer's and manufacturer's end so that all logistics will be fully in place when the product is delivered. The next steps are the warranty phase and after-sales support; they may cover several decades depending on the product, the customer or the individual service agreement. Customer requirements for long-term support and maximum usability of the product or system can only be met through well-planned product support, continuous processes and iterative analyses.

## Summary

Customer-oriented PLM covers all aspects of the economic viability of high-end capital goods and systems. It optimally harmonizes the overall costs incurred by procurement, operation and use with costs, timing and best possible availability. The Rohde&Schwarz Cologne Service Center offers all required services from a single source.

Wolfgang Weber; Martin Fischer

**More information at www.rohde-schwarz.com**

## The Rohde&Schwarz Cologne Service Center at a glance

The Rohde&Schwarz Cologne Service Center is one of Europe's largest service centers for electronic test and measurement. Its service portfolio includes maintenance and repair, technical information management as well as logistics and training courses. The Cologne Service Center is an accredited calibration center of the German Calibration Service (DKD). The entire service portfolio is provided by a single source, making it easier to solve demanding and complex tasks.

Photo: Eurofighter GmbH

**Eurofighter Typhoon now with radiocommunications equipment from Rohde & Schwarz.**

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## Eurofighter Typhoon with radiocommunications equipment from Rohde & Schwarz

**Rohde & Schwarz received a follow-up order for supplying radiocommunications equipment for tranche 2 of the Eurofighter Typhoon. The company will equip 236 aircraft with two VHF/UHF transceivers each.**

In 1999, Rohde & Schwarz won the order for supplying radiocommunications equipment for the first tranche of aircraft of the series. For the present tranche, the radiocommunications equipment has been modernized and is now based on the successful airborne transceivers of the R&S®M3AR family from Rohde & Schwarz.

In the joint project for the Eurofighter Typhoon, Germany, the United Kingdom, Italy and Spain developed Europe's most advanced combat aircraft of this class. Delivery of this second tranche to the customer countries is scheduled to start in 2008

## Rohde & Schwarz SIT wins order for several million euros

**The German armed forces awarded Rohde & Schwarz SIT GmbH an order worth several million euros for ELCRODAT 4-2 encryption devices.**

Early last year, the German armed forces, represented by the German Federal Office for Information Management and Information Technology (IT-AmtBw), ordered multifunction encryption units of this type from the Rohde & Schwarz subsidiary. The order had a volume of five million euros. Germany's army, navy and air force will use these modern encryption units. The ELCRODAT 4-2 can be operated both in mobile and stationary mode for encrypting and decrypting analog and digital messages at all national grades of classified information. This large-scale order again underscores the position of Rohde & Schwarz SIT GmbH as a leading supplier of professional encryption technology in Europe.

## Naval radiocommunications for the United Kingdom

**Rohde & Schwarz was recently awarded a contract to supply and install a radiocommunications system for a helicopter carrier of the British Navy. HMS Clyde will replace two aging vessels and will be used for patrols in the waters around the Falkland Islands.**

The vessel will be designed and built by VT Shipbuilding Ltd UK and will be a successor to the River Class offshore patrol vessel already deployed by the UK Royal Navy. The decision in favor of the radiocommunications system from Rohde & Schwarz was based on its high reliability and sustained availability proven by the systems already in service.

Rohde & Schwarz already offers software-defined systems for military radiocommunications that securely transmit voice and data in combination with encryption units.

## New service concept for *ACCESSNET*®-T mobile radio systems

**With the *ACCESSNET*®-T TETRA mobile radio system now being used worldwide, R&S BICK Mobilfunk has expanded its service structures. Specific on-site support will help reduce response times. R&S BICK Mobilfunk was able to enlist local service organizations as partners and provide them with the relevant technical training.**

The new service structure is a three-tier system. The first tier includes simple local service work, installation and replacement of components. The other tiers cover the configuration and diagnostics of the entire network as well as system optimization and repair. Attaining the third tier means that the service partner is able to support the *ACCESSNET*®-T mobile radio system during all project phases, from the configuration to the end of the warranty period.

## Rohde & Schwarz is cooperating with the Munich University of Applied Sciences

**By signing an agreement of cooperation, Rohde & Schwarz and the Munich University of Applied Sciences are strengthening their existing good interaction. Rohde & Schwarz will furnish equipment and software to the Department of Electrical Engineering and Information Technology, thus significantly promoting the educational program at the Munich University of Applied Sciences.**

Joint R&D projects are also planned. Students at the University of Applied Sciences will have the opportunity to pursue internships at Rohde & Schwarz, gain insight into the company as working students, or write their thesis there.

## Rohde & Schwarz Japan certified to ISO 9001 for its service center

**The service center of Rohde & Schwarz Japan has received certification for ISO 9001, the international standard for quality management systems. Rohde & Schwarz in Germany has been certified for ISO 9001 in development, production and service since 1992.**

The service center was set up in Saitama in November 2004 to provide repair, calibration and maintenance of Rohde & Schwarz products. It obtained ISO 9001 certification only six months after being established.

In line with the Rohde & Schwarz strategy to expand its service network to provide customers with on-site service, Rohde & Schwarz Japan took the necessary steps to furnish its customers with a complete service portfolio ranging from sales and technical support to maintenance. The certification is proof of the company's commitment to improving customer satisfaction.

## Rohde & Schwarz opens second office in Taiwan

**Rohde & Schwarz opened its second office in Taiwan on July 1, 2005. The ROHDE & SCHWARZ Taiwan Ltd. Kaohsiung Office is in charge of all of southern Taiwan. Rohde & Schwarz established its first Taiwan office in Taipei in 2003. The Kaohsiung office with its four staff members will handle sales in addition to providing support and service.**

Kaohsiung is located on the southwest coast and is the home of Taiwan's largest commercial port. Many foreign companies already have established offices there. The city primarily attracts companies from the fields of high-tech engineering, automation and capital goods.

The new address is:
ROHDE & SCHWARZ Taiwan Ltd.
Kaohsiung Office
26F-2, NO. 55,
Jhongjheng 3rd Rd., Sinsing District,
Kaohsiung City 800, Taiwan
Tel: ++886-7-229-1977
Fax:++886-7-226-1577

## Rohde & Schwarz expands its portfolio with ZigBee products from Frontline

**Since January 2004, Rohde & Schwarz has been marketing and selling the *Bluetooth* sniffer from Frontline®. Rohde & Schwarz now also distributes the ZigBee and IEEE 802.15.4 protocol sniffer from Frontline®.**

The FTS4ZB ZigBee and IEEE 802.15.4 Protocol Analyzer and Packet Sniffer includes the FTS software and the ZigBee ComProbe® (FIG), which captures the ZigBee packets at the air interface. The FrameDecoder™ decodes the protocols down to the bit level and also allows user-defined decoding of all protocols based on IEEE 802.15.4. The FTS software runs under Windows 2000 and XP, and the ComProbe® is connected via a USB interface.

Typical ZigBee applications include centralized alarm systems, the automation of switch-on cycles of household appliances, monitoring of weak spots in vehicles, monitoring in supermarkets and status messages of medical analyses. The ZigBee sniffer displays the protocols in plain text, making it ideal for R&D and error diagnostics.


**The ZigBee ComProbe® for the FTS4ZB protocol sniffer with USB connector.**

**Dr Amend (Head of Human Resources) welcomes the participants of the symposium.**

## Rohde & Schwarz hosts VDE meeting

**The Association of Electrical Engineering, Electronics and Information Technology held its 96th symposium on "academics and practical application". Rohde & Schwarz hosted the symposium, which was attended by about 70 electrical engineering professors from all over Germany.**

By means of lectures and product demonstrations, Rohde & Schwarz presented itself and informed the participants about trends in radiocommunications and radio T&M. The participants wanted to know more about technologies such as UMTS, WLAN, DVB-H, TETRA or software defined radio, for example. The professors will incorporate the information obtained during the symposium in their lectures.

Rohde & Schwarz and the guests also discussed what industry expects German universities to teach future engineers. As a result, the professors were offered internships and theses for their students.

**www.rohde-schwarz.com**

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