NEWS

197/08

ROHDE&SCHWARZ

Positively confidential:

One of the most secure voice encryption devices for mobile phones on the market

GENERAL PURPOSE

Fastest and most accurate medium-class signal analyzer with 40 MHz analysis bandwidth

EMC / FIELD STRENGTH

For small budgets: EMI test receiver and full-featured spectrum analyzer in a single instrument

RADIOMONITORING / RADIOLOCATION

Accurate direction finder with comprehensive measurement and analysis functions

NEWS

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Cover feature

Rohde & Schwarz is one of the world's leading providers of high-security crypto solutions. The encryption methods used by the TopSec product family satisfy the highest security requirements and have been tried and tested for confidential communications regardless of the

application. This includes secure video, data and fax communications as well as secure voice communications. The new TopSec Mobile, the most flexible and compact voice encryption device for mobile communications on the market, connects to virtually any commercially available mobile phone via a Bluetooth® interface, enabling globally available, tap-proof communications (page 56).

Contents

The R&S®TSMW universal radio network analyzer is a high-performance radio network scanner for optimization of all current mobile radio networks (p. 6).

WIRELESS TECHNOLOGIES

GENERAL PURPOSE

The R&S®FSV signal and spectrum analyzer is superior to established instruments in its class in almost every respect, and is the only medium-class analyzer to offer analysis bandwidths of up to 40 MHz and a touch screen (p. 18).

The new R&S®ESL EMI test receiver combines two instruments in one: measuring disturbance in accordance with the latest standards and also serving as a full-featured spectrum analyzer for diverse lab applications – the ideal instrument for small budgets (p. 40).

EMC / FIELD STRENGTH

The R&S®DVSG digital video signal generator currently offers the largest variety of interfaces and test signals in a single instrument. It generates analog as well as digital video and audio signals and features an MPEG-2 transport stream recorder and player (p. 46).

The chief attraction of the R&S®DDF255 digital direction finder: It is a highly accurate radio direction finder based on the principle of the correlative interferometer and also offers an extensive range of powerful measurement and analysis functions (p. 64).

BROADCASTING

The compact R&S®SLA8000 low-power transmitter is ideal for optimizing DAB and T-DMB networks (p. 53).

SECURE COMMUNICATIONS

RADIOMONITORING / RADIOLOCATION

MISCELLANEOUS

Radio network scanner with two receiver frontends and a digital I/Q data interface

The new R&S®TSMW universal radio network analyzer is a high-performance radio network scanner for optimization of all current wireless communications networks. It has been specially developed for applications requiring fast measurement and analysis of digital baseband data. Equipped with two highly sensitive frontends for any input frequencies between 30 MHz and 6 GHz, it provides unsurpassed performance.

Compact, upgradable platform for mobile baseband measurements

The new R&S®TSMW universal radio network analyzer (FIG 1) is a versatile and powerful platform for measuring digital baseband data via the air interface in mobile operation. In addition to its basic application as a wireless communications analyzer in conjunction with the R&S®ROMES coverage measurement software, the R&S®TSMW can be equipped with a high-performance digital I/Q data interface (R&S®TSMW-K1 option) for the direct measurement of baseband data. This opens up a wide range of customer-specific applications in test & measurement as well as in research & development.

The analyzer is controlled via Gigabit Ethernet from a host PC running Windows XP®. The digital I/Q data interface is implemented as a universal and high-performance software interface using a C++ DLL. For example, it provides convenient functions to start parameterized measurements or download measurement data in various formats. In addition, the option includes an equivalent MATLAB® interface. This opens up virtually unlimited capabilities for analyzing measured baseband data, or for the fast and simple creation of signal processing algorithms. These algorithms can then be ported to C++ with next to no effort in order to achieve higher performance. The analyzer can also be used for performing calibration measurements on tools used for radio network planning.

FIG 1 The R&S®TSMW is an SDR-based high-performance radio network analyzer for optimizing all current radio networks.

A tabular overview of the various radio network analyzers available from Rohde & Schwarz is given in the article on page 9. This article describes a complete test solution for WiMAX™ provided by the R&S®TSMW in conjunction with the R&S®ROMES software.

The core of the R&S®TSMW is formed by an FPGA board that is configured by means of a CompactFlash card. This future-oriented SDR technology (SDR = software defined radio) enables a wide range of applications and also ensures that this versatile platform can be used as the basis for future developments.

Two independent frontends, each featuring 20 MHz bandwidth

At the RF end, the R&S®TSMW is equipped with two highly sensitive frontends, each with a bandwidth of 20 MHz and a preselection. This allows both independent measurements at different center frequencies and synchronized measurements at the same center frequency. The integrated preselection provides sufficient protection against intermodulation products and, with its preamplifier and attenuator, ensures a wide dynamic range. For example, at a center frequency of 3.5 GHz, the R&S®TSMW achieves a typical noise figure of 7 dB when set to maximum sensitivity, but can also handle extremely high input levels.

Time-synchronized and frequency-synchronized measurements also from MATLAB®

The strengths of the R&S®TSMW lie not only in its excellent RF performance, but also in its versatile capabilities regarding measurement configuration, triggering and filtering. The frontends cannot only be driven internally via the built-in GPS receiver or externally in synchronism with a 10 MHz source. The R&S®TSMW can also perform time-synchronized measurements. The measured baseband data is time-stamped by means of internal I/Q clock counters. Once a periodic signal such as a WiMAX™ downlink burst has been recorded and its start time and repetition period have been determined, a measurement on one of the subsequent downlink bursts can be triggered exactly at the desired time, i.e. with the accuracy of the clock signal. This type of measurement can even be triggered from an environment that offers virtually no realtime capabilities such as MATLAB®. If no exact time information is available on the controlling host PC for the start of a measurement, a measurement can be triggered directly on the R&S®TSMW if a pulse is present at one of its trigger inputs.

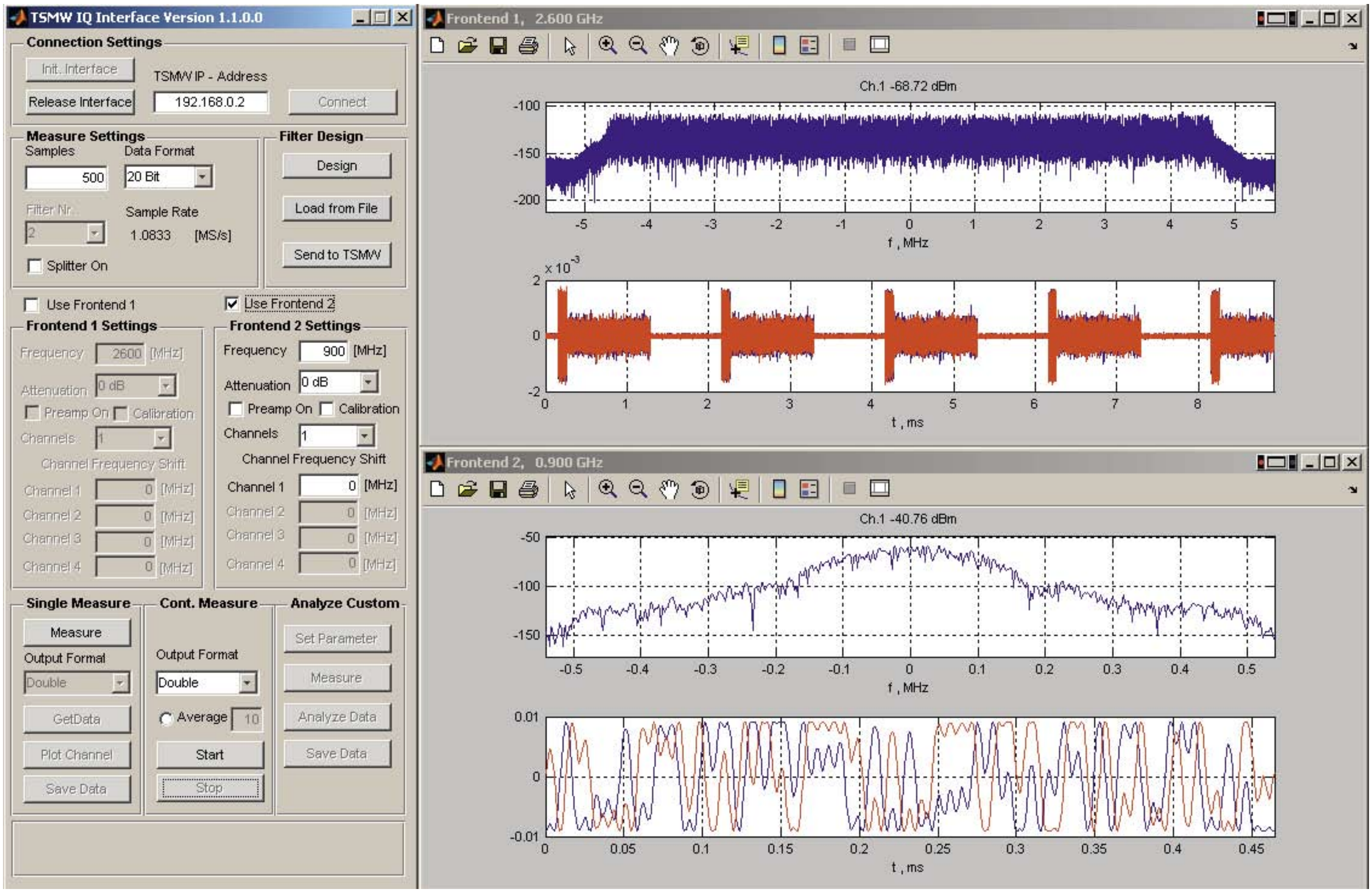


FIG 2 Example application in MATLAB® for the I/Q data interface of the R&S®TSMW: measurement of a 10 MHz WiMAX™ signal with a sampling rate of 11.2 Msample/s with frontend 1, and a GSM signal with 1.0833 Msample/s with frontend 2 (in each case with appropriate filtering and fractional sampling rate reduction).

Wide streaming bandwidth due to Gigabit Ethernet and data compression

To maximize measurement rates – even when using a notebook – measured data can be compressed into blocks of 2 × 8/12/16/20 bits per complex I/Q sample before it is transmitted to the host PC. Measurements can thus be configured either for maximum dynamic range or maximum measurement rate. This is particularly important for applications in which I/Q data has to be recorded over several minutes or even hours. A sampling rate of 5 Msample/s and compression into 2 × 8 bits per sample, for example, would generate only around 80 Mbits of measured data per second, a volume that can easily be handled by the Gigabit Ethernet interface.

High-sensitivity GPS receiver

The R&S®TSMW has an integrated, highly sensitive GPS receiver that can also easily be addressed via the C++ interface or MATLAB®. In addition to position determination, the GPS information can also be used for frequency and time synchronization. The inherent deviation of the local oscillators in the R&S®TSMW frontends from those in the wireless communications transmitters can thereby be significantly reduced, which simplifies and speeds up synchronization with the radio network.

Compact design and flexible power supply

Despite the high versatility of the R&S®TSMW, its designers have managed to produce a compact device for mobile applications. The analyzer's wide input voltage range from 9 V to 18 V DC enables operation in vehicles. For battery operation, its total power consumption of approx. 70 W can be significantly reduced by using an optional operating mode that activates only one of the frontends.

Dr. Markus Herdin

The first comprehensive drive test solution for WiMAX™ wireless communications networks

The sophisticated R&S®ROMES coverage measurement software can handle all wireless communications standards and can measure, merge and evaluate measurement data from a wide range of different sensors and devices, e. g. radio network analyzers, test mobile phones, data cards and GPS receivers. In conjunction with the R&S®TSMW universal radio network analyzer, it represents the first comprehensive test solution on the market for the WiMAX™ standard.

The versatile R&S®ROMES software platform

Using appropriate sensors, e.g. WiMAX™ trace data cards, the R&S®ROMES measurement software can display, store and evaluate network parameters. It provides insight into the PHY layer with important information such as RSSI, CINR and transmit power. Measurement data from up to eight neighboring cells can also be compared. The user can thus check whether the base station with the best reception quality is really always used. The layer 3 decoder in the software also assists in solving problems with cell handovers, which can result in the disconnection of calls, by providing insight into the MAC and IP layers. The integrated filter helps to find specific protocol messages or suppress irrelevant messages, for example. In conjunction with the coupled focus function in R&S®ROMES, any desired points of a test drive can thus be selected, and all results with an identical time stamp visualized. The map view allows the convenient identification and selection of measurement areas with low coverage, for example. The map presents all parameters measured at the different layers. The user can thus easily compare the (limited) view from the perspective of a mobile phone or data card with the (comprehensive) view of the scanner, and thus draw conclusions with respect to user problems in the network.

QoS is what counts

In addition to physical parameters, R&S®ROMES can also measure network quality and performance. The data quality analyzer (DQA) option uses a job list to generate data traffic (FTP, HTTP, PING, UDP, e-mail) and measures parameters such as effective data transfer rate, round trip time (RTT) or connection setup time. These parameters are combined in key performance indicators (KPI), which present the essential performance aspects in concise form. The DQA also measures the effective data throughput at the application level, which if lower than expected indicates a potential need for optimization. Possible causes can, for example, be a poor CINR, a low-order modulation format (QPSK instead of 64QAM, despite a high CINR), or a configuration problem in the relevant base station. The numerous views of the R&S®ROMES measurement software allow optimal checking of all of these possibilities.

	R&S®TSML-x	R&S®TSMU	R&S®TSMQ	R&S®TSMW
Frequency range	80 MHz to 3 GHz 80 MHz to 6 GHz (R&S®TSML-CW)	80 MHz to 3 GHz	80 MHz to 3 GHz	30 MHz to 6 GHz
Standard	GSM, WCDMA, CDMA2000®, EV-DO, CW, spectrum	GSM, WCDMA, CDMA2000®, EV-DO, CW, spectrum	GSM, WCDMA, CDMA2000®, EV-DO, CW, spectrum	WiMAX™, digital I/Q data interface
Features	Supplied with one standard in each case	All standards can be installed simultaneously; one standard can be measured at a time	All standards can be installed and measured simultaneously (except for CW)	All standards can be installed and measured simultaneously

Overview of radio network analyzers available from Rohde & Schwarz

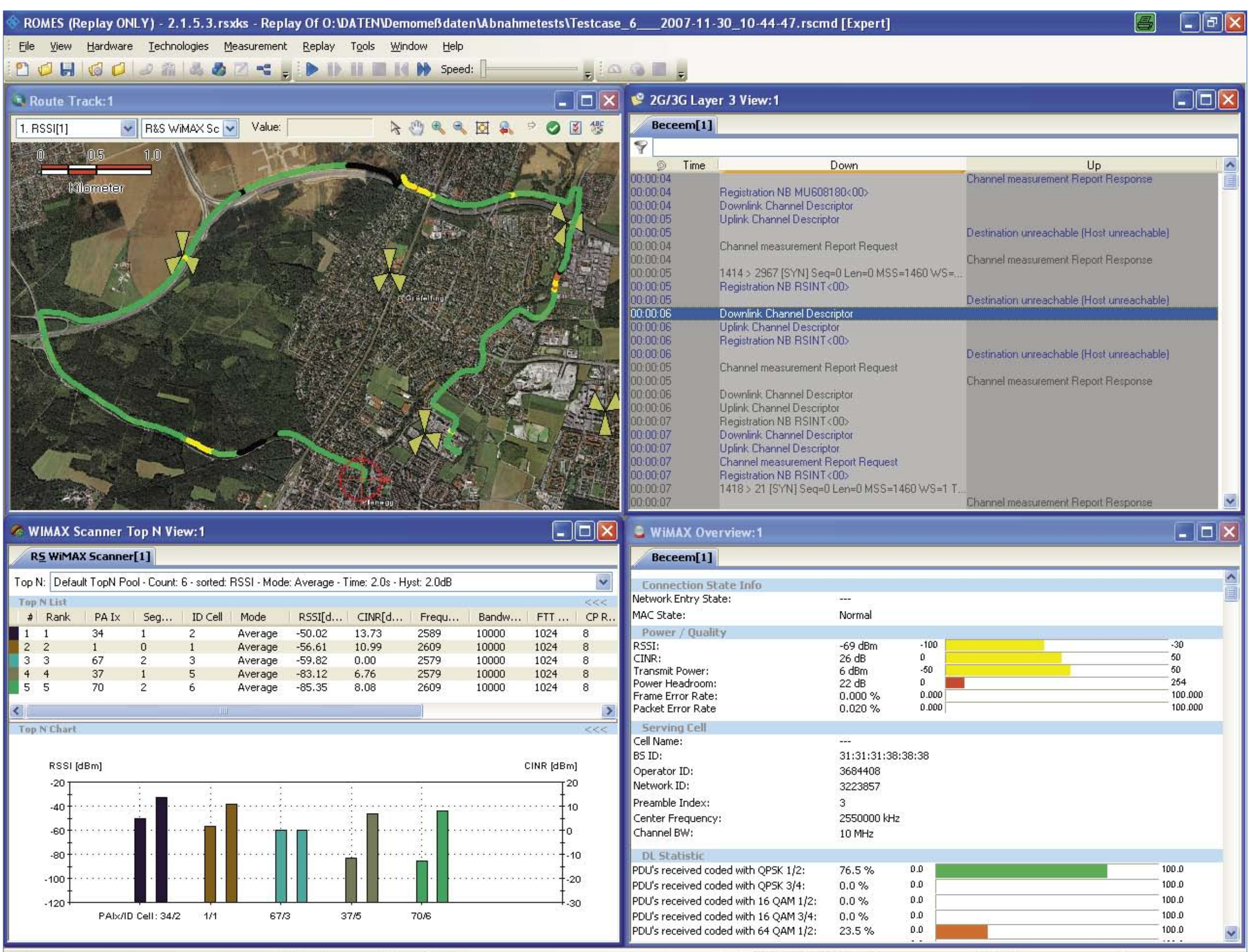
Detecting what mobile phones can't "see"

The R&S®ROMES measurement software and the R&S®TSMW universal radio network analyzer (see also page 6) together form a particularly powerful duo for WiMAX™ measurements. The R&S®TSMW-K28 WiMAX™ scanner option enables a detailed analysis of what actually takes place on the air interface. A mobile phone normally only receives neighborhood information from the broadcast channels of the active base station; the analyzer, however, is not restricted in this respect, and detects each and every available WiMAX™ signal with a sensitivity significantly below the noise level. It can therefore not only check neighborhood information, but can also identify interference signals from remote base stations.

The 20 MHz bandwidth offered by both frontends in the R&S®TSMW enables operation with all established WiMAX™ bandwidths.

The scanner not only detects basic parameters such as FFT size, length of cyclic prefix and frame rate, but also the preamble ID and the cell ID as well as the segments used in the WiMAX™ signal. At the same time, it calculates the RSSI and the CINR based on the preamble. This provides the user with an overview of the actual situation on the air interface. Incorrect configurations in the network such as preamble IDs used more than once on the same center frequency in neighboring cells, different cycle prefix lengths or unexpectedly poor CINR values despite high RSSIs can thus be detected immediately.

FIG 1 Evaluation of WiMAX™ data cards using the R&S®ROMES coverage measurement software. At the top right MAC and IP messages, at the bottom right an overview of the WiMAX™ parameters, and at the bottom left WiMAX™ scanner data. The recording of the route is used for correlating measured values.



High sensitivity paired with high immunity to interference

Sensitivity, dynamic range and scanning speed are the key parameters of a radio network analyzer, fields in which the R&S®TSMW offers outstanding performance. A noise figure of typically 7 dB at 3.5 GHz, for example, ensures high sensitivity. This by no means compromises immunity to interference. The integrated preselection sufficiently attenuates interference signals outside the reception band and protects against undesired intermodulation products.

In order to achieve a high scanning speed, the R&S®TSMW has been equipped with two powerful frontends. This enables simultaneous scanning and demodulation on different center frequencies. The short switchover time of <5 ms between different center frequencies even enables the quasi-parallel reception on any number of carrier frequencies across the entire frequency range from 30 MHz to 6 GHz. The very good phase noise figure of the R&S®TSMW frontends, in conjunction with the sophisticated signal processing, ensures unparalleled measurement performance.

A platform for all technologies

The R&S®TSMW-K28 WiMAX™ scanner option provides the first wireless communications standard for the R&S®TSMW. The R&S®TSMW universal radio network analyzer is prepared to handle all established standards, and can support all of these with a bandwidth of up to 20 MHz. This requires no hardware reconfiguration. Based on a software-defined architecture (SDR), the R&S®TSMW can easily be expanded to include current and future standards such as LTE by adding the appropriate software options. This makes it a future-oriented investment. The multiplex capability of the R&S®TSMW also enables the parallel measurement of two or more standards without any significant loss in performance. A further powerful advantage is provided by the integrated GPS receiver which can be used for synchronization via PPS and for determining the positions of base stations.

With its R&S®TSMW universal radio network analyzer and the R&S®ROMES universal software platform for drive tests, Rohde & Schwarz is the first manufacturer to offer a comprehensive, seamless solution for the WiMAX™ standard.

Dr. Markus Herdin; Stefan Schindler

Rear panel of the R&S®TSMW universal radio network analyzer.

Abbreviations

CINR	Carrier-to-interference-plus-noise ratio
MAC	Medium access control
RSSI	Receiver signal strength indicator
QoS	Quality of service
UDP	User datagram protocol
SDR	Software defined radio

When is a test mobile phone used?

- When access to measurement data via the trace interface is sufficient
- For link-related measurements:
  - Data throughput
  - Link quality
  - Soft and hard handover
  - Speech quality
  - Video quality
  - Detection of call interruptions
  - IP protocol analysis
- For end-to end tests from the customer's perspective

Advantages offered by a radio network analyzer

- Higher measurement speed
- High dynamic range and sensitivity
- Operates independently of wireless communications network
- Is capable of detecting missing or incorrect neighborhood information
- Can be used for multiple applications and multiple wireless communications networks
- Can be used as a measurement reference due to independence from chipsets
- Future-oriented investment due to upgradability via software options
- Requires no network resources
- No operating costs, since a SIM card is not necessary

Early verification of the air interface of wireless terminals

The R&S®R-Line compact test chamber allows wireless equipment manufacturers to reliably verify the radiated RF performance of wireless terminals at an early stage of development, thus avoiding unpleasant surprises during the certification measurements.

Compact test chamber for use in the lab

In the development of wireless terminals, the RF characteristics have to be optimized by striking the best possible balance between reducing radiated spurious emissions (RSE), minimizing the specific absorption rate (SAR), and achieving high-quality antenna characteristics (over-the-air-performance = OTA). Any adjustment of one of these parameters also affects the others. The precise and repeatable measurement of RSE and OTA has so far taken up valuable time in an anechoic chamber.

The new R&S®R-Line test chamber (FIG 1) makes it possible to perform effective RSE and OTA measurements already at the development stage without the need for a large anechoic chamber. The test chamber fits into any lab and requires no special infrastructure or constructional measures. As it is equipped with castors, it can quickly and easily be moved to wherever it is needed. The size of the test chamber has been optimized to make it as compact as possible (W × D × H: 1690 mm × 1560 mm × 2130 mm) without making unreasonable compromises in terms of performance.

Measurements in a compact test chamber will provide the desired benefit, i.e. reduce the subsequent measurement time in an anechoic chamber, only if the results it delivers are directly comparable to those obtained in the anechoic chamber. This requirement must be met in order to ensure that the measurements performed during development are not just estimates that provide no reliable information about the results to be expected in an anechoic chamber. One of the big advantages of the R&S®R-Line is the high level of comparability it offers. This is a prerequisite for the subsequent, successful certification of equipment under test (EUT) that has passed the measurements in the test chamber.

In addition to carefully selected absorber materials and features, the R&S®R-Line has a dual-polarized test antenna for the frequency range from 0.8 GHz to 18 GHz, a circularly polarized communications antenna for the range up to 6 GHz, and a two-axis turntable for positioning the EUT in any orientation. Due to the special design of the turntable using RF-transparent material, effects on field uniformity are minimal. A particularly critical area here is the zone directly surrounding the EUT, since even plastic materials with a dielectric constant of >1.5 result in major field distortions and consequently measurement inaccuracies. For this reason, the R&S®R-Line has been specially optimized in this zone to cause low interference while providing sufficient stability. This applies to the support and fixture taking up the EUT, as well as to the mounting and the drive gear for the inner positioner (FIG 3). The motors are remotely controlled, which enables not only accurate positioning but also automatic measurements and thus reduced measurement costs.

FIG 1 Featuring compact dimensions and lockable castors, the R&S®R-Line test chamber can quickly and easily be moved to any desired location.

Example of field Distribution in the R&S®R-Line test chamber

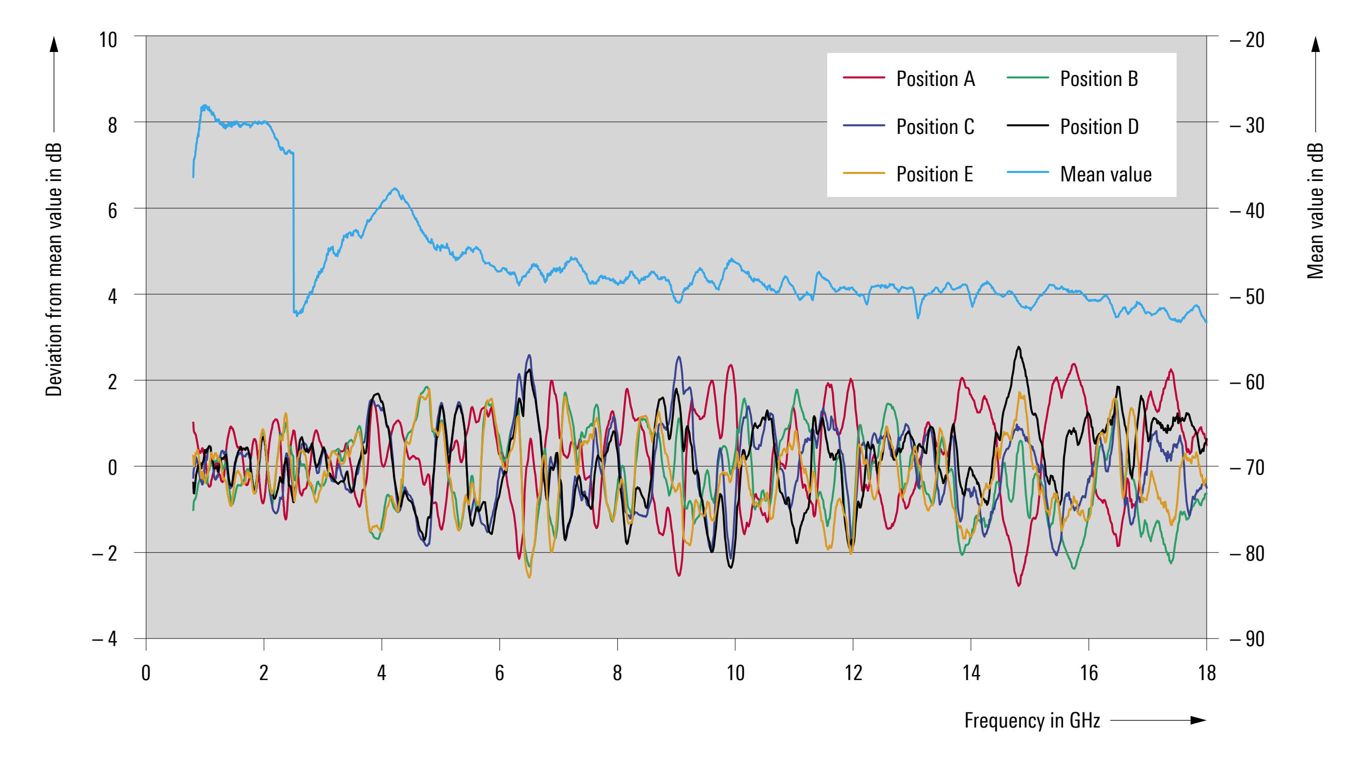


FIG 2 Field distribution in the R&S®R-Line. The above example demonstrates the high degree of uniformity of the electromagnetic field, measured at five positions of a plane.

Demonstrably good RF characteristics

To demonstrate the good RF characteristics of the R&S®R-Line test chamber, field distribution measurements were first performed. A reference dipole was installed on the turntable in place of the EUT and fed with signals from the tracking generator of a spectrum analyzer. The test antenna picked up the field thus generated with the appropriate polarization. These measurements were repeated at various positions in the chamber to check uniformity of the field distribution.

FIG 2 shows an example of such a measurement. The reference antenna was placed in five different positions: in the center of the zone surrounding the EUT and at the four corner points of a horizontal square with 20 cm edge length around the center point. The transmission loss measured with the test antenna was determined. The diagram shows the deviation from the mean value versus frequency for each position of the reference antenna (colored lines in lower half of diagram with left-hand scale). The mean value (blue line in upper half of diagram with right-hand scale) is the mean of the maximum and the minimum transmission loss and also indicates the frequency response of the reference antenna (two antennas for the ranges 0.8 GHz to 2.5 GHz and 2.5 GHz to 18 GHz), since no corrections were made to the antenna factors.

Measurement of radiated spurious emissions (RSE)

Measuring the radiated spurious emissions of an EUT requires tests at a high degree of sensitivity. Since the EUT also communicates with the radiocommunications tester (i.e. the base station emulator = BSE), the uplink signal, i.e. the signal in the direction of the BSE, must be sufficiently suppressed to enable reception of the weak spurious signals. This is achieved through the use of filters that suppress exactly the uplink frequencies. Since the EUTs normally support different wireless frequency bands, a separate filter is required for each of these bands. The filter is switched into the path between the antenna and the preamplifier via a switching matrix. The R&S®TS8996 RSE test system from Rohde&Schwarz includes all components required for these measurements and offers a user-friendly solution together with the R&S®R-Line test chamber.

RSE measurements are performed to verify whether and in what direction an EUT radiates spurious emissions above the specified limit values. The EUT must therefore be rotated into a wide range of positions so that it can be tested from all directions. Automatic positioning can significantly facilitate these measurements. The R&S®R-Line is equipped with a two-axis turntable for this purpose (FIG 3). It includes a supporting plate with an inner positioner at its center. The positioner, which takes up the EUT, is rotated by means of a belt drive. The supporting plate is rotated vertically about the main axis.

RSE test standards specify measurements in a fully anechoic chamber. Such chambers are installed in many quality assurance test labs. For use in development, however, chambers of this kind would not only involve high investments but also take up too much space. Simple solutions, on the other hand, e.g. GTEM cells for tests in the microwave range, offer only low measurement accuracy and reproducibility and therefore allow no reliable correlation to standard-compliant measurements performed in an anechoic chamber. Here, the R&S®R-Line is impressive for its high quality. Due to its elaborate design and the careful selection of absorber materials and features, it exhibits RF characteristics as good as those of an anechoic chamber. Using the compact test chamber, RSE measurements can also be carried out in the lab, allowing improvements to be made at an early stage in the development of wireless terminals.

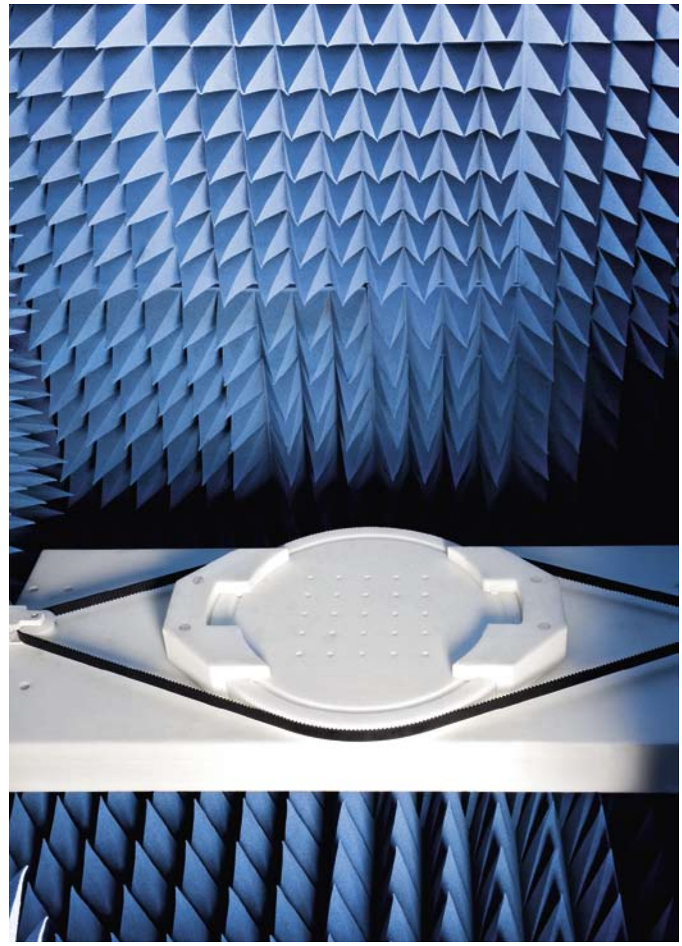


FIG 3 Two-axis turntable in the R&S®R-Line test chamber.

Performance measurements

OTA measurements are normally also carried out in fully anechoic chambers. The suitability of a chamber for these tests is established by measuring the region around the EUT position, which is referred to as the quiet zone. As the good characteristics of the R&S®R-Line shown in FIG 2 indicate, the test chamber can also be used for OTA measurements in conjunction with the R&S®TS 8991 test system. In these measurements, both the transmitted power and the sensitivity of reception are recorded three-dimensionally. From the results obtained, the characteristic total radiated power (TRP) and total isotropic sensitivity (TIS) of the EUT are derived [*].

Summary

The R&S®R-Line is a compact test chamber for use at an early stage of development. The results it delivers can be fed back directly into the design of wireless terminals, thus saving valuable time in the development process. The test chamber fits into any lab and, featuring lockable castors, can quickly and easily be set up wherever it is needed.

Dr. Christoph von Gagern; Jürgen Kausche

REFERENCE

* R&S®TS 8991 OTA Performance Test System: First certified test system for OTA measurements on WLAN user equipment. News from Rohde & Schwarz (2007) No. 192, pp 12–15.

Versatile and precise signals for the production of wireless devices

The R&S®CMW500 wideband radio communication tester generates complex signals exhibiting maximum precision, speed and flexibility – characteristics that are of utmost importance for calibrating and testing the quality of frontends in the production of wireless devices.

The specialist for production

Modern production of wireless devices requires versatile and accurate signals. The R&S®CMW500 wideband radio communication tester, featuring a highly precise RF module and the R&S®CMW-B110A baseband generator module hardware option, is ideally equipped for this purpose. Its frequency range up to 3.3 GHz or 6 GHz (R&S®CMW-KB036 option) and its transmit-side IF bandwidth of 70 MHz meet virtually any requirement and also offer ample room for future wireless communications standards. The baseband generator module has two operating modes, the *arbitrary waveform mode* (*ARB generator*) and the *realtime mode* for the *online generators*.

The R&S®CMW500 wideband radio communication tester is fast, precise and highly scalable for use in production. Featuring a frequency range of up to 6 GHz and an IF bandwidth of 40 MHz/70 MHz (analyzer/generator), the production tester is excellently primed for future technological developments (see News from Rohde&Schwarz (2008) No. 195, pp 4 to 9).

ARB generator

In ARB waveform mode, the instrument processes I/Q data available as waveform files, allowing users to generate any application-specific modulation signals they desire. The R&S®WinIQSIM2 waveform creation tool can create waveform files conveniently and directly. I/Q data can also be generated using commercial software tools such as MATLAB®, Mathcad® or ADS®, but this data must then be converted to the waveform file format with the help of the MATLAB® transfer toolbox or the I/Q wizard from Rohde&Schwarz.

The use of multisegment waveform files makes it possible to achieve minimum switchover times between different modulation modes. To this end, the ARB generator provides various modes that control switching from one segment to another as required. In combination with a user-configurable frequency/level list (that can contain up to 2000 entries), the ARB generator offers solutions for all production-typical requirements, e.g. for fast alignment of the wireless device receiver via predefined test sequences using the modern R&S®Smart Alignment concept. You can switch from one entry to another in the frequency/level list in different ways, e.g. time-controlled (variable dwell time per list entry), or by means of marker signals contained in the waveform file, or by internally generated trigger signals from other firmware applications (FIG 1). A generously dimensioned waveform RAM offers sufficient memory capacity for playing even long and wideband signals.

Online generators

In addition to the ARB generator, the R&S®CMW500 also provides online generators (R&S®CMW-KGxyz software options, FIG 2) – generator firmware applications that use the real-time mode of the baseband generator module. The network-specific signals can be configured online via a graphical user interface and output promptly over a wide RF frequency and level range. These downlink signal sources are especially easy to operate and highly flexible. Moreover, they generate complex signals with high data volume, without violating memory limits. They are therefore of particular interest when preparing for production, performing regression tests and for development in the lab.

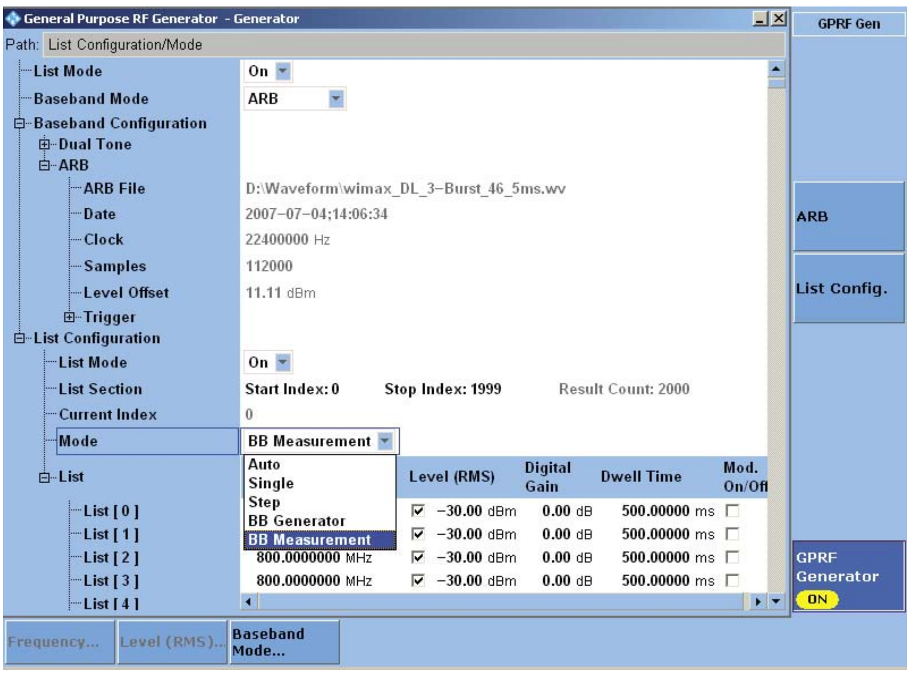


FIG 1 The ARB generator provides different modes for controlling the user-configurable frequency/level list.

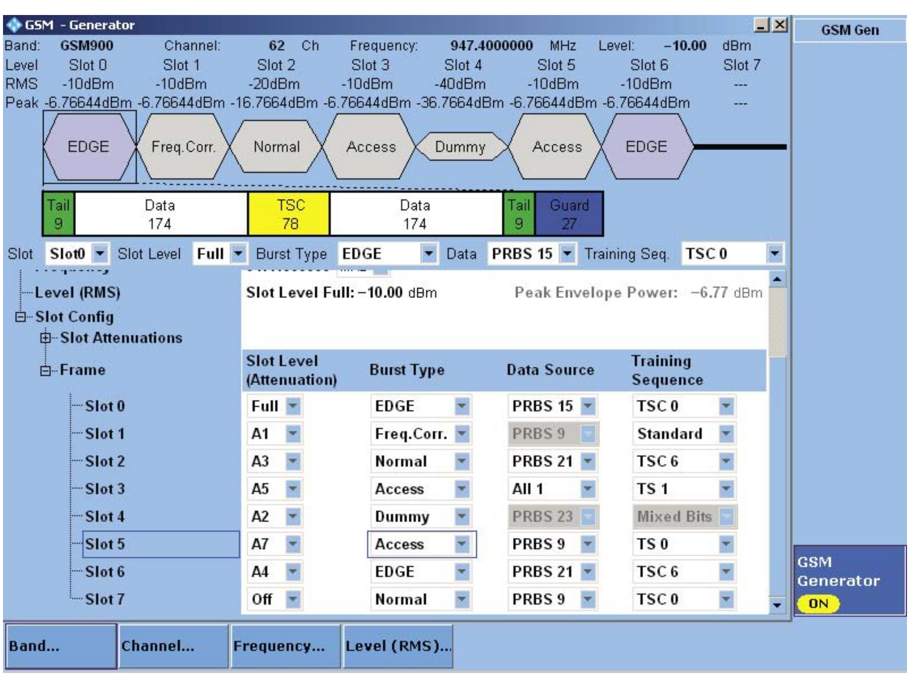


FIG 2 The graphical visualization of the timeslot structure of the online generator for GSM/GPRS/EDGE provides a good overview of the settings.

Online generators for GSM/GPRS/EDGE (R&S®CMW-KG200 option) and 3GPP FDD (R&S®CMW-KG400/401 option) are currently available (FIG 3), and others will follow.

Torsten Bilz; Daniel Hank

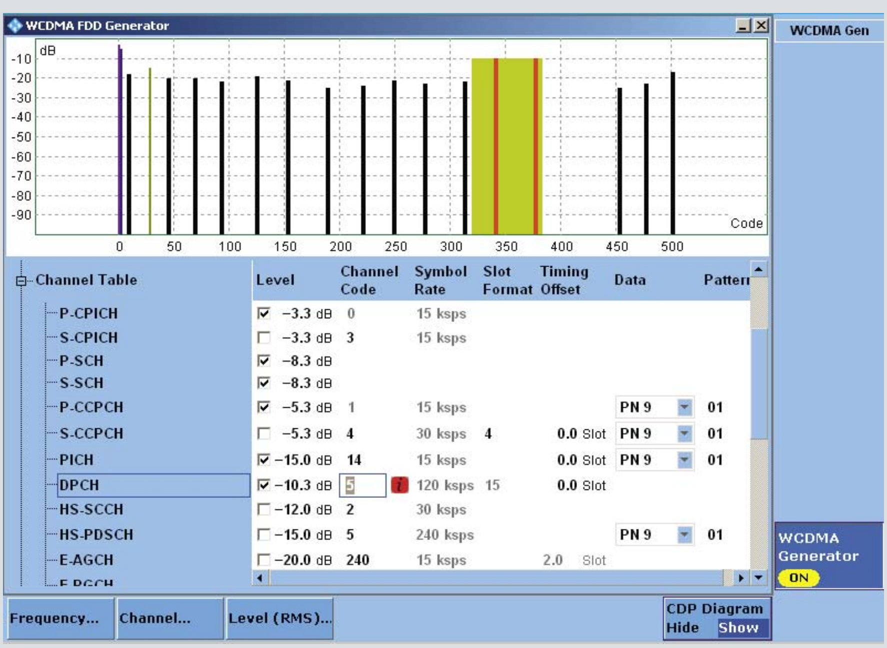
Options	Type designation
Hardware	
ARB + Realtime Baseband Generator Module	R&S®CMW-B110A
Optional online generators	
GSM/GPRS/EDGE, Downlink	R&S®CMW-KG200
WCDMA, Downlink	R&S®CMW-KG400
WCDMA HSPA Extension, Downlink	R&S®CMW-KG401
R&S®WinIQSIM2 waveforms	
GSM/EDGE	R&S®CMW-KW200
WCDMA	R&S®CMW-KW400
WCDMA HSDPA Extension	R&S®CMW-KW401
WCDMA HSUPA Extension	R&S®CMW-KW402
WiMAX™ (IEEE 802.16)	R&S®CMW-KW700
TD-SCDMA	R&S®CMW-KW750
CDMA2000®	R&S®CMW-KW800
1xEV-DO	R&S®CMW-KW880

FIG 3 Generator options for the R&S®CMW500.

Example: online generator for 3GPP FDD (R&S®CMW-KG400 option)

The R&S®CMW-KG400 software option provides the online generator for 3GPP FDD, which generates a downlink signal in line with Release 99 of the 3GPP FDD specification. It supports the most common physical channels and fills them with transport channel information, making it possible, for example, to select the predefined reference measurement channels in line with 3GPP TS25.101 (RMC 12.2 kbit/s, 64 kbit/s, 144 kbit/s, 384 kbit/s); see FIG 4.

The realtime mode of the baseband generator module allows the 3GPP FDD online generator to generate the transmit power control (TPC) bits in realtime and feed them to the control information of the dedicated physical channel (DPCH). The wireless device under test can thus be controlled via different power profiles (in line with 3GPP TS34.121 5.4.2, for example) and checked by measurement.

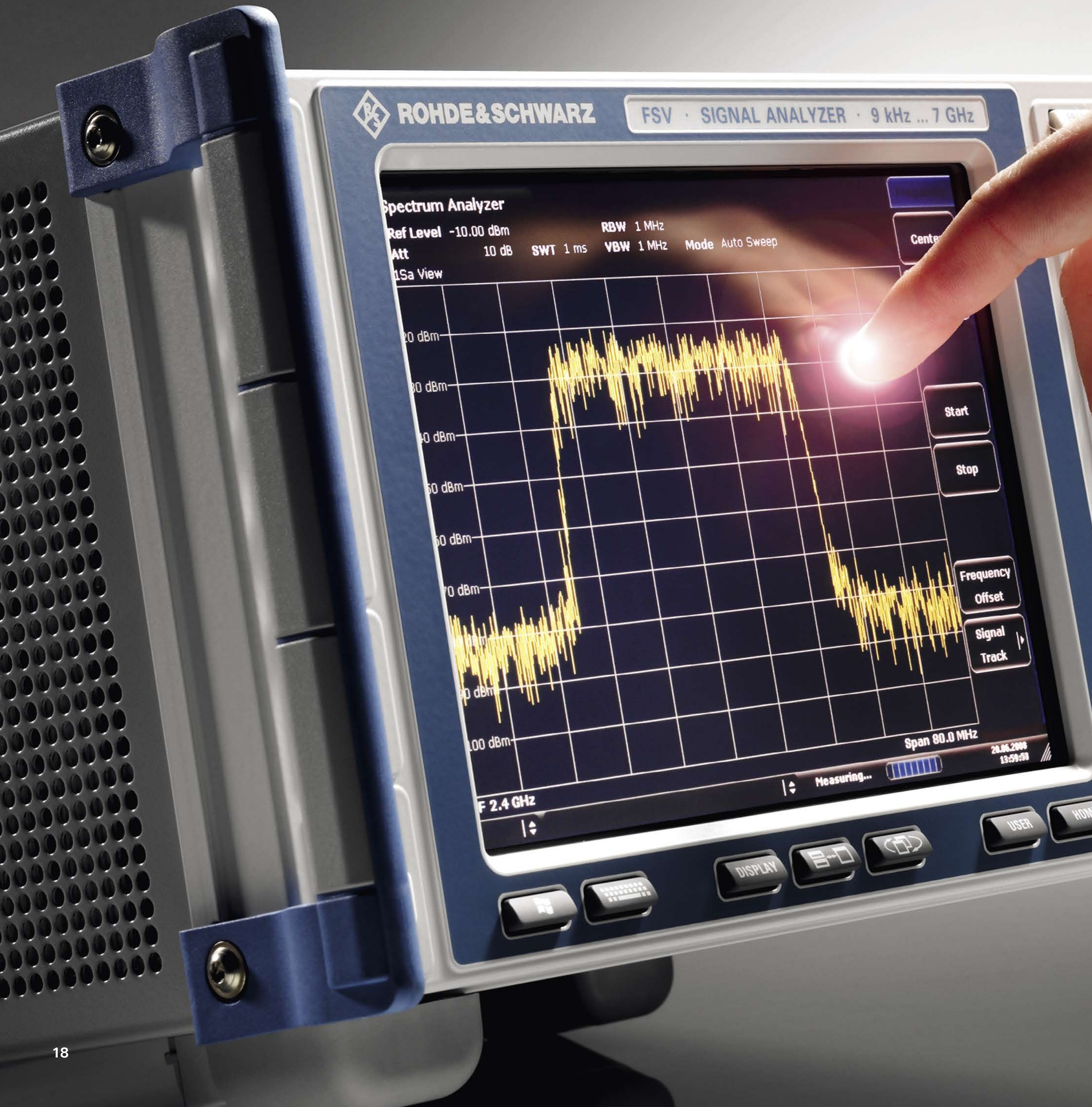


The R&S®CMW-KG401 option expands the 3GPP FDD online generator to a downlink signal source in line with Release 5/6. Five fixed-reference measurement channels standardized in line with 3GPP TS 25.101 are available for HSDPA. For HSUPA, on the other hand, three flexibly configurable downlink channels can be used.

FIG 4 Typical channel setup of the 3GPP downlink generator with RMC 384 kbit/s and OCNS. The code domain diagram makes it easier for users to configure the channel table and immediately reveals code conflicts.

The fastest and most accurate signal and

The R&S®FSV is superior to established instruments of its class in almost every respect, and is the only medium-class analyzer to offer analysis bandwidths of up to 40 MHz and a touch screen.



spectrum analyzer in the medium class

FIG 1 Offering analysis bandwidth of up to 40 MHz, the R&S®FSV covers wireless standards from 3GPP LTE through to WLAN 802.11n. Plus, its touch screen makes it very quick and easy to operate.

A signal analyzer that redefines the medium class

Manufacturers of wireless terminals are faced with an enormous cost pressure, and at the same time need to respond to the demand for innovation. This leads to the requirements for cutting development times by using more versatile and easier-to-operate T&M equipment, and for reducing production test times by using faster T&M equipment. Moreover, the steadily growing bandwidth requirements of modern wireless standards call for ever increasing analysis bandwidths.

The new R&S®FSV signal analyzer (FIG 1) has been specially designed to meet these requirements. It is the fastest, most accurate and most versatile medium-class signal analyzer currently available to meet the needs of performance-oriented, cost-conscious users in the development, production, installation and servicing of RF systems. Superior in almost all respects to established devices in this class, it is the only medium-class analyzer to offer analysis bandwidth of 40 MHz. This enables it to cover wireless standards from 3GPP LTE through to WLAN 802.11n. Plus, its innovative operating concept featuring a touch screen makes it extremely easy to use.

The R&S®FSV comes in two models for the frequency ranges from 9 kHz to 3.6 GHz and 9 kHz to 7 GHz. Models for the microwave range will soon be available. The frequency range can be expanded down to 20 Hz for both models. At low frequencies, the R&S®FSV performs direct A/D conversion of the RF signal. This prevents a degradation of performance caused by local oscillator feedthrough and phase noise, as encountered with many signal and spectrum analyzers.

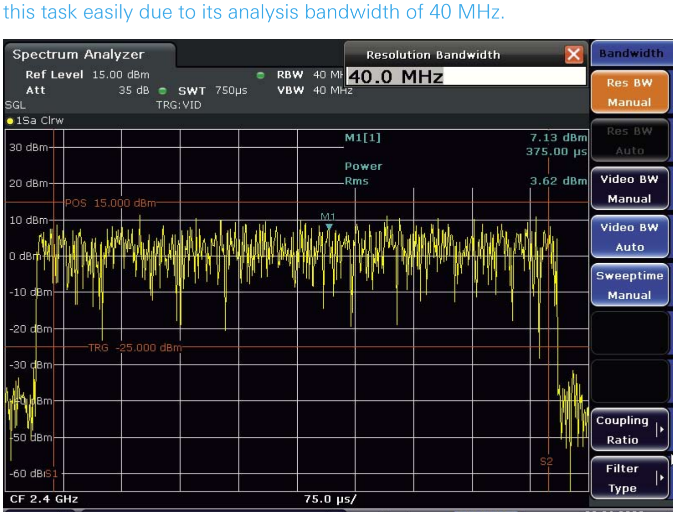


FIG 2 Measurement of the burst power of a wideband WLAN signal (802.11n) using the time domain power function – the R&S®FSV handles this task easily due to its analysis bandwidth of 40 MHz.

Ready to handle all standards with 40 MHz analysis bandwidth

In its fully digital signal analysis module, the R&S®FSV combines the functionalities of a signal analyzer and a spectrum analyzer. Its 128 MHz A/D converter digitizes the last IF with a resolution of 16 bits. In contrast to conventional analyzers, whose I/Q memory can take up only a few Msamples, the R&S®FSV offers I/Q memory depth for up to 200 Msamples. This allows signals to be recorded over extended periods of time, even with large bandwidths and correspondingly high sampling rates.

The R&S®FSV's standard analysis bandwidth of 28 MHz not only covers all currently established wireless communications standards; it can also be used for mobile WiMAX™ and the new LTE standard. The upgrade option for 40 MHz analysis bandwidth supports the measurement of IEEE 802.11n signals and makes the R&S®FSV suitable for use in the development of modules for satellite communications and satellite TV – demanding tasks which previously required the use of high-end analyzers.

The R&S®FSV offers resolution bandwidths from 1 Hz to 10 MHz and, in the zero span mode, additionally up to 20 MHz and 28 MHz, and optionally up to 40 MHz. This makes the analyzer an ideal choice for a frequently encountered task: accurate power measurements of broadband WLAN or WiMAX™ burst signals. Channel power measurements are difficult to perform by means of standard frequency sweeps as they require stable triggering in the gate mode. With its 20 MHz, 28 MHz or 40 MHz filters, the R&S®FSV can carry out these measurements in the zero span mode, with synchronization being provided by the internal video trigger. A special time domain power measurement function allows the user to precisely define the part of a burst to be measured (FIG 2).

Superior level measurement accuracy up to 7 GHz

With its low total level measurement uncertainty of 0.3 dB up to 3 GHz, and only 0.4 dB up to 7 GHz, the R&S®FSV ensures highly accurate and reliable results. Especially in the range between 3 GHz and 7 GHz, the R&S®FSV delivers results with an accuracy closer to that of power meters than is the case with conventional analyzers, which often exhibit a frequency response of 1 dB to 2 dB above 3 GHz/3.6 GHz. The R&S®FSV simplifies test setups in development and production, as in many cases it does away with power meters, e.g. in the analysis of WLAN 802.11a signals in the 5.8 GHz ISM band or WiMAX™ signals between 3.4 GHz and 3.8 GHz.

Top speed in all areas boosts production efficiency

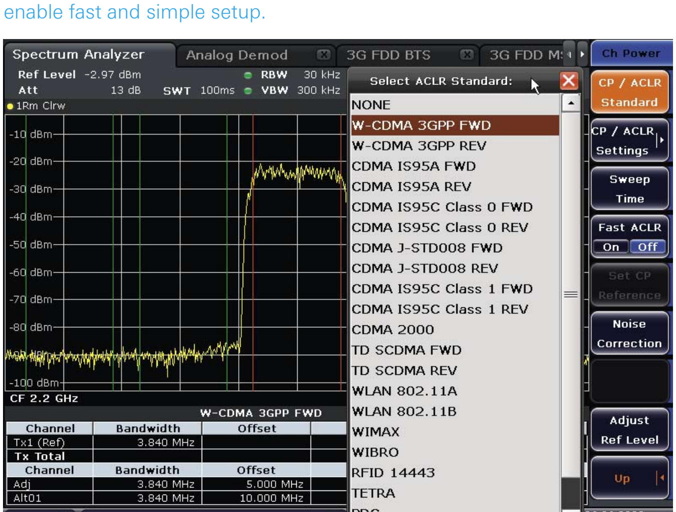
The R&S®FSV was designed with a focus on high measurement speed. It significantly reduces test costs in production as it performs simple measurement tasks as well as complex modulation analyses quickly, reliably, and with low measurement uncertainty.

FIG 3 shows the various measurement speeds of the R&S®FSV. With more than 500 sweeps/s in manual operation and up to 1000 sweeps/s in remote operation, the R&S®FSV is up to five times faster than other devices in its class. The high sweep speed is a major asset not only in production. Especially in cases that require averaging of a large number of measurements, as stipulated by many standards, the R&S®FSV supplies results in a considerably shorter time.

The R&S®FSV also offers a variety of functions that speed up test routines by cutting alignment and measurement times, thus increasing overall throughput:

- Frequency list mode (LIST MODE) for fast measurements on up to 300 frequencies with different analyzer settings by means of a single remote control command
- Measurement of different power levels in the time domain in a single sweep for especially fast alignments (multi-summary marker)
- Fast ACP measurements in the time domain using channel filters (FIG 5) or in the frequency domain using FFT sweeps
- Frequency counter with 0.1 Hz resolution at a measurement time of <50 ms
- Gigabit LAN interface for the fast transfer of large data volumes
- Trigger interface for synchronization with the production system in the frequency list mode

FIG 5 ACP measurement: A large number of predefined standards enable fast and simple setup.



Mode	Measurement rate/time
Sweep rate, remote control, averaged over 1000 sweeps	1000/s
Sweep rate, manual control	500/s
LIST MODE, measurement of level of fundamental and five harmonics	21 ms
Marker peak search	1.5 ms
Frequency change and query	15 ms
Fastest sweep time (zero span)	1 µs
Fastest sweep time (frequency sweep)	1 ms

FIG 3 Measurement rates of the R&S®FSV signal analyzer in various modes.

Setting	Currently available conventional signal analyzers	R&S®FSV
1 kHz RBW, conventional sweep	10 s	1 s
1 kHz RBW, FFT sweep	200 ms	5.7 ms
10 Hz RBW, FFT sweep	20 s	2.7 s

FIG 4 Sweep times for a 10 MHz span.

All analysis filters of the R&S®FSV are digital, and consequently have precisely defined characteristics and are faster than analog filters. Moreover, the R&S®FSV's optimized FFT sweep covering a wide bandwidth reduces the time required for sweeping a specific frequency range. This is particularly important when measuring spurious emissions, where the analyzer has to capture and measure signals with a low level across a wide frequency range.

High sensitivity can in many cases only be achieved by using narrowband filters to minimize the noise level. Reducing the bandwidth by half, however, will increase the sweep time by a factor of four, making the measurement of spurious emissions extremely time-consuming. FIG 4 compares the sweep time of the R&S®FSV for a span of 10 MHz with that of currently available conventional analyzers. The comparison clearly shows that users can complete their tasks significantly faster with the R&S®FSV.

A typical measurement task in the production of wireless terminals is alignment of the output power. This requires measuring a wide range of different power levels at a specific frequency. The R&S®FSV performs these measurements during a single sweep in the remote mode.

- AM, FM, φM modulation
- GSM/EDGE
- 3GPP UL/DL (including HSPA)
- WLAN 802.11 a, b, g, j
- WLAN 802.11n
- WiMAX™ 802.16e
- LTE UL/DL

FIG 6 R&S®FSV signal analysis functions.

Another task regularly encountered in production is harmonics measurement. The R&S®FSV handles this conveniently in manual operation with its harmonics measurement function. In remote operation, its LIST MODE ensures short measurement times for this and for other measurements. In this mode, the analyzer carries out measurements at up to 300 different frequencies requiring only a single setting and a single remote control command. The R&S®FSV also tunes in to the different frequencies very rapidly. Measuring the levels of a fundamental and five harmonics takes no more than 21 ms.

Numerous signal analysis functions

The R&S®FSV base unit provides all the required functions such as measurement of channel and adjacent channel power and spectrum emission mask. Plus, it offers an extensive range of detectors. Options for GSM/EDGE, 3GPP WCDMA, 3GPP LTE, WiMAX™ and WLAN analysis make the R&S®FSV an ideal development tool in the wireless communications lab (FIG 6). Two further benefits are the analog measurement demodulator and the capability of operating a power sensor of the R&S®NRP-Zxx series directly on the R&S®FSV.

The base unit already provides a large number of established automatic test routines, e.g. measurement of adjacent channel power for numerous standards, measurement of complementary cumulative distribution function (CCDF), spurious emissions, spectrum emission mask, and harmonics. Up to six measurement traces, which can all be active simultaneously, and up to 16 markers support the evaluation of results.

Touch screen: Operating an analyzer has never been so easy

The R&S®FSV offers unparalleled ease of operation. It requires neither a mouse nor a keyboard, thus saving considerable space. The R&S®FSV relies on a highly convenient, intuitive operating concept featuring a touch screen and straightforward menu guidance, which greatly facilitates instrument control and helps users to get familiarized with the instrument quickly. The touch screen significantly speeds up manual operation as it allows rapid switching between different operating modes. To select a desired application or mode, you simply touch the corresponding tab on the screen. Or, to call up a specific 3GPP application for example, you touch a block in the signal flow chart: This will open a configuration menu where you can make the desired settings (FIGs 7 and 8). With its touch screen, on-screen keyboard and hotkeys, the R&S®FSV sets new standards for a state-of-the-art signal analyzer.

FIG 7 In several configurable windows, you can group result displays as required for your particular application. Using the tabs, you can select a desired application or mode in next to no time.

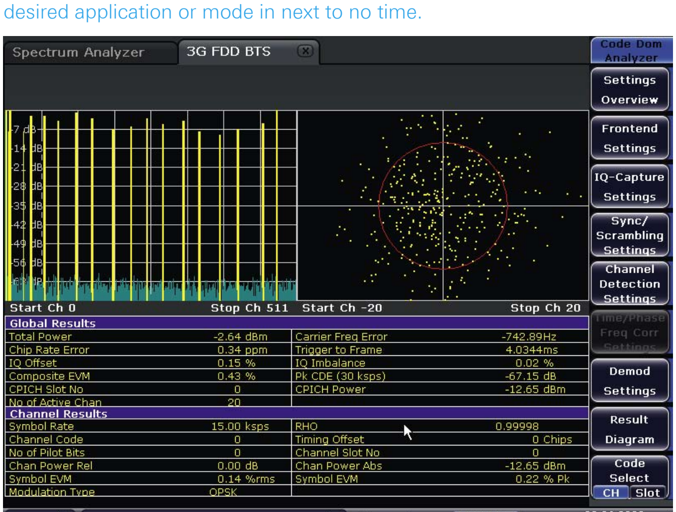
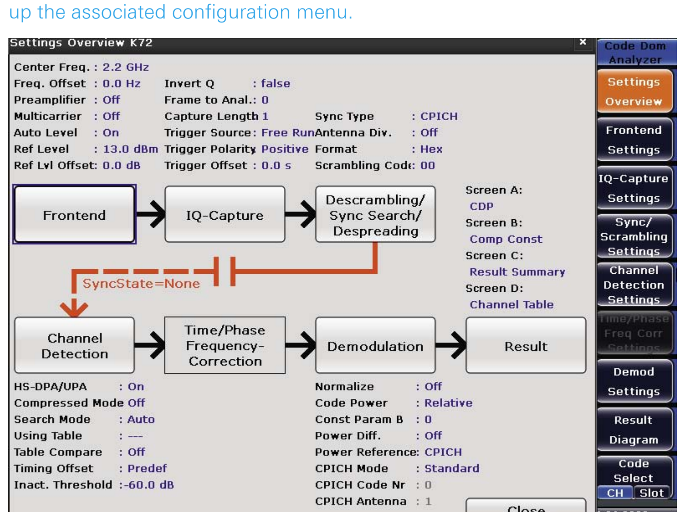


FIG 8 To make configuration easier even for the most complex measurements, the signal flow is displayed together with the current settings listed in a straightforward manner. By touching one of the blocks, you can call up the associated configuration menu.



If required, a keyboard can be displayed on the screen. Alternatively, all functions and measurement parameters can also be configured in the conventional manner by means of keys and a rotary knob, or a mouse and keyboard. The large SVGA display ensures high resolution and good readability.

The comprehensive, context-sensitive help provides detailed information about the current function and also displays the associated remote control commands – a much faster alternative than using printed manuals. Up to six preceding operating steps can be canceled or restored using the UNDO/REDO keys. This allows you to correct operating errors or toggle between two different states. A valuable aid in setting up the analyzer are the AUTO SET functions, which make it possible to adapt analyzer settings to the current measurement signal at the press of a key.

Easy transition to the next generation in signal analysis

Compatibility with previous instrument families based on the consistent Rohde & Schwarz instrument concept greatly simplifies the transition to the new generation – no matter whether the issue is remote control programs used on a production line, the space required by an instrument in a rack, or manual operation of an instrument in a development lab. The ultimate customer benefit is safety of investments in software, system design and training.

The remote control command set used in the R&S®FSV for the spectrum analysis mode and most applications is compatible with that of the R&S®FSP and R&S®FSU spectrum analyzers. This allows you to continue using existing remote control programs without incurring any additional development costs as you transition to the new generation in signal analysis.

Summary

With its wealth of custom-made applications for all common radiocommunications standards, the R&S®FSV offers an unrivaled price/performance ratio and enhanced efficiency in development, module characterization and production. Due to its outstanding RF characteristics (see condensed data), the R&S®FSV ranks top among currently available medium-class analyzers. Plus, featuring analysis bandwidth of up to 40 MHz, excellent analysis capabilities and exceptionally high speed, it offers performance that is close to, and in some respects even superior to, that of high-end analyzers.

Herbert Schmitt

Condensed data of the R&S®FSV3/R&S®FSV7

Frequency range	
R&S®FSV3	9 kHz (20 Hz) to 3.6 GHz
R&S®FSV7	9 kHz (20 Hz) to 7 GHz
Resolution/bandwidths	
Resolution bandwidths	
Standard sweep	1 Hz to 10 MHz
Standard sweep, zero span	1 Hz to 10 MHz, 20 MHz , 28 MHz, optionally 40 MHz
FFT sweep	1 Hz to 300 kHz
Channel filters	100 Hz to 5 MHz
EMI filters	200 Hz, 9 kHz, 120 kHz, 1 MHz
Video filters	1 Hz to 10 MHz, 20 MHz, 28 MHz, 40 MHz
Signal analysis bandwidth	28 MHz
With R&S®FSV-B70 option	40 MHz
Displayed average noise level (DANL)	
(1 Hz bandwidth)	
1 GHz	–152 dBm, typ. –155 dBm
3 GHz	–150 dBm, typ. –153 dBm
7 GHz	–146 dBm, typ. –149 dBm
Intermodulation	
Third-order intercept (TOI)	
f < 3.6 GHz	+13 dBm, typ. +16 dBm
3.6 GHz to 7 GHz	+15 dBm, typ. +18 dBm
Phase noise	
(1 GHz carrier frequency)	
10 kHz offset from carrier	–106 dBc (1 Hz), typ. –110 dBc (1 Hz)
100 kHz offset from carrier	–115 dBc (1 Hz)
1 MHz offset from carrier	–134 dBc (1 Hz)
Total measurement uncertainty	
3.6 GHz	0.3 dB
7 GHz	0.4 dB

New functions for the R&S®SMF100A microwave signal generator

Two new options add further exceptional capabilities to the R&S®SMF100A microwave signal generator, enhancing its unique position on the market. The R&S®SMF-K27 pulse train option allows complex, user-configurable pulse scenarios to be generated for the first time. The R&S®SMF-K28 power analysis option opens up applications that previously required a network analyzer or a peak power analyzer.

R&S®SMF-K27 pulse train option

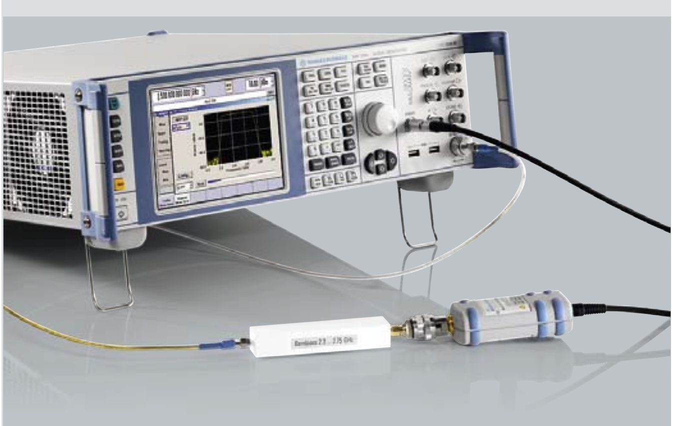
Conventional signal generators can generate single and double pulses and allow definition of the pulse width and pulse spacing. Recently, especially in the aerospace & defense (radar) sector, there has been an increasing demand for creating more complex scenarios such as:

- Jittered pulse widths and/or spacings
- Increasing pulse widths and/or spacings
- Sequences of pulses with different widths and spacings, e.g. 100 pulses of 10 ns width followed by 200 pulses of 20 ns width

Previously, ARB-based vector signal generators have been used for simulating complex signals of this type. These, however, have the following disadvantages:

- High costs (extremely complex hardware)
- Low dynamic range (i.e. insufficient carrier suppression in the gaps between the pulses)
- Limited edge steepness (due to the limited sampling rate)

Signal quality, speed and flexibility – three key criteria at which the R&S®SMF100A microwave signal generator excels (see News from Rohde&Schwarz (2007) No. 192, pp 21–24).



The new R&S®SMF-K27 pulse train option combines the advantages of a classic pulse modulator with the flexibility of memory-based solutions, allowing users to freely define the modulator control signal while profiting at the same time from the excellent characteristics of the R&S®SMF-K3 pulse modulator in the R&S®SMF100A:

- Pulse widths and spacings selectable between 5 ns and 5 ms
- Rise time <10 ns
- On/off ratio >80 dB

More than 2000 single pulses can be combined in a pulse train, with the capability to output each individual pulse as many times as necessary. Pulse trains can be conveniently configured and edited in a table. FIG 1 shows a configuration example for a signal consisting of two bursts of ten single pulses each. A graphical preview function is also available, allowing you to check the signal before it is output (FIG 2).

In addition to the manual configuration of pulse trains, lists can be imported from Excel or in text format. It is thus possible to meet even more sophisticated requirements – e.g. to generate jittered pulse widths controlled by specific probability density functions – without crowding the signal generator display.

An unmodulated signal (CW) is normally transmitted during the on-phase of the pulse. The high flexibility of the R&S®SMF100A microwave signal generator also allows pulse modulation to be combined with other types of modulation and operating modes. An option of particular interest here is combining the pulse train with FM modulation synchronized to the edges of the pulse modulator output signal. If an LF sawtooth signal is applied, chirps are transmitted during the on-phase of the pulse, i.e. the carrier signal quickly sweeps a predefined frequency range.

R&S®SMF-K28 power analysis option

The R&S®SMU200A, R&S®SMA100A, R&S®SMB100A and R&S®AMU200A signal generators from Rohde & Schwarz have for some time already provided the capability of directly connecting a power sensor of the R&S®NRP-Zxx family, e.g. for correcting the frequency response of the test setup or for power measurement.

The new R&S®SMF-K28 power analysis option now also provides R&S®NRP-Zxx power sensor connectivity for the R&S®SMF100A, allowing the signal generator to perform tasks that previously required a scalar network analyzer or a pulse analyzer. Customers who do not need high-end performance or flexibility and use an R&S®SMF100A thus already have an inexpensive alternative.

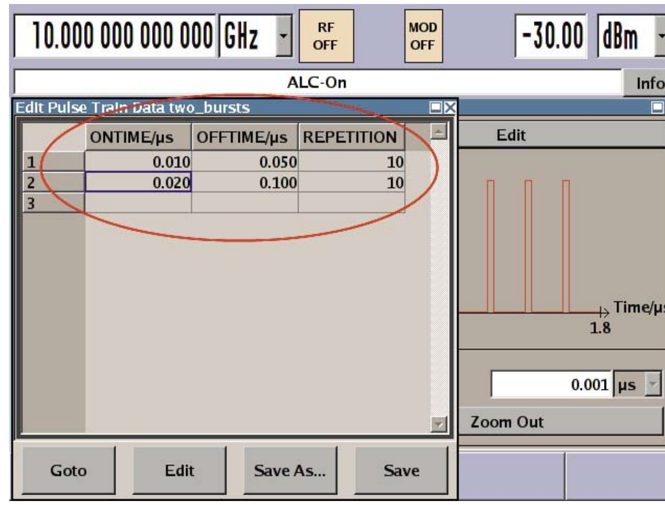


FIG 1 Configuration of a pulse train.

Frequency response measurements

To measure the frequency response, the RF output of the signal generator is connected to the input of the device under test (DUT), e.g. a filter or an amplifier. The output of the DUT is connected to the power sensor, which measures the DUT signal and transmits the measured power to the signal generator (FIG 3). If the generator now sweeps across a predefined frequency range, the measured power versus frequency describes the DUT's frequency response.

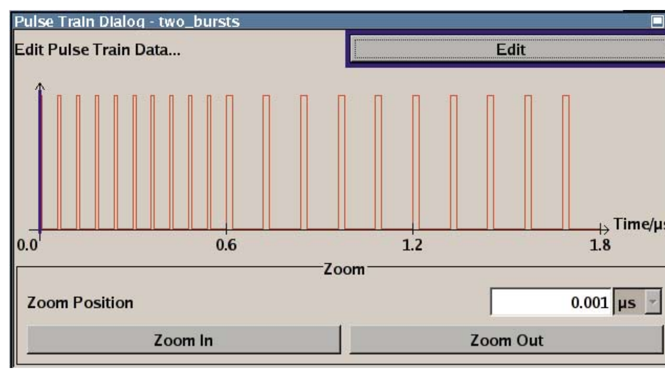
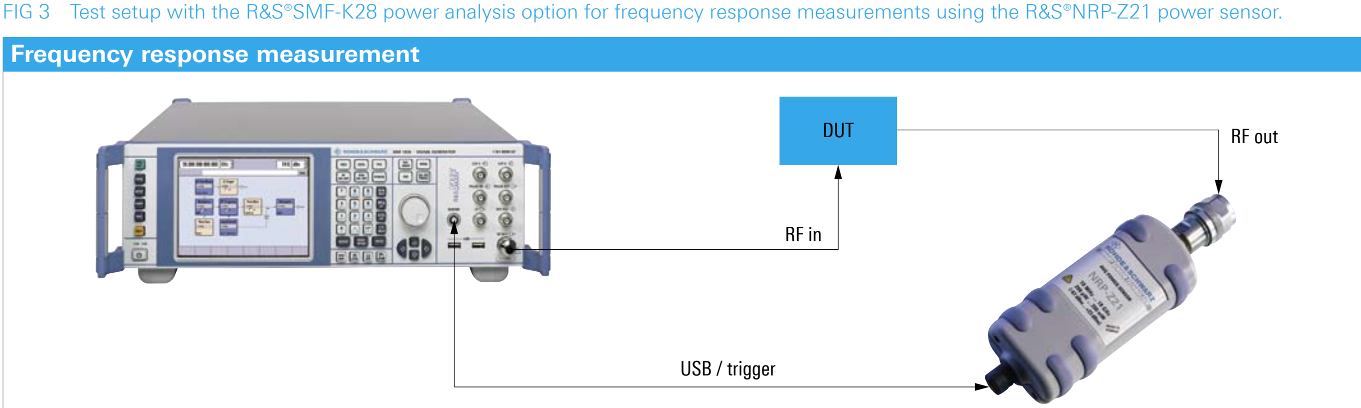


FIG 2 Preview of the envelope of the pulse train configured in FIG 1.

Four markers are available to read out the power at any desired points of the frequency response trace. Moreover, traces can be saved as diagrams or as Excel files. To optimally adapt the R&S®SMF100A screen display to the measurement task, users can choose among several different screen layouts. FIG 4, for example, shows a measurement diagram displayed together with a setting window.

The number of test points and the level accuracy can be selected. The measurement time and dynamic range depend on the power sensor used. The R&S®NRP-Z21 is ideal for use with the R&S®SMF100A, as it provides level accuracy better than 0.1 dB at a level of –40 dBm and a sweep time of approx. two seconds.

FIG 3 Test setup with the R&S®SMF-K28 power analysis option for frequency response measurements using the R&S®NRP-Z21 power sensor.



Compression measurement

It is also possible to characterize a DUT, e.g. an amplifier, in terms of its compression characteristics. The test setup is identical. For this measurement, the signal generator performs a level sweep instead of a frequency sweep.

Measurement of the RF envelope

If the power levels are measured in quick succession, the envelope of the measured signal will be displayed. The R&S®NRP-Z81 power sensor, which provides high-resolution display even for pulses as narrow as 150 ns (FIG 5), is an ideal choice for this application.

Summary

The new R&S®SMF-K27 pulse train and R&S®SMF-K28 power analysis options provide the R&S®SMF100A microwave signal generator with measurement capability that no competitor can offer. Both options will shortly also be available for the R&S®SMA100A signal generator.

Thomas Braunstorfinger

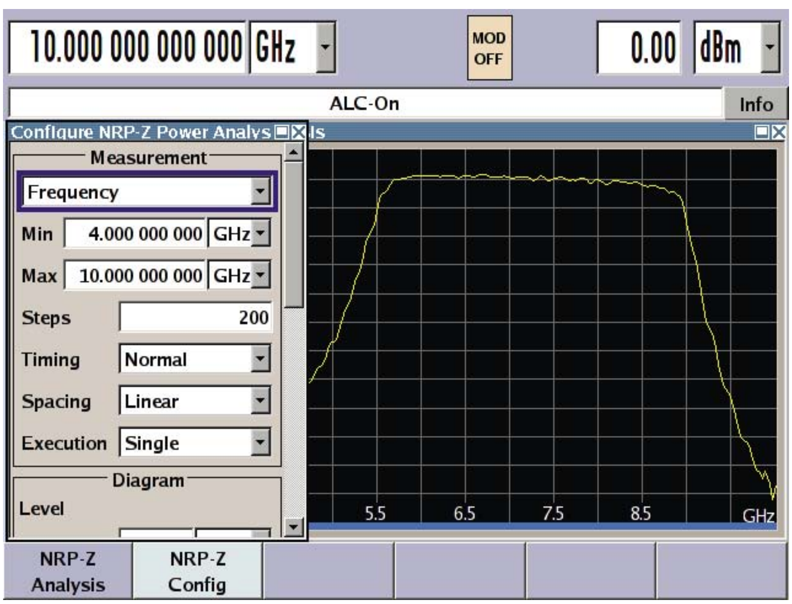


FIG 4 Measurement of the frequency response of a bandpass filter.

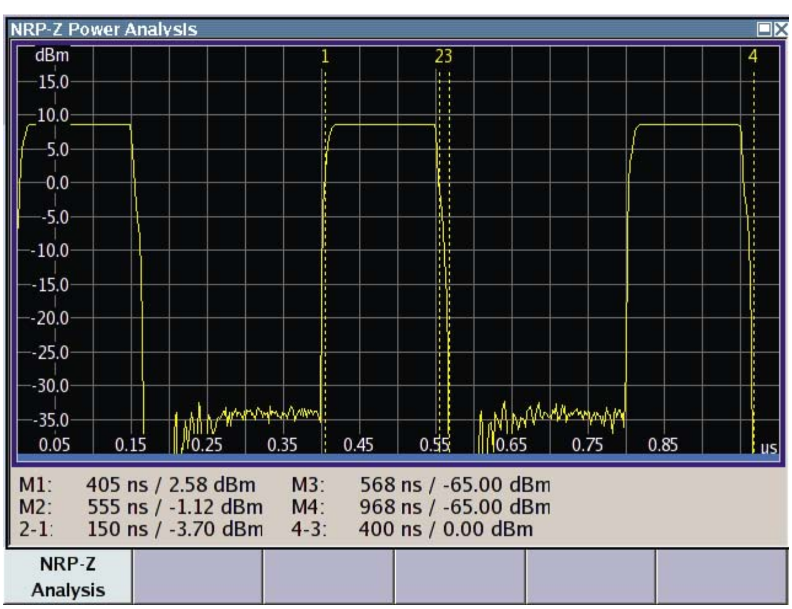


FIG 5 High-resolution display of an RF signal envelope measured with an R&S®NRP-Z81 power sensor.

R&S®OSP open switch and control platform: even more versatile with new extensions

The new R&S®OSP130 base unit of the modular R&S®OSP open switch and control platform comes with a control panel and a display. In addition to remote control, this allows manual operation of the switch and control modules directly on the device. Additional modules and new software functions significantly enhance the range of applications for the platform.

The new R&S®OSP130 base unit

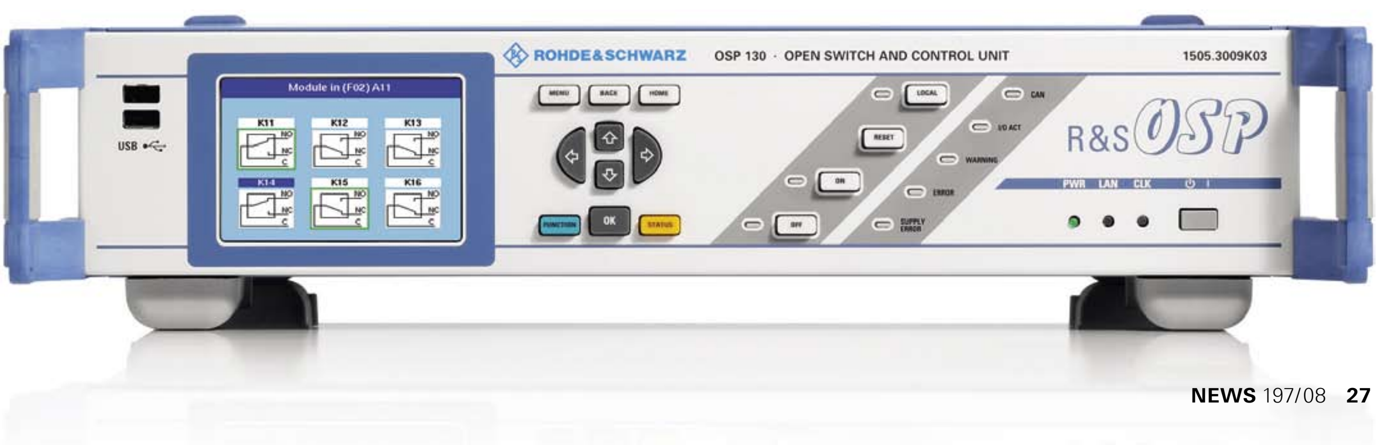
The product family consisting of the R&S®OSP120 base unit and the R&S®OSP150 extension unit (see box on right) has been expanded by a new member: the R&S®OSP130 base unit featuring a control panel and a display (FIGs 1 and 4). The new device can be manually controlled itself, and also enables manual control of any connected R&S®OSP150 extension units. A connection to a network or a PC is possible but not necessary – a major benefit for lab applications and in manually operated systems.

The base and extension units of the platform as well as their relay and I/O modules are selected by means of the cursor and function keys. The selected relays and digital I/Os can be switched at the press of a key. The display indicates the switching status after completion of the switching operation (FIG 2). The user can thus be sure that the desired switching action has actually taken place.

In the case of complicated circuit configurations, it is advisable to store the required switching states as a path that can be selected by means of the cursor keys and activated with "OK". This allows any number of relays of the platform to be switched reliably and repeatably at a single keystroke. Operator errors are reduced to a minimum, and incorrect measurements caused by wiring errors as well as damage to equipment are avoided. The new graphical user interface of the R&S®OSP130 is also available for the R&S®OSP120. After connecting a monitor to the DVI interface of the R&S®OSP120, the unit can be manually controlled via an external USB keyboard and mouse.

The R&S®OSP modular platform makes RF switching and control tasks fast and easy (see News from Rohde & Schwarz (2008) No. 195, pp 28–31). The R&S®OSP120 base unit (bottom) and the R&S®OSP150 extension unit (top) have now been complemented by a base unit featuring a display and a control panel. A range of new modules are also available.

FIG 1 The new R&S®OSP130 base unit can also be operated manually via the front panel and indicates the switching states on the display.



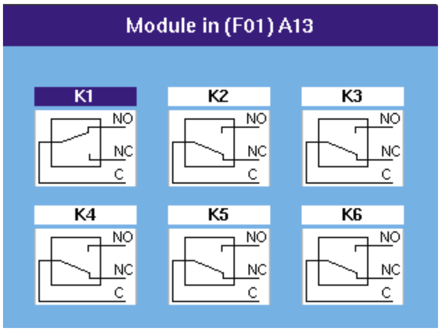


FIG 2 Relay positions of the R&S®OSP-B101 SPDT RF switch module.

FIG 3 R&S®OSP-B104 relay driver module.

Universal software integration

Each base unit can be controlled via its Ethernet interface using the operating software for the R&S®OSP or user software. For user software, a VXI-11-compatible software interface is available for direct control of the platform from C, LabWindows/CVI, VXI P&P and IVI-COM using the SCPI command set. Various programming examples and a virtual instrument for LabView users are also available, which significantly simplifies integration of the units.

New modules provide enhanced functionality

The R&S®OSP-B101 and R&S®OSP-B102 modules with coaxial switching relays up to 18 GHz and the R&S®OSP-B103 digital I/O module have been complemented by the following universal modules:

- The **R&S®OSP-B111 RF switch module** with six coaxial changeover relays (SPDT) and the **R&S®OSP-B112 RF switch module** with two coaxial multiposition relays (SP6T) for the frequency range from 0 Hz to 40 GHz perform switching tasks in radar applications, for example.
- The **R&S®OSP-B107 RF switch module** with six solid-state changeover relays is intended for applications involving short switching times and an extremely large number of switching cycles. It operates in the frequency range from 0 Hz to 6 GHz.
- The **R&S®OSP-B104 relay driver module** (FIG 3) controls up to four external RF power relays. Two channels are provided for each driver, enabling the use of transfer relays with a return signaling function. The module additionally contains four digital input channels and five digital output channels (open-drain) as well as an interlock loop. The digital inputs and outputs and the interlock loop can, for example, be used to control devices and to monitor the doors of anechoic chambers.
- The **R&S®OSP-B106 RF switch module** (FIG 5) includes three SPDT (N) and three SPDT (BNC) RF relays. Combining different relay types in a single module enables cold switching of RF signal paths between 0 Hz and 12.4 GHz as well as the switching of DC voltages (60 W, 2 A) and RF signals between 0 Hz and 900 MHz.

FIG 6 provides an overview of all the modules available for the R&S®OSP open switch and control platform.

FIG 4 Rear view of the new R&S®OSP130 base unit, equipped with three modules in this example.

FIG 5 R&S®OSP-B106 RF switch module.

Summary

The new, manually controllable R&S®OSP130 base unit plus a range of new modules round out the product portfolio of the R&S®OSP open switch and control platform. In conjunction with the new firmware, this opens up new applications and simplifies system integration of the platform.

Gert Heuer

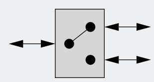
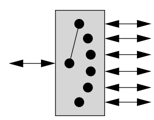
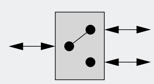
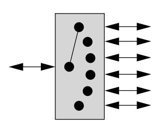
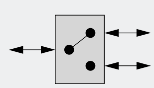
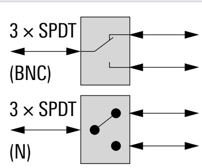
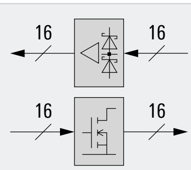
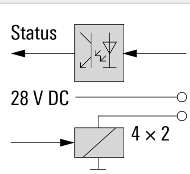
Connectors	Module	Symbol	Features
	**R&S®OSP-B101 RF switch module** (1505.5101.02)		6 × RF changeover relay (SPDT), 0 Hz to 18 GHz
	**R&S®OSP-B102 RF switch module** (1505.5201.02)		2 × RF multiposition relay (SP6T), 0 Hz to 18 GHz
	**R&S®OSP-B111 RF switch module** (1505.4605.02)		6 × RF changeover relay (SPDT), 0 Hz to 40 GHz
	**R&S®OSP-B112 RF switch module** (1505.4611.02)		2 × RF multiposition relay (SP6T), 0 Hz to 40 GHz
	**R&S®OSP-B107 RF switch module** (1505.5901.02)		6 × RF solid-state relay (SPDT), 0 Hz to 6 GHz
	**R&S®OSP-B106 RF switch module** (1505.5601.02)		3 × SPDT (BNC), 0 Hz to 900 MHz, (20 W to 60 W), DC: 60 W, 2 A 3 × SPDT (N), 0 Hz to 12.4 GHz, (200 W to 700 W)
	**R&S®OSP-B103 digital I/O module** (1505.5301.02)		16 × digital input (LV-CMOS, TTL); 16 × digital output (open drain)
	**R&S®OSP-B104 relay driver module** (1505.5401.02)		Control of four external power relays; additional digital inputs/outputs

FIG 6 Overview of modules available for the R&S®OSP open switch and control platform.

Interface card for the latest data formats complements the R&S®UPV audio analyzer

State-of-the-art circuits in multichannel audio systems, wireless communications applications and Bluetooth® components use new data formats to transmit audio content. The top-class R&S®UPV audio analyzer is already well prepared for these formats: Equipped with the new R&S®UPV-B42 universal serial interface, it can adapt virtually all existing audio data formats.

Increasing variety of digital audio interfaces

Nowadays, interconnecting digital audio equipment via standardized interfaces is considered standard procedure. Professional sound studios use the AES/EBU format, while devices for the consumer sector are equipped with electrical or optical interfaces based on the S/P-DIF standard.

However, when looking inside such audio devices, i.e. at the circuitry interconnecting the various modules and components, primarily different serial data interfaces are used. Dual-channel, device-internal audio data transmission often utilizes the inter-IC sound (I²S) bus standard that has been established worldwide. The R&S®UPV has supported this format for quite some time now with the R&S®UPV-B41 I²S interface option.

The compact R&S®UPV audio analyzer easily handles all types of measurements in the audio sector, meeting the extreme demands of both analog technologies and high-resolution digital media (see NEWS from Rohde & Schwarz (2008) No. 196, pp 36–38).

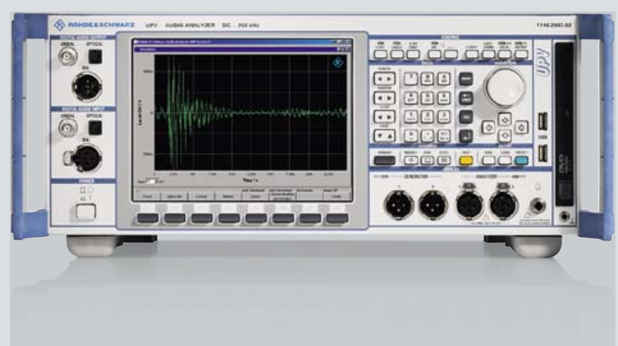
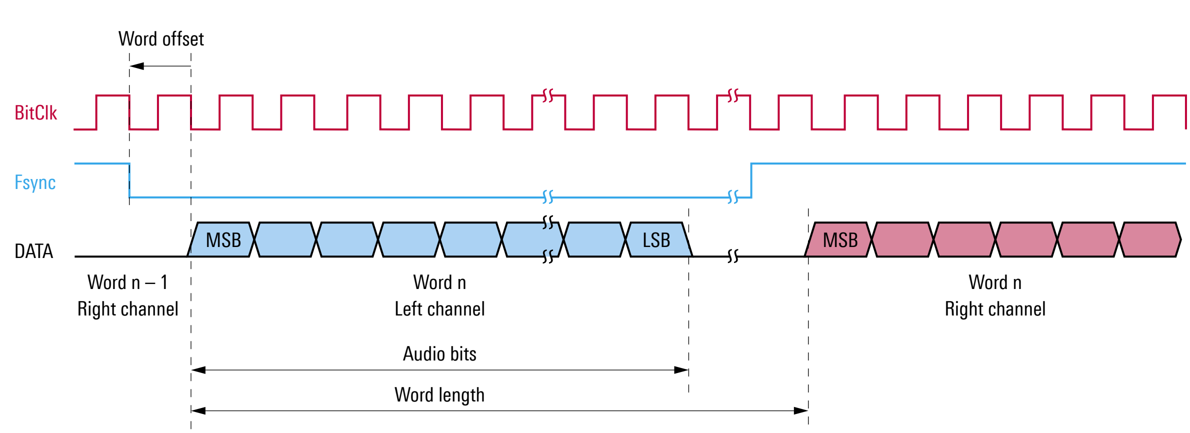


FIG 1 Fundamental signal characteristic of a digital audio transmission in I²S format.

I²S data format



Multichannel applications

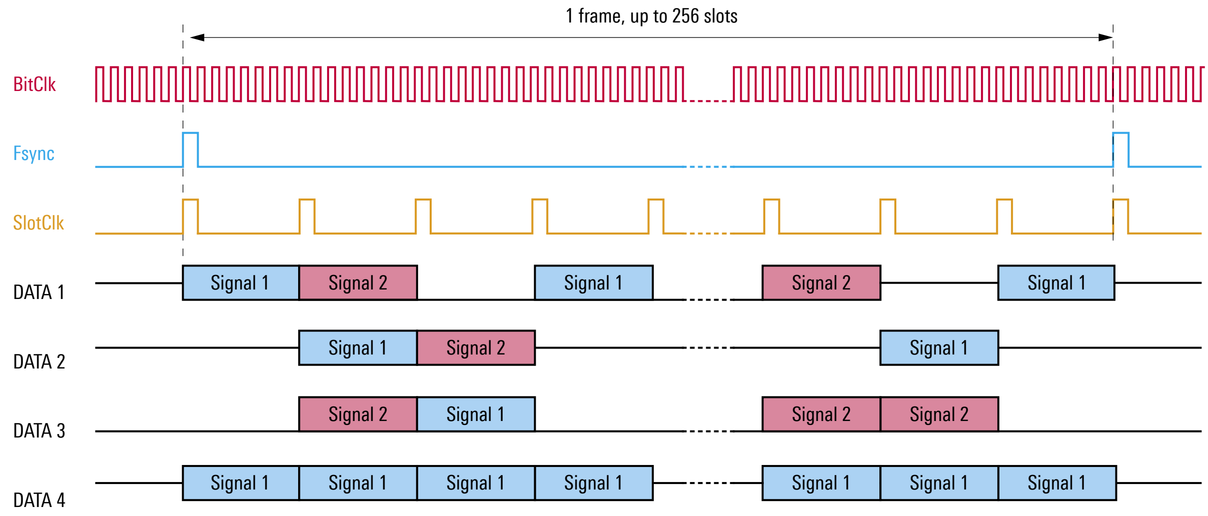


FIG 2 The R&S®UPV-B42 interface card can handle a maximum of 256 slots in up to 4 data lines.

With new applications, however, the limits of the I²S bus have been reached. The widely spread use of surround sound technology, for example, resulted in the development of multichannel A/D and D/A converters. Plus, wireless communications applications and audio transmission in Bluetooth® components demanded new data formats for transmitting audio content.

The new universal serial interface card (R&S®UPV-B42 option) for the R&S®UPV audio analyzer supports all of these developments. Like all other options of the R&S®UPV-B4x series, this interface card is simply plugged into one of the two slots on the rear of the audio analyzer.

The I²S audio format – basis for numerous new developments

The new R&S®UPV-B42 interface card also supports the conventional I²S audio format, which is briefly described below, as many state-of-the-art developments are based on it. Three basic signals are defined with this standard: BitClk (bit clock), Fsync (frame synchronization) and DATA (FIG 1). With each period of the bit clock, one audio data bit is transmitted; DATA is a dual-channel, multiplexed, bit-serial data stream, and Fsync designates the start-of-word in the serial data stream and differentiates between the left and the right channel. Audio data is transmitted using the "MSB first" method in two's complement format. Common word lengths are 16 bit, 24 bit and 32 bit, but operation with fewer audio bits is also possible. Generally, the transmit IC generates the clock, frame synchronization and data; in more complex systems, the transmit IC can be synchronized by a central system clock referred to as the master clock.

Further developments in the transmission of serial digital audio data extend and modify many of these parameters, use more channels and higher clock rates, etc. The new R&S®UPV-B42 interface card offers even more functionalities than currently required.

Multichannel applications and variable data formats

Converter ICs for multichannel audio systems are currently available with up to eight serially transmitted audio channels; the telecommunications sector uses systems with even more channels. The new R&S®UPV-B42 option can generate and analyze data streams with up to 256 channels (slots) transmitted in time multiplex. Up to four data lines, each with different data content, can be used (FIG 2). The individual slots can be generated individually with up to two different test signals or with zero signals. In addition, each channel can be switched to high impedance (tristate). The analyzer can simultaneously evaluate up to eight audio data streams that can be selected from among all data lines and slots.

All signals used in digital transmission can be adapted to the task at hand as is shown by FIG 4:

- **BitClk** Can be set to rising or falling slopes.
- **Fsync** In addition to the square wave typically used with I²S (Fsync is set to low during the first half of of the word length, and high during the second half), the signal can also be operated with the length of one or more clock periods. Variable offsets allow the Fsync signal to be shifted to any position of the frame. Rising or falling slopes can also be used here.
- **SlotClk** While Fsync defines a signal for each frame, slot clock is an additional line that generates a signal for each slot. SlotClk offers the same setting capabilities as the Fsync signal.
- **DATA** The data lines can be operated in the "MSB first" or "LSB first" formats. The length of the slots can be set from 8 bit up to 256 bit and the slots can be filled with audio data words ranging from 8 bit to 32 bit. Depending on the selected settings, the audio data bits can be preceded by lead bits that have no data content so that the data can be positioned at any point within the frame.

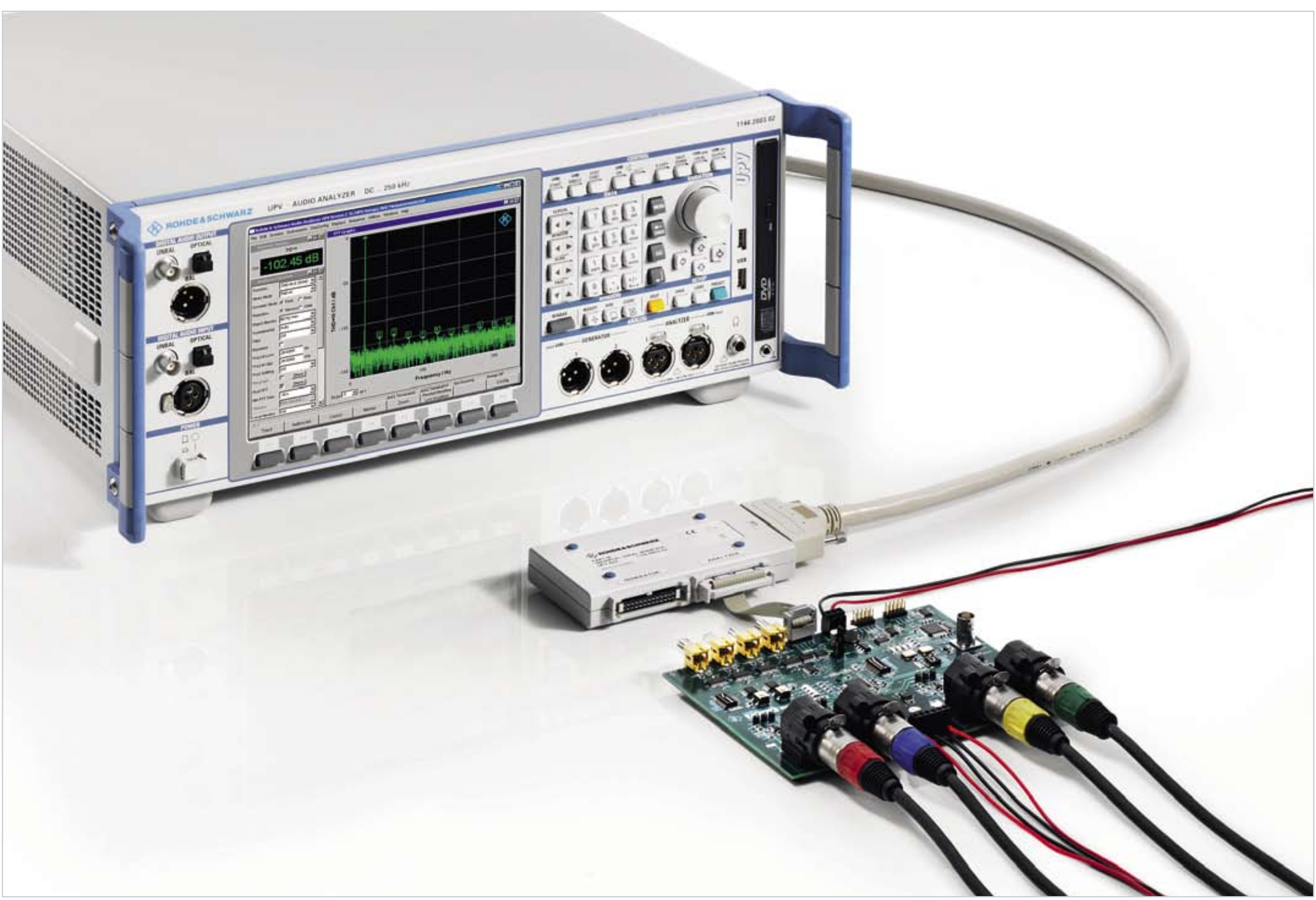
Wide variety of synchronization capabilities and other features

The generator and analyzer of the interface card can each be operated using internal (master) or external (slave) synchronization. Synchronization can be performed via a master clock, Fsync, or both Fsync and BitClk. In complex systems, for example, the central clock can be generated by the R&S®UPV audio analyzer, or the analyzer can be synchronized to external clocks in slave mode.

In special applications, the BitClk signal may not be continuously present. In the gated clock mode, the new R&S®UPV-B42 option also handles this mode in both the generator and the analyzer. For checking the jitter sensitivity of input circuits, the master clock and the Fsync, BitClk and DATA signals can also be output with jitter.

The explanations above clearly show that full utilization of the maximum frame and data lengths results in clock rates that extend well into the MHz range. The option has therefore

FIG 3 Measurement on a multichannel converter: The probe for the new interface card helps to avoid reflections by enabling short connections to the DUT.



Signal configuration

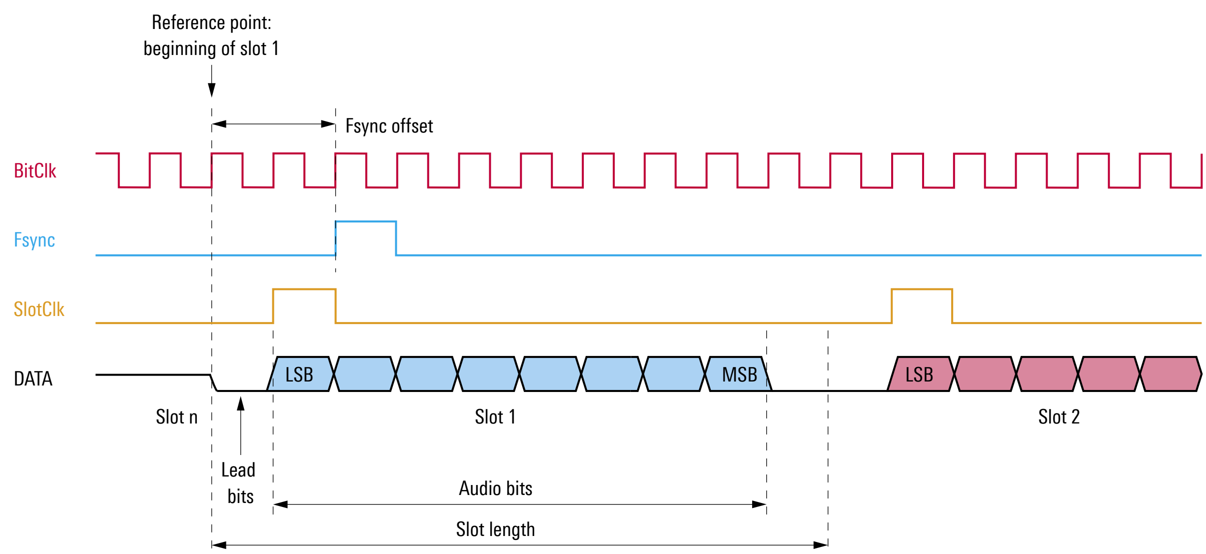


FIG 4 Versatile signal settings for digital data transmission.

been equipped with a probe that can be used to establish short and therefore low-reflection connections to the circuits to be analyzed (FIG 3). All logic families from 3.3 V down to 0.9 V can be connected.

The generator and the analyzer of the interface card can be configured independently of each other, allowing the evaluation of components and modules with different input and output formats. And the generator and analyzer can also be used together with the other interfaces of the R&S®UPV audio analyzer. For measurements on eight-channel D/A converters, for example, the new option can be combined with another new option, the R&S®UPV-B48 eight-channel analog inputs card [*].

This article describes only some of the many configurations that are possible with the new R&S®UPV option. Further information on the data formats required for special applications can be found in the R&S®UPV-B42 data sheet.

References

* Audio analysis in production: saving time with 16 measurement channels. News from Rohde&Schwarz (2008) No. 196, pp 36–38.

Summary

The new R&S®UPV-B42 universal serial interface provides digital audio interfaces, allowing extremely versatile adaptation to almost any audio circuit. Up to eight digital audio signals can be measured simultaneously. Like all options of the R&S®UPV-B4x family, this option can be retrofitted by the customer and installed in existing devices.

Klaus Schiffner

Condensed data of the R&S®UPV with the R&S®UPV-B42 option

Input/output voltages	for 0.9 V, 1.2 V, 1.5 V, 1.8 V, 2.5 V, 3.3 V logic families
Data format	linear PCM, A-law, µ-law
Frame synchronization frequency	0.85 kHz to 400 kHz
Number of slots per frame	1 to 256
Frame synchronization slope	rising or falling
Slot length	8 bit to 256 bit
Audio bits	8 to 32
Audio bit sequence	MSB first or LSB first
Bit clock slope	rising or falling
Bit clock frequency	up to 55 MHz
Master clock frequency	up to 110 MHz

State-of-the-art: the German Arme

In 1989, the German Armed Forces (Bundeswehr) contracted Rohde & Schwarz to supply the entire test and measurement equipment for its EMC test center in Greding, one of the largest worldwide. Over the last few years, in close collaboration with the Bundeswehr Technical Center for Information Technology and Electronics (WTD 81), this test center has been completely updated with the latest technology. It relies on an elaborate concept that satisfies even the most challenging demands placed on EMC test centers.

FIG 1 Amplifiers/antenna units detached from the preamplifiers generate field strengths of between 200 V/m and 300 V/m at a distance of 1 m at 40 GHz and with 40 W power.

d Forces' EMC test center

The decisive factors in EMC test centers: flexibility and 100% versatility

EMC tests are indispensable in the development of electronic instruments and systems. In contrast to individual components, complex systems such as vehicles or radar systems can be subjected to EMC tests as complete functional units only at a relatively late stage in their development. In addition, the usually tight development schedules demand quick and flexible adjustment of test schedules, with the consequence that test center capacities are utilized to a constantly varying degree, which makes resource planning very difficult. Moreover, the installed test equipment should be capable of testing a wide variety of equipment.

The EMC test center in the Bundeswehr Technical Center for Information Technology and Electronics (WTD81) in Greding, one of the largest worldwide, is a prime example of flexibility, versatility and usability for fully automatic measurements. As early as 1989, Rohde&Schwarz installed a full range of T&M equipment, and in the last few years the center has been upgraded with the latest technology as part of a modernization and expansion program.

Elaborate design for optimal use of system resources

In every development project, the time schedule and consequently the scheduling of the associated EMC tests are subject to frequent changes. Developers are permanently confronted with the issues of whether equipment under test (EUT) has to be modified, whether the modification can be performed on site, or whether an additional test date is necessary. In many cases, the time required for measurements cannot be precisely defined, which complicates test lab resource planning. State-of-the-art EMC test centers must therefore be designed to ensure maximum and efficient utilization of resources despite the fact that short-term planning of their test capacity is normally not possible.

These requirements formed the basis for the design of the WTD81 EMC test center. A large and a small anechoic chamber and a reverberation chamber are available for measurements. Each test chamber is permanently assigned a control room with a test receiver, signal generator, power meter, EUT monitoring and R&S®EMC32 measurement software from Rohde&Schwarz (FIG 3). Amplifiers with powers of 5 kW and 10 kW for frequencies between 9 kHz and 100 MHz and 2 kW and 5 kW for frequencies between 80 MHz and 1 GHz are provided in a central, shielded amplifier room (FIGs 2 and 4).

The necessary power depends on the test conditions and requirements in each case, e.g. the stipulated test severity, the distance to the EUT, or the antenna used. The maximum available power is not always needed in all chambers. The amplifiers can therefore be assigned as required to the individual test chambers or – for system tests and system calibration – to the load resistors, which ensures efficient

FIG 2 The amplifiers are accommodated in a central, shielded room and can be assigned to the test chambers as required.

measurements using the most suitable amplifiers in each case. Maximum power can also be provided for each test chamber if necessary. The component redundancy offered increases system availability, thus ensuring, for example, that measurements can be performed without restrictions even while maintenance is being carried out.

Uncompromising in terms of safety

An important aspect of planning in which no compromises can be accepted is the safety of the system. The risks associated with EMC measurements are well-known: Not only can an incorrectly connected cable falsify measurement results; if high RF powers are applied, it can also damage or even destroy the test system and the EUT, for example if the electromagnetic field is inadvertently generated in the wrong test chamber.

The test center in Greding has been designed to exclude configuration errors of this kind. This is achieved through fixed RF cabling and automatic relay switching. The status of each power relay is signaled back before the required path is activated. Amplifier assignment from a central location also avoids configuration conflicts. In addition, as part of a completely revised safety concept, the doors of all chambers have been included in the interlock circuit, which also covers and indicates further important parameters of the test system:

- Pressure and temperature of cooling water for the amplifiers
- Temperature in amplifier room
- Final positions of RF relays
- Correct locking of antennas in H and V positions
- Cooling of E/H generators

Safety measures to protect the operating staff include large illuminated displays above the entry doors to the test chambers. Moreover, a safety button is provided that will open the interlock circuit when staff enters a chamber and will keep it open as long as anyone is inside the chamber. Each amplifier is assigned the safety loop of the test chamber to which it is allocated. This makes sure that the correct amplifier is switched off when, for example, a chamber door is opened, and that test operation in the other chambers can continue

FIG 3 Each test chamber is permanently assigned a control room with test receiver, signal generator, power meter, EUT monitoring and measurement software from Rohde&Schwarz.

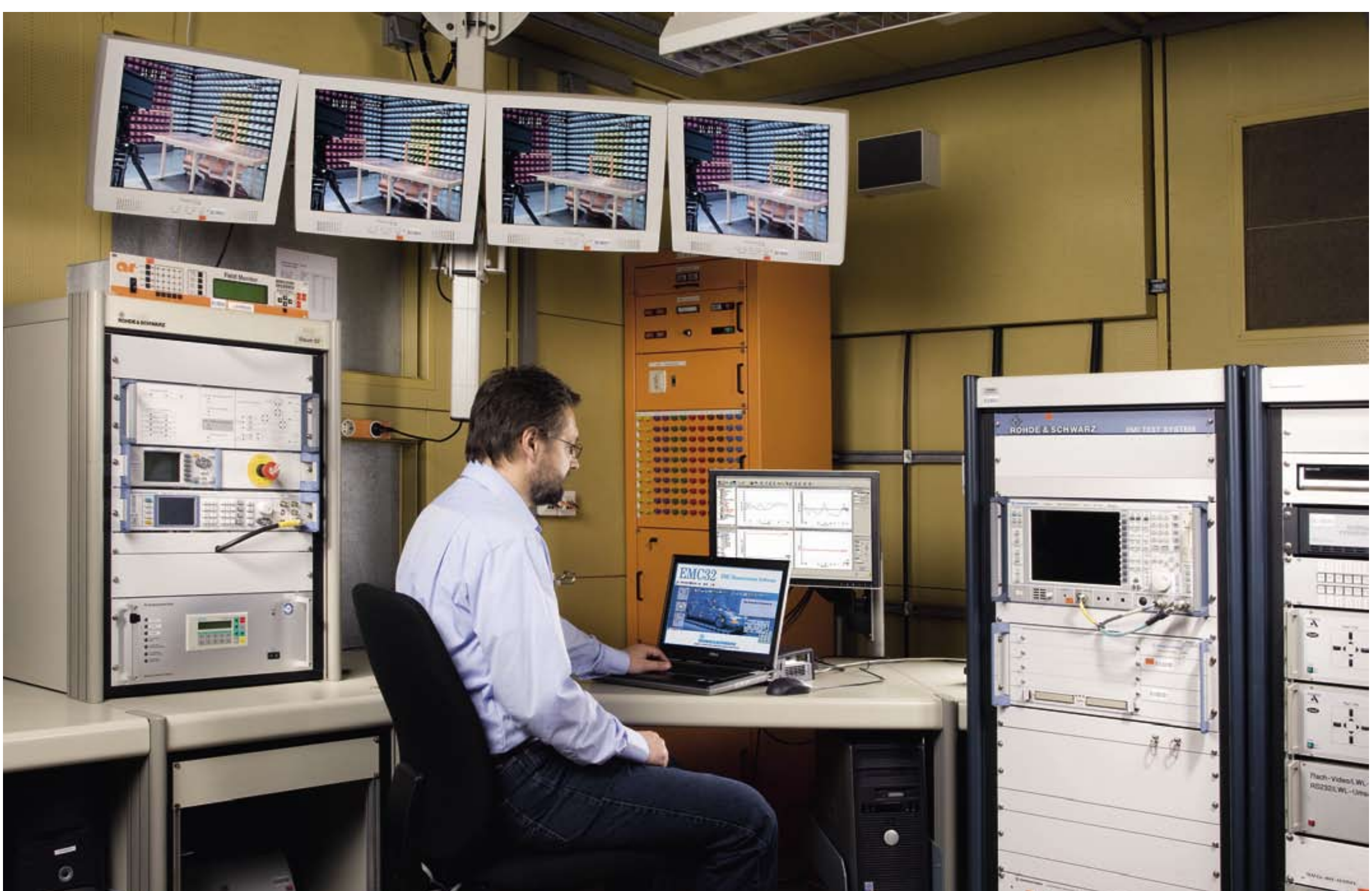


FIG 4 Rack for controlling the amplifier switching in the amplifier room, and in the background the associated RF power switch unit.

FIG 5 Strip line for component tests. The table can be removed, allowing the test configuration to be used also for conducted EMC measurements.

unimpaired. System and safety status messages are output directly at each operator's workplace. In addition, the R&S®EMC32 measurement software from Rohde & Schwarz automatically recognizes the configuration and takes it into account in the measurements. The complete system status, including the status of each individual safety switch, is displayed in detail at a central location, allowing faults to be traced and eliminated rapidly.

Another important prerequisite for the efficient utilization of the test system is fast and flexible function monitoring of a wide variety of EUTs. Due to the complexity of many EUTs, the capabilities of purely visual monitoring are quickly exhausted. In this respect, the EMC test system in Greding offers a wide range of communications options, including the monitoring of complete vehicles via their bus systems. Complex EUTs are frequently equipped with a software-based test environment of their own, via which data can easily be exchanged with the R&S®EMC32 software using TCP/IP. In such cases, the software can determine the immunity to disturbance of various components of an EUT by means of a single measurement.

Field strengths for all requirements

Due to its efficient field generation, the EMC test system is capable of producing a minimum field strength of 200 V/m seamlessly across the entire frequency range from 9 kHz through 40 GHz, which means that it covers all severity levels defined in MIL-STD-461. This also applies to tests on large EUTs and the large measurement distances that have to be observed in such cases.

Below 20 MHz, fields are generated by means of a strip line and E/H generators. The strip line used generates both the electric and magnetic field components with both polarizations, which reflects the conditions prevailing in a real

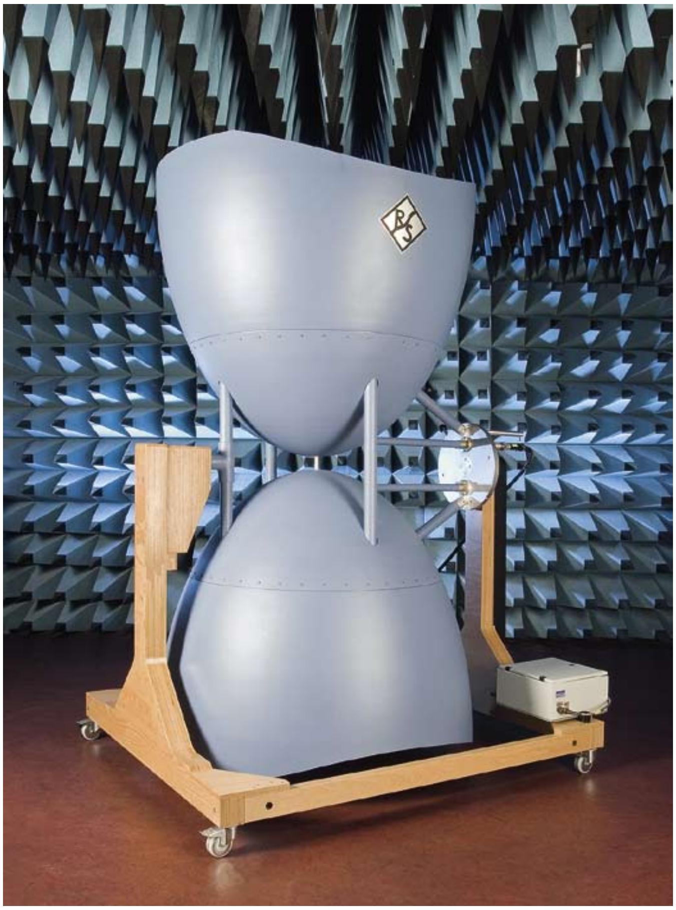


FIG 6 Due to its high efficiency, the R&S®HK5000 broadband dipole from Rohde&Schwarz generates very high field strengths in the range from 20 MHz to 100 MHz.

FIG 7 Mobile test systems generate pulsed and non-pulsed fields with strengths of up to 600 V/m in the range up to 18 GHz.

operating environment. The table on which the component under test is placed can be removed and taken together with the component to another location, allowing conducted EMC measurements to be performed using the same test configuration (FIG 5). Above 80 MHz, compact directional LPD antennas with high power-handling capacity are available (FIG 8). The strip line as well as the LPD antennas are tried-and-tested components that have been in use for many years.

The frequency range between 20 MHz and 100 MHz is particularly critical since high field strengths are difficult to achieve here. The EMC test center in Greding uses a specially developed broadband dipole – the R&S®HK5000 – in this range (FIG 6). Compared with the considerably shortened LPD antennas previously used, this dipole not only is much more compact but also requires 50% lower input power. At an input power of up to 10 kW, the R&S®HK5000 produces significantly higher field strengths than the LPD antennas before. The frequency range of interest is thus effectively covered.

A second important aspect is field generation in the microwave range, particularly for measuring the impact of radar equipment in both military and civil environments. Two mobile EMC test systems with amplifiers of 200 W and 500 W, respectively, generate pulsed and non-pulsed fields with strengths of up to 600 V/m for frequencies up to 18 GHz (FIG 7). At 40 GHz, however, high losses of 4.5 dB, i.e. 65% of the output power, occur even with short, flexible waveguides with a length of only 3 m. Lengths in this order are necessary, however, since in the microwave range, not the EUT as a whole is irradiated but only its critical areas. These areas may be located in inaccessible positions, e.g. inside a vehicle. The solution to this problem is to use amplifiers detached from the preamplifiers and operated directly on the antenna (FIG 1). This allows field strengths of between 200 V/m and 300 V/m to be achieved at a distance of 1 m even with a power of 40 W.

Summary

The system concept developed by Rohde & Schwarz in close collaboration with the Bundeswehr Technical Center for Information Technology and Electronics (WTD 81) in Greding combines optimal utilization of system resources and efficient field generation with a high level of automation and high reliability achieved through reproducible test sequences. The system excellently fulfills the exacting quality and flexibility demands placed on a test lab.

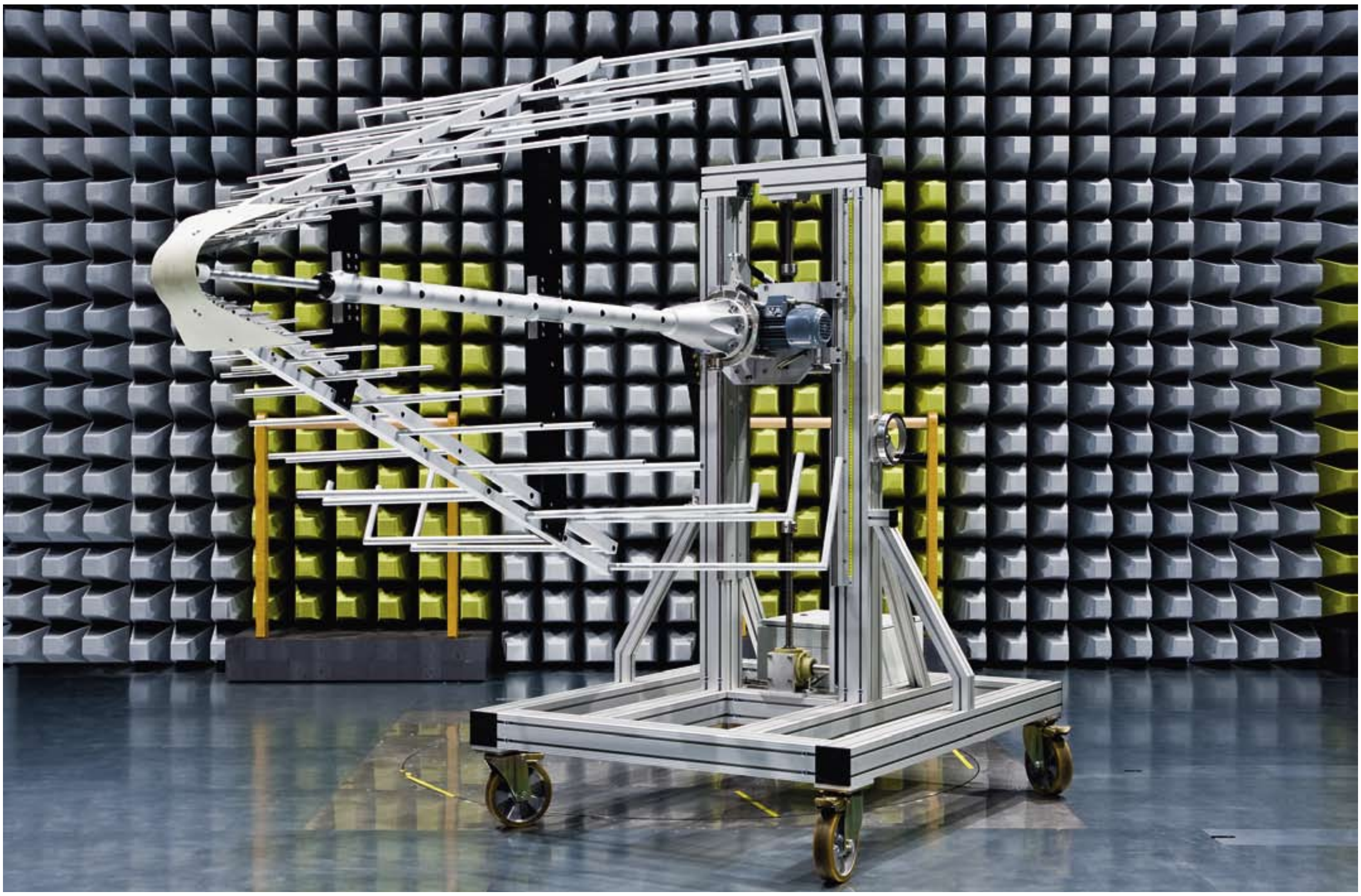
Jürgen Kausche; Werner Leimer

Rohde & Schwarz – the world market leader for EMC test solutions

Rohde & Schwarz provides the full range of EMC test and measurement equipment from a single source. Based on decades of experience and offering a complete product portfolio, Rohde & Schwarz can set up and deliver even large EMC test systems on a turnkey basis. The equipment complies with all international standards both with respect to electrical and mechanical requirements. Available products include:

- Complete, turnkey EMC test centers for measuring electromagnetic interference (EMI) and electromagnetic susceptibility (EMS)
- EMI test receivers and spectrum analyzers for compliance and precompliance measurements
- Comprehensive range of accessories
- Sophisticated EMC measurement software

FIG 8 Above 80 MHz, compact directional LPD antennas are used to generate the required electromagnetic fields.



Favorably priced EMI measuring r

The new R&S®ESL EMI test receiver combines two instruments in one, measuring disturbance in accordance with the latest standards and also serving as a full-featured spectrum analyzer for diverse lab applications – the ideal instrument for low budgets.

eceiver for the development lab

Lots of test and measurement for low budgets

All electrical devices – PCs, household appliances, control units for cars, etc. – must be tested for electromagnetic compatibility. Experience shows that taking EMC requirements into account at an early stage and checking the EMC measures in the development phase makes it easier to certify the finished product and helps to avoid expensive redevelopment work.

Compliance EMI test receivers such as the R&S®ESU or the R&S®ESCI are often overdimensioned and too costly for diagnostic or overview measurements. This is where a favorably priced instrument such as the R&S®ESL (FIG 1) is ideal, for in addition to its function as an EMI test receiver it can also be used as a full-featured spectrum analyzer. FIG 2 lists the different models.

FIG 1 Diagnostic measurements in development with the R&S®ESL and the R&S®HZ-14 near-field probe set.

Fast, dependable measurements with automated test sequences

The R&S®ESL carries out EMI tests on a DUT, either manually or by means of fully automatic or semi-automatic test sequences. Automatic test sequences ensure reproducible results, save a considerable amount of measurement time and make measuring easier for users who do not regularly perform EMI tests. Regardless of whether disturbance voltage, disturbance power or disturbance field strength is measured, an automated test sequence has three phases:

- A fast overview measurement with peak (and average) detector, based on a user-programmable scan table that defines the frequency ranges and receiver settings such as bandwidth and measurement time
- Determination of the frequencies with levels near or above the specified limits (data reduction)
- Automatic final measurement using the CISPR detectors only on these critical frequencies

All the parameters needed for data reduction and final measurement on the critical frequencies can be configured quickly and easily in a single window (FIG 3)

Model	Frequency range	Tracking generator
R&S®ESL3, model 03	9 kHz to 3 GHz	–
R&S®ESL3, model 13	9 kHz to 3 GHz	1 MHz to 3 GHz
R&S®ESL6, model 06	9 kHz to 6 GHz	–
R&S®ESL6, model 16	9 kHz to 6 GHz	1 MHz to 6 GHz

FIG 2 The different R&S®ESL models.

Remote control of line impedance stabilization networks (LISNs) with the R&S®ESL

Disturbance voltage measurements detect disturbances that occur on power lines in the lower part of the RF spectrum. To measure these conducted signals, an LISN/V-network is normally used as a coupling device to which the power and measurement signal lines are connected. Limit lines, e.g. in accordance with the CISPR product standards, exist for the range from 9 kHz or 150 kHz to 30 MHz (FIG 4). To determine the maximum disturbance, measurements must be performed on all phases of the power line.

For this measurement, Rohde & Schwarz provides the R&S®ENV216 two-line V-network as well as the R&S®ESH2-Z5 and R&S®ENV4200 four-line V-networks. The R&S®ESL automatically switches the different phases of the V-network via a control cable (FIG 5).

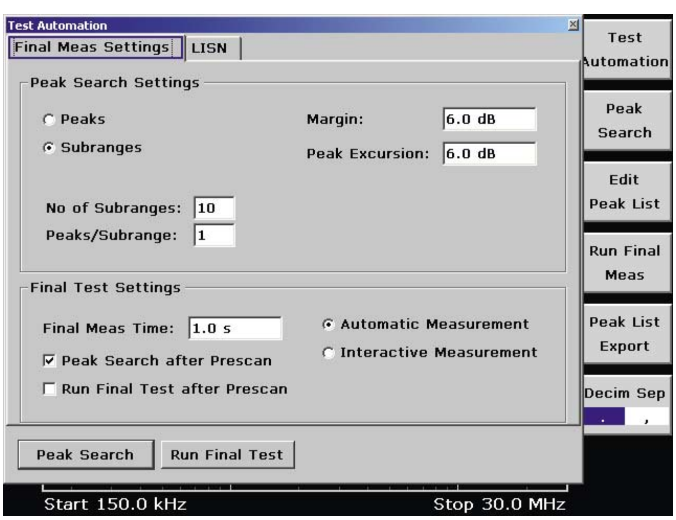


FIG 3 Setting window for data reduction and final measurement. The final measurement frequencies are automatically determined either for the absolute peaks or as subrange maxima. The relative magnitude of disturbance (peak excursion), its distance to the limit (margin) and the maximum number of subranges/peaks can all be set (1 to 500). The final measurement on the determined frequencies is performed either automatically or interactively.

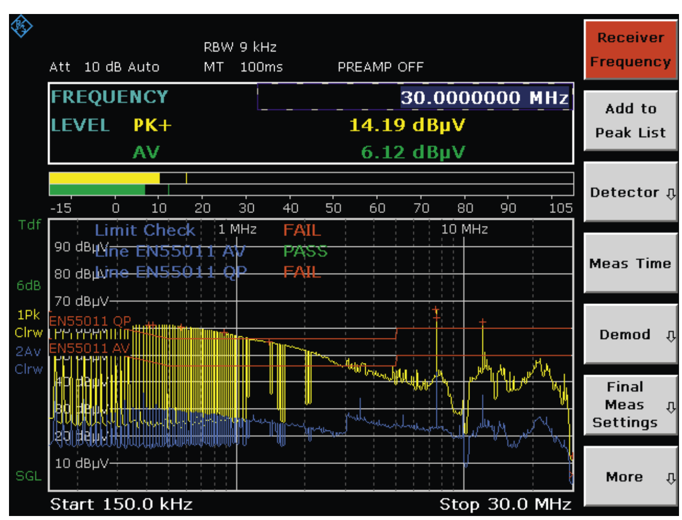


FIG 4 Result of an overview measurement of disturbance voltage with simultaneous peak weighting (yellow trace) and average weighting (blue trace). The critical frequencies for the final measurement that were determined by way of data reduction are indicated by appropriate symbols. The R&S®ESL can simultaneously display up to six traces with different weighting detectors; each trace can have max. 1 million measurement points in receiver mode.

In the final measurement, the R&S®ESL determines the disturbance levels on the selected phases and subsequently finds the disturbance maximum. It shows violations of the selected limit lines in the results table of the final measurement (FIG 6). It measures disturbance voltage fully automatically. Active overload detection with an autorange function ensures that the input level is in the optimal range so that valid results are obtained.

The R&S®ESL features a selection of important limits (LIMIT LINES) for disturbance voltages, disturbance powers and disturbance field strengths in line with commercial standards. New limit lines can be entered and stored in tabular form.

Disturbance field strength measurements with the R&S®ESL

Besides the disturbance voltage measurement at low frequencies, measurement of disturbance field strength starting at 30 MHz is the prescribed method for assessing disturbance in accordance with most product standards. During development, the simplest way of doing this is to use, in a first step, near-field probes to uncover hotspots at the module level. The R&S®HZ-11, R&S®HZ-14 and R&S®HZ-15 probe sets for E and H field measurements do the job well (FIG 1).

In the next step, to get a good picture of the radiated disturbance of the entire DUT on an open-field test site or in a shielded chamber, all you need is an R&S®ESL together with a broadband antenna. Here too, autoranging and overload detection deliver reproducible and reliable results. With its frequency range up to 6 GHz, the R&S®ESL6 covers most commercial standards such as CISPR 22 for IT equipment, which was expanded to 6 GHz in 2005.

Universal spectrum analyzer for daily use in the lab

As a full-featured spectrum analyzer, the R&S®ESL is also ideal for general-purpose applications in the lab and in development and for service applications. In spectrum mode, it is handled and controlled in the same way and has the same operating functions as the analyzers of the R&S®FSL family. Like these instruments, the R&S®ESL offers numerous complex measurement functions for a variety of typical analyzer applications – including preconfigured and user-configurable measurements of channel and adjacent-channel power, of occupied bandwidth, as well as functions for measuring burst power, intermodulation (FIG 7) and noise figure.

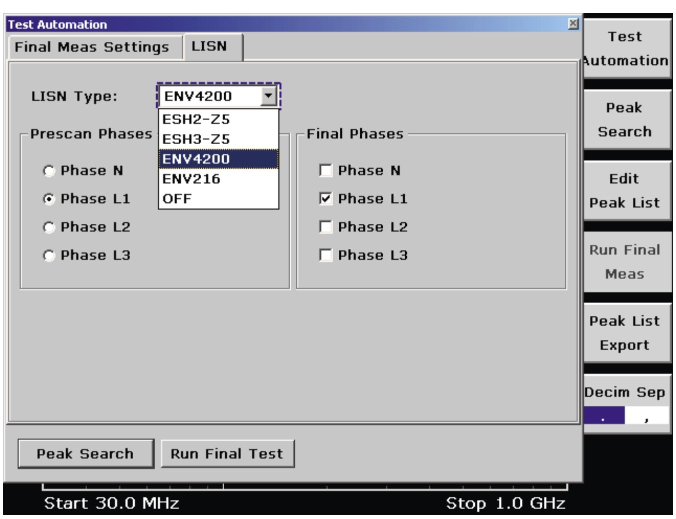


FIG 5 Window for selecting a connected LISN/V-network from Rohde&Schwarz and for remote-controlled phase switchover for the automatic overview and final measurement.

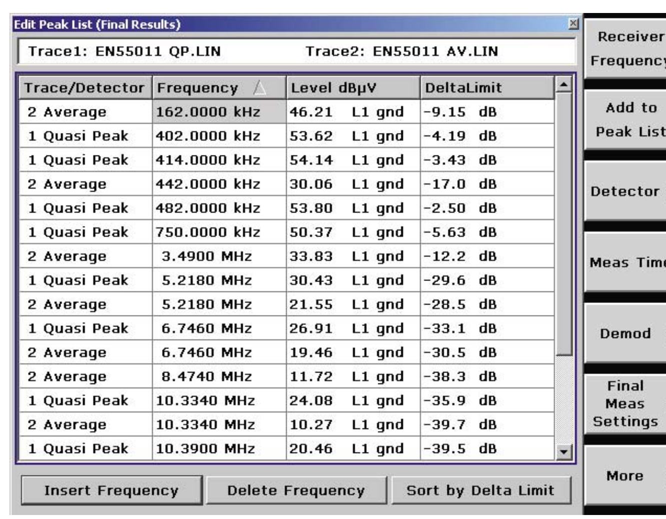


FIG 6 Final result of an automatic disturbance voltage measurement. The final measurement with quasi-peak and average weighting is performed on the critical frequencies determined by the fast overview measurement. The phase of the disturbance maximum and the margin (delta) relative to the limit are displayed directly.

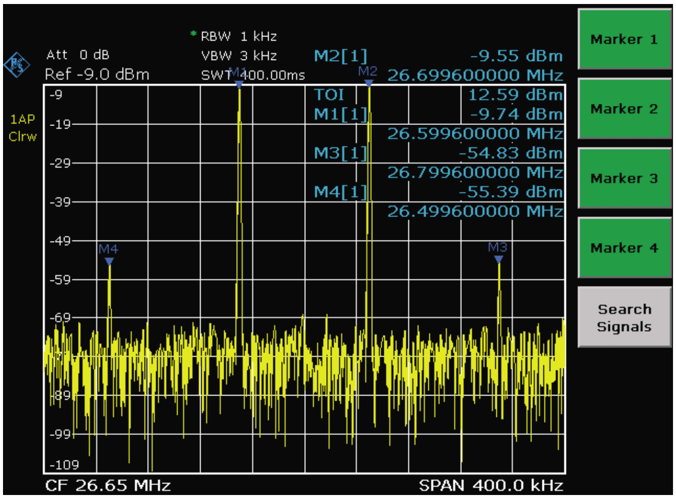


FIG 7 Intermodulation measurement with the R&S®ESL: The third-order intercept point (IP3) can be determined from the spectrum at the press of a button. The data carriers, from which the intermodulation sidebands are determined, are detected automatically. With max. 95 dB, the receiver offers a very good dynamic range. RF attenuation can be set in 5 dB steps, which facilitates optimal level setting.

Overview measurements of the disturbance spectrum with all available bandwidths can also be displayed in spectrum analyzer mode. Users can choose between the standard-compliant CISPR bandwidths (including 1 MHz impulse bandwidth) and 3 dB bandwidths (10 Hz to 10 MHz). When switched to logarithmic frequency scaling, traces that are directly comparable to the usual test receiver diagrams, including the associated limit lines, are generated in the sweep mode. In analyzer mode, the number of measurement points can be set over a wide range (125 to max. 32,001 points per trace).

The two R&S®ESL base models are also available with a built-in tracking generator that covers the full frequency range of the respective test receiver model. The R&S®ESL can thus be used to perform quick and easy measurements of frequency response and attenuation on filters or cables. The n-dB marker determines, for example, the 3 dB bandwidth of a bandpass filter at the press of a button. Using an external SWR bridge, the receiver measures return loss and impedance matching.

FIG 8 Diagnostic measurement with the R&S®ESL on unshielded telecommunications ports using the R&S®ENY81 eight-wire impedance stabilization network (ISN) and the R&S®ES-SCAN EMI precompliance software.

When equipped with the R&S®FSL-K9 option, the R&S®ESL supports highly accurate power measurements. Users can connect all the sensors of the R&S®NRP power meter directly to the receiver and do not need a separate power meter.

Diagnostic measurements made easy with the R&S®ES-SCAN EMI precompliance software

The R&S®ES-SCAN EMI precompliance software is an ideal addition to the R&S®ESL. It is favorably priced and user-friendly Windows® software specially designed for EMC measurements in development (FIG 8). Plus, it is easy to use and meets the main requirements for disturbance measurements in accordance with commercial standards:

- Measurement settings and storage
- Scan and sweep data acquisition and display
- Automatic data reduction
- Peak search with acceptance analysis
- Selectable number of critical peaks or subranges
- Final measurement with worst-case selection (e.g. for LISNs/V-networks with automatic phase switching)
- Report generation and measurement data storage

Summary

Powerful, compact and favorably priced, the R&S ESL is ideal for versatile and mobile use in development departments as well as for precertification measurements in EMC test labs and test houses. It supports users with a full-featured analyzer mode, automated test sequences and the latest weighting detectors in line with CISPR 16-1-1.

Matthias Keller; Karl-Heinz Weidner

Options for the R&S®ESL

- R&S®FSL-B4: OCXO reference frequency, aging 1 × 10^{-7}/year
- R&S®FSL-B5: Additional interfaces (video output, IF output, noise source control output, remote control interface for LISNs, interface for R&S®NRP-Zxx power sensors)
- R&S®FSL-B8: Gated sweep
- R&S®FSL-B10: GPIB interface
- R&S®FSL-B22: RF preamplifier (3/6 GHz)
- R&S®FSL-B30: DC power supply, 12 V to 28 V
- R&S®FSL-B31: NiMH battery pack

Software/firmware

- R&S®ES-SCAN EMI precompliance software
- Measurement demodulators for AM, FM, φM
- Power measurements with R&S®NRP-Zxx power sensors
- Application firmware for noise figure and gain measurements

Condensed data of the R&S®ESL3/R&S®ESL6

Frequency range	R&S®ESL3	9 kHz to 3 GHz
	R&S®ESL6	9 kHz to 6 GHz
Resolution bandwidths (–3 dB)		10 Hz to 10 MHz in 1/3/10 sequence, additionally 20 MHz (in zero span and receiver mode)
EMI bandwidths (–6 dB)		200 Hz, 9 kHz, 120 kHz, 1 MHz (impulse bandwidth)
Level measurement uncertainty		
10 MHz < f ≤ 3 GHz		<0.5 dB
3 GHz < f ≤ 6 GHz		<0.8 dB
1 dB compression point		nominally +5 dBm
Immunity to pulses		150 V / 10 mWs (10 µs)
Displayed average noise level (DANL)		
With preamplifier 50 MHz to 3 GHz		<–152 dBm (1 Hz)
500 MHz		typ. –162 dBm (1 Hz)

Digital video signal generator for testing state-of-the-art TV display equipment

The R&S®DVSG offers the widest range of interfaces and test signals currently provided by a single unit. It generates both analog and digital video and audio signals and features an MPEG-2 transport stream player and recorder.

Interfaces and signals even for the most demanding scenarios

The days of the well-known cathode-ray tube are nearly over, and new display technologies are rapidly conquering the market (see page 48). New interfaces and new signals are being created in this process, which means that new test and measurement requirements have to be met in development, production and quality assurance. The new R&S®DVSG digital video signal generator (FIG 1) has been designed to meet these requirements. It offers all established analog and digital video and audio interfaces (FIG 3) as well as SDTV and HDTV signals for testing modern TV displays and projectors. The test signals are available at all[1)] interfaces simultaneously – provided the signal and the interface type are compatible – which further simplifies tests. A special feature of the generator is its ability to output complex moving-picture sequences with high resolution. This is a prerequisite for testing important fundamental characteristics of modern display equipment. The R&S®DVSG therefore includes test signals specially developed for this purpose (FIG 6). This allows the fast and easy testing of format conversion (including de-interlacing), motion blur compensation, overdrive, noise suppression and many other functions.

FIG 1 The R&S®DVSG is a high-precision signal source containing all state-of-the-art digital interfaces as well as the appropriate test signals, including HD signals and moving-picture sequences. It can also be used as a pure transport stream player and recorder.

Graphical user interface (GUI)

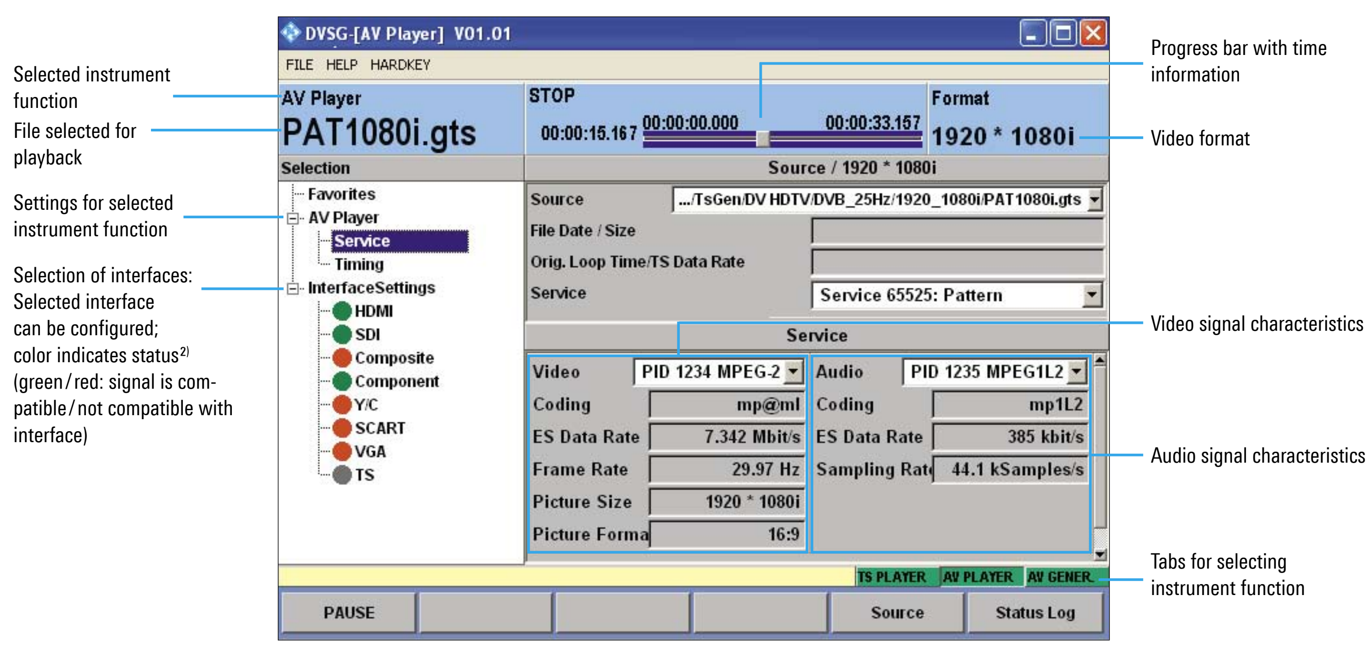


FIG 2 Graphical user interface (GUI) of the AV signal player option for the R&S®DVSG: playback of a video signal with an audio component.

The R&S®DVSG generates audio and video signals in two ways:

- Sequential, realtime output of uncompressed pictures stored in its memory
- Decoding of video and audio data contained in transport streams (live or from hard disk)

With sequential output, each pixel is individually defined. This makes it possible, for example, to generate continuous and stepless brightness and color variations. The set of signals supplied with the generator is free from compression artifacts and has been carefully generated. The user can easily expand the R&S®DVSG set of signals as required for the intended application. For example, any pictures in BMP format created on a PC can be used to generate the video signal in the R&S®DVSG. This functionality is useful both in development and production.

The transport stream decoding function enables the playback of video and audio contents of any transport stream. FIG 2 shows the graphical user interface (GUI) of the AV signal player option. The decoder function is particularly useful in development and quality assurance, as it allows convenient

FIG 3 The interfaces of the R&S®DVSG

Digital video
- HDMI
- DVI (via HDMI port)
- SDI / HD-SDI

Analog video
- RGB / YPbPr
- VGA
- S-Video
- CCVS
- SCART
- D4

Digital audio
- HDMI
- SDI / HD-SDI (embedded audio)
- S/PDIF

Analog audio
- SCART
- RCA

1) The only exception: The SCART and the D4 interface cannot be driven simultaneously.
2) HDTV signals, for example, cannot be output on a composite interface.

New display technologies call for new signals and made-to-measure test equipment

The most significant technical innovations …
So far, the signal to be displayed and the display equipment were matched to each other. In Europe, 50 fields were transmitted per second and in the U.S. 59.94 fields, with 576 and 480 active lines per frame, respectively. A cathode-ray tube was used to generate the picture. With the cathode-ray tube, the individual pixels and lines lit up only very briefly when activated (for a period significantly shorter than the field duration of 20 ms / 16.7 ms), resulting in a slightly perceptible flickering of the picture. The interfaces of the display equipment were designed for standard-resolution analog signals.

Nowadays, display equipment based on LCD, plasma or DLP technology is available with significantly higher resolutions (up to 1080p in consumer products), see FIG 4. Same as with the cathode-ray tubes, resolution is fixed, but not the same for all display equipment. To achieve increased brightness and suppress perceptible line structures, progressive formats are normally used. The display does not flicker, since the individual pixels light up for almost the entire duration of a frame. The display equipment has inputs for RF signals such as DVB-T or ATSC/8VSB, as well as interfaces for connecting local signal sources. The HDMI interface in particular is being more and more widely used, as it supports the digital transmission of video and audio signals simultaneously and in high quality. Many manufacturers also integrate additional methods for improving the picture quality. These are intended, for example, to suppress noise, blocking and film judder, or to improve contrast, definition and color.

… and their consequences
In newer equipment, the picture resolution and the physical resolution of the display equipment often do not match, e.g. in the case of an SDTV signal displayed on a modern LCD. To utilize the entire screen area, the resolution of the received signal has to be increased (scaled) to match the resolution of the display equipment. Interlaced formats also have to be converted to progressive formats. The quality of the displayed picture therefore depends on the quality of the format conversion carried out in the display unit. Moreover, the fact that, with modern display technologies, the individual pixels are activated for almost the entire frame duration results in perceptible motion blur (FIG 5) in the case of moving objects. Manufacturers attempt to reduce or suppress motion blur using techniques such as a 100 Hz frame refresh rate with repeated intermediate frame calculation. Another effect is that the individual pixels require a certain time to reach their full luminous intensity. This characteristic can be minimized using the overdrive technique, in which the pixels are initially overdriven so that they reach their intended intensity quicker.

Conventional technology	New technology
Image generation	
Cathode-ray tube (576 / 480 lines, interlaced)	Plasma, LCD and DLP technology (typical physical TV resolutions: 1366 × 768, 1920 × 1080, progressive)
Interfaces	
SDTV only: composite, components, S-Video, SCART	SDTV and HDTV: components, DVI, HDMI
Video format	
576 / 480 × 720, interlaced	1280 × 720, 1920 × 1080 and others, with different frame refresh rates, progressive or interlaced
Image enhancement	
	Suppression of noise, blocking and film judder; improvement of contrast, definition, color, etc.

FIG 4 Main differences between conventional and new display technologies

Motion blur

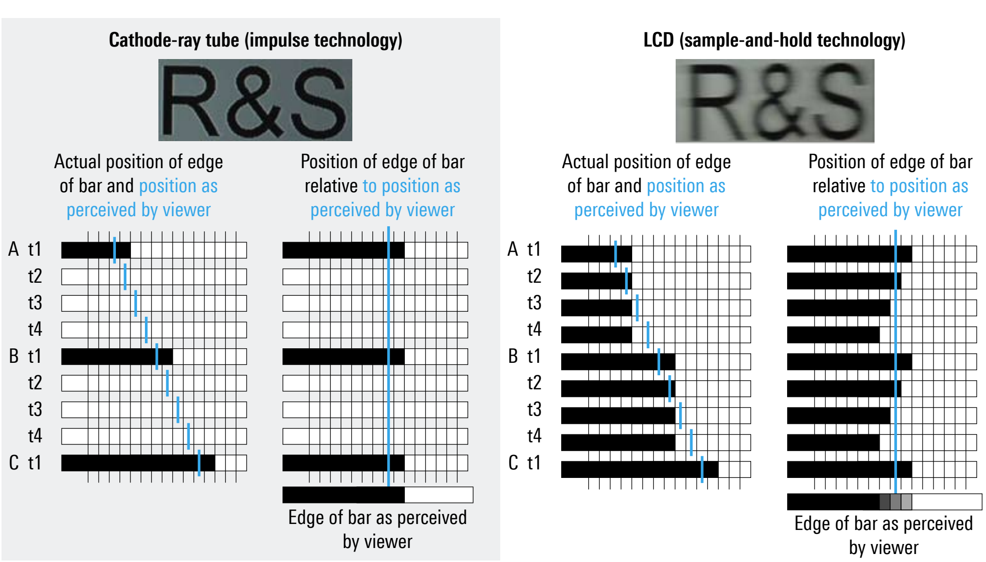


FIG 5 Display of moving elements. Top: The photo of the horizontally scrolled text "R&S" shows the motion blur on the LCD display. No blur is visible on the CRT display. Bottom: Illustration of the perception of the edge of a horizontally scrolled bar to explain the problem of motion blur. In this example, four viewing times (t1 to t4) have been selected for each frame (A, B and C).

testing of how display equipment handles complex, critical or typical scenes as encountered in everyday use. By using the universal transport stream format, virtually any live situation can be simulated. All that is needed is a recording of an arbitrary transport stream containing the required signals, which is possible with any transport stream recorder.

The R&S®DVSG features an integrated transport stream player and recorder. Transport streams can be recorded and their video and audio contents utilized for signal generation using only a single unit. With this application, the decoder integrated in the R&S®DVSG can additionally be used for monitoring. For this purpose, a program in the transport stream is displayed on a monitor connected to the R&S®DVSG and compared with the picture output by the equipment under test. The transport stream player and recorder is a valuable tool for testing multiplexers, decoders and all other components used in transport stream processing. In conjunction with a modulator, e.g. the R&S®SFE or the R&S®SFE100, the R&S®DVSG forms a compact and powerful system for testing set-top boxes.

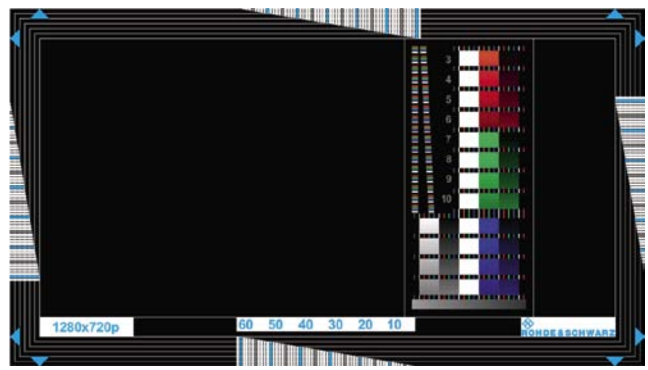
Summary

New challenges have to be met in the development and testing of modern TV display equipment. These include the requirement for high-precision signal sources containing all state-of-the-art digital interfaces as well as the appropriate test signals, including HD signals and moving-picture sequences. The new R&S®DVSG digital video signal generator from Rohde & Schwarz has been specially designed to meet these requirements. It can also be used as a pure transport stream player and recorder, an application for which it is particularly suited due to its extensive signal libraries and excellent price/performance ratio. The R&S®DVSG is an ideal choice not only in the development and production of TV displays, but also in servicing as well as for test houses and professional studio applications.

Thomas Tobergte

Test signals

Opera (natural test sequence)
Richly detailed background and costumes, with fast-moving dancers and flying spears. This is used to check the display of elements (static and moving) containing many details.



Horizontal moving color fields (synthetic test sequence)
An area with colored elements moves at a constant speed from right to left and back again. This is used to assess the intensity of motion blur on plasma and LCD displays. The elements at the edges of the screen can be used to check whether pixels have been clipped and to verify correct scaling of the picture.

Horizontal scrolling text (synthetic test sequence)
Text blocks with different font sizes move from right to left at different speeds. The speed and the font size are indicated at the left. This is used to assess the readability of text with different font sizes and moving at different speeds. The elements at the edges of the screen can be used to check whether pixels have been clipped and to verify correct scaling of the picture.

FIG 6 Numerous, often extremely sophisticated, test sequences are included as standard in each R&S®DVSG digital video signal generator.

Fast to market: TV transmitters for the Brazilian ISDB-T$_B$ standard

The sophisticated modularity and rapid configurability of Rohde & Schwarz transmitters were proven once again with the R&S®NV8300 and R&S®NV8600 families of transmitters: They were used to implement the new Brazilian ISDB-T$_B$ TV standard and to deliver ready-to-use transmitters to Brazil in a short period of time.

The TV transmitter market — fast and multifaceted

As digitization in broadcasting has progressed, so have the interpretations of the TV standard. As a result, Brazil also decided to develop its own digital TV standard. In a project coordinated by Mackenzie University in São Paulo, the Japanese digital ISDB-T TV standard was modified and approved as ISDB-T$_B$ (integrated services digital broadcasting terrestrial Brazil). At the end of 2007, ISDB-T$_B$ was introduced in Brazil's large metropolitan areas, including São Paulo and Rio de Janeiro. Since that time, it has been expanded to other regions.

Rohde & Schwarz was able to keep pace with the short development cycle by using the R&S®Sx800 TV/DTV exciter. The R&S®Sx800 provides a powerful and flexible platform on which new digital standards can be implemented quickly and efficiently. In addition, the standardized platform concept ensures that the exciter for ISDB-T$_B$ can immediately be integrated into the R&S®Nx8600 and R&S®Nx8300 families of TV transmitters. Rohde & Schwarz also entered into a cooperation agreement with Mackenzie University, providing direct access to the local experts. The R&S®Sx800 exciter was successfully tested on the ISDB-T$_B$ reference system at Mackenzie University.

Rohde & Schwarz transmitters are designed for versatile applications and easy configuration as evidenced by the R&S®Nx8600 family of transmitters (News from Rohde & Schwarz (2007) No. 194, pp 37–39) and the R&S®Nx8300 family of transmitters (News from Rohde & Schwarz (2008) No. 196, pp 44–45), both of which were quickly expanded for the Brazilian ISDB-T$_B$ TV standard.

The ISDB-T$_B$ standard in detail

Television, radio, and data services — all at varying levels of quality

ISDB-T$_B$ is a transmission standard for digital terrestrial broadcasting. At the transmitter level, the changes made to the Japanese digital TV standard mostly relate to the transmission templates and broadcasting channels, and are customized for Brazil.

Unlike other digital transmission standards, this standard covers television, radio, and data services. Because all these services can be transmitted independently of one another and in many different combinations, HDTV, SDTV, audio, and text are all possible. At the same time, the data that is broadcast can contain the same programs at a lesser quality and using less bandwidth for mobile terminal equipment.

In particular, this partial reception capability, where only a portion of the transmitted data is received, and the associated advantages for mobile reception are the features that make ISDB-T$_B$ so interesting as a transmission standard.

Hierarchical transmission

The MPEG-2 method is used for source coding in ISDB-T$_B$. Like in DVB-T, modulation is carried out using a COFDM (coded orthogonal frequency division multiplex) multicarrier method in 2K, 4K, and 8K mode. The 6 MHz channel is split into 13 subbands (segments) (FIG 1). Each subband is about 429 kHz wide, resulting in a useful bandwidth of about 5.57 MHz and making the signal suitable for transmission in the 6 MHz channel. The 13 segments in the OFDM spectrum can be combined into segment groups, called layers. These layers make hierarchical transmission possible with ISDB-T$_B$.

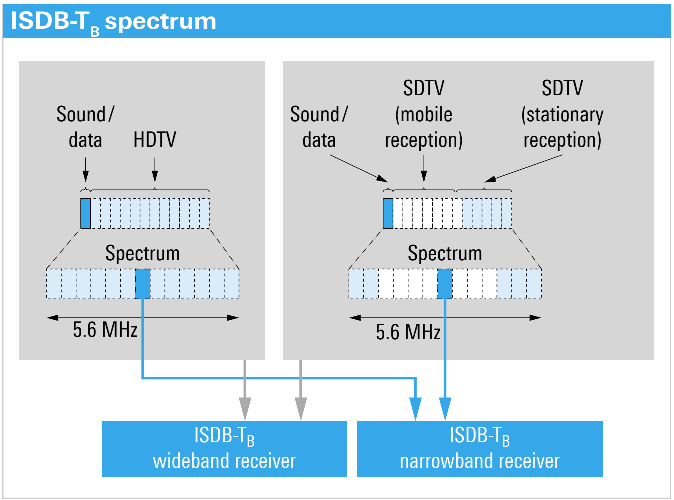


FIG 1 The ISDB-T$_B$ spectrum allows hierarchical transmission and partial reception.

Each channel can transmit up to three layers (A, B, C) simultaneously, each with different contents. For each layer, the code rate of the inner coder, the length of time interleaving, the modulation mode, and the number of segments per layer can be selected (FIG 2). High-quality transmission requires all 13 segments to be combined into one layer. For a narrowband receiver that can receive programs only at lower quality, such as mobile terminal equipment, each layer will contain only one segment. This segment is always placed in the center of the 6 MHz channel (FIG 1) and can easily be received as a result of its position and its width of about 429 kHz. However, it is still a complete receive signal.

The standard permits configurations for every need. The following example describes a possible transmission scenario for a 6 MHz channel with three layers (A, B, and C): A stationary TV receiver receives an HDTV program (layer C, seven segments), mobile TV receivers in a tour bus receive a TV signal at lower resolution (layer B, five segments), and portable receivers in mobile-phone format receive the same TV program at even lower resolution (layer A, partial reception, one segment). Auxiliary information regarding the current program can also be transmitted and accessed by the viewer as needed.

Channel coding

Three identical branches are available for channel coding. The transport stream first runs through the outer coder, creating an error-protected data stream. A splitter is placed at the output. This splitter assigns the individual transport stream packets to the one, two, or three hierarchical layers based on control information. The blocks that follow, i.e. energy dispersal, delay adjustment, bytewise interleaving, and convolutional coding, are present at all three branches. Modulation is performed after channel coding.

FIG 2 User interface of the R&S®Sx800 exciter.

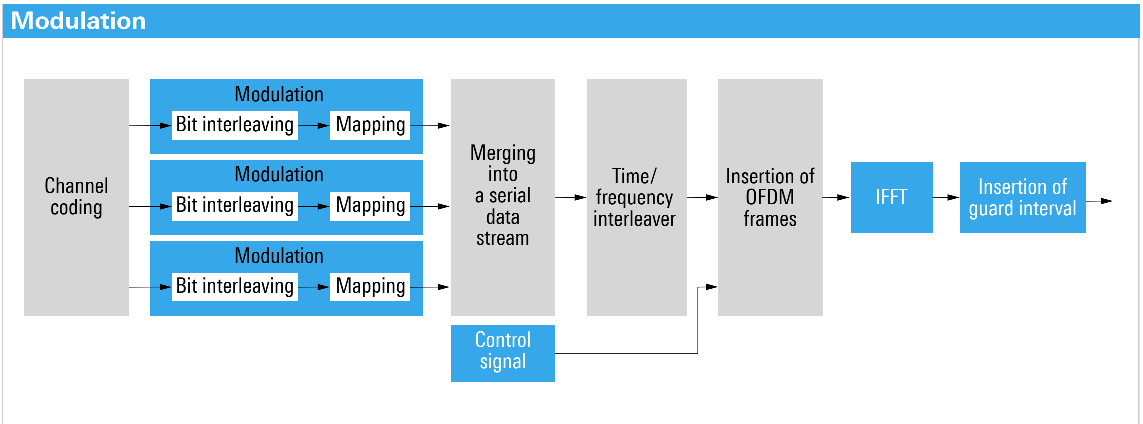


FIG 3 Modulation principles of the ISDB-T_B standard.

Modulation

This process includes bitwise interleaving (FIG 3) with delay adjustment, as well as mapping in the modulation constellation diagram. The constellation for ISDB-T_B can be DQPSK, QPSK, 16QAM, or 64QAM. After modulation, the complex, mapped data from each of the three branches is merged into a serial data stream using a specifically defined logic. The data then passes the time and frequency interleaver, after which the OFDM frames are formed. As for DVB-T, the pilot carrier, the TMCC (transmission and multiplexing configuration control) carrier, and the AC (auxiliary channel) carrier are added to the OFDM frames at varying points in the data stream.

	Mode 1	Mode 2	Mode 3
Number of segments	13		
Bandwidth	5.575 MHz	5.573 MHz	5.572 MHz
Carrier offset	3.968 kHz	1.984 kHz	0.992 kHz
Number of carriers	1405	2809	5617
Carrier modulation	QPSK, 16QAM, 64QAM, DQPSK		
Symbols per frame	204		
Symbol duration (rms)	252 µs	504 µs	1008 µs
Guard interval	1/4, 1/8, 1/16, 1/32		
IFFT length	2K	4K	8K
Inner code	convolutional (1/2, 2/3, 3/4, 5/6, 7/8)		
Outer code	Reed-Solomon (204,188)		

FIG 4 Transmission parameters for ISDB-T_B (6 MHz channel).

The IFFT (inverse fast Fourier transform) typically seen in OFDM methods is carried out after the frames have been formed. The IFFT lengths of 2K, 4K, and 8K depend on the selected ISDB-T_B mode. The OFDM symbols are then extended to include one of the four selectable guard intervals (1/4, 1/8, 1/16, or 1/32). FIG 4 provides an overview of the individual ISDB-T_B transmission parameters.

Summary

The ISDB-T_B standard is available for the R&S®NV8600 family of liquid-cooled, high-power UHF TV transmitters as well as for the R&S®NV8300 family of air-cooled, medium-power UHF transmitters. These compact, energy-saving transmitters provide maximum power density in a minimum of space. In a very short period of time, Rohde & Schwarz was able to win important reference projects, including the first ISDB-T_B transmitters for TV Justicia and for Rede Vida, as well as transmitters for Bandeirantes, one of the largest TV network operators in Brazil.

Thomas Graf; Jens Stockmann

The R&S®SLA8000 low-power transmitter – a bundle of energy for DAB / T-DMB

The number of DAB and T-DMB networks set up over the last few years has been continuously increasing. Especially the optimization of these networks requires low-power transmitters. Rohde & Schwarz now offers a compact solution for current and future requirements in this area.

The focus in many countries: the DAB and T-DMB standards

Ever since especially Europe profited from the allocation of new frequencies in band III by the Regional Radio Conference 2006 (RRC06), European countries plan to expand their network infrastruture, with equal focus on DAB and T-DMB. Significant markets such as France and Italy are preparing to set up nationwide T-DMB and DAB networks. Networks are also being expanded in Australia, which has opted for DAB+. Countries such as Great Britain, Norway, Korea and Germany are already one step ahead and are now addressing secondary and tertiary coverage as well as optimization of existing networks.

Network optimization requires low-power transmitters, and Rohde & Schwarz now offers a compact solution for current and future requirements in this area.

The R&S®SLA8000 – low-power DAB / T-DMB transmitters from 40 W to 300 W

Rohde & Schwarz has been actively involved in the DAB transmitter sector right from the start, and in recent years has been able to continually expand its market share for medium- and high-power DAB / T-DMB transmitters, to the point where the company has now become the market leader in these power classes. With the new R&S®SLA8000 low-power DAB / T-DMB transmitter family, customers worldwide can now benefit from additional products with output power from 40 W to 300 W (FIG 1).

The R&S®SLA8000 is an excellent example of the flexibility of the Rohde & Schwarz platform strategy. This DAB / T-DMB transmitter family is based on the R&S®SLx8000 low-power transmitter platform that is already implemented in the models for the ATV and DTV standards for VHF and UHF.

FIG 1 The R&S®SLA8200 low-power transmitter provides an output power of 300 W in a cabinet that takes up only four height units.

The main features of the new transmitters are as follows:

- Shortest processing time on the market
- High output power and compact design
- High efficiency
- Extreme ease of operation
- Easily configurable for SFN operation

With <100 ms (DAB mode I), the R&S®SLA8000 offers the shortest processing time on the market. Short processing times are particularly important in large, nationwide networks, for satellite feeds and for operation with transmitters from different providers. Another outstanding feature of this top-class transmitter is its efficiency of up to 30 %. The following models of the R&S®SLA8000 DAB/T-DMB low-power transmitters are available:

	Output power	Height units (HU)
R&S®SLA8025	40 W	3
R&S®SLA8050	75 W	3
R&S®SLA8100	150 W	3
R&S®SLA8200	300 W	4

The R&S®SLA8000 – the specialist for remote locations

Small transmitter sites at remote locations often present a problem for network operators because of the limited space available, insufficient voltage stability, unreliable GPS reception, lack of monitoring capabilities, and difficult access for servicing and maintenance. All these problems are minimized when using the R&S®SLA8000 low-power transmitters, as they require no maintenance. A check during the routine site inspection every 24 months is sufficient. Moreover, the 19" desktop models, with a maximum height of only four HU and full functionality, generate DAB output power of up to 300 W. The R&S®SLA8000 can be easily transported and quickly installed.

The transmitters are precorrected for all frequencies and power levels, eliminating the need for manual correction on-site, which in turn significantly reduces the time required for putting them into operation. The power supply unit in the R&S®SLA8000 tolerates input voltages between 90 V and 265 V and can buffer voltage interruptions up to 20 ms.

For protection against larger voltage fluctuations, the 300 W model can be equipped with an internal uninterruptible power supply that consists of zero-maintenance condensers and buffers the power supply of the critical internal components (exciter and GPS receiver) for an average of 10 s. This ensures that transmission is resumed quickly after a short downtime.

The 300 W model is equipped with redundant fans and, at nominal power, can operate with only one fan. If the ambient temperature is too high, entailing a risk of overheating the transmitter, output power is reduced automatically and incrementally.

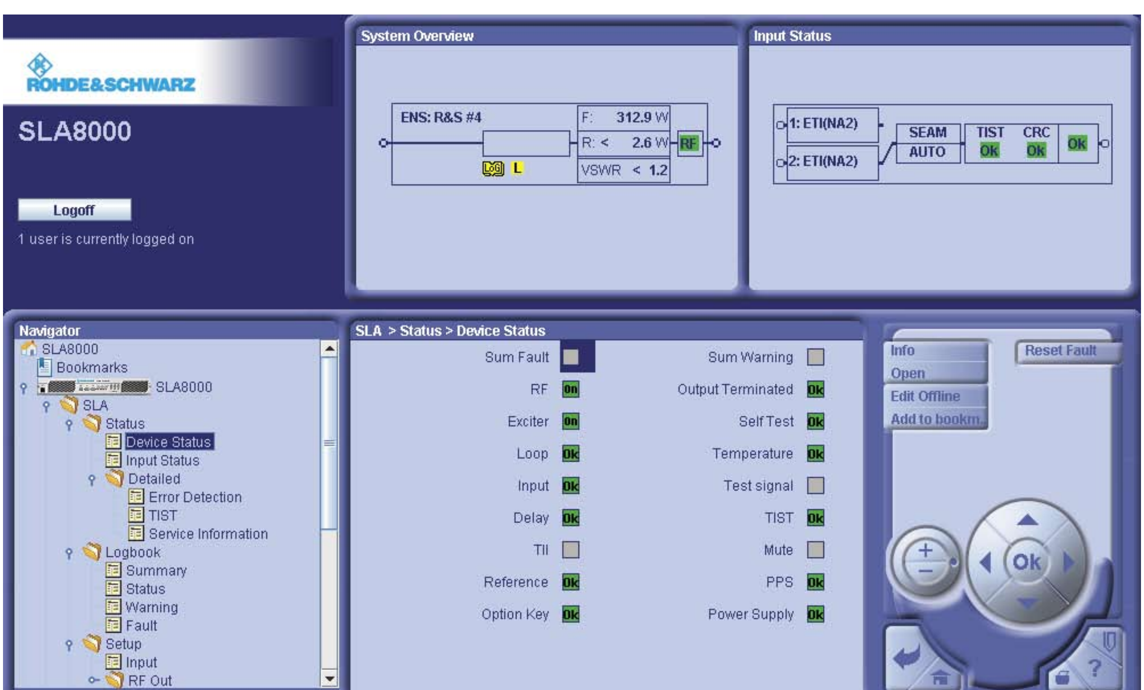


FIG 2 The transmitter status is displayed by the operating software of the R&S®SLA8000.

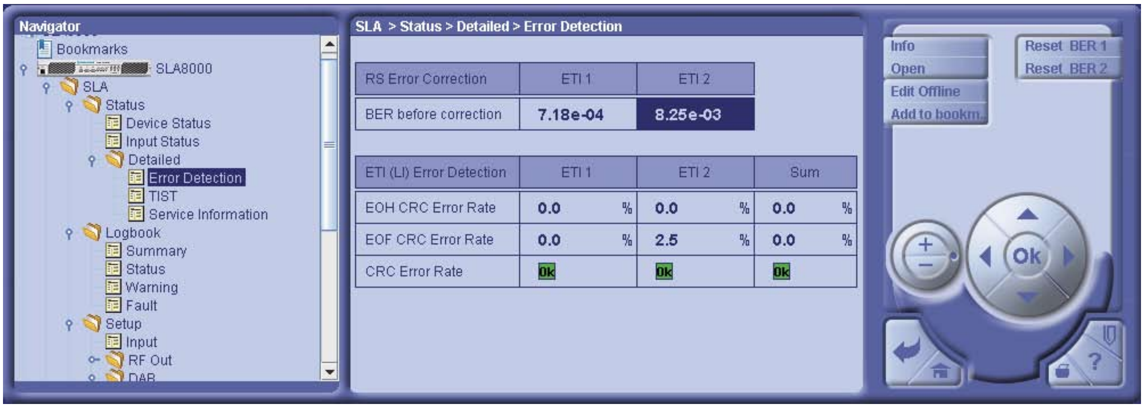
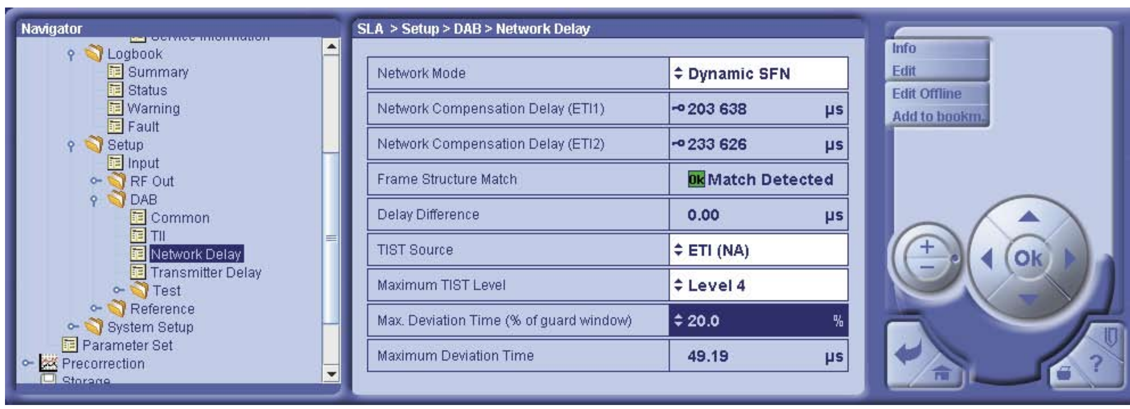


FIG 3 Left: The bit error rate is determined and displayed for both ETI input signals, both before Reed-Solomon and in the cyclic redundancy check (CRC). Below: Display of the time difference between the two ETI inputs after network delay adjustment.



Fluctuating antenna matching up to a VSWR of 1.5 does not affect the output power. Transmission is even possible with a VSWR >1.5; in this case, the output power is reduced depending on the VSWR. Only if the VSWR exceeds 3.0 is the transmitter switched off to avoid damage.

The integrated, extremely sensitive GPS receiver enables reliable reception even in critical conditions. The transmitter's screen can display all GPS-relevant parameters.

Failures and malfunctions of GPS antennas, e.g. as a result of lightning or other external influences, are critical for network operators, since the associated loss of the reference clock means that there is no longer a basis for synchronizing the single-frequency network (SFN). Network operators who use the R&S®SLA8000 have a distinct advantage here: The low-power transmitter can transmit interruption-free for up to 24 hours without the GPS 1PPS clock. This period of time is configurable and depends on the tolerated deviations from the guard interval. Minimum coverage can still be ensured after the set time has expired since the R&S®SLA8000 continues to transmit with reduced output power if this function has been activated. The reduction of the output power takes place automatically and can be configured in steps of 1 dB, enabling continued coverage of the core area and avoidance of possible SFN problems at the borders of the coverage area.

For configuration or diagnostic purposes, the transmitter can be accessed via the Internet using a standard web browser. The R&S®SLA8000 is equipped with a web server as standard. Remote monitoring via SNMP or floating contacts can also be provided as an option.

Easy to operate, like all transmitters from Rohde & Schwarz

In addition to using the transmitter's own display, a straightforward and more extensive display of the settings can be output on a PC using the operating software (FIG 2). Integrated Help functions are also available. The frequency settings can be made by entering the DAB channel, which is a very hands-on solution; the frequency can also be entered with a resolution of 1 Hz.

The processing time of the transmitter is automatically taken into account when setting the SFN delay. And when setting the static delay, the software automatically carries out a plausibility check of the set delay. Incompatible settings on the two ETI inputs are indicated and the time difference is displayed (FIG 3), significantly simplifying the setting of the SFN parameters and configuration of a smooth and click-free ETI switchover.

Jens Stockmann; Jan Gulde

FIG 1 The TopSec Mobile is an easy-to-use encryption device that is independent of the mobile phone. It can be connected to virtually any modern mobile phone via its Bluetooth® interface. The mobile phone acts as the interface to the communications network, whereas the TopSec Mobile – featuring a microphone and a loudspeaker – is used to conduct the call. Security of the phone call is assured end-to-end, from the TopSec Mobile's microphone through to the loudspeaker of the partner device.

One of the most secure voice encryption devices for mobile phones on the market

The TopSec Mobile is a voice encryption device that works with virtually every modern mobile phone. It enables tap-proof, globally available communications in wireless and fixed networks. The encryption functionality is hardware-implemented in the TopSec Mobile. Susceptibility to manipulation, which is always a risk in unprotected GSM mobile phones, is thus avoided.

New member of the TopSec product family

The TopSec Mobile (FIG 1) is a voice encryption device that connects to a mobile phone using a Bluetooth® interface. The mobile phone serves as the communications interface to the public network (FIG 2). The TopSec Mobile is the follow-up product to the successful and widely used TopSec GSM crypto mobile phone, a member of the tried-and-tested TopSec product family that offers encryption devices approved for the transmission of classified information for practically every requirement.

Encryption with TopSec Mobile

FIG 2 Mobile communications with the TopSec Mobile: The voice encryption device can be used with virtually all modern mobile phones.

Crypto mobile phone or generic encryption device?

There are numerous reasons why Rohde&Schwarz decided not to develop a special crypto mobile phone as a follow-up product to the successful TopSec GSM crypto mobile phone and instead created the versatile TopSec Mobile encryption device that works with virtually any modern mobile phone. Many users typically replace their mobile phone after one or two years, and manufacturers bring new models to the market every six months with new features and up-to-date designs. Such short-lived innovation cycles are only possible with mass-produced goods and cannot be adhered to with crypto mobile phones. Crypto devices are not designed for the mass consumer market. Instead, they represent a high-value capital investment with a life cycle of five years or longer.

However, the more powerful reasons that clearly provide the incentive to develop a standalone crypto device rather than a new mobile phone product, lie in the complexity, enormous functionality and flexibility of modern mobile phones, and therefore in the security of the application. This is because there is ample opportunity to gain access to and manipulate mobile phones without users realizing it. GSM standards allow applications to be downloaded on mobile phones using the SIM application toolkit (SAT) function. Responding to an inquiry regarding the account status of a prepaid mobile phone is another example of how operators can access mobile phones: The operator sends the account status and potentially other information direct to the mobile phone. Moreover, modern mobile phones can download and activate applications without the user actually knowing it.

Many of these opportunities to access, and thus potentially manipulate, mobile phones are provided for in the standards, and users expect to have them as convenience functions. Crypto devices, by contrast, require trust, and trust can only be created when the deactivation or manipulation of security functions – with or without the user realizing it – is effectively prevented. Qualities of this type can be verified by manufacturer-independent organizations as part of an evaluation. The software-defined functions integrated in modern mobile phones are so extensive, however, that conducting an adequate evaluation in an acceptable timeframe is not possible. In addition, the evaluation is always limited to the status of a specific version of the mobile phone.

Another disadvantage of mobile phones, and therefore of pure crypto mobile phones, is their distinct identifiability by means of the international mobile equipment identity (IMEI). The IMEI enables network operators to provide only restricted services to specific types of mobile phones or even ban crypto mobile phones from their networks altogether.

The TopSec Mobile eliminates these issues since the underlying generic concept of the device offers the best possible protection against manipulation. This is because the crypto device is not directly connected to a wireless network and is thus not registered with a wireless network provider. The TopSec Mobile is not a telephone, rather a device designed specifically for voice encryption with a range of functions matched to this task. And this is exactly what enables comprehensive evaluation to be carried out by manufacturer-independent organizations to demonstrate the security of the device. In the case of the TopSec Mobile, this evaluation is conducted by the German Federal Office for Information Security (BSI) to verify compliance with the "restricted" classification level.

FIG 3 As simple to operate as a mobile phone, yet a highly secure encryption device for mobile communications.

TopSec Mobile – compatible with state-of-the-art mobile phones

The basic concept of the TopSec Mobile was to develop and bring to market a highly portable, very small, lightweight and wireless device for the mobile encryption of voice communications. The connection to the public wireless or fixed network is set up by the mobile phone or modem, which communicates with the TopSec Mobile via the universal Bluetooth® interface (FIG 2). The TopSec Mobile encrypts the voice information before it is transferred via Bluetooth® to the mobile phone for transmission over the network. Encryption thus takes place right in the hand of the user. The mobile phone still provides all of the convenience functions one expects today, giving users a vast degree of freedom in selecting their telephone. Users can choose their preferred mobile phone and enhance it with the TopSec Mobile for tap-proof communications.

The TopSec Mobile uses Bluetooth® 2.0, a transmission mode offering very good error control and ample bandwidth for encrypted voice transmission. Requirements placed on a mobile phone in order to operate with the TopSec Mobile are few: support of version 1.2 or later of the Bluetooth® wireless standard, at a minimum the dial-up networking gateway (DUN-GW) profile, and optionally the hands-free profile (HFP) and the OBEX object push profile (client role). The mobile phone should also support the GSM circuit-switched data service. Most modern mobile phones from the majority of today's manufacturers offer these minimal functions, which are controlled via AT commands.

The TopSec Mobile can basically be used together with any terminal equipment that has a Bluetooth® interface and can establish a dial-up data connection with a rate of at least 9.6 kbit/s. This means that not only mobile phones are suitable, but also other devices such as analog or ISDN modems equipped with a Bluetooth® interface.

Groundbreaking design and function

The TopSec Mobile is targeted at senior management levels in government and at business leaders in important industries and sensitive departments such as security, sales, finance, engineering and science. The elegant and timeless design of the TopSec Mobile is representative for this user group without attracting undue attention. It can be carried in a shirt, suit or coat pocket; its wide clip provides secure fastening. It can also be attached to a carrying strap.

The TopSec Mobile is a voice encryption device with integrated audio components (FIG 4). It has a built-in microphone for talking and two separate loudspeakers for signaling and listening to conversations. The loudspeaker integrated in the clip on the rear of the TopSec Mobile signals incoming calls. The loudspeaker integrated on the front side of the device is used for listening; it delivers outstanding voice quality.

The TopSec Mobile is controlled with a four-way rocker switch and a center key. The three-line display can be rotated by 180° as a convenience to both right- and left-handed users. The compact device further includes two keys to control the loudspeaker volume. A multifunctional interface is integrated at the bottom of the device.

The TopSec Mobile is powered from a built-in rechargeable battery. Recharging is via a USB cable – e.g. on a laptop – or by means of a plug-in power supply, both of which are supplied with the device.

Encrypted phone conversations: as simple as using a normal mobile phone

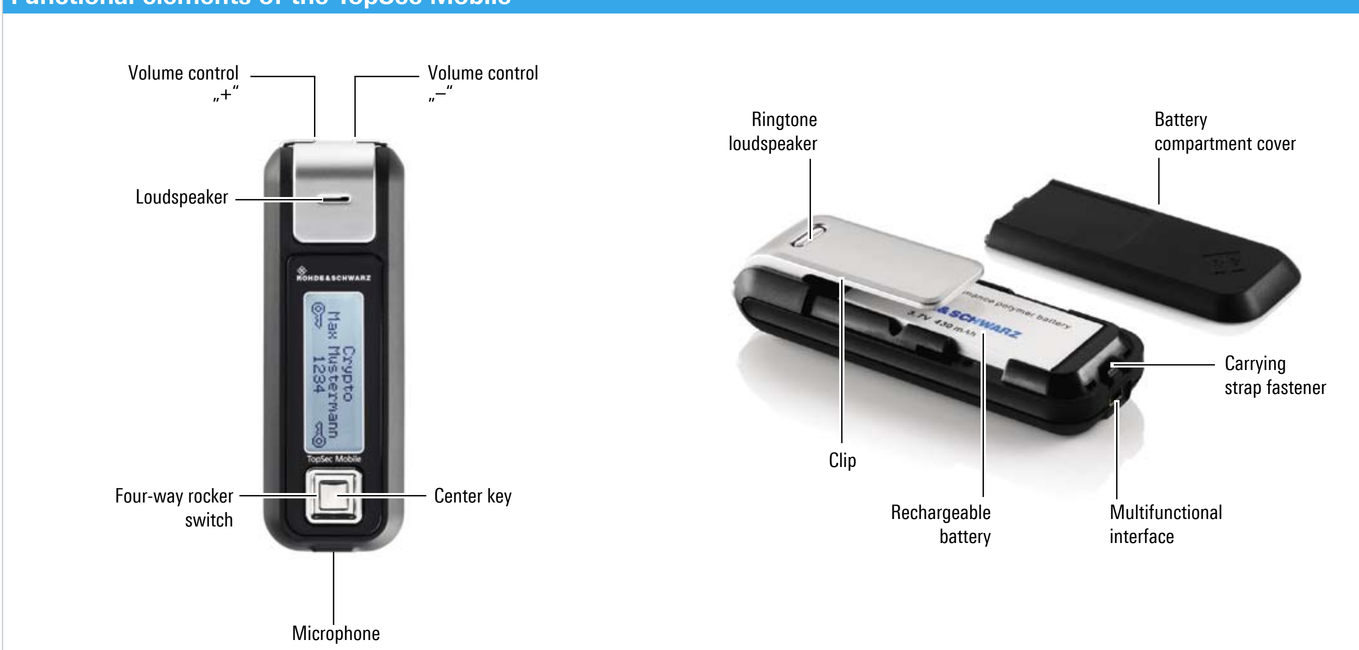
Before using the TopSec Mobile and the mobile phone together for the first time, they must be "paired." For this purpose, the Bluetooth® search mode is started on the TopSec Mobile. When the desired mobile phone is selected, the personal identification number (PIN) – a random eight-digit number – is displayed on the TopSec Mobile. The PIN must be entered on the mobile phone. A Bluetooth® connection between the mobile phone and the TopSec Mobile is then established. The TopSec Mobile is now ready for encrypted voice communications.

Before setting up an encrypted call, the telephone number of the party to be called is selected from the TopSec Mobile's integrated telephone directory. The TopSec Mobile sends the telephone number to the mobile phone via the Bluetooth® connection, and the mobile phone establishes a data connection to the partner device. Either the ITU-T V.110 or V.32 protocol is used. When the data connection is established, the partner devices initiate encryption synchronization. During the key agreement phase, the TopSec Mobile displays moving key symbols. When the encrypted connection is established, the partner encryption device (or a connected telephone) rings. After acceptance of the call, a four-digit security code appears on the display, which can be used to verify whether the connection is secure. The two call participants can now conduct a confidential phone call.

The TopSec Mobile signals incoming encrypted calls first by means of a short beep tone. Encryption synchronization is then started, indicated by moving key symbols on the TopSec Mobile display. On completion of synchronization, the TopSec Mobile rings. The user accepts the call by pressing the center key, and the four-digit security code appears on the display. The participants can now proceed with their confidential phone call.

FIG 4 Despite its small dimensions, the TopSec Mobile has everything needed to ensure optimum performance and maximum operator convenience.

Functional elements of the TopSec Mobile



The integrated telephone directory can be edited at any time using the TopSec Mobile's control elements. An even more convenient approach is to use the PC telephone directory software, which is delivered with the TopSec Mobile. The telephone directory is transferred from the TopSec Mobile to the PC over the supplied USB cable, edited on the PC, and transferred back to the TopSec Mobile.

Confidential phone calls also with a headset

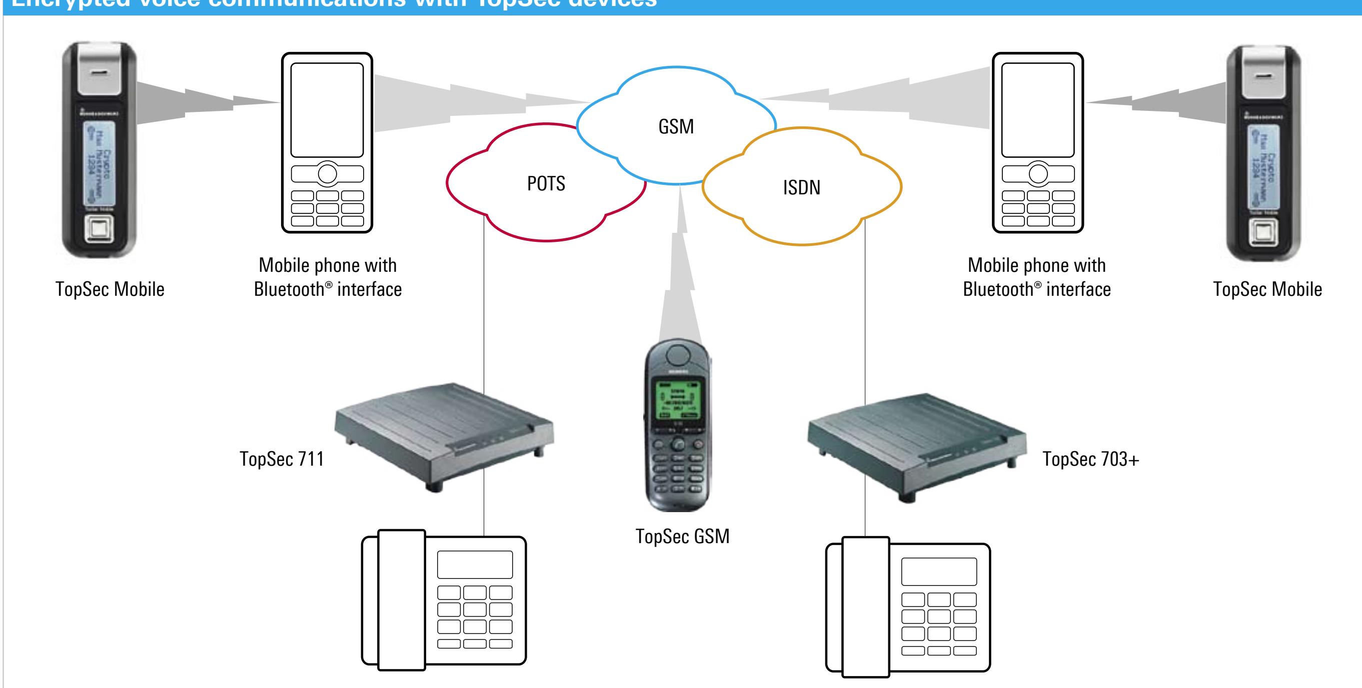
The TopSec Mobile is normally held to the ear like a mobile phone (FIG 3). Alternatively, a headset can be used, which is connected to the multifunctional interface on the TopSec Mobile. This requires a headset adapter to be connected between the headset and the TopSec Mobile interface. The headset adapter has a control element to accept incoming calls, a microphone, and a 2.5 mm jack for connecting the headset. The headset adapter is fastened to the jacket or shirt with a clip, and the TopSec Mobile can remain concealed in the jacket pocket.

Interoperable with the TopSec product family

The TopSec Mobile is interoperable with the widely used TopSec GSM crypto mobile phone. TopSec GSM users can therefore easily migrate to systems that employ the new mobile crypto device. If the called partner is using a TopSec 703+ ISDN crypto device for encrypted voice communications over a digital network, the ITU-T V.110 protocol is selected. For calls over an analog network with a TopSec 711 at the other end, the ITU-T V.32 protocol is used. As the required protocols are integrated in the TopSec Mobile, it can communicate with the TopSec GSM, TopSec 703+ and TopSec 711. FIG 5 shows the types of secure communications connections that can be established between the TopSec Mobile and other products of the TopSec family.

FIG 5 After selection of the appropriate protocol, the TopSec Mobile voice encryption device can be used for secure communications with the TopSec GSM, TopSec 703+ and TopSec 711.

Encrypted voice communications with TopSec devices



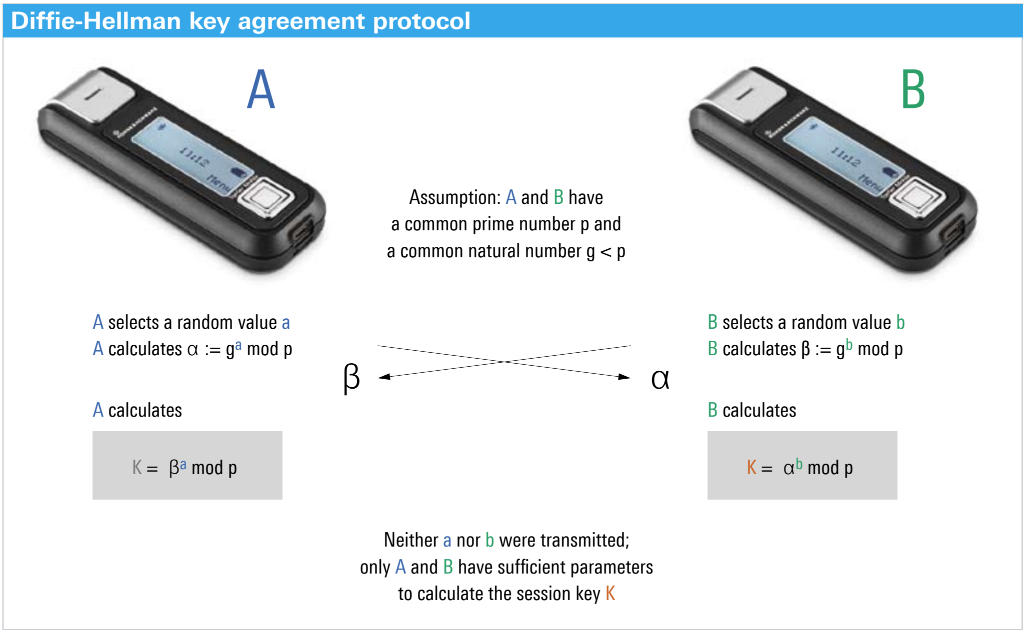


FIG 6 The TopSec encryption devices use the Diffie-Hellman key agreement protocol to generate a unique session key for each call.

Secure crypto concept that makes no compromises

Hybrid approach for maximum security

The TopSec Mobile relies on a tried-and-tested hybrid encryption method used by all TopSec devices. This hybrid approach combines asymmetric algorithms for key agreement and authentication and symmetric algorithms for the actual encryption of information. The session keys required for the symmetric algorithms are calculated for each call and deleted on completion of the call. The encryption devices can optionally verify if both parties belong to the same closed user group.

Diffie-Hellman key agreement protocol

As a prerequisite for conducting an encrypted phone call, the partner encryption devices must have the same mathematical parameters and use identical algorithms. The TopSec encryption devices utilize the Diffie-Hellman key agreement protocol to generate an individual session key for each call (FIG 6). Diffie-Hellman is a public key method, i.e. both public and private parameters are used. The parameters p and g in FIG 6 are pre-installed and delivered with the equipment. By contrast, the private parameters (a, b) of the Diffie-Hellman key agreement protocol are created exclusively to generate the session key for each encrypted connection. Afterwards, the parameters and the session key are deleted. The session key (K) calculated by the two partner devices is used by the symmetric algorithms to encrypt or decrypt the voice information.

The Diffie-Hellman key agreement protocol permits encrypted communications between two partner encryption devices without the need for central administrative services and without any prior key exchange. Within the framework of the TopSec family, this is referred to as an open system as it enables secure communications between any two TopSec encryption devices.

Playing it safe with user authentication

The TopSec Mobile effectively prevents pretended encrypted connections and man-in-the-middle attacks

In theory, the Diffie-Hellman key agreement protocol is susceptible to man-in-the-middle attacks carried out for the purpose of eavesdropping. Such attacks, however, involve extensive effort and require, for example, that the attacker has access to the communications link between the two partner encryption devices. To meet the most stringent security requirements, the TopSec encryption concept includes measures to detect and stop man-in-the-middle attacks that are carried out with such extensive effort.

A man-in-the-middle attack would have to simulate two encryption devices simultaneously, each of which would need to be accepted as being the “true” encryption device of one partner by the encryption device of the other partner. In such a case, a session key (K1) would be generated between partner A and the man in the middle using the Diffie-Hellman key agreement protocol, and another session key (K2) between partner B and the man in the middle. The two session keys, K1 and K2, cannot be identical. Without a man-in-the-middle attack, however, only one session key (K) exists (FIG 6). This key is used by the symmetric crypto algorithms to encrypt and decrypt the digitized and compressed voice information.

The principle described above permits a simple method of authentication. A four-digit security code (hash code) – derived from the session key – is calculated and displayed on the TopSec Mobile. With high probability, the four-digit security code delivered by each of the partners will be identical only if there is no man-in-the-middle attack. When the four-digit security code appears on the TopSec Mobile display, a crypto connection between the two partners has been established. After verifying that the security codes on the two crypto devices are identical, the two partners can be assured that the connection has not been compromised.

The functionality described so far demands neither a management system nor a trust center on the part of the customer. It comes "out of the box."

Exclusive security: closed systems

Another measure to defeat man-in-the-middle attacks is the creation of cryptographically protected closed systems, i.e. user groups with a restricted, well-defined number of participants. This requires a trustworthy central administrative instance. In the TopSec system, this is referred to as the TopSec Administrator. It combines the functions of a trust center with the centralized administration of operational parameters.

All TopSec devices that belong to a closed system receive a unique certificate from the TopSec Administrator identifying them as a member of that specific closed system. The certificate contains information defined in the ITU-T X.509 standard. The most important information in the certificate is the equipment ID of the TopSec device and an associated public authentication key (FIG 7). The certificate contains a digital signature. To create a digital signature, the TopSec Administrator generates a key pair that consists of a public and a private key. The private key S_{TC} is used to add the digital signature to the certificate's hash value. The private key S_{TC} remains in the TopSec Administrator; it is the most confidential component of a closed system. The digital signature and thus the certificate can be authenticated by means of the public key P_{TC}.

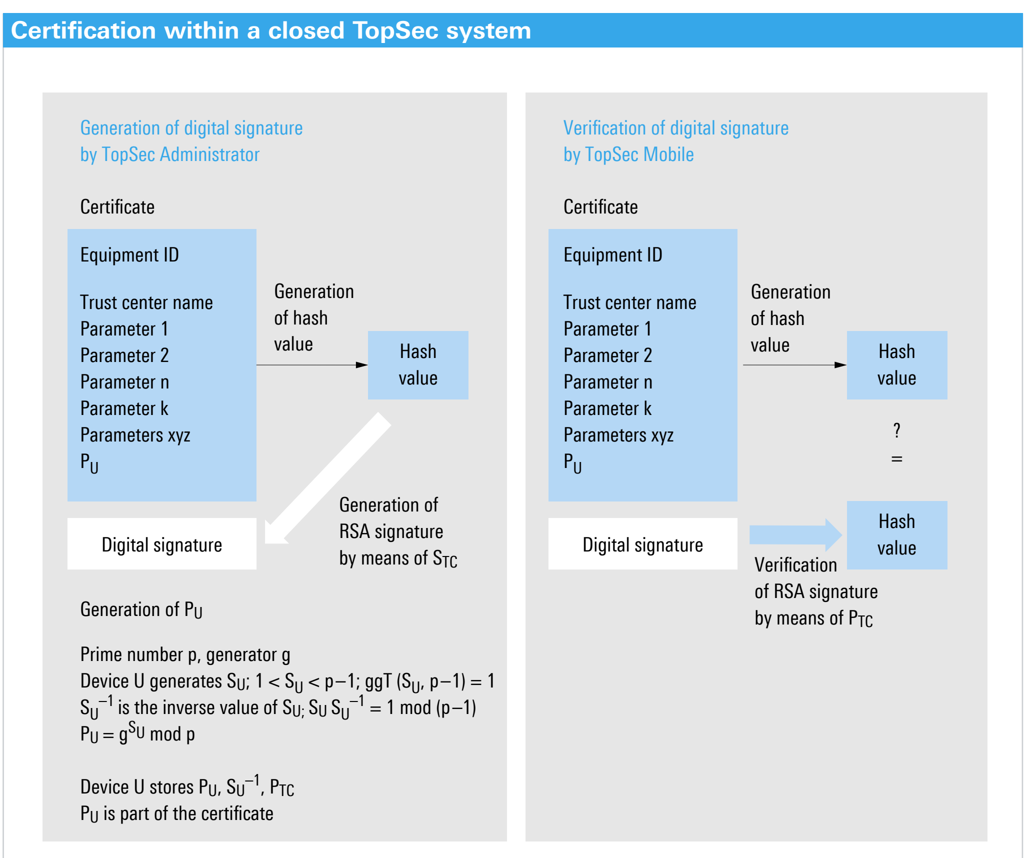
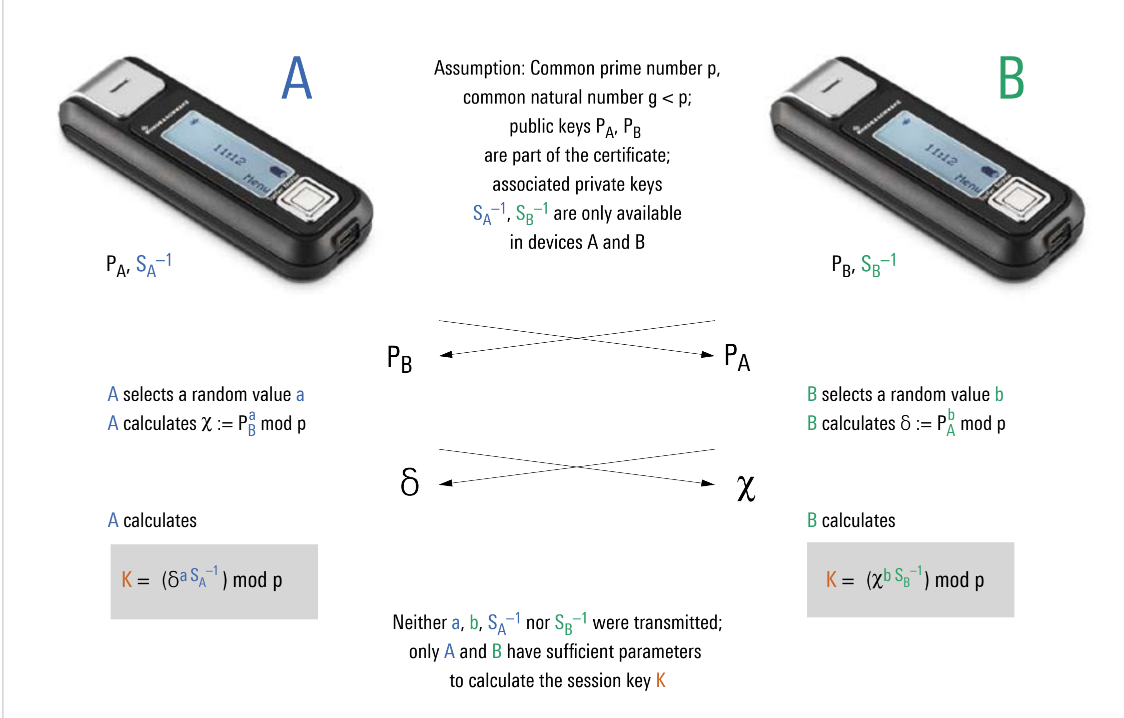


FIG 7 All TopSec devices that belong to a closed user group receive a certificate from the TopSec Administrator identifying them as a member of that specific closed system.

FIG 8 Devices with certificates that belong to a common closed system can automatically authenticate each other (simplified scenario).

Combined key agreement and authentication



During the initialization process, TopSec devices that belong to a closed system generate an additional key pair, which is used for authentication. The private authentication key S_u^{-1} remains in the TopSec device. The public authentication key P_u is part of the certificate. In addition to the certificate itself, TopSec devices receive the public key P_{TC} for verifying certificates.

TopSec devices that are already members of a closed system can subsequently be supplied with new certificates and the associated public keys "over the air". This is done via the public communications network using a secure method preventing manipulation, and is authenticated by the administrator. Devices with certificates that belong to the same closed system can automatically authenticate each other. As a first step, the certificate of the partner encryption device is verified. This is followed by a combined key agreement and authentication (FIG 8). An encrypted connection is established only if key agreement and authentication are successful. The two partners can additionally authenticate each other using the four-digit security code. TopSec encryption devices thus enable confidential voice communications that meet the most exacting security requirements.

If a TopSec Mobile device is lost or misplaced, measures are in place that prevent unauthorized users from pretending to be members of a closed group. For this purpose, the lost device is entered in a black list at the TopSec Administrator. The list is sent to the other devices of the closed user group via a secure communications link. During the authentication process, the devices check whether their partner is on the black list and, if so, drop the connection.

Secure communications, secure future

The TopSec Mobile is based on a powerful hardware with large storage capacity. The firmware is updated in the TopSec Administrator using a secure process. This makes the TopSec Mobile ready to handle also future network and security protocols. The TopSec Mobile is one of the most secure voice encryption devices for wireless communications on the market today. Its attractive design, great ease of operation and excellent voice quality make it an ideal choice for secure voice communications.

Anton Enterrottacher

R&S®DDF255 digital direction finder wi

The chief attraction: The R&S®DDF255 is a highly accurate radio direction finder based on the principle of the correlative interferometer. It also offers an extensive range of powerful measurement and analysis functions. It employs a patented

th measurement and analysis functions

DF method which, due to the use of special wide-aperture DF antennas, offers a high degree of accuracy and outstanding immunity to reflections. With its compact dimensions and optional DC power supply, the R&S®DDF 255 is also an excellent choice for mobile applications.

FIG 1 The R&S®DDF 255 digital direction finder offers a high-precision DF method, patented by Rohde & Schwarz, at an excellent price/performance ratio.

Highly accurate direction finding combined with extensive measurement and analysis functions

The R&S®DDF255 (FIG 1) combines the capabilities of the new and extremely powerful R&S®ESMD wideband monitoring receiver* with those of a direction finder based on the correlative interferometer method. This combination yields a highly accurate wideband direction finder featuring a wide range of measurement and analysis functions. With its compact housing and optional DC power supply, it is also an excellent solution for mobile applications. The R&S®DDF255 will replace the tried-and-tested R&S®DDF190/195 direction finders.

Due to the use of wide-aperture DF antennas with a very large number of antenna elements, the patented DF method offers a high degree of accuracy and outstanding immunity to reflections at an excellent price/performance ratio.

The R&S®DDF255 is based on the same concept as the successful R&S®DDF190/195 family of direction finders. Both the R&S®DDF190 and the R&S®DDF195, which is an expanded version, enjoy wide market acceptance and are used by 23 regulatory authorities around the world.

Due to the extensive functionality of the R&S®ESMD digital wideband receiver, the R&S®DDF255 offers more standard features than a conventional direction finder. With the appropriate options, the R&S®DDF255 transforms into a complete, integrated solution for radiomonitoring and radiolocation. When controlled through a PC or laptop, the R&S®DDF255 offers, for example, the following capabilities:

- Extremely fast spectrum monitoring with scan speeds of up to 100 GHz/s in the 20 MHz to 3.6 GHz range (optional 9 kHz to 26.5 GHz)
- Wideband direction finding with a realtime bandwidth of up to 20 MHz and selectable channel resolution
- Display and demodulation of signals with extremely large bandwidths of up to 20 MHz
- High-precision direction finding in line with ITU recommendations in the 20 MHz to 3 GHz (optional 300 kHz to 6 GHz) range including map display (optional)
- Signal analysis including the classification, demodulation and decoding of important transmission methods (optional)
- Measurement of technical parameters in line with ITU recommendations (optional)

REFERENCE

* R&S®ESMD Wideband Monitoring Receiver – The radiomonitoring specialist: versatile, fast, accurate. News from Rohde&Schwarz (2008) No. 194, pp 62–67.

To enable more in-depth analysis of the signal spectrum and the signal environment, the R&S®DDF255 features an IF panorama. The current receive frequency is positioned in the center of the spectrum display. The display width can be set between 1 kHz and 20 MHz for optimal adaptation to the task at hand. MinHold, MaxHold and average displays are also possible, allowing an even broader scope of applications. All of the R&S®DDF255 functions can be remote-controlled via a 1 Gbit LAN interface, which is also used for data output.

Performance and measurement methods in line with ITU recommendations

The R&S®DDF255 meets, and in many cases clearly surpasses, the ITU recommendations for monitoring direction finders and receivers. For example, the R&S®DDF255 receiver offers large-signal immunity clearly superior to the minimum values recommended by the ITU (higher intercept points, lower phase noise).

As an option, the R&S®DDF255 can be furnished with comprehensive, ITU-compliant measurement methods including:

- Frequency and frequency offset in line with ITU-R SM.377
- Field strength in line with ITU-R SM.378
- Modulation in line with ITU-R SM.328
- Spectrum occupancy in line with ITU-R SM.182/SM.328 (on control PC)
- Bandwidth in line with ITU-R SM.443
- Recognition of mono and stereo transmissions from FM broadcast transmitters

Wideband direction finding with realtime bandwidth of up to 20 MHz

By using high-speed signal processing, the R&S®DDF255 can take bearings of all signals in a wide frequency range of up to 20 MHz with selectable resolution. For all signals above the level threshold, bearings are calculated in parallel and displayed. Wideband direction finding offers a variety of applications and benefits such as:

- All channels in the aeronautical or maritime frequency bands can be simultaneously displayed and their bearings taken.
- All FM broadcast channels can be simultaneously displayed and their bearings taken.
- The bearings of signals with large bandwidths such as DAB and DVB-T can be taken with high channel resolution. The bearing is then an average value (histogram) calculated from many individual bearings. This compensates for frequency-dependent bearing fluctuations.

Direction finding up to 6 GHz

Together with the new R&S®DDF255-SHF option and the R&S®ADD075 DF antenna, the R&S®DDF255 delivers accurate DF results up to 6 GHz. For the first time, bearings can be obtained for signals above 3 GHz, e.g. of WLAN or WiMAX™ transmitters or microwave systems.

Locating the target transmitter previously required the use of rotatable directional antennas, which have disadvantages regarding manageability and measurement speed. The R&S®DDF255 immediately displays the bearing and significantly simplifies direction finding while driving. The high DF accuracy and reflection immunity available in the VHF/UHF range are also achieved in the SHF range.

Fast and reliable radiolocation due to high DF accuracy

In the VHF/UHF range, the R&S®DDF255 uses the correlative interferometer DF method (see page 68). In contrast to simple amplitude comparison methods, the R&S®DDF255 therefore offers significantly higher DF accuracy compliant with class A (highest accuracy class) of the ITU recommendations.

This high DF accuracy relies on the precise measurement of the phase angles between the reference antenna element and the other elements. Measuring the phase difference between two signals normally requires two coherent receive paths. For this reason, most interferometer direction finders on the market use at least two receivers. With the R&S®DDF255, the two receive paths are coherently linked in the DF antenna using a patented method from Rohde & Schwarz.

FIG 2 The R&S®ADD295 DF antenna mounted on the roof of an all-terrain vehicle.

Technical background

Reliable direction finding, even with reflections
Due to multipath propagation, DF antennas often pick up a significant amount of reflection, particularly in urban areas. Compared to most other products on the market, the R&S®DDF255 offers higher immunity to reflections (FIG 3). This is due to the use of DF antennas with a very large number of antenna elements. In the VHF/UHF/SHF range, the R&S®DDF255 uses eight or nine elements. Other products on the market typically have five elements.

The spacing between two adjacent elements of a DF antenna is limited due to the requirement that, for all angles of incidence of incoming waves, at least one pair of elements must have a spacing smaller than half the wavelength at the highest operating frequency. For this reason, the aperture of a DF antenna (diameter referenced to the wavelength) can be significantly increased only if the number of antenna elements is also increased. The aperture of the DF antenna is a major factor contributing to the effectiveness of a direction finder. As the ITU Spectrum Monitoring Handbook 2002 also points out, the DF accuracy, DF sensitivity and immunity to reflections increase in direct proportion to the diameter of the DF antenna aperture.

This advantage comes to light only in an actual operational environment that includes reflections and weak signals. This is not apparent in product specifications, since, for the purpose of comparison, the instrument and system accuracy specified there are valid for ideal, reflection-free DF antenna environments and strong signals.

Reflections can impair DF accuracy. Depending on their design, some DF antennas can handle reflections better than others. The R&S®DDF255 was designed to provide accurate bearings even with a 50 % share of incoming signal reflections. This high immunity to reflections is an advantage gained by the use of many antenna elements. If only five antenna elements are used for instance, a 50 % share of reflections can produce bearing errors in the order of 100°.

Bearing error

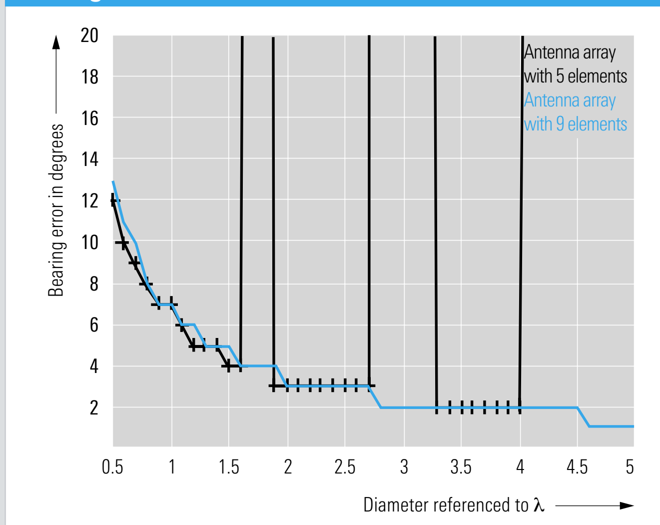


FIG 3 Bearing error of DF antennas with five and nine antenna elements as a function of the antenna diameter (referenced to the wavelength) in a two-wave field.

Single-channel interferometer DF method
The correlative interferometer DF method is based on measuring the phase difference between several antenna elements of a DF antenna. To measure the phase angle φ between the signals of two antenna elements by means of a single receiver, a patented method from Rohde&Schwarz is used (FIG 4). With this method, the phase of one of the signals is shifted in four steps (0°/90°/180°/270°) in the quadrature multiplexer, and the resulting signal is added to the second signal in each case. The receiver measures the amplitude of the sum signal after each phase shift. Placing the four amplitude values (A1/A2/A3/A4) thus obtained in the formula in FIG 4 yields the phase angle between the two signals. The measurement is performed for each antenna element.

Single-channel interferometer DF method

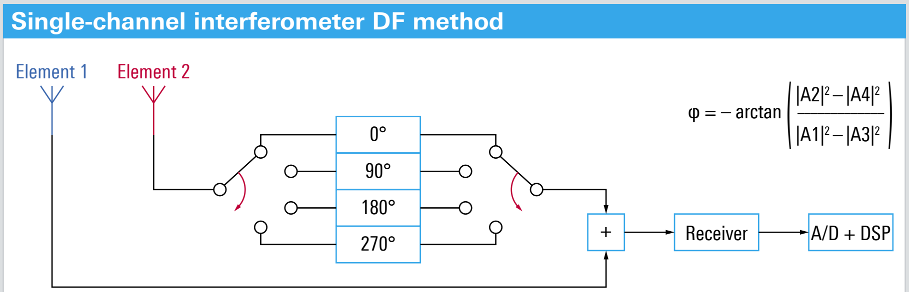


FIG 4 A patented method from Rohde&Schwarz makes it possible to measure the phase angle φ between the signals of two antenna elements by means of a single receiver.

Comprehensive DF antenna program

Rohde&Schwarz offers DF antennas for the R&S®DDF255 to support a variety of applications. The antennas described in the following sections are of particular interest.

For mobile DF applications: R&S®ADD295
(available 1st quarter 2009)
The R&S®ADD295 is a VHF/UHF DF antenna optimized for mobile applications. It covers the entire 20 MHz to 3 GHz frequency range in a compact radome. This is possible through the use of two concentric circles of dipoles.

Previously, two DF antennas were required to cover the entire VHF/UHF range. This caused additional reflections, particularly with systems mounted on vehicle roofs. The new R&S®ADD295 solves this problem and in addition requires only half the space on the vehicle roof. The antenna can be mounted on a vehicle roof by using the R&S®AP502Z1 vehicle adapter (FIG 2). For installation on a mast, the R&S®ADD150A mast adapter is recommended.

For all types of polarization: R&S®ADD197
Rohde&Schwarz is the world's first manufacturer to develop a DF antenna with compact dimensions that contains both vertically and horizontally polarized antenna elements (FIG 6, with lightning protection). In the free space between the nine vertically polarized dipoles, nine horizontally polarized loop antennas have been inserted.

The R&S®ADD197 is suitable for both stationary and mobile applications and covers the 20 MHz to 1.3 GHz frequency range (horizontal polarization: 40 MHz to 1.3 GHz). The R&S®ADD197 can be mounted on a vehicle roof by using the R&S®AP502Z1 vehicle adapter. For installation on a mast, the R&S®ADD150A mast adapter is recommended.

For the SHF range: R&S®ADD075
(available 4th quarter 2008)
With the R&S®ADD075, Rohde&Schwarz offers its first DF antenna for the SHF range. With two circular antenna arrays arranged on top of each other, the R&S®ADD075 covers the 1.3 GHz to 6 GHz frequency range. For mobile applications, the antenna can be flat-mounted on a vehicle roof. For stationary applications, the R&S®ADD196 DF antenna can be mounted above the R&S®ADD075 to create a DF antenna system that covers the 20 MHz to 6 GHz frequency range.

The R&S®ADD119 (FIG 5), a compact DF antenna based on the Watson-Watt DF method, is available **for the HF range**. It can be mounted on a vehicle roof by using the R&S®AP502Z1 vehicle adapter or it can be installed on an R&S®ADD1XTP tripod. Because of its compact dimensions, it can even be camouflaged under an elevated plastic roof.

For stationary and semi-mobile applications in the VHF/UHF range, Rohde&Schwarz offers the **R&S®ADD196** and **R&S®ADD071** DF antennas. They can be mounted above one another on a mast by using the R&S®ADD150A mast adapter and the R&S®ADD071Z antenna adapter.

Application example: mobile radiomonitoring and radiolocation

The R&S®DDF255 is optimally prepared for integration in vehicles:

- High integration density: Its 19" width and its height of only four units make the direction finder extremely compact.
- Flexible power supply: The R&S®DDF255 can be optionally equipped with a DC power supply.
- Front panel control: The R&S®DDF255 can alternatively be controlled from the front panel without using a PC.
- Multiple antenna inputs: Multiple DF and/or monitoring antennas can be connected to the R&S®DDF255.

FIG 5 R&S®ADD119 for the HF range, mounted on an R&S®ADD1XTP tripod.

Application example: stationary radiomonitoring and radiolocation up to 6 GHz

Together with the R&S®ADD197 and R&S®ADD075 DF antennas, the R&S®DDF255 forms an extremely powerful stationary system for radiomonitoring and radiolocation up to 6 GHz. It meets, and in many cases clearly surpasses, ITU recommendations.

With the R&S®ADD197 DF antenna for the VHF/UHF range, direction finding is now also possible for any horizontally polarized transmitters. This means that precise bearings can be taken of all TV and sound broadcast transmitters, for example. The signals from such transmitters can then be used as a reference to align the direction finder to north and check its functionality. The R&S®ADD197 can also take accurate bearings of defective transmitting and receiving systems with horizontally polarized antennas.

Additional monitoring antennas can be directly connected to the R&S®DDF255. The recommendations of ITU can thus be met without using external antenna switches. Together with the R&S®DDF255-ITU option, this yields a radiomonitoring and radiolocation system that delivers reproducible and reliable results in line with ITU recommendations.

Lightning protection

To protect the DF antennas from lightning strikes at high-risk locations, Rohde&Schwarz developed the R&S®ADD-LP lightning protection (FIG 6). This option is recommended for installations higher than 30 meters above ground (masts higher than 30 meters, high buildings, mountain tops). The crossed lightning rods prevent lateral strikes in nearly all cases since the rods project beyond the DF antenna.

Summary

The R&S®DDF255 combines high-precision direction finding with the outstanding performance features of the R&S®ESMD wideband monitoring receiver in a single compact device. The R&S®DDF255 is setting standards both by its extensive functionality and the high quality of the results it delivers. It offers superior performance in terms of accuracy, large-signal immunity and immunity to reflections, characteristics that are especially relevant in practical applications.

An extensive range of DF antennas is available for use with the new R&S®DDF255 digital direction finder. This includes DF antennas for all polarization types and all important frequency ranges as well as for stationary and mobile applications. Featuring front-panel control and an optional DC power supply, the R&S®DDF255 is also an ideal choice for mobile applications.

Philipp Strobel

FIG 6 R&S®ADD-LP lightning protection (mounted on an R&S®ADD197).

Case study competition goes global: Teams from Singapore participated for the first time.

Communications and information security: a balancing act

Science requires open communications to survive. In the high technology sector, knowledge is considered the most important asset. But are knowledge and information being adequately protected or are we too careless in the way we manage communications in Germany? This issue was addressed during a podium discussion held at Berlin Adlershof in July, an event co-organized by Rohde & Schwarz SIT GmbH.

The aim of the discussion was to identify the potential risks related to industrial espionage and raise security awareness. The initial podium and subsequent plenary discussion included the following participants: Dr. Udo Helmbrecht, President of the German Federal Office for Information Security, Dr. Stefan Harant, Board Member of the Berliner Wirtschaftsgespräche e.V. (Berlin-based non-profit organization dedicated to raising the awareness of business issues), Prof. Dr. Peter Pepper from the Fraunhofer Institute for Computer Architecture and Software Technology FIRST, Dr. Jürg Kramer from the Humboldt University Institute for Mathematics in Berlin, and Henning Krieghoff, President of Rohde & Schwarz SIT GmbH.

The roughly 70 guests were provided an overview of the dangers related to information security, as well as recommendations for suitable solutions. Apart from implementing enough basic protection at the IT infrastructure level, the panel also cited the need for behavior guidelines for employees. Prof. Dr. Pepper boiled it down to this: "We can make sure that the cost of hacking into protected information exceeds the benefit of the knowledge obtained as a result."

Hamburg-Harburg Technical University wins case study competition

More than 200 university students from Germany, and for the first time six teams from Singapore, participated in the 5th Rohde & Schwarz case study competition. Under the motto "Go wireless! Testing for future communications standards", the finalists put their knowledge of RF to the test in the final round which took place at the end of June in Munich. The competition focused on engineering challenges that surface during the development of future mobile radio standards such as UMTS LTE. The teams faced tasks such as working on the design of an RF transmitter path, creating a proposal for the development of a synthesizer concept or analyzing the measurement uncertainty of a power amplifier. The up-and-coming engineers also tinkered with multiple-antenna systems such as those deployed for WiMAX™. At the end of the day, the team from Hamburg-Harburg Technical University celebrated by capturing the € 2000 first-place prize.

Rohde & Schwarz China earns technical training award

The Foxconn Technology Group has presented Rohde & Schwarz China with the Excellent Lecturer Award. The award is presented for outstanding quality in the area of technical training. Training programs from 1300 suppliers were evaluated based on the results of a survey. Foxconn was impressed with the training services offered by Rohde & Schwarz China. Rohde & Schwarz now joins an elite group of 12 companies that have been honored with the award during 2007/2008.

First Asian DVB-H network launched with Rohde & Schwarz transmitters

The Malaysian mobile TV provider UMobile kicked-off its Mobile LiveTV™ service for the Kuala Lumpur metropolitan region. For its network, UMobile had ordered transmitters of all power classes from Rohde & Schwarz Malaysia Sdn. Bhd. The Malaysian subsidiary set up the transmitter network in a record time of only two months. The transmitters, periphery equipment, RF feeder cables and antenna systems were installed at 20 locations.

Fujitsu selects Rohde & Schwarz for WiMAX™ SoC test solution

Together with Rohde & Schwarz, Fujitsu Microelectronics has developed a test solution for Fujitsu's MB86K21 mobile WiMAX™ system-on-a-chip (SoC). The solution is based on the R&S®CMW270 WiMAX communication tester from Rohde & Schwarz and will be used to calibrate and verify WiMAX™ mobile stations that are based on the MB86K21 chip. Manufacturers can reliably and efficiently test their products with the R&S®CMW270. Transmitter and receiver parameters such as frequency response and linearity can be automatically aligned. In addition, the base station emulator verifies the correct functions in a WiMAX™ network operation. Fujitsu was impressed by the measurement speed of the R&S®CMW270, which is ten times faster than conventional measurement instruments. As a result, Fujitsu customers now have a cost-effective test solution for the development of new products.

Moscow university equipped with RF lab from Rohde & Schwarz

The Scientific Educational Center of the Moscow State University (MSU), which is part of the physics department, was officially opened in May. Among other equipment, the laboratory boasts spectrum and network analyzers as well as signal generators from Rohde & Schwarz. The center currently offers five training and education programs, which to date have been completed by more than 20 students.