News from Rohde & Schwarz

High-precision PN scanner helps
to optimize UMTS networks

Cost-effective mobile phone test system
for use in mass production

Air-cooled, medium-power VHF transmitters
for analog and digital TV standards

2002/IV
176

ROHDE&SCHWARZ

43942

The UMTS PN Scanner R&S TS5K51C allows rapid, precise and error-free analysis of the reception conditions for CDMA signals (page 4).

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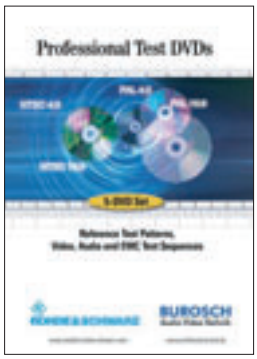
The new Test System R&S TS7180 for PCB tests, RF adjustment and final tests supports the current mobile radio standards GSM / GPRS, TDMA (IS-136), AMPS, CDMA (IS-95), CDMA2000 and soon WCDMA and the *Bluetooth*™ radio standard as well (page 10).



MOBILE RADIO

Coverage measurement systems

Test systems

Protocol testers

Radiocommunication testers

GENERAL PURPOSE

Test signals

43869/2

The strengths of the Network and Component Analyzer R3860 from Advantest are measurements on balanced devices with all required simulation functions, measurement speed and multi-port measurements by using automatic test routines (page 32).

43703

The air-cooled, medium-power VHF Transmitters R&S NM/NW7001 round out the Rohde&Schwarz product family which covers all power classes from 50 W to 40 kW in the VHF and UHF range (page 40).

Network analyzers

Test methods

BROADCASTING

TV transmitters

FOCUS

Datacasting

MISCELLANEOUS

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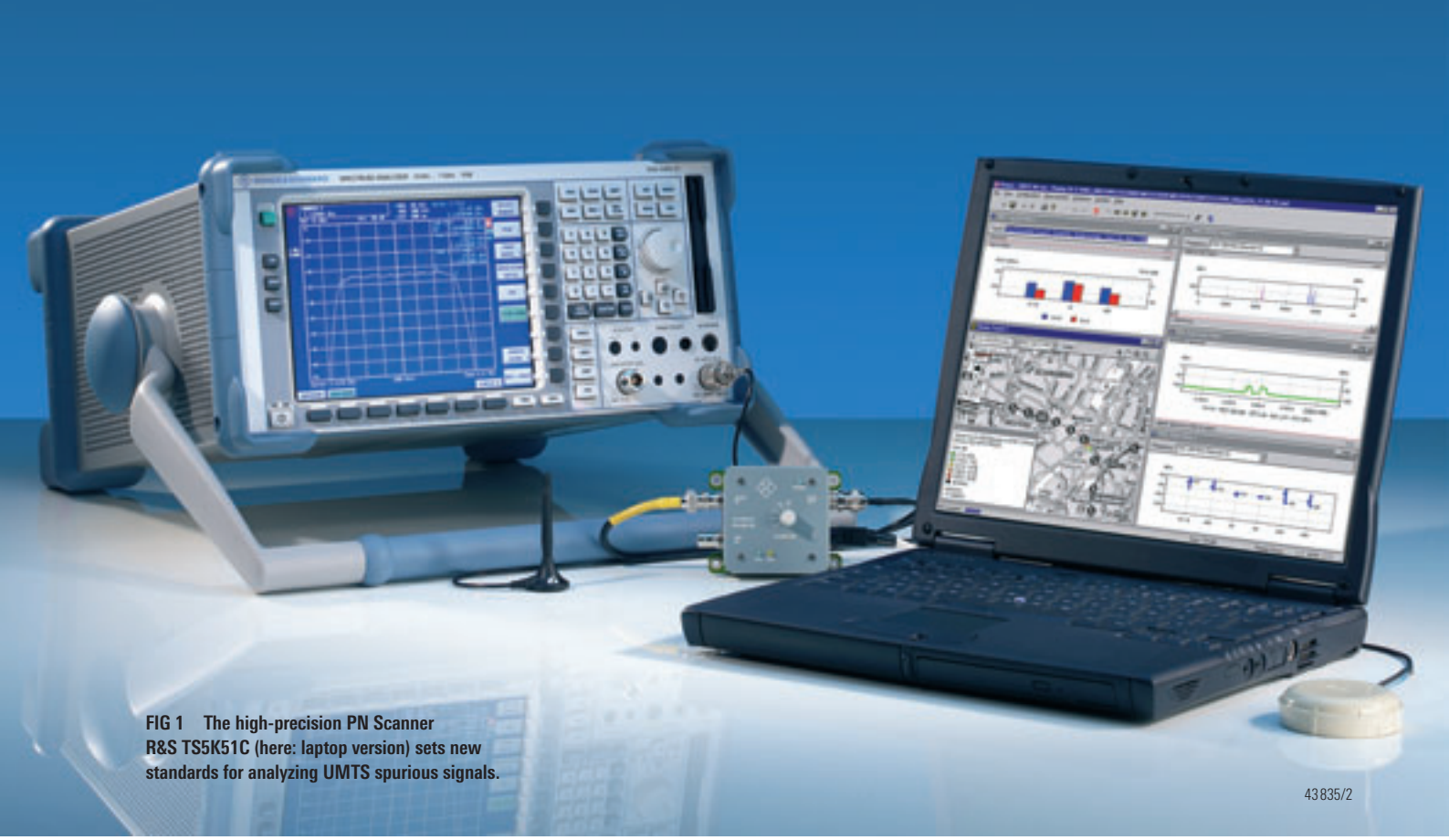

FIG 1 The high-precision PN Scanner R&S TS5K51C (here: laptop version) sets new standards for analyzing UMTS spurious signals.

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PN Scanner R&S TS5K51C

Turbo for UMTS network optimization

Similar to a fast Fourier transform that produces the result within fractions of the calculation time of a DFT algorithm, scalar products can also be highly efficiently calculated. The turbo in the UMTS PN Scanner R&S TS5K51C (FIG 1) is one such quick method, and the first in a new line of products for rapid, precise and error-free analysis of the reception conditions for CDMA signals.

PN scanners help with problems in UMTS networks

Pseudo random noise code scanners (PN scanners) are used to closely analyze the reception conditions in a 3GPP network. By means of the measured data, network operators can quickly detect errors in planning and setup, eliminate them and also refine their planning tools.

Pilot pollution can be caused by a number of factors, e.g. uneven terrain, bridges and overpasses that are covered by too many transmitter stations at the same time and on the same RF channel (FIG 2). Despite high field strength, connection is poor because of the co-channel interference. In these situations, UMTS is more tolerant than GSM – interference does not lead to disconnection, only to a reduced data rate. This, however, causes additional load on the radio channel. To maintain the required minimum transmission rate, transmit power is increased and handovers are made to the base stations with the best reception in this area. Since the desired characteristic, best server, is only of short duration with pilot pollution, handovers that tie up further precious channel resources occur frequently. By adjusting cell size parameters or aligning a few antennas, pilot pollution can often be eliminated by means of the measurement data from PN scanners, thus enabling better use of the precious frequency band and increasing the average data rate.

Quick fading and multipath propagation are similar sources of interference

for UMTS connections (FIG 3). In these cases, too, the incoming RF power at the mobile phone is at first sufficient. It is, however, partitioned into different paths which, depending on the quality of the mobile phone, provide a greater or lesser number of signal components for transmission. In the case of different signal delays, the orthogonality of all codes transmitted by a base station fades. This causes all signals sent by the server station, and in particular the signals of other subscribers, to strongly interfere with mobiles that have multipath reception. This CDMA-specific effect, which is not present in the case of FDMA and TDMA, calls for careful analysis of the multipath propagation when setting up and optimizing UMTS networks.

PN scanners are superior to UMTS test mobiles

Network operators face the challenge of making full use of the improved features of mobile radio coverage provided by UMTS technology. As with GSM networks, test mobiles are utilized with UMTS to determine the coverage quality. However, they cannot adequately determine the causes for poor quality. PN scanners are far better suited for these tasks, because they have superior characteristics compared to a terminal and can keep track of the overall situation, especially in difficult areas.

In contrast to UMTS mobile phones that process only a few signals from the strongest paths of one or two base stations simultaneously, PN scanners must be able to measure the pilot carriers of any number of base stations in as many paths as possible so that interference such as pilot pollution, multipath propagation and fading can be reliably detected. This capability is provided in

FIG 2 The pilot pollution map shows how many base station pilot signals within a channel exceed a power threshold value that is within a configurable spacing below the pilot power of the best server.

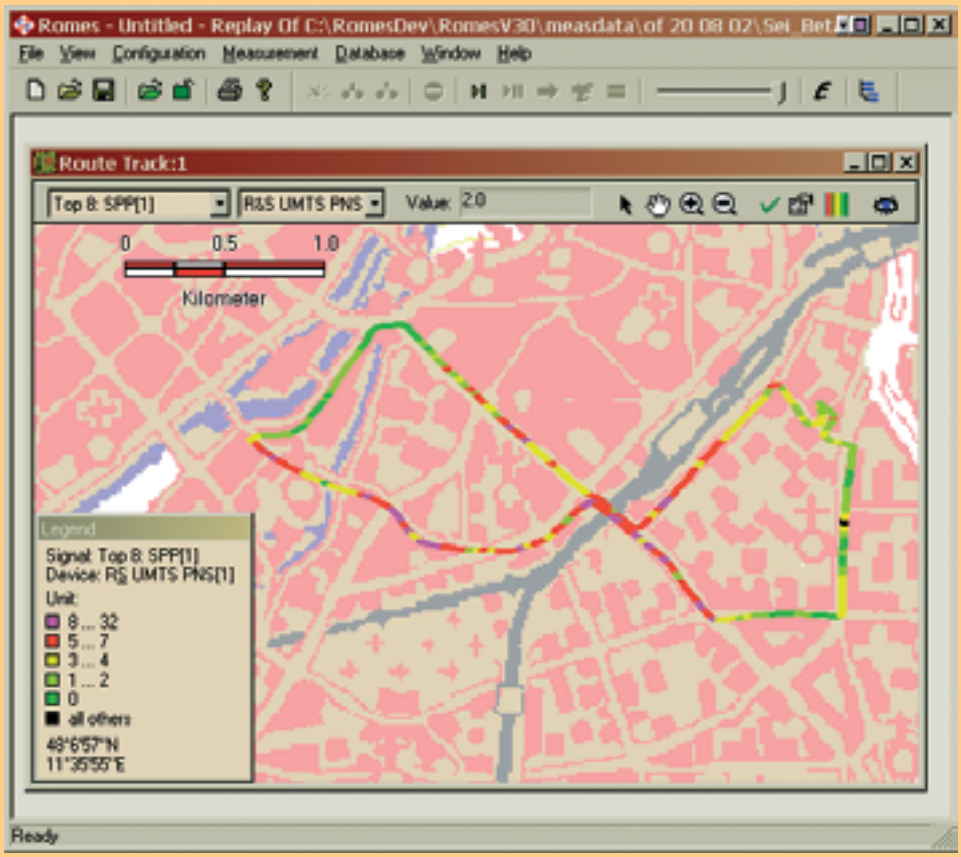
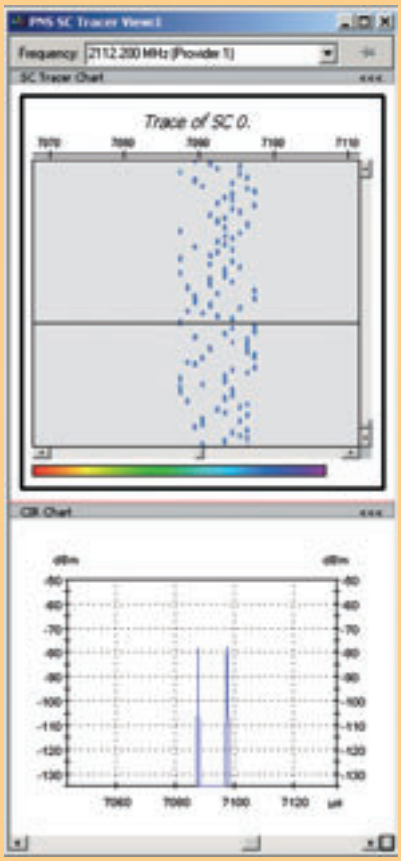


FIG 3 Birth death fading, 3GPP-specified for mobile conformance tests, generated by the Signal Generator R&S SMIQ and measured with the R&S PN scanner. Two pseudo-randomly selected paths out of a total of 11 are active with the same signal power on an alternating basis.



the PN Scanner R&S TS5K51C by an innovative rake receiver. It differs from a UMTS mobile receiver in that it can synchronize to the pilot carrier of a base station at a considerably lower E_c/I_0 and has a far larger number of rake fingers which ensure simultaneous reception of numerous useful and spurious signals.

Sophisticated technology ensures reliable synchronization

When a UMTS receiver synchronizes to a base station, it searches for the pilot carrier that is specific to this base station and is QPSK-modulated with a chip rate of 3.84 MHz. Its content is repeated every 10 ms. Since the chip sequence of the pilot carriers differs depending on the scrambling code (SC) and since 512 SCs are used, there are nearly four million possible configurations of pilot signals in any UMTS signal section with a time resolution of half a chip duration. These signals are measured by the PN scanner. In practice, however, testing all four million possible configurations takes too long – even with fast hardware and optimized algorithms.

To find the pilot carriers more quickly, the PN scanner from Rohde&Schwarz first searches for the primary and secondary synchronization sequences included in the UMTS signal. Once these sequences have been found, the number of possible configurations is reduced to as few as eight, where the actual number is determined by the number of secondary sequences detected.

Since continuously transmitted pilot carriers can be measured at a considerably lower E_c/I_0 than the synchronization sequences of only 256 chips, successful synchronization depends almost exclusively on the measurement of the synchronization sequences. FIG 4a shows the result of a standard correlation filter for primary synchronization channels (P-SCH), while FIG 4b shows the result of the improved filter in the PN scanner from Rohde&Schwarz. With the exception of the P-SCH cross-correlation, this filter suppresses all other spurious signals by approx. 10 dB more than the standard filter, and thus allows synchronization with a dynamic range improved by 10 dB.

When used with the optimized filter, the PN scanner from Rohde&Schwarz – in contrast to mobile phones, receivers based on mobile technology or other PN scanners – can also synchronize to pilot carriers of base stations that, although too weak for data transmission, still interfere with existing connections.

The primary purpose of a PN scanner is to detect spurious signals and synchronize to them. The R&S TS5K51C does this by using a method that has been refined compared to mobile receivers. UMTS mobiles tolerate pilot carriers that were incorrectly determined during synchronization because they are eliminated during the subsequent demod-

FIG 4a
Primary synchronization sequence filtered from a UMTS signal by means of a standard correlator.

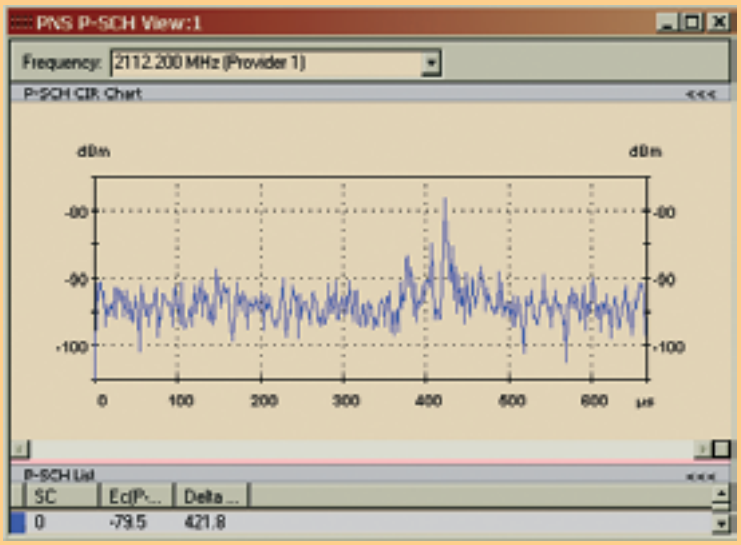
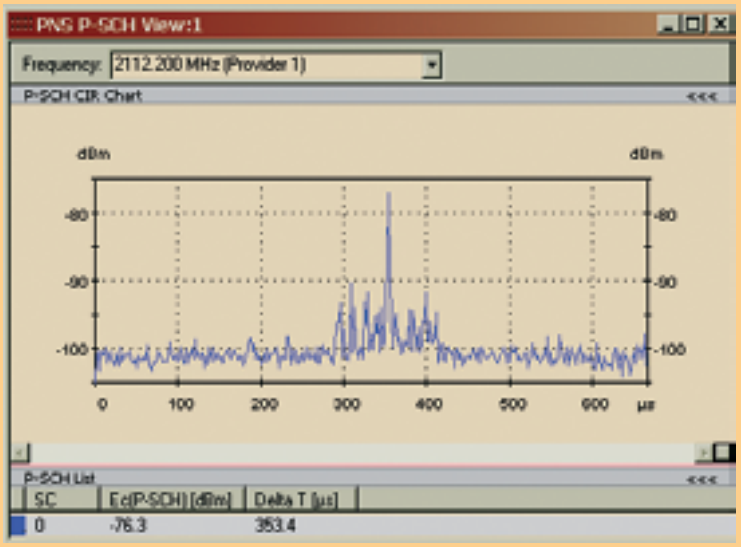


FIG 4b
The filter used in the PN scanner from Rohde&Schwarz yields a P-SCH correlation result that is improved by 10 dB.



ulation. Basically, weak or fluctuating spurious signals cannot be demodulated. The Rohde&Schwarz PN scanner modifies the measurements by analyzing several long pilot signal sections and taking into consideration Doppler effects. It thus attains higher correlation gain than a mobile. Correct synchronization is ensured; incorrect or missing codes (referred to as ghost codes) that occur during the first synchronization steps are, in contrast to competitor solutions, detected and eliminated.

Highly efficient rake receivers for measuring pilot carriers

The pilot carrier power (FIG 5) is measured by an innovative rake receiver with 2 × 2500 fingers that operate in parallel. Working independently of each other, these fingers dissect a measured composite signal from all relevant base stations to filter out pilot signals for the different receive paths. The fingers of the Rohde&Schwarz rake receiver exchange intermediate results when they generate scalar products, thus multiplying the efficiency of the entire receiver. The calculations required for reception are performed in the MMX unit of the Pentium processor, providing another speed advantage compared to typical DSP implementations as well as a good base for expanding and improving the PN scanner.

In addition to the path power of base stations, the frequency shift between receiver and transmitter and the timing of drift of the base stations in relation to the internal timebase are measured. The

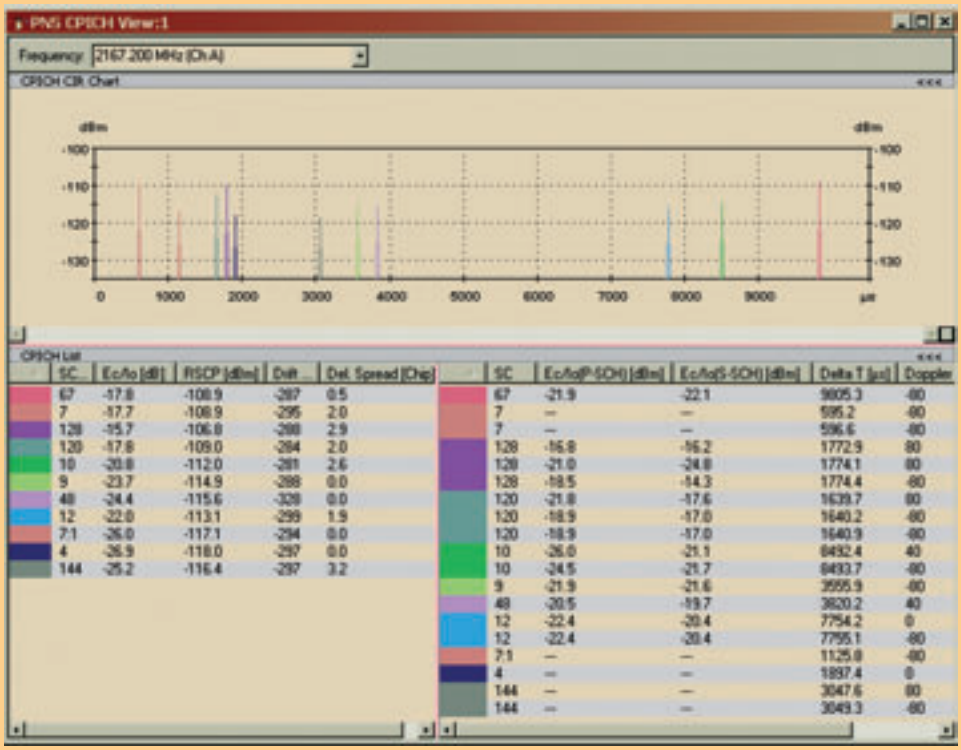


FIG 5 Simultaneously measured PN code power of 11 different base stations from 19 propagation paths in total. The difference in arrival time, Delta T [µs], of the UMTS frame limits of different signals is used, additionally to the scrambling code SC, to differentiate the base stations (in the FIG two different stations were received with scrambling code 7).

Advantages of the PN scanner

- Easy, time-saving and high-precision UMTS coverage measurements and network optimization
- Universal RF frontend, spectrum analyzer or test receiver
- No authorization, e.g. by SIM card, required for measuring
- Versatile indoor and outdoor applications
- Standard processor platform, PCs or notebooks with Windows® NT/2000/XP can be used
- Future-proof owing to modular control software R&S ROMES
- In addition to specific UMTS displays, informative displays for online analysis such as X/Y diagram, table, statistics, map display
- Universal test concept; combinable with test receivers for pure CW measurement tasks and with test mobiles for CDMA, GSM/GPRS
- Post Processing Tool R&S RODAS for processing individual, regional or nationwide measurement data from UMTS or other technologies

latter can be synchronized by means of the highly accurate timebase of the GPS satellites. Both measured values are key quality parameters of the UMTS base stations for mobile phone synchronization and handover. The Rohde&Schwarz PN scanner can monitor the base station timing also during network operation.

Spectrum analysis for uplink and downlink

Even a perfectly set-up UMTS network experiences a significant loss of quality if it is subjected to external interference. To detect such interference by means of the PN scanner, uplink and downlink spectra are measured, displayed and recorded in parallel to PN code measurements. The spectral power that changes over time is displayed in two-dimensional colour graphics (FIG 6); the frequency/time characteristic helps to narrow or directly determine the source of the displayed external interferers. Spectrum analysis is performed by means of the hardware-controlled analog narrowband filters in the spectrum analyzer. Compared to FFT-based digital methods, the analog method stands out for its increased dynamic range which is required for mobile measurements across several UMTS bands.

PN scanner configuration and applications

The UMTS PN scanner can be configured either as a cost-effective version with notebook or as a high-performance solution. The preferred system solution depends on the field of application.

The notebook version (FIG 1) is for flexible applications, e.g. when used in different vehicles or indoors. All system components can be used as standalone devices; magnetic antennas are employed, and power is supplied via 12 V DC from the test vehicle.

The high-performance system solution is designed as a turnkey solution for installation in a test vehicle. The sturdy and robust construction ensures reliable tests and measurements even under difficult environmental conditions.

The system can be configured either as a pure PN scanner or as a CW (level measurement, only R&S ESPI) and PN scanner. The R&S FSP/ESPI devices that are used as an RF frontend and spectrum analyzer in this application are top-quality, state-of-the-art products from the Rohde&Schwarz family of test instruments [1, 2].

Software platform R&S ROMES

The extremely versatile and powerful Measurement Software R&S ROMES [3], which is used for all coverage measurement systems from Rohde&Schwarz, is

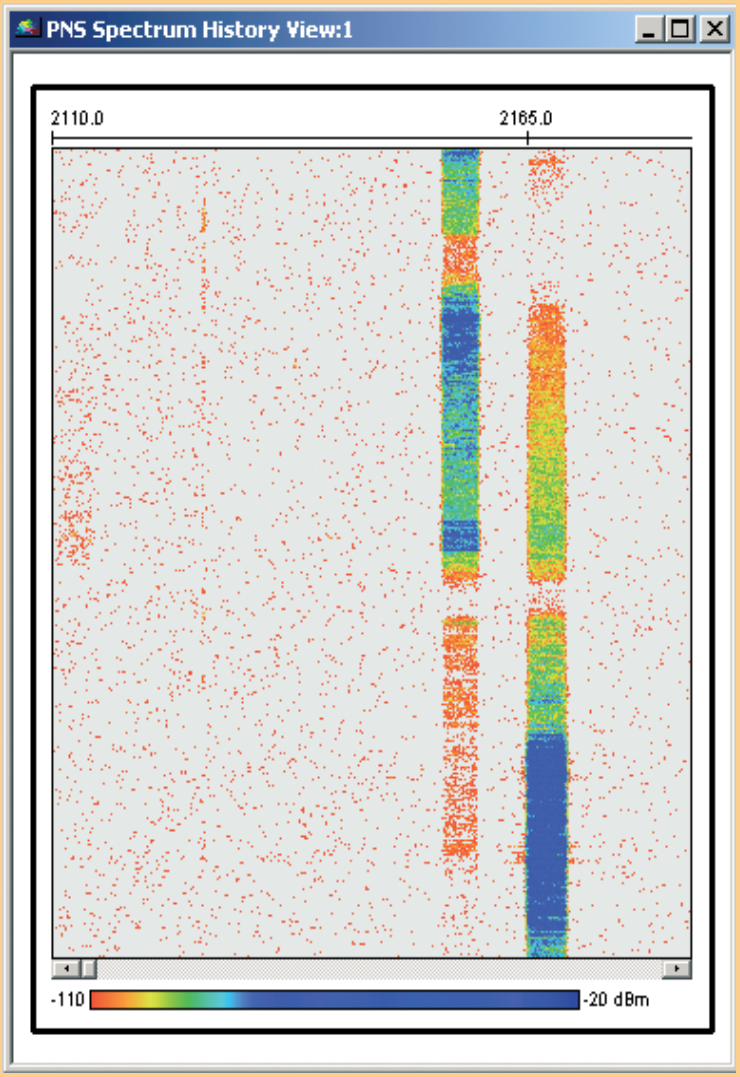


FIG 6
Time characteristic of the spectral power density in the UMTS downlink band. You can see three active UMTS channels and, top left, a transient CW interferer.

part of the PN scanner. It controls test receivers, GPS systems and UMTS test mobiles, and stores and analyzes measurement data. By providing Windows interface elements and techniques such as drag-and-drop, R&S ROMES allows user-friendly and intuitive operation. The software concept is modular, i.e. the software can be matched to the desired application by loading and configuring the appropriate device drivers. This is of particular importance when integrating different types of future UMTS test mobiles, but also for composite applications when different technologies such as GSM / GPRS, UMTS, IS-95, CDMA2000 etc are tested in parallel.

Summary

With the high-precision PN Scanner R&S TS5K51C, Rohde & Schwarz is setting new standards when it comes to analyzing UMTS spurious signals. Commercial as well as UMTS test mobiles from different manufacturers are adapted to determine Quality of Service (QoS). The PN scanner covers network planning, network setup, optimization, quality assurance and service for systems that have been optimized in function and size.

Johann Maier; Otmar Wanierke

Versatile and precise measurement functions

- Extremely fast measurements in high-speed mode (10 measurements/s)
- Extreme sensitivity up to –127 dBm in high-dynamic mode, –119 dBm in high-speed mode
- 2 × 2500 dynamic rake fingers for detecting any occurring UTMS signals
- High-speed synchronization to PN codes (24 ms per pilot)
- Measurement of multipath propagation (CIR View)
- Multichannel measurements (up to 12 channels per test tour)
- Display of UMTS frequency band and uplink and downlink spectrum with a dynamic range of 70 dB
- Spectrum history display for detecting external interferers and fading effects
- Automatic best server display mode (top 1 to top 32)
- Analysis of pilot pollution
- Power measurements in P-SCH (primary) and S-SCH (secondary synchronization channel)
- Measurement of the relative frequency error of base stations
- Root mean square (RMS) delay spread referenced to a chip
- Measurement of time drift of base stations referenced to GPS time
- Measurement of the Doppler frequency of individual paths
- Integrated GPS system with mapped measured values

Technical information at www.rohde-schwarz.com (search term: TS5K51C)

Technical information for R&S TS5K51C

REFERENCES

[1] Spectrum Analyzer R&S FSP – Medium class aspiring to high end. News from Rohde & Schwarz (2000) No. 166, pp 4–7

[2] PrecomplianceTest Receiver R&S ESPI: Multitalent in the development lab. News from Rohde & Schwarz (2001) No. 171, pp 33–38

[3] Coverage Measurement Software R&S ROMES3 – Acquisition, analysis and visualization of data in coverage measurements. News from Rohde & Schwarz (2000) No. 166, pp 29–32

Test Platform for Mobile Phone Production R&S TS 7180

Ready for mass production, incoming goods inspection and service

Compact design with a minimum of components is characteristic of modern mobile phones. Although this simplifies the scope of production tests, precise, fast and comprehensive RF measurements are still necessary. Moreover, with the launch of 3G there will also be mobile phones that support several mobile radio standards in one unit. This calls for a production test system such as the new R&S TS 7180 which meets all these requirements with a high degree of both economic viability and flexibility.

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FIG 1 R&S TS 7180 test system with R&S TS 7110 fixture.

Economical and flexible

As with the Cellular Phone Production Test Platform R&S TS 7100 [1] , the new R&S TS 7180 (FIG 1) is also designed for PCB tests, RF adjustment and final tests. Both test systems equally support the current mobile radio standards GSM / GPRS, TDMA (IS-136), AMPS, CDMA (IS-95), CDMA2000 and soon WCDMA and the *Bluetooth*™ radio standard* as well. Both systems provide almost the same basic functionality. The new test system uses as process controller a favourably priced industrial PC, whereas the R&S TS 7100 incorporates the PCI/CompactPCI Test System Versatile Platform TSVP. The comprehensive generic test software library (GTSL) from Rohde & Schwarz runs on both systems.

Owing to its economic viability and flexibility, the new test system is of interest to start-up companies in the mobile phone market as well as to contractual manufacturers, since they can test their

* *Bluetooth* is a registered trademark of Bluetooth SIG, Inc., USA and is licensed to Rohde & Schwarz.

products at relatively low investment costs. This is also an important factor for use in service centers and for incoming goods inspection at network operators. Handover tests from WCDMA to GSM or from CDMA2000 to IS-95 require only an R&S TS 7180 test system. Future mobile phones are likely to support several 3G technologies such as WCDMA and CDMA2000 in a single unit. The R&S TS 7180 has been designed to meet these requirements, too.

Used in combination with the new Shielded Fixture R&S TS 7110, all wireline RF tests, tests via antenna as well as voltage supply and acoustic tests can be performed by means of one and the same fixture. The mobile phones to be tested need be fitted with neither a battery nor a SIM card.

The R&S TS 7180 consists of the following standard components (FIG 2):

- Universal Radio Communication Tester R&S CMU 200
- Commercial PC with Windows® 2000
- GTSL running on TestStand test executive from National Instruments
- Dual-Channel Analyzer / Power Supply R&S NGM 02 or Keithley 2306

Future-proof Universal Radio Communication Tester R&S CMU 200

The Universal Radio Communication Tester R&S CMU 200 [2] performs all acoustic and RF tests (with and without signalling). Its modular design and expandability to cover future standards is a major asset since the R&S CMU 200 can be expanded to a multiprotocol tester by means of additional hardware or software options at any time. This currently applies to the GSM, GPRS, EDGE, CDMA (IS-95), AMPS, TDMA (IS-136), CDMA2000 and WCDMA standards. Its compact size of only four height units, low power loss, in-depth selftest capability and high reproducibility of results are crucial, particularly for use in production.

Intelligent fixture kit

The R&S TS 7110 is a flexible fixture kit that can be remote-controlled via a universal serial bus (USB) and modularly expanded from a simple shielded housing through to a complete final test fixture with built-in antenna, loudspeaker, microphone and pneumatics (FIG 2). The mobile phone is on a removable disk that can easily be replaced by another UUT. The pneumatic support considerably facilitates the handling of the shielding cover. The test fixture interface includes all required switchover facilities and amplifiers for testing the audio loops in the mobile phone. An RS-232-C level converter sets up the connection to the UUT. Additional spare relays allow expansions, e.g. test points for voltage measurements. Simple system expansions can thus be economically implemented in the fixture.

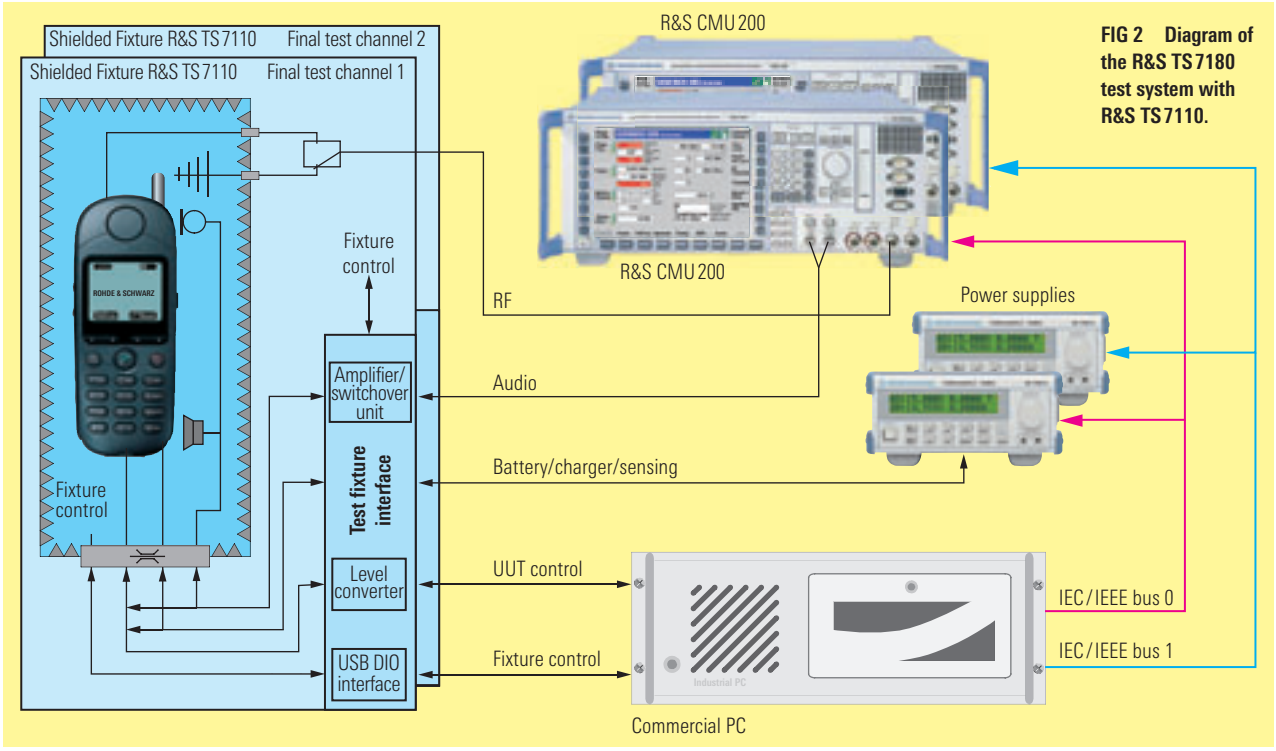


FIG 2 Diagram of the R&S TS 7180 test system with R&S TS 7110.

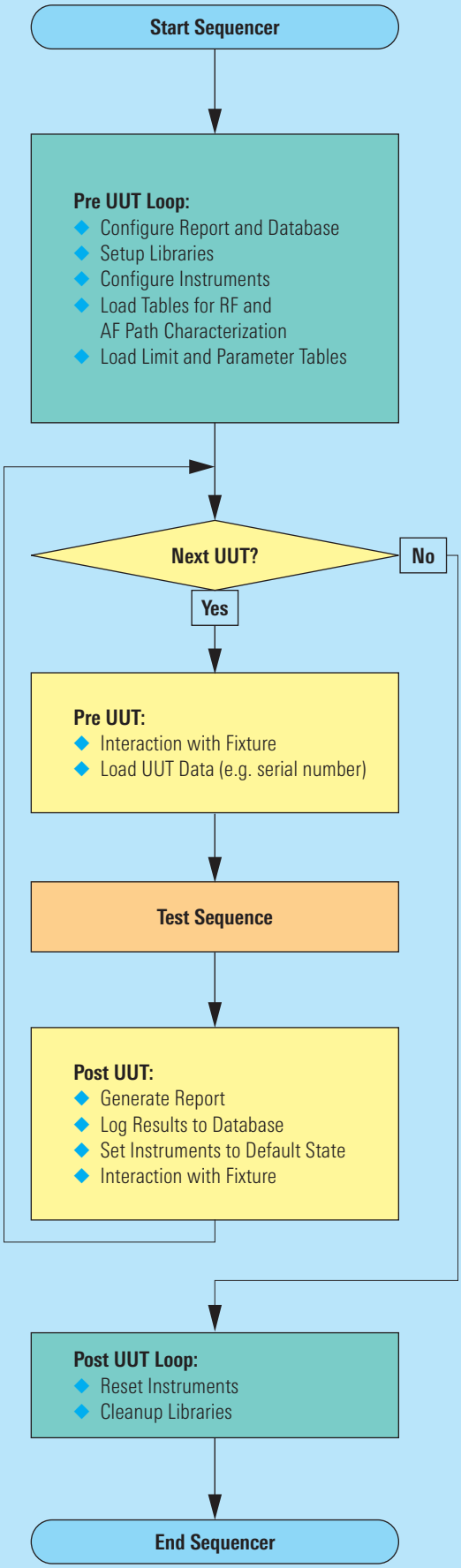


FIG 3 TestStand process model.

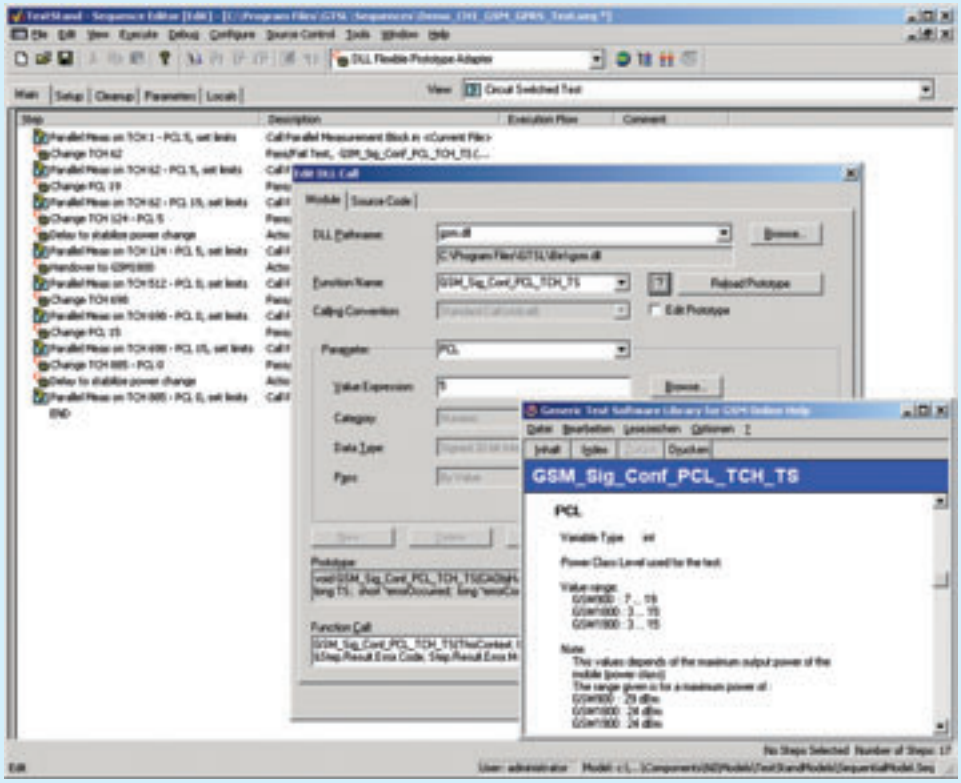
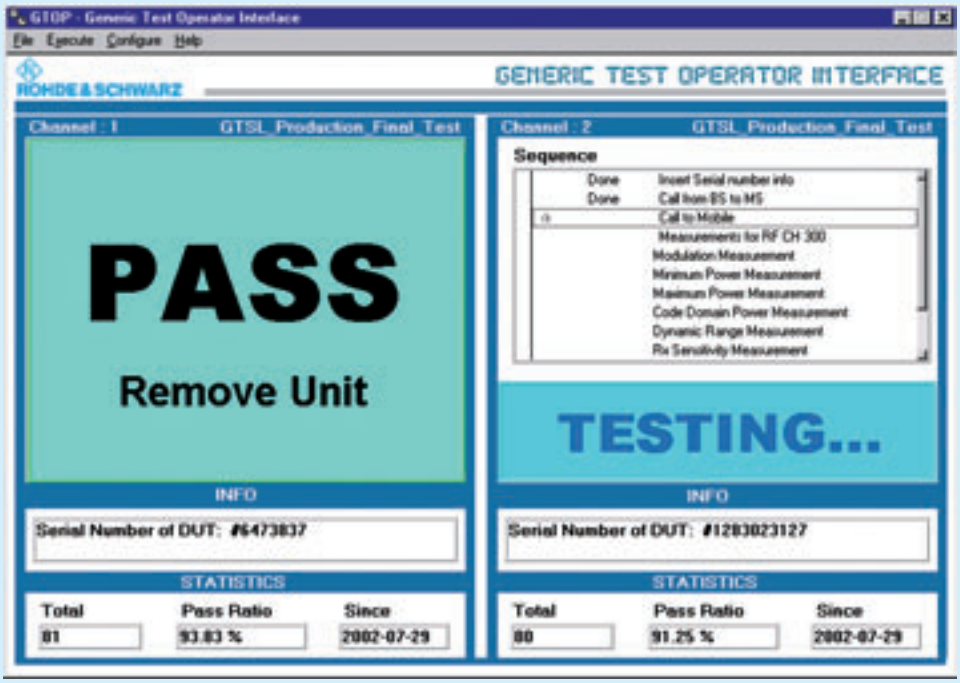


FIG 4 TestStand sequence editor.

FIG 5 Generic test operator interface.



Production-tailored

By means of the TestStand sequence editor, the individual setting and measurement functions of the GTSL are combined to form a complete test run so that a fully automatic test sequence can be implemented(FIG 4), including audio measurements as well as fixture and UUT control. No programming knowledge is required. Dual-channel operation is also possible, i.e. two UUTs with the same test sequence are tested simultaneously, independently of each other. A process model from TestStand, specially tailored to meet production requirements, considerably facilitates the additional integration of one-time instrument settings after the system has been started (FIG 3). Fixture control, serial number determination as well as report generation and database connection after each test sequence are similarly integrated.

Worldwide support

Rohde&Schwarz regional integration centers provide customer support worldwide. Experienced engineers help users with their individual system configuration, finding the optimum test strategy and integrating the system into the existing infrastructure. The portfolio also includes service and maintenance after installation and the training of the operating, service and maintenance personnel. Upon request, customized maintenance contracts are possible, taking into account user-specific requirements.

The new test system from Rohde&Schwarz with its support offers an all-in-one solution for mobile phone testing, enabling short start-up time, high production throughput, minimum test costs and comprehensive test coverage.

Manfred Gruber; Georg Steinhilber

More information and data sheet at www.rohde-schwarz.com (search term: TS7180)

REFERENCES
[1] Cellular Phone Production Test Platform R&S TS7100: Compact, flexible and ready to go for mass production. News from Rohde&Schwarz (2000) No.169, pp 4–7
[2] See article on page 21 in this issue.

Main features of the R&S TS7180 test system

- Low costs and therefore ideal for both mass production and service.
- Includes the R&S CMU200 which combines all established mobile-radio standards in one unit.
- Considerable simplification of R&S CMU200 programming by virtue of GTSL.
- GTSL software runs on desktop PCs as well as on R&S TS7180 or R&S TS7100.
- GTSL will be continuously expanded by new standards also in future. It currently supports GSM/GPRS, TDMA (IS-136), AMPS, CDMA (IS-95), CDMA2000, Bluetooth and soon WCDMA.
- Multiprotocol tests with UUT and test system.
- Library concept allows integration into any production test software.
- Libraries are user-expandable.
- Simultaneous asynchronous testing of two UUTs.
- Automatic consideration of the RF and AF path frequency response.
- Powerful development environment for the generation of test sequences (TestStand from National Instruments).
- Database interfaces and report generation.
- Executable sequences for final tests and system characterization.
- Easy-to-operate GTOP operator interface for fully automatic test sequences in production (FIG 5).
- Fixture concept which includes antenna tests and acoustic tests.
- Worldwide support with the help of our system support centers in Asia, Europe and the USA.

FIG 1 Cost-effective multicell system with a Universal Protocol Tester R&S CRTU-G and three R&S CRTU-S. 43913/6

GSM Protocol Testers R&S CRTU-G / CRTU-S

Multicell systems with up to four GSM cells

Rohde&Schwarz is continuously expanding its portfolio for GSM protocol analysis. Current developments include, for example, multicell systems that consist of up to four GSM Universal Protocol Testers R&S CRTU-G and simulate as many as four complete GSM cells for tests, and the Protocol Tester R&S CRTU-S (CRTU "small"), the "little brother" of the R&S CRTU-G.

More RF channels for complex protocol test scenarios

Launched last year, the GSM Universal Protocol Tester R&S CRTU-G [1] has positioned itself as a test platform that embraces new GSM technologies and expansions. It not only supports GSM, but also GPRS, EGPRS, AMR, LCS, as well as the new 850 MHz GSM frequency band that has recently been introduced in North America.

The two RF channels in the R&S CRTU-G, which can be configured independently of each other, allow the implementation of most 3GPP test cases on this tester. However, to simulate several rather complex scenarios, more physical RF channels are required: in the case of handover, for example, which involves a total of four radio channels, the mobile station has to be aware of two BCCHs and two TCHs simultaneously. Other examples are the GPRS test where three PBCCHs must be implemented, and the simulation of LCS scenarios where the position of the telephone is measured by means of three BCCHs.

Abbreviations: see page 16

Previously, these tests could only be run on the R&S CRTx-DUO [2] or the GSM Simulation System R&S TS 891x from Rohde & Schwarz. Now, the new multicell system is a cost-attractive alternative.

A multicell system includes an R&S CRTU-G, the master, which controls one or more slaves (R&S CRTU-G or R&S CRTU-S – see box below) without requiring any additional hardware or software options (FIG 1).

Connectors that can be used to synchronize the channels of the various units as to time are provided on the rear panels. A second TCP/IP link allows communication between master and slave and uses the network cards in the protocol testers. A common hub or, in the case of two standalone instruments, a joint crossed cable is enough to combine the testers into a system. A third link is for the 10 MHz reference signal, which is common to all instruments, to ensure exact phase and frequency accuracy. The RF link, finally, is implemented by means of the power splitters, which can be accessed via the front panels of the tester. Attenuation caused by RF cables and power splitters is automatically compensated for, ensuring maximum accuracy of the radio levels. Every R&S CRTU-G / -S comes with all the cables required for setting up a multicell system.

A new software utility, the Configuration Manager, is used to select the operating mode of the instrument (master or slave). The multicell system needs to be calibrated only for the first commissioning (calibration data is stored in the R&S CRTU-G /-S). It can easily be set up within a few minutes from individual testers and, if required, quickly disconnected. This ensures cost- and time-efficient use of the individual instruments.

The program library (Applics API) from the R&S CRTU-G fully supports application development for multicell systems. It is an easy-to-use tool for the further development of applications that were created for the previous R&S CRTx-DUO or R&S TS 89x systems. The versatile design of Applics API ensures that the test cases to 3GPP specification 51.010, provided by Rohde & Schwarz, can automatically detect the number of available channels and, if there are not enough channels, operate also at a lower number. Although the system in this case is not suitable for type approval, operation with fewer channels is still beneficial for developing GSM terminals.

Data Test Suite

Mobile radio terminals are developing toward higher data rates. After WAP, i.e. the implementation of a browser in a mobile phone, the new GPRS terminals are characterized by a bandwidth comparable to a fixed telephone line and by comprehensive functions such as client e-mail, browser, I mode, MMS, etc.

Data Test Suite (FIG 2) was conceived by British Analytek Ltd., a long-standing partner of Rohde & Schwarz. Data Test Suite helps to check the data trans-

New Protocol Tester R&S CRTU-S

Since not every application requires all functions of the Universal Protocol Tester R&S CRTU-G, Rohde & Schwarz offers the R&S CRTU-S, which features fewer functions than its "big brother" at a highly competitive price. What is the difference between the two?

Unlike the R&S CRTU-G, the R&S CRTU-S cannot be used as a standalone unit for protocol testing and does not have any development tools (C++ compiler, message composer, etc). Its primary application is as a slave unit in multicell systems, thus considerably reducing the costs for a system with four or more physical channels.

Without incurring any additional costs, the R&S CRTU-S features all GPRS functions, all available frequency bands and some test scenarios, such as data transmission via GPRS from an FTP server, for example. A call setup including a loopback of the audio signal with AMR codec is also possible to measure sound quality in combination with an Audio Analyzer R&S UPL 16 from Rohde & Schwarz.

Moreover, the R&S CRTU-S can be used in the RF Test System R&S TS 8950 G [3] from Rohde & Schwarz if an instrument with two RF channels and limited signalling is required to perform RF conformance tests.

The R&S CRTU-S is also ideal for use in combination with Data Test Suite, a software package for testing the application layer in mobile radio terminals.

mission functions of GSM and GPRS mobile phones in a controlled, reproducible radio network environment. Data Test Suite is a Windows® application based on a state machine and is used to simulate the mobile radio network. The package includes a web server and a WAP server, both of which run directly on the R&S CRTU-G. The telephone is connected to the tester via an RF cable, allowing the generation of a series of scenarios such as an I mode or WAP session, with a CHTML or WML page being downloaded from the server via the R&S CRTU-G and the telephone. Depending on the mobile phone, the pages are shown either on the display or on a PC connected to the telephone.

Data services RLP (NTDS) and GPRS are available, and soon HSCSD and TDS protocols will be supported as well.

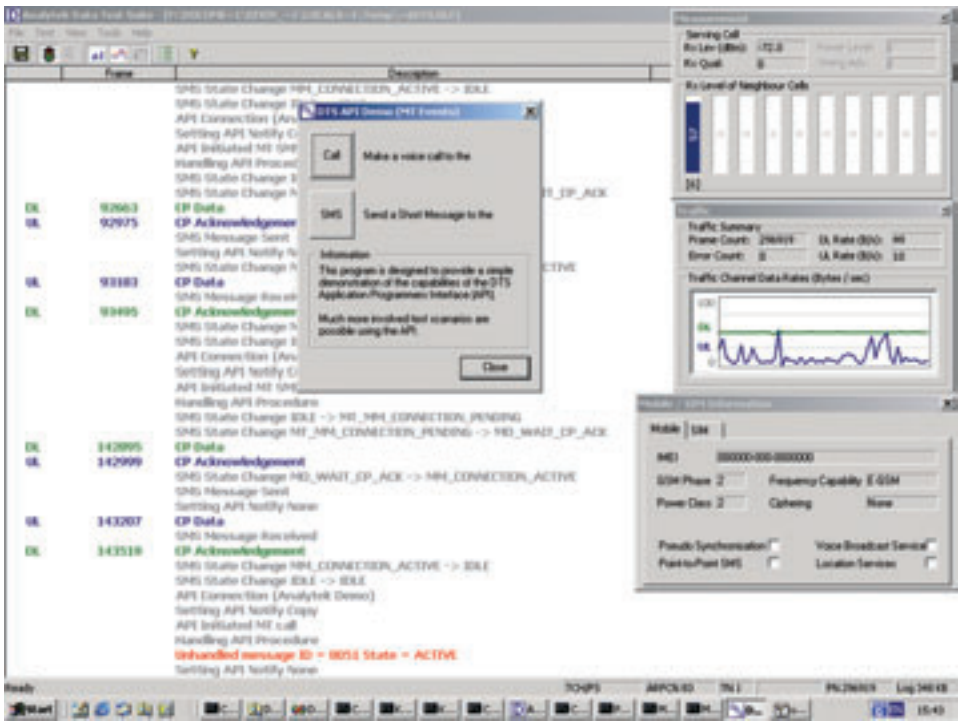
A program library for Data Test Suite, which can be obtained separately, permits the development of test scripts. This yields two considerable benefits: full automation of test scenarios and the generation of events coming from the network (e.g. data query via telephone, SMS, etc). A wide variety of scenarios can thus be created in a reproducible environment to economically test the behaviour of applications in GSM / GPRS terminals under different network conditions.

Reiner Götz; Roberto Pagano

Abbreviations

3GPP	3rd Generation Partnership Project
AMR	Adaptive multirate
BCCH	Broadcast channel
CHTML	Compact hypertext markup language
GPRS	General packet radio service
EGPRS	Enhanced GPRS
HSCSD	High-speed circuit-switched data
I-mode	GPRS-like method in Japan
LCS	Location services
PBCCH	Packet broadcast control channel
RLP	Radio link protocol
TCH	Traffic channel
TDS	Transparent data services
MMS	Multimedia message service
NTDS	Non-transparent data services
WAP	Wireless application protocol
WML	Wireless markup language

FIG 2 Data Test Suite for testing the data transmission functionality of GSM and GPRS mobile phones.



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

Data sheet R&S CRTU-G

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[1] GSM Protocol Analyzer R&S CRTU-G – Changing of the guard: after more than 10 years, a new GSM reference system. News from Rohde & Schwarz (2001) No. 171, pp 4–8

[2] Digital Radiocommunication Test Set R&S CRTx-DUO – Test platform for HSCSD and multicarrier applications. News from Rohde & Schwarz (1999) No. 161, pp 13–14

[3] RF Test Systems R&S TS 8950G / TS 8955G: Reliable RF testing of GSM, GPRS and EDGE mobile phones. News from Rohde & Schwarz (2002) No. 174, pp 4–7

FIG 1 Universal Radio Communication Tester R&S CMU 300.

Universal Radio Communication Tester R&S CMU 300

WCDMA generator for tests on 3GPP base station receivers

The new options R&S CMU-B76 und R&S CMU-K76 add WCDMA generator functions to the R&S CMU 300 (FIG 1), thus making it ideal not only for receiver measurements on GSM/EDGE base stations, but also for unprecedented receiver measurements on 3GPP base stations.

Options at a glance

The R&S CMU 300 [1] is the world's first instrument to support all reference measurement channels (RMC) defined in the 3GPP specification TS 25.141 [2] up to a data rate of 2 Mbit/s. The WCDMA options (FIG 2) provide all key functions for production tests. The major innovations are the following:

- Support of data rates up to 2 Mbit/s
- Signal generation in realtime with a test data length up to PRBS16 for continuous receiver measurements
- Near-realtime response to changing RF parameters, preventing long power-off phases and allowing high-speed measurements
- Compact tester with GSM, GPRS, EDGE and WCDMA standards in a single instrument

FIG 2 New options for the R&S CMU 300.

Model/option	Designation	Functions
R&S CMU 300	Basic unit	
R&S CMU-B76	Hardware option WCDMA layer 1 board	Layer 1 board for receiver measurements on 3GPP base stations
R&S CMU-K76	Software option; WCDMA transmitter for R&S CMU 300	Software for receiver measurements on 3GPP base stations
R&S CMU-U76	Hardware upgrade; WCDMA generator for R&S CMU 300	Includes WCDMA Layer 1 Board R&S CMU-B76 and Power Supply R&S SN 250

Abbreviations: see page 20

Sensitivity measurements on base station receivers

WCDMA generators are used to test receivers in base stations (Node B) as well as their modules (FIG 3). The bit error rate (BER) of the signal generated by the R&S CMU300 can be measured in the base station, in the connected radio network controller (RNC) or via an external analyzer.

For BER measurements, the analyzer must be synchronized to the received signals. Particularly for reference measurement channels, the transmitter must emit them in a defined format at a specific time transmission interval (TTI) at the physical layer. For this purpose, the R&S CMU300 provides the frame trigger input. After the WCDMA generator is started, the requested channel is transmitted once the frame trigger (10 / 20 / 40 / 80 ms) has been received.

The base station receiver synchronizes to the RF signal of the R&S CMU300 and then calculates the BER from the deviation of the received signal from the expected PRBS. In 3GPP base station production, the BER can be measured without connection setup, thus keeping loss of time to a minimum.

Functions and operating modes

The generator parameters defined in the 3GPP specification TS25.141 ensure standardized measurements. The WCDMA generator of the R&S CMU300 supports all data rates defined for the reference measurement channels, i.e. 12.2 / 64 / 144 / 384 / 2048 kbit/s (FIG 4).

If one of these RMCs is selected, essential parameters for BER measurement such as coding, slot format or time transmission interval are defined. Moreover, the user can also set customized channel combinations. In addition to the RMC mode, the new WCDMA generator supports the physical channel mode (FIG 5). In this case, the generator creates one dedicated physical control channel (DPCCH) and up to six data channels (DPDCH). The associated data rates can be flexibly selected in the range 1×15 kbit/s to 6×960 kbit/s.

The test data is applied either to the reference measurement channels at the transport channel layer or directly to the physical channels (FIG 6). Pseudo-random bit sequences PRBS9 / 11 /15 and 16 as well as fixed data (00000…, 11111…, 010101…) are available as test data.

The signal power in particular can be set in almost any manner designed for BER measurements. The user is able to set the total power as well as the power

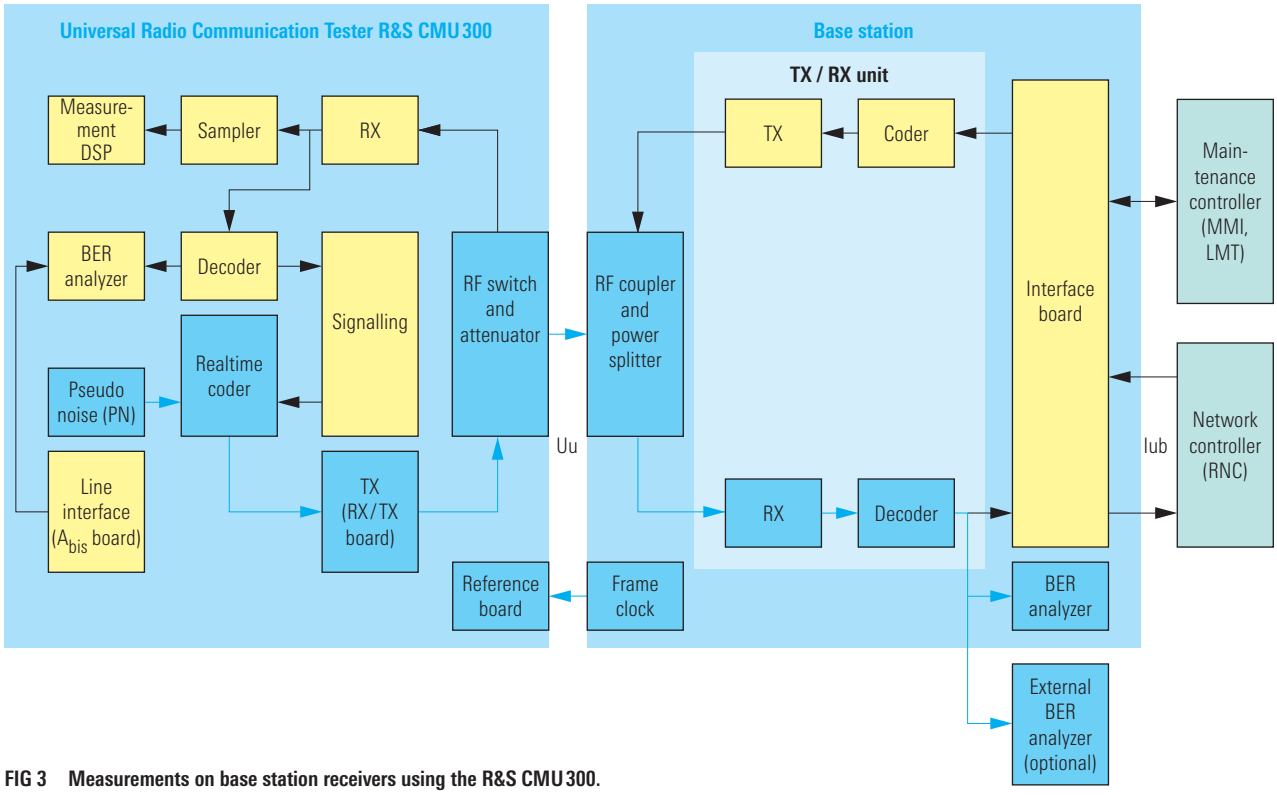


FIG 3 Measurements on base station receivers using the R&S CMU300.

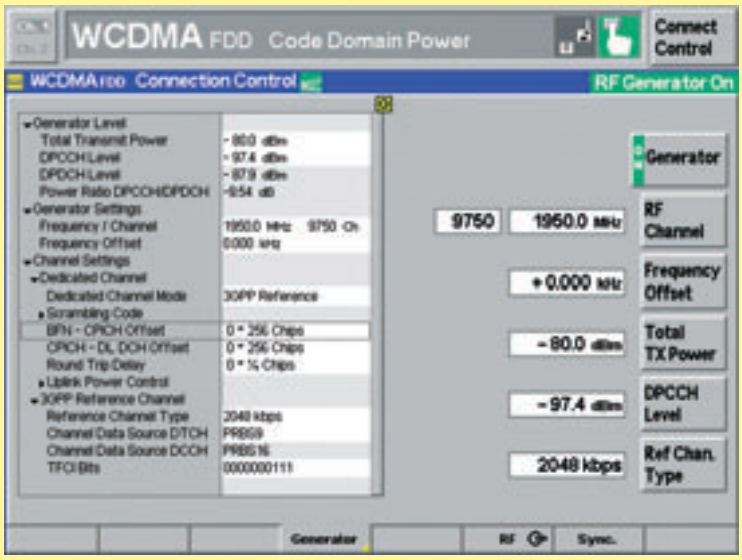


FIG 4 Generator menu of the R&S CMU300 in the reference channel mode with selected 2 Mbit/s channel.

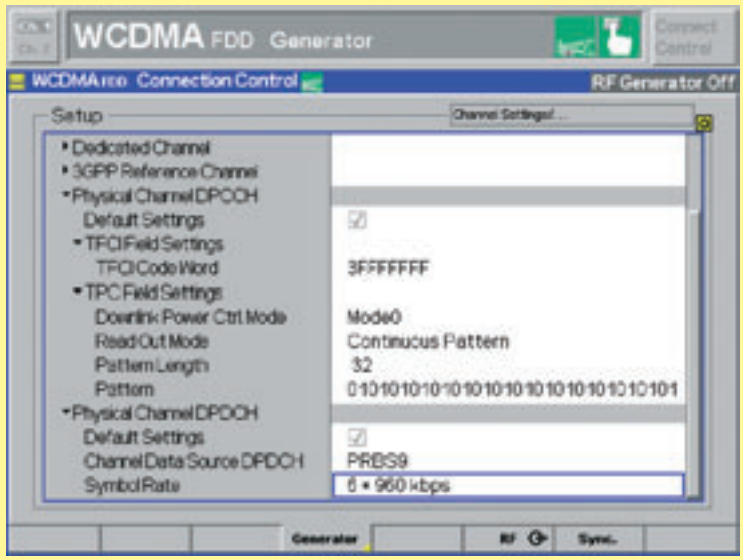


FIG 5 Generator setup menu of the R&S CMU300 with set physical channel mode.

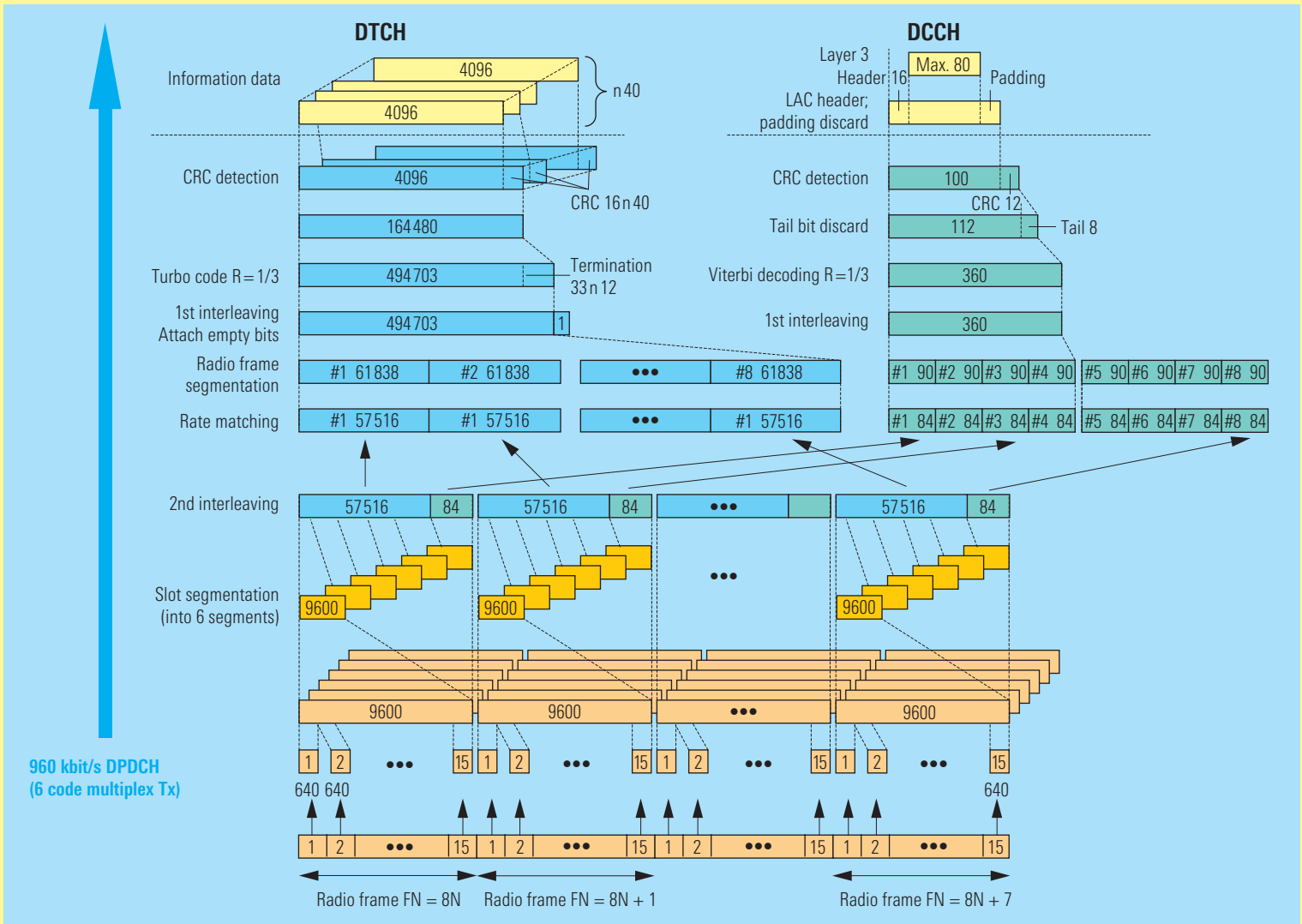


FIG 6 Example of 3GPP uplink channel coding using a reference measurement channel with 2048 kbit/s (1 × DPCCH and 6 × DPDCH).

of the control channel and the power ratio of the DPCCH and the DPDCH. The R&S CMU300 offers a wide variety of further settings which by far exceed the RMCs defined by 3GPP.

At the physical layer, the TFCI code word and the TPC bit pattern can be varied. If channel coding has been activated, the generator calculates the TFCI code word with the associated TFCI bits. These settings allow the control of a base station receiver via the uplink signal. The base station receiver receives the TPC bits and controls the power according to the selected downlink power control mode.

At the transmitter end, the R&S CMU300 supports power control modes 1 and 2.

In mode 1, the transmit power of the generator changes in every alternating slot, increasing or decreasing by 1 dB or 2 dB. In mode 2, transmit power is constant.

Future functions

In addition to the above WCDMA generator functions for BER measurements, WCDMA transmitter measurements on 3GPP base stations are currently being developed for the R&S CMU300.

Choosing the R&S CMU300 base station tester is a sure decision in favour of a compact radio communication tester that embraces tomorrow's applications.

Anne Stephan; Karsten Friedrich

Main abbreviations

3GPP	3rd Generation Partnership Project
BER	Bit error rate
BTS	Base transmitter station (base station)
CRC	Cyclic redundancy checksum
DCCH	Dedicated control channel
DPCCH	Dedicated physical control channel
DPDCH	Dedicated physical data channel
DSP	Digital signal processor
DTCH	Dedicated transport channel
LAC	Location area code
Iub	3GPP interface between base station and RNC
LMT	Local maintenance terminal
MMI	Man-machine interface
Node B	3GPP definition for BTS
PN	Pseudo noise
PRBS	Pseudo random bit sequence
RMC	Reference measurement channels
RNC	Radio network controller
RX	Receiver of a base station
TFCI	Transport block combination identifier
TPC	Transmitter power control
TTI	Time transmission interval
TX	Transmitter of a base station
Uu	Interface between R&S CMU300 and base station

More information and data sheet at www.rohde-schwarz.com (search term: CMU300)

Data sheet R&S CMU300

REFERENCES
[1] Universal Radio Communication Tester R&S CMU300: RF tests on base stations – comprehensive, fast and accurate. News from Rohde&Schwarz (2001) No. 170, pp 4–6
[2] 3GPP specifications: www.3gpp.org.

Condensed data of the WCDMA options for R&S CMU300

Standard	3GPP FDD
Symbol rate	3.84 MHz
Trigger input	sub-D connector AUX 3, pin 6, TTL level
Recommended trigger signals	physical channel mode: 10 ms frame trigger reference channel mode: TTI trigger (20 ms, 40 ms, 80 ms)
Physical channels	15 / 30 / 60 / 120 / 480 / 1×960 / 2×960 / 3×960 kbit/s, 4×960 / 5×960 / 6×960 kbit/s
Power ratio DPCCH	15/15, 14/15, 13/15, 12/15, 11/15, 10/15, 9/15, 8/15,
DPDCH	7/15, 6/15, 5/15, 4/15, 3/15, 2/15, 1/15, DPDCH off
Reference measurement channels	12.2 / 64 / 144 / 384 / 2048 kbit/s (to 3GPP TS 25.141)

Receiver measurements on GPRS and EGPRS mobile phones

What UMTS holds for the future is already materializing in GSM networks: high-speed data transmission. This is made possible with the 2.5G standards GPRS and EGPRS. While EGPRS mobile phones are still in the development stage, GPRS mobiles are already on the market. The new 2.5G standards mean new measurement challenges for manufacturers of mobile phones. For example, new approaches have to be taken in receiver measurements. The Universal Radio Communication Tester R&S CMU 200 from Rohde & Schwarz provides full receiver test capability not only for GPRS, but now for EGPRS mobile phones as well.

See page 25 of this issue for another contribution on the R&S CMU 200.

GPRS/EGPRS packet-based data links

In packet-based data transmission, an entire physical path will not generally be established between the communicating terminals throughout the time of communication. Rather, a link is set up only when data is actually transmitted. First, the base station agrees with the mobile phone on the timeslot(s) of the RF channel to be used for data exchange. A total of eight timeslots is available. The number of timeslots used depends on the multislot class of the mobile and on the base station loading. In addition, the mobile is assigned an uplink state flag (USF). The USF flag, which is transmitted by the base station in the downlink (DL), determines whether or not the mobile may send data in one of the corresponding uplink (UL) timeslots. Up to seven mobiles can in this way share a timeslot. Each time a mobile decodes its USF in a data block in a downlink timeslot, it may – and should – send a data block in the corresponding uplink timeslot in the subsequent radio link control (RLC) block frame if the mobile was assigned this uplink timeslot beforehand (FIG 1). If, at a given instance, the mobile has no user data to send in the uplink timeslot, it sends a dummy block instead. This addressing mode is known as dynamic allocation. However, if the mobile is assigned several uplink timeslots, this mode has the disadvantage that, for each uplink data block to be sent, the mobile first has to decode a downlink data block. The capabilities of today's mobiles, featuring only one synthesizer for the uplink and the downlink, are thus stretched to their limits, i.e. mobiles can handle no more than two uplink timeslots. For this reason, the extended dynamic allocation mode was introduced. With this addressing mode, the first valid USF flag received by the mobile is also valid for all uplink timeslots in the current RLC block frame (FIG 2). The addressing mode to be used in a packet-based data link is determined by the base station.

Receiver measurements with packet-based data links

Standardization bodies have defined the block error rate (BLER) as the relevant quantity for receiver measurements with packet-based data links. In GPRS or EGPRS systems, the mobile requests all errored data blocks received to be retransmitted. The BLER is the ratio of errored data blocks received (i.e. data blocks to be retransmitted) to the total number of data blocks transmitted. But the BLER is not the only receiver quantity of interest.

There is, for example, the USF BLER. What does this quantity stand for? A mobile may send a data block in the uplink only if it has received a valid USF in the downlink. However, if the mobile does not correctly decode the USF, it will not send a data block in the corresponding uplink timeslot. The USF BLER designates the ratio of the number of incorrectly decoded USF flags to the total number of USF flags transmitted (FIG 3).

BLER and USF BLER measurements are mandatory for conformance testing of GPRS and EGPRS mobiles. BLER measurements are problematic in production, however, since they are time-consuming and, by their very nature, may stop, so that measurement time is not reliably

predictable [1]. Bit error rate (BER) measurements are, therefore, the much more viable alternative for production. BER measurements require a pseudo random data stream. They can be implemented by means of the GPRS test mode B defined by the standardization bodies. In this test mode, the mobile returns the data block received, so that the transmitted data stream can be compared with the received data stream and the BER determined. Unfortunately, standardization bodies originally only had transmitter measurements in mind when working out test mode B, and had not specified exactly what kind of data a mobile should return in response to an errored data block. Most of the mobiles presently available return dummy RLC blocks instead of the data received. This does not allow BER measurements, however. Test mode B was therefore modified by standardization bodies so that it can be used for BER measurements.

One more test mode was defined for EGPRS mobiles: EGPRS switched radio block loopback mode (frequently also referred to as test mode C). In this mode, channel coding is omitted, leaving more data bits for BER measurement (comparable to burst-by-burst BER measurement in circuit-switched links). Mobiles capable of 8PSK EDGE modulation both in the uplink and the downlink return exactly as many data bits as they have received (FIG 4). By contrast, mobiles capable of handling 8PSK EDGE modulation only in the downlink and using GMSK modulation in the uplink are able to return only one third of the data bits received. To solve this problem, test equipment is allowed to transmit data blocks to such a mobile in every third RLC block frame only. The mobile will then return the data in three consecutive RLC block frames (FIG 5).

Reduced signalling cuts down on test time

In mobile phone production every millisecond of test time counts. Manufacturers therefore make every effort to reduce test time. A substantial reduction of measurement time can be achieved by omitting signalling sequences. These are irrelevant in production, as they are software based and therefore need not be tested on every mobile. Many mobile phone manufacturers have for this reason replaced GSM signalling sequences by proprietary mobile phone interfaces and commands, and expect their mobile radio test system to be capable of handling such reduced sequences [2].

GPRS and EGPRS receiver measurements with R&S CMU 200

The Universal Radio Communication Tester R&S CMU 200 performs all relevant receiver measurements on GPRS and EGPRS mobile phones, offering outstanding user convenience. For example, BLER is output separately for each timeslot and as a total value over all timeslots used. The total data transmission rate achieved is also output (FIG 6). In test mode A, which is actually intended for transmitter tests only, the R&S CMU 200 in addition determines the USF BLER. This is of interest especially for GPRS mobiles that only support test mode A. In test mode B, the R&S CMU 200 calculates the BER as well as the USF BLER and the D(data)BLER (FIG 7). The DBLER is a calculated block error rate, which comes very close to the actual BLER [1]. The DBLER can be determined even if the mobile, in test mode B, only returns a dummy RLC block in response to an errored data block. The tester supports test modes A and B for GPRS also with reduced signalling sequences, thus cutting down on measurement time.

For the figures shown opposite, the following should be noted: The frames comprising timeslots 0 to 7 are RLC block frames and should not be confused with GSM frames. Several GSM frames, i.e. several transmit bursts in a given timeslot, are needed to transmit one RLC data block.

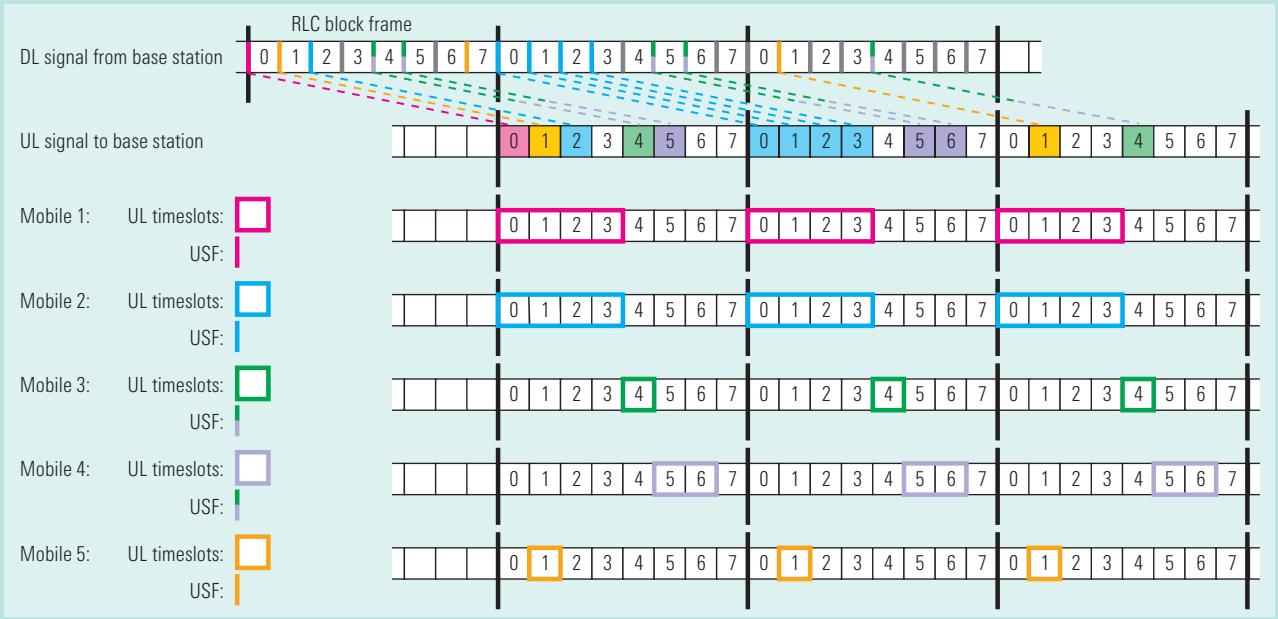
FIG 1
Packet-based data transmission with dynamic allocation. On link setup, the base station agrees with the mobile on the timeslot(s) in which the mobile may send data and assigns a USF flag to the mobile. Several mobiles can be assigned identical timeslots and different USF flags (mobiles 1, 2 and 5 in this example) or identical USF flags and different timeslots (mobiles 3 and 4 in this example). The USF flags transmitted by the base station in the downlink are marked by different colours. The mobile receives the different USF flags. It will send a data packet each time it recognizes its own USF flag if the corresponding uplink timeslot is assigned to the mobile.

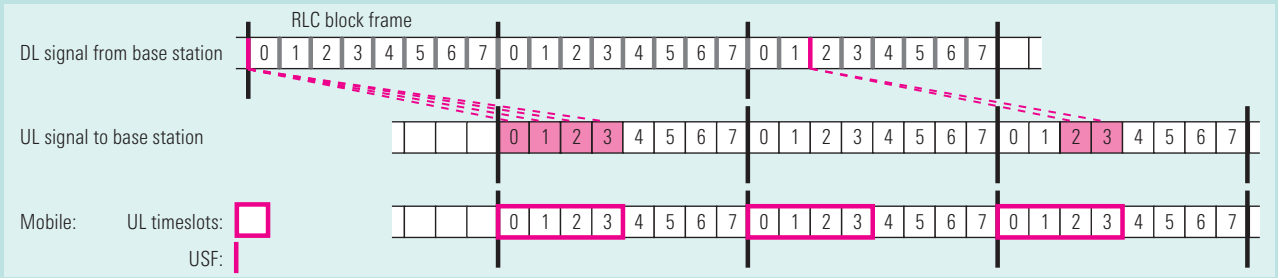
FIG 2
Packet-based data transmission with extended dynamic allocation. This mode functions the same as dynamic allocation. It differs from dynamic allocation only in that the first valid USF flag received is also valid for all following uplink timeslots assigned to the mobile in the current RLC block frame.

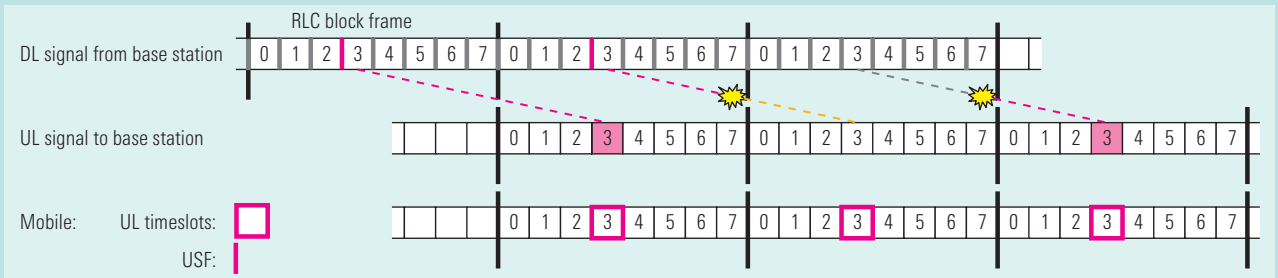
FIG 3
USF BLER: If a mobile decodes a USF flag incorrectly, it will not transmit a data packet in the corresponding uplink RLC timeslot. The USF BLER is the ratio of incorrectly decoded USF flags to the total number of USF flags transmitted. It is also possible that the mobile decodes a USF flag assigned to another mobile as its own flag. In such a case, the mobile would send a data packet in a wrong timeslot. This type of error, which is also measured, is frequently referred to as negative USF BLER.

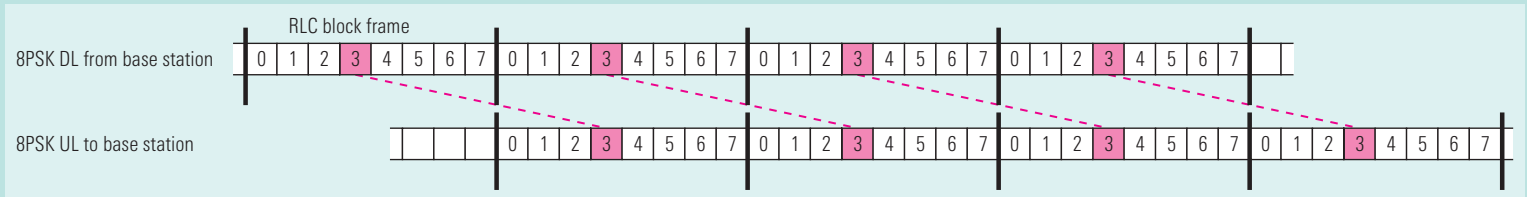
FIG 4
In the symmetrical EGPRS switched radio block loopback mode, the mobile returns to the measuring instrument exactly as many data blocks (without channel coding) as it has received.

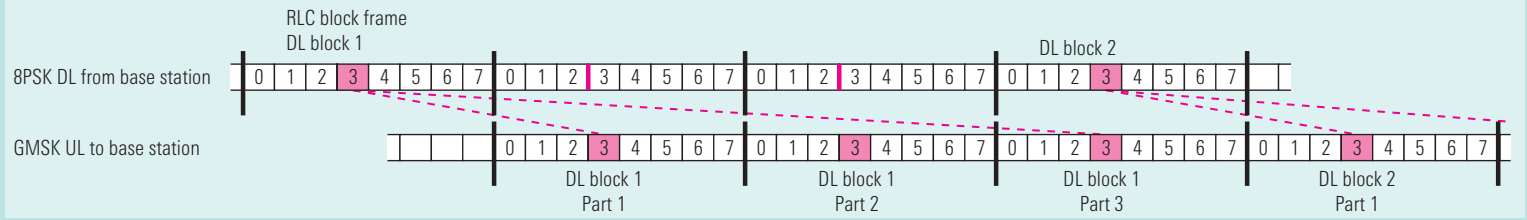
FIG 5
In the nonsymmetrical EGPRS switched radio block loopback mode, the mobile receives three times as many data bits as it can return. For this reason, the measuring instrument is allowed to transmit a valid data block to the mobile only in every third RLC block frame. The mobile returns the data block in three consecutive RLC block frames.


RLC block frame
DL signal from base station
UL signal to base station
Mobile 1: UL timeslots:
USF:
Mobile 2: UL timeslots:
USF:
Mobile 3: UL timeslots:
USF:
Mobile 4: UL timeslots:
USF:
Mobile 5: UL timeslots:
USF:


RLC block frame
DL signal from base station
UL signal to base station
Mobile: UL timeslots:
USF:


RLC block frame
DL signal from base station
UL signal to base station
Mobile: UL timeslots:
USF:


RLC block frame
8PSK DL from base station
8PSK UL to base station


RLC block frame
DL block 1
DL block 2
8PSK DL from base station
GMSK UL to base station
DL block 1 Part 1
DL block 1 Part 2
DL block 1 Part 3
DL block 2 Part 1

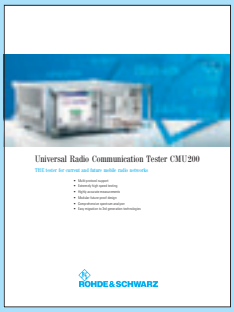
The R&S CMU 200 is also the first mobile radio tester to support test modes A and B for EGPRS as well as the EGPRS test mode with reduced signalling. It can handle EGPRS tests both for symmetrical (8PSK in the uplink and the downlink) and nonsymmetrical configurations (8PSK in the downlink and GMSK in the uplink). The EGPRS BLER measurement is already implemented in the Rohde & Schwarz development lab and will soon be available on the market.

Summary

Due to its innovative hardware and software concept, the R&S CMU 200 over the past few years has not only maintained but even enhanced its position as the top-ranking product on the mobile radio market. Its transmitter and receiver test functionalities are unrivalled especially with regard to the radiocommunication standard of the future – EGPRS. The Universal Radio Communication Tester R&S CMU 200 has thus become indispensable in the development labs of EGPRS mobile phone manufacturers.

Rudolf Schindlmeier

More information and data sheet at www.rohde-schwarz.com (search term: CMU 200)



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[2] Universal Radio Communication Tester R&S CMU 200 – Speeded-up test of GSM mobiles without signalling. News from Rohde & Schwarz (2000) No. 168, pp 16–17

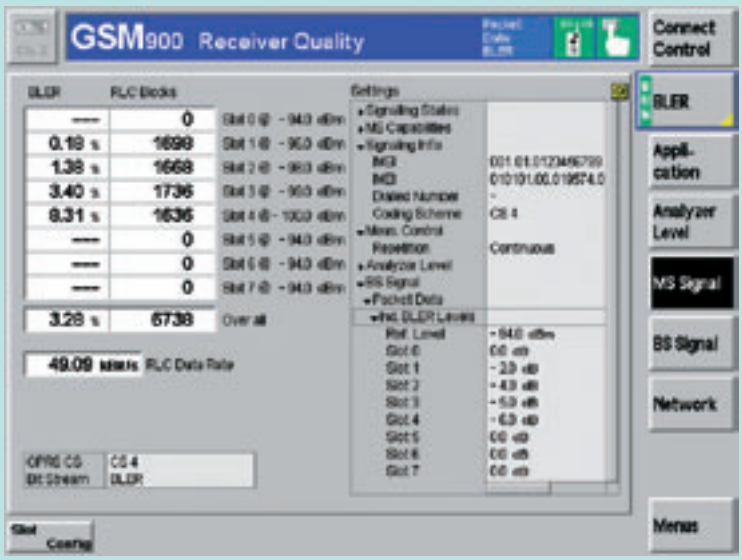


FIG 6 In BLER measurements, the R&S CMU 200 not only determines the total BLER but also the BLER for each timeslot. In conjunction with the tester's capability of transmitting different RF levels in different timeslots, this function enables a quick overview of a mobile's receiver sensitivity. The R&S CMU 200 also determines the achieved data transmission rate.

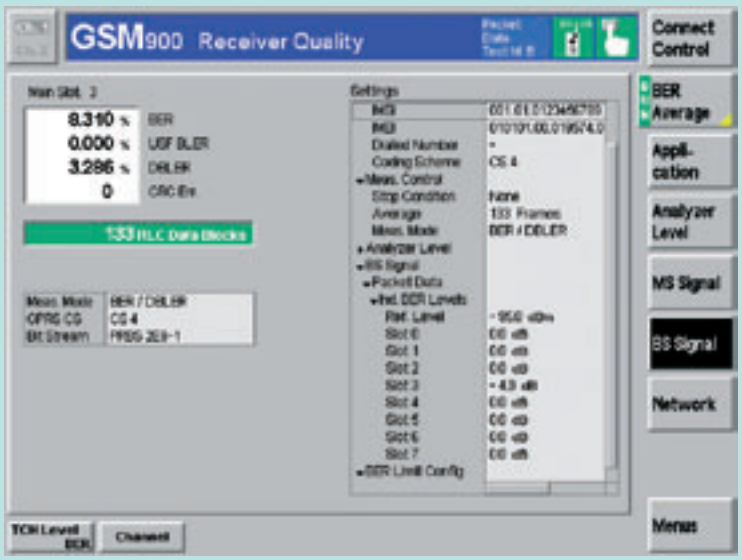


FIG 7 BER measurements are the appropriate choice in mobile phone production. The R&S CMU 200 determines BER as well as USF BLER and DBLER.

Speech coder for CDMA2000 audio measurements

The quality of a mobile phone is defined above all by its acoustic characteristics. When the audio signal is tested, the radio communication tester must be fitted with a speech coder. Due to the high complexity of the mobile radio standards cdmaOne and CDMA2000, no speech coder had been provided in a test set before now; the audio section of CDMA mobile phones was usually tested in the analog AMPS standard. Fitted with the new speech coder option, the R&S CMU 200 is the first mobile radio test set capable of performing audio tests on CDMA mobile radios.

Market gap filled

Radio communication testers for digital-standard mobile phones primarily test their RF parameters, for example waveform quality (rho factor) and frequency error. The decisive factor for the acoustic quality of a mobile phone, however, is the audio signal. To verify the audio signal quality, a speech coder is required in the radio communication tester converting analog audio signals into digital signals, which are transmitted to the mobile phone after channel coding; plus, a speech decoder is needed to reconvert the digital signals coming from the receive direction into audio signals. While speech coders for GSM and TDMA (TIA / EIA-IS-136) for mobile radio testers have been on the market for some time, none was available for cdmaOne (TIA/EIA-95) and CDMA2000 (TIA / EIA-IS-2000). The R&S CMU 200 is now filling an important market gap.

The R&S CMU 200 currently supports the 8k speech coder (TIA / EIA / IS-96-B) as well as the 8k enhanced speech coder (TIA / EIA / IS-127, enhanced variable rate codec EVRC), i.e. service options 1 and 3. The 13k speech coder (TIA / EIA / IS-733), i.e. service option 17, will soon be available as well.

More information and data sheet at www.rohde-schwarz.com (search term: CMU 200)

REFERENCES
[*] Audio Analyzer R&S UPL – Measuring the acoustic characteristics of 3G mobile phones. News from Rohde & Schwarz (2002) No. 173, pp 15–17

Speech coding: methods

Human speech can be described by means of a source filter model, which is based on the assumption that speech is generated in response to a time-variable filter with specific signals. Voiced sounds (vowels) can be modelled via a periodic pulse sequence, unvoiced sounds (consonants) via noise. The time-variable filter usually includes a formant synthesis filter or linear predictive coding (LPC) synthesis filter and a pitch synthesis filter.

For speech coding, there are two basic methods, analysis and synthesis (AaS) and analysis by synthesis (AbS). Analysis and synthesis are separate in the AaS method. The encoder extracts a parameter set which corresponds to the source filter model and transmits it to the decoder, which in turn reconstructs speech from the parameters received.

A better approach is the AbS method, for which the encoder provides a local synthesizer. A trial and error procedure determines the optimum parameters. This ensures good speech quality – even at lower data rates. The code excited linear predictive (CELP) algorithm is one procedure based on this method. A special feature of the QCELP (Qualcomm CELP) algorithm is its dynamic adaptation of the data rate, depending on signal energy, background noise and speech characteristics. The average data rate can thus be significantly decreased without impairing the speech quality.

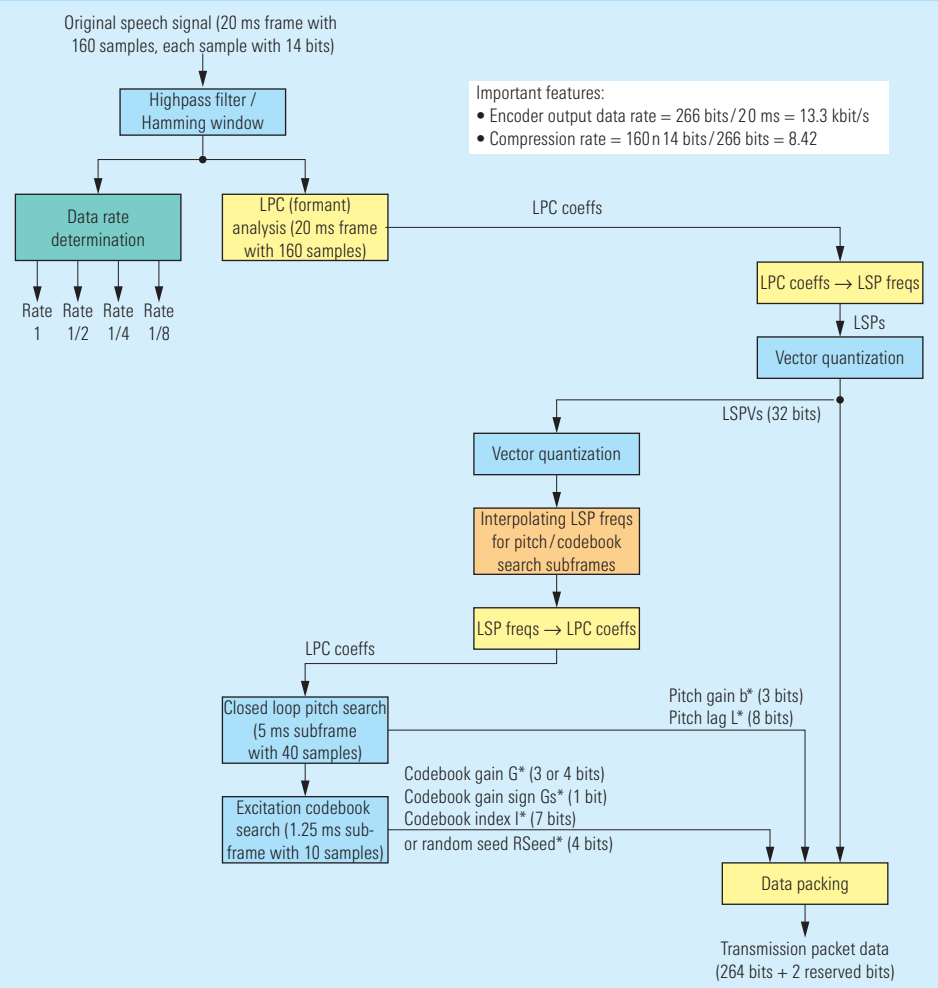


FIG 1 Coding process with LPC (formant) analysis, data rate determination, pitch search and codebook search by example of the 13k speech coder.

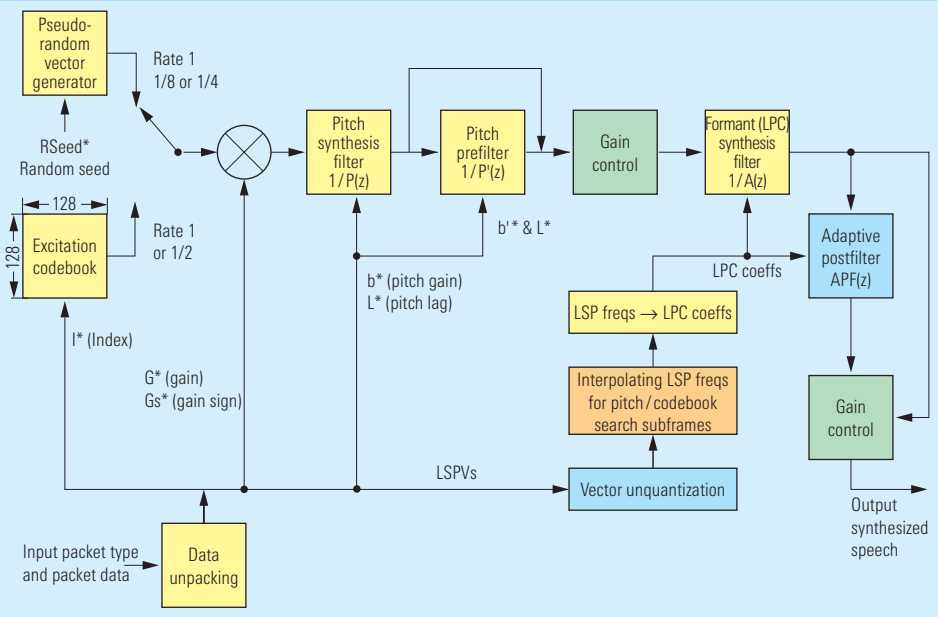


FIG 2 Generation of the synthesized speech signal by filtering the codebook vector by means of the pitch synthesis filter and the formant synthesis filter.

Speech coding: several steps

Coding is performed roughly in four steps (FIG 1):

- LPC (formant) analysis
- Data rate determination
- Pitch search (also referred to as long-term predictor, LTP)
- Codebook search

In a first step, the LPC (formant) is analyzed to find the optimum filter coefficients. A formant is a resonance frequency of the human vocal tract, discernible by a peak in the short-term spectrum. Each frame of the input signal (which is divided into 20 ms frames) first passes through a highpass and a Hamming window filter.

In a second step, the data rate is determined for each frame. Background noise and pauses are transmitted at 1/8 rate, unvoiced sounds at 1/4 rate, stationary, periodic and well-modelled frames at 1/2 rate; frames with speech transitions, non-periodic frames and frames that are poorly modelled are transmitted at full rate.

The third step is the pitch search. A pitch is the fundamental frequency of periodic signal sections in the human voice. The pitch search is based on subframes.

By means of the parameters thus determined, the vector, which best describes the input signal and thus minimizes the weighted error between input signal and synthesized signal, is selected from a codebook in the final stage.

Once these parameters (LPC filter and pitch filter coefficients, codebook vector) are transmitted, the synthesized speech signal is produced by filtering the codebook vector by means of the pitch synthesis filter and the formant synthesis filter (FIG 2).

Everything under control with the R&S CMU 200

The R&S CMU 200 allows user-friendly configuration of all parameters that are relevant to setting up a speech connection (FIG 3), particularly the service option and the associated radio configurations (RC).

The new speech coder option provides a wide variety of applications. With the appropriate setup, the R&S CMU 200 internal audio signal generator, for example, is able to generate a test signal for the forward link (base station to mobile phone) and the reverse link (mobile phone to base station) and evaluate the resulting audio signal by means of the AF analyzer (FIG 4). However, CDMA speech coders are not ideally suited for transmitting individual audio tones, but rather more complex signals that simulate a speech signal. For this purpose, the Audio Analyzer R&S UPL [*] can be connected to the R&S CMU 200, for example.

The new speech coder also allows testing of data transmission applications that operate with an analog modem. This is a common implementation, for example in automotive engineering, to set up emergency call systems.

Thomas Rösner; Peter Sterly

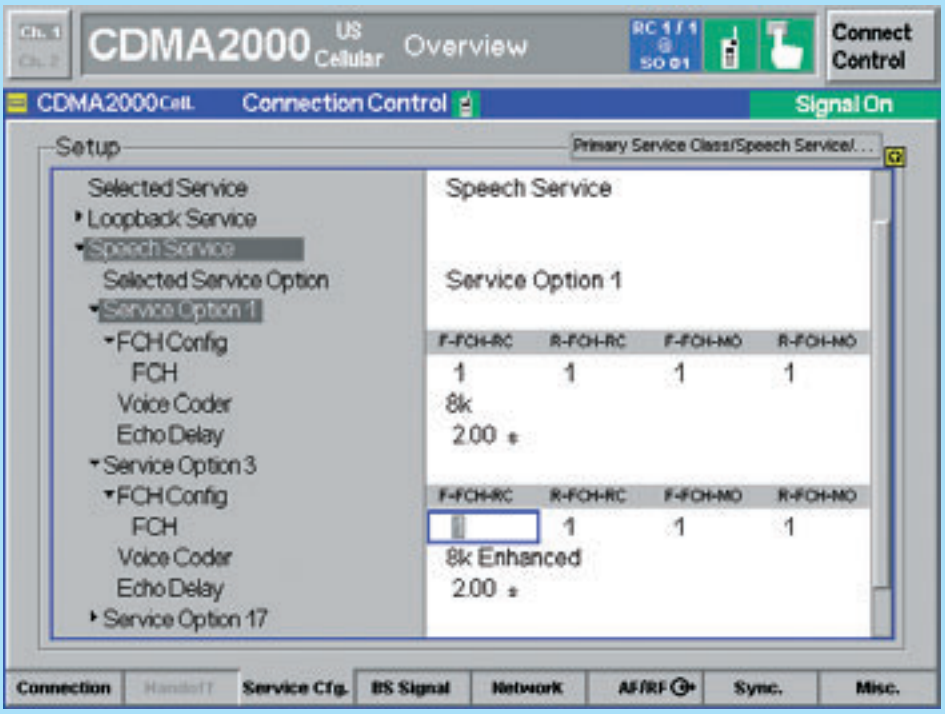


FIG 3 User-friendly configuration of all relevant base station, network and connection parameters in the R&S CMU 200.

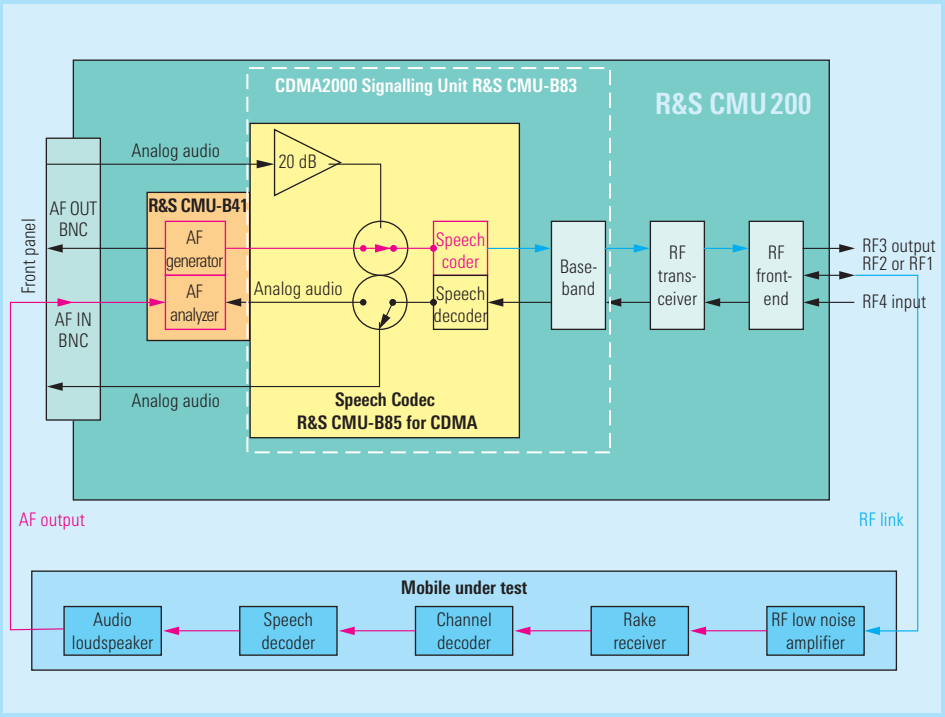
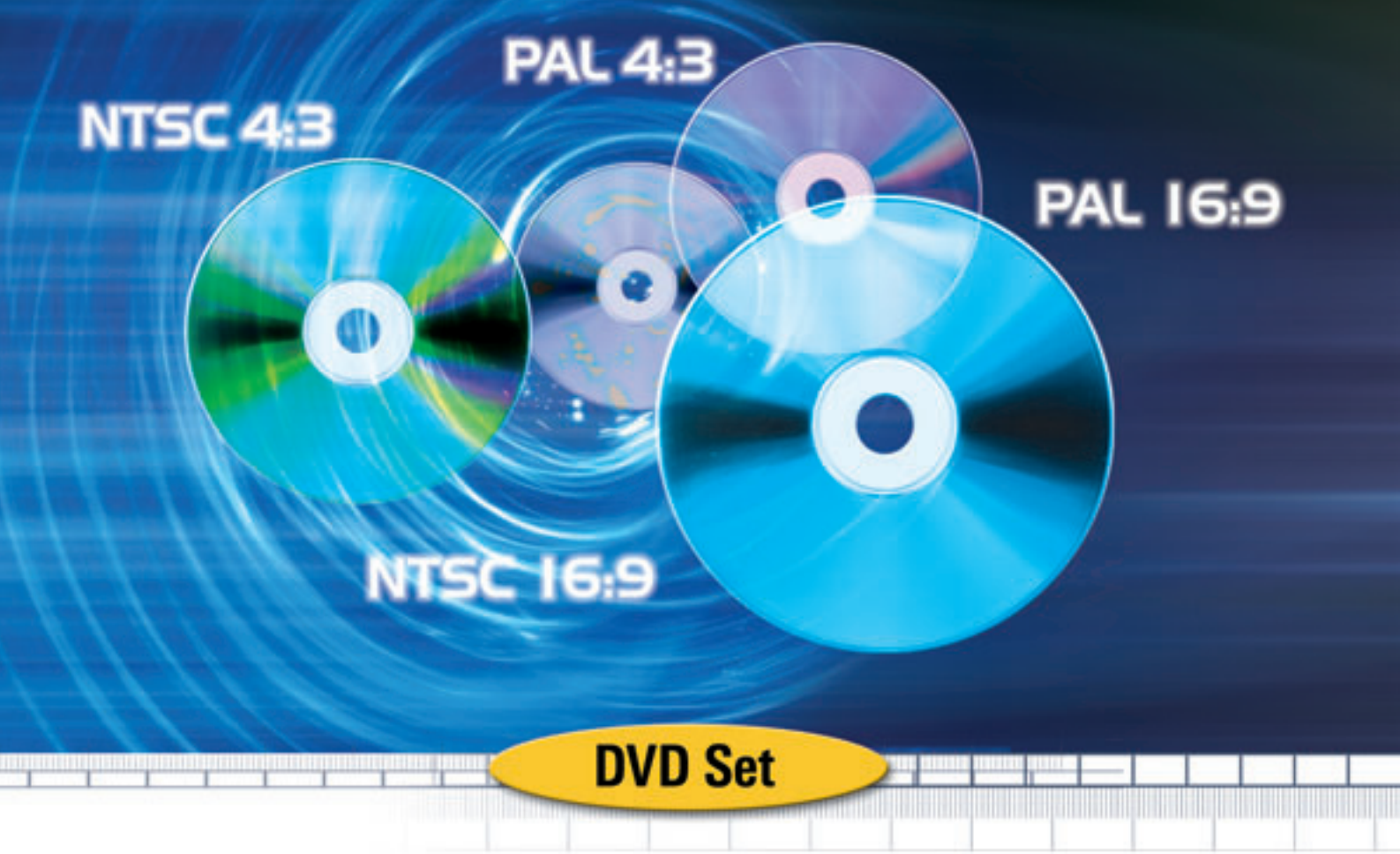


FIG 4 The block diagram shows the versatile tests that are possible with the R&S CMU-B85 speech coder in combination with an external audio analyzer (e.g. the R&S UPL) or the internal R&S CMU-B41 audio option.



The test DVDs come as a compendium of several DVDs with professional test patterns and test data streams for audio, video and EMC applications relating to DVD players. These include measurements of video and audio quality, automatic error correction tests, reliability and laser tests, as well as test patterns for subjective quality assessment. Used in conjunction with audio and video analyzers or EMC test systems from Rohde&Schwarz, the DVDs also enable fully automatic quality measurement and analysis of DVD equipment.

Professional Test DVDs

Video and audio test signals for professional applications

Test signals of utmost quality

In many cases, measurement quality is determined to a considerable extent by the scope and quality of the test signals used. The DVD compendium – jointly created by Rohde&Schwarz and BUROSCH – offers a unique compilation of many different video and audio test signals for professional applications including:

- Precompliance measurements on video and audio equipment
- Objective measurement and assessment of video and audio signals used in DVD equipment, for example by means of video and audio analyzers from Rohde&Schwarz
- Subjective quality tests of video and audio equipment
- Type approval tests in accordance with international standards, e.g. using EMS Test System R&S TS 9980, to determine electromagnetic susceptibility of sound and TV broadcast receivers as well as satellite and DVB receivers

Particular importance was attached to the digital test sequences meeting exacting quality standards. Offering a choice of suitable picture structures and audio frequencies, the test sequences allow standard-conforming measurements of maximum quality as well as the subjective assessment of audio and video equipment.

The compendium, which comes in two separate versions for PAL and NTSC, comprises three albums for different

types of tests. Album 1 contains over 100 different test patterns as well as video and audio sequences on a video DVD for picture quality assessment, including EMS measurements. Album 2 contains a video DVD and an audio DVD supplying stereo and multichannel test sequences for audio quality assessment. Album 3 comprises two DVDs with data streams for testing the reliability of systems containing DVD components, including automatic error correction tests and endurance tests of DVD equipment.


DVD 1

Measuring the signal and video quality

Automatic video quality measurements

DVD players often feature a wide variety of video outputs. Many players not only offer CCVS signal outputs to PAL or NTSC, but also RGB and YCbCr component signal outputs as well as a YC S-video signal output. In addition, video signals can be output with 525 or 625 lines and with aspect ratio 4:3 or 16:9. Reliable quality assessment for such a wealth of signals calls for professional video test equipment, for example Video Measurement System R&S VSA or Video Analyzer R&S UAF from Rohde&Schwarz (FIG 1). Test DVD 1 delivers all the necessary signals with the levels and timing conforming to the standards. Main measurements include:

- Level
- Linear and nonlinear distortions
- Chrominance/luminance delays
- Levels and delays of components relative to one another
- S/N ratio
- Timing

Utmost care was taken to avoid any artefacts being generated in signal coding, and thus avoid any impairments to measurement quality. The most important signals are combined in test patterns, allowing a wide variety of measurements to be performed in just a few seconds without any tedious switchovers being required on the DVD player (see Codec 43 test pattern in box on page 31). This enables extensive testing of video and audio signal outputs even during short production cycles. Plus, comprehensive measurement series carried out for comparing different products can be speeded up considerably. No extra time is required for configuring the Rohde&Schwarz video analyzers. In addition to the main test sig-

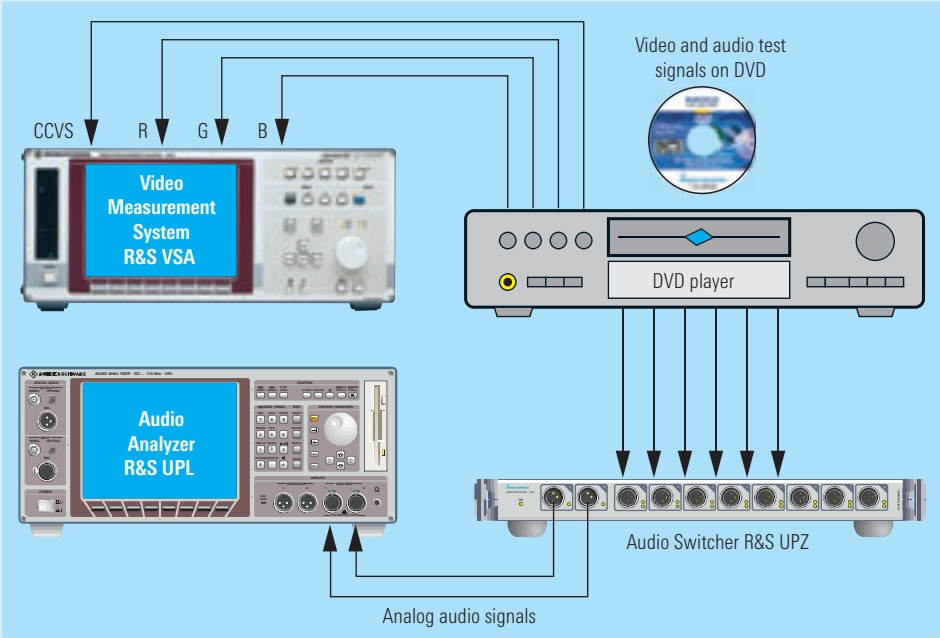


FIG 1 Test setup for automatic measurements of video and audio data streams.

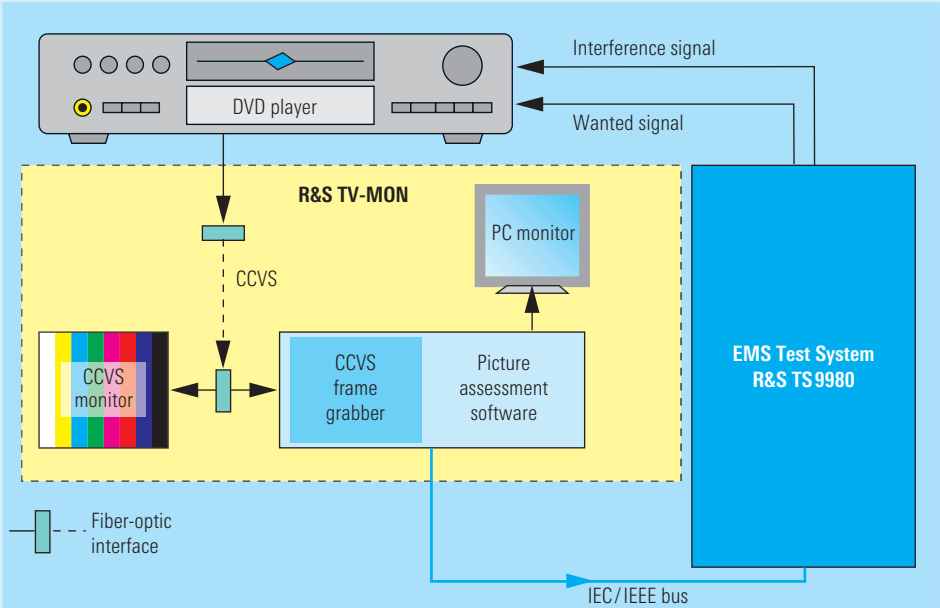


FIG 2 Configuration of EMS Test System R&S TS9980 with R&S TV-MON option for automatic picture assessment during EMS measurements.

nals, the Codec test pattern comprises moving elements that provide information on whether the correct TV standard was set on the DVD player, or whether decoding errors occur. Moreover, a 30 s CCITT O.33 audio sequence is added to the test pattern, thus allowing important audio measurements to be carried out along with the video measurements in a single test cycle.

Most of the video sequences also contain audio signals ranging from 997 Hz reference signals and pink noise up to AC-3 test signals for simultaneous and complete assessment of audio and video streams.

EMS measurements with automatic picture assessment

The video DVD (DVD 1) contains a special menu supporting EMS measurements, e.g. by means of Test System R&S TS 9980 (FIG 2). For equipment under test (EUT) without an integrated monitor, the optional R&S TV-MON system extension enables direct assessment of the CCVS signal, i.e. the detection of analog and digital picture degradations such as moiré patterns, contrast degradation, sync loss or blocking. The test sequence for objective and automatic picture assessment is based on the ITU-R BT.801-1 colour bar test pattern, into which a moving element is introduced so that data stream interruptions can be identified.

Subjective picture quality assessment

The test patterns not only allow the automatic evaluation of data streams but also subjective video quality assessment. This is supported by numerous video sequences including:

- Sequences containing elements with rotating or back-and-forth motion for the assessment of smearing effects on monitors, TFT displays, plasma tubes or projectors as contrasted with conventional TV picture tubes
- Special video test data streams such as zone-plate signals that support the visual assessment of artefacts generated in scaling conversion
- Portraits of persons against different backgrounds for assessment of contrast and skin colour reproduction
- Video streams representing landscapes, e.g. a forest, to test the MPEG decoder performance

The video test sequences are available for the 4:3 and 16:9 aspect ratios.

DVD 2/3

Automatic measurements of audio signals

To meet the different requirements of the video and audio DVD standards, the audio test data streams are provided both on a video and an audio DVD (DVDs 2/3). The audio DVD standard allows audio test signals to be stored loss-free. In line with this standard, the audio DVD (DVD 3) contains PCM coded audio files in different formats (e.g. 192 kHz/24 bit stereo and 48 kHz/24 bit 5.1 multichannel). These files are also available on the video DVD (DVD 2) in 48 kHz/16 bit and 96 kHz/24 bit stereo format; in addition, the video DVD contains encoded test files in Dolby Digital and DTS 5.1 format.

The audio signals on the two DVDs allow the exact determination of multichannel frequency response as well as the accurate measurement of S/N ratios and distortions. In addition, numerous test sequences are available for the control of discrete channels, for example to test downmix functions or loudspeaker parameters set in the decoder.

The DVDs contain pulse code modulated (PCM) test signals with various sampling rates as well as coded audio signals (Dolby Digital, DTS). These signals allow the full range of audio parameters to be tested, including frequency response, distortion, S/N ratio, linearity, crosstalk, etc. For many of these measurements, setups or macros are available on the Audio Analyzer R&S UPL for the performance of automatic test sequences.

DVD 4

Testing error correction capacity

DVD 4 (video) has been specially compiled for testing the laser characteristics and the error correction capacity. The various error correction parameter values can be accurately determined by introducing picture degradation and steadily increasing it. The error correction capacity can also be assessed visually.

Where test series are to be performed for a large number of EUTs, it is advisable to use the Digital Video Quality Analyzer R&S DVQ, which is connected to the EUT via a converter that transforms the analog RGB component signals to digital signals to ITU-601. The R&S DVQ automatically logs picture degradations together with the time of their occurrence, so eliminating the need for continuous picture monitoring.

DVD 5

Reliability tests

Apart from user-friendly operation and high video and audio quality, long-term reliability is the most important quality requirement to be met by DVD players. Visual monitoring of video sequences carried out during quality inspection only yields sample results; it does not provide coherent results that would allow complete quality assessment over several hours. DVD 5 (video), therefore, delivers a continuous test signal by which picture degradations (e.g. picture freeze or picture loss) can be automatically detected by means of the Digital Video Quality Analyzer R&S DVQ. Reliabil-

ity tests can thus be implemented that allow DVD players to be tested to their limits of performance, for example by putting EUTs through temperature cycles at the same time.

Summary

The test DVD compendium is a comprehensive compilation of test patterns, video data streams and audio signals for professional quality assessment of the audio and video data streams of DVD equipment. Particularly noteworthy is the fact that, besides supplying a variety of professional test signals, the compilation for the first time offers a test DVD to the DVD audio standard.

The R&S Professional Test DVDs are available separately for the PAL and NTSC systems.

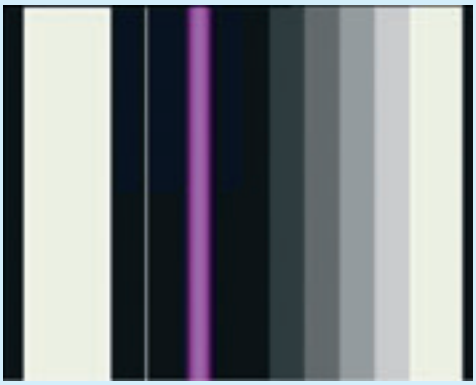
Regional code 0 ensures that the test signals can be used on a variety of DVD systems regardless of their regional code number.

The DVD compendium is provided by Rohde&Schwarz and BUROSCH with support from the audiovision T&M journal and the TESTfactory test lab of the Video T&M journal.

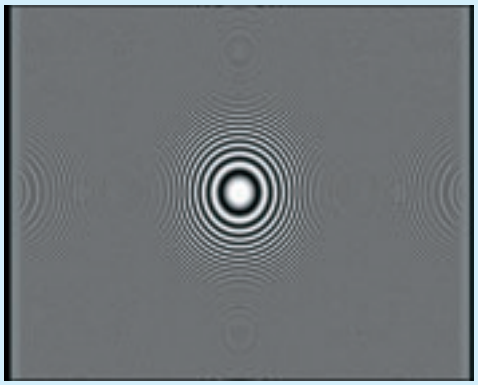
Gert Heuer

Descriptions of the data streams can be downloaded from the Internet address www.testdvd.rohde-schwarz.com from November 2002. For more information, refer to the address www.professional-dvd.de. Information on the instruments and test systems mentioned in this article is available at the Rohde&Schwarz website (search term: type designation of instrument/system).

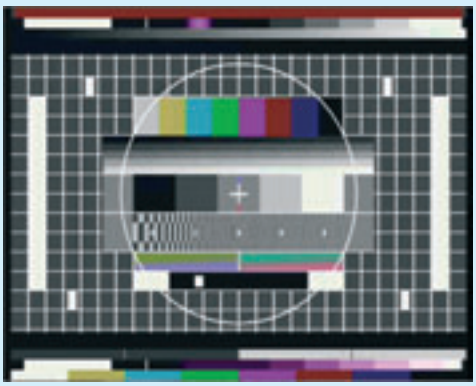
Examples of test patterns and video data streams provided by the DVDs



CCIR17 for measuring nonlinearities, level and group-delay errors.

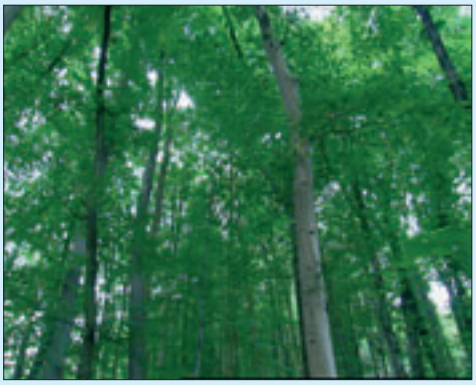


Zone-plate signal supports visual assessment of artefacts generated in scaling conversion.

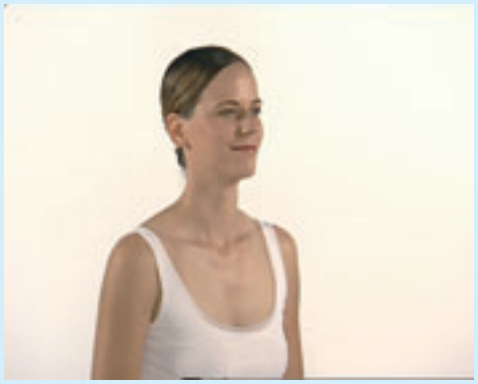


Codec 43 combines many different test signals in one pattern for simultaneous, automatic measurement of significant parameters of a video signal.

ITU-R BT.801-1 colour bar test pattern with moving element for automatic picture assessment during EMS measurements.



Forest pattern for testing MPEG decoder performance.



Portrait against white background for assessment of contrast and skin colour reproduction.

Network and Component Analyzer R 3860 from Advantest

Flexible automatic system for testing RF components and modules

With innovation cycles becoming increasingly shorter, measuring instruments must be adaptable to future requirements. This is the case with the new Network and Component Analyzer R 3860 from Advantest (FIG 1), whose modular design offers optimum flexibility and adaptability. The basic model covers a frequency range from 300 kHz to 8 GHz and comes in different versions for measurements on two-port, three-port and four-port devices.

FIG 1 Network and Component Analyzer R 3860 with Nine-Port Test Adapter R 3968.

The R 3860 – more than just a network analyzer

The modular design of the R 3860 from Advantest allows flexible and user-specific configurations. Subsequent expansions are no problem, e.g. upgrading from three to four ports or retrofitting of options.

For example, active devices such as amplifiers can be characterized with the aid of a second signal source, and multiport devices such as antenna switching modules for mobile radio can be directly powered from an R 3860-internal power supply module and thus set to different switching states. Since devices and modules can be conveniently analyzed, the R 3860 is more than just a network analyzer.

High-speed measurements

Time is money – and this is particularly important in component production. With a measurement speed of 10 µs/point, Advantest has blazed a new trail in the reduction of test times. Owing especially to the low-noise receivers in the R 3860, the same measurement accuracy can be achieved with a wider resolution bandwidth which results in an increase in measurement speed.

More information and data sheet at www.rohde-schwarz.com (search term: R 3860)

Sophisticated operating concept

The user interface runs on a Windows® NT platform so that measurement results can be easily processed. Application-specific test programs, e.g. for performing automatic measurements, can also be executed.

Since a large screen is of advantage for the display of measured traces especially in network analysis, the R3860 is provided with a 12.1-inch SVGA TFT display with touch screen function. Up to 16 split windows can be displayed, permitting different s-parameters to be represented in various ways.

Customer wishes were taken into account in the operating concept: the instrument front panel can be removed and set up at the most favourable position for the actual application. This advantage should not be underrated particularly in production.

Measurements on balanced devices

Balanced components are used to an increasing extent in many modern electronic products. They reduce the power consumption of mobile phones, for example, which in turn increases the lifetime of the batteries. Baluns, impedance converters and matching circuits are required for analyzing balanced components. In the R3860, these devices are simulated by software. This increases the measurement accuracy, saves time, offers greater flexibility and provides the analyzer with four special capabilities:

1. Impedance conversion

Instead of using external impedance converters, the R3860 converts impedances by way of calculation so that the impedance can be selected at each port. The impedance of a balanced DUT is normally not 50 Ω. Calibration can nevertheless be performed when a 50 Ω calibration set is used.

2. Simulation of matching circuits

The R3860 simulates any matching circuit and also uses files in Touchstone format that can either be added or subtracted. This process is also referred to as embedding/deembedding. This is required because many DUTs can only be connected to the network analyzer by means of additional matching circuits. To prevent the characteristics of these circuits from influencing the measurement results, they have to be subtracted. Only then will the true characteristic of the DUT be obtained.

3. Simulation of baluns

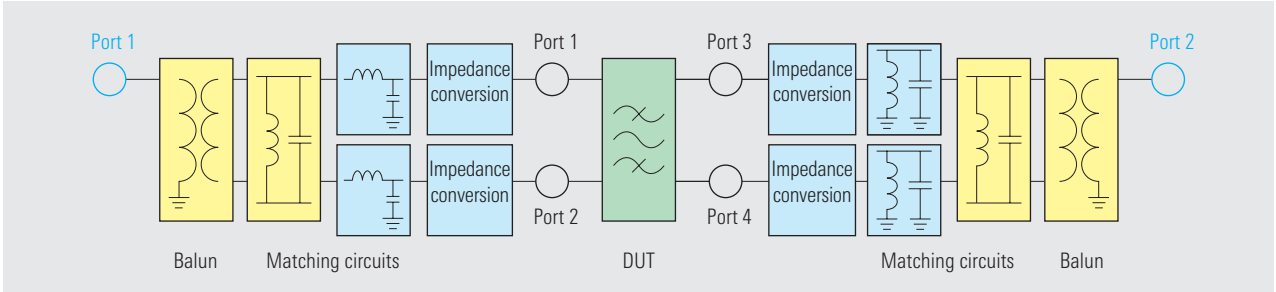
A filter with a balanced input and output, i.e. a four-port network, can be measured in the same way as a normal filter after baluns have been connected to the input and output. The R3860 simulates the baluns and thus allows four-port networks to be characterized in the same way as two-port networks although all four ports are physically connected. Balanced components must also exhibit good balance. This can be analyzed by the R3860 with the aid of a special function for measuring the degree of balance.

4. Analysis of differential s-parameters (mixed-mode analysis)

Ideal balanced components expect differential signals of inverted polarity at their input and provide the same signals at the output. In practice, however, unwanted common-mode components are produced in addition. This is a problem that makes an analysis of the differential s-parameters necessary even in development. This analysis, which is important for balanced DUTs, cannot be performed with the aid of external baluns, which means that the baluns have to be simulated in the analyzer (FIG 2).

All four capabilities can be combined as required so that a flexible platform is obtained for the analysis of balanced components (FIG 3). Measurement results can be stored in Touchstone format or as an s-parameter matrix for further processing in Microsoft™ Excel.

FIG 2 Combination of software simulations for four-port measurements.



Up to nine ports

Since more and more single components are integrated in ICs and modules, measuring instruments have to fulfill different requirements. A nine-port measurement is required, for instance, for the frontend module of a three-band mobile phone. These measurements can be performed with the Nine-Port Test Adapter R 3968 (FIG 1) from Advantest which is automatically controlled by the analyzer.

Convenient test programs

For complete characterization of multiport DUTs, a number of measurements must be performed. The measurements can be combined to form a user-specific test program that can be automatically executed. These convenient solutions save a significant amount of time when the same measurements have to be performed over and over again.

Calibration with automatic kits

The calibration of multiple ports is time-consuming and error-prone. This can be avoided by means of automatic calibration kits that include the individual calibration standards to verify the performed calibration. Calibration errors, e.g. due to loose connectors or broken cables, can thus be excluded. Advantest offers an automatic two-port and an automatic four-port calibration kit, which are controlled by the analyzer. Normal calibration kits can, of course, also be used.

Conclusion – fit for the future

As innovation cycles become shorter and shorter, flexible test equipment is required. The modular design of the Advantest Network and Component Analyzer R 3860 provides this flexibility so that future requirements can also be met. The strengths of the R 3860 are measurements of balanced DUTs with required simulations, measurement speed and multi-port measurements with the aid of automatic test routines.

Andreas Henkel

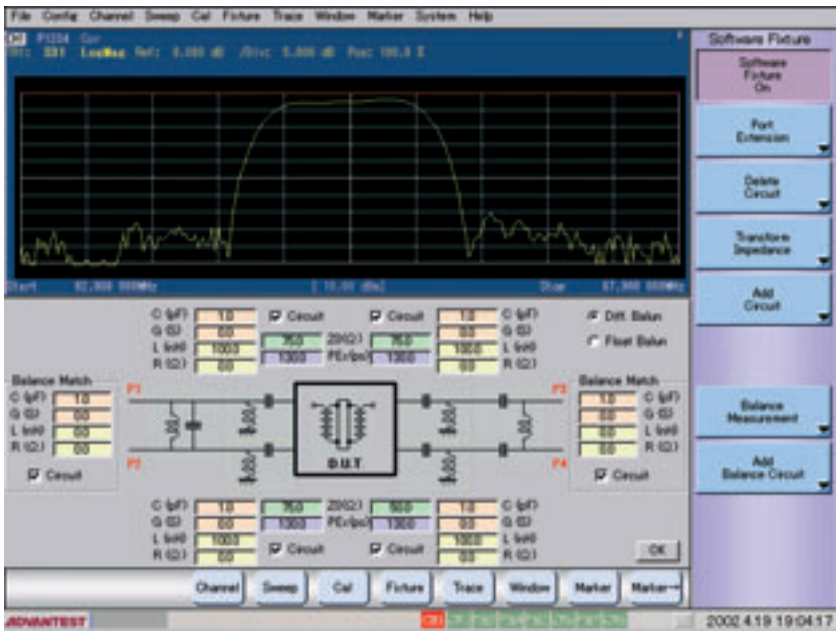


FIG 3 Measurement of balanced DUT with matching circuits.

FIG 4 Analysis of antenna switching module of a mobile phone by means of an automatic test program.

Vector Signal Generator R&S SMV

Golden devices: ideal path or detour?

Featuring a frequency range of 9 kHz to 3.3 GHz, a precise vector modulator with 100 MHz RF bandwidth, high frequency and level accuracy, short setting times and an electronic attenuator, the R&S SMV03 (FIG 1) is the ideal signal generator for automatic component and module tests in production as well as for general applications in research, development and service. It offers significant advantages over the use of golden devices as a signal source.

43 792/5

FIG 1 Module test using R&S SMV03, R&S AMIQ and Spectrum Analyzer R&S FSP.

Are golden devices really more economical?

Manufacturing mass-produced articles such as mobile phones or WLAN modules is inconceivable without automatic test sets. Several signal sources with vector modulation capability are, of course, required for this purpose. Golden devices are often used, and the test sets are implemented as shown in FIG 2. These golden devices usually consist of circuits taken from the modules or components that are currently being produced. The I/Q modulator of a WLAN module, for example, is basically able to generate test signals for this module. In order to obtain a useful golden device, some modifications are generally necessary, but the effort involved is usually limited.

Does this mean a golden device is more economical than purchasing a signal generator? At a first glance, the answer is yes. However, this answer does not take into consideration that several additional requirements must be met for such a golden device to be truly beneficial for use in automatic test systems.

First of all, an interface is necessary for the connection to the remote-control system of the test set. Moreover, the RF level must be settable, and this can only be accomplished if a variable attenuator is provided. Since the accuracy and stability of the RF level generated by the golden device leave a lot to be desired, a power meter with power splitter for coupling is indispensable. To prevent level drift, the power meter must be continuously queried and the variable attenuator reset, which drastically increases the setting times.

More information and data sheets at www.rohde-schwarz.com (search term: SMV03 or AMIQ)

REFERENCES
[*] Vector Signal Generator R&S SMV03: Allrounder with excellent vector modulator. News from Rohde&Schwarz (2001) No. 172, pp 24–26

The happy medium: Signal Generator R&S SMV03

All the above disadvantages can be neatly circumvented by using a Vector Signal Generator R&S SMV03 [*]. As shown in FIG 3, the variable attenuator and the power meter with associated power splitter can thus be omitted. Of course, operating these instruments is also no longer necessary, resulting in considerably shorter setting times – a factor of great importance in automatic test systems. The R&S SMV03 typically requires only 10 ms for a frequency setting and 5 ms for a level setting. Accuracy and stability are ensured by the built-in level control and the wear-free electronic attenuator in the generator. The level error is typ. 0.3 dB up to 2 GHz, and typ. 0.7 dB above 2 GHz. Owing to the built-in IEC/IEEE bus and RS-232-C interfaces, the connection to the controller of the test set is no problem either.

The use of golden devices is difficult if several different products are to be tested on the test set, which may have been devised for diverse digital communication standards. In this case, these makeshift solutions simply lack the required adaptability. The only remaining possibility would be to use several different golden devices. In contrast, the R&S SMV03 as a universal signal generator effortlessly meets the most disparate T&M tasks. If the I/Q Modulation Generator R&S AMIQ with the associated Simulation Software R&S WinIQSIM™ is used as an I/Q signal source, the generation of any conceivable signals for different digital standards is child's play.

Golden devices entail some other disadvantages as well: their specifications match those of the DUTs. This is due to the common technical relationship mentioned at the beginning of this article. The test results thus obtained rather resemble Go/NoGo tests. However, a rule of thumb tested in practice and verifiable also in theory says that the test setup has to be more precise by at least 10 dB than the DUT in order to obtain conclusive test results.

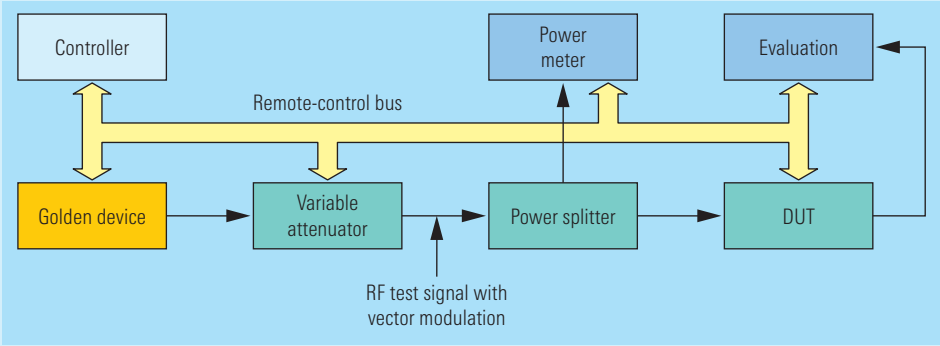


FIG 2 Test setup for tests using a golden device.

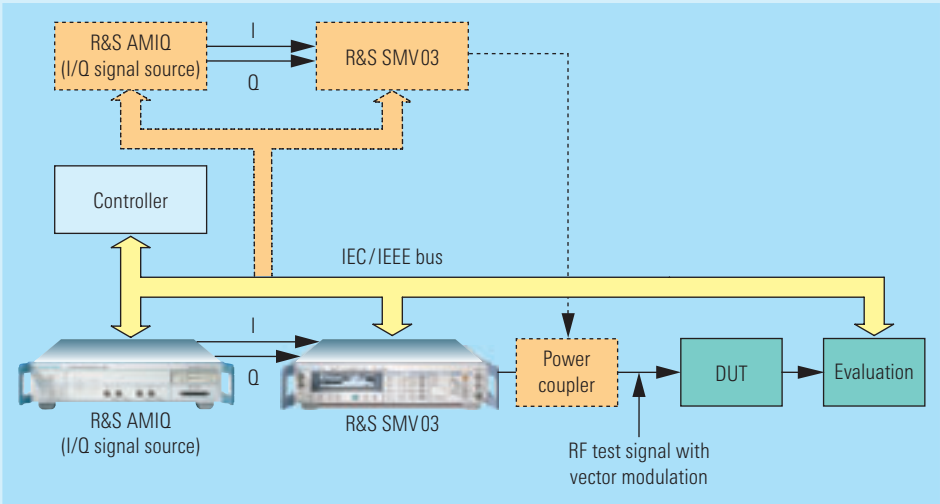


FIG 3 Test setup for tests using the R&S SMV03 and the R&S AMIQ.

Owing to the outstanding technical characteristics of the R&S SMV03 in combination with the I/Q Modulation Generator R&S AMIQ, this rule can be easily fulfilled for all measurements on WLAN receiver modules for the 2.4 GHz range, for example. FIG 3 depicts the required test setup in accordance with IEEE 802, allowing the following tests:

- Minimum input sensitivity
- Suppression of adjacent channels
- Suppression of non-adjacent channels
- Maximum input level

The interference sources of the adjacent-channel tests are shown as dotted lines in FIG 3.

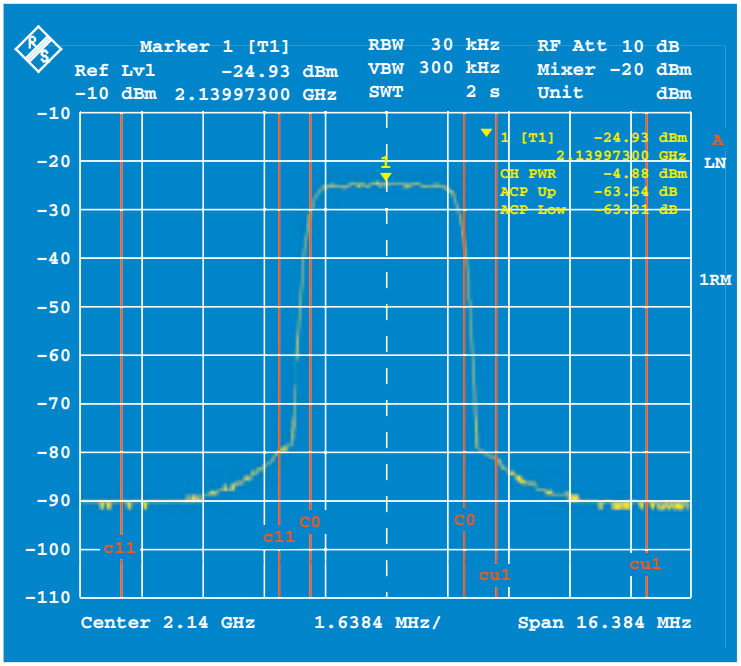
The listed measurements place considerable demands on the I/Q Modulation Generator R&S AMIQ and the signal quality of the R&S SMV03, which both instruments ideally fulfill. The R&S AMIQ is able to effortlessly generate the required OFDM signals in realtime, while the R&S SMV03 features an SSB phase noise of typ. –128 dBc (measured at 1 GHz, 20 kHz carrier offset, 1 Hz measurement bandwidth) and a broadband noise of typ. –140 dBc (measured at 1 GHz, >2 MHz carrier offset, 1 Hz measurement bandwidth). This signal quality was until recently achieved only by high-

end generators. The patented I/Q modulator of the R&S SMV03 with its RF modulation bandwidth of 100 MHz and an error vector magnitude of typ. 0.3% (for RF signals below 2.6 GHz) also surpasses the requirements.

FIG 4 shows a typical WCDMA output signal at 2.14 GHz with a measured ACLR value of 63 dB (test model 1, 64DPCH, 10.7 dB crest factor). This signal allows, for example, the measurement of ACLR values of output amplifiers for WCDM handsets without impairing the measurements, and these amplifiers exhibit ACLR values of about 45 dB at nominal power (+27 dBm at 1950 MHz). The test setup in this case is again analog to FIG 3, however without the dotted circuits. A Spectrum Analyzer R&S FSU is the ideal evaluation tool.

Wilhelm Kraemer

FIG 4 Typical WCDMA output signal of the R&S SMV03 at 2.14 GHz (test model 1, 64DPCH, 10.7 dB crest factor).



GENERAL PURPOSE | Test tip

Frequency response compensation for generators of the R&S SMx family

Test specifications prescribe defined input levels for equipment such as broadband amplifiers. The signal path between the generator and the device under test (DUT) may however exhibit nonlinear frequency response, especially at higher frequencies. This nonlinearity can be compensated for with the aid of the UCOR (user-specific correction) function available on the R&S SME, SMIQ, SML, SMP, SMR, SMT and SMV generators. First, the frequency response is determined, and the deviation from nominal level is entered into the generator's UCOR table for the frequency range of interest. With the UCOR function activated, the corresponding level offset will be added automatically for each frequency to which the generator is set. The R&S SMR and R&S SMP generators are capable of measuring the frequency response directly via the IEC/IEEE bus interface by means of a Power Meter R&S NRVD or R&S NRVS, and the values are entered automatically into the UCOR table. This functionality is not provided on the other generators mentioned above. An application note available on the Rohde&Schwarz website describes in detail how to perform frequency response compensation for either type of generator. The application note comes with a free-of-charge program (SMxUCor). This program is primarily intended for generators that offer UCOR functionality but cannot be connected to an external power meter. SMxUCor imports correction values from an ASCII file and enters the data into the generator UCOR table.

Ottmar Gerlach

Detailed application note 1MA56 and SMxUCor program available on Rohde&Schwarz website.

Microwave Signal Generator R&S SMR

Excellent signal source for scalar network analysis

Network analysis systems are indispensable measurement tools in research, development, production and service. Conventional scalar network analyzers with simple broadband diode sensors were predominant in the past, but have now been largely displaced by vector systems with selective receivers. Scalar network analyzers are used in great number only in the high-frequency microwave range starting at 20 GHz, where they are a cost-effective alternative. The broadband characteristics of the diode sensors, however, place high demands on the harmonic, subharmonic and spurious suppression of the signal generators used so that measurement errors are kept to a minimum. This is where the qualities of the R&S SMR really shine (FIG 1).

FIG 1 Microwave Signal Generator R&S SMR 60.

Conventional scalar network analysis

FIG 2 shows the configuration of a scalar network analysis system for measuring the input reflection (magnitude of S_{11}) and transmission (magnitude of S_{21}) of a DUT as a function of the RF frequency. All major parameters such as start and stop frequency for frequency sweep, frequency markers, sweep time and RF level are set on the microwave signal generator. After each new device setting, the signal generator transmits both the start and stop frequency to the network analyzer, which then displays the values. In a next step, the R&S SMR assumes control of the entire sweep. The scalar network analyzer concentrates on measurement and display.

To determine a display value pair for input reflection and transmission, the network analyzer must measure three values first:

- The power output by the Microwave Signal Generator R&S SMR (measurement channel R)
- The power reflected at the input of the DUT (measurement channel A)
- The power output by the DUT (measurement channel B)

From these three values, the network analyzer calculates the display values for reflection and transmission; correction values that were included prior to the measurement can be taken into consideration to eliminate attenuation and frequency responses. Since each measured value must be calculated individually, the minimum permissible sweep time to be set depends on the number of pixels to be displayed and the number of active display channels (FIG 3). The table applies to one or two active display channels. In the first case, only reflection or transmission is displayed; in the second case, both measured values are displayed simultaneously.

About 10 sweeps per second are required in order to make adjustments by using the display of the network analyzer. A maximum of 401 pixels may be selected, as shown in FIG 3. Option R&S SMR-B4 (analog frequency ramp

sweep) is a must to achieve such quick sweeps in the R&S SMR. However, the shortest possible sweep time depends not only on the number of selected pixels and activated display channels, but is also influenced by the start and stop frequency. The higher the two frequencies, the shorter the sweep times.

Meets all expectations – scalar network analysis with a spectrum analyzer

All R&S SMR models include a powerful digital step sweep and an interface to connect spectrum analyzers from the R&S FSP, R&S FSQ or R&S FSU families. The spectrum analyzers must be fitted with the associated -B10 option, for example R&S FSP-B10, or generally speaking R&S FSx-B10. This connection allows exact synchronization of the frequency sweeps of both instruments. The generator and the spectrum analyzer thus form a tracking system for scalar network analysis that satisfies all requirements for sweep speed and dynamic range.

FIG 4 shows the basic test setup to determine transmission (magnitude of S_{21}) of a twoport. The use of an SWR bridge helps to measure the reflection (magnitude of S_{11}) at the input of the DUT (dotted lines in FIG 4).

Unlike the conventional scalar network analyzers with broadband diode sensors, the spectrum analyzers operate selectively at a relatively narrow bandwidth. The harmonic, subharmonic and spurious suppression levels of the microwave signal generators are thus of no consequence with regard to measurement accuracy and dynamic range. Frequency-converting components can be measured despite the narrow bandwidths, since the frequency sweeps of both the signal generator and the spectrum analyzer can be staggered.

Wilhelm Kraemer

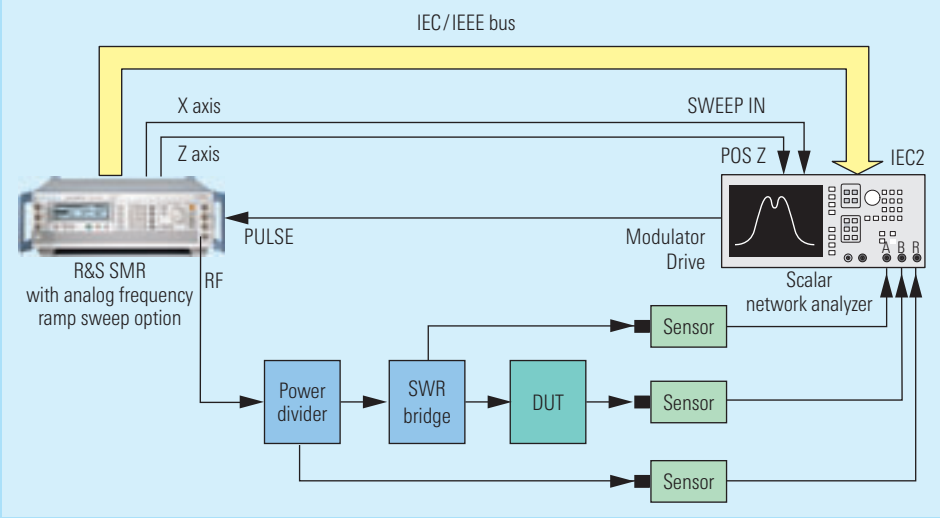


FIG 2 Reflection and transmission measurement using the R&S SMR and a scalar network analyzer.

Pixels	Minimum sweep (1 display channel)	Minimum sweep (2 display channels)
101	40 ms	50 ms
201	50 ms	75 ms
401	100 ms	100 ms
801	200 ms	250 ms
1601	400 ms	–

FIG 3 Minimum sweep time as a function of the displayed pixels.

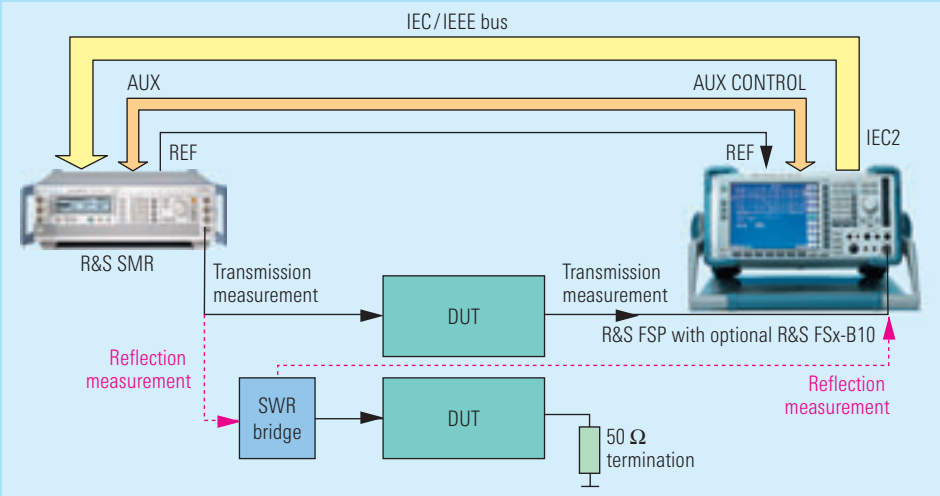


FIG 4 Reflection and transmission measurement using the R&S SMR and an R&S FSx spectrum anaylzer.

Rohde&Schwarz has expanded its portfolio of TV transmitters: the medium-power VHF Transmitters R&S NM/NW7001 are now offered in addition to the well-established liquid-cooled TV transmitters for VHF and UHF [1, 2] and the air-cooled medium-power and low-power UHF transmitters [3, 4].

VHF Transmitter Family R&S NM/NW7001

Medium-power VHF TV transmitter for all terrestrial standards

Transmitters for all frequencies and power levels from one source

The air-cooled, medium-power VHF Transmitters R&S NM/NW7001 (FIG 1) round out the Rohde&Schwarz product family which covers all power classes from 50 W to 40 kW in the VHF and UHF range (higher or lower power on request). Transmitter operators will also enjoy other advantages: a contact partner with a global presence that is a market leader, one source for all equipment and a cost-saving spare-part concept for the transmitter family.

Uniform design minimizes spare parts stock

The medium-power VHF transmitters (block diagram in FIG 2) are based on the tried-and-tested UHF Transmitter Family R&S NH/NV7001. To minimize the spare parts stock for transmitter operators, a great number of modules and concepts such as power supplies, fans and the control concept of the UHF family are also used in the VHF transmitters. Frequency-specific components such as the Amplifier R&S VM650A1, power combiners and splitters, lightning protection and the (optional) channel filter are new developments.

FIG 1
Medium-power VHF Transmitters NM/NW7001 with output power of up to 800 W (DBV-T), 1200 W (ATSC) or 2 kW (analog TV).

The use of the Exciter R&S SC/SV700 [5] permits transmitters for all analog and digital TV standards to be set up. All common standby concepts can be implemented. With the aid of an Automatic Switchover Unit R&S GB700 [6], (n+1) standby configurations are also possible.

Air-cooled power amplifiers

With the air-cooled VHF Amplifier R&S VM650A1 (FIG 3), output power of up to 800 W (DVB-T), 1.2 kW (ATSC) or 2 kW (analog TV) can be achieved in one transmitter rack. Owing to state-of-the-art, powerful MOSFETs and a patented transformation network, the amplifiers are broadband in the range 170 MHz to 250 MHz. Each amplifier has its own switching power supply which is made up of two separate units. The two units together feed the pre-driver and driver amplifier and each of them powers one half of the output stage transistors separately. This ensures that part of the amplifier output power is always available even if one of the power supply unit fails.

The 19" standard rack can be air-cooled from the top, the bottom or through the rear rack panel. The outgoing air is expelled at the top.

Comprehensive extras

The transmitter can be connected to LANs, WANs and ISDN, GSM or analog telephone networks via the R&S NetLink option. Standard protocols (TCP/IP, UDP/IP) and standard software (web browsers, SNMP platform) provide the desired flexibility.

With the aid of test software R&S GT610A1, all main amplifier parameters (transistor currents, RF detectors, output power, AC supply voltage, etc) can be displayed on a laptop for diagnostics and maintenance.

Owing to the simple conversion from analog to digital operation (exchange of exciter plug-ins) and the multiple use of spare parts in all transmitters of the 7000 family, a future-oriented and economical solution that is a highly safe investment is available to the user.

Uwe Dalisda

FIG 2
Block diagram of new medium-power VHF TV transmitters.

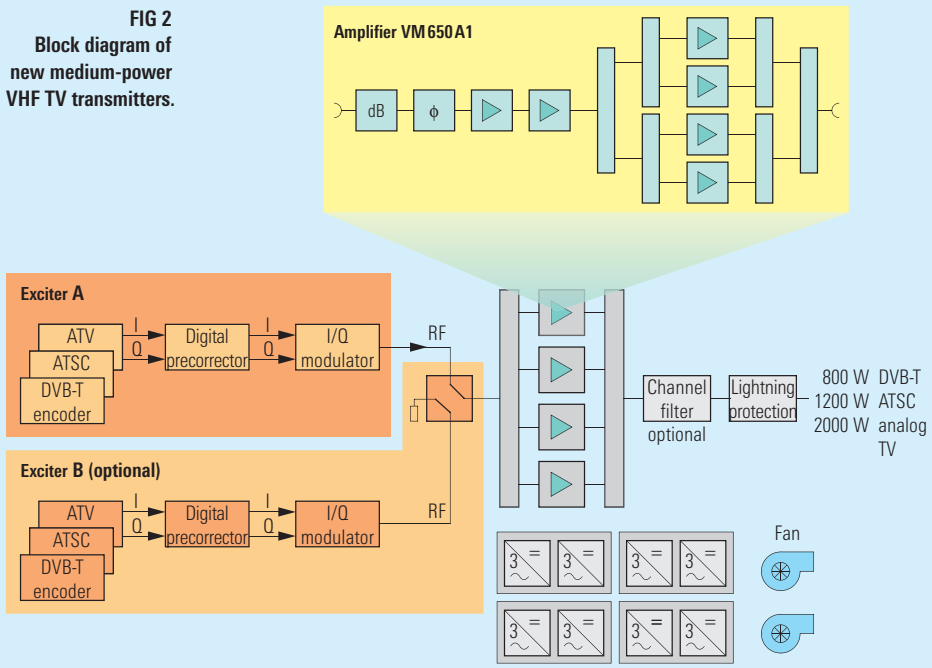


FIG 3 VHF Amplifier R&S VM650A1.

More information, service offers and data sheets at www.rohde-schwarz.com (search term: NM/NW7001)

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[2] UHF Transmitter Family R&S NV / NH7000 – Liquid-cooled TV transmitters for terrestrial digital TV. News from Rohde&Schwarz (1999) No. 165, pp 11–13

[3] UHF Transmitter Family R&S NH / NV7001 – Medium-power transmitters for terrestrial digital and analog TV. News from Rohde&Schwarz (2001) No. 171, pp 39–41

[4] UHF Transmitter Family R&S SV7000 – Low-power transmitters for terrestrial digital TV. News from Rohde&Schwarz (2002) No. 174, pp 36–37

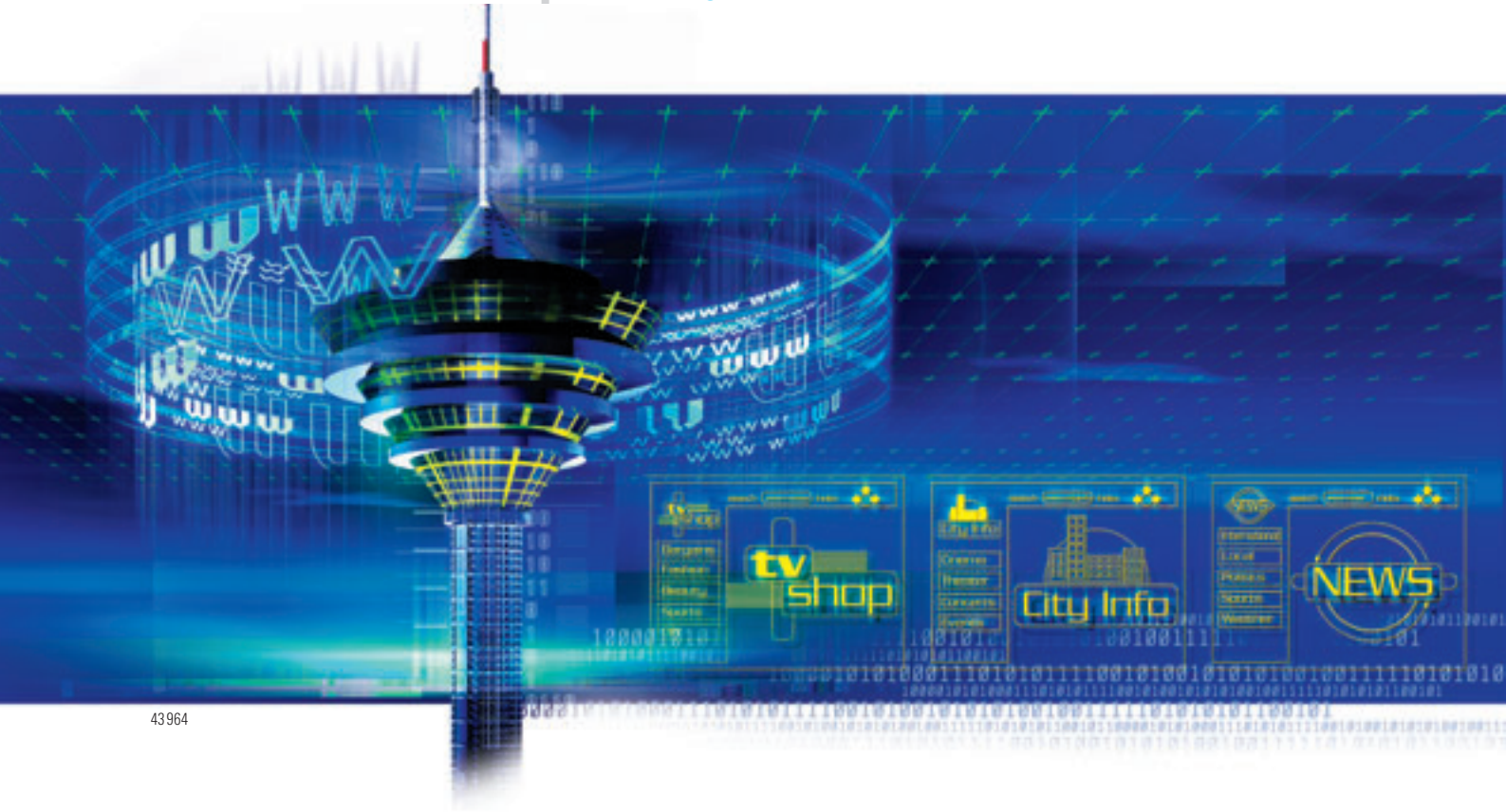
[5] Exciter R&S SV700 – Digital TV standard ATSC for Transmitter Family R&S Nx700x. News from Rohde&Schwarz (2001) No. 172, pp 40–41

[6] (n+1) standby configuration of TV transmitters – Always "on air" through automatic switchover. News from Rohde&Schwarz (2001) No. 172, pp 38–39

[7] R&S NetLink – Remote control and monitoring of transmitters on the Internet. News from Rohde&Schwarz (2001) No. 170, pp 27–29

Condensed data of R&S NM/NW7001

Frequency range		170 MHz to 250 MHz
RF output power,	analog	500 W to 2000 W combined
	DVB-T	200 W to 800 W
	ATSC	300 W to 1200 W
TV standards,	analog	B/G, D/K, M/N, I
	DVB-T	ETS300744
	ATSC/8VSB	A54
Colour transmission		PAL, SECAM, NTSC
Audio transmission		dual-sound to IRT
		FM single sound and NICAM 728 (–13 dB /–20 dB)
		FM single sound (–10 dB)
		BTSC multiplex channel
Interfaces		RS-232-C, RS-485, TCP/IP SNMP (NetLink)
Dimensions (W × H × D)		570 mm × 2004 mm × 800 mm (without filter)



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Data packets on the Internet: Many paths lead to one destination

Using the Internet is nothing special anymore. Even the combination of Internet and digital broadcasting – data broadcasting – is possible without any difficulties. But what is behind these technologies? This article examines the basic principles and explains the Internet protocol, IP.

Abbreviations: see page 44

Protocols ensure communication

Communication systems are structured according to the OSI 7-layer model. Each layer provides a function in a complex system – starting with the connector and signal levels (physical layer) through addressing and routing (network layer) up to the actual application. Different systems can only communicate with each other, i.e. exchange data, by means of standardized interfaces, layers and functions.

The Internet protocol ensures reliable communication on the Internet and for Internet-based applications as well as for data broadcasting (FIG 1). A protocol defines the commands to be exchanged, their structure, format and parameters and the timing of the messages during communication.

An important layer in the OSI model is the IP layer, whose main parameter is the IP address. This layer 3 (network layer) is responsible for selecting the routes in the network.

Data exchange in computer networks and on the Internet is based on connectionless communication. The transmitting system simply transfers the data to the network without verifying if the receiver is ready for reception or exists at all. Contrary to connection-oriented systems such as the telephone network, where a link must first be set up by dialling and switching, this function is left to the network.

Data packets are therefore transmitted from one network node to another by means of the store-and-forward method. The IP layer is consequently a connectionless protocol – there are no com-

mands for dialling or confirming a correct address or for acknowledging the delivery of a packet. This layer is usually unidirectional, a link in the opposite direction is not required.

Data packets on tour

On the Internet, all data is fragmented into packets and every single packet is packed in a container. Each container has a packet header (IP header) which contains important information such as the version of the protocol used, the packet length, and above all the receiver and transmitter addresses (FIG 2). In version 4 of the Internet protocol (IP v4), each of these IP addresses has a length of four bytes resulting in the known IP addresses, e.g. 192.24.410.12. Each byte is specified in decimal form, separated by periods.

These IP addresses are evaluated by the network nodes, mainly by the routers, and used to select the path of transport. A router knows or learns how to send a packet to an IP address. However, every single IP packet is handled separately and packets of the same application or link may be transported via different paths (FIG 3).

To guarantee the correct sequence at the receiving end and to ensure that all packets are transmitted correctly, another protocol is required, the transfer control protocol (TCP). This connection-oriented protocol sets up a socket via which the terminal has to confirm the establishment of a connection. Every TCP packet is acknowledged, and incorrect or missing packets are requested anew. The TCP is therefore a bidirectional link and requires compliance with specific response times during transmission.

If data is to be sent via unidirectional paths, or if acknowledgements are not

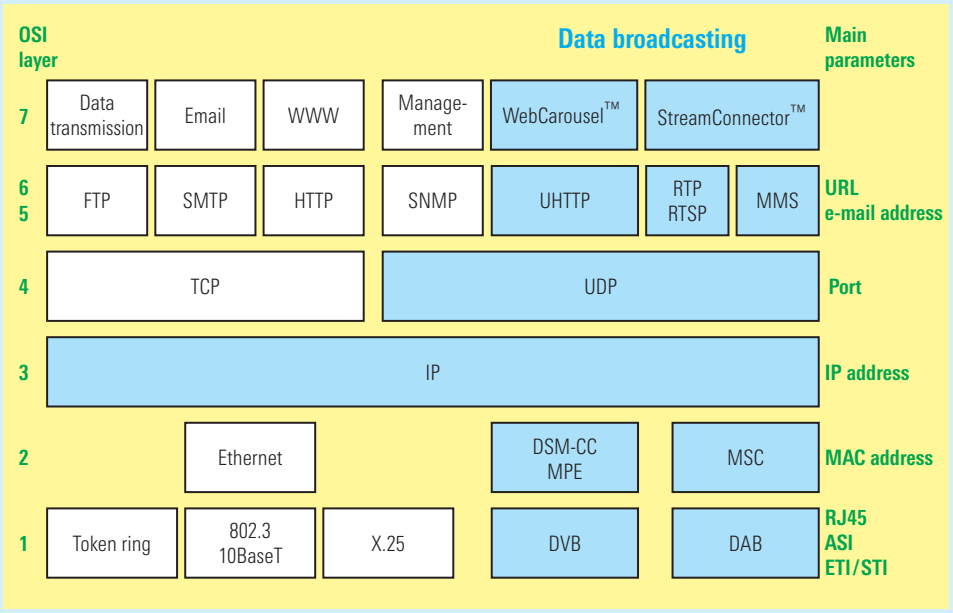


FIG 1 **Protocol stack of the Internet protocol.**

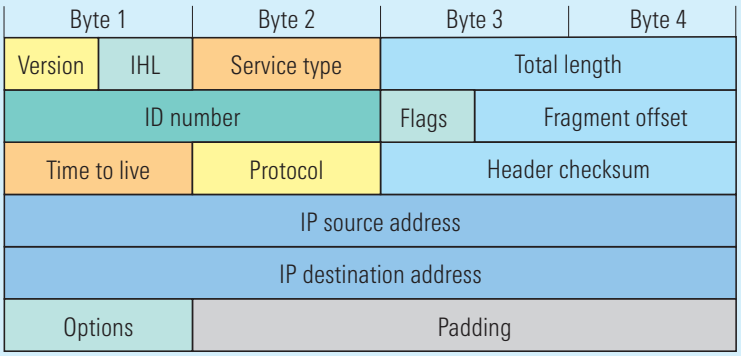


FIG 2 **IP packet header structure.**

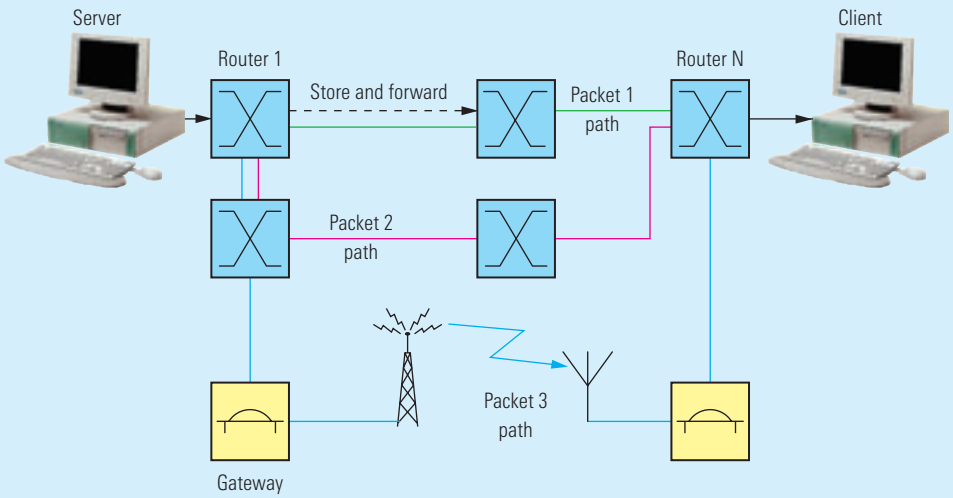


FIG 3 **Router and gateways on the Internet.**

useful or possible with realtime applications such as the streaming of sound and video sequences, the user datagram protocol (UDP) is applicable.

Since IP addresses represent the device addresses of the involved computers or terminals, yet several applications can exchange data simultaneously, another parameter, the TCP or UDP port number, ensures within the TCP layer that connections between different programs and applications of the same system can be differentiated.

Wireless is possible, too

Structuring systems according to the OSI reference model allows the substitution of layers without affecting the upper functions. It is thus feasible to change the physical transport layers and run the applications without restrictions. All types of data can be transmitted also as IP packets via broadcasting systems such as DVB or DAB [1, 2].

Instead of the computer network with LAN or WAN, wireless broadcasting systems are involved. This allows mobile and regional applications as well as the combination of broadcasting and data services. For some time now, satellite broadcasting has been providing Internet access with large bandwidth (e.g. Sky-DSL), which no telephone or ADSL line has so far been able to provide at home. Data transmission via DVB-T is also possible and offers considerable advantages: Data rates up to 24 Mbit/s can be achieved, reception is possible also in fast-moving vehicles and transmission is completely wireless – and all this very reliably and even at a more favourable price than with cable access.

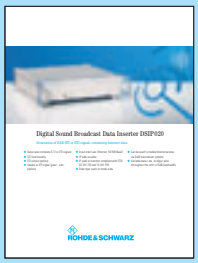
Because of the international standards, transport layers can be substituted. The necessary equipment, i.e. the gateways, connects different network architectures and implements the protocols accordingly (FIG 3). IP inserters from Rohde&Schwarz, e.g. the R&S DSIP010 or the R&S DSIP020 [3], perform this task, routing the data packets via broadcasting networks and adapting the data traffic to the broadcasting system characteristics.

Torsten Jaekel

Abbreviations

ADSL	Asynchronous digital subscriber line
ASI	Asynchronous serial interface
DAB	Digital audio broadcasting
DSM-CC	Digital storage media – command control
DVB	Digital video broadcasting
ETI	Ensemble transport interface
FTP	File transfer protocol
HTTP	Hypertext transfer protocol
IP	Internet protocol
MAC	Media access control
MMS	Microsoft media streaming protocol
MPE	Multiprotocol encapsulation
MSC	Main service channel
OSI	Open system for intercommunication
RTP	Realtime transfer protocol
RTSP	Realtime streaming protocol
SMTP	Simple mail transfer protocol
SNMP	Simple network management protocol
STI	Service transport interface
TCP	Transfer control protocol
UDP	User datagram protocol
UHTTP	Unidirectional hypertext transfer protocol
URL	Uniform resource locator

More information about the comprehensive program on datacasting at www.rohde-schwarz.com (search term: datacasting)



e.g. data sheet R&S DSIP020

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Nationwide radiomonitoring system for Nicaragua

Spectrum monitoring and spectrum management system for Nicaragua

The growing requirement for communication is also being felt in Nicaragua. Mobile radio in particular needs consistent and efficient enhancement in order to support the necessary economic development and to control the anticipated problems caused by an increase in unlicensed radiocommunication. For this reason, Rohde&Schwarz as a turnkey supplier was commissioned to install the Spectrum Monitoring and Management System ARGUS-IT on a nationwide scale. This system helps the Nicaraguan regulatory authority to accomplish its governmental tasks by means of state-of-the-art tools.

The system implemented in Nicaragua comprises a spectrum management component that administers frequencies and licenses and a monitoring component that measures and controls the frequencies. The two system components operate in line with ITU (International Telecommunication Union) recommendations which enable cross-border coordination of frequency occupancy. The core of the system is the control center located in the Nicaraguan capital Managua where monitoring and management are performed. Six unattended fixed monitoring stations based in the economically developed eastern half of Nicaragua are remote-controlled by the control center. Two monitoring vehicles are mainly used for locating fixed transmitters more accurately and for homing (detection of mobile transmitters).

Frequency and license management is performed using an Oracle database. Special software packages from other manufacturers allow frequency planning and coordination of radio, television, land mobile radio and geostationary satellites as well as frequency planning for directional radio and wireless local loop. An interface with Spectrum Monitoring Software R&S ARGUS makes it possible to compare the licensed data from the central spectrum management database with the data actually measured by the radiomonitoring stations and to analyze any differences that may occur.

The spectrum monitoring system supplied by Rohde&Schwarz covers the frequency range from 20 MHz to 3 GHz. It helps the Nicaraguan authorities to check the transmitters for compliance with the agreed and stipulated operating parameters and to determine failure sources. The core of the system is the Monitoring Receiver R&S ESMB that is connected to various antennas of horizontal and vertical polarization. One station is additionally equipped with an HF extension that expands the frequency range down to 10 kHz. The receiver is complemented by the Direction Finder R&S DDF190. All equipment is controlled by means of ARGUS software.

Data is exchanged via an Ethernet-based network. The different management workstations in the control center access the database server by means of a LAN that can transmit data records at a rate of 100 Mbit/s in order to meet the occasionally very high requirements. A nationwide directional radio system ensures data transfer at 64 kbit/s.

Photo: Authors

Rohde&Schwarz succeeded in installing the nationwide radiomonitoring system in only eight months. The photo shows the station in Casitas.

On-site work began in October 2001. Shelters and masts had to be set up; the antennas were assembled and cabled, and the racks were installed and connected. The directional radio system was set up at the same time. To withstand power failures to the largest possible extent, the most important components (PCs, servers, routers, directional radio units) were equipped with uninterruptible power supplies. Extensive work also had to be carried out in the control center, such as putting the PCs into operation, installing various software packages and above all training the operators. Finally, the complete system had to be tested in depth for perfect functioning. The comprehensive system was installed in the record time of only eight months, so that acceptance testing and handover to the customer were able to take place in May 2002. On-site acceptance testing with intensive checks of each individual station took more than one week. The test results impressed both the customer and the consultant contracted by the customer. Handover to the customer was celebrated in the presence of the director of the regulatory authority. Last but not least, the system was presented to press and television. Once again Rohde&Schwarz was able to excel as the turnkey supplier of the complete system. Further fixed stations in Nicaragua are already being planned.

Erhard Korger, Jörg Pfitzner

△

Russian and German Ministers of the Interior visit Rohde & Schwarz

To find out more about the latest technological developments in information and communication security, the Minister of the Interior of the Russian Federation, Boris W. Gryzlov, and the German Minister of the Interior, Otto Schily, visited Rohde & Schwarz SIT in Berlin on 3 September 2002.

The Russian Minister of the Interior was specially interested in TopSec GSM, the first tap-proof mobile phone, which is also used by various German governmental bodies and authorities, as well as the secure TETRA trunked radio networks, utilized by authorities and organizations responsible for security issues. Europe's leading company in the field of crypto solutions briefed the two ministers about the latest means of protecting information and communication from unauthorized access or manipulation.

Rohde & Schwarz supplies transmitter systems for first German DVB-T transmission region

The Berlin metropolitan area is the first region in Germany to be converted from terrestrial analog to digital signal transmission. Broadcast specialist Rohde & Schwarz was awarded an exclusive contract to supply the required transmitter systems.

In the first phase, the Munich-based company will supply 13 new transmitters and modify the existing analog high-power transmitters so that they can be used for digital transmission. The DVB-T coverage of households is scheduled to be completed by August 2003. Digitization of terrestrial frequencies is more effective since more TV program channels can be transmitted on fewer frequencies and auxiliary services can be offered, e.g. electronic television magazines, as is already possible with cable and satellite TV.

After the conversion, 30 TV channels instead of 12 can be received in Berlin by means of antennas. Since the frequency spectrum assigned to the broadcast corporations is not sufficient, simultaneous analog and digital operation is planned for a relatively short period of time.

New 2003 Test & Measurement Products Catalog

The new T&M catalog will soon be available from every Rohde & Schwarz representative. More than 500 pages in PDF format on a CD-ROM provide a comprehensive overview of all T&M products from Rohde & Schwarz and its cooperation partner Advantest. Tried-and-tested instruments are presented on the intuitive CD-ROM, as well as new mobile radio protocol testers of the R&S CRTU family for 3G, or the production test systems of the R&S TS 7100 series. Numerous links allow convenient scrolling and browsing through the catalog. The chapters are organized by topic, e.g. mobile radio, EMC or power measurements, so that instruments and systems can be quickly searched for and found.

New nationwide police and security network for Austria

R&S BICK Mobilfunk, a subsidiary of Rohde & Schwarz, has been awarded the contract to supply the new Austrian TETRA security radio network ADONIS (Austrian digital operating network for integrated services).

Together with Siemens, the company will set up one of the largest digital trunked radio systems in Europe (total order volume € 190 million) by the end of 2005. The first stage will be put into operation next year. In addition to the numerous small and medium-sized projects already carried out, this contract establishes Rohde & Schwarz, with its *ACCESSNET*®-T technology, as the leading supplier for major TETRA projects.

As part of the Schengen agreement, the European nations resolved to equip their security authorities with EU-standardized and -compatible digital trunked radio systems to enable smooth communication and cooperation among the authorities, if required. After numerous regional pilot projects and the start of network installations in Europe, the Austrian order marks the final breakthrough for TETRA technology. ADONIS is the largest security radio network ever to be set up in Central Europe. If the Federal Republic of Germany also decides in favour of this network, the security authorities on both sides of Germany's longest border will be able to communicate with each other in the future by means of state-of-the-art technology.

The Austrian Ministry of the Interior has contracted the Viennese company Master-Talk to set up and operate the nationwide TETRA security radio network as part of an operating model. R&S BICK Mobilfunk and Siemens have now been commissioned to install the network. Both companies will set up more than 1200 TETRA stations nationwide by 2005 to provide a comprehensive communication network. R&S BICK Mobilfunk will supply the TETRA radio technology, while Siemens as the general contractor and system integrator will install the network.

"After numerous successful local TETRA projects in Germany and abroad, we are now able to demonstrate our competence for large-scale projects with this network installation in Austria," says Heinz Bick, Managing Director of R&S BICK Mobilfunk (FIG). "Our *ACCESSNET*®-T TETRA technology has repeatedly proven itself in practice. We are therefore firmly convinced that our system is optimally suited for use as a German security network."

Electrical engineering graduates consider Rohde & Schwarz Germany's most popular employer among small to medium-sized firms

According to the latest Access survey, Rohde & Schwarz is the most popular medium-sized employer among electrical engineering graduates in Germany. Rohde & Schwarz thus ranks ahead of companies such as Audi, Motorola or SAP. Only a few corporations and larger companies such as Siemens, DaimlerChrysler and BMW are considered more attractive by the graduates. In the overall ranking of all German companies, Rohde & Schwarz is the 14th most popular employer.

While Rohde & Schwarz ranked number 23 among all German companies last year, its appeal as a potential employer climbed to position 14 this year. This is not only due to recruiting efforts, but also reflects a general trend in which graduates are increasingly deciding in favour of small to medium-sized companies to start their careers. Priorities have changed, too: While a high salary was the determining factor several years ago, job diversity and personal development have now become more important. The opportunity to develop their own ideas and state-of-the-art technologies are factors that graduates rate highly at Rohde & Schwarz.

New subsidiary in Mexico

Rohde & Schwarz has now set up a new subsidiary in Mexico. Founding the Rohde & Schwarz de México S. de R.L. de C.V. subsidiary reaffirms the high importance attached to the Latin American market.

The office is located in the German Centre in Santa Fé and offers Mexican customers the complete Rohde & Schwarz product portfolio from T&M instruments and systems through broadcasting to radiocommunication and radiomonitoring. The first customer seminars will take place by the end of this year. The new subsidiary can be contacted as follows:

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