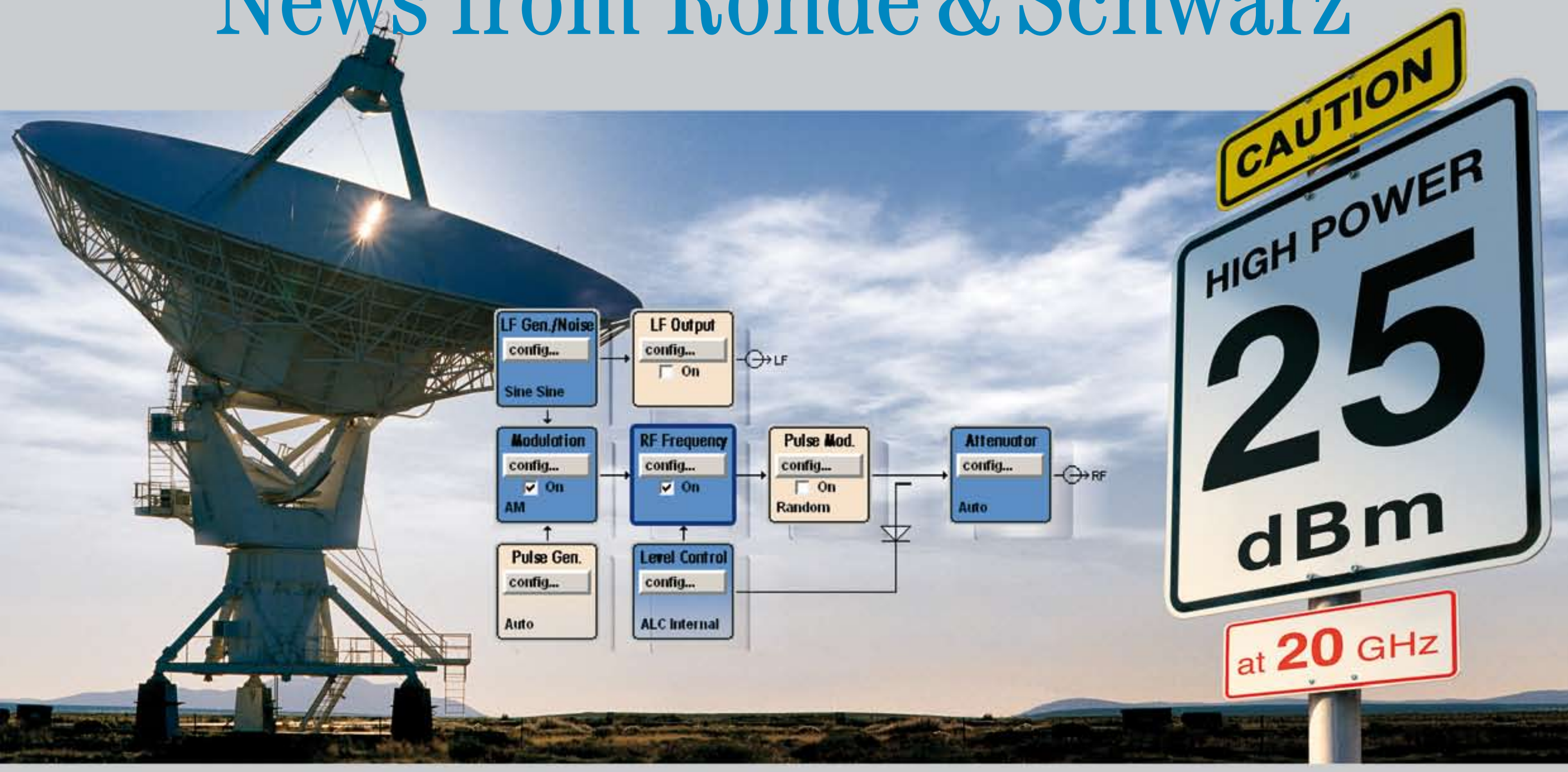
News from Rohde & Schwarz



Analog microwave signal generator – excellent in all disciplines

First certified test system for OTA measurements on WLAN user equipment

Pulse profile measurements up to 40 GHz with enhanced ease of operation

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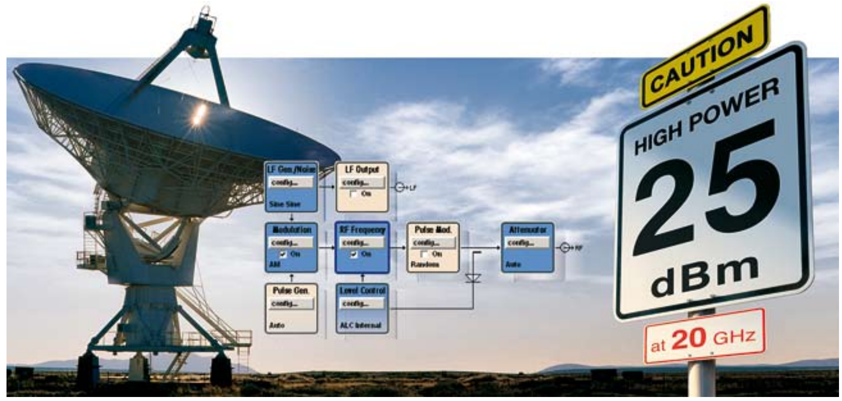
ROHDE & SCHWARZ

The new analog R&S®SMF100A microwave signal generator excels in terms of output power and signal quality as well as speed and flexibility (page 20).



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Rohde & Schwarz has expanded the R&S®TSMx radio network analyzer family to cover all requirements: Five new testers complement the product portfolio (page 4).

A new sensor for the R&S®NRP power meter offers the complete functionality required today for high-frequency power measurements (page 33).

MOBILE RADIO

Coverage measurement systems

Test systems

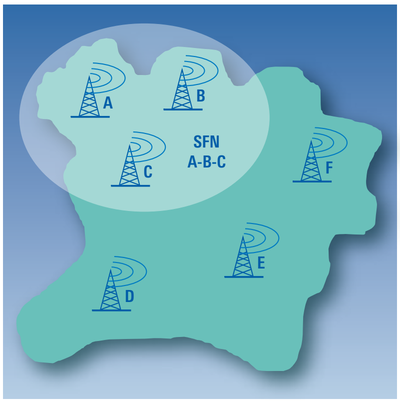
Technology

GENERAL PURPOSE

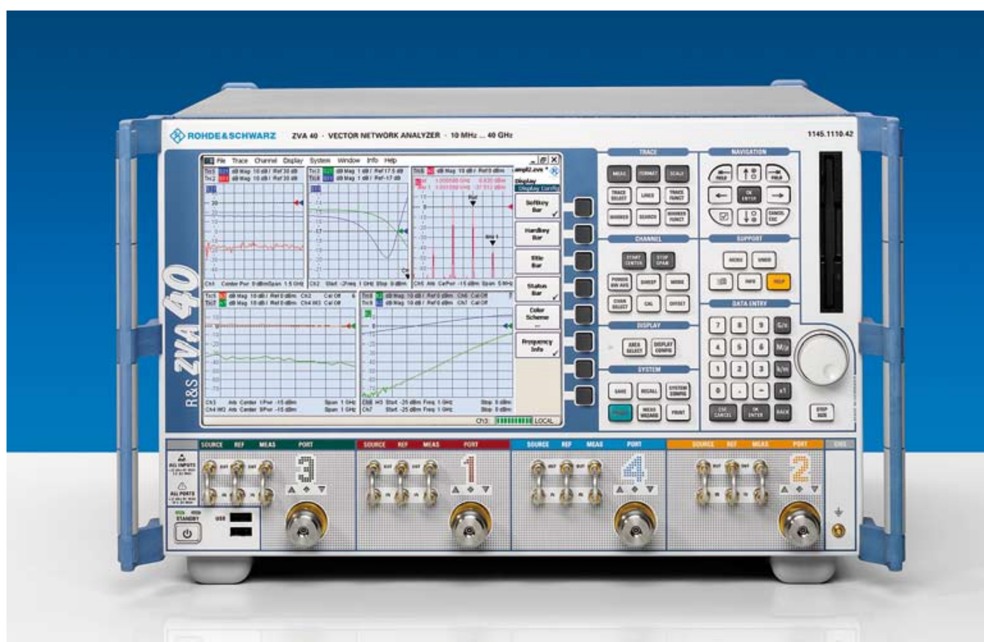
Signal generators

Network analyzers

Power meters / voltmeters



Ensuring the quality and availability of signals in digital TV networks is indispensable. This first part of a two-part article explains how to determine the monitoring points in a network and select the measurements to be performed (page 43).



The high-end network analyzers from Rohde & Schwarz now include an option for pulse profile measurements. Plus, the new R&S®ZVA 40 covers the frequency range up to 40 GHz (page 28).

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FIG 1 The R&S®TSMx radio network analyzer family offers the suitable unit for any task and any budget.

Radio network analyzers for all tasks and any budget

Five new instruments expand the radio network analyzer portfolio: The tried and tested R&S®TSMU radio network analyzer is supplemented by the R&S®TSMQ and the R&S®TSML-x quartet. The R&S®TSML-x has a particularly attractive price and – depending on the model – can be used for GSM network scan and PN scan for CDMA2000® or WCDMA, as well as for power measurements and handover analysis. The R&S®TSMQ all-purpose instrument is equipped with comprehensive functions and can analyze several different networks at the same time.

T&M equipment for all needs

Maintaining, expanding, and optimizing mobile radio networks are some of the never-ending tasks network operators have to perform. Highly specialized T&M equipment can facilitate such complex tasks. With the expanded R&S®TSMx family, Rohde & Schwarz thus offers radio network analyzers to meet any requirement (FIG 1). The analyzers offer many solid advantages and are not subject to the drawbacks of a test mobile phone. The box on page 6 describes how network operators can profit from the Rohde & Schwarz radio network analyzers; for the major differences between the various product lines, see FIG 2.

Cost-efficient specialists: R&S®TSML-x

The new R&S®TSML-x radio network analyzers offers attractive solutions for applications within a particular mobile radio standard. If a test system is to be expanded at a later time to meet additional standards, the FireWire interface (IEEE 1394) and the modular structure of the R&S®ROMES coverage measurement software make it possible to integrate several analyzers without modifying the system.

The ViCOM interface – a special feature of all the R&S®TSML-x analyzers – allows you to access raw measurement data using customer-specific software. A detailed description, example programs, and a preconfigured source code facilitate implementation and offer utmost flexibility.

All the instruments of the R&S®TSML-x family are very compact and weigh only 1.5 kg. They can also be integrated into 19" racks. Owing to their low power consumption of only 8 W, they are ideal for mobile use. Measured data can quickly be transferred to a PC via the FireWire interface.

The **R&S®TSML-CW power measurement receiver** is perfect for performing radio-network-independent CW measurements and RF power level measurements of modulated and unmodulated carriers. Triggering is by time or by distance. The instrument's large frequency range of 80 MHz to 6 GHz and settable resolution bandwidths between 12.5 kHz ▶

FIG 2 The R&S®TSMx product line at a glance

	new Four models: R&S®TSML-x	R&S®TSMU	new R&S®TSMQ
Mobile radio standards (GSM, CDMA, WCDMA) or CW	defined standard	user-defined standard	several standards in parallel (CW separately)
ViCOM interface for user-specific software	yes	no	no
Measurement speed			
WCDMA	10 measurements/s	20 measurements/s	50 measurements/s
CDMA2000®	5 measurements/s	10 measurements/s	10 measurements/s
GSM	40 channels/s	80 channels/s	100 channels/s

The article on page 9 shows how conveniently the R&S®TSMx radio network analyzers perform neighborhood analysis in 2G and 3G networks.

and 4 MHz make it highly versatile. No matter if it is used for broadband reception, TV bands, WiMAX, TETRA, GSM (all bands) or WCDMA (bands I to IX) – it can do virtually everything. WiMAX measurements can be performed not only in line with the IEEE 802.16-2004 stationary standard but also in line with the IEEE 802.16e-2005 standard for mobile applications, allowing coverage gaps to be detected at an early rollout stage. Also its measurement speed is convincing: 20 channels per second (GSM) with a resolution of 10 cm at a speed of 180 km/h (GSM-R).

The **R&S®TSML-G GSM network scanner** decodes system information such as CI, MNC, LAC, MCC, and BSIC for all GSM bands. At 40 channels per second including demodulation and decoding, its measurement speed is extremely high and thus ideal for the fast optimization of GSM, GPRS, and EDGE networks. Problems during roaming or interference caused by carriers from other networks can be easily detected.

The **R&S®TSML-C and R&S®TSML-W PN scanners** demodulate RF parameters of CDMA2000® networks (R&S®TSML-C) or WCDMA networks (R&S®TSML-W). Network operators can thus automatically analyze all PN codes of the corresponding signals with respect to RF power, timing, and quality parameters. With its frequency range, the R&S®TSML-C covers all CDMA2000® bands and performs five measurements per second. The RF receiver of the R&S®TSML-W covers all WCDMA frequency bands (I to IX) and can perform ten measurements per second. Both instruments have rake receivers with 512 fingers and measure up to six carriers at the same time. This makes them ideal for benchmark applications.

The universal R&S®TSMU radio network analyzer

The established modular R&S®TSMU radio network analyzer [1, 2] can be specially configured for the desired application. It can perform WCDMA, CDMA2000®, GSM, and CW measurements. The required options can be quickly and easily integrated – a classic example of versatility and cost efficiency.

The receivers of the instrument family are not based on a chipset but are equipped with a broadband RF input section. This is a huge advantage, since standards and frequencies may be completely different and since the R&S®TSMU offers utmost flexibility for measuring frequencies between 80 MHz and 3 GHz.

An integrated distance triggering was for the first time implemented in the R&S®TSMU. Wheel-generated pulses provide a fixed distance irrespective of the driving speed. The advantage of this is that the spatial distribution of measurement points is always the same. Thus, power measurements in line with the Lee criterion are no problem. Even measurement distances of 15 cm at a speed of up to 200 km/h are no difficulty for the R&S®TSMU.

Fully equipped: the R&S®TSMQ

The new R&S®TSMQ radio network analyzer (FIG 4) offers the highest performance in the family. It not only supports networks of all standards (WCDMA, GSM, CDMA2000®) but can also simultaneously perform measurements in all standards. No additional options are required; everything is integrated in the analyzer. It thus offers new applications

Unbeatable:

Radio network analyzers from Rohde & Schwarz are an indispensable tool in all cycles of a mobile radio network (FIG 3), and they provide measurement results far more quickly and more accurately than test mobile phones. Their broadband RF input section and the easy and modular optioning offer utmost flexibility for network operators, service providers, regulatory authorities, and hardware manufacturers.

Test drives with radio network analyzers are performed to check whether mobile radio networks allow complete and interference-free radio coverage. But network coverage also has to be ensured in areas inaccessible by car, e.g. public buildings such as exhibition halls, train stations, or airports. The radio network analyzers from Rohde & Schwarz are ideal for these tasks: They are small, light in weight, and can be operated for quite a long time without an external power supply.

The numerous radio cells in large cities and many small cells in public buildings increase the complexity of mobile radio networks. They call for coverage measurements with a high spatial resolution. This is also important for measurements to be carried out on railway lines, since mobile radio customers want to be as accessible in increasingly fast trains as in their homes. The frequent cell handovers caused by the high speed as well as large Doppler shifts place extremely high demands on the T&M equipment: It has to provide quick and meaningful results. No problem for the R&S®TSMU: Even at distances of 15 cm and speeds of 200 km/h, it can provide accurate measurement results.

The radio network analyzers from Rohde & Schwarz are far superior to conventional test mobile phones in terms of acccuracy and speed. In contrast to conventional test mobile phones, they also synchronize to signals with far less received power – either by pulses from a GPS receiver or by network-

radio network analyzers from Rohde & Schwarz in practice

internal, highly accurate synchronization sequences. You can also measure signals that are too weak for data transmission but able to impair existing links. Mobile phones in WCDMA networks, for example, tolerate erroneous codes by simply discarding them during demodulation. For handover procedures, however, this can be very annoying. The R&S®TSMx radio network analyzers, on the contrary, evaluate several signal sections to achieve a far higher correlation gain.

In addition, the radio network analyzers can also detect interference originating from external sources, e.g. broadband signals. Owing to their analog spectrum monitor, they measure signals over a wide frequency range. 2D waterfall diagrams help to clearly display external interference and to detect it over a long period of time.

The R&S®TSMx radio network analyzers support you in finding suitable sites for base stations or provide information on required antenna modifications. When optimizing and maintaining radio networks, new base stations have to be checked for network integration. Interference measurements are necessary to check whether additional interference is created by the new transmitters. This would be a drawback, since interference reduces the valuable network capacity and transmission quality. Owing to their sophisticated technical features, the radio network analyzers from Rohde & Schwarz together with the R&S®ROMES coverage measurement software [3] are able to detect and accurately localize such interference.

They also help to avoid interference, e.g. when parameters in the network are incorrectly set. Handover hystereses, target block error ratios, or errors in neighbor lists may cause additional problems. With test mobile phones, the analyzers can, for instance, evaluate target block error ratios (BLER) that are set too high by means of the perceptual evaluation of speech quality (PESQ) algorithm. This end-to-end measurement method measures from the customer's point of view and easily provides mean opinion score (MOS) values reflecting the speech quality of the network.

Handover and neighborhood analysis carried out in the past by time-consuming data post-processing can now be performed already during the test drive using the R&S®ROMES coverage measurement software (see box on page 9).

The most important advantages

- Convenient and time-saving coverage measurements and network optimization
- Patented measurement methods from Rohde & Schwarz, irrespective of a test mobile phone
- Future-proof due to flexible hardware and software expansion
- Compact and handy design for indoor and outdoor use
- Versatile frequency-band-independent use owing to broadband RF input module
- Conclusive spectrum monitor of air interface for uplink and downlink
- Decoding of broadcast information in 2G and 3G networks without SIM card authorization

FIG 3 The radio network analyzers from Rohde & Schwarz help in all cycles of mobile radio networks.

Network setup	Network maintenance	Network optimization	Network regulation
Power level measurements Selection of base station sites – Network coverage – Calibration of planning tools – Verification of network planning – Adjustment of antennas	Interference measurements Avoiding pilot pollution Functional tests of base stations	Increasing capacity Increasing quality – Handover – Neighborhoods – Quality of service (QoS) Benchmark tests	Interference measurement Network coverage QoS Spectrum
CW measurements	Interference analysis	Handover analyses Neighborhood analyses Voice and video quality Key performance indicator (KPI) Data rates and network quality	Interference measurement Voice and video quality Data rates Spectrum display

and provides unique ways to reduce costs. During a test drive, for example, it performs measurements in additional networks, such as another network of a network operator with a different mobile radio standard.

Due to its high performance, the instrument can also run benchmark tests – offering cost advantages and saving a considerable amount of time. Another application is neighborhood analysis: The R&S®ROMES coverage measurement software can decode base station information from the measured values in 2G and 3G networks simultaneously. This data is compared with a base station list and thus quickly provides missing neighborhood relationships or detects potential interference. Moreover, the R&S®TSMQ can also perform analog CW measurements.

Owing to its compact size, light weight, and low current consumption, the instrument can be easily accommodated in a backpack and is suitable for mobile use by means of a battery pack. Areas that are only accessible on foot can thus be fully measured and optimized at a high measurement speed.

Stefan Schindler

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

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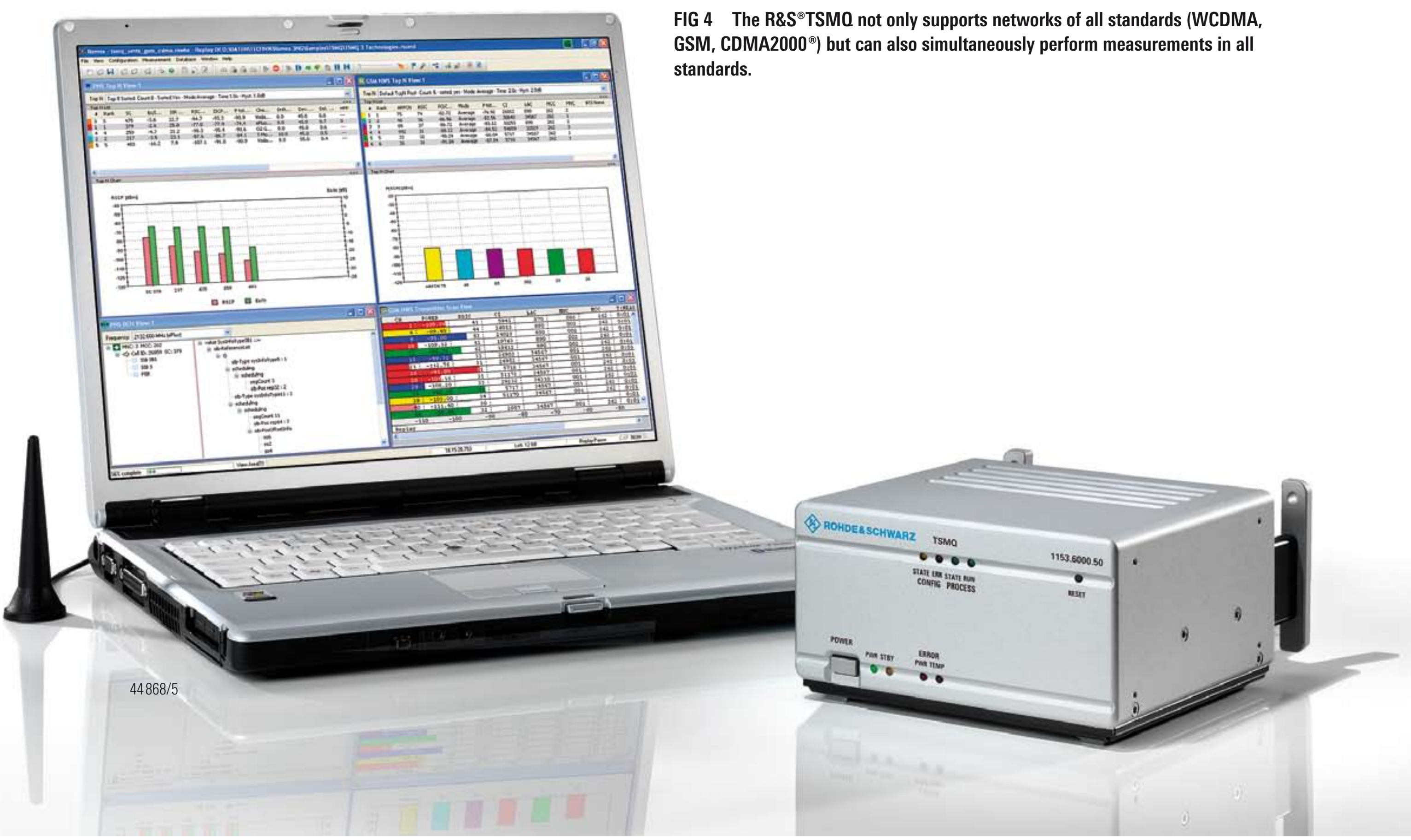

FIG 4 The R&S®TSMQ not only supports networks of all standards (WCDMA, GSM, CDMA2000®) but can also simultaneously perform measurements in all standards.

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Straightforward solution: neighborhood analysis in 2G and 3G networks

Advanced, complex 3rd generation mobile radio networks require measurement methods that easily and conveniently provide information about potential trouble spots and offer remedies. The R&S®TSMx radio network analyzers fully meet these requirements. Together with the R&S®ROMES coverage measurement software, they offer a sophisticated algorithm to analyze neighborhood relationships and have been tried and tested for half a year in the existing network.

Crucial: neighbor cell properties

Every cellular network must be able to perform a handover from one cell to another if a call has been set up, for example, between a mobile phone and the network. In a GSM network, a handover involves only two cells (source cell and target cell). In UMTS networks, however, a group of cells that is managed in the active set may be involved. This article takes a closer look at UMTS networks.

To be able to hand a call over to another cell, you have to know which UMTS cells are available in the neighborhood of a base station. These "neighbor lists" are stored in all the base stations and are usually generated by the network operators using planning tools; results are based on simulations. The lists are then compared with the real conditions in the network and are optimized accordingly.

Avoiding dropped calls

If relevant base stations are missing in the neighbor list, the call may be dropped if a mobile phone has a certain moving profile (FIG 1). Entering every neighboring cell into the list would therefore seem to be the most obvious solution. Yet this cannot be done, since the length of the list is limited and mobile phones should not be used to perform unnecessary measurement tasks. Practical neighbor lists thus contain only those base stations whose receive field strength is large enough to justify inclusion in the active set.

At the peripheries of a UMTS network, the base stations of a GSM network are also entered into the lists and subjected to a neighborhood analysis.

Detecting interference

Detecting potential network interference is just as important as finding missing neighborhood relationships. Active sets have a limited space, and only base stations stored there may contribute to setting up a call. Since all base stations emit at the same frequency, unstored base stations must be regarded as potential interferers – this is referred to as pilot pollution.

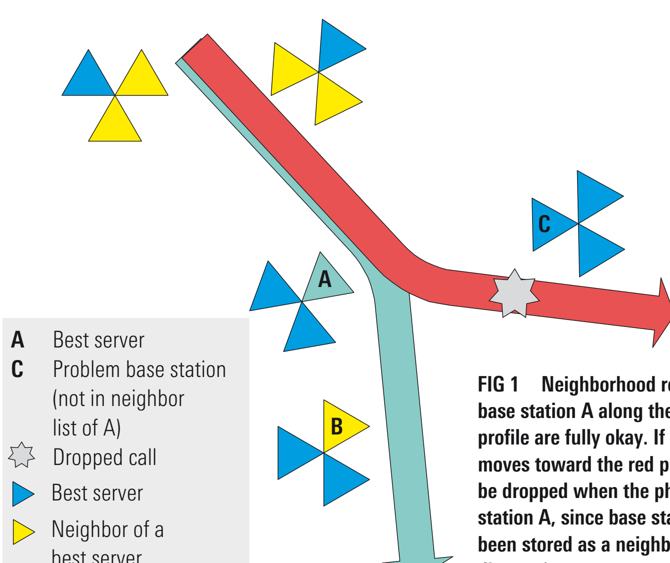

FIG 1 Neighborhood relationships of base station A along the green moving profile are fully okay. If a mobile phone moves toward the red profile, the call will be dropped when the phone leaves base station A, since base station C has not been stored as a neighbor of A (simplified diagram).

The R&S®TSMx as neighborhood analyzers

The R&S®TSMx radio network analyzers from Rohde & Schwarz can automate and simplify these relatively lengthy measurements to a very high degree. Owing to their high dynamic range and measurement speed, the optional R&S®TSMU-K13 GSM network scanner and R&S®TSMU-K11 WCDMA network scanner provide a sound basis for accurate neighborhood relationship analyses.

The algorithm

Neighborhood analysis is based on the assumption that the conditions in a network are fine when every base station meets the requirements for neighborhood relationships. To start the analysis, you first have to find out whether an entry is available in the top N pool, which includes the N qualitatively best base stations found by the UMTS PN scanner in a defined time window. To limit the analysis to relevant base stations, only base stations received with a minimum strength and quality will be considered (received signal code power, or RSCP, and E_c/I_0). The ideal base station for meeting these requirements (top 1 in top N pool) is called "best server"; it will be the reference for further analysis.

The algorithm described as follows is used for every base station (top M (M = 2 to N)). It first checks whether a base station, with reference to the best server, was received strongly enough to make an analysis worthwhile. If this is the case, the base station list is used to check whether this base station is planned to be a neighbor of the best server. If it is, you have to find out whether sufficient space is left in the active set. If so, network planning is fine, since the network could ask the mobile phone to save this base station in its active set. If the active set is already occupied, this base station cannot contribute anything to the call and will be handled as a potential interferer (PI type 2).

If the base station is not listed as a neighbor of the best server, the algorithm checks whether its field strength is sufficient for being stored in the active set ("Add Window" in FIG 2). If the field strength is not sufficient, the base station is regarded as a potential interferer (PI type 1). If the interference caused by the base station is strong enough – i.e. if it falls into the "Interferer Window" – and further examination is thus called for, an alarm will be triggered.

If the receive strength and receive quality of the base station fall into the "Add Window", the base station may always contribute to the call even if it is not entered as a neighbor. A precondition for this, however, would be a free space in the active set. If space is left, a "missing neighbor" alarm is triggered. If the active set is occupied, it has to be checked whether the base station is to be regarded as a potential interferer.

Neighborhood to GSM networks

At the peripheries of a UMTS network, the R&S®TSMx radio network analyzers additionally check the neighborhood to GSM networks. This check is performed in a similar way as that of the algorithm described above. Instead of the top N pool elements, the GSM base stations measured by the GSM network scanner are checked for a correct implementation as neighbors to the 3G network.

Result: base station couples

The result of the analysis are base station couples – one being the best server, the other being the problematic cell. For each couple, R&S®ROMES lists the corresponding spots indicating type, length, and duration of the problem (FIG 3). The software can also display the critical spots in a map.

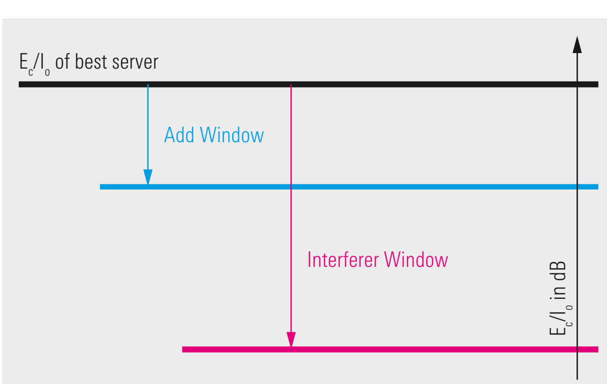

FIG 2
Depending on receive strength and quality, a base station falls into "Add Window" or "Interferer Window".

SIB11 analyzer

Apart from detecting interference sources and missing neighbors, the method provides further information about problems in network planning and configuration. The R&S®TSMx radio network analyzer decodes the network parameters included in the received system information block (SIB). These parameters also contain the neighborhood relationships of a base station. It automatically compares the neighbor lists received via the air interface with those stored in the test system. If they do not match, the user will receive detailed information about the specific differences in the two lists (FIG 4).

Summary

The R&S®TSMx radio network analyzers together with the versatile R&S®ROMES coverage measurement software offer an automated measurement method that allows network operators to quickly and easily gain important information about neighborhood relationships of their network and potential interferers. This information is essential for network planning and thus largely contributes to quality assurance. You can perform neighborhood analysis in parallel with the measurements used so far – with no extra effort and thus no additional costs.

Andreas Spachtholz

More information at www.rohde-schwarz.com (search term: TSMU)

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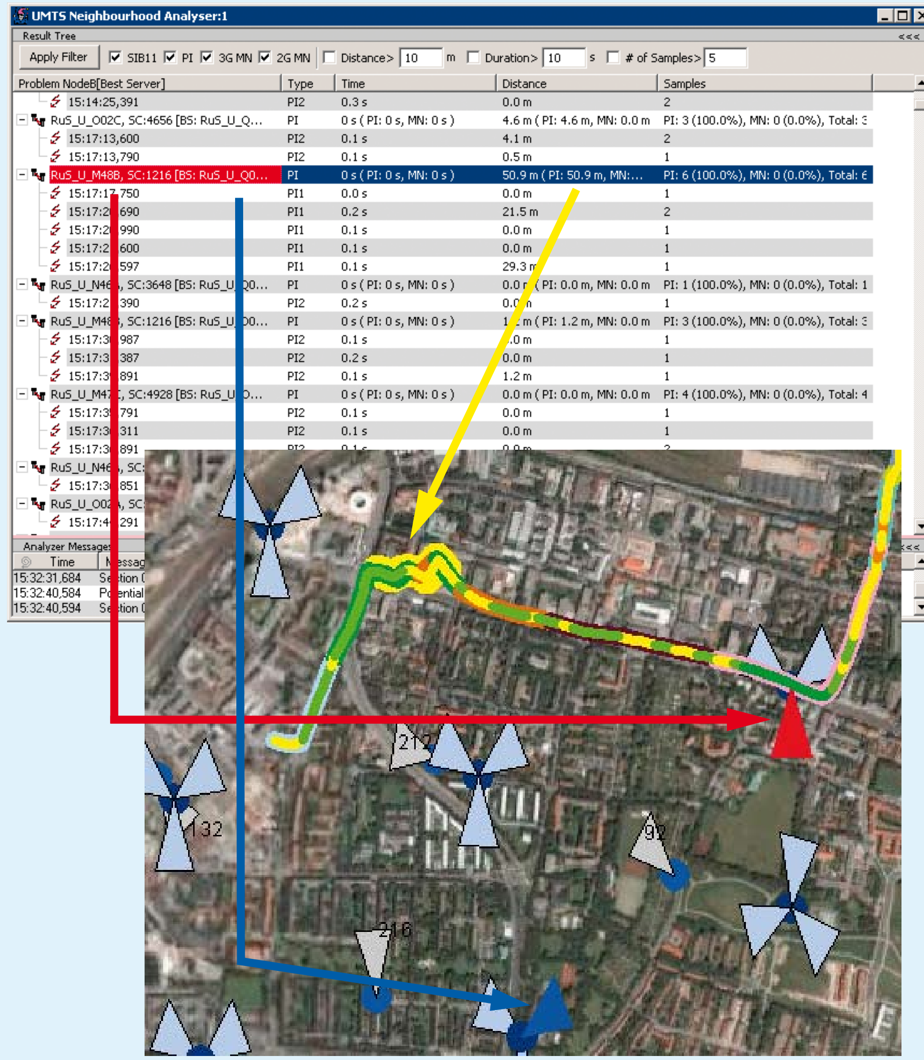

FIG 3 List of potential trouble spots. If required, the corresponding node is marked on the map.

FIG 4 The SIB11 analyzer displays the differences between the neighbor list in the base station and the received neighbor list.

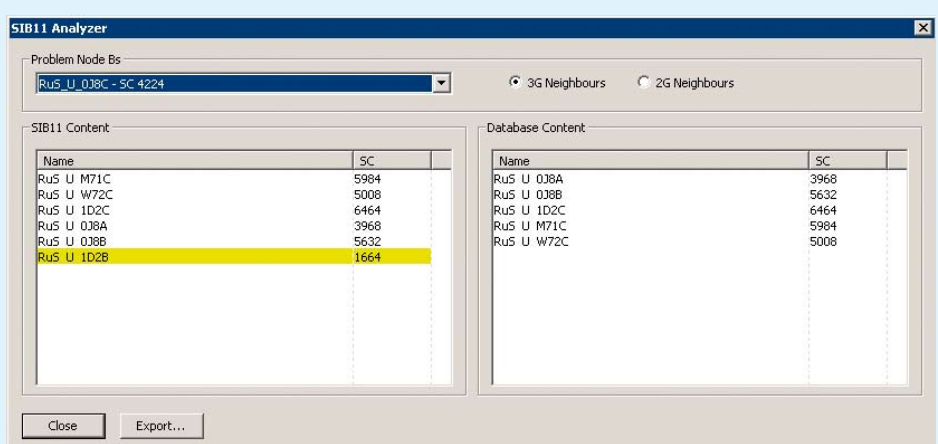

FIG 1 The R&S®TS8991 OTA test system is the first system worldwide to comply with the current standard for performance tests on WLAN user equipment.

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First certified test system for OTA measurements on WLAN user equipment

At the end of October 2006, the Wi-Fi Alliance and CTIA certified the R&S®TS8991 test system (FIG 1) for performing over-the-air (OTA) measurements on mobile phones with a Wi-Fi interface. Rohde & Schwarz is thus the first company worldwide to offer a test system that complies with the current standard for performance tests on WLAN user equipment.

Always keeping pace with new standards

The implementation of new mobile radio standards and test methods to meet market requirements is a great challenge. Rohde & Schwarz – in close cooperation with mobile phone manufacturers, network operators, and test houses – has always successfully mastered this challenge. The most recent example are over-the-air (OTA) measurements performed on WLAN user equipment, for which a special standard was defined by the Cellular Telecommunications Industry Association (CTIA) and the Wi-Fi Alliance [1]. OTA performance is an important parameter for assessing the behavior of mobile phones in the radio network. It allows you to three-dimensionally record both the transmitted power and the reception sensitivity and derive the total radiated power (TRP) and the total isotropic sensitivity (TIS) [2]. There is a great demand for these measurements, since WLAN functions are increasingly being integrated into mobile phones and good quality of service (QoS) can only be ensured by OTA measurements.

Rohde & Schwarz, together with the test house Telecommunication Metrology Center (TMC) in China, implemented this new standard into the R&S®TS8991 OTA test system in a very short time. The R&S®TS8991 is based on the R&S®TS9970 test system, which has already become an established market solution for OTA measurements in networks supporting common mobile radio standards as well as for Bluetooth®. When the standard was implemented, the optimization of the measurement speed and, in particular, the reliability and reproducibility of measurement results were paramount. The success of these activities is reflected by the certification of TMC: It is now the first test house worldwide that can perform these measurements with the R&S®TS8991 OTA test system. A turnkey system solution or an upgrade of existing OTA test systems to test WLAN functionality is now availabe for all customers.

Protocol tester with multimode capability

FIG 2 outlines the basic system structure. While the R&S®CMU200 universal mobile radiocommunication tester performs call setup and call control during measurements in line with mobile radio standards, the R&S®PTW70 WLAN protocol tester [3] is implemented to perform these tasks for WLAN tests. The high versatility of the system considerably simplifies the measurements: It sets up the call, sets the link parameters, generates the data packages, and measures the packet error ratio (PER). Plus, you do not have to bother about the functional separation stipulated in the standard between a call setup via a WLAN reference device, a subsequent switchover to a signal generator for packet generation, and the use of a step attenuator to determine the level (substitution method). Even in the unlikely event of a dropped call, the R&S®TS8991 will quickly and automatically set up the call again and continue the measurement. The dynamic range of the test system, which has already been optimized for the mobile radio standards, as well as the diversity of the communications antennas will also help to ensure stable WLAN communications.

Objective achieved: High system performance

During the implementation of WLAN tests, every effort was made to optimize the measurement speed by taking both the measurement accuracy and reproducibility into account. Especially when determining the reception sensitivity, the signal level has to be ascertained iteratively for a given PER. With GSM, adaptive step widths and the early pass / fail decision have already reduced the measurement time to a large extent [4]. Comparable methods, such as the adaptation of the number of measured data packets as a function of the PER reduce WLAN test time to a considerable extent. Thus, a test period comparable to the GSM measurement times is obtained. A WLAN OTA measurement as specified by the standard is performed only on the center channel (GSM: 3 channels); in principle you can select any channel. The R&S®TS 8991 supports measurements in the ISM frequency band from 2.4 GHz to 2.4835 GHz (IEEE 802.11b, g) and in the U-NII band from 5.15 GHz to 5.825 GHz (IEEE 802.11a). Moreover, the wide range of analyzer functions offered by the R&S®PTW 70 WLAN tester allows you to make a more detailed statement about the DUT: If sensitivity problems occur, for example, you can find out whether the RF performance is insufficient or whether protocol problems cause a deviation.

The high measurement accuracy of the test system is also reflected by the fact that the measured total radiated power (TRP) and the total isotropic sensitivity (TIS) perfectly match; see FIGs 3 and 4. Since the DUT transmits and receives with the same antenna, you would expect identical antenna radiation patterns for transmission and reflection. Yet the integrated active DUT electronics additionally affects the reception sensitivity, producing measurement errors. It is therefore important to perform individual transmission and reception measurements and also to measure the receiver at its sensitivity limit.

New software

The new R&S®AMS 32 software, which replaces the R&S®RPS 16 software used in the R&S®TS 9970 predecessor system, further increases the measurement speed. In addition to standard-compliant measurements, it also makes it possible to perform fast measurements during development. A measurement mode with a continuously rotating positioner is available for this purpose. The measurement time is largely reduced using a complete 3D sphere.

The R&S®AMS 32 software also offers further automatization: The measurements can be performed in one go on several mobile radio channels and also across several mobile radio bands. The mobile radio channels to be tested are sequentially activated via handover procedures that are remote-controlled via the R&S®CMU 200.

A wide range of device drivers support nearly the complete Rohde & Schwarz product portfolio of spectrum analyzers and power meters as well as mobile phone positioners and turntables of all important suppliers worldwide. You can therefore combine the R&S®TS 8991 OTA test system in various ways with any absorber halls and positioners.

The R&S®AMS 32 software offers the tried and tested, advanced, and intuitive Windows® user interface known from the R&S®EMC 32 EMC test software [5]. A powerful 3D evaluation tool is integrated into the software [6] and allows a three-dimensional representation of measured values and a calculation of the required parameters as well as further data analysis. This tool provides versatile reports in different output formats (RTF, PDF, HTML).

Summary

Rohde & Schwarz's longstanding expertise in the field of OTA test systems and communications testers as well as a close cooperation with the users – in this particular case with the test house TMC – ensured the fast implementation of these tests into the R&S®TS 8991 OTA test system. These tests are now available to all users and enable them, like TMC, to obtain certification.

Jürgen Kausche; Bernhard Rohowsky

More information at www.rohde-schwarz.com (search term: TS8991)

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[6] RF Performance Test System R&S®TS 9970: Displaying and evaluating spatial radiation characteristics. News from Rohde & Schwarz (2006) No. 190, pp 10–12

FIG 2 Basic structure of the R&S®TS 8991 OTA test system.

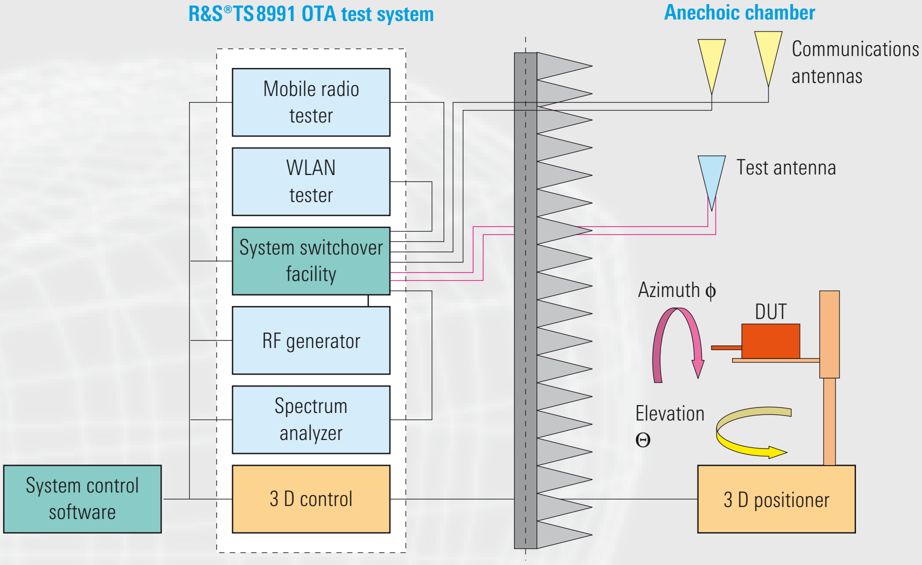


FIG 3 Result of a WLAN TRP measurement.

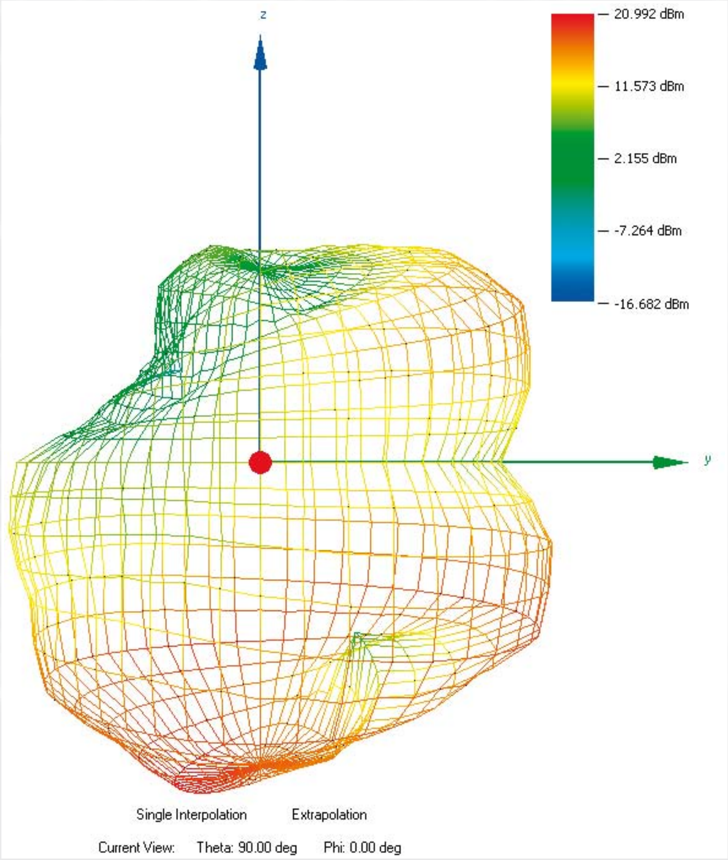
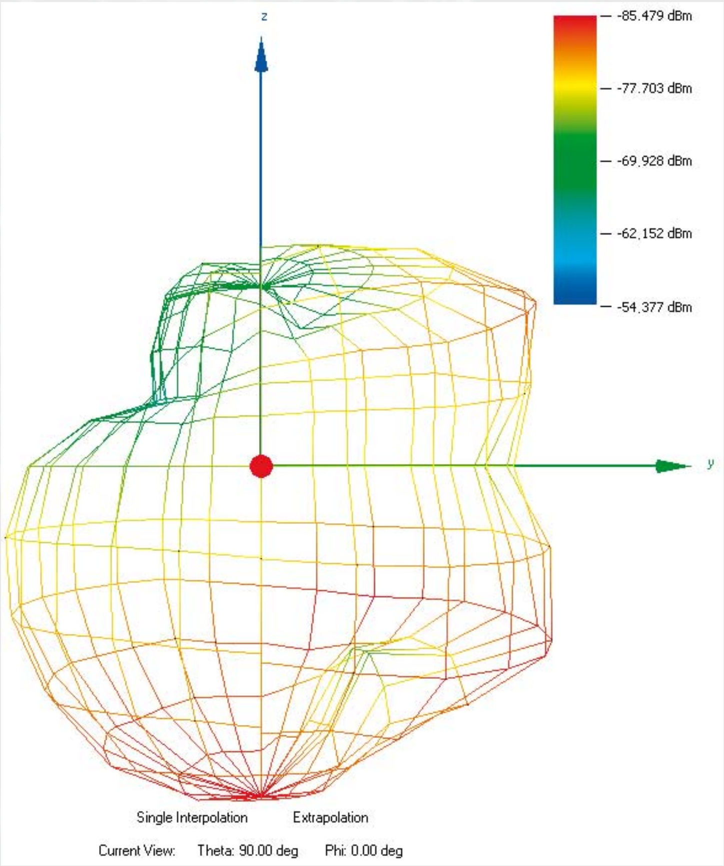


FIG 4 Example of a WLAN TIS measurement.



From SISO to MIMO – taking advantage of everything the air interface offers

In the heated race among mobile radio standards to improve transmission rates and reliability, spectral efficiency, network coverage, etc, the resource space as part of the air interface is increasingly becoming the focus of attention. Irrespective of the mobile radio standard, there is room for improvement in both transmission reliability and data throughput. This article describes how multiple antenna systems can fully utilize this resource and how such systems can be tested. Part 1 discusses SIMO and MISO systems; part 2, which will be published in News from Rohde & Schwarz 194, deals with MIMO systems.

Many paths, one destination: optimum reception quality

In classic TV broadcasting, multipath reception was undesired due to its impairing effect of producing ghost pictures, but in digital mobile radio it is used to improve transmission. Each additional transmission path used by a transmitter to reach a receiver increases reception performance and improves the signal-to-noise ratio (SNR). Multipath reception eases the effects of the strong receive level fluctuations a single transmission channel is subjected to in mobile operation. The probability that several channels are impassable at the same time is far smaller than if only one channel is used.

Another way to reduce strong receive level fluctuations and thus increase the transmission quality is the frequency hopping method specified in the GSM standard. In addition, suitable coding (e.g. interleaving) reduces the effects of short interruptions in transmission.

A yet unutilized means of improving the transmission quality is the use of additional antennas at the transmitter and / or receiver end. Various alternatives are available, depending on the antenna configuration (see box below).

From SISO to MIMO: diversities at a glance

SISO Single Input Single Output The classic and easiest way: one transmitting and one receiving antenna.

SIMO Single Input Multiple Output One transmitting and several receiving antennas. Is also often referred to as receive diversity. With reference to the downlink, this means one transmitting antenna at the base station and more than one receiving antenna at the mobile radiotelephone.

MISO Multiple Input Single Output Several transmitting antennas and one receiving antenna. Is also referred to as transmit diversity. With reference to the downlink, this means more than one transmitting antenna at the base station and one receiving antenna at the mobile radiotelephone.

MIMO Multiple Input Multiple Output Complete expansion: N transmitting antennas provide signals to M receiving antennas.

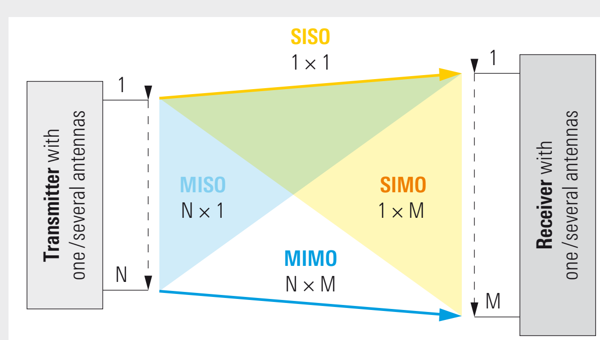


FIG 1 The different diversities at a glance.

More information and data sheets on the test instruments and systems at www.rohde-schwarz.com (search term: type designation)

SIMO – one transmitting antenna, multiple receiving antennas

The transmit signal of an antenna reaches a receiver with multiple antennas (FIG 2). There are various ways of evaluating these antenna signals (FIG 3). With switched diversity, the receiver always evaluates only the strongest receive signal and discards the weaker signals. Performance is best improved by maximum ratio combining (MRC): The sum of all signals is evaluated and nothing is lost.

MISO – multiple transmitting antennas, one receiving antenna

Several transmitting antennas provide signals for one antenna at the receiver. The following methods can be used, depending on what is emitted via the antennas:

Transmit diversity

With this method, the same signal is emitted via antennas that are situated close to each other. The geometric antenna arrangement ensures that a stronger signal arrives at the receiver. Multiple power amplifiers and antennas are therefore required at the transmitter end. Since the antennas are close to each other, the paths are largely correlated, considerably limiting the potential benefit.

Space time block coding

The special feature of this method is not only that the same signal is emitted at two antennas that are located close to each other but also that different data blocks that are appropriately related to each other are sent: With space time block coding (STBC) in accordance with Alamouti, two different data blocks (d_1, d_2) are sent in a first step (FIG 4). In a second step, these two blocks are sent once more; but this time, block d_1 is sent in complex conjugation and block d_2 in complex conjugation with inverted sign. The data blocks are also sent with reversed antenna roles. This does not increase the transmission rate but significantly improves transmission reliability and coverage.

Currently defined test scenarios – that's how they are tested

GSM DARP phase 2

3GPP TS 45.005, release 7, annex N, defines test scenarios for a SIMO system with two receiving antennas. It is referred to as a Single Input Dual Output (SIDO) system (FIG 5).

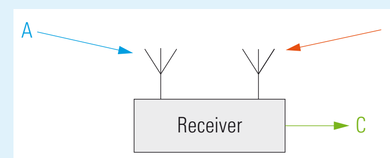


FIG 2
The transmit signal of an antenna reaches a receiver with multiple antennas.

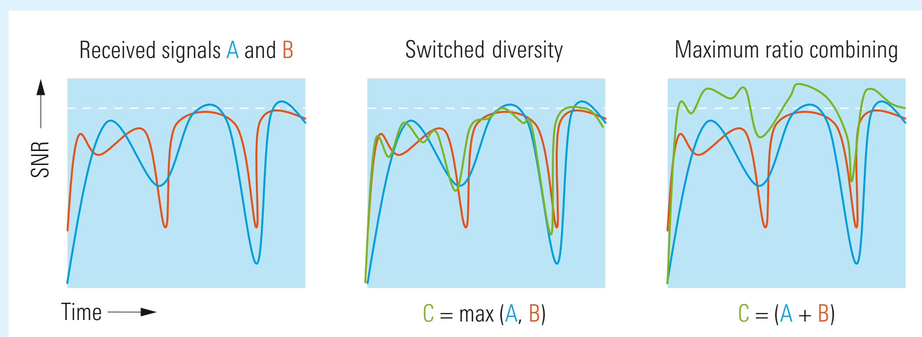


FIG 3 **Comparison between switched diversity and maximum ratio combining at a receiver with two antennas.**

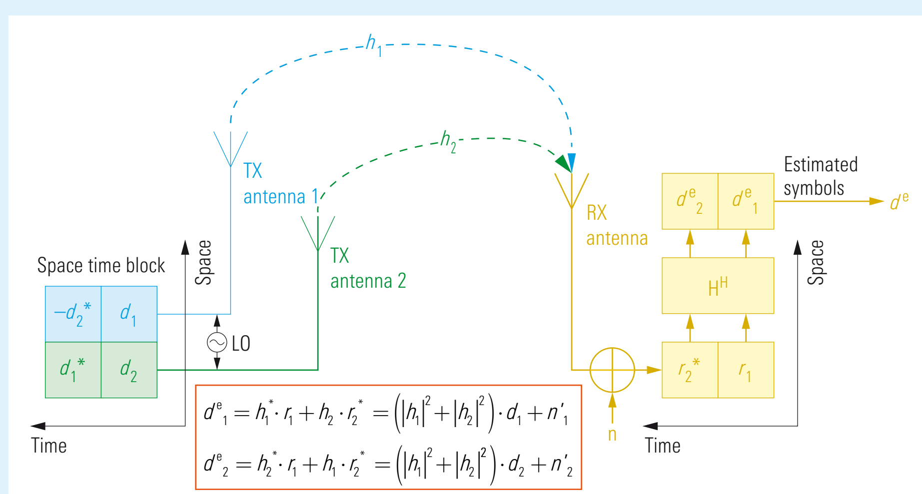


FIG 4 **Dual Input Single Output (DISO) with space time block coding in accordance with Alamouti. Here, the mobile radiotelephone "sees" two different data streams (e.g. STBC) at an antenna which are generated by the signaling unit. From the base station emulator's point of view, two downlink signals with different data and correlated fading conditions are generated. The two signals are added after the fading process.**

The base station emulator generates two downlink signals (referred to as "TX wanted" in FIG 5) with identical data content and correlated fading profiles. Thus, no additional demands are placed on this emulator.

To test real-world scenarios at the receiver, different combinations of modulated interferers (co-channel and adjacent-channel interferers) and additive white Gaussian noise (AWGN) are applied to the two inputs of the mobile radiotelephone. These combinations are distributed among the two antennas (FIG 5). The co-channel interferer superimposes the downlink signal on the same frequency, while the adjacent-channel interferer is available one channel (200 kHz) next to this. As far as time is concerned, both interferers match the downlink signal.

You can thus implement a model for multi-interferer scenarios very easily using Rohde & Schwarz equipment (FIG 6). The signaling unit (the R&S®CRTU-G protocol tester or the R&S®CMU 200 radiocommunication tester) generates the downlink signal TX 1 (wanted signal), which is distributed by the R&S®AMU 200 A fading simulator (see box below) among the two receive paths using two correlated fading profiles. The correlation factor between the two fading profiles can be set. The interferer can be generated in various ways; see the following example:

R&S®SMU 200 A with two RF outputs (up to 3 GHz)

A baseband unit of the R&S®SMU 200 A vector signal generator generates a modulated interferer (in the baseband). The two fading modules provided in the generator then perform correlated fading for the two outputs. Two RF interferers with correlated fading are thus obtained by means of the two RF frontends (FIG 7).

WCDMA

Receive diversity

3GPP TS 34.121, release 6, defines tests for a Single Input Dual Output (SIDO) system. As with GSM, the objective is to improve transmission in the downlink by means of an additional receiving antenna. In contrast to GSM, the fading profiles are not correlated and, apart from one AWGN interferer per antenna, no other scenarios with interferers are planned. Thus, the GSM test configurations also apply to WCDMA, with only minor simplifications required.

R&S®AMU 200 A baseband signal generator and fading simulator

The new R&S®AMU 200 A combines the functionalities of a realtime I/Q source, an arbitrary waveform generator, and a channel simulator in a single box. Even complex signal scenarios can be easily generated due to the optional two-path capability. The impact of interfering signals, noise, multipath propagation, and antenna diversity on the function of a DUT can very easily and reproducibly be simulated using a single instrument.

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The most important features:

- Two-channel fading simulator; supports predefined fading scenarios
- Arbitrary waveform generator with 16 / 64 / 128 Msamples
- Scalable platform
- One or two signal paths
- Supports many digital standards such as GSM/EDGE, 3GPP FDD, CDMA2000®, LTE/EUTRA, TD-SCDMA, WLAN, WiMAX, DVB-H, GPS, etc
- Wide range of signal inputs and outputs
- Three-year calibration cycle

The R&S®AMU 200 A baseband signal generator and fading simulator will be described in further detail in the next issue of News from Rohde & Schwarz.

Transmit diversity

Transmit diversity is already used with WCDMA, and test solutions are available, e.g. the R&S®TS8950W WCDMA test system including a built-in R&S®CRTU-W.

WiMAX (IEEE 802.16e)

The tests defined in Wave 1 are all based on SISO; the validation of these tests began at the end of 2006. With Wave 2, real MIMO with multiple transmitting and multiple receiving antennas including beamforming (due to the directionality of the antenna array of the base station, the transmission lobe follows the movement of the mobile radiotelephone) will be possible in the course of this year. The discussion about the implementation is in full swing.

Unfortunately, complete specifications and scenarios for testing MIMO systems are currently (i.e. March 2007) not yet available. Part two of this article will be published in News from Rohde&Schwarz 194 and deal with MIMO's remarkable capabilities and, above all, with testing such systems.

Josef Kiermaier

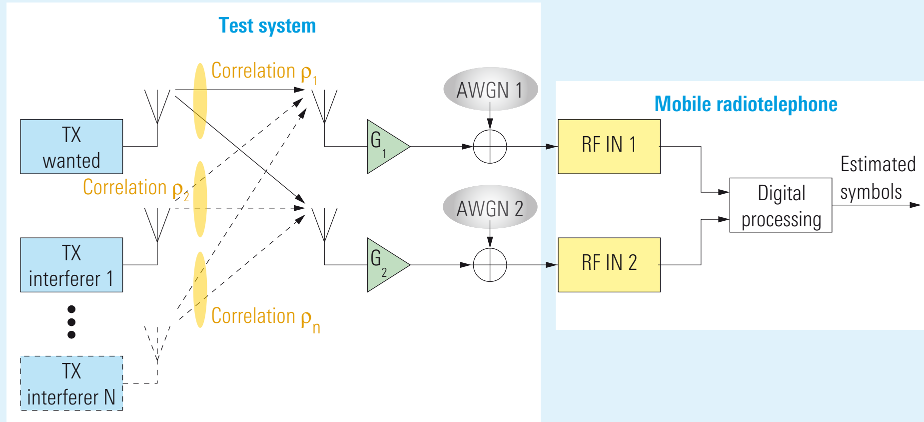


FIG 5 Channel model of tests in line with GSM DARP Phase 2. "TX wanted" refers to the downlink signal transmitted to the two receiving antennas via correlated multipath propagation (correlation factor ρ). G_1 and G_2 symbolize the different gain of the two mobile radiotelephone antennas. AWGN1/2 are the two noise sources, which – like the modulated TX interferers – belong to the real-world scenario. The modulated interferers are subjected to correlated fading. RF IN 1/2 are the two inputs of the mobile radiotelephone.

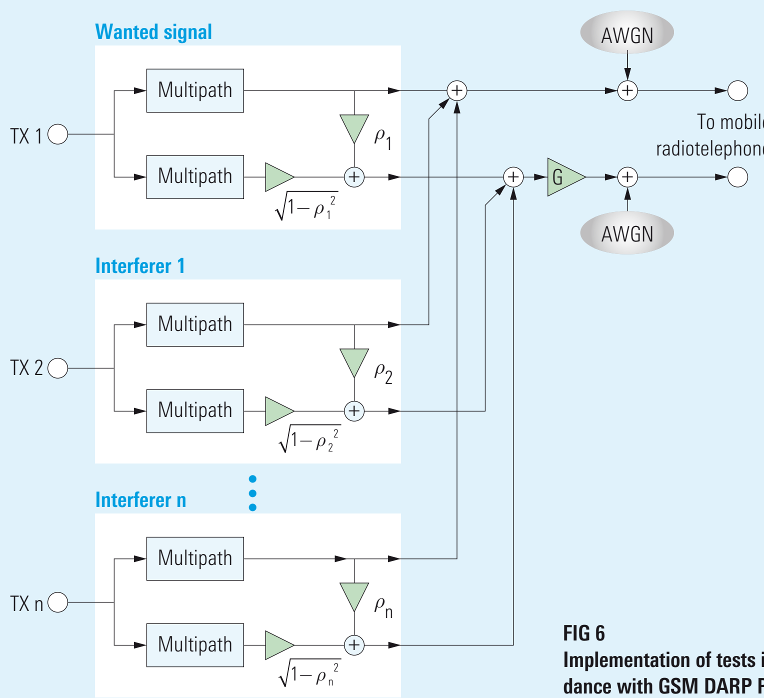


FIG 6
Implementation of tests in accordance with GSM DARP Phase 2

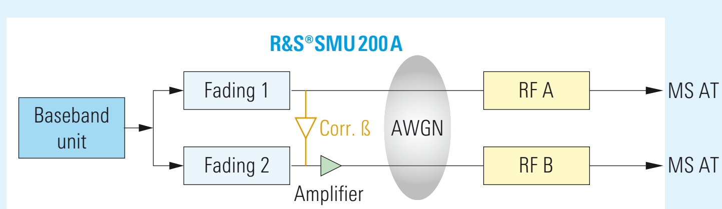
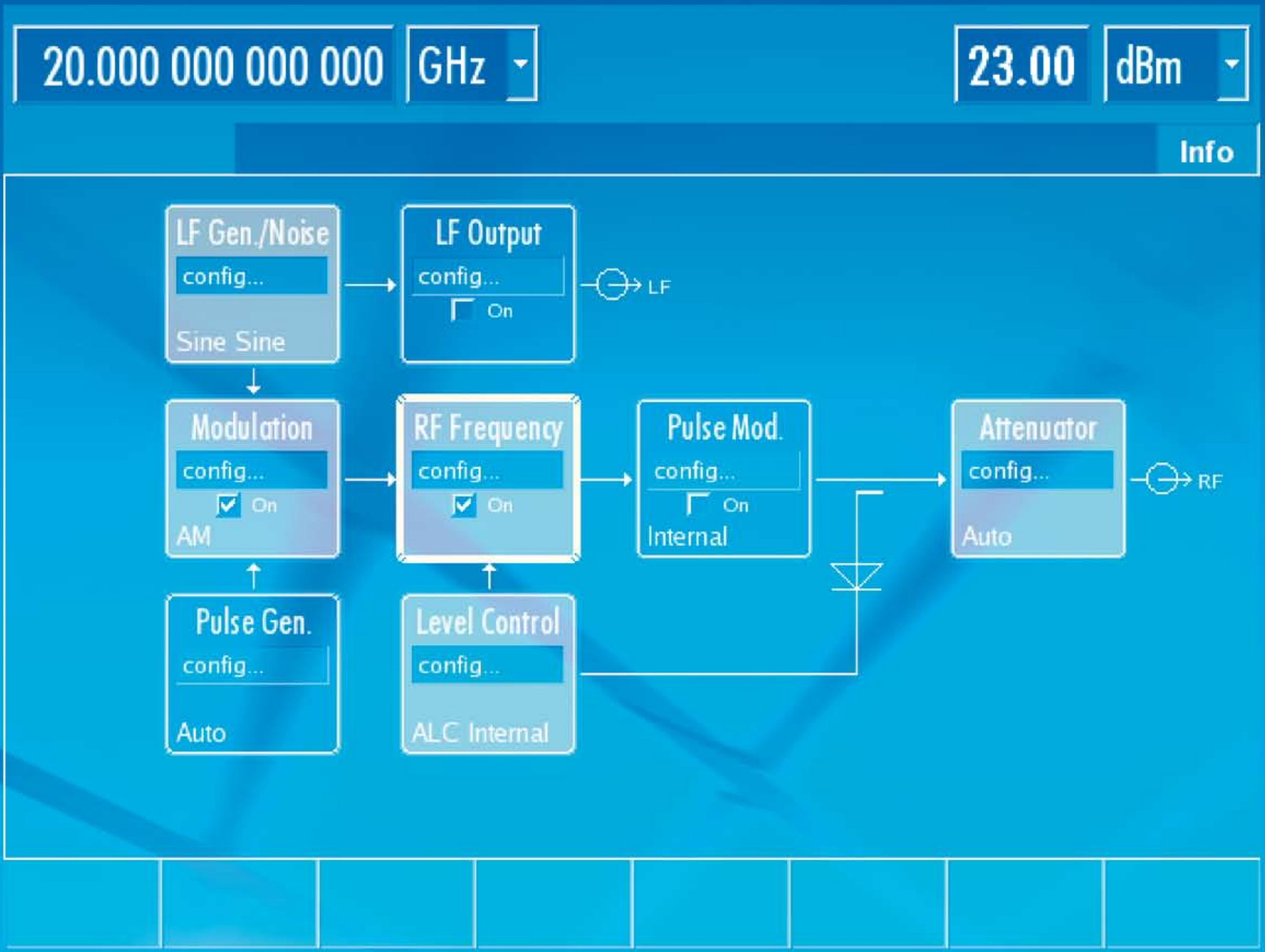


FIG 7 An R&S®SMU200A with one baseband unit generates a modulated interferer, which is subjected to correlated fading at the two RF outputs.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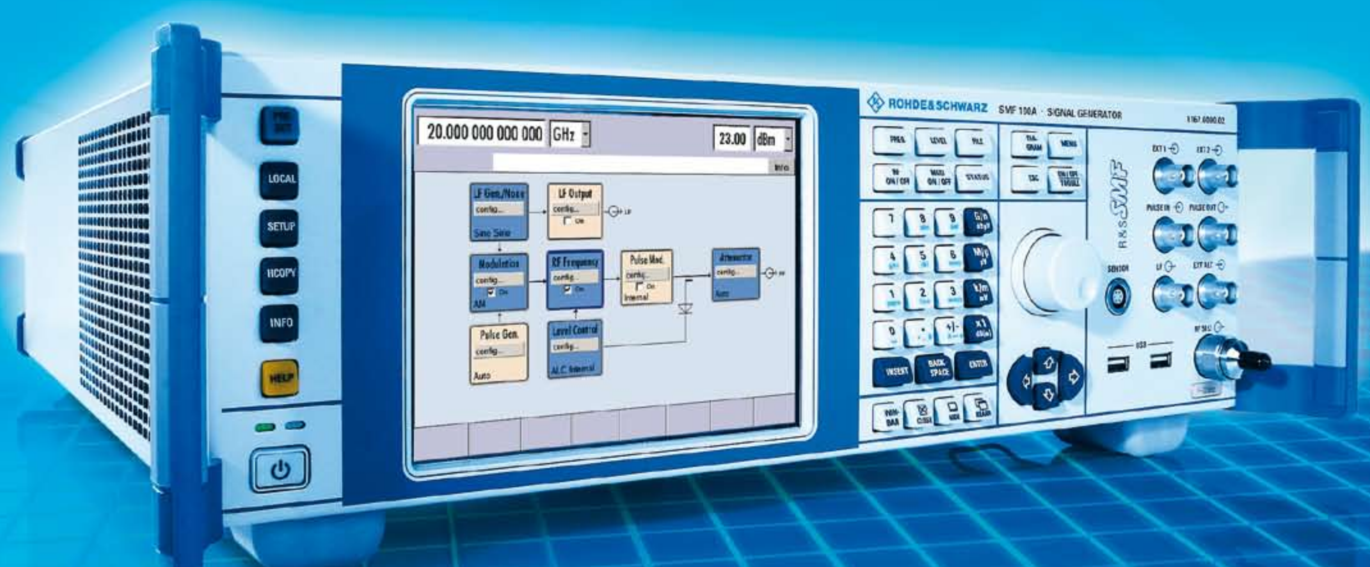
ROHDE&SCHWARZ
LOCAL
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Designed for maximum performance

Signal quality, speed, and flexibility – these are three key criteria by which modern signal generators are assessed. To launch a microwave signal generator that is in the lead in each of these disciplines was the objective in designing the R&S®SMF100A.

Generator of the premium class

To meet the exacting development objectives, Rohde & Schwarz has devised a completely new design concept for the R&S®SMF100A. The result is impressive: The generator's excellent spectral purity, high output level, short frequency and level setting times, and intelligent option concept make the R&S®SMF100A the ideal signal source for any type of application in R&D, production, maintenance, and repair.

While offering an architecture consistently geared to maximum performance, the generator is accommodated in a relatively small box. With a height of three units, a width of 19", and a depth of 550 mm, the generator takes up minimum space on your lab bench or in the rack. And its weight is also acceptable: no more than 18 kg including all options.

High-quality CW generator

To generate premium-quality CW signals in the range 1 GHz to 22 GHz, the R&S®SMF100A requires no more than the R&S®SMF-B122 frequency option. Even in the simplest configuration, the generator provides output power of >+16 dBm between 1 GHz and 11 GHz, and >+14 dBm up to 21 GHz. Between 21 GHz and 22 GHz, output power as high as >+12 dBm is available. Higher output power can be provided by using the R&S®SMF-B31 high output power option in addition to the R&S®SMF-B122 option: The generator then supplies +25 dBm up to 11 GHz, +23 dBm up to 21 GHz, and an extraordinary +22 dBm up to 22 GHz. FIG 1 shows the typical maximum output level versus frequency with and without the high output power option.

The level can be set from –20 dBm to the maximum value with a resolution of 0.01 dB. A high-speed, digital level control ensures low-drift, high-accuracy level setting as well as excellent level repeatability (FIG 2). With remote control, level setting takes less than 3 ms after the IEC/IEEE bus delimiter. And setting times are even shorter in the List mode, i.e. below 700 µs. The List mode is a programmable mode for the sequential setting of maximally 65 000 frequency and level pairs. Intended primarily for frequency hopping, it can also be used for fast frequency and level sweeps.

Levels below –20 dBm are often required, for example to test the sensitivity of communications or radar receivers. For such purposes, various test specifications define power levels between –60 dBm and –110 dBm. This poses no problem for the R&S®SMF100A: The R&S®SMF-B26 step attenuator option, an extremely reliable mechanical attenuator, expands the adjustable level range to –130 dBm.

High output levels in conjunction with short setting times are definitely essential for a premium-class microwave signal generator. A feature of equal importance is spectral purity. The R&S®SMF100A offers an excellent specified single-sideband (SSB) phase noise figure of <–115 dBc, measured at a frequency of 10 GHz at 1 Hz bandwidth and 10 kHz carrier offset. Typically, the generator even attains an unparalleled value of –120 dBc. This outstanding spectral purity makes the generator an ideal reference source for all SSB phase noise measurements in the microwave range. The optional R&S®SMF-B1 OCXO reference oscillator further reduces phase noise close to the carrier (FIG 3).

More information, brochure and data sheet at www.rohde-schwarz.com (search term: SMF100A)

Brochure

Specifications

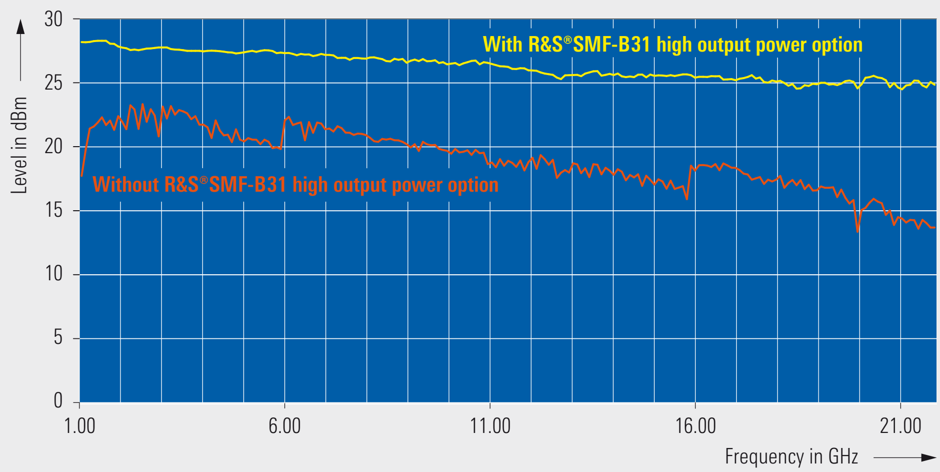

FIG 1 **Maximum output power with and without high output power option.**

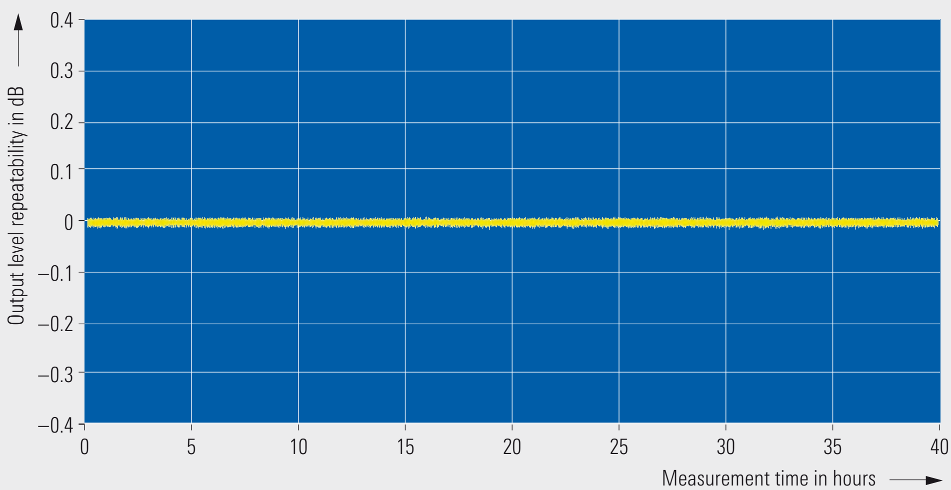

FIG 2 **Level repeatability versus time (with random level and frequency changes carried out during the measurement time).**

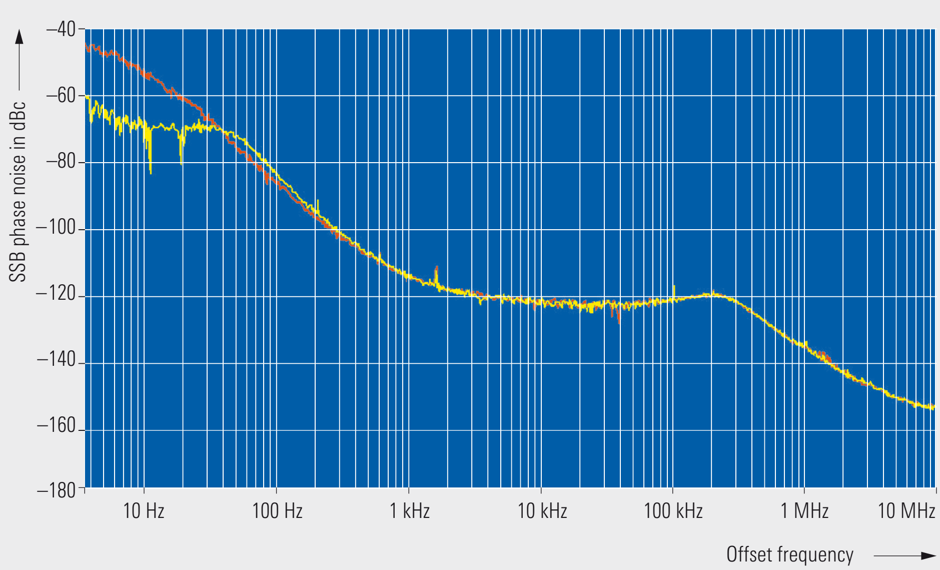

FIG 3 **Typical SSB phase noise at 10 GHz (yellow: with the R&S®SMF-B1 option, red: without the R&S®SMF-B1 option).**

▶ The excellent SSB phase noise of the output signal is the result of an innovative frequency synthesis concept, which also offers other outstanding features: high frequency resolution of 0.001 Hz, extremely high accuracy, excellent stability and, last but not least, short setting times. With remote control, it takes no more than 4 ms to set any frequency within the full range of the generator to an accuracy of $<1\cdot10^{-7}$, as measured after the IEC/IEEE bus delimiter. These very short setting times are again significantly reduced in the List mode mentioned above: Use of this mode brings frequency and level setting times down to less than 700 µs.

Highly flexible signal generator

Featuring a future-proof option concept, the R&S®SMF100A can be expanded from a CW generator to a signal generator as required. From the wide range of options, you can choose only what you really need. Available options for implementing signal generator functionality include the following:

- **R&S®SMF-K3 narrow pulse modulator** for pulse frequencies from 0 Hz to 10 MHz, featuring extremely short rise and fall times of <10 ns, an on/off ratio of >80 dB, and a minimum pulse width of <20 ns – ideal for radar and EMC measurements.
- **R&S®SMF-K23 pulse generator** for pulse periods from 20 ns to 100 s and pulse widths from 5 ns to 100 s. The option generates single and double pulses and thus ideally complements the narrow pulse modulator option.
- **R&S®SMF-B20 modulator** for AM, FM, φM and LOG AM, featuring a modulation bandwidth of DC to 100 kHz for AM, DC to 10 MHz for FM, and DC to 1 MHz for φM. The option also includes a noise generator, as well as two LF generators for sinewave, triangular, squarewave, and trapezoidal waveforms.

Other special features

The R&S®SMF100A can be manually operated via the front panel controls or a USB keyboard and mouse via the two USB interfaces on the front panel. The R&S®SMF-B84 option provides two extra USB interfaces on the rear panel for remote control of the generator and for an additional USB device.

In many applications, it is desirable to transfer instrument settings from one instrument to another quickly and without errors. The solution is to use a USB memory stick: Settings can be transferred to another R&S®SMF100A rapidly by using Save and Recall.

As a special feature, this microwave generator allows you to directly connect an R&S®NRP power sensor (FIG 4). The desired power can thus be set directly on the DUT and displayed on the generator – unaffected by cable loss or any components that may be connected between the generator and the DUT.

The power sensor allows the generator output power to be set with extremely high precision – a vital asset in applications that call for utmost level accuracy.

Versatile applications

FIG 5 shows a typical automatic test assembly as encountered, for example, in the production of microwave components for communications satellites. Such components usually contain n inputs and m outputs that have to be connected to the test equipment. This is done via two remotely controlled switching matrices. To stimulate the DUT, one or more of its inputs are connected to the output of the signal generator via the first switching matrix. The second switching matrix is used to connect one or more outputs of the DUT to the input of a signal analyzer. In this way, the DUT's response to a stimulus can be checked.

FIG 4 A feature that affords many advantages: The high-precision R&S®NRP-Zxx power sensors can be connected directly to the generator.

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The level measurement accuracy offered by power meters is usually significantly higher than the accuracy provided by signal analyzers or generators. For this reason, power meters are additionally connected via the switching matrices. The power meters measure the DUT's input and output levels with high accuracy, and determine correction values for the generator settings and for the results output by the signal analyzer. The correction values increase the measurement accuracy in testing the DUT. A unique feature is that the power meters can be directly connected to the R&S®SMF100A microwave generator, and results read from the generator's display.

Test assemblies like the one described above normally exhibit substantial insertion loss between the signal generator output and the DUT input, especially at operating frequencies above 10 GHz. Depending on the test cabling and the design of the switching matrix, insertion loss may be as high as 10 dB. If special two-port networks such as power dividers or filters are used in addition, insertion loss may even increase to 16 dB and above. Power dividers, which may be used in conjunction with phase shifters, are required, for example, if coherent stimulus signals are needed for the DUT. In the unlikely event that the high output power of the R&S®SMF100A is not sufficient, an extra RF amplifier with the required output power has to be connected between the signal generator and the switching matrix.

Wilhelm Kraemer

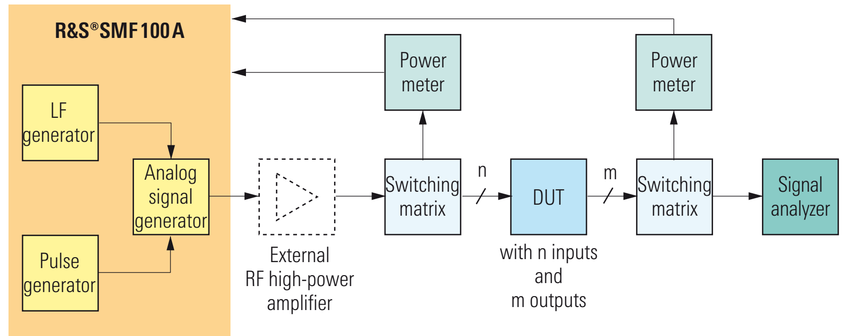

FIG 5 **Typical automatic test assembly for testing microwave modules.**

Condensed data of the R&S®SMF100A

Frequency	
Frequency range	1 GHz to 22 GHz
Setting time	<4 ms
Setting time in List mode	<700 µs
Level	
Setting range	–130 dBm to +30 dBm
Setting time	<3 ms
Setting time in List mode	<700 µs
Spectral purity	
SSB phase noise (at f = 10 GHz, carrier offset 10 kHz, 1 Hz measurement bandwidth)	<–115 dBc (typ. –120 dBc)
Harmonics (at 1 GHz ≤ f ≤ 22 GHz)	<–50 dBc, typ. <–55 dBc
Nonharmonics (at 1 GHz < f ≤ 11 GHz, carrier offset >3 kHz, +10 dBm)	<–62 dBc (typ. –67 dBc)
Wideband noise (at 1 GHz ≤ f ≤ 11 GHz, carrier offset >10 MHz, 1 Hz measurement bandwidth; +10 dBm)	typ. <–148 dBc
Modulation modes with R&S®SMF-B20 option	AM / FM / φM / LOG AM
Interfaces	
Standard	LAN (100BaseT), 2 × USB
With R&S®SMF-B83 option	IEEE 488.2
With R&S®SMF-B84 option	1 × USB, 1 × USB slave
With R&S®SMF-B85 option	removable flash disk

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FIG 1 The R&S®SMA100A high-end signal generator together with the new R&S®SMA-K25 firmware option provides precise signals for comprehensive air navigation receiver testing.

R&S®SMA100A Signal Generator

Precise signals for testing air navigation receivers

The new R&S®SMA-K25 firmware option makes the R&S®SMA100A signal generator (FIG 1) a precise signal source for testing air navigation receivers.

Air navigation signals

VHF omnidirectional radio range (VOR) and instrument landing system (ILS) together with marker beacon (MKR BCN) continue to be used as analog navigation aids in international civil and military air traffic. VOR covers the frequency range from 108 MHz to 117.95 MHz and serves for automatic route navigation between the individual VOR beacons. ILS is used for runway approach and informs the pilot about any drift from the ideal course, thus allowing pure instrument landing if visibility is poor. An ILS localizer (LOC) informs the pilot about the aircraft's lateral position with reference to the optimum approach line and uses the frequency range from 108.1 MHz to 111.95 MHz. ILS glideslope (GS), operating in the frequency range from 329 MHz to 335 MHz, is used to monitor the angle of approach during let down. The marker beacon includes three radio beacons, located at a distance of 7200 m, 1050 m, and 300 m in front of the runway, which emit signals between 74.6 MHz and 75.4 MHz. They help to ensure the correct altitude during approach.

Earlier automatic direction finder (ADF) systems are also sometimes still used in route navigation. They determine the direction by using non-directional beacons (NDB) in the frequency range from 190 kHz to 1.75 MHz.

Equipped with the R&S®SMA-K25 firmware option, the R&S®SMA100A signal generator can now handle all above-mentioned modulation modes used in air navigation.

Digital signals of utmost quality

High precision of all set parameters is ensured by the purely digital generation of modulation signals. All important setting values for simulating real signals, e.g. the phase angle of modulation signals when applying VOR or the AM deviation difference (DDM) when applying ILS, can be set or varied as required.

The signal generator can also create specific pulsed modulation signals in accordance with the ICAO standard. To be able to distinguish between the three radio beacons during approach, the modulation signals are sent with different pulse-pause codings. Moreover, a VOR station or airport identifier (MUC for Munich, for example) can be added for all modulation modes via a COM/ID signal that is pulsed in accordance with the international Morse alphabet. You can activate the codings in the corresponding operating menu by pressing a button and modify the parameters.

The "ideal" modulation signal is directly provided at the LF generator output and can be fed into receiver modules.

Excellent RF performance

In addition to highly accurate modulation signal generation, the low frequency and phase response of the AM modulator are critical for the quality of the modulated RF signal (FIG 2). Level accuracy, stability, and linearity (FIG 3) are also essential parameters in receiver testing. Another extremely important factor in blocking and selectivity measurements on receivers is spectral purity (phase noise, broadband noise, and nonharmonics) of the signal generator. When performing these measurements, the response threshold of a receiver is tested which, at the same time, receives a jammer of far higher level in the adjacent channel. To avoid having the measurement result corrupted, the power sent from the jammer into the useful channel should be kept to a minimum. With regard to all these parameters, the R&S®SMA100A offers excellent signal performance, thus minimizing the measurement uncertainty of a test setup and increasing the reproducibility of measurements.

Most important settings of the R&S®SMA-K25 option

- Four different VOR test modes (Norm, Var, Subcarrier, Subcarrier + FM)
- Three different ILS test modes (Norm, 90 Hz, 150 Hz)
- Pulsed marker beacon in line with ICAO, Annex 10
- VOR bearing angle (REF to VAR) at a resolution of 0.01°
- ILS DDM resolution 10^{-4}
- AM deviation of all signals in 0.1% steps
- Frequencies of all signals at a resolution of 0.1 Hz
- COM/ID signal pulsed in line with international Morse alphabet can be added
- External AM interfering signal can be added

Clear-cut, convenient, and user-friendly

Not only does the R&S®SMA100A have excellent technical characteristics, its user-friendly operating concept and the clear-cut display of parameters on the built-in color monitor (FIG 4) make the signal generator an impressive tool. At a keystroke, you can use the appropriate standard mode as well as special modes to suppress specific signals in order to conveniently test the relevant alarm function of a receiver. If desired, you can also easily set all VOR / ILS / MKR BCN channels defined in the ICAO standard one after the other using the rotary knob.

All the parameters of the signal generator can of course be remote-controlled via IEC / IEEE bus or LAN, allowing you to perform automated test sequences in a very short time.

Owing to its compact design, the signal generator only requires two height units in a rack. Its light weight of less than 10 kg makes the instrument very easy to transport and thus suitable for a wide range of tasks. Equipped with the R&S®SMA-B46 option, it also meets the MIL-PRF-28800F requirements for an operating altitude up to 4600 m.

Summary

The R&S®SMA-K25 firmware option combines the special functions for generating air navigation signals with the versatile characteristics of an analog high-end signal generator [1, 2].

Jürgen Ostermeier

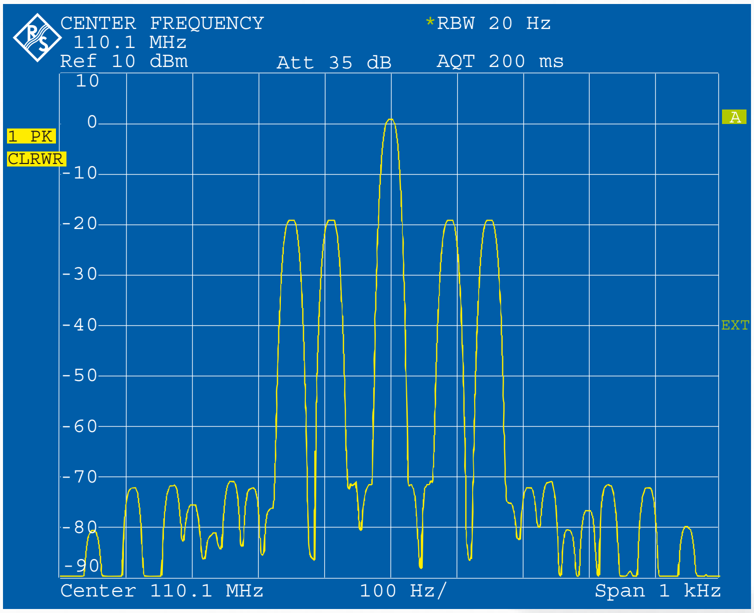


FIG 2 ILS/LOC spectrum with DDM = 0.

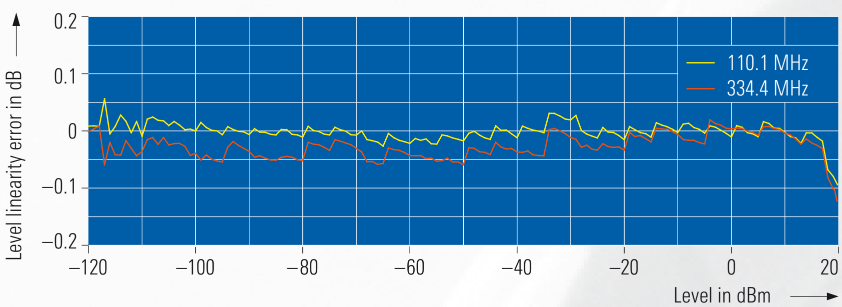


FIG 3 Level linearity error at 110.1 MHz and 334.4 MHz.

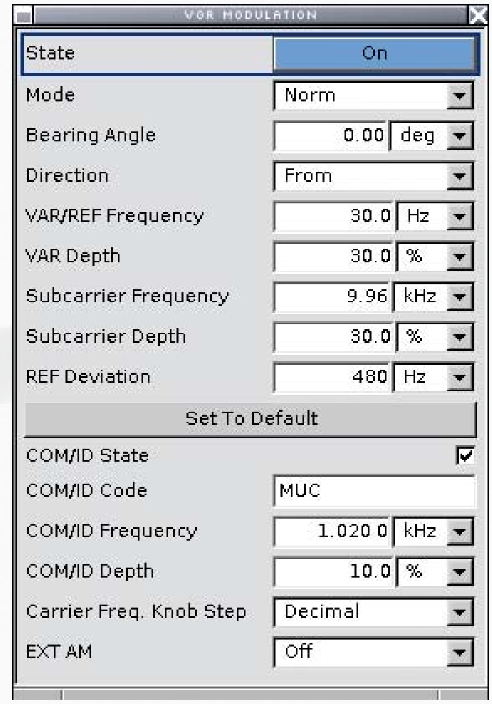
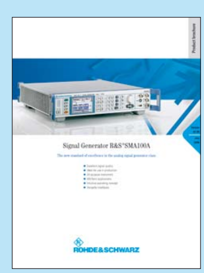


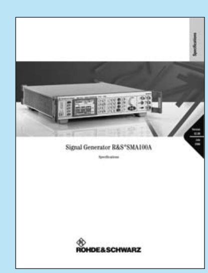
FIG 4 Clear-cut and user-friendly display: all parameters of the VOR menu.

Condensed data of the R&S®SMA100A

Frequency	
Frequency range	9 kHz to 3 GHz / 6 GHz
Level	
Level range	–145 dBm to +28 dBm
Level uncertainty (–120 dBm to +18 dBm)	<0.5 dB
Spectral purity	
Nonharmonics	
f < 1.5 GHz and offset > 10 kHz	<80 dBc
SSB phase noise	
f = 100 MHz and 20 kHz offset	typ. –151 dBc (1 Hz)
Wideband noise	
6.6 MHz < f < 750 MHz and 10 MHz offset	<–152 dBc (1 Hz)
Modulation modes	
AM / pulse modulation	standard
FM / φM	R&S®SMA-B20 option
VOR / ILS / MKR BCN / ADF	R&S®SMA-K25 option
Inaccuracy of VOR bearing angle	<0.05°
DDM inaccuracy	<0.0004 (at DDM = 0)
AM deviation error	<2% of set deviation
Frequency error of modulation signal	<0.02 Hz
Interfaces	IEC / IEEE bus, LAN, USB
Environmental conditions	
Operating temperature range	0 °C to 55 °C
Max. operating altitude	3000 m (standard) 4600 m (R&S®SMA-B46 option)

More information, brochure, and specifications at www.rohde-schwarz.com (search term: SMA100)



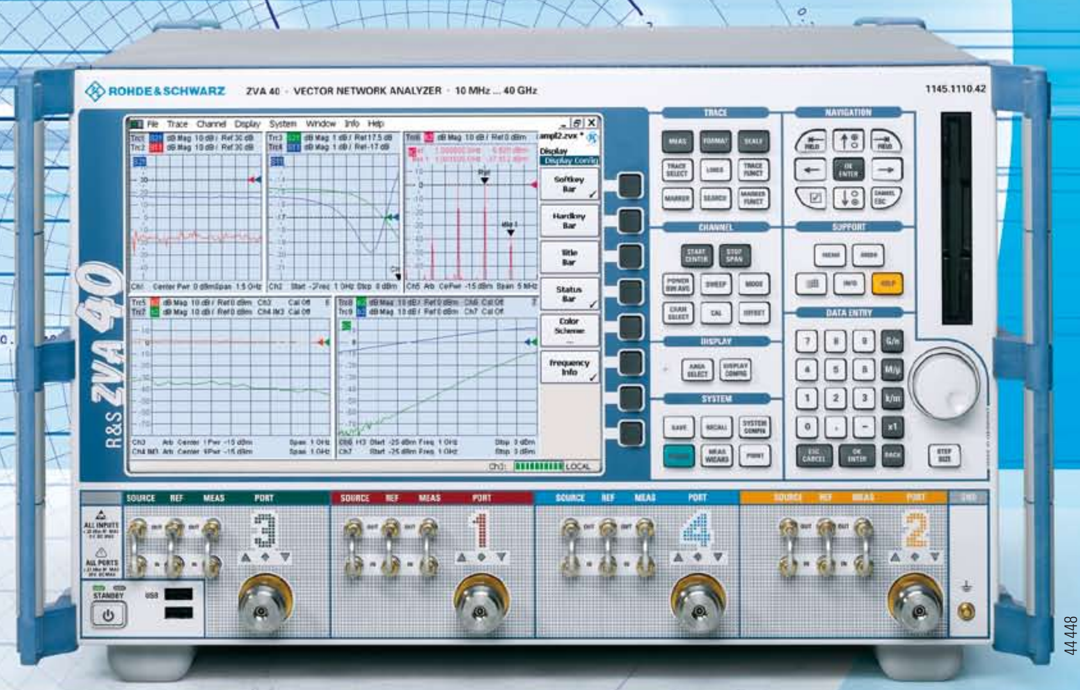


REFERENCES

[1] Signal Generator R&S®SMA100A – Analog signal generator that meets virtually every requirement. News from Rohde & Schwarz (2005) No. 189, pp 30–34

[2] R&S®SMA100A Signal Generator – Frequency doubled: spectrally purest signals now up to 6 GHz. News from Rohde & Schwarz (2006) No. 191, pp 29–31

The high-end network analyzers from Rohde & Schwarz now include an option for pulse profile measurements – plus, the new R&S® ZVA 40 covers the frequency range up to 40 GHz.



Easy-to-use pulse profile measurements up to 40 GHz

Equipped with the new R&S®ZVA-K7 pulsed measurements option, the R&S®ZVA and R&S®ZVT network analyzers test the time-dependent characteristics of amplifiers and mixers under pulsed conditions and measure the absolute power, magnitude, and phase of S-parameters with a resolution of 12.5 ns.

The R&S®ZVA 40 is a high-end network analyzer with two or four test ports and a frequency range from 10 MHz to 40 GHz. Its exceptionally high output power of more than 13 dBm, a power sweep range up to 50 dB, a dynamic range exceeding 135 dB, and the short measurement time of 3.5 μs per test point make the R&S®ZVA 40 the ideal tool for research and development applications in the microwave range. The high output power and the second internal source of the four-port instrument ensures fast and accurate compression, intermodulation, and hot S-parameter measurements on amplifiers and mixers also under pulsed conditions.

Why make things more difficult …

In a wide range of applications, DUTs must be characterized by using pulsed signals instead of CW signals. This procedure reduces the average power in on-wafer measurements to prevent thermal destruction of the DUT. Moreover, power amplifiers in mobile phones or radar output stages only exhibit the desired qualities under pulsed stimulus conditions. The DUT behavior often changes during the pulse duration (FIG 4). The pulse widths for these applications vary between some 100 ns and several microseconds. To test the behavior of the pulsed components as a function of time, i.e. to perform a pulse profile measurement, the network analyzer must feature a time resolution that is significantly higher than the pulse duration.

The time resolution of conventional network analyzers ranges from 3 μs to 20 μs for measurements in the frequency or time domain. To achieve resolutions in the nanosecond range, additional external hardware and software were previously required. This old technique chops the pulsed signals to be measured again, and the pulse profile is calculated offline in accordance with the average pulse method. Such elaborate test setups are expensive and difficult to operate. Moreover, measurement speed, accuracy, and dynamic range are intrinsically limited.

… when they can be so simple

Equipped with the new R&S®ZVA-K7 pulsed measurements option, the network analyzers of the R&S®ZVA family [1] and the R&S®ZVT network analyzer [2] analyze pulses with widths of less than 1 μs at high resolution. In this article, we will use the R&S®ZVA 40 as an example. The measurements allow intuitive and easy operation and are outstanding for their high measurement speed. The option uses the large IF bandwidth of the R&S®ZVA receivers plus special hardware (FIGs 1 and 2).

The method in detail

The R&S®ZVA samples the IF-converted signal at a rate of 80 MHz. A digital signal processor usually filters the collected data before the main processor calculates the error-corrected S-parameters and displays them on the screen. In addition to the sampling time, there is a data processing time of 1 μs to 2 μs between two test points, which used to be the bottleneck when it came to high-resolution measurements in the time domain. To avoid this bottleneck, the sampled raw data is first stored during the pulse profile measurement without filtering, ensuring that no delay occurs between the samples of the individual test points. When the recording process is finished, the analyzer software further processes this data; i.e. in this mode, the main processor of the network analyzer performs digital filtering in addition to error correction.

Because the sampling rate of the A/D converter is 80 MHz, a measurement result is output every 12.5 ns, i.e. the time resolution is 12.5 ns. The large memory depth of the R&S®ZVA allows a recording time of 3 ms for all wave quantities. The trigger signal, which is usually derived from the rising edge of the pulse, determines the zero point in time. It is thus possible to display events that start prior to the trigger point, and an exact time correlation between the trigger signal and the RF pulse can be established (FIG 3). Such a correlation is especially important for determining the correct trigger delay in point-in-pulse measurements versus frequency or power.

Owing to this progressive method, the R&S®ZVA performs extremely fast pulsed measurements. With more than 10 sweeps/s at 1001 test points, DUTs can easily be adjusted during the pulse profile measurement (FIG 4). The pulse profile measurement performed with the R&S®ZVA is not limited to periodic signals, as is the case with conventional measurement methods – it is also suitable for analyzing single and double pulses as well as user-defined pulse trains.

DUTs with very short group delay

Measuring the S-parameters of DUTs with group delays that are of the same order as the pulse width is often difficult or even impossible, because a signal may no longer be present at the DUT input by the time the network analyzer can measure this signal at the DUT's output. However, the value of s_{21} is only correct for measurements with a phase of temporal signal overlapping. FIG 5 shows the measurement of the wave quantities and S-parameters of a DUT with a group delay of 100 ns. The R&S®ZVA solves this issue by means of a time offset: Before calculating the S-parameters, it mathematically shifts the wave quantities by the DUT's group delay. Each wave quantity can be assigned a specific time delay, depending on the stimulating port (FIG 6). After the delayed signal has been offset, the R&S®ZVA correctly displays the gain s_{21} versus the entire pulse duration (FIG 7).

Measurements with pulse-modulated input signals

For applications where the DUT requires a pulse-modulated input signal, a generator with pulse modulation such as the R&S®SMA100A or R&S®SMR can be used. By directly accessing the generator path by means of the R&S®ZVA-B16 option, the pulse-modulated RF signal of the generator (instead of the CW signal) is directly applied to the R&S®ZVA test set (FIG 8). This setup is also suitable for pulsed measurements versus frequency and power, as the R&S®ZVA controls external generators via LAN or IEC/IEEE bus. Because the pulsed signal passes the internal coupler, it is also measured by the reference receiver, thus permitting system-error-corrected s_{11} and s_{21} measurements. A system error or power calibration recorded

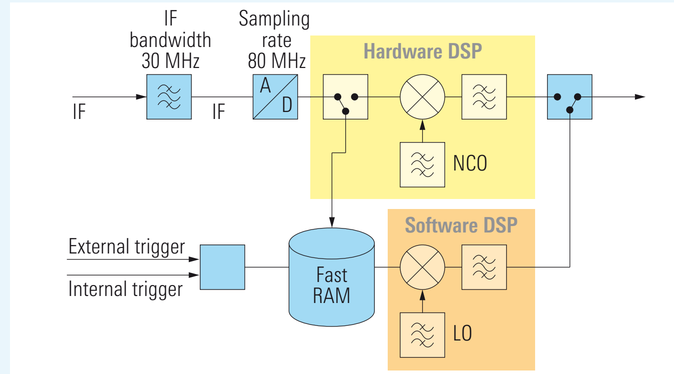


FIG 1 Signal flow during pulse profile measurements using the R&S®ZVA-K7 option.

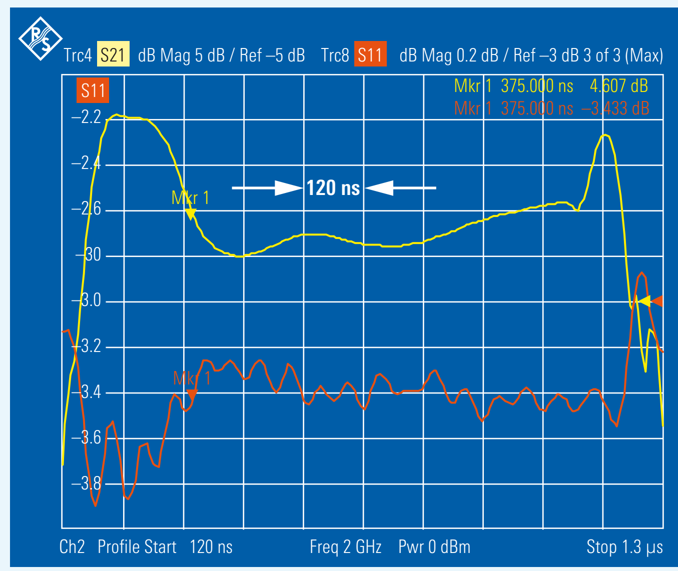


FIG 4 Pulse profile of the S-parameters of an amplifier.

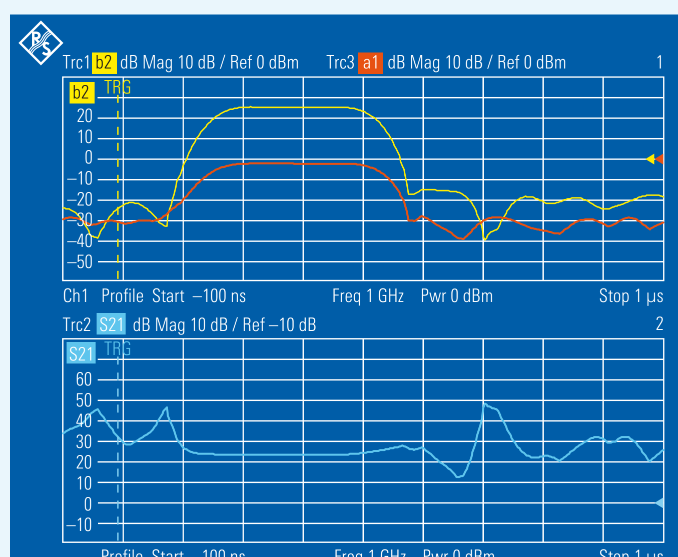


FIG 7 Measurement result after a time offset of the output signal b2 by 100 ns.

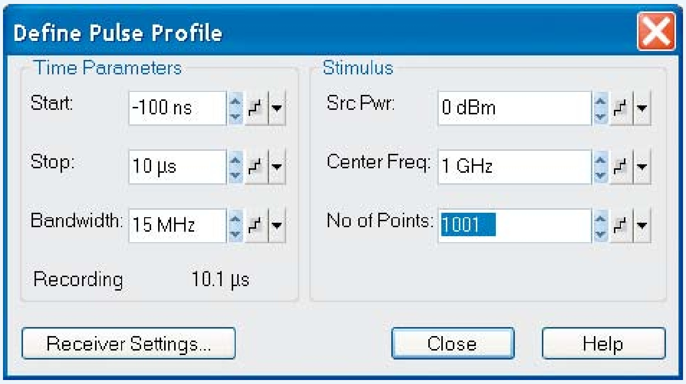


FIG 2 Dialog for configuring the pulse profile measurement.

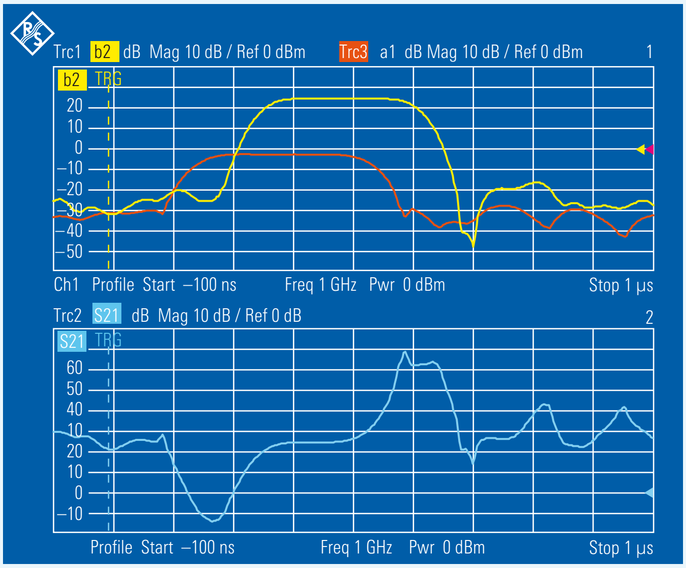


FIG 5 DUT with 100 ns group delay: input signal (red), output signal (yellow), and s_{21} (blue).

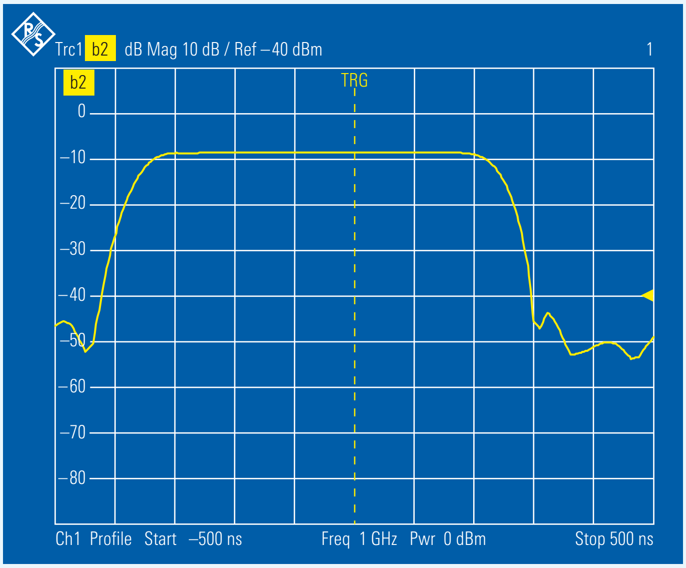


FIG 3 Pulse profile of a wave quantity with trigger signal.

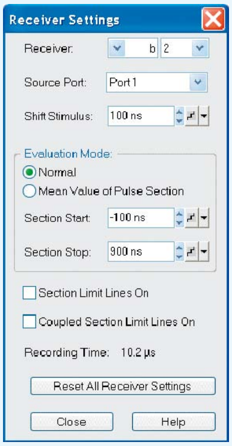


FIG 6
Dialog for delay compensation.

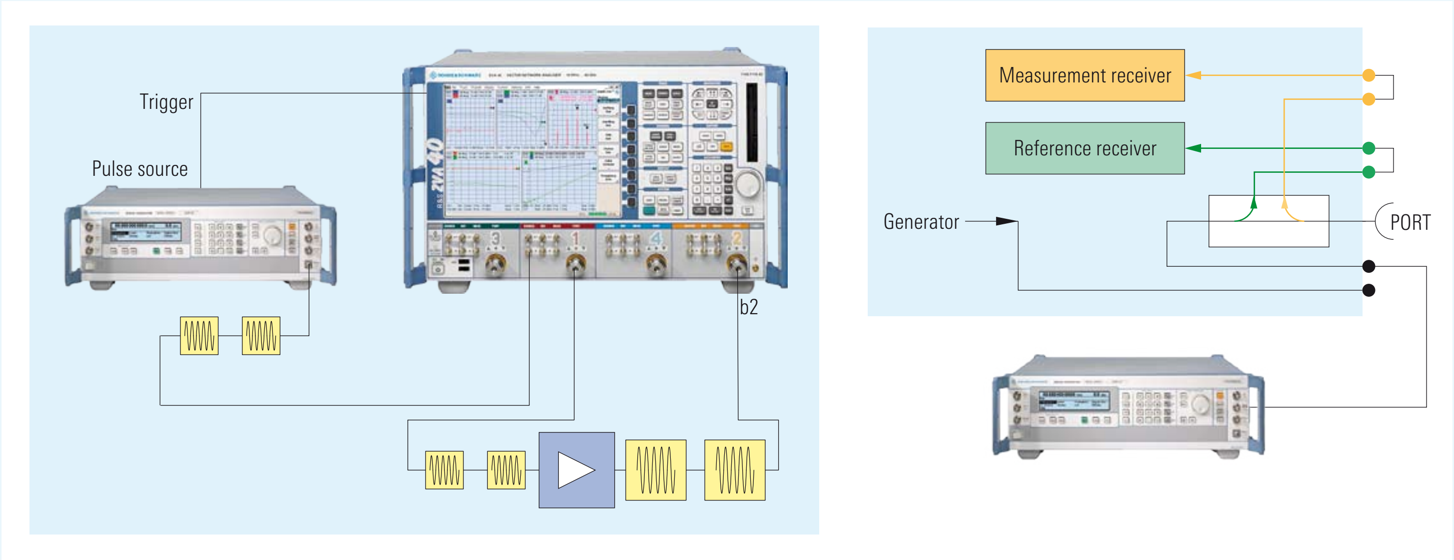


FIG 8 Test setup with an external generator with pulse modulation.

under CW conditions thus also applies under pulsed conditions and need not be repeated even when the duty cycle is changed.

Instead of the external pulse generator, a pulse modulator can be inserted into the generator path (FIG 9), enabling bidirectional measurements and thus also complete two-port calibrations. With a modulator connected to port 1, the forward parameters s_{11} and s_{21} are measured under pulsed stimulus conditions, and the reverse parameters s_{12} and s_{22} under non-pulsed stimulus conditions. If pulsed signals are to be used for both measurements, a second modulator is connected to port 2. Only an additional arbitrary waveform generator is required for a pulsed DUT (FIG 10).

Frequency-converting measurements such as the conversion loss of mixers can also be performed. In this case, the second internal source of the R&S®ZVA is the ideal local oscillator.

Summary

The R&S®ZVA-K7 option allows the time-dependent behavior of amplifiers and mixers to be analyzed with a resolution of 12.5 ns. Operation and test setup are mere child's play. Further benefits include a wide dynamic range and high measurement speed. The option processes single pulses, periodic pulses, and user-defined pulse trains.

Thilo Bednorz

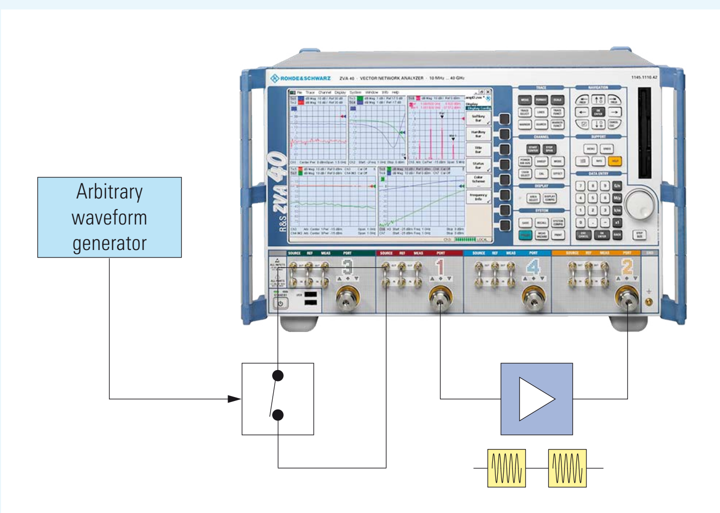


FIG 9
Test setup with pulse modulator.

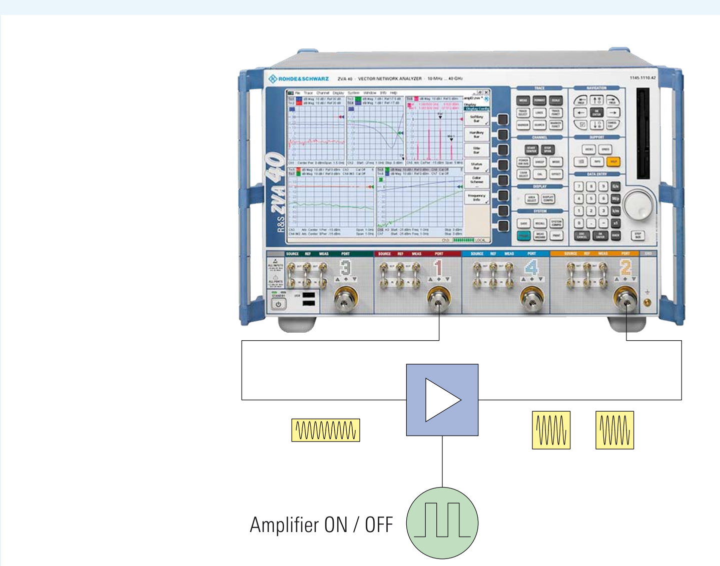


FIG 10
Test setup with pulsed DUT.

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

REFERENCES
[1] Vector Network Analyzer R&S®ZVA: High-end network analyzer – future-proof and extremely fast. News from Rohde & Schwarz (2005) No. 188, pp 26–31
[2] Vector Network Analyzer R&S®ZVT8: Unrivaled: up to eight test ports in a single unit. News from Rohde & Schwarz (2006) No. 189, pp 26–29

R&S®NRP-Z81 Wideband Power Sensor

State-of-the-art technology for wireless digital communications

A new sensor for the R&S®NRP power meter now offers the complete functionality required today for high-frequency power measurements: 30 MHz video bandwidth for power envelope analysis, short measurement times, and 80 dB dynamic range for average power measurements.

More and more in demand: power envelope analysis

Measuring electrical power in the RF and microwave range has long been a task for sophisticated T&M equipment. While in the beginning the key requirement was high measurement speed combined with high measurement accuracy, power envelope analysis is now increasingly required. This includes waveform, peak and average values, rise and fall times, and statistical distribution. Once again, the driving force is wireless digital communications technology with its complex RF signals. For example, hundreds of thousands of new base stations are put into operation every year, and their output power has to be tested in production, installation, and as part of routine maintenance. For this task, all manufacturers rely on power meters – and increasingly on those from Rohde & Schwarz.

This latest member of the R&S®NRP instrument family (FIG 1) is another superior-quality power sensor, as it measures all the parameters you expect from a peak power meter, with or without a base unit:

FIG 1
R&S®NRP power meter with R&S®NRP-Z81 wideband power sensor.

- Power envelope as a function of time
- Statistical power distribution
- Average power

The sensor features a frequency range from 50 MHz to 18 GHz, a lower measurement limit of approx. –60 dBm for average power measurements, and approx. –47 dBm for envelope power measurements. This ample functionality is accommodated in a compact box no larger than that of its predecessors and, like them, capable of remote control from a PC via USB. In short: state-of-the-art technology that can handle present and future measurement tasks, unrivaled in functionality, size, and price.

Oscillographic power measurements

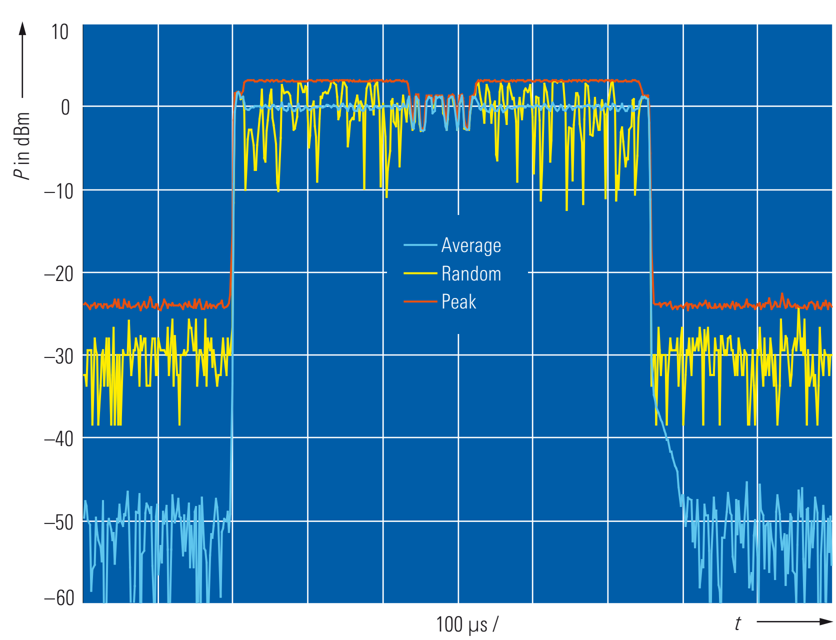
The primary feature that distinguishes the new power sensor from its predecessors – the R&S®NRP-Z11 and the R&S®NRP-Z21 / 22 / 23 / 24 – is its large video bandwidth of 30 MHz for carrier frequencies above 500 MHz. This in conjunction with a continuous sampling rate of 80 million values per second, i.e. a time resolution of 12.5 ns, is sufficient for displaying the envelope power of radar pulses and analyzing all current transmission methods based on digital modulation: TDMA (e.g. GSM/EDGE), OFDM (e.g. WiMAX, IEEE 802.11 a / b / g, 3.9G) and (W)CDMA, as well as RF carriers that are a combination of such signals (multicarriers). It is thus possible to perform oscillographic measurements of the power envelope – with the accuracy that is expected from power meters.

For the display of the power envelope, the fully processed measured data is output as pixels, i.e. measured power can be displayed directly. While 250 pixels are normally sufficient for displaying a trace, the sensor can deliver up to 8192 pixels, which means a safe margin satisfying even exacting demands on display resolution. As each pixel represents a time interval and thus usually comprises many samples, it may be useful to output different values for each pixel in order to characterize the specific time interval. The sensor therefore supplies the following: a random sample representing the waveform characteristic, the average value for a display with reduced noise, and the maximum and the minimum value – all in realtime, without time-consuming post-processing (FIG 2). The display of average values allows even extremely small powers to be measured.

And here is one of the strengths of the new power sensor: Whereas conventional peak power meters fail when it comes to measuring signal details below –30 dBm, the R&S®NRP-Z81 power sensor performs such measurements down to approx. –47 dBm. This is made possible by a chopper that switches synchronously with the signal (see box on page 35). It reduces zero drift and zero offset to a minimum and allows noise reduction to virtually any level by averaging several traces.

An oscilloscope is only as good as its trigger capabilities. Therefore, the new power sensor offers everything that is needed in practice: internal or external triggering on single-shot or repetitive events, and various types of trigger qualification. These include the conventional hold-off, as well as defining a trigger hysteresis or a drop-out parameter, which enables triggering only if the signal is below the trigger threshold for a minimum period of time. Pretriggering can be selected if the trigger event occurs after the signal section to be recorded. The start of a measurement can be shifted to an earlier point by up to 4096 pixels, i.e. a multiple of the recording time with conventional screen display. The video bandwidth can be reduced to 5 MHz, 1.5 MHz, and 300 kHz in order to increase trigger sensitivity and reduce noise.

FIG 2 Power envelope of a GSM EDGE signal, measured with the R&S®NRP-Z81. The three traces display different pixel representations. Blue: average values; yellow: random values; red: peak values.



The wideband power sensor in detail

Analyzing signals with large RF bandwidth often strains the performance limits of conventional diode power sensors: They are not able to follow the rapidly changing signal envelope. The diode detector then outputs a signal from which the profile of the measured quantity can no longer be properly reconstructed. This is aggravated by nonlinear distortion outside the square-law region of the detector diode, rendering even average power measurement impossible.

Therefore, the signal processing chain in a wideband power sensor starts with a diode detector that is designed such that its rise time, and particularly its fall time, are shorter than those of the measured signal. In the case of the R&S®NRP-Z81 sensor (FIGs 3 and 4), the detector is followed by a switch that cyclically reverses the polarity of the detector signal when several measurements are averaged. This process is referred to as chopping. This helps to minimize the zero offset and to change the spectral composition of the display noise so that the noise can be reduced as required by means of averaging. With conventional peak power meters without a chopper, noise can be reduced only to a certain extent due to the 1/f noise component. This means that high-resolution measurements are not possible.

All this is only possible on the basis of powerful digital signal processing, which in turn requires a sufficient input: In the case of the R&S®NRP-Z81 power sensor, this is 80 million samples per second. The R&S®NRP-Z81 immediately calculates the equivalent instantaneous power for each sample depending on the set RF carrier frequency, the current sensor temperature, and the measured signal amplitude. These calculations are based on a comprehensive set of calibration data that is compiled individually for each sensor. The data is so accurate and so finely graduated that the raw detector characteristic is optimally corrected. And because this correction data is valid throughout the life of the sensor, recalibration requires only a normal power calibration system.

FIG 3 Compact, high-precision electronic design: internal circuitry of the R&S®NRP-Z81 wideband power sensor.

Calculating the instantaneous power already constitutes the main step in signal processing. What follows is correct time allocation in the case of triggered measurements, the combination of samples into pixels or average-power values, the extraction of extreme values, and statistical analysis. All this is performed by a highly complex FPGA of the latest generation.

What distinguishes the R&S®NRP-Z81 power sensor from comparable products is that its complete signal processing – from the microwave frontend to the output of results – is integrated in a highly compact box. One of the advantages this affords for the user is absolute immunity to interference, even when the sensor is exposed to strong electromagnetic fields as may occur in EMC tests, for example.

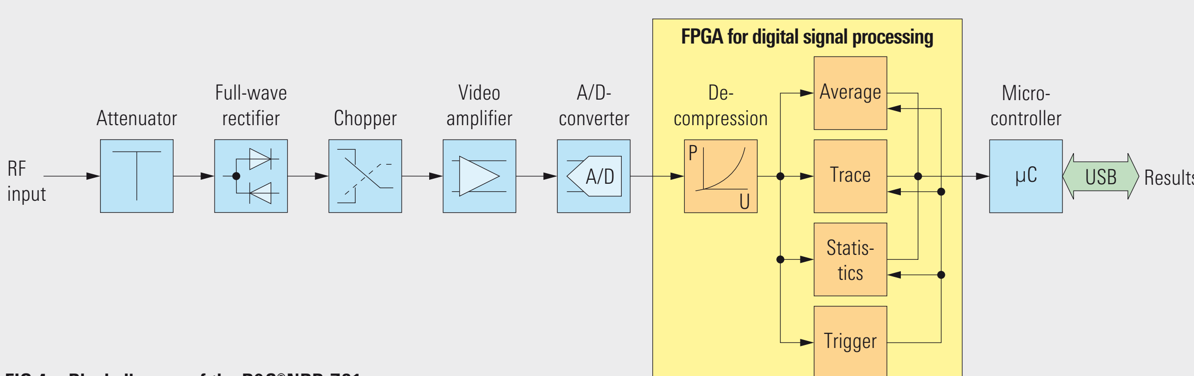


FIG 4 Block diagram of the R&S®NRP-Z81 power sensor.

Statistical analysis

More and more often, high-frequency signals are modulated in such a way that their power envelope assumes a stochastic character, with the result that their representation versus time yields hardly any useful information. Time-domain representation then has to be replaced by statistical analysis. A method commonly employed is, for example, to calculate the complementary cumulative distribution function (CCDF), which indicates the probability of signal peaks occurring above a defined power threshold.

Here, too, speed is what counts, and this has been the difficulty so far. The R&S®NRP-Z81 power sensor solves this problem in realtime, i.e. in less than 25 ms. This is the time it takes for the sensor to record and analyze one million samples. It is thus possible to monitor changes in the signal composition virtually without delay. If a smaller number of samples, i.e. 100 000 values, is sufficient, the process is accelerated accordingly. The video bandwidth can be reduced in this case, too, and the measurement performed synchronously with the signal. Statistical analysis will then cover only a specific signal section, whose position and duration can be exactly defined (FIG 5). The results of statistical analysis are likewise processed such that they can be directly displayed in graphical form. The level range and the number of pixels are user-definable within wide limits; resolution as high as 0.006 dB per pixel can be selected. Instead of a CCDF, the result can be output as a probability density function (PDF).

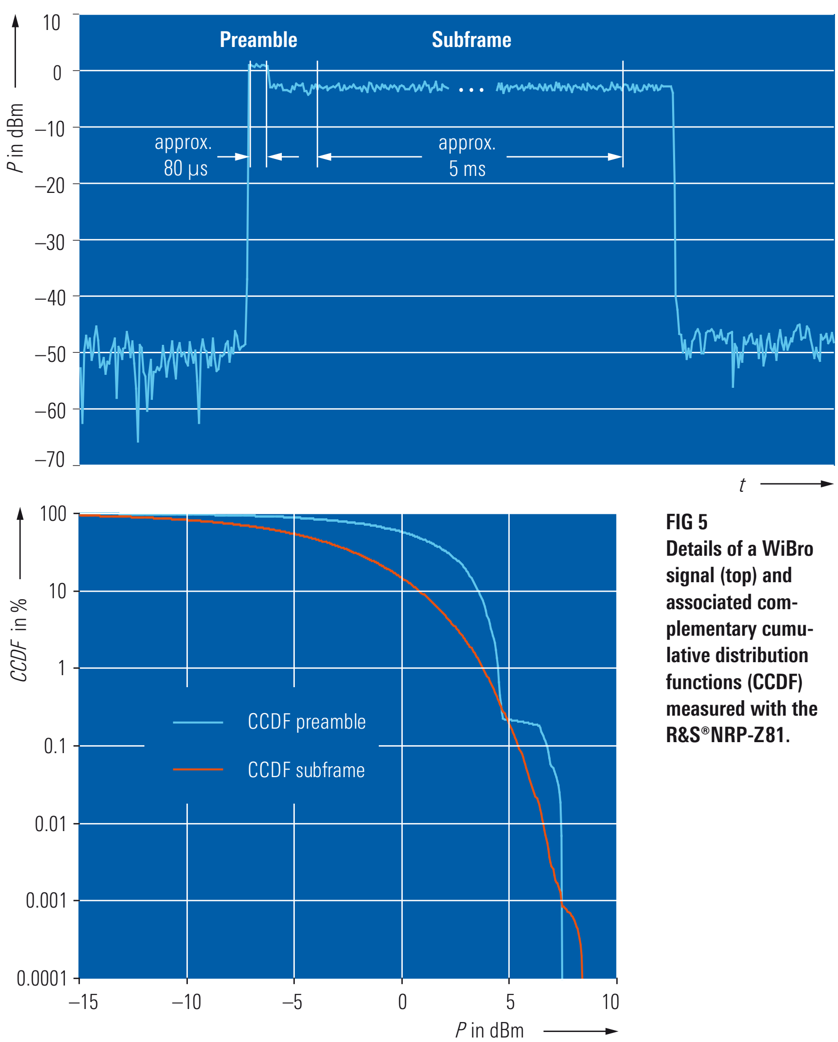


FIG 5
Details of a WiBro signal (top) and associated complementary cumulative distribution functions (CCDF) measured with the R&S®NRP-Z81.

Average power measurement for utmost accuracy

The rule of the golden mean applies also, and especially, to power measurement. For this reason, the R&S®NRP-Z81 offers various functions for measuring average power:

- **Cont Av** Continuous average power
- **Timeslot Av** Average power over signal-synchronized measurement windows (gates)
- **Burst Av** Average power of bursts

The above modes have in common that they determine average power over a defined time interval. In the Cont Av mode, this is done continuously without any reference to the signal, comparable to the operation of a thermal power meter. In the Burst Av mode, the beginning and the end of the measurement are automatically determined by the rising and falling edges of the burst – the ideal function for measuring pulsed signal power with a minimum number of settings. Exclusion periods at the beginning and the end can be defined.

The Timeslot Av mode for signal-synchronized measurements offers even greater versatility. The gate duration can be selected from a range including six decades (50 ns to 100 ms). Exclusion periods can be defined not only at the beginning and the end, but also within a gate. The position and duration of exclusion periods are defined by the user alone. Up to 16 gates can be linked to yield a timeslot structure. It is thus possible to measure power over all timeslots of a TDMA signal in one go.

Actually a matter of course and yet a completely new feature for wideband sensors is the wide dynamic range available for the averaging modes. With continuous averaging, for example, it extends from –60 dBm to +20 dBm – not only for CW signals but also for signals with any type of modulation. This is the logical consequence of a superior concept.

Extras included

It goes without saying that the new sensor includes all the tried and tested features of the R&S®NRP-Zx power sensors already established on the market:

- **Fixed noise mode** for the auto-averaging filter
- **Gamma correction** for increased measurement accuracy with DUTs exhibiting substantial mismatch
- **S-parameter correction** allowing users to easily take into account attenuators, directional couplers or amplifiers connected ahead of the DUT in the measurement result

For the continuous output of results, the output rate can be reduced as far as necessary to prevent overload of the controlling host. This could easily happen in the past when R&S®NRP sensors were operating at their speed limits, for example with very short measurement windows or with sliding averaging. Output rate reduction is therefore also available for the existing range of power sensors. It can be downloaded as part of a free-of-charge firmware update from the Rohde & Schwarz website and installed in only a few seconds.

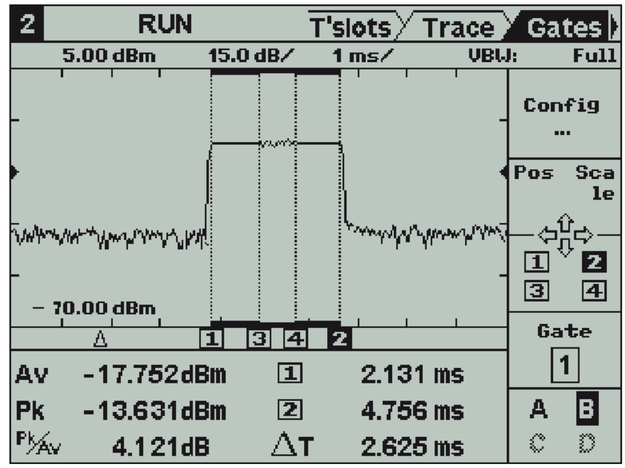


FIG 6 Enlarged area for trace and new softkeys: redesigned user interface of the R&S®NRP in the Trace / Gate mode.

Control and output of results

The new sensor, like all other R&S®NRP sensors, can be controlled from a PC, the R&S®NRP base unit, or any other Rohde & Schwarz instrument. The sensor therefore comes with drivers that support the complete sensor functionality.

The operating concept of the R&S®NRP base unit has been completely redesigned (FIG 6):

- Enlarged waveform display
- Simplified scaling and positioning of waveforms by direct key control
- More directly controllable functions with new softkey bar
- Gate and marker functions now separate; display of peak power and peak-to-average ratio

The existing range of sensors also benefits from the improvements in the control of the base unit. It is therefore advisable to download the current R&S®NRP firmware version from the Internet.

Future developments

The R&S®NRP instrument family will be continuously enhanced with the focus on customer benefit: high quality at an affordable price, always at the forefront of the technological development – true to the motto "just plug and play".

Thomas Reichel

To learn how the R&S®NRP-Zxx power sensors perform EIRP measurements on satellite signals, refer to the next page.

More information at www.rohde-schwarz.com (search term: NRP / NRP-Z81)

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FIG 1 The R&S®NRP-Zxx power sensors are standalone measuring instruments capable of communicating with a PC via USB, and thus an ideal choice also for measurements on antenna systems.

EIRP measurements in the receive path of satellite links present a special challenge for T&M equipment in commercial satellite communications – and a new field of applications for the R&S®NRP-Zxx series of power sensors (FIG 1). The sensors measure EIRP at the detached antenna system of a Eutelsat earth station – with high accuracy and speed and excellent long-term and temperature stability, and remotely controlled via USB.

R&S®NRP Power Meters

Smart solution for satellite level monitoring

Satellite signals – subject to a variety of influences

Satellite links are indispensable in sound and TV broadcasting and in worldwide communications via telephone, the Internet, or mobile radio. Smooth, round-the-clock operation must therefore be ensured in particular for commercial systems.

However, if satellite signals arrive at an earth station with insufficient field strength, this may cause serious problems. The bit error ratio (BER) increases rapidly, to an extent that a communications link may be rendered useless. Such detrimental effects are attributable to a variety of causes. In many cases, atmospheric influences affect wave propagation: fog, clouds, and precipitation attenuate signals and also increase noise. Errors in antenna alignment may result in only part of the available power being picked up. This applies in particular to large, high-directivity parabolic antennas. Close attention must also be paid to the ambient conditions under which receiving systems have to operate: Many satellite antennas are installed in the open, i.e. they have to withstand humidity, extreme temperatures, and mechanical stress caused by wind load. This also has a negative effect on signal quality, which is aggravated by the effects of wear and tear that occur over the course of time.

Although the above effects increase attenuation on the transmission path by a few decibels only, this may easily exceed the capabilities of the background correction algorithms. This is due to the fact that only relatively low headroom is provided for the carrier-to-noise (C/N) ratio. This is by no means a planning error, but the result of economic considerations. Because, if the level of the incoming signal – which arrives at the antenna at approx. –115 dBm – were increased by a mere 3 dB in the interest of higher safety, either the satellite transmit power would have to be doubled or the diameter of the receiving antenna enlarged by 50 %. The more meaningful approach therefore is to invest in appropriate alternative strategies to make full use of the existing, scarce resources. This includes the continuous monitoring of the receive power in order to prevent creeping degradation of the system.

EIRP: the power that matters

To obtain comparable results of the receive power independently of the receive antenna characteristics, the equivalent isotropic radiated power (*EIRP*) of the satellite is calculated from the receive power. The *EIRP* is the power the satellite must radiate so that the measured receive power is obtained. For this calculation, it is assumed that an isotropic transmit antenna is used, i.e. an antenna that uniformly radiates in all directions.

$$\frac{EIRP}{\mathrm{dBW}} = \frac{P_{\mathrm{RX}}}{\mathrm{dBm}} + \frac{G_{\mathrm{r}}}{\mathrm{dB}} + \frac{a}{\mathrm{dB}} - 30$$

where P_{RX} is the receive power, G_{r} the gain of the receive antenna, and a the nominal path attenuation in the order of 200 dB. Comparing the *EIRP* values thus obtained with the satellite's specified *EIRP* will yield a measure of the current quality of the radio link.

How receive power is measured

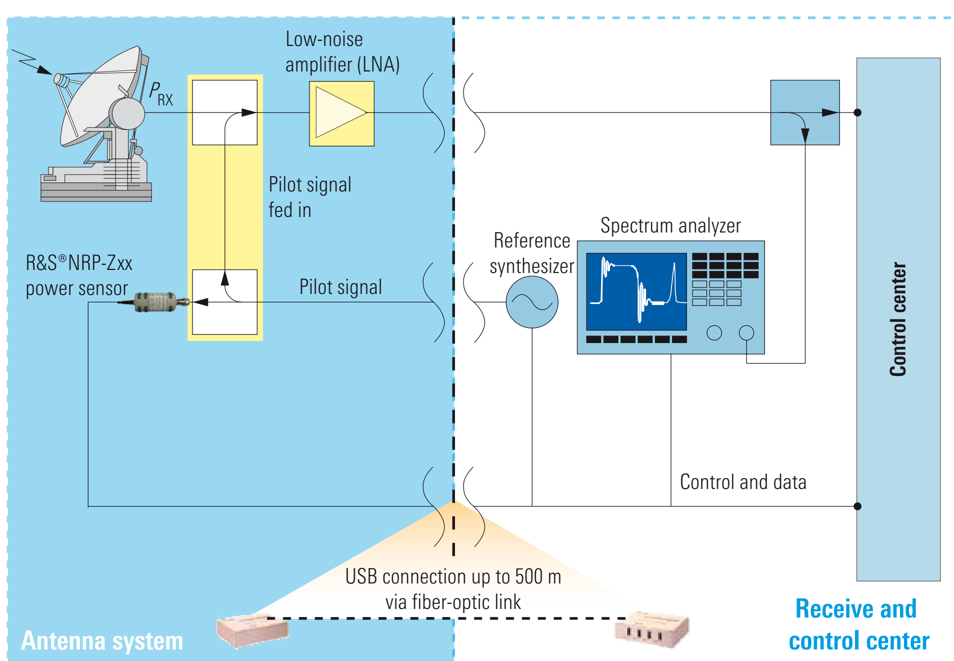
Optimal measurement point

The optimal measurement point is located between the antenna output and the input of the first, extremely low-noise amplifier (LNA), which is flange-mounted on the antenna. While signal level is lowest at this point, achievable measurement accuracy is highest. Measuring power at the receive and control center would cause uncertainties as a result of inadequate stability of the gain provided by the LNA and the attenuation introduced by the – possibly very long – antenna cable. As the receive level at the antenna output is very low – i.e. approx. 50 dB below the measurement limit of a diode power sensor – it must be measured indirectly.

The trick with the pilot signal

FIG 2 shows the measurement setup. A reference pilot signal with a known level is fed in at the measurement point. Like the signal from the satellite, the pilot signal travels through the entire transmission path up to the receive and control center, where a spectrum analyzer is used to determine the level difference between the two signals. Along the entire transmission path, both signals undergo the same amplification and attenuation, as their frequencies are almost identical. This means that the level difference measured at the spectrum analyzer is identical to the level difference at the measurement point, and thus the receive level at the antenna output is known. This is subject to the limitation, however, that the power sensor does not measure the pilot signal level directly at the feed-in point but some distance ahead where the pilot level is significantly higher. This level difference is due to the attenuation introduced by the intermediate, tightly connected passive components. Since the

FIG 2 Test setup for *EIRP* measurement in the receive path of a satellite-to-earth radio station configured for R&S®NRP-Z21 power sensors.



attenuation can be assumed to be stable in the long run, it needs to be measured only once. The resulting value is then subtracted from the value displayed on the power meter.

The critical point: the power meter

The actual measurement challenge, however, has to be met by the power sensor itself. It has to deliver accurate results under extreme temperature conditions and at a long distance from the base unit. Attempts to solve this measurement challenge have repeatedly been made using classic power meters, with varying outcome, however. The reason for this lies in the basic operating principle of these power meters, which use an internal 50 MHz reference signal. Since a reference signal is indispensable in order to perform accurate measurements – especially at the limits of the operating temperature range – a reference must also be provided for the pilot signal measurement. While this makes the test setup considerably more complex – involving additional switches and cable connections – it still does not yield the desired performance.

Always perfectly calibrated: power sensors from Rohde & Schwarz

The R&S®NRP-Zxx power sensors are tailor-made for this measurement task. They require only a simple measurement setup, deliver accurate results even without a reference signal, and considerably cut the costs of purchasing and maintenance. This is due to the sensors' design concept. The R&S®NRP-Zxx power sensors are standalone, remote-controllable instruments offering the complete functionality of a power meter. They are factory-calibrated to provide highly accurate measurements across their entire level, frequency and temperature range. They require no reference signal.

This concept has fully proven itself in over four years of field use. The power sensors have exhibited such excellent long-term stability that recalibration is actually unnecessary. As to the lack of a reference source in this application, it might be objected that it is not possible to detect defective sensors without a reference. While this is correct, the levels in this application are so low that any damage caused by overload can be ruled out. Failures of the sensors due to other causes are very rare, as they have an MTBF of over 300 000 hours (in accordance with IEC 1709, continuous operation at 50 °C ambient temperature).

The showstopper: the remote-control interface

Another difficulty that has to be overcome in this application is bridging the relatively large distance between the receive and control station and the antenna system. The power sensors must be capable of remote control over a distance of several hundred meters. Here, the high versatility of the power sensors really becomes apparent. Their standardized USB digital interface allows them to be used together with a wide range of favorably priced accessories. To enable operation beyond the USB-specific five-meter limit, active extenders are used. They are either based on conventional wired lines (e.g. economy-priced LAN cables) or fiber-optic links, the latter allowing distances up to 500 m to be bridged. The application described here uses a glass-fiber-based product from Icron® Technologies Corporation [*]; the power sensor is remotely controlled from a PC in the receive and control center. Eutelsat uses the R&S®Power Viewer software, which is a small application available free of charge for the R&S®NRP.

Thomas Reichel; Dr Markus Funk; David Tunkelrott

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

REFERENCES
[*] USB extenders, USB Ranger Series, Icron® Technologies Corporation, http://www.icron.com/company/contact.php

TV transmitter network in Romania modernized and expanded

In January 2005, Rohde & Schwarz received an order from the Romanian network operator Societatea Nationala de Radiocomunicatii S.A. (SNR) to expand the Romanian TV transmitter network. The order included analog transmitters of all power ranges which were either to be installed for the first time or to replace existing transmitters. With the modernization of the TV transmitter network now completed, the Romanian TV network has been expanded to provide public broadcasting for the entire country.

All photos: Rohde & Schwarz

FIG 1 One of many modernized transmitter stations: the Rarău station in the North Carpathians.

Rohde & Schwarz receives order to provide transmission equipment

To provide the Romanian people with better public broadcasting coverage (channels TV1, TV2, and regional TV), the government decided to expand and modernize the entire existing transmitter network. The network operator, SNR, chose Rohde & Schwarz to supply and install 60 % of the required transmitters.

The order consisted of more than 200 transmitters, including the corresponding antenna systems. Twenty-seven of these transmitters are liquid-cooled high-power transmitters of the R&S®NH 7000 family for the basic network; they were integrated into existing transmitter sites. The required masts and antennas were replaced or new ones installed.

Most of the other transmitters were low-power units for covering shadowed valleys in Romania's mountainous regions. These transmitters were mainly installed in shelters. New transmitter masts had to be installed for each shelter; the program feed is via satellite.

To gain experience for the future digitization of the complete analog network, one DVB-T high-power transmitter each plus associated headends such as encoders and multiplexers was put into operation at the Bucharest and Sibiu sites. The supplied analog high-power transmitters can of course easily and cost-efficiently be upgraded to digital operation (DVB-T).

Solutions for monitoring and servicing the analog network as well as the DVB-T pilot project were also provided. To ensure unattended operation, the transmitter sites can be remote-monitored and remote-controlled. Rohde & Schwarz supplied a set of T&M instruments for each of the four regions.

A mobile standby transmitter – which was installed in an all-terrain vehicle – was also delivered to the customer. This transmitter system is ready for operation within minimum time irrespective of the site.

FIG 2 Antenna system at the Iași site in northeast Romania.

FIG 3 The Iași transmitter station.

On air: from the Carpathian Mountains to the Black Sea

Since the project was quite complex and extensive, it was not easy to implement. Yet, careful planning by the network operator SNR and Rohde & Schwarz produced success. SNR also handled the enormous task of providing accurate frequency planning for hundreds of low-power transmitters and their transposers.

All these challenges were met in June 2005 when Rohde & Schwarz was able to send the first transmitters to the customer. More than 50 trucks were needed to bring the material required for the transmitter and antenna systems to the various sites in Romania. Some of these sites are located at altitudes between 1500 m and 2500 m, which made transport quite difficult and tightened the project schedule (FIGs 1 to 3).

It was necessary to assemble the transmitters and put them into operation on site as well as to perform various coordination tasks. Further tasks included providing the signal feed, the expansion of antenna systems, as well as checking the carrying capacity of antenna masts. The project has meanwhile been completed: The transmitters from Rohde & Schwarz now help ensure perfect program emission from the Carpathian Mountains to the Black Sea.

Friedrich Rottensteiner

Efficient and to the point: monitoring of digital TV signals

Ensuring high signal quality and signal availability is as indispensable in digital TV networks as it is in analog TV. Signal monitoring is a key method in quality assurance, but it is getting increasingly complex – not least because of the wide variety of programs and auxiliary data services. This first part of a two-part article explains how to determine monitoring points in a network, plus the measurements that need to be performed.

Which is the best concept?

Finding the ideal concept for monitoring digital TV networks depends on different criteria and needs to be established separately for each application. To identify the best possible solution, the following aspects should be taken into account:

- **Reason for monitoring** – what are the objectives involved?
- **Network structure** – at which point in the network is the monitoring to be performed?
- **The signals to be monitored and their characteristics** – which measurements need to be performed?

Why is monitoring performed – and what are the objectives?

Program providers and network operators place considerable importance on the error-free generation of digital TV signals and their correct distribution and transmission in networks, not least because of contractual obligations toward their business partners. Monitoring institutions, however, handle different tasks. For example, they check if relevant standards are complied with, including whether the coverage in a specific transmission area is adequate, or if a specific program set is correctly broadcast.

There is a wide variety of monitoring objectives, including:

- **Prevention of serious interference** by intervening early on whenever minor changes to signals or in the system are discovered
- **Immediate and efficient troubleshooting** by quickly detecting and locating signal failures or signal errors and determining their causes
- **Recording signal characteristics and system** availability for subsequent analysis or demonstration purposes toward the contracting partners
- **Enhanced quality of service** by detecting and remedying even sporadic errors

At which points in the network is monitoring to be performed?

Complex structure: distribution networks for digital TV signals

Networks for distributing digital TV signals are often complex and elaborate in structure, for example because individual network sections or feeder links are frequently operated by different organizations. In these cases, there are transfer points for handing over signals and / or responsibility.

Different methods are used to physically transmit signals; cable headends, for example, can be supplied via satellites or fiber-optic links (IP or ATM), while standalone terrestrial transmitters can be connected via microwave links or off-air reception, and terrestrial MFNs may also include local SFN sections. There are thus plenty of reasons for examining the structure of these networks in more detail.

Network characterization based on the content of the distributed signals

One of the basic network characterizations takes into account whether all customers receive the same signal, i.e. the same content. If this is the case, the signal is usually compiled at one location and then distributed via the network. If the content varies, different signals are transmitted simultaneously, or only one signal is transmitted but is modified at specific points in the network to accommodate a limited number of customers. FIG 1 shows a typical simple example[1]: Six transmitters broadcast four programs each on two channels. Six programs are identical on all transmitters; five are only of local interest and are fed separately to the relevant regions.

Network characterization based on sections

Networks with identical signals for all customers can be classified in sections of different types:

Network sections of type 1 are used to combine all programs that are ultimately intended to reach the customers. The programs are received by very different providers at home and / or abroad. A wide range of transmission standards can be used to transmit the programs; these standards may change along partial paths and do not even exclude analog transmission methods. With analog transmission methods, the received program must be digitized and compressed on-site. If the programs are received from a studio on-site or from a local server, for example, the network section can be very short, or is limited to local signal processing.

Via **network sections of type 2 (contribution)**, the processed signal is transmitted to the network sections of type 3, which ultimately supply the services to the customers.

Network sections of type 3 (distribution) are used for direct customer coverage; they may be transmitter, cable, or satellite networks, for example. In special terrestrial networks, a signal received via a network section of type 3 can be distributed virtually simultaneously in additional network sections of type 3. This method is referred to as off-air reception; it is used whenever the additional network section of type 3 is difficult to access via a network section of type 2.

Networks where not every subscriber receives the same signal can also be classified according to this pattern. In this case, however, network sections of type 1 can directly feed network sections of type 3 after the signals have been appropriately processed.

FIG 2 shows the different types of network sections. They are based on the DVB-T network shown in FIG 1, which supplies the customers with TV signals and thus corresponds to the network section of type 3 (distribution, shown in blue). The individual transmitters receive the signals from an ATM network in ring configuration (yellow), which is a network section of type 2 (contribution). In practical applications, this section is often redundant in design to ensure enhanced reliability of transmission.

Abbreviations

ATM	Asynchronous transfer mode
BER	Bit error ratio
CRC	Cyclic redundancy check
DTS	Decoding time stamp
DVB-C/S/T	Digital video broadcasting – cable / satellite / terrestrial
IP	Internet protocol
MER	Modulation error ratio
MFN	Multifrequency network
PCR	Program clock reference
PTS	Presentation time stamp
SFN	Single frequency network
PER	(MPEG TS) packet error ratio

The signal that is to be distributed is generated at a location between the transmitters A and C, where several programs are received in different ways. The networks used for this purpose correspond to a network section of type 1 (white). The networks for feeding the regional programs to the transmitters D, E, and F also correspond to the network section of type 1.[2]

Typical monitoring points in the network

The interface to the customer is very important in monitoring: This is where the signal is checked to ensure that it is without errors. Monitoring of the transmitter modulation quality must be carried out directly on the transmitter. Otherwise, environmental influences would impair the measurement result. The SFN characteristics must be monitored at a point where the reception of all transmitters included in the SFN is good. If transport streams are combined or modified, the newly generated transport stream should be monitored directly on-site to ensure that it is correct. If the individual network sections are in different areas of responsibility, monitoring should be performed at the transfer points between two sections. The same applies when errors occur in order to quickly pinpoint the error source. The individual programs are usually monitored directly at the site of program provision or channel coding. FIG 3 shows an example of typical monitoring points for the different network sections.

1) The SFN in this example (which is also used for FIGs 2 and 3) is only important insofar as all transmitters involved in the SFN transmit the same transport stream.
2) Local signal processing of the locally transmitted programs to the transmitter stations D, E, and F is not included.

Which measurements need to be performed?

This question can be answered by taking into account the monitoring objective and the function of the system being monitored. If the transport stream is to be distributed without any changes, for example via a terrestrial transmitter network, monitoring will focus on the RF characteristics. If, however, the network operator modifies the transport stream, additional monitoring of the transport stream characteristics can be beneficial.

Program providers, however, mainly concentrate on the correctness of the signal to be transmitted as well as on the video and audio signal quality of the individual programs. Thus, their main focus is on checking the program quality and the correct structure of the transport stream.

Deriving measurements from the signal processing chain

FIG 4 shows the signal processing chain in digital TV in simplified form. It is based on digitized but not yet compressed signals for each program. The signals may be transmitted by a camera, a server, or a decoder, for example. The encoders reduce the signal data rate for transmission. The multiplexer combines the individual, compressed signals and adds additional data which the receivers need in order to correctly replay the programs. In addition to the audio and video signals, all other data such as teletext and subtitles or program information for an electronic program guide is inserted. The signal to be transmitted – the transport stream – is provided at the multiplexer output. Depending on the transmission method, the transport stream is channel-coded, modulated, and then transmitted (e.g. terrestrial transmission, via satellite uplink, or via cable).

	Transmitter					
Program	A	B	C	D	E	F
News channel	✓	✓	✓	✓	✓	✓
Movie channel 1	✓	✓	✓	✓	✓	✓
Movie channel 2	✓	✓	✓	✓	✓	✓
Sports channel	✓	✓	✓	✓	✓	✓
Home shopping	✓	✓	✓	✓	✓	✓
Cartoons	✓	✓	✓	✓	✓	✓
Regional channel SFN 1	✓	✓	✓			
Regional channel SFN 2	✓	✓	✓			
Regional channel D				✓		✓
Regional channel E					✓	
Regional channel F				✓	✓	✓

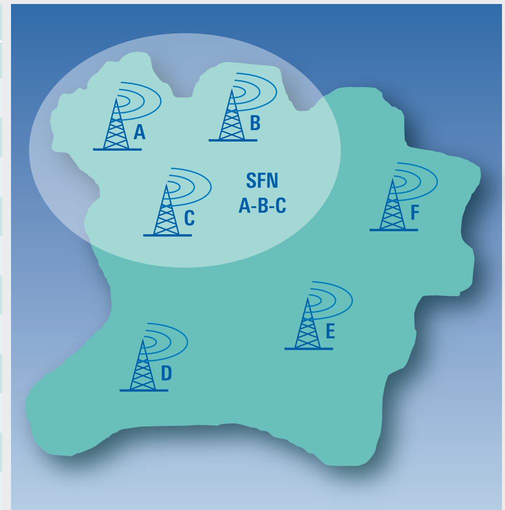


FIG 1 Example of a DVB-T network with different regional programs.

FIG 2 Example of the different types of network sections.

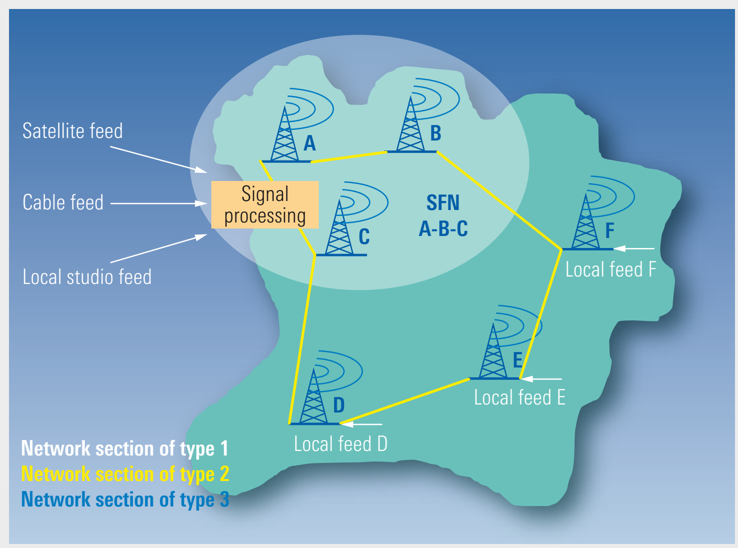
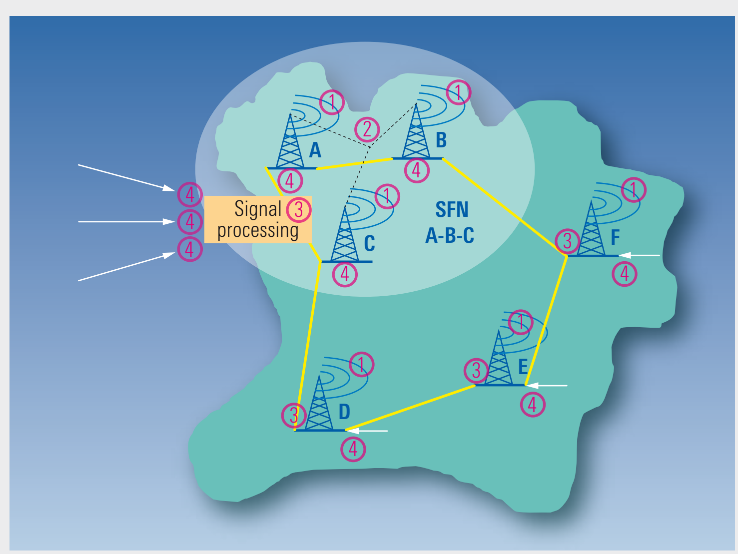


FIG 3 Example of typical monitoring points:
① Regional DVB-T transmission
② SFN characteristics
③ Processed signal
④ Received signal (of network sections of type 2 or 3)



Based on the signal processing chain described, measurement points can be identified by performing the appropriate measurements:

Program level / data level – between encoder and multiplexer (❶)

- Poor picture and sound quality or, in the case of data services, incorrect data structures
- Coding with syntax errors
- Incorrect time references (e.g. PCR, PTS, and DTS)
- Unnecessarily high data rate

Transport stream level – between multiplexer and channel coder (❷)

- Incorrect or missing content (e.g. programs or their components such as audio signals)
- Data rate too high / too low
- Incorrect references
- Syntax error
- Important auxiliary data (tables) that is to be repeated periodically is transmitted too frequently / too seldom
- Incorrect modification of the time references of the individual programs

RF signal level – transmitted signal (❸)

- Missing channel
- Insufficient signal strength / quality, or bit error ratio too high
- Impaired transmitter synchronicity in SFNs

Recommendations of the measurement guidelines

A guideline for measurements in DVB systems was published as a Technical Report (TR) with the designation ETSI TR 101 290, "Digital Video Broadcasting (DVB); Measurement guidelines for DVB systems", and is now available as version 1.2.1 (2001-05).

The document specifies how to perform measurements on DVB systems both with regard to RF and transport stream characteristics. It also suggests measurements especially with a view to transport stream monitoring. The measurements are classified in three groups and prioritized. All measurements refer to the syntax and the logical structure (references in tables) of the transport stream as well as to the characteristics with time reference (PCR and buffer) and the integrity (CRC). They can be performed without having any knowledge of the specific transport stream to be measured.

Measurements in practical applications

In practical applications, the measurements focus on RF and transport stream characteristics. In some cases, the individual programs are automatically monitored in order to check their video and audio quality, and – insofar as possible – the correct structures for data services.

Monitoring RF characteristics

Only a few RF measurements are needed to detect the errors at the RF level as described in the section "Deriving measurements from the signal processing chain". They are part of the basic measurements in practical monitoring applications:

- **RF Sync** Is there any signal that can be synchronized?
- **Level** Is the signal strength sufficient?
- **MER** Is the modulation quality sufficient?
- **BER** Is the proportion of correctly received bits (prior to error protection) sufficient?
- **PER** What is the proportion of defective transport stream packets (after error protection)?

During DVB-T transmission in SFNs, transmitter synchronicity must also be monitored – by measuring changes in frequency, level, and time reference of all transmitters included in the SFN. Thus, an individual transmitter that no longer transmits synchronously can be immediately detected and switched off. This prevents a failure of the entire network; the deactivation of the defective transmitter affects only a few customers.

The example of an SFN with four transmitters in FIG 5 shows how the R&S®ETX-T monitoring receiver displays the measurement results. The upper diagram includes the amplitudes of the individual signals versus the time reference of the signals to each other. The lower diagram shows the frequency errors. The colored rectangles mark the defined tolerance limits; due to the color-coding, a violation of these limits can be quickly detected.

In addition, the modulation parameters of the received signal are often checked to verify that they are correct, i.e. that they comply with the nominal values stored in the monitoring device. A constellation diagram provides a graphical display of the modulation and the signal quality. FIG 6 shows an example of the RF measurement result display.

Detecting small changes of a transmitter signal at an early stage is of vital importance in RF monitoring. By taking measures early on, extensive changes and even transmitter downtimes can be prevented. However, detecting small signal changes requires a wide dynamic range during the MER measurement.

Monitoring the transport stream

By performing the measurements of priority 1, 2, and 3 as specified in the DVB measurement guidelines, the transport stream syntax and structure can be appropriately determined. In most cases, however, further measurements need to be performed. For example, the megaframe initialization packet (MIP) is checked in SFNs; the MIP is a transport stream packet required for synchronizing the transmitters involved. A MIP inserter inserts the TS packet in a transport stream that is sent to all transmitters. Comprehensive measurements for analyzing the MIP are defined in the DVB measurement guidelines.

Further measurements provide answers to the following questions:

- Are all programs available?
- Do the programs contain all desired elements?
- Does a program take up too much bandwidth?
- Are all program designations correct?
- Are pay-TV programs really encrypted?

If all these aspects are to be monitored, the monitoring equipment needs to know the nominal values so that it can compare them with the measured values. FIG 7 shows how this function has been implemented in the R&S®DVM MPEG-2 monitoring system. The configuration window (large) for automatic template generation shows the wide range of characteristics that can be specified. The measurement result window (small) shows the template in a structured form and highlights in color the deviations from the measured signal with the appropriate measurement value.

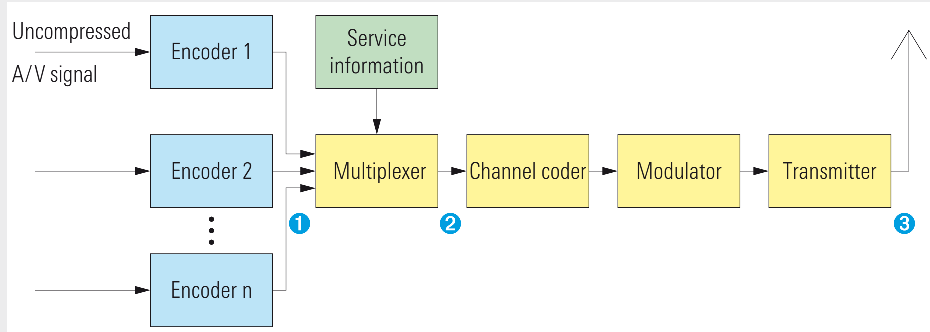


FIG 4 Signal processing chain for digital TV (simplified). The markers 1 to 3 define suitable measurement points.

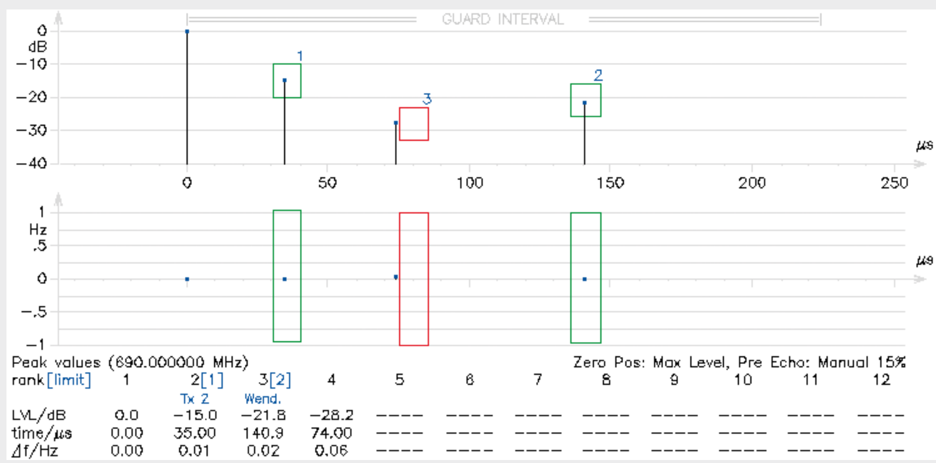


FIG 5 Display of important measurement results in an SFN using the R&S®ETX-T monitoring receiver.

FIG 6 Display of the RF measurement results using the R&S®DVM MPEG-2 monitoring system.

Monitoring of programs and services

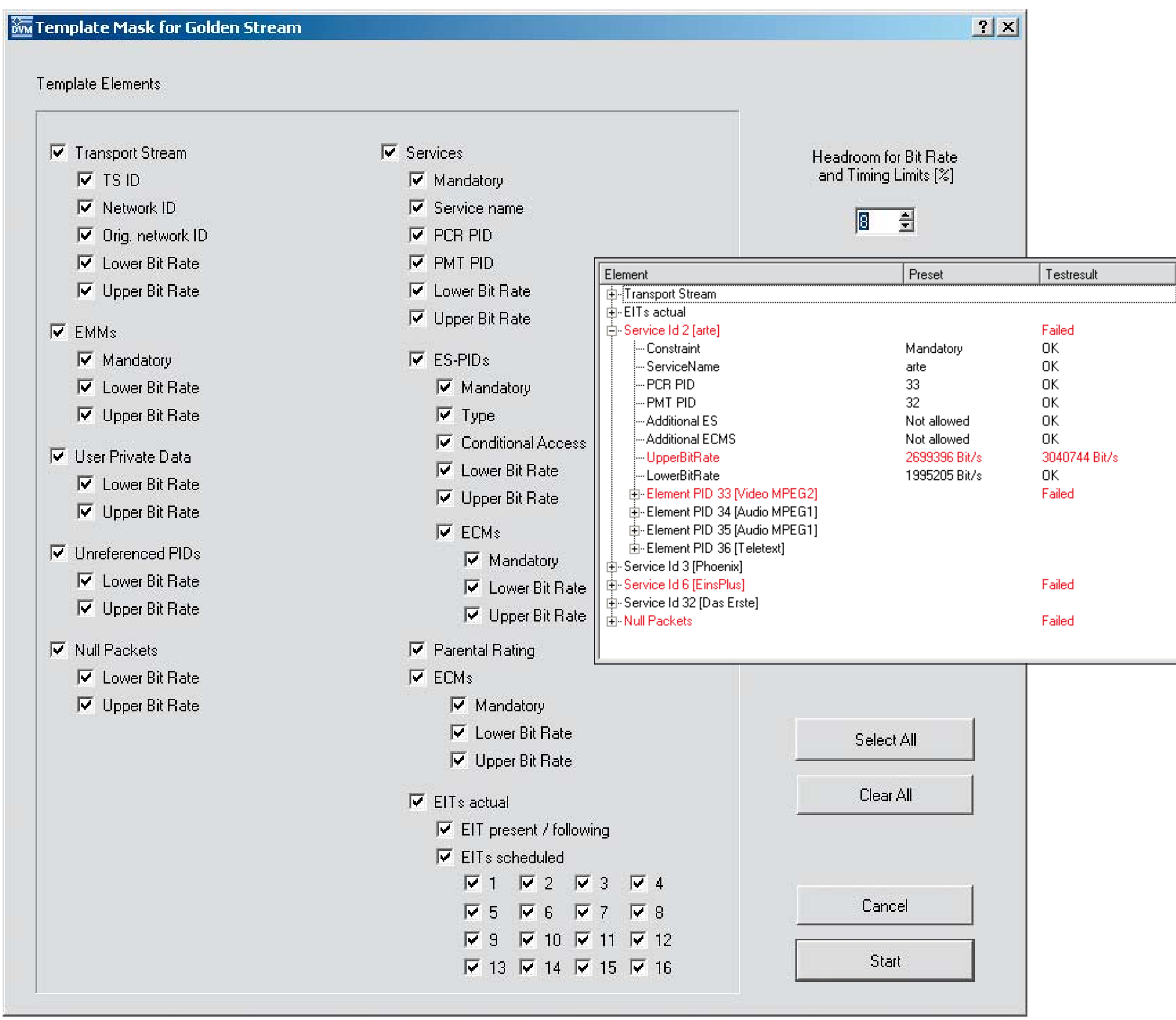
When the quality of video and audio signals is monitored, the test equipment signals picture freeze or picture loss as well as silence or sound loss. High-end and specialized equipment additionally calculates a quality value for the video signal.

Analysis functions and equipment are used to check the configuration of data services such as teletext, subtitles, or MHP applications. However, monitoring equipment for realtime checking of all data services of a transport stream is not commercially available. To find out whether data is transmitted to the individual services, the data rate of the individual elementary streams can be monitored. This simplified way of monitoring can also be used for video and audio elementary streams if the budget does not suffice for monitoring the video and audio quality.

Part 2 of this article, which will be published in one of the next issues, will analyze the requirements that state-of-the-art T&M equipment needs to comply with to ensure effective monitoring.

Thomas Tobergte

FIG 7 Monitoring application using the R&S®DVM MPEG-2 monitoring system: configuration window for automatic template generation (large) and structured display of measurement results (small).



International workshop for network operators – a valuable exchange of views.

Network operators take center stage

Almost 70 customers from all over Europe, plus Rohde & Schwarz sales staff, gathered in the Technology Center at Rohde & Schwarz headquarters in Munich to take part in the international workshop for network operators.

The purpose of the event, which took part at the end of November 2006, was to improve global sales support for internationally active customers. This will help to recognize customers' needs at an early stage and enable the national Rohde & Schwarz offices to intensify local support.

In addition to workshops dealing with topics such as drive testing, mobile testing, as well as solutions for operation and maintenance, there were also customer presentations on the DVB-H pilot project in Germany. "The customers appreciate the presence and willingness of Rohde & Schwarz when it comes to jointly finding appropriate solutions", explained Christian Müller, Business Development Manager for Network Operators at ROHDE & SCHWARZ Europe GmbH.

Technical University of Munich honors Dr Lothar Rohde

The Technical University of Munich dedicated a lecture hall to Dr Lothar Rohde at the suggestion of the Faculty of Electrical Engineering and Information Technology.

The university thus honored a pioneer of radio frequency engineering in 2006, marking the 100th anniversary of his birth. According to the assistant dean, Prof. Dr.-Ing. Jörg Eberspächer, the dedication also expresses the longstanding and productive cooperation between business enterprises and research institutions. This also includes support for outstanding students for the first time through the Lothar and Sigrid Rohde Foundation.

For several decades, Rohde & Schwarz has maintained close relations with the Technical University. Not only have there been numerous joint research and development projects in the past years, also many candidates for graduate and doctoral degrees began their career at Rohde & Schwarz.

Second award for EMC experts from Rohde & Schwarz

At the general meeting of the IEEE German EMC Chapter in December 2006, Manfred Stecher received the IEEE Certificate of Acknowledgement.

Manfred Stecher

The EMC expert from Rohde & Schwarz was awarded this certificate for the development and standardization of emission measurement procedures. This was the second award for Manfred Stecher, who represents Rohde & Schwarz on various committees for EMI measurement procedures. In 2005, he received the DKE needle for his outstanding work in the field of standardization for protecting radio and broadcast reception, radio interference suppression, the measurement of radio interference and, above all, for his international commitment to CISPR work.

The IEEE German EMC Chapter constitutes an active forum for technical and scientific activities in the field of electromagnetic compatibility.

The German Commission for Electrical, Electronic and Information Technologies of DIN and VDE (DKE) is an organization which is responsible in Germany for the elaboration of standards and safety specifications covering the area of electrical engineering, electronics, and information technology.

Most popular employers: Rohde & Schwarz ranks high among young engineers

Young engineers are much sought after by employers in Germany. Rohde & Schwarz, which has more than 6900 employees, is therefore all the more pleased that it ranks high in surveys conducted among this target group.

Those surveyed associate Rohde & Schwarz primarily with engaging work, highly interesting product portfolio, outstanding innovative strength, international job prospects, as well as impressive market success. In 2006, the electronics company was rated second by communications engineers on the barometer of graduates taken by the *trendence* HR marketing agency and in the study conducted by *access*. Electrical engineers also ranked Rohde & Schwarz highly: 10th on the *trendence* barometer and 7th in the *access* study.

President and COO Manfred Fleischmann (right) and Joseph Soo (Managing Director of Rohde & Schwarz Malaysia) open the doors to future successes.

New office for Rohde & Schwarz Canada …

The new office of ROHDE & SCHWARZ Canada Inc. in Ottawa provides plenty of space for sales, service, and support activities. Rohde & Schwarz has been represented in Canada since 1970.

… and a huge celebration in Penang

Many colleagues and customers attended a celebration to mark the opening of a new Rohde & Schwarz office, where President and COO Manfred Fleischmann, together with Joseph Soo (Managing Director of Rohde & Schwarz Malaysia), symbolically opened the doors to future successes.

R&S®FSUP signal source analyzer receives 2007 Best in Test award – R&S®ESU receives honorable mention

For the third time, Rohde & Schwarz has received a Test & Measurement World award.

The editors of the American trade journal chose the brand-new R&S®FSUP signal source analyzer as the winner of the 2007 Best in Test award. As the world's only combined spectrum analyzer / phase noise tester up to 50 GHz, the analyzer was selected best product in the RF / microwave test category.

The R&S®ESU EMI test receiver, which impressed Test & Measurement World with its unrivaled measurement speed and ultra-high measurement accuracy, received honorable mention. The journal thus paid tribute to Rohde & Schwarz's many years of experience and skill in the field of EMC.

Online showcase for demo instruments

Rohde & Schwarz has added instruments from the Asian/Pacific region to its portfolio of used instruments offered on the Internet. Demo instruments can be purchased at a special price including a one-year guarantee. One click – and the customer is forwarded to the appropriate office, which submits an offer.

No chance for spies

ROHDE & SCHWARZ SIT GmbH has been developing state-of-the-art top-security solutions for information and communications technology for 15 years.

To mark this milestone, the German cryptology market leader held a security symposium in Berlin-Adlershof. Experts from science, industry, government agencies, and the German Armed Forces discussed all aspects of the topic – from mobile communications to corporate security – with approximately a hundred invited guests. Dr Udo Helmbrecht, President of the German Federal Office for Information Security (BSI), gave a lecture on the protection of critical IT infrastructure in Germany.

ROHDE & SCHWARZ SIT GmbH supplies 2000th ELCRODAT 4-2

International organizations increasingly rely on encryption solutions from Rohde & Schwarz

After the success of its ISDN encryption system ELCRODAT 6-2 with NATO and the European Union, the Rohde & Schwarz subsidiary has again been successful with the ELCRODAT 4-2 encryption unit: On February 2, Henning Krieghoff, President of ROHDE & SCHWARZ SIT GmbH, symbolically presented the 2000th unit to the German Armed Forces at the Rohde & Schwarz Memmingen factory.

ROHDE & SCHWARZ SIT GmbH developed the ELCRODAT 4-2 on behalf of the Federal Office for Information Management and Information Technology. During development, the German Federal Office for Information Security (BSI) provided advice and support with regard to security-relevant aspects.

Henning Krieghoff, President of ROHDE & SCHWARZ SIT GmbH, presents the 2000th ELCRODAT 4-2 encryption unit to Lieutenant Colonel Gerd Weiß from the German Federal Ministry of Defense.

Rohde & Schwarz to supply Vietnam with TV

Rohde & Schwarz has been commissioned to provide full analog terrestrial TV coverage in Vietnam.

The customer is the country's national TV operator, Vietnam Television (VTV), which broadcasts nationwide programs such as VTV1, VTV2, and VTV3. The order includes the delivery of 19 high-power transmitters of the R&S®NH7000C series. The transmitters can be easily converted to a digital standard at a later date. Rohde & Schwarz won the order by beating out other international competitors in the invitation to tender.

Nationwide TETRA network for Qatar

In December 2006, the 15th Asian Games were held in Doha, Qatar's capital. R&S BICK Mobilfunk GmbH was commissioned by Qatar Telecom (QTEL) to supply a nationwide *ACCESSNET*®-T TETRA communications network for the security forces and the Games' organizers. QTEL is the exclusive national telecommunications operator in Qatar.

Well over 10000 subscribers used the network for voice und data services during the Asian Games. QTEL already provided these network services successfully on a commercial basis before the event took place. Subscribers include governmental organizations and security forces, oil and gas companies, transportation companies, international hotels, as well as the Doha airport.

Communications system from Rohde & Schwarz on humanitarian mission in the Philippines

At the beginning of December 2006, typhoon Durian swept through the Philippines with speeds of up to 230 km/h, hitting the region of Bicol especially hard. On the isolated island of Catanduanes, the entire communications system broke down. Contact to the disaster area via mobile radio or landline network was cut off. The Philippine National Disaster Coordinating Council (NDCC) called on ROHDE & SCHWARZ (Philippines) Inc. to provide an emergency HF communications system. Within only three days, Rohde & Schwarz installed a stable HF voice and data connection between the disaster area and Manila free of charge.

Operated by NDCC personnel, the HF system was in service for news about relief work and logistics 24 hours a day. After three weeks, the regular mobile and landline networks were up and running again, allowing the HF system to be dismantled.

Prof. Dr Holger Stahl of the University of Applied Sciences in Rosenheim explains measurements made by the R&S®TSMU radio network analyzer.

UMTS hands-on – R&S®TSMU radio network analyzer at Rosenheim's University of Applied Sciences

UMTS provides plenty of discussion material for the classroom. The complex methods of the air interface are often not covered in detail until the students' practical training period. For this purpose, Rohde & Schwarz provided a coverage measurement test system for the benefit of electrical engineering and information technology students completing their post-graduate studies at the university.

In addition to the R&S®ROMES software, the test system also includes the R&S®TSMU radio network analyzer. Prof. Dr Holger Stahl, responsible for the seminar on communications systems at the University of Applied Sciences in Rosenheim, uses this test system in a practical course on UMTS.

Above all, the functionality of the R&S®TSMU helps to demonstrate this technology. The instrument makes it possible to simultaneously measure the RF downlink parameters of all receivable base stations of network operators, for example. The participants of the practical course then compare and analyze the data at a glance.

New Test & Measurement Products Catalog

The new Test & Measurement Products Catalog 2007/2008 is now available from Rohde & Schwarz in English and German.

T&M solutions for mobile radio, EMC, and broadcasting, as well as general-purpose and RF test equipment are described on 495 pages. The catalog provides descriptions, specifications, and ordering information for nearly 200 products. Moreover, the catalog offers information on service, calibration, and training at Rohde & Schwarz.

The CD version also contains data sheets and articles from *News from Rohde & Schwarz*. The printed catalog or the CD version, or both, can be ordered at the local customer support via e-mail.

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