News from Rohde & Schwarz

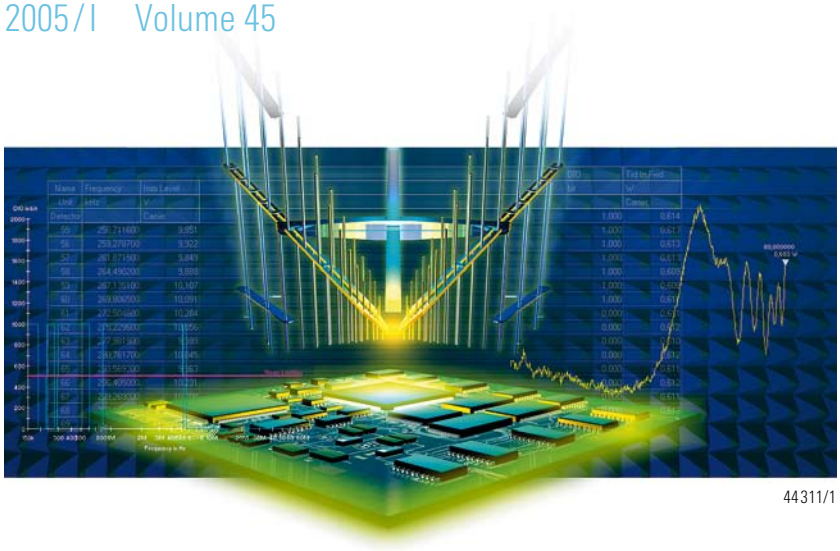
Compact integrated measurement system
for versatile EMC measurements

Calibration test setup for signal generators
in a single instrument

Air-cooled analog / digital TV transmitters
for the medium-power segment

2005/I
185

ROHDE&SCHWARZ



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A compact test setup for performing development EMC and acceptance test measurements from 9 kHz to 3 GHz in compliance with all common commercial, military and automotive standards – the new Integrated Measurement System R&S®IMS (page 28).

Secure communications facilities are a basic prerequisite for trouble-free operation of underground trains. Siemens TS thus had good reason to select the *ACCESSNET*®-T TETRA mobile radio system from Rohde & Schwarz for its underground train project in Bangkok (page 8).

MOBILE RADIO

Rohde & Schwarz has now introduced an instrument with outstanding characteristics for calibrating signal generators and attenuators – the Measuring Receiver R&S®FSMR (page 18).

GENERAL PURPOSE

The R&S NetCCU®700 transmitter control unit can be used for many purposes – as a transmitter control unit, a local control unit or a network interface for web and SNMP applications in which the control unit provides the hardware platform. By adding the new DVB-T receiver modules, you can broaden its range of applications even further (page 34).

Rohde & Schwarz is the world market leader in digital broadcast transmitters as well as a leading manufacturer of analog transmitters in Europe. The company's extensive portfolio also features exceptional products such as transmitters in containers or lightweight transmitter buildings (page 38).

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FIG 1 **Typical test setup for MMS tests on multimedia mobile phones.**

Protocol Tester R&S®CRTU-G / -W

MMS tests on multimedia mobile phones

With the R&S®CRTU-ATE application test environment software platform for the Protocol Testers R&S®CRTU-G / -W, Rohde & Schwarz has expanded its portfolio by an MMS test solution for developing, verifying and certifying multimedia mobile phones.

MMS – a new challenge in mobile radio networks

GPRS, EGPRS and UMTS are powerful communications and data transmission networks offering attractive applications such as the transmission of pictures, video clips or music files to one or more subscribers simultaneously. For this purpose, a mobile phone uses the multimedia message service (MMS), which transmits a combination of text and multimedia files. An SMS then informs the recipients that they have new data they can download from a server in the network by pressing a key.

Network operators must ensure smooth multimedia file exchange. However, as a prerequisite for an efficient network, all mobile phones have to meet specific minimum requirements for handling the file formats used. For example, because display sizes differ, all mobile phones must be able to display and replay the pictures and video clips transmitted in various sizes and file formats in suitable quality without having to revert to conversion aids for the different types of mobile phones that network operators provide in the network. Otherwise, for example, a picture sent in GIF format to a mobile phone that can only process

JPEG format would have to be converted in the network. In view of the multitude of disparate mobile phones and file formats, this task would be virtually impossible to handle.

Minimum standard with new test cases

To circumvent such problems, a minimum standard for transmitting multimedia files has been defined. On behalf of the Global Certification Forum (GCF), the Open Mobile Alliance (OMA) specified test cases by means of which it is possible to verify whether mobile phones comply with this minimum standard when reproducing multimedia content. Some of these test cases were adopted by the GCF and the PCS Type Certification Review Board (PTCRB) and have thus become part of the certification for all mobile phones supporting MMS. Unlike signaling test cases, these test cases verify application layers instead of lower protocol layers.

For reception tests, OMA provides references that also include picture, video and sound files in different formats and sizes. For test purposes, a multimedia message is sent to the mobile phone; visual or acoustic comparison determines whether the display on, or replay by, the mobile phone complies with the reference content. To facilitate comparing the results on the mobile phone with the reference content, the reference content is displayed on the R&S®CRTU screen after the message has been sent.

Unlike reception tests, transmission tests can be evaluated automatically. For this purpose, the mobile phone sends a message with multimedia content to the protocol tester. Using a parser, the protocol tester splits the content into separate media files and the SMIL specification, checks whether they comply with the reference and then indicates whether the mobile phone has passed the test. A manual file comparison using a viewer, i.e. a supplied program that can display pictures and videos and replay music files, is of course also possible.

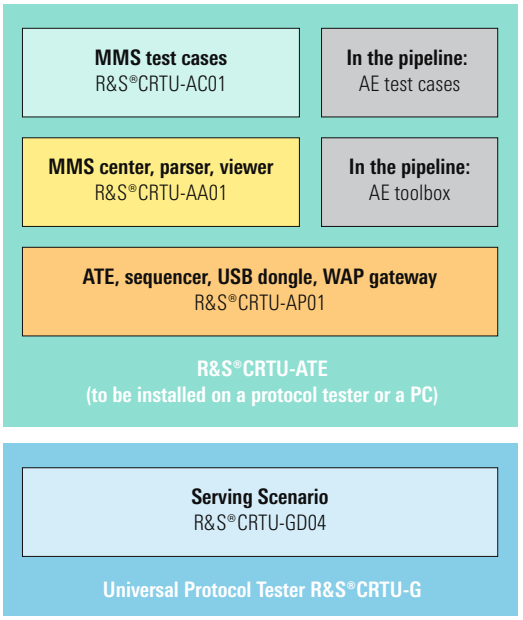


FIG 2 Basic architecture of the Rohde & Schwarz solution for MMS tests on mobile phones.

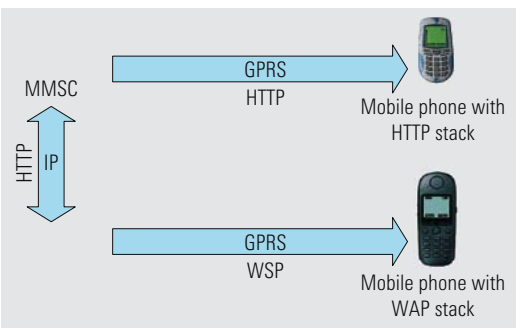
Fit for the future with solutions from Rohde & Schwarz

The R&S®CRTU-ATE application test environment software platform from Rohde & Schwarz is a flexible MMS test solution to be installed on a Protocol Tester R&S®CRTU-G / -W or on a PC (FIGs 1 and 2). Via Serving Scenario R&S®CRTU-GD04, it is connected to a protocol tester that provides the radio resources required for MMS. The R&S®CRTU-ATE software platform includes all components for MMS testing and can be expanded for future test requirements by means of modules. The supplied test cases only perform tests at the application layer and are independent of mobile radio standards. However, the serving scenario is bound to a specific hardware, namely the R&S®CRTU-G or R&S®CRTU-W protocol testers. Despite the independence of mobile radio standards, some interfaces between R&S®CRTU-ATE and the serving scenario are necessary to ensure smooth running of the test cases.

The core of the new solution from Rohde & Schwarz is the MMS center (MMSC). It allows multimedia messages to be sent and received. It was specially developed for MMS testing and offers maximum transparency in troubleshooting, since the internal states of the MMSC can be seen. Moreover, the test environment includes a WAP gateway, which is required for mobile phones without an HTTP stack and that only have a WAP stack implemented. The WAP gateway converts the HTTP messages into WAP messages and vice versa, thus ensuring correct functioning of the test environment for all mobile phones (FIG 3).

In addition to the above components, the MMSC contains a parser and a viewer. The parser splits the multimedia message into separate contents; comparing them with the reference content indicates whether a mobile phone functions correctly. This process can run automatically and does not call for any intervention by the operator. The

FIG 3 A WAP gateway converts HTTP messages into WAP messages, and vice versa.



supplied viewer can display pictures or videos and help find out why a display is not correct. If the viewer is installed on a PC or a laptop with a sound card, the music files can be replayed via the built-in loudspeaker.

The MMS portfolio from Rohde&Schwarz currently comprises four software products:

Serving Scenario R&S®CRTU-GD04 is installed on the Universal Protocol Tester R&S®CRTU-G. For the R&S®CRTU-W, a serving scenario is in the pipeline. All other software products communicate via IP with the hardware platform and can be installed both on an R&S®CRTU-G / -W and on a PC (also linked via IP) (FIG 4). If the software is installed on an external PC, the IP connection is made via an Ethernet cable; if it is installed on the R&S®CRTU, the software is addressed via an internal IP connection between the two protocol testers.

The following software products are connected via IP (FIG 2):

R&S®CRTU-AP01 includes the application test environment with USB dongle, WAP gateway and sequencer for starting the individual application enabler test cases. This product is the framework for MMS test cases and for all other application enabler test cases.

R&S®CRTU-AA01 contains all MMS-specific components such as the MMSC, parser and viewer.

R&S®CRTU-AC01 includes all relevant MMS test cases.

Rohde&Schwarz implements changes in the MMS test cases specifications, which are available to all customers with a software upgrade agreement.

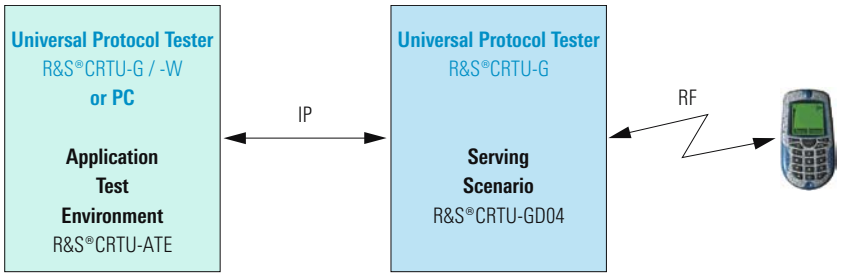


FIG 4 Schematic of the Rohde&Schwarz solution for MMS tests on mobile phones.

Summary

With the R&S®CRTU-ATE MMS test solution, Rohde&Schwarz has expanded its portfolio by a key component for developing, verifying and certifying multimedia mobile phones. Efficient tools for analyzing the test results and straightforward operation considerably facilitate working with the test cases and easily yield fast results. The MMS test solution seamlessly integrates into the comprehensive product portfolio of the R&S®CRTU platform, making it even more appealing.

Markus Hendeli

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

Important abbreviations

ATE	Application test environment
AE	Application enabler
EGPRS	Enhanced GPRS
GCF	Global Certification Forum
GPRS	General packet radio services
HTTP	Hypertext transfer protocol
IP	Internet protocol
MMS	Multimedia message service
OMA	Open Mobile Alliance
PCS	Personal communications system
PTCRB	PCS Type Certification Review Board
SMIL	Synchronized multimedia integration language
SMS	Short message service
WAP	Wireless application protocol
WSP	Wireless session protocol
UMTS	Universal mobile telephone standard
USB	Universal serial bus

Test cases for dual transfer mode in GSM and (E)GPRS networks

Competition energizes the business. The standard features of the new UMTS networks are leading to substantial improvements in GSM and (E)GPRS networks. Dual transfer mode (DTM) is the keyword here. This new method will also make it possible in GSM networks to perform functions such as receiving a call or sending an SMS while receiving e-mails (figure). The implementation of DTM in the R&S®CRTU-G will offer protocol stack developers a more powerful tool.

In UMTS networks it is everyday practice to use several services in parallel, thus turning your mobile phone into a terminal. So far, however, GSM networks only allow you to set up either a voice connection (circuit-switched) or a data connection (packet-switched). Therefore, you cannot be reached while receiving data via your mobile phone. The introduction of DTM will make it possible to use several services in parallel also in GSM networks, and network operators without UMTS licences can thus expand their portfolio. This new technology can be of great importance also for UMTS network operators as GSM networks equipped with DTM can offer these services in areas without UMTS coverage.

In future, mobile phones must therefore be able to handle the signaling procedures of both standards correctly and master numerous new procedures. This especially applies to the mobility management layer (MM / GMM) and radio resource layer (RR / GRR), whereas the radio link control/media access control layer (RLC / MAC) largely remains unchanged.

The Universal Protocol Tester R&S®CRTU-G is equipped with the main signaling expansions specified in release 99 (R99) and release 4 (R4) of 3GPP 51.010. R&D departments all over the world thus have a tool for implementing protocols at an early stage. For conformance and preconformance tests, 52 DTM test cases from various sections of the 3GPP specification are already implemented in the protocol tester.

For DTM tests that simultaneously require a circuit-switched (CS) and a packet-switched (PS) channel, you need two R&S®CRTU-G or one R&S®CRTU-G and one R&S®CRTU-S. This is because a BCCH / CCCH of the base station must also always be available. Thus, you need a total of three channels. During the test, one to three timeslots of the packet-switched service are generated on one channel, and additional timeslots on the fourth channel. You can cascade up to eight R&S®CRTU-G or R&S®CRTU-S, thus offering sufficient leeway for all future scenarios. Of course, you can use all Universal Protocol Testers R&S®CRTU-G / -S for the specified tasks without making any hardware modifications.

Gerhard Götz

Example: Downloading a video during a call in a GSM network.

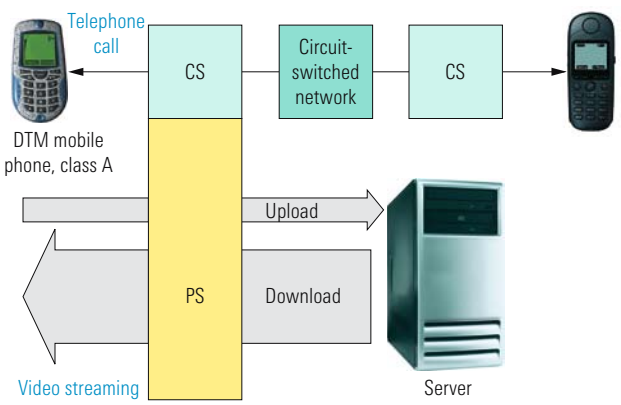


Photo: R&S BICK Mobilfunk

FIG 1 "On break": Underground trains at their depot in Bangkok.

Bangkok Metro Corporation Limited contracted Siemens TS (Transportation Systems) to equip the first underground train system in the Thai capital. The order covered the delivery of the complete infrastructure including signal technology, set of coaches, power supply, depot equipment and radio communications system. Siemens TS selected the *ACCESSNET*®-T TETRA radio system from R&S BICK Mobilfunk as the radio communications system.

TETRA Mobile Radio System *ACCESSNET*®-T

Reliable communications system for Bangkok's underground train system

Reliable operation throughout the world

TETRA radio systems such as *ACCESSNET*®-T implement an open ETSI standard and are known for their reliability throughout the world. *ACCESSNET*®-T systems are already being used successfully at government authorities and organizations with security missions, oil and gas companies, railway companies, public transport and private network operators. Secure communications facilities are also a basic prerequisite for trouble-free operation in underground trains. Siemens TS thus had good reason to select *ACCESSNET*®-T for its project in Bangkok. The main criteria were reliability, ruggedness and flexibility.

Complex infrastructure

Nineteen TETRA base stations cover the above- and underground lines, the railway premises (FIG 1) and the stops. The project implements a wide variety of antenna types. Special antennas were installed to cover the inner and outer areas, and flat vehicle antennas were installed on the trains. Leaky feeders ensure secure communication within tunnels.

The central exchange controls all communications facilities (FIG 2). The base stations are coupled to the central exchange via E1 lines and an optical network. The exchange has interfaces to the private telephone network

(PABX), the voice recording system and the SCADA system. The network management system and the control center for trains are also directly coupled to the exchange. The trains have two trainborne radio subsystems each.

SRP-2000 TETRA terminals from Sepura were selected as radios for mobile use; SRM-1000 terminals, also from Sepura, were selected for use in the vehicle. *ACCESSNET*®-T of course also operates with terminals from other manufacturers. This allows each operator to choose the units that fit their specific requirements.

Control center

The control center is the heart of the complete system. It manages and monitors all communications including rail traffic. If necessary, the control center coordinates and controls unscheduled events. The multiposition R&S®TRD-500 dispatcher system with eight workstations was installed for this task. It is connected to the central exchange via a LAN. Voice communications are handled via a voice-over-IP connection. The full functionality of the PABX interface can be used via the control center. TETRA subscribers can thus make phone or mobile phone calls to other communications networks.

Addressing is user-specific and based on train numbers, i.e. staff members wanting to make a call use the corresponding train number as an address. This number will then be displayed on the units and in the control center. Received and sent status calls, text messages as well as individual or group calls will be processed in the control center. A control center monitoring mode is available as well as a data mailbox and a call memory. You can also assign priorities for individual subscribers, if required.

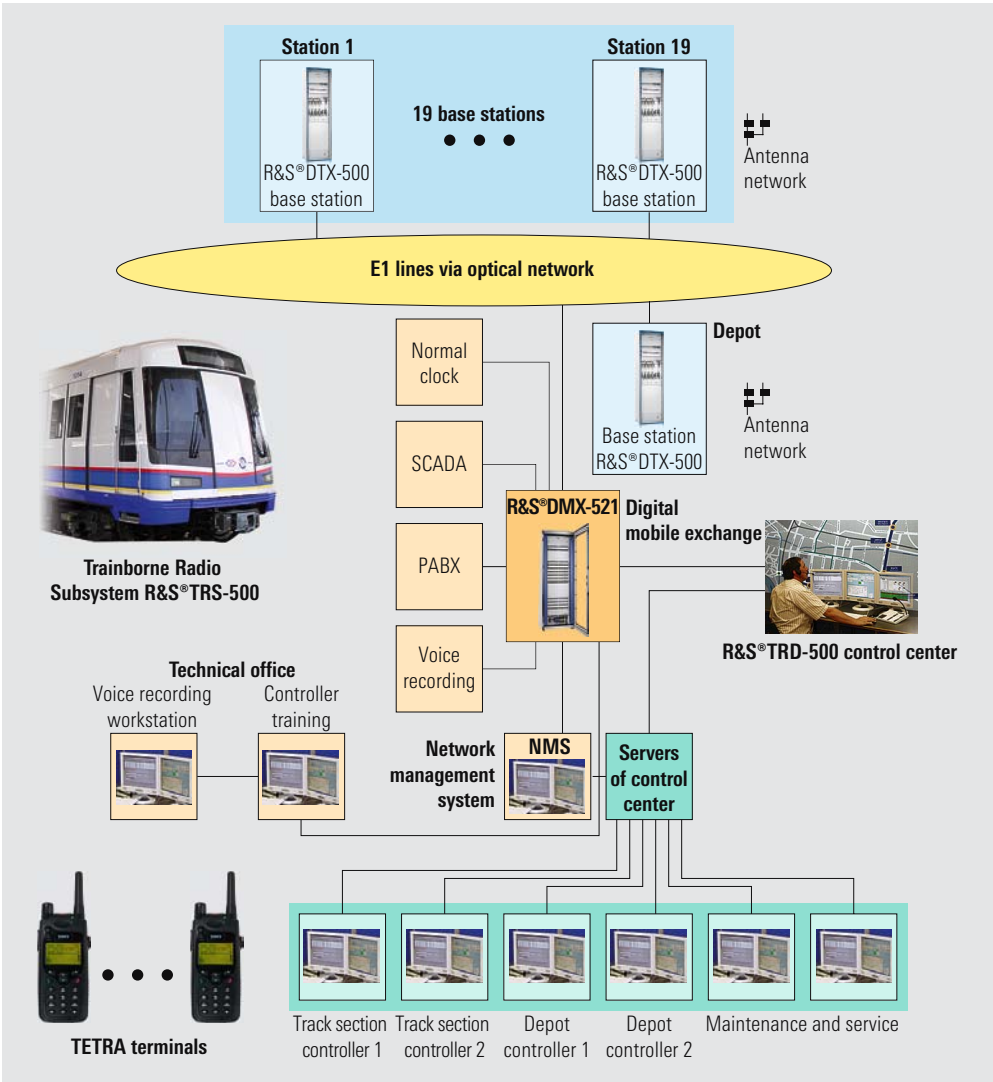
Voice recording

Public transport applications are subject to particularly stringent security requirements. The TETRA Voice Recorder R&S®TVR-500 was installed to ensure continuous traceability of communications in the event of downtime or emergencies. The system records the 8-kbit data stream as a TETRA-coded signal. This ensures much higher capacity than other voice recording systems on the market.

Network management system

You can perform service and maintenance work on the radio system with the Network Management System R&S®NMS-500. Every network element (exchange, base station) has its own network management server including database. Operating data is exchanged via the lines of the network elements. You can use different clients for different tasks – one for subscriber management, another for network configuration and network optimization, and a third for error analysis. The clients are connected to the server via a LAN and can be operated either locally or remotely, e.g. in a central control office. The clients are installed on commercial PCs as a central network management system in a technical office.

FIG 2 Basic setup of the *ACCESSNET*®-T system in Bangkok's underground train system.



Inhouse and tunnel coverage

In addition to the four-story underground stations and technical offices, underground train paths and tunnels are also covered. Antennas tailored to the specific requirements of the coverage area as well as leaky feeders for tunnel coverage were coupled to the base stations. To meet high security requirements also in this area, R&S BICK Mobilfunk developed a leaky feeder monitoring facility which automatically signals cable breaks or ruptures to the control center.

Photo: R&S BICK Mobilfunk

FIG 3 The Trainborne Radio Subsystem R&S®TRS-500.

Trainborne radio subsystems

The Trainborne Radio Subsystems R&S®TRS-500 (FIG 3) were developed to ensure communication with and inside the trains. The SRM-1000 terminals are connected to these trainborne radio subsystems. The trainborne radio subsystems transmit train maintenance and positioning data. A maintenance system in the underground trains uses sensors to monitor the electronics, air pressure and temperature. The maintenance system signals any data deviating from specified values to the maintenance control center via the TETRA system. The maintenance control center immediately takes appropriate actions and provides the maintenance staff with the required information. This saves valuable time and helps to avoid costly repairs. The trainborne radio subsystem transmits general information for passengers to the loudspeaker system of the train. In the event of emergency, emergency calls are transmitted to the control center via the R&S®TRS-500 systems.

Since GPS reception is not possible in a tunnel, a different procedure was selected: The train receives its positioning data when traveling over induction loops installed in the stations. A positioning signal is transmitted to the control center via *ACCESSNET*®-T and displayed there.

SCADA interface

Each network element has alarm sensors. An alarm is immediately triggered at high priority via *ACCESSNET*®-T. The SCADA interface is the preset address. This ensures that the alarm is sent to the SCADA system and can be processed in compliance with the required operating regulations.

Training and operation

To ensure trouble-free operation and maintenance of the system, staff and engineer training was also included in the package. This training was provided in spring 2004 at the R&S BICK Mobilfunk headquarters in Bad Münder.

In operation ahead of schedule

The installation of the communications system was started in 2003 and completed in summer 2004. The underground train has been in operation since July 2004 ahead of schedule. The opening ceremonies were attended by His Majesty, King Bhumibol Adulyadej of Thailand, and his wife, Sirikit.

Harald Haage

Important abbreviations

E1	Physical interface in line with ITU standard
GPS	Global positioning system
LAN	Local area network
PABX	Private automatic branch exchange
SCADA	Supervisory control and data acquisition; traffic management and process visualization system
TETRA	Terrestrial trunked radio (only European ETSI standard for digital trunked radio)

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

Vector Signal Generator R&S®SMU 200 A

Polar modulation

The two-path concept of the R&S®SMU 200 A makes this instrument considerably more versatile than conventional vector signal generators. While conventional generators with I/Q modulation cannot generate polar-modulated signals, for example, the R&S®SMU 200 A can do so when equipped with two baseband generators.

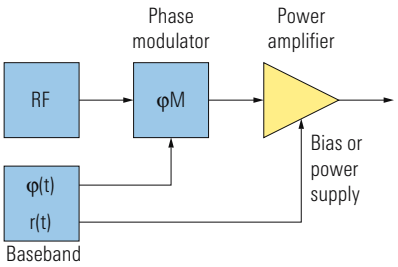


FIG 1 The principle of polar modulation.

In polar modulation, digital modulation is not implemented via I/Q modulators but as a combination of phase and amplitude modulation φ(t) and r(t). Polar modulation is being used to an increasing extent in mobile radio; an important application is, for example, the expansion of GSM modules and equipment to EDGE. In many GSM solutions, phase modulators generate the GMSK modulation. If you now implement EDGE signals as a combination of amplitude and phase modulation and control the output level of the power amplifier with the amplitude component, the EDGE expansion will be possible without extensive modifications (FIG 1).

For example, the signal generator for generating test signals for such a power amplifier must generate a phase-modulated RF signal as well as the corresponding amplitude modulation as a separate AF signal. While this is no problem for an R&S®SMU 200 A with two baseband generators [1], a conventional vector signal generator cannot handle this task. FIG 2 shows such a test setup. Baseband A generates the phase-modulated RF signal. For this purpose, the phase signal φ(t) is calculated externally and transformed into suitable I/Q values in accordance with

$$i_A(t) = \cos\varphi(t)$$
$$q_A(t) = -\sin\varphi(t)$$

These values are stored in a waveform file and transferred to the waveform generator of baseband A. The amplitude signal is also transformed into the I/Q representation:

$$i_B(t) = \frac{r(t)}{r_{max}}$$
$$q_B(t) = 0$$

This signal is also written to a second waveform file (with the same length and sampling rate) for baseband B. As the I/Q outputs of the R&S®SMU 200 A are routed to path B, the amplitude signal is available at the I output. Both baseband generators are started sychronously. Moreover, you can set a defined delay between A and B to compensate for possible delay differences in the test setup.

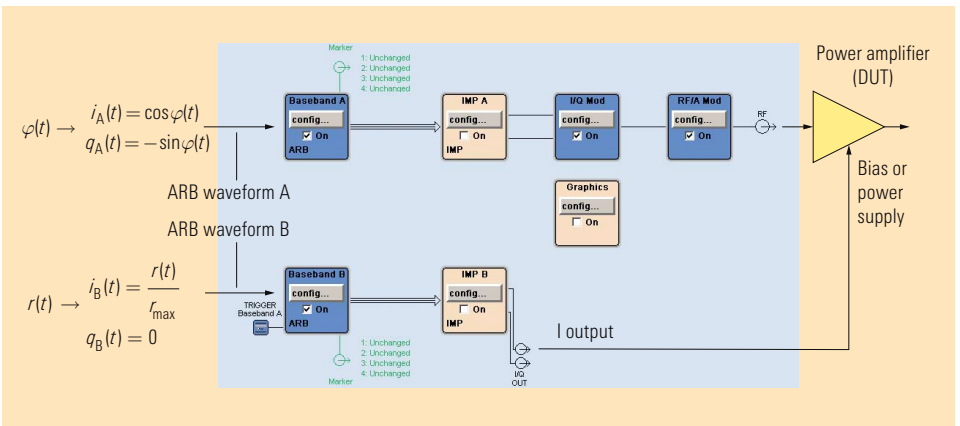
This is only one of many applications possible with the two-path R&S®SMU 200 A. Further examples are provided in [2, 3].

Dr René Desquiotz

More information, Application Note and data sheet at www.rohde-schwarz.com (search terms: SMU200A, 1GP58, 1GP50)

REFERENCES
[1] Generating Polar Modulation with R&S®SMU 200A. Application Note 1GP58 from Rohde & Schwarz
[2] Vector Signal Generator R&S®SMU 200 A: Complex signal scenarios at almost no effort. News from Rohde & Schwarz (2004) No. 183, pp 36–38
[3] New Dimensions in Signal Generation with R&S®SMU 200 A. Application Note 1GP50 from Rohde & Schwarz

FIG 2 The R&S®SMU 200 A can generate polar modulation to test, for example, power amplifiers for GSM / EDGE.



Signal Analyzer R&S®FSQ / Spectrum Analyzer R&S®FSU

Measuring spurious emissions

By virtue of their sensitivity and excellent modulation capabilities, the R&S®FSU and R&S®FSQ (FIG 1) analyzer families are ideally suited for measuring spurious emissions. The new Spurious Emissions application for these instruments provides flexible device configuration and high measurement speed as well as straightforward evaluation of results. With up to 100 001 points per measurement, the analyzers do not miss a single spurious signal, even with large frequency ranges.

Configuring the measurement

Measuring spurious emissions is very important with nearly all devices under test that transmit RF power. The reason is that they usually must comply with frequency-dependent limits so that they do not interfere with other radio services or transmit unwanted signals in the case of security-relevant applications.

The R&S®FSU and R&S®FSQ analyzers support the measurement of spurious emissions with a new user-friendly application. For configuring the measurement, they provide up to 20 frequency ranges for which all relevant test parameters can be customized (FIG 2):

- Frequency range
- Level settings
- Bandwidths and sweep time
- Detector
- Number of measurement points
- Transducer

Measuring and evaluating

After a measurement has been configured and the suitable limit line switched on, one keystroke is all it takes to automatically run the measurement sequentially over the defined subranges. Of course, it is also possible to automatically stop the measurement at the end of a range, for example to switch the signal path. The measurement can also be stopped and resumed by remote control. At the end of the measurement, the analyzer displays all the ranges simultaneously on the monitor (FIG 3).

A single keystroke is all it takes to perform the numeric evaluation. With the PEAK LIST function, the analyzer marks all limit violations (FIG 3) and transfers them to a list. A safety margin can be added to the limit line and peak search, permitting additional analyses with respect to existing margins from the limits. For a quick overview, you can

Another article in this issue features the Signal Analyzer R&S®FSQ: "EVM measurements on ZigBee signals" on page 25.

FIG 1 The Signal Analyzer R&S®FSQ.

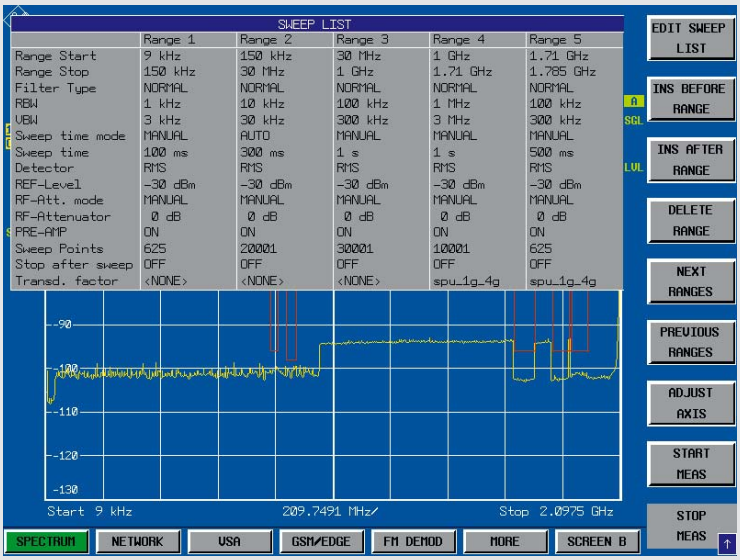


FIG 2 Configuration table for measuring spurious emissions.

choose between sorting the evaluation by frequency or by margin from the limit line (FIG 4).

Measurement accuracy

The factors that influence the measurement accuracy of the analyzers are explained in detail in [1].

RMS detector

With 30001 sweep points and 1 MHz resolution bandwidth, a frequency range of up to 7 GHz can be measured, without the error value of the RMS detector exceeding 0.2 dB. If requirements are more stringent, the frequency range is simply divided into multiple sweep ranges. A total of 100001 measurement points across all frequency ranges is allowed.

Modulation

Optimal modulation of the analyzer minimizes measurement errors and ensures a maximum dynamic range. The optimal reference level adapted to the DUT is therefore available in the sweep list for each frequency range. In addition, with measurements that extend into the GHz range, the frequency response of the external circuitry (e.g. cables or filters) must be taken into account. For this purpose, the R&S®FSU and R&S®FSQ analyzers provide a separate transducer for each range for correcting the frequency ▶

Test setup used in the example

A 3GPP base station sends a multicarrier signal at the frequencies 2110 MHz and 2115 MHz. Spurious emissions are checked in accordance with category B, band I, wide-area base stations with coexisting GSM900 network [2].

The 10 dB power attenuator is used as a broadband load for the base station. The level offset setting of 10 dB takes this into account. The bandstop filter used attenuates the carrier signals of the base station by at least 60 dB, allowing the reference level to be lowered without overloading the analyzer.

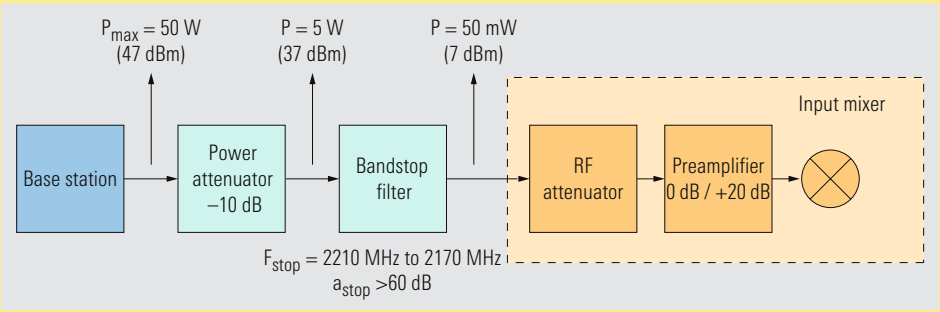


FIG 5 Test setup.

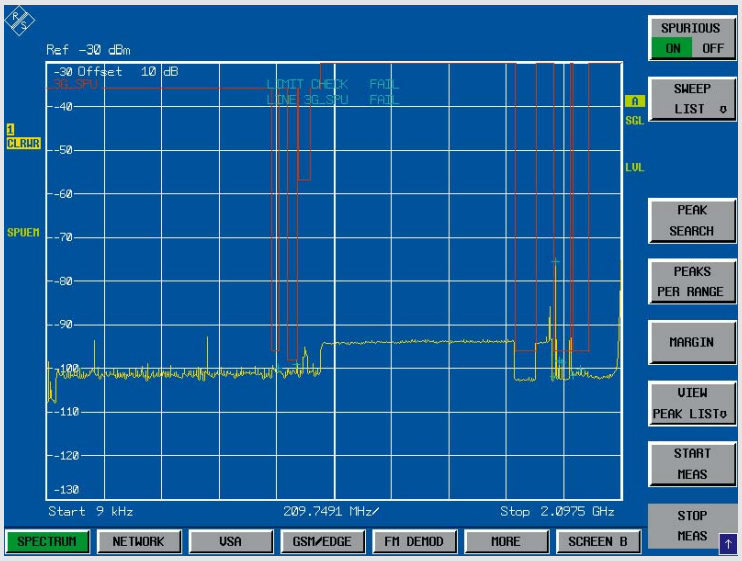


FIG 3 Measurement in the frequency range from 9 kHz to 2.0975 GHz. Red: limit line.

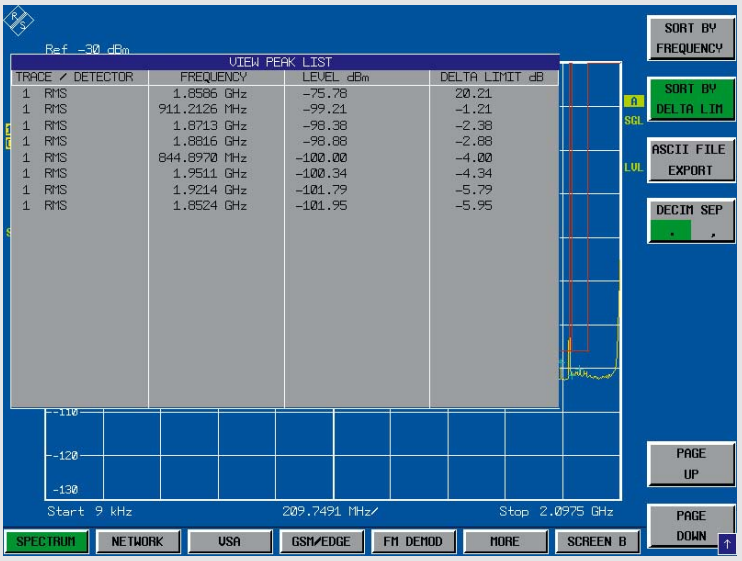


FIG 4 List of limit or margin violations, sorted by margin from the limit line.

response of the external circuitry. The analyzers can now generate the data record necessary for this.

Equipped with the optional tracking generator (R&S®FSU-B9) up to 3.5 GHz or external generator control (R&S®FSP-B10), the analyzers can measure the frequency response in the NETWORK operating mode (FIG 6). With the SAVE AS TRD FACTOR function, they then convert the data record into a transducer that is subsequently used to compensate the frequency response error (FIG 7). The standardizing measurement (SOURCE CAL), which must be performed beforehand, eliminates virtually all level errors of the signal or tracking generator and of the analyzer, which means that only matching errors contribute to the measurement uncertainty.

A separate transducer can be assigned to each range of the sweep list, making a total of 12500 reference values possible for correcting the frequency response and thus allowing the residual error of the frequency response to be reduced to a minimum.

Summary

With the new Spurious Emissions application, the Spectrum Analyzer R&S®FSU and the Signal Analyzer R&S®FSQ offer a user-friendly and time-saving function for measuring spurious emissions. In combination with their low displayed average noise level and outstanding dynamic range, the analyzers are the first choice for this task.

The Spurious Emissions application is available as part of the basic software package for the R&S®FSU as of version 3.51 and for the R&S®FSQ as of version 3.55.

Richard Eßbaumer

More information, data sheets and the Application Note 1EF45 at www.rohde-schwarz.com (search terms: FSU / FSQ / 1EF45)

Application Note 1EF45

REFERENCES
[1] Spurious Emission Measurement on 3GPP Base Station Transmitters. Application Note 1EF45 from Rohde & Schwarz
[2] Technical Specification TS 25.141 V6.2.0, 3rd Generation Partnership Project (3GPP) Technical Specification Group, Radio Access Network, Base Station (BS) conformance testing (FDD) (Release 6)

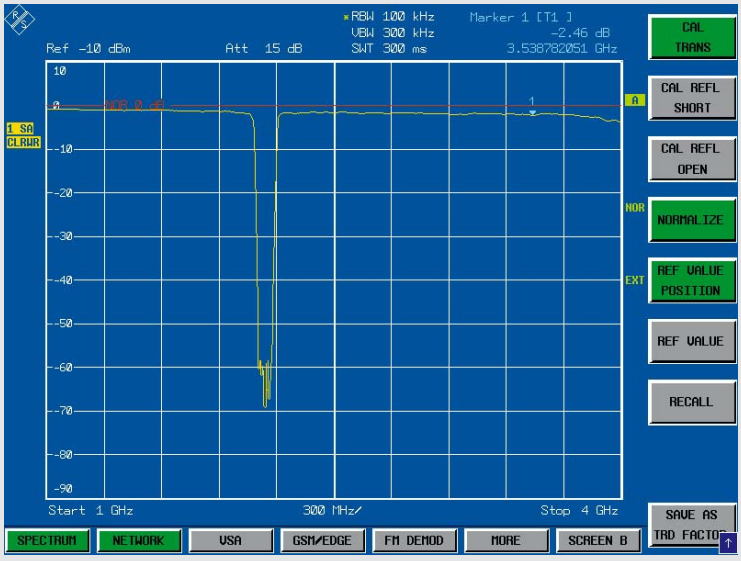


FIG 6 **Measured frequency response of the notch filter used for carrier suppression.**

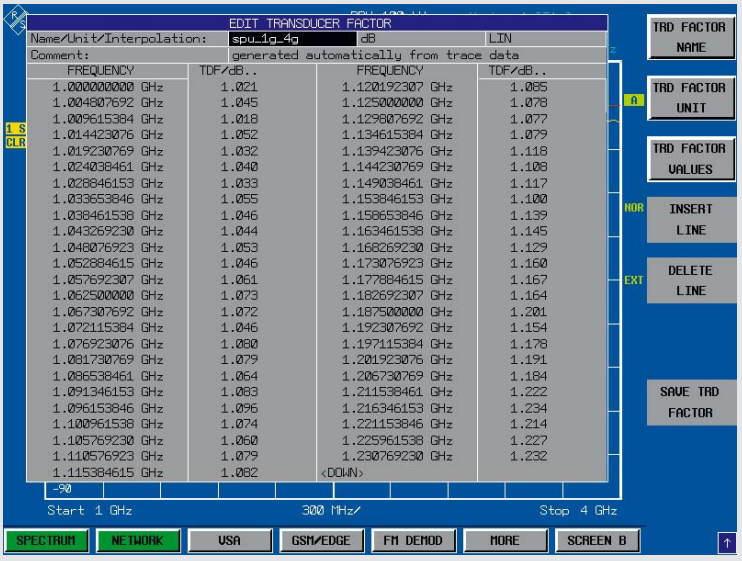


FIG 7 **Transducer automatically generated with SAVE AS TRD FACTOR.**

Power Meter R&S®NRP

Gated measurements made easy

Due to signal-synchronized gates and graphical display of the power envelope, power measurements on pulsed RF signals have become simpler than ever with the Power Meter R&S®NRP (FIG 1). This article describes the operation of the Gates function in the Scope mode using a TDMA signal as an example and shows that this mode is indispensable for power measurements when developing modern communications standards.

FIG 1 The Power Meter R&S®NRP can handle development and production problems with great ease. It has the right sensor for every task.

Representation of a signal in the time domain

Modern mobile radio system designs increasingly use time division multiple access (TDMA) standards, since they are much better at exploiting the capacity of transmission channels. Using this method, the information for the individual voice and data channels is output in compressed form in timeslots. Several consecutive timeslots in such a TDMA system form an entire frame. After the frame is transmitted, the process generally resumes with the first timeslot.

The power within one or more timeslots is of interest when developing such mobile radio systems or when troubleshooting. With respect to these requirements, the most appropriate sensor needs to be selected. Conventional thermal power sensors cannot adequately measure complex signal characteristics of this type, since they cannot delimit specific areas of power contribution in a timeslot, e.g. the data section of a GSM burst [1]. It is also not possible to separately measure the burst power of the individual timeslots in a frame, as thermal sensors average

the RF power occurring over the entire frame. This is because thermal sensor operation involves converting power into heat. Sampling the power envelope over time – which is feasible with diode sensors – is also not possible with thermal sensors. In contrast to diode sensors, thermal sensors have an inherently lower dynamic range. However, diode sensors always include signal details such as overshoots, interference pulses and glitches as well as signal edges of a pulsed RF signal in the measurement in proportion to their power.

The Power Meter R&S®NRP makes it easy to avoid these effects, since its intelligent diode sensors (R&S®NRP-Z11 or -Z2x) enable the R&S®NRP to display power versus time like an oscilloscope. This means that you do not miss a single detail of the signal you want to investigate. Furthermore, you can add timeslot and gate structures to your pulsed RF signals and configure them. To do this, you merely have to change to the Gates or Timeslot mode of the Scope mode. By graphically editing the gates added to the Scope window, you can selectively suppress unwanted components at the beginning and end, which occur, for example, in the transition between two timeslots. You can thus systematically delimit and measure signal components of interest. Extensive trigger functions, derived from an external source or from the test signal, ensure stable conditions. When the R&S®NRP is set to internal triggering, it can perform stable triggering of the pulsed RF signal down to a threshold value of –40 dBm without any problem. The R&S®NRP with its R&S®NRP-Z11 or -Z2x power sensors truly excels due to its wide dynamic range and due to the fact that it can perform time domain measurements down to –50 dBm at a video bandwidth of 100 kHz [2].

Up to four gates in the Scope mode

Just how easy the Gates function is to use in the R&S®NRP's Scope mode can be seen by looking at a GSM/EDGE signal, whose eight 577 µs timeslots form a 4.615 ms frame. In the Scope mode, you can define up to four different gates. For each gate, the R&S®NRP can display the average power (Avg), the peak value in the display (Peak) and the Peak/Avg ratio as numeric values [3].

The power meter's capability to create and display the ratio of the gated measurement results of two different sensors is unprecedented in the field of modern power measurements (FIG 3). This capability makes it quite simple, for example, to measure the gain or gain compression of a power amplifier in specific sections of a test signal and display the result together with the envelope. This feature is also very useful when determining the return loss of an amplifier.

Unbeatable dynamic range: Timegate and Timeslot modes

If the Scope mode's excellent dynamic range* is not sufficient, the dedicated Timegate and Timeslot modes provide an even more impressive dynamic range of 85 dB [4]. To use the modes, you merely have to change to one of them after you set all necessary parameters in the Scope mode in the R&S®NRP's Sensor menu. You do not even need to transfer the marker positions manually, since the power meter automatically sets them in the appropriate entry field in the Timegate mode. The Timeslot mode is actually a special case of the Timegate mode in which a repeating gate is configured that can be shifted timeslot by timeslot in the frame structure. You can define the frame length by entering the number of timeslots and thus easily measure the power of the individual timeslots in a GSM/EDGE frame by switching the timeslot counter.

Gates in the Scope mode provide you with the required overview of your designs

The R&S®NRP's Scope mode is an excellent tool in many areas of development. The integrated Gates measurement function helps you to develop future communications standards faster and better. The R&S®NRP is an indispensable tool because it enables you to visualize burst and pulsed signals, exactly delimit specific areas of power contribution, and measure their power with great precision.

Dr Markus Banerjee

* 70 dB, power vs time, 256 points (external trigger).

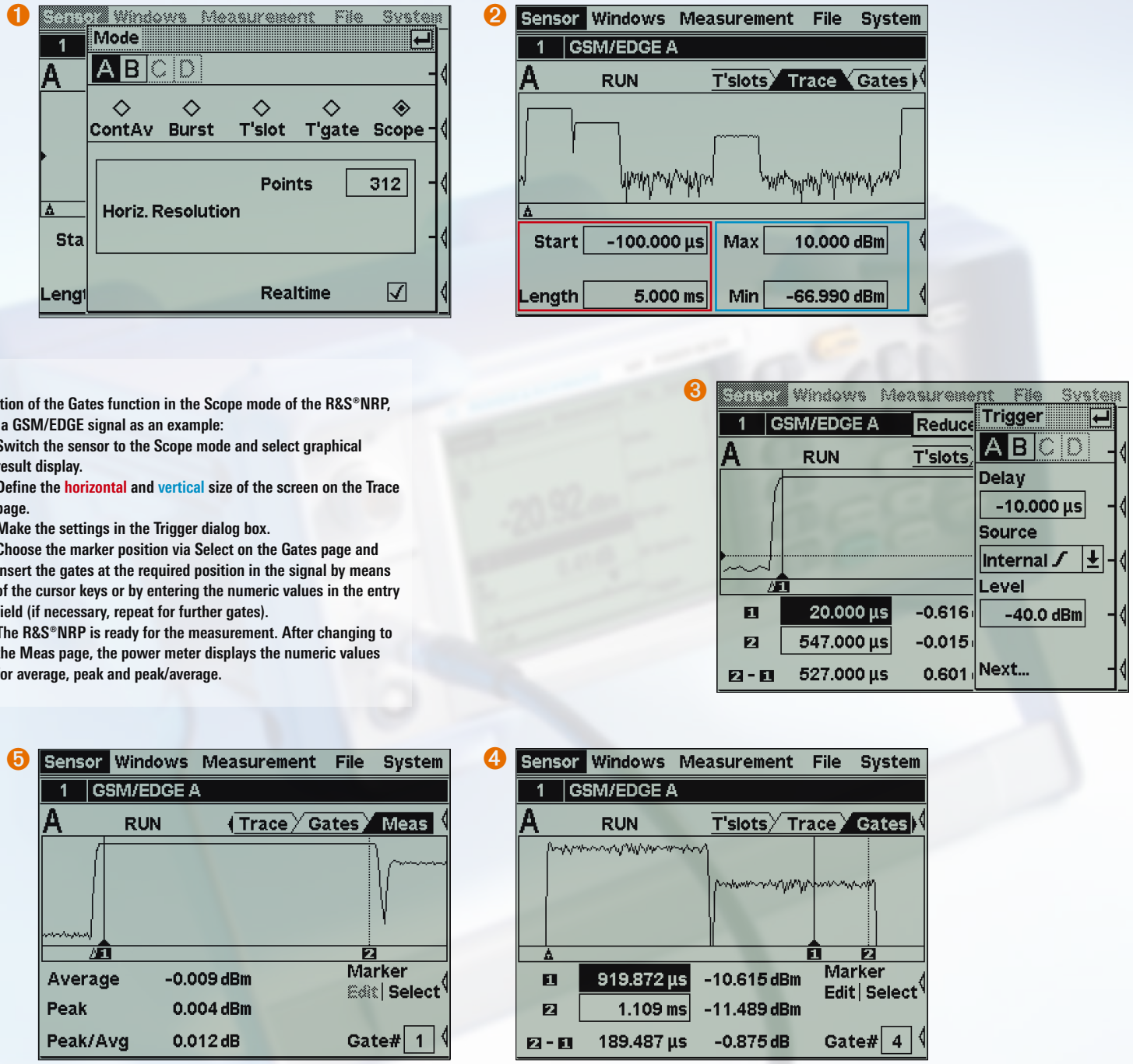


FIG 2
Operation of the Gates function in the Scope mode of the R&S®NRP, using a GSM/EDGE signal as an example:

1. **Switch the sensor to the Scope mode and select graphical result display.**
2. **Define the horizontal and vertical size of the screen on the Trace page.**
3. **Make the settings in the Trigger dialog box.**
4. **Choose the marker position via Select on the Gates page and insert the gates at the required position in the signal by means of the cursor keys or by entering the numeric values in the entry field (if necessary, repeat for further gates).**
5. **The R&S®NRP is ready for the measurement. After changing to the Meas page, the power meter displays the numeric values for average, peak and peak/average.**

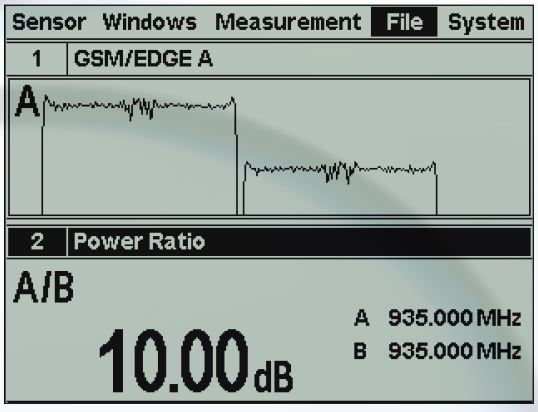


FIG 3
Display of a section of the envelope power in the Scope window together with the ratio of the gated measurement results of two different sensors.

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

REFERENCES

[1] Power Measurements on GSM/EDGE Signals with an R&S®NRT Power Reflection Meter. Application Note 1GP47 from Rohde & Schwarz (2001)

[2] See data sheet for details

[3] Operating manual for the Power Meter R&S®NRP

[4] Power Meter R&S®NRP: Evolution in power measurement – intelligent sensor technology. News from Rohde & Schwarz (2002) No. 174, pp 12–16

Measuring Receiver R&S®FSMR

Single, compact instrument for calibrating signal generators

The new Measuring Receiver R&S®FSMR (FIG 1) is the first instrument to combine a wide variety of functions for signal generator calibration in a single, compact instrument. Featuring excellent characteristics in measurement accuracy and measurement speed, it is ideal for use in calibration labs as well as for mobile applications.

Complete calibration test setup in one instrument

One of the primary tasks when calibrating signal sources or attenuators is the highly accurate measurement of RF power traceable to calibration standards. Although power meters are best suited for this purpose, their intrinsically limited dynamic range only allows precise measurements of relatively high levels. Very low levels, wide dynamic range or high attenuation require frequency-selective methods.

Rohde&Schwarz has now introduced an instrument with outstanding characteristics for calibrating signal generators and attenuators – the Measuring Receiver R&S®FSMR. With a maximum upper frequency limit of 50 GHz, it is the first solution to combine a wide range of different equipment in a single, compact measuring instrument:

- High-precision measuring receiver
- Power meter
- Modulation analyzer
- High-end spectrum analyzer

The Measuring Receiver R&S®FSMR is based on the spectrum analyzers of the R&S®FSU [1] family. To ensure highly accurate level measurements, all components that may cause level error or level drift are systematically switched off or bypassed in the measuring receiver mode. Demodulating analog-modulated signal sources via digital signal processing has long been possible with the spectrum analyzers from Rohde&Schwarz. High-precision power measurements are performed by using a power sensor from the R&S®NRP family that is connected directly to the receiver. An audio input for frequencies up to 1 MHz complements the scope of functions. The conventional image of a test setup consisting of multiple instru-

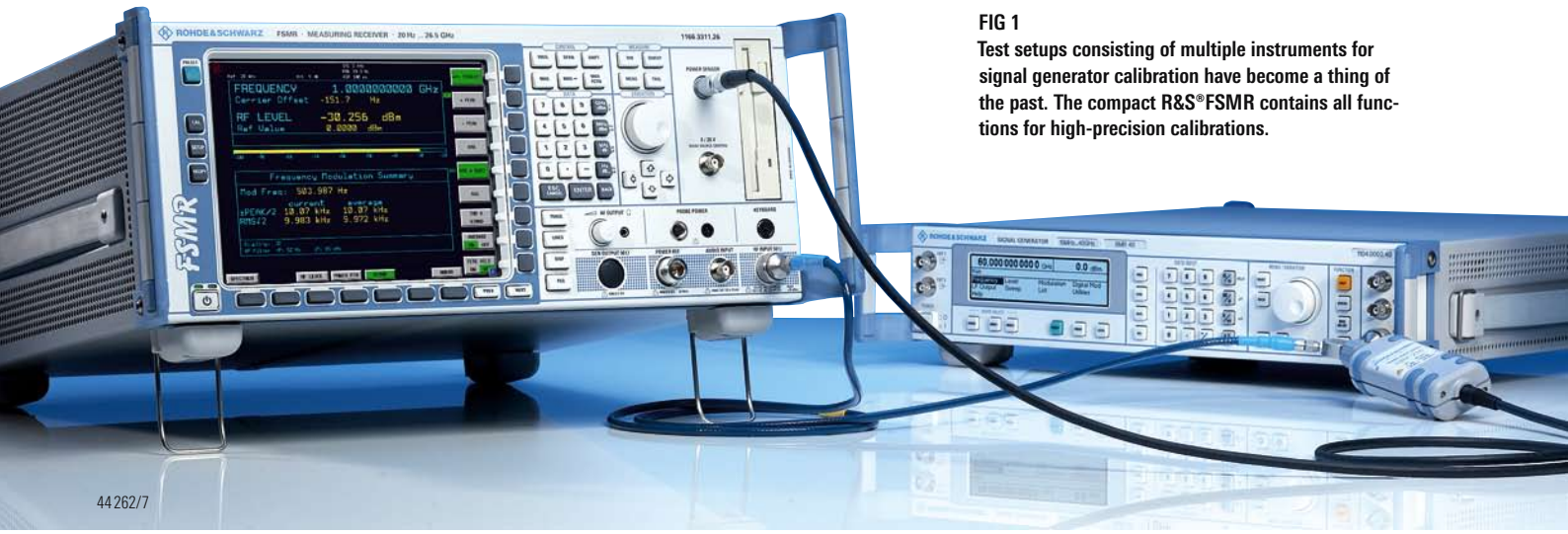


FIG 1
Test setups consisting of multiple instruments for signal generator calibration have become a thing of the past. The compact R&S®FSMR contains all functions for high-precision calibrations.

ments for signal generator calibration has become a thing of the past. The R&S®FSMR's minimum space requirements, compact design and low weight also make it ideal for mobile use.

The measuring receiver achieves its full dynamic range by automatically switching the measurement range and correcting the resulting error by again referencing to the power meter (FIG 2).

Three measurement ranges and early switchover at good signal-to-noise ratios enable the R&S®FSMR to achieve virtually constant measurement accuracy across the entire measurement range

Measurement uncertainty at the limits of verification

Highly accurate level measurements across a wide dynamic range are definitely one of the most demanding measurement tasks when calibrating signal generators and attenuators. Apart from a measuring receiver, you previously needed additional downconverters and generators. The R&S®FSMR makes these setups unnecessary. Depending on the model, its RF input seamlessly covers the frequency range from 20 Hz to 3.6 GHz, 26.5 GHz or 50 GHz; all necessary converters are already integrated in the instrument.

Modern signal generators provide output levels of +10 dBm to –130 dBm, which must be accurately measured by the receiver. Power sensors undoubtedly yield the most precise measurement results; however, their wide bandwidth limits their use to levels above approx. –50 dBm. At lower levels, you have to use a frequency-selective measuring receiver whose absolute level error is corrected by a power meter. The measurement bandwidth and the noise figure of the receiver determine the lower measurement limit of the level measurement; the measurement error mainly depends on the display linearity of the receiver. The R&S®FSMR digitizes the input signal after it has been converted to the IF by means of a fast A/D converter. A patented dither method from Rohde & Schwarz ensures extremely high linearity of the digital IF signal. Further processing such as IF filtering, logarithmic conversion or power calculation is purely digital in ASICs so that virtually no additional measurement errors occur.

Level measurement procedure with adjacent-range calibrations

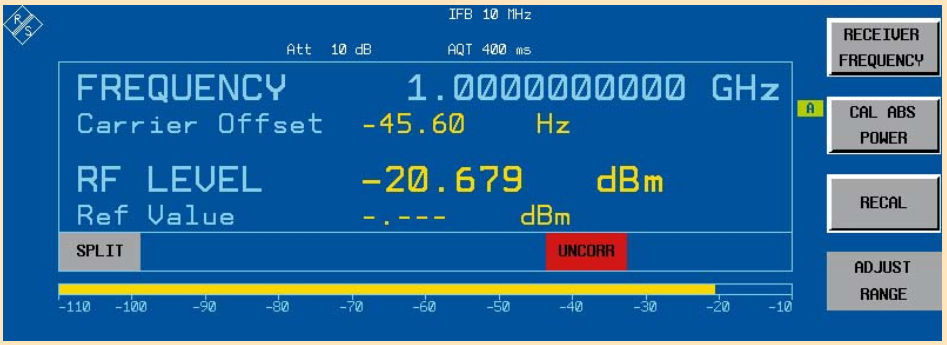


FIG 2a If no absolute calibration has been performed, the R&S®FSMR activates the red UNCORR field to warn you that the measurements may be inaccurate.

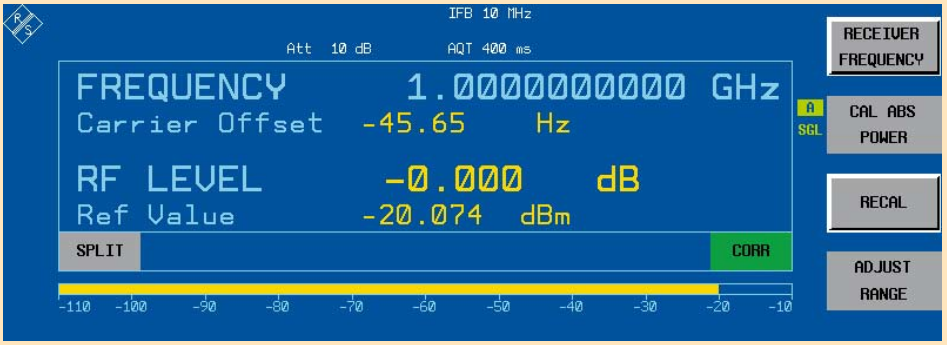


FIG 2b After absolute calibration with the power meter, the measuring receiver is ready for high-precision level measurements, which is indicated via the green CORR field.

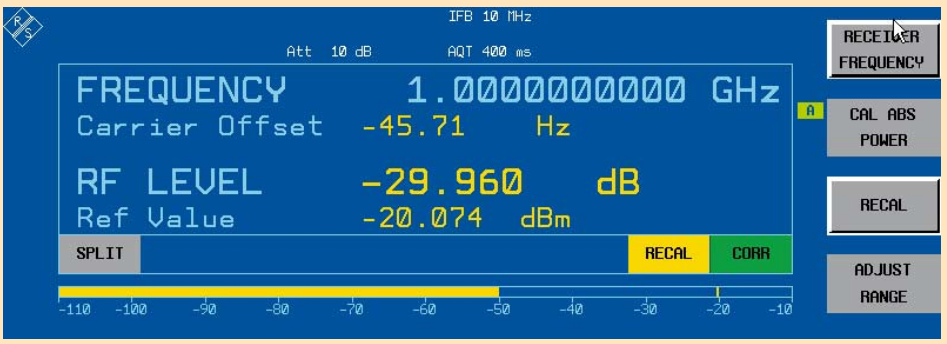


FIG 2c If the level is changed and the measurement range limits have been reached, the R&S®FSMR activates the yellow RECAL field to inform you that you need to calibrate the adjacent range.

(>140 dB) (FIG 3). You can verify the measurement accuracy by using, for example, calibrated attenuators whose attenuation is traceable to national standards. Rohde & Schwarz offers the Calibration Kit R&S®FSMR-Z2 for this purpose; it consists of several attenuators certified by the German Standards Laboratory (PTB).

Modulation measurements and audio analysis

The calibration of a signal generator usually also requires extensive measurements of analog modulation parameters such as AM, FM and φM and their distortion such as signal-to-noise and distortion (SINAD) or total harmonic distortion (THD). In addition to the modulation parameters of the RF signal, the quality of the modulation signal (audio signal) has to be measured. To make this possible, the R&S®FSMR comes with a complete modulation analyzer [2]. The receiver measures either the demodulated RF signal or the AF signal at the high-impedance audio input. Its digital demodulation of the input signal ensures unprecedented accuracy and flexibility – special calibration signals are not required. All common filters (highpass and lowpass filters), detectors (+peak, –peak, RMS, AVG) and deemphasis are available for audio analysis. Modulation distortion is simultaneously measured as THD and SINAD; tuning to the fundamental frequency is performed automatically within the measurement bandwidth.

The modulation analyzer in the R&S®FSMR offers a wide variety of straightforward result displays (FIG 4). In addition to displaying pure numeric values, you can also choose between time-domain display (FIG 5) and spectral display of the modulation signal. Several consecutive results can also be averaged.

High-end spectrum analyzer

To calibrate signal generators, the frequency and level as well as the spectral purity of the output signal (phase noise, harmonics) must be determined. These measurements call for a high-end spectrum analyzer, which the Measuring Receiver R&S®FSMR already includes. It is based on the tried-and-tested R&S®FSU family of instruments, which offers a wide variety of functions and technical features.

Maximum flexibility, yet easy to operate

Instruments with a wide variety of functions pose a challenge for the operating concept. The R&S®FSMR provides a very good solution: You can always directly access its main operating modes via hotkeys at the bottom of the screen. This makes menu structures flat and allows you to almost always access important settings via the main menu. Operating the R&S®FSMR is thus very similar to operating a conventional instrument with function keys on the front panel.

The R&S®FSMR automatically uses the optimum settings for each measurement. However, you are free to configure everything manually to ensure the maximum possible measurement accuracy for specific tasks. This flexibility is required, for example, when calibrating signal generators with large residual FM where a wider measurement bandwidth is necessary in order to accurately measure the level of the signal generator. The R&S®FSMR offers bandwidths up to 10 MHz, which also enable it to measure sources with low frequency stability. You can save all instrument settings as a configuration for later use. Storage media are the disk drive or USB memory sticks. You can remote-control the measuring receiver either via IEC/IEEE bus or a LAN interface.

Future-proof due to digital concept

The R&S®FSMR does an excellent job of meeting the increasing demand for compact calibration instruments. As a combination of a spectrum analyzer and a measuring receiver, it is a universal solution for numerous measurement tasks. The digital implementation of all primary parts of the circuitry allows the R&S®FSMR to be adapted to future requirements at any time simply by updating its firmware.

Kay-Uwe Sander

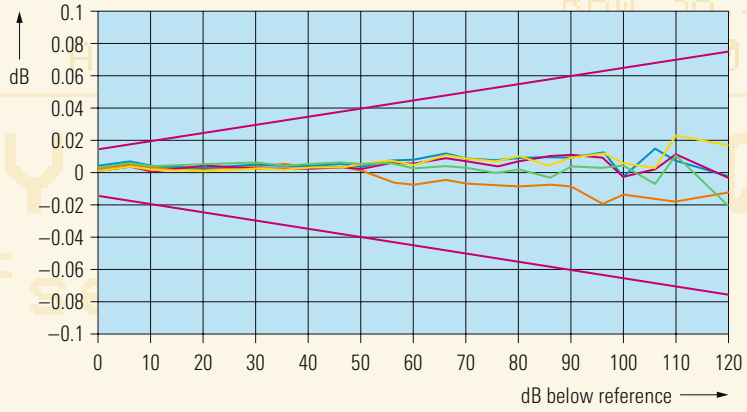


FIG 3 Typical measurement results of a level measurement across a wide level range and comparison with the limit values of the industrial standard.

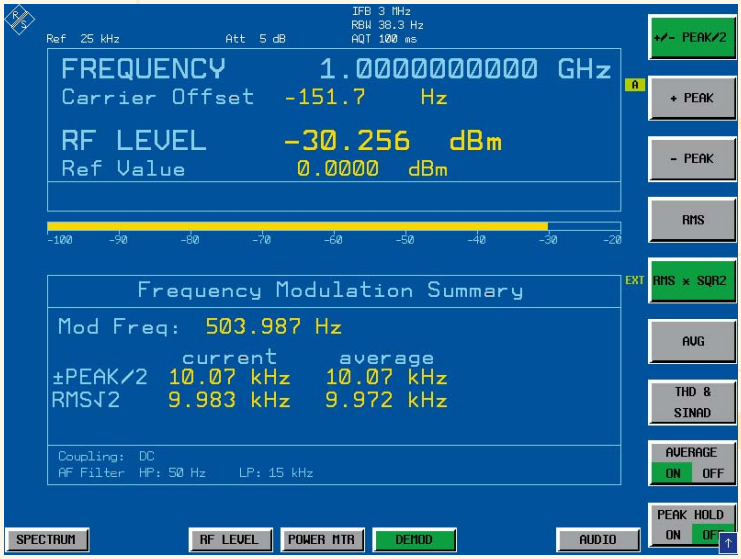


FIG 4 Frequency modulation measurement with the R&S®FSMR: All measurement results such as signal frequency error, input level, modulation frequency and modulation deviation are clearly displayed.

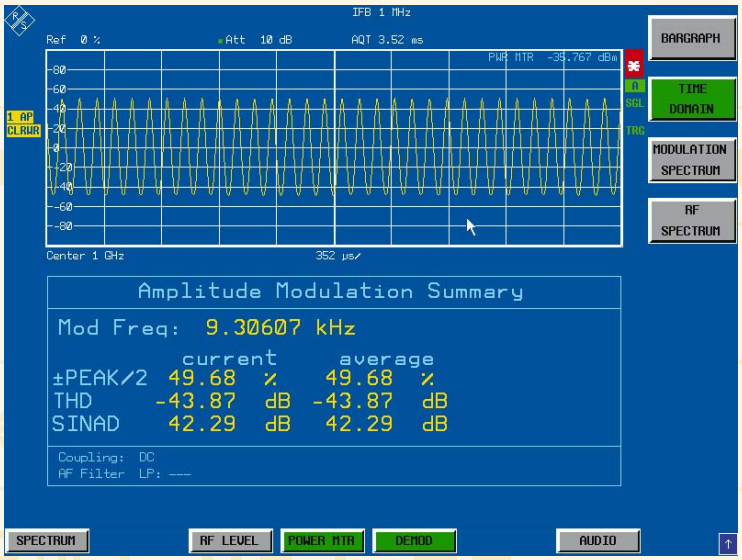


FIG 5 Amplitude modulation measurement: The R&S®FSMR measures the modulation depth and modulation frequency and can also determine the averaged modulation values if needed. The demodulated audio signal is displayed in the time domain.

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

R&S®FSMR product brochure and specifications

REFERENCES

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

[2] Spectrum and Signal Analyzers R&S®FSP / FSU / FSQ: Extended measurement functions for analog modulation analysis. News from Rohde & Schwarz (2004) No. 183, pp 24–25

Condensed data of the R&S®FSMR

Frequency range	20 Hz to 3.6 GHz / 26.5 GHz / 50 GHz
Level range	+10 dBm to –130 dBm
Level measurement uncertainty	0.01 dB + 0.005 dB per 10 dB
Demodulation	AM / FM / φM
AF frequency range	0 Hz to 100 kHz
Frequency deviation	max. 400 kHz
AM modulation depth	0 % to 100 %
Measurement uncertainty	1 %
THD, SINAD measurement range	0 dB to 80 dB

Audio Analyzer R&S®UPV

Interface for the I²S serial data bus

The compact Audio Analyzer R&S®UPV smoothly handles any audio measurement. With features that are as advanced as technically possible, it is predestined for high-resolution digital media and meets the stringent requirements of analog technology [*]. By means of two rear extension slots, it can be adjusted to rapidly changing technical developments. Brand-new is the interface extension for the I²S bus, which is gaining ground worldwide. This option allows direct audio measurements on a wide variety of components and modules with maximum precision.

The R&S®UPV: always state-of-the-art

Today, we take it for granted that digital audio equipment can be interconnected via standardized interfaces. With professional equipment, the AES/EBU format has become standard; with consumer equipment, the S/P DIF interface is used.

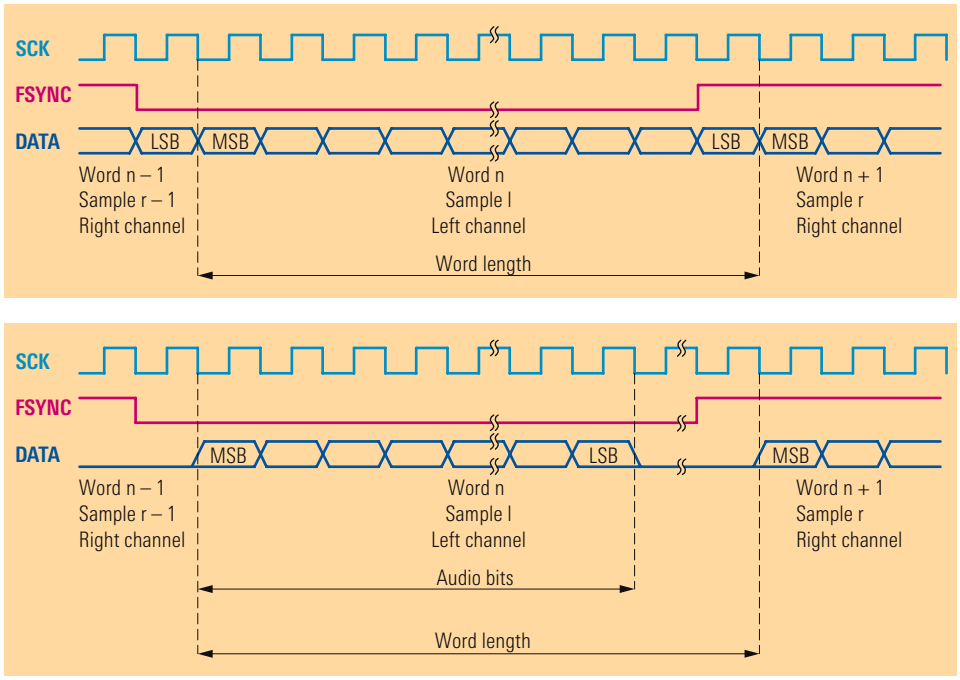
However, if you take a close look at how individual modules and components are interconnected inside such audio equipment, you will usually find other serial data interfaces. Over the last few years, a serial data bus referred to as the inter-IC sound bus (I²S bus) has been gaining ground. This digital interface is often used throughout the world for dual-channel, device-internal audio data transmission; numerous audio A/D and D/A converters support this format.

The Audio Analyzer R&S®UPV with its new I²S Interface R&S®UPV-B41 is even more versatile. It can be inserted at the rear and adds new audio interfaces. This new option enables the R&S®UPV to perform measurements directly on digital audio components, making it a compact development tool that is unique in its class.

The I²S format in detail

Three signals have been defined as standard for the I²S interface: SCK (bit clock), FSYNC (frame synchronization) and DATA (FIG 1). SCK (often also referred to as BCLK) is the bit clock of this interface. One audio data bit is transmitted with each clock period. DATA is a dual-channel, multiplexed, bit-serial data stream. FSYNC (often also referred to as LRCLK)

FIG 1 Top: Basic signal characteristic at the I²S interface. Bottom: For measurements with reduced resolution, the number of audio bits can be set between eight and 32 in a data word; the remaining data bits in the generator are set to zero.



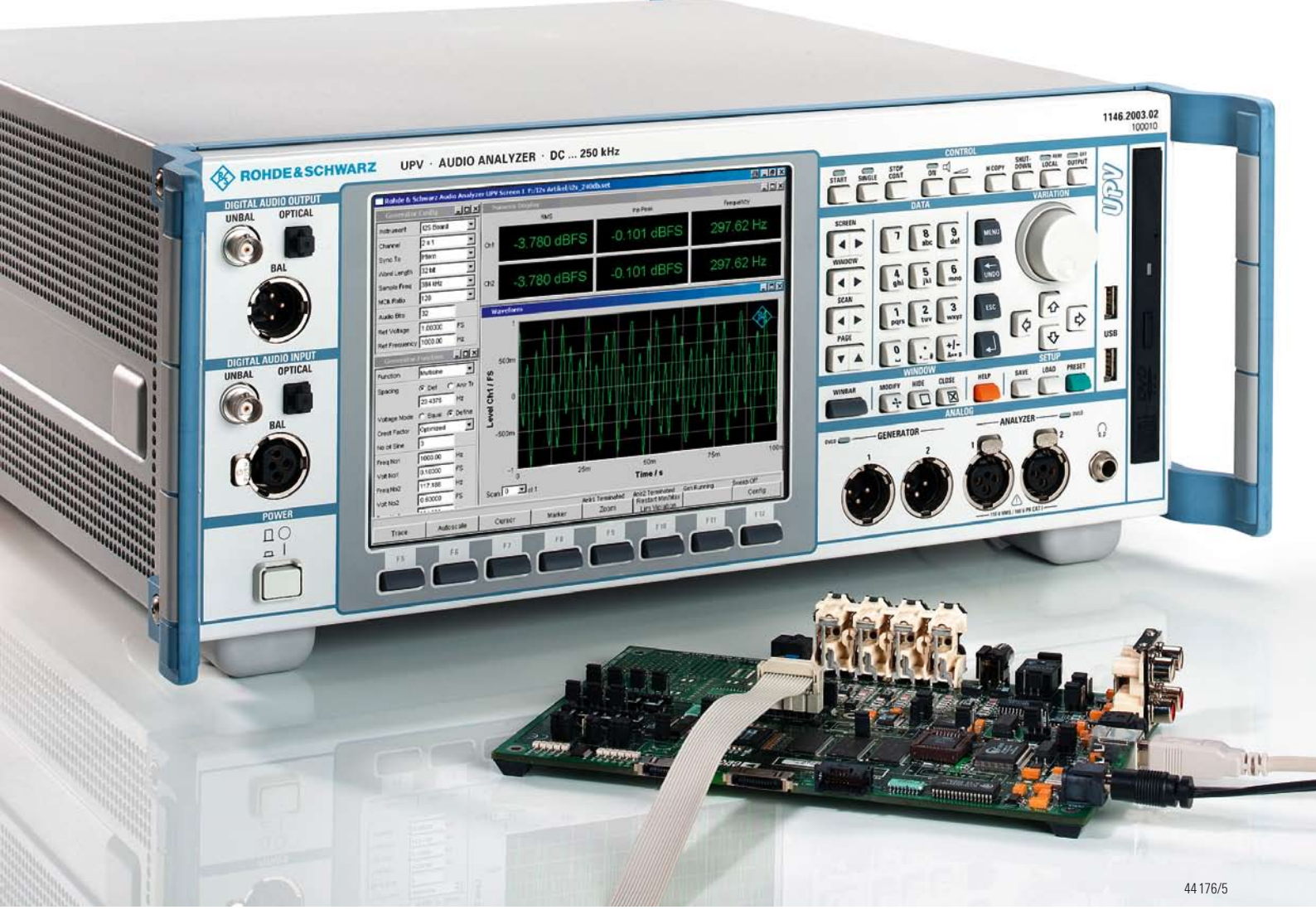


FIG 2 The Audio Analyzer R&S®UPV with its new I²S Interface R&S®UPV-B41 is even more versatile (measurement on a digital audio module shown here).

marks the beginning of a word in the serial data stream and differentiates the left from the right channel.

The receiver clocks in the FSYNC and DATA signals at each rising edge of the SCK signal. The transmitter changes these signals at the falling edge. Thus, you obtain virtually ideal sampling in the center of a bit window, making the transmission immune to any skew of individual signals.

In the simplest scenario, a transmission component generates clock, frame synchronization and data. In more complex systems with several transmitters and receivers, it may be necessary to centrally generate the system clock to ensure interference-free data transmission. For this reason, the I²S interface for the R&S®UPV uses either internal (master) or external (slave) synchronization.

Special to the I²S format is that the FSYNC edge transition already occurs one clock before the transmission of the first data bit of a word. This offset permits synchronous switching logic in a transmitter that is operated as a slave. Serial data is transmitted with MSB first. Two's complement is used as the numerical format.

Depending on the application, I²S formats with different word lengths are used. The R&S®UPV-B41 can be set to I²S data streams with all usual word lengths of 16 bits, 24 bits and 32 bits.

Audio measurements with maximum precision

FIG 2 shows a typical application of the audio analyzer with the I²S interface: To evaluate a digital audio circuit, the DUT is connected directly with the analyzer. The data word length of up to 32 bits helps to achieve unprecedented spectral purity, making it possible to perform audio measurements with maximum precision (FIG 3).

If audio data streams with reduced resolution are to be tested in high-resolution

I²S formats, the number of audio bits in a data word can be set between eight and 32, while the remaining data bits in the generator are set to zero (FIG 1). For the measurement, the analyzer evaluates only the selected number, starting from the MSB.

The sampling rates of the generator and the analyzer can be set individually. Plus, all audio interfaces in the R&S®UPV – both in the analog and the digital domain – can be activated individually. Thus, a wide variety of modules and components such as A/D and D/A converters, DSPs, sampling rate converters, format converters and numerous other interface components can be directly connected. Some of these components require a master clock that is an integer multiple of the FSYNC signal. The R&S®UPV can either generate this master clock or synchronize itself to it.

Summary

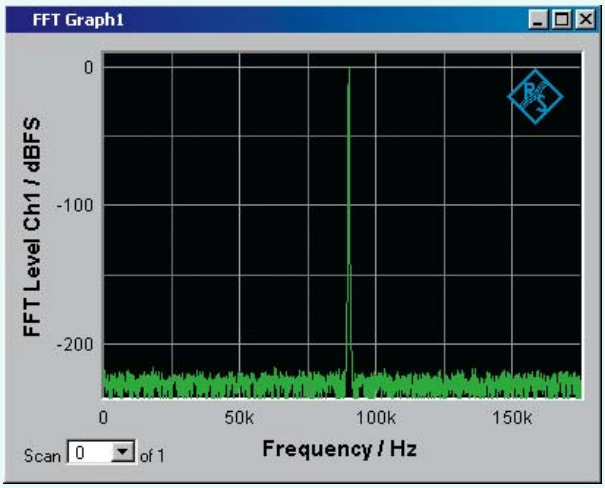
With the new I²S Interface R&S®UPV-B41 option and the R&S®UPV-B2 option for sampling rates up to 192 kHz (which has been available since the R&S®UPV 's market launch), the Audio Analyzer R&S®UPV covers a major part of analog and digital audio measurements. Other interfaces are in the pipeline.

Norbert Hersch

Important abbreviations

AES/EBU	Audio Engineering Society / European Broadcasting Union
BCLK	Bit clock
FSYNC	Frame synchronization
I²S	Inter-IC sound bus
LRCLK	Left right clock
LSB	Least significant bit
LVTTL	Low voltage TTL
MSB	Most significant bit
SCK	Serial clock
S/P-DIF	Sony/Philips digital interface format

FIG 3
Data word lengths up to 32 bits for audio measurements with maximum dynamic range.



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

REFERENCES
[*] Audio Analyzer R&S®UPV: The benchmark in audio analysis. News from Rohde & Schwarz (2004) No. 183, pp 16–20

Condensed data of the I²S Interface R&S®UPV-B41

Input

Level	low: <0.8 V (min. –5 V) high: >2 V (max. 10 V)
Word length	16 / 24 / 32 bits / channel
Audio bits	8 to 32
Word clock	6.75 kHz to 400 kHz

Output

Level	LVTTL
Word length	16 / 24 / 32 bits per channel
Audio bits	8 to 32
Word clock	6.75 kHz to 400 kHz
Synchronization	internal clock; external word clock or master clock
Master clock	432 kHz to 51.2 MHz

Signal Analyzer R&S®FSQ

EVM measurements on ZigBee signals

The ZigBee™ standard (IEEE 802.15.4) defines a system for data transmission at low data rates and duty cycles with long pauses. ZigBee products can be used for versatile applications such as building automation, industrial facilities, or for light and thermostat control at home. This article explains how to perform EVM measurements on ZigBee signals by using the Signal Analyzer R&S®FSQ. For details on the new standard, see page 27.

Not every analyzer is suitable

The most important band for the recently adopted ZigBee standard is the global 2.4 GHz ISM band, for which it has been specified with 250 kbit/s on 16 channels. But also the European band at 868 MHz and the North American ISM band at 915 MHz are used. OQPSK modulation is performed in the 2.4 GHz band, and BPSK modulation in the 868 MHz and 915 MHz bands (FIG 1).

Standard vector signal analyzers can demodulate BPSK-modulated ZigBee signals that have been processed with RRC filters and determine the modulation quality. However, this differs from OQPSK-modulated ZigBee signals because ZigBee uses a special filter with an impulse response in the form of a half sine. In this case, conventional analyzers cannot be used, since they are usually not fitted with this filter and measurement demodulation therefore does not yield useful results.

Such measurements do not pose any problems for the universal Signal Analyzer R&S®FSQ from Rohde&Schwarz together with the option R&S®FSQ-K70: In combination, they can load user-definable modulation filters and are thus ideal for measurements on ZigBee OQPSK-modulated signals.

ZigBee air interface

OQPSK modulation is related to QPSK and operates with two bits per modulation symbol. With QPSK modulation, signal transitions occur at the origin of the I/Q diagram (zero crossings). This amplitude modulation calls for virtually linear amplifiers with correspondingly high power consumption.

RRC filters are usually used with OQPSK, and the I and Q transitions are shifted by half a symbol time to avoid such zero crossings. The special ZigBee filter eliminates amplitude modulation and converts the vector diagram of the OQPSK modulation to a circle. This makes the OQPSK modulation a modulation with constant envelopes (FIG 2, bottom diagram), similar to MSK.

Ready for ZigBee in no time

Baseband filters for ZigBee can be designed with the MatLab® simulation program, for example, and, by using Windows® FILTWIZ software, can be converted into a format readable by the R&S®FSQ. But there is an even easier way: You can download FILTWIZ, a ready-to-use ZigBee filter file plus a comprehensive Application Note [*] free of charge from the Internet pages of Rohde&Schwarz.

Important abbreviations

BPSK	Binary phase shift keying
EVM	Error vector magnitude
ISM	Industrial scientific medical
MSK	Minimum shift keying
OQPSK	Offset QPSK
QPSK	Quadrature phase shift keying
RRC	Root raised cosine

FIG 1 Modulation mode, modulation rate and baseband filtering in different frequency ranges in accordance with IEEE 802.15.4.

Band (MHz)	Frequency (MHz)	Chip rate (kchip/s)	Modulation	Baseband filter
868 / 915	868 to 868.6	300	BPSK	RRC
	902 to 928	600	BPSK	RRC
2450	2400 to 2483.5	2000	OQPSK	Half sine

Importing the filter file into the signal analyzer is child's play: Copy the file to a disk and insert the disk into the measuring instrument. By pressing the IMPORT FILTER key, the file is copied to the filter list of the option R&S®FSQ-K70. Next, set up the ZigBee demodulator with a transmit and receive filter by using the NEW USER SET function (in the MODULATION SETTINGS menu) and save it. The ZigBee filter is the transmit filter, NONE is the receive filter (similar to GSM).

The data rate in vector signal analyzers is usually entered as a symbol rate and not as a bit or chip rate. A chip rate of 2 Mchip/s thus corresponds to a symbol rate of 1 Msymb/s in the option R&S®FSQ-K70. After selecting the OQPSK modulation mode and the symbol rate (below MODULATION SETTINGS), the ZigBee measurement demodulation in the R&S®FSQ is ready for use.

EVM and other modulation characteristics

The ZigBee signal is like a pure, unfiltered MSK signal, which is why the side lobes are not attenuated and you have to perform demodulation using an appropriately large bandwidth. In the option R&S®FSQ-K70, the points/symbol setting together with the symbol rate determines the demodulation bandwidth. For the ZigBee demodulation, this oversampling factor should be set to a maximum value of 16 points/symbol. In combination with a symbol rate of 1 MHz, you obtain a demodulation bandwidth of 16 MHz (upper diagram in FIG 2).

FIG 3 shows a modulation error measurement with these settings. The constellation diagram is depicted in the upper diagram; the modulation parameters and modulation errors of the measurement signal are displayed in the table in the lower diagram.

Summary

New modulation modes and standards can be easily integrated into the measurement sequences of the option R&S®FSQ-K70 without requiring a software update. Modulation filters and the assignment of constellation points can be reloaded and the vector signal analyzer can be configured for new standards with little effort. The measurements are explained in detail in the Application Note 1EF55, which you can download.

Herbert Schmitt

More information, data sheet, Application Note, FILTWIZ and filter file at www.rohde-schwarz.com (search term: FSQ-K70)

REFERENCES

[*] Application Note 1EF55: EVM Measurements for ZigBee signals in the 2.4 GHz band

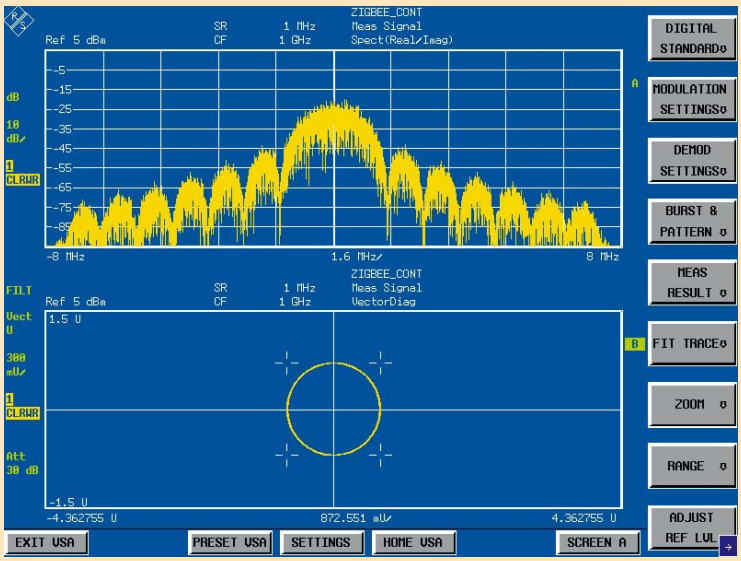


FIG 2 Spectrum and vector diagram of a ZigBee signal. Top: modulation spectrum of the measured signal; bottom: vector diagram of the measurement signal (constant envelope).

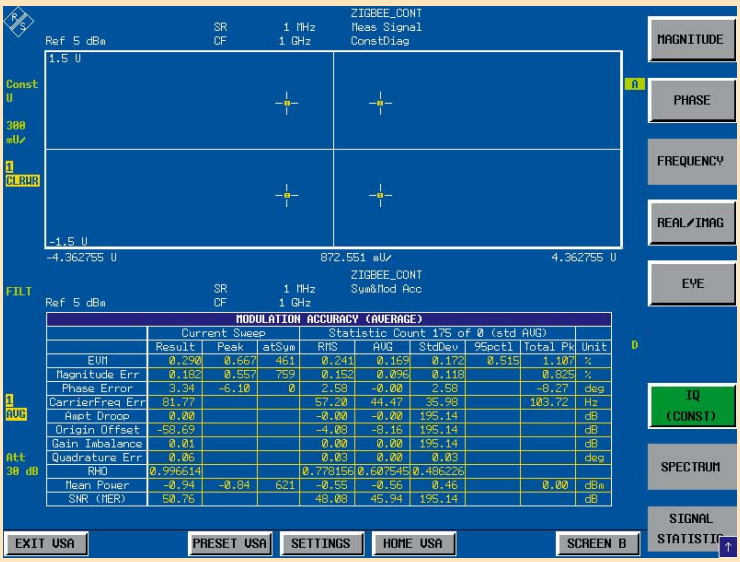


FIG 3 EVM measurement on a ZigBee modulation generated by using the Vector Signal Generator R&S®SMU200A: The very low residual EVM of <0.3 % is a prerequisite for exact EVM measurements. Top: constellation diagram of the measured signal; bottom: numeric modulation parameters and modulation errors.

The ZigBee standard at a glance

Designed for minimum power consumption and low costs

Low data rates have been deliberately defined in the ZigBee standard, since they contribute to favorably priced products which, in turn, allow sensors or machines to be inexpensively networked. Especially attractive, compared with *Bluetooth*®, is the lower power consumption, ensuring a battery operating time of several years. A power consumption in Sleep mode of only 0.1 µA makes it possible to implement applications previously inconceivable: For example, ZigBee break-in sensors installed in windows can be fed even by small solar cells.

ZigBee products have a typical range of approx. 10 m; their data rate is approx. 250 kbit/s (FIG 4).

Numerous applications

ZigBee technology is highly versatile – it can be used for light and thermostat control, for computer keyboards, but also for branched sensor networks, in facility management and so forth. In addition to star and tree structures, the standard also supports mesh networks (FIG 6). To inexpensively implement simple wireless connections with ZigBee products, both full function devices (FFDs) as well as reduced function devices (RFDs) have been specified that can only communicate with a ZigBee node.

Standardization and ZigBee Alliance

ZigBee is based on the IEEE 802.15.4 standard and was adopted on 16 December 2004 by the ZigBee Alliance. The ZigBee Alliance describes the protocol stack between the physical and the MAC layer (FIG 5) that is to ensure the interoperability among instruments from different manufacturers.

Although numerous semiconductor manufacturers have registered with the ZigBee Alliance, only relatively few products have been announced so far. Freescale, a prominent member, has already launched a transceiver (MC 13192), but also some smaller semiconductor manufacturers such as Chipcon (CC 2430), Atmel (Z-Link) or Ember (EM 2420) have already included products in their portfolio or stated that they will soon do so.

Market forecast

Five million units are forecast for 2005, and for 2008 as many as 150 million (source: Instat).

Martin Müller

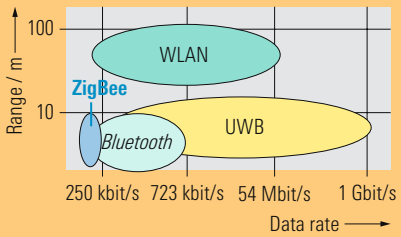


FIG 4 ZigBee compared with other methods.

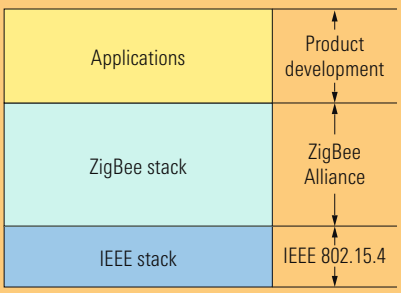


FIG 5 ZigBee layer structure.

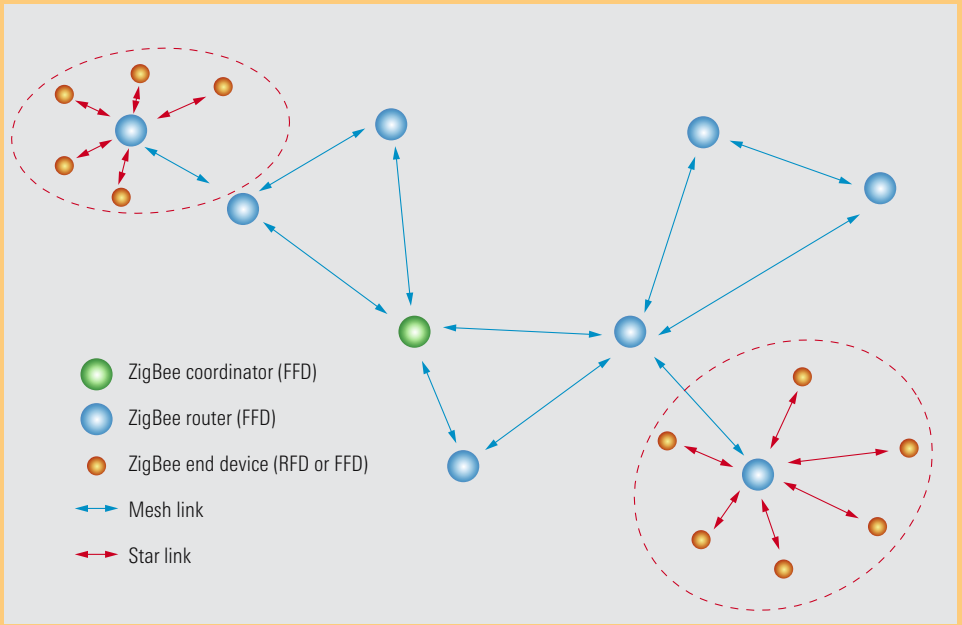


FIG 6 Examples of possible network structures in the ZigBee standard.

FIG 1 Test setup for fully automatic EMS and EMI measurements with the Integrated Measurement System R&S®IMS (model 04) and the EMI Test Receiver R&S®ESCI.

Integrated Measurement System R&S®IMS

A new era in systems solutions

The R&S®IMS is a compact and cost-efficient EMS measurement system that can be converted to a complete EMC test system merely by adding a few components. You can then perform measurements in compliance with all common commercial, military and automotive standards.

Cost-efficient alternative

Test systems for determining electromagnetic susceptibility (EMS) usually consist of separate instruments mounted in racks. These systems are effort-intensive since each one has to be planned and designed separately and their installation and configuration require a lot of work.

The new Integrated Measurement System R&S®IMS is a cost-efficient alternative that complements the tried-and-tested EMS test systems from Rohde&Schwarz. It is a compact instrument for performing development and acceptance test measurements from 9 kHz to 3 GHz in compliance with all common commercial, military and automotive standards. Users will like the R&S®IMS since they can create the test setup they want merely by adding a few components at comparatively low cost. The R&S®IMS offers everything needed in a modern EMC test system: signal source and signal switching, power measurement as well as control and switching for up to three amplifiers, including interlock. Owing to additional internal and external amplifier modules, it can be scaled to perform a wide variety of measurement tasks.

The R&S®IMS operating system is a fully compliant test software for cost-efficient, fully automated EMS and EMI measurements. You only have to add the EMI

Test Receiver R&S®ESCI or the precompliance Test Receiver R&S®ESPI (FIG 1) to the measurement system.

All important components installed

The Integrated Measurement System R&S®IMS is controlled via the standardized USB interface available in every state-of-the-art PC. The 19" cabinet houses all major components:

Signal generation

The integrated signal generator covers the frequency range 9 kHz to 3 GHz and offers the AM, FM, φM and PM analog modulation methods.

Power measurement

The Power Sensor R&S®NRP-Z91 is used to measure forward and reflected power and to monitor factors such as current for bulk current injection (BCI). A fast and wear-free PIN diode switch is used to switch between forward and reflected power and monitoring. Alternatively, you can also use several sensors to attain even higher measurement speed. For measurements in compliance with the ISO standard – for which a selective power meter is required – the cabinet offers enough space for an optional spectrum analyzer module.

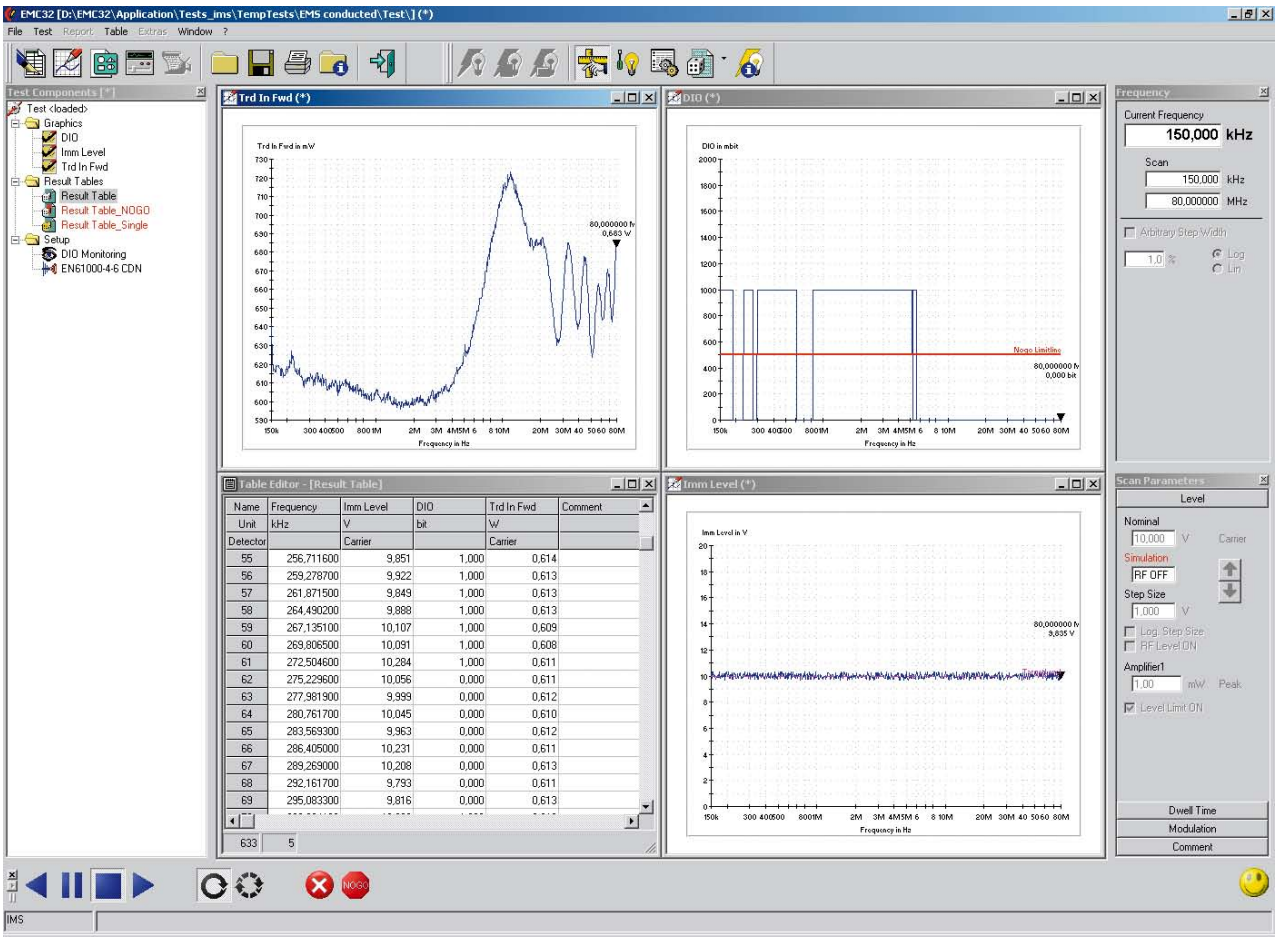
Switching unit

The switching unit switches all RF paths in the R&S®IMS for up to three amplifiers. Two amplifier outputs can be switched to two different transducers (e.g. antennas, current probes) or connection points (e.g. in anechoic chambers and shielded enclosures) by means of the optional transfer relay.

Amplifier

An optional internal amplifier with a frequency range from 9 kHz to 250 MHz is available for measuring conducted EMS. Up to two external amplifiers can be connected to supply the RF power for radiated and/or conducted EMS measurements. Amplifiers with an authorized USB remote-control interface can be easily integrated into the system. Amplifiers with an IEC/IEEE bus interface are controlled using the GPIB expansion.

FIG 2 User interface of the R&S®IMS operating system during an EMS test.



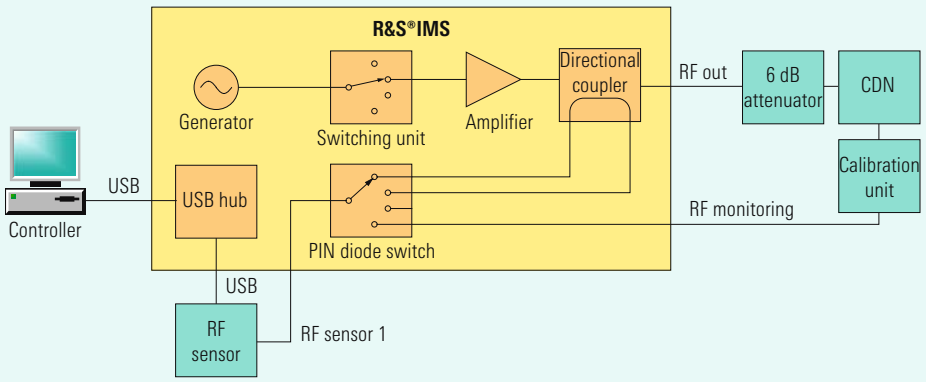


FIG 3 Setup for measurements in accordance with EN 61000-4-6 with coupling/decoupling network (CDN).

Safety functions

To ensure personal safety during an EMS test, the R&S®IMS offers an interlock and activation of a "Test in progress" lamp.

Digital inputs and outputs

The EUT is stimulated via four digital outputs on the R&S®IMS (static values or pulse signal). The EUT is monitored during the EMC test via four digital inputs on the measurement system. These inputs can be queried individually or together.

R&S®IMS operating system

Complete EMC package

The operating system, which is based on the established R&S®EMC32 software platform [1, 2], supports measurements performed on terminals, modules and integrated circuits to determine emission and susceptibility to conducted and radiated disturbance.

The intuitive user interface (FIG 2) makes learning and operating the instrument quick and easy. All measurement results are stored in an EUT-specific directory structure. Since the data format is open, results can also be processed and archived with other applications. You can open archived measurement results whenever needed and use them as a basis for final measurements. A report tool outputs the measurement data via a printer or stores it as a file (RTF, HTML, PDF).

Electromagnetic susceptibility

The operating system software contains all required measurement functions (closed-loop method, substitution method) for generating – together with the R&S®IMS hardware – the interference signals stipulated by commercial and automotive standards. Integrated control algorithms limit the susceptibility level during susceptibility tests, thus protecting the EUT and the test system against overloading.

Monitoring and stimulation

The most important tasks of EMS test software are to generate interference and to monitor and stimulate the EUT. The following integrated stimulus functions make it possible to control the EUT at defined points in the test sequence:

- Change the EUT to a defined state (e.g. switch it on or off) when a measurement is started or stopped.
- Trigger an action of the EUT at specific frequencies or at each test frequency and then check the EUT's response to the interference (by using the monitoring functions).
- Reset the EUT to a defined state after a malfunction has been detected.

The monitoring functions in the R&S®IMS operating system provide a fully automatic means of monitoring the EUT. Monitoring channels can be defined that indicate a GO/NO-GO (PASS/FAIL) depending on the test frequency and interference level. This includes measuring physical parameters (voltage, current, frequency, temperature) and acoustic (sound level) or visual (camera) monitoring. In the case of automotive tests, vehicular bus systems (CAN, LIN, MOST, FlexRay) can also be monitored.

The software displays the measured values in tables or graphs. An additional table contains only frequencies at which NO-GO was determined.

Application example

The following example shows how the R&S®IMS and a few additional components can be used to set up a complete EMS test system for measuring electromagnetic immunity to conducted signals in compliance with EN 61000-4-6. The system has a coupling/decoupling network (CDN) and provides a test voltage of 10 V. The following components are required for the measurement (FIG 3):

- Integrated Measurement System R&S®IMS model 04 with internal amplifier 9 kHz to 250 MHz, 25 W
- Power Sensor R&S®NRP-Z91
- USB Adapter R&S®NRP-Z4
- Controller
- Set of cables (RF and EUT monitoring)
- 6 dB attenuator
- CDN with calibration unit suitable for the EUT

System configuration

After installing the R&S®IMS operating system software and the USB driver on the controller, configure the test setup by using the integrated configuration wizard. This wizard handles all important settings and creates the test templates for calibration and measurement (FIG 4).

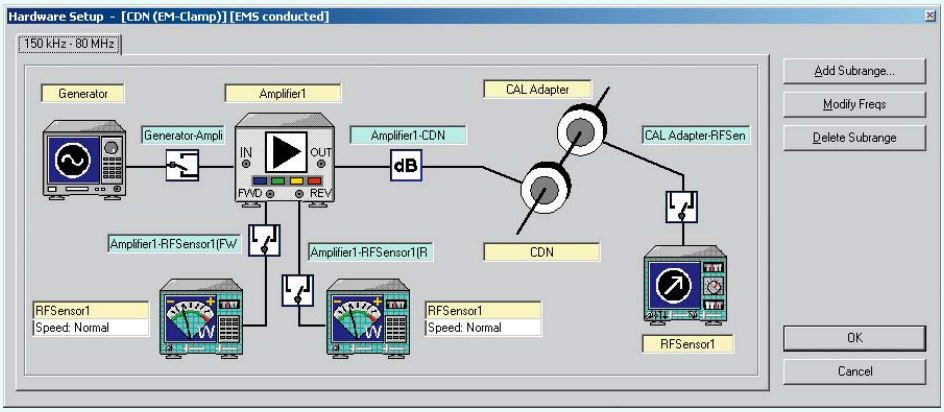


FIG 4 Measurement configuration via the convenient user interface of the R&S®IMS operating system.

System calibration

To ensure high measurement accuracy, you can measure all signal paths in the test setup by means of the power sensor and the integrated signal path calibration. Then perform the CDN reference calibration stipulated in the standard. In this case, the EUT output of the CDN is connected to the RF monitoring input of the R&S®IMS via the calibration unit. The required amplifier power for the nominal test voltage is then provided as the calibration result in a table.

EUT test

You are now ready to perform the actual measurement. EUT errors can be marked by the mouse or keyboard. You can also stimulate and monitor the EUT via the integrated EUT monitoring TTL interface.

The R&S®IMS software provides measurement methods for fully automatic acceptance testing as well as development measurements. You can stop a measurement at any time during the automatic frequency scan and interactively determine the immunity threshold. When the EUT monitoring TTL interface and the susceptibility method are used, the software provides a fully automatic means of determining maximum susceptibility as a function of frequency.

Summary

The Integrated Measurement System R&S®IMS can be converted to a complete, compact and cost-efficient EMC test system simply by adding a few components (such as amplifiers, transducers and antennas). A variety of options can be installed on the R&S®IMS to prepare it for different measurement tasks within development and certification. The operating system offers a standardized user interface for EMS and EMI measurements. Owing to its modular structure, the operating system can be easily configured and adapted to future changes in standards or manufacturer-specific test procedures. The instrument's hardware and software combine to form a future-proof investment.

Robert Gratzl; Xaver Sutter

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

R&S®IMS product brochure and specifications

REFERENCES

[1] EMC Measurement Software R&S®EMC32-A: Versatile EMS and EMI measurements for the automobile sector. News from Rohde&Schwarz (2003) No. 178, pp 36–40

[2] EMC Measurement Software R&S®EMC32: Comprehensive EMI and EMS measurements at a keystroke. News from Rohde&Schwarz (2001) No. 172, pp 27–29

EMI Test Receiver R&S®ESCI

Click rate analysis in accordance with CISPR 14

Thermostat- or program-controlled devices such as washing machines or air conditioners generate discontinuous interference, also referred to as click interference. Since this interference is aperiodic, reduced limit values – compared with those applicable to continuous interference – apply. To determine the extent of the specified limit values, manufacturers have to measure the time period of the clicks, their repetition rate (click rate) and their levels (FIG 1). CISPR 14 and EN 55014 [1] specify limit values for RFI voltage with a click rate weighting in the frequency range from 0.15 MHz to 30 MHz. Using the R&S®ESCI and the free-of-charge Click Rate Analyzer software, this is child's play.

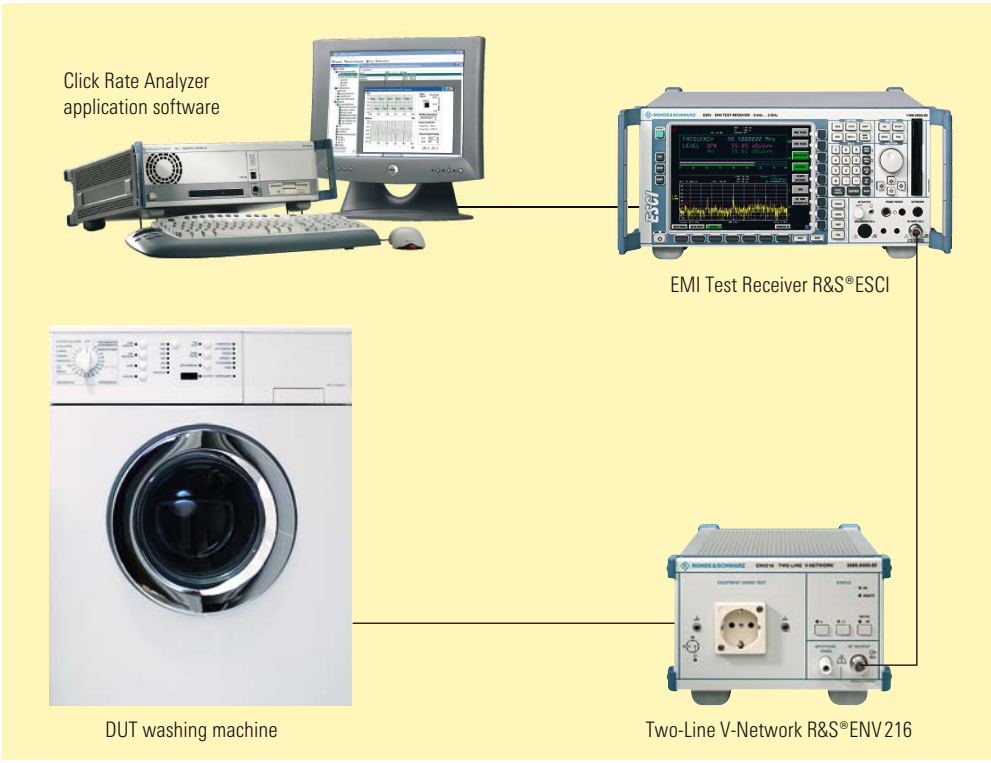


FIG 1 A V-network decouples the RFI voltage generated by the DUT.

Time domain measurements

The R&S®ESCI [2] includes a time domain analysis with settable observation time per measured value. Owing to the digitally implemented detectors, it obtains the measured values without any time gaps and stores them in the memory. They can then be zoomed, for example, and, if required, each of them can be analyzed in more detail by using the marker (FIG 2). In the time domain analysis, the memory has a capacity of 1.44 million values per trace and thus per detector. At a measuring time of e.g. 5 ms per measured value, the memory depth is large enough to simultaneously and seamlessly record the peak value and the quasi-peak value. Thus, the entire program of a washing machine can be evaluated for click interference.

Automatically with the Click Rate Analyzer software

To automatically evaluate the clicks with respect to dividing them into short clicks or long clicks, or for determining the click rate as specified in CISPR 14, use the Click Rate Analyzer Windows® application software, which you can download free of charge from the Rohde & Schwarz Internet pages.

This program uses the IEC/IEEE bus or the LAN interface (option R&S®FSP-B16) of the R&S®ESCI to transmit the peak and quasi-peak value levels that have been determined with a time resolution of 500 µs to the controller during the ongoing measurement.

The controller analyzes the measured values in realtime and updates all key results every second: click rate, number of clicks and, depending on this value, the increased limit value Lq (FIG 3). Experienced users can draw conclusions about the type of interferer by looking at the simultaneous display of the measurement time characteristics. The controller stores all individually measured values so that they can also be subsequently analyzed: By pressing a button, the display jumps to the individual click events.

The software can also record the measurement results. A conclusive test report includes statistical data as well as information about whether the exceptions specified in the standard were used (FIG 4). Last but not least, the significant PASSED or FAILED statement is also included.

All this information can be stored and reloaded together with the individually measured values; as a result, the measurement results remain reproducible and transparent.

Matthias Keller

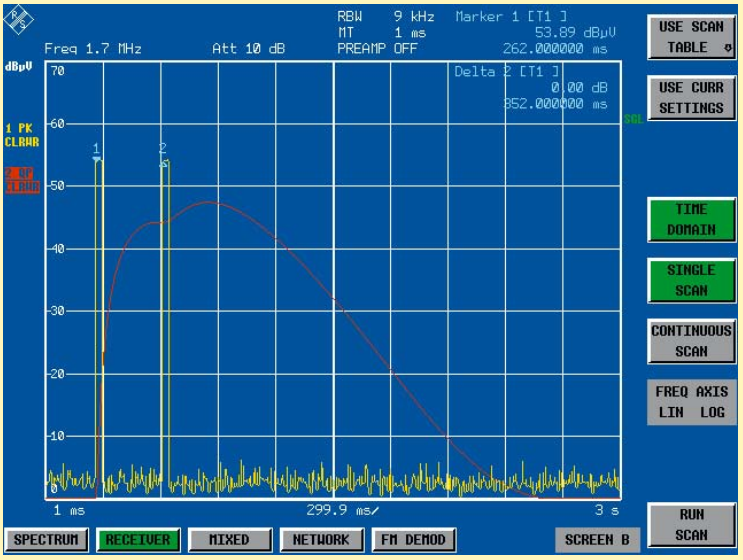


FIG 2
Two click interferences at an interval of approx. 350 ms; peak value display (yellow) and quasi-peak value (red), measured with the time domain analysis.

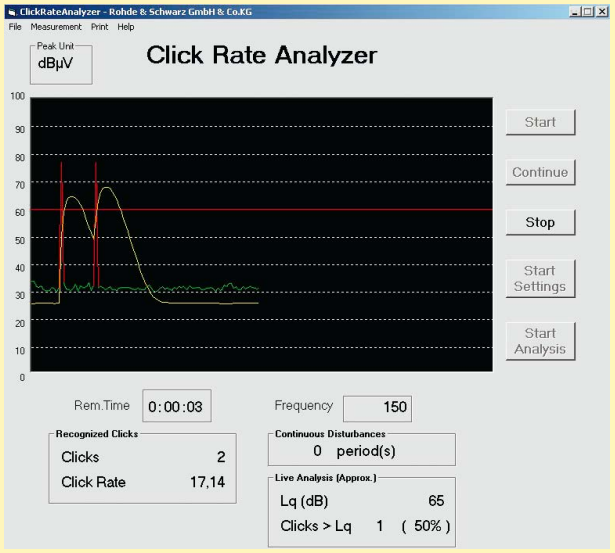


FIG 3
Display of an ongoing measurement. Click values that exceed the limit value are marked in red in the diagram.

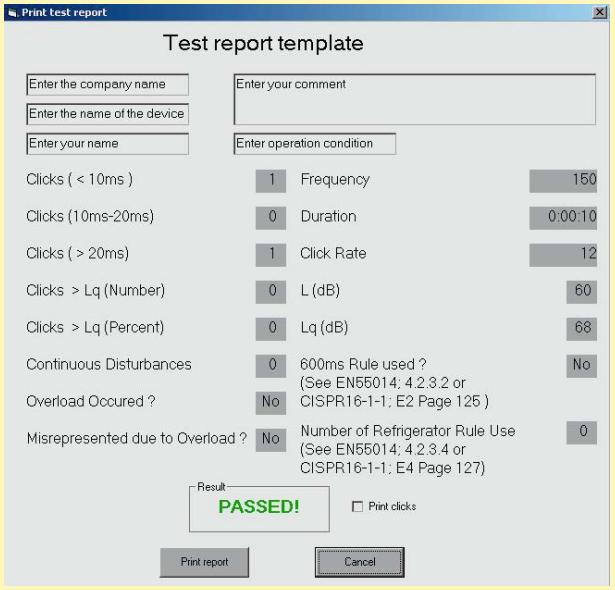


FIG 4
Test report with statistical data.

More information, data sheet and Click Rate Analyzer software free of charge at www.rohde-schwarz.com (search term: ESCI)

REFERENCES

[1] EN 55014, Electromagnetic compatibility – Requirements for Household Appliances, Electric Tools, and Similar Apparatus – Part 1: Emission – Product Family Standard

[2] EMI Test Receiver R&S®ESCI: Compact test receiver for full-compliance measurements up to 3 GHz. News from Rohde&Schwarz (2004) No. 182, pp 40–43

FIG 1 **The R&S NetCCU®700 transmitter control unit offers numerous functions yet is very compact.**

Transmitter Control Unit R&S NetCCU®700

All-purpose instrument with integrated DVB-T receiver module

The R&S NetCCU®700 (FIG 1) can be used for many purposes – as a transmitter control unit, a local control unit or a network interface for web and SNMP applications in which the R&S NetCCU®700 provides the hardware platform. By adding the unit's optional DVB-T receiver module, you can broaden its range of applications even further.

DTV-B receiver module means more applications

By adding the optional DVB-T receiver module to the R&S NetCCU®700 transmitter control unit [*], you can greatly expand the unit's functionality. The module not only turns the unit into a retransmitter for demodulating an off-air signal but also enables it to monitor a transmitter's output signal.

Retransmitters do not require a signal feed since they receive the main transmitter signal off air and apply the demodulated RF signal at the transmitter's ASI input (FIG 2). This reduces network operator costs, as there is no need for feeding signals to the transmitter station. In contrast to a converter, a retransmitter refreshes the signal by applying the error protection technique specified by the DVB-T standard during demodulation.

Using the integrated DVB-T receiver module to **monitor the output signal** is very cost-efficient (FIG 3). Important parameters such as MER, BER, S/N, input level and information specific to the DVB-T mode can be monitored, output on the display and transmitted for remote control as needed. All these parameters are included in a hierarchical tree structure of the SNMP MIB and can be used to generate traps (FIGs 4 and 5).

Installing the DVB-T receiver module on the R&S NetCCU®700 yields compact and cost-efficient solutions and complements the entire Rohde&Schwarz product portfolio of DVB-T transmitters.

Main features

- Can be used as a retransmitter or to monitor a transmitter's output signal
- Two-channel receiver version opens up numerous applications – for example, diversity reception – and ensures high flexibility
- Provides compact transmitter solutions by incorporating many functions into one instrument
- Offers a uniform concept for DVB-T transmitters of all power classes
- Can also be used as a stand-alone instrument

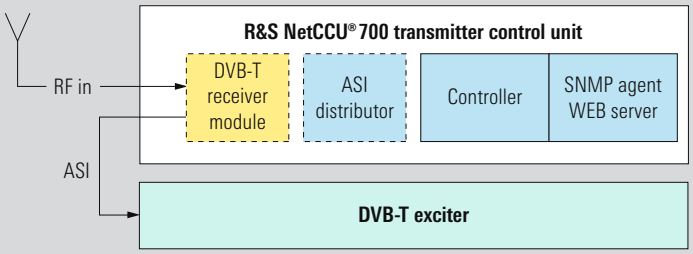


FIG 2
Configuration of the R&S NetCCU®700 as a retransmitter.

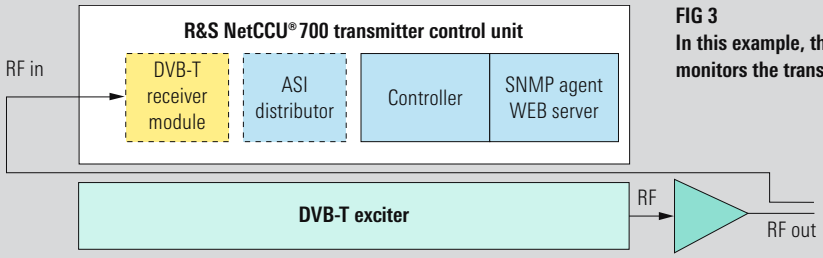
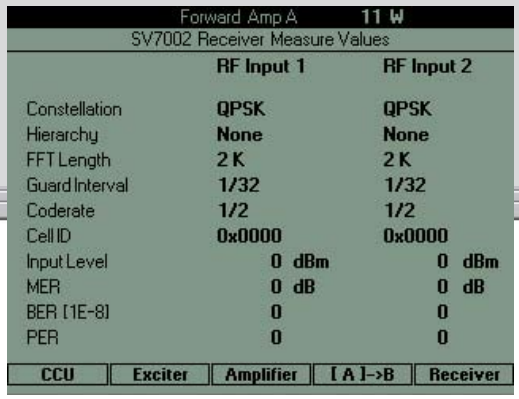


FIG 3
In this example, the R&S NetCCU®700 monitors the transmitter output signal.

FIG 4
Right: The DVB-T parameters shown on the R&S NetCCU®700 display. Below: Part of the SNMP MIB for the R&S NetCCU®700 with the DVB-T receiver module.



Input level	dBm
MER	dB
C/N	dB
BER	10^{-8}
PER	packets/s
AGC locked	Y / N
Carrier locked	Y / N
TPS locked	Y / N
Viterbi locked	Y / N
MPEG sync locked	Y / N
MPEG data locked	Y / N
Uncorrected MPEG packet	Y / N
FFT length	2k; 8k
Guard interval	1/32; 1/16; 1/8; 1/4
Constellation	QPSK; 16QAM; 64QAM
Code rate	1/2; 2/3; 3/4; 5/6; 7/8
Cell ID	0x000 to 0xFFFF
Hierarchy	none; $\alpha = 1$; $\alpha = 2$; $\alpha = 4$

FIG 5 The R&S NetCCU®700 can monitor these parameters and transmit them to remote locations.

The DVB-T receiver module also allows the R&S NetCCU®700 to be used as a standalone instrument for other transmitters in retransmitter and monitoring applications. This offers network operators a uniform receiver interface, even if they use transmitters from different manufacturers in their networks.

Two versions of the DVB-T receiver module

The receiver module is available in two versions. In the **single-channel version**, the signal path consists of a tuner, demodulator and ASI interface. The R&S NetCCU®700's internal controller controls the receiver module via an RS-232-C interface.

The **two-channel version** has two identical signal paths (FIG 7) with the special feature that the two demodulators are interconnected via a signal bus, thus allowing four configurations (FIG 6). The box on the right shows three typical applications for the two-channel version.

Comprehensive transmitter concept

Due to its numerous functions, the R&S NetCCU®700 offers very compact, cost-efficient solutions. Moreover, identical functional groups in high-, medium- and low-power transmitters reduce training and spare parts costs for network operators.

By offering the DVB-T receiver module, Rohde&Schwarz is adding major new functions to its product portfolio while remaining true to its concept of modular and uniform transmitter families.

The DVB-T receiver module expands the functionality of the R&S NetCCU®700 for further applications. The two-channel version of the module offers maximum flexibility and unique applications such as diversity reception. The fact that the R&S NetCCU®700 can still be operated as a standalone instrument even after the receiver module has been added means that it remains a valuable all-purpose instrument.

Simone Gerstl; Manfred Reitmeier

Condensed data of the R&S NetCCU®700 DVB-T receiver module

Receive frequency range	VHF (172 MHz to 230 MHz) UHF (470 MHz to 862 MHz)
Bandwidth	6 MHz, 7 MHz or 8 MHz
Frequency offset	±167 kHz or ±125 kHz
Input level range	–92 dBm to –20 dBm (depending on the DVB-T mode)
Signal throughput time	typ. 7.8 ms (for e.g. 8 MHz, 8k, 1/32 QPSK 7/8)
TV standard	DVB-T ETS 300 744

Possible applications for the two-channel version

The two-channel version of the DVB-T receiver module offers maximum flexibility and a wide range of applications. It can be used for hierarchical, redundant or diversity reception but also as a module that operates as a retransmitter and simultaneously monitors the output signal. Some examples follow.

Its **use as a module that operates as a retransmitter and simultaneously monitors the output signal** (FIG 8) deserves a closer look. The first demodulation path of the module receives the main transmitter signal off air. The demodulated signal replaces the signal that is normally fed in via the ASI input. The second path demodulates and monitors the output signal of the transmitter. A 100 W retransmitter equipped with these features takes up only seven height units.

Another important application for the two-channel version is to **feed signals to two transmitters** (FIG 9), allowing them to be controlled cost-effectively via one R&S NetCCU®700.

Another unique application – especially under difficult reception conditions – is **diversity reception**, in which the two RF inputs of the receiver module are connected with two different receiving antennas for the same channel (FIG 10). The module analyzes both signals, and the signal of better quality is fed to the retransmitter. This is controlled by means of the diversity bus in the receiver module. This bus is used to continuously monitor the reception quality and, if necessary, toggle between the RF inputs.

All applications can be implemented using identical hardware. You can implement a different application simply by changing the software settings and switching the cable connections.

Mode	RF inputs	ASI outputs
Dual input	RF 1, RF 2	ASI 1, ASI 2
Hierarchical	RF 1, RF 2	ASI 1 = HP or LP ASI 2 = LP or HP
Redundant	RF 1 = RF 2	ASI 1 = ASI 2
Diversity	RF 1 via antenna 1 RF 2 via antenna 2	ASI 1 = ASI 2

FIG 6 The four possible configurations of the two-channel version of the DVB-T receiver module.

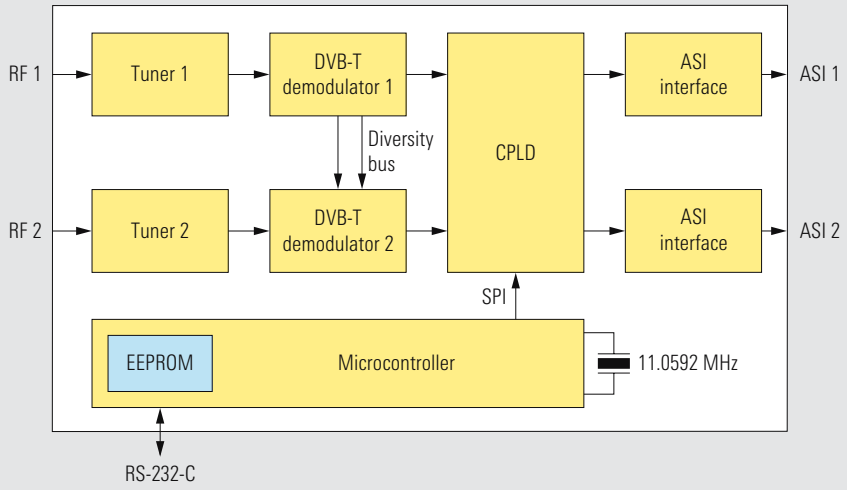


FIG 7 Basic design of the two-channel DVB-T receiver module.

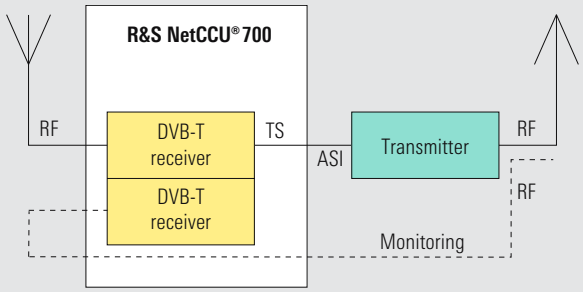


FIG 8 Simultaneous use as a retransmitter and for monitoring the output signal.

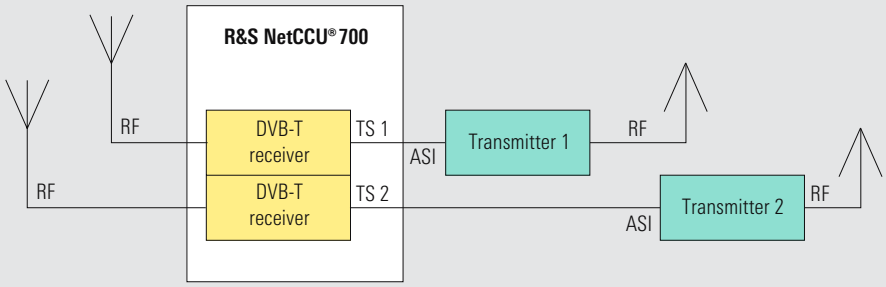


FIG 9 ASI feed for two transmitters.

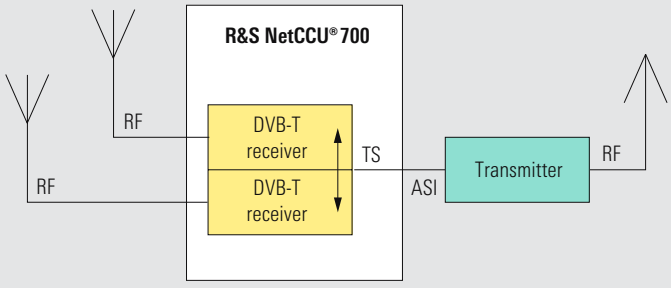


FIG 10 Configuration for diversity reception under difficult reception conditions.

Important abbreviations

ASI	Asynchronous serial interface
AGC	Automatic gain control
BER	Bit error ratio
CPLD	Complex programmable logic device
HP	High priority
LP	Low priority
MER	Modulation error ratio
MIB	Management information base
PER	Packet error ratio
SNMP	Simple network management protocol
SPI	Synchronous parallel interface
TS	Transport stream

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

REFERENCES

[*] Transmitter Control Unit R&S NetCCU®700: Transmitter control and remote monitoring in one unit. News from Rohde & Schwarz (2003) No. 179, pp 26–28

TV Transmitters in Containers

Transmitter systems for special applications

Rohde & Schwarz is the world market leader in digital broadcast transmitters as well as a leading manufacturer of analog transmitters in Europe. This preeminent market position is no doubt the result of the company's innovative products plus its excellent reputation for delivery reliability and for getting equipment up and running even when project deadlines are very tight. Rohde & Schwarz's extensive portfolio also features exceptional products such as transmitters in containers or lightweight transmitter buildings.

All-purpose customized transmitter systems

Rohde & Schwarz provides transmitter systems for specific applications in three configurations:

- Mobile emergency containers for rapid availability when stationary systems break down, e.g. in the case of catastrophes
- Transmitter systems in stationary containers
- Transmitter systems in lightweight stationary buildings

Mobile emergency containers

No matter whether digital or analog, TV transmitters must be available around the clock. If viewers lose television service for an extended period of time, network operators risk considerable contractual penalties. This can be avoided by using emergency containers from Rohde & Schwarz (FIG 1). The transmitter systems in emergency containers are custom-configured to your specific applications. The transmitter systems are usually installed in standardized 10' or 20' containers that can be easily transported with standard vehicles, but can also be mounted directly on off-road vehicles.

State-of-the-art modulation signal processing as well as the broadband concept of the high-power amplifiers ensure that the transmitters can be set to the required channel very quickly, thus minimizing downtime at the affected stations. The compact design also means that liquid-cooled transmitters of any power class will completely fit into one container – including all equipment required for program input and cooling, plus heat exchangers. No other external equipment is necessary for transmitter startup; only the AC power supply, the program feed and RF output line need to be added.

A good example of one such installation is at Crown Castle International (CCI) in Great Britain [*], where Rohde & Schwarz supplied emergency transmitter systems for the company's DVB-T transmitter network. The transmitter systems consisted of four containers – each with a 4 kW transmitter, which can be daisy-chained. If an entire station with four multiplexes experiences a total failure, the 16 digital programs are quickly back on the air.

Transmitter systems in stationary containers

In some areas, coverage is possible only if transmitters are installed at locations that are elevated or difficult to access, such as mountain stations, thermoelectric power plants or on top of high-rises. In such a case, transmitter systems in stationary containers offer the clear advantage that they can be mounted, started up and acceptance-tested while still at the factory. Afterward, they merely need to be transported to their operational site by means of a helicopter or a crane, where they can be connected in no time. This minimizes the amount of work necessary at sites with difficult conditions.

More information about our comprehensive broadcasting portfolio at www.rohde-schwarz.com

REFERENCES
[*] UHF Transmitter Family R&S®NH/NV7000: 20 kW TV transmitters – compact and mobile. News from Rohde & Schwarz (2002) No. 173, pp 42–43

Lightweight transmitter buildings

Compared to fixed transmitter buildings, transmitter systems in lightweight buildings (FIG 2) offer the advantage that protracted technical and regulatory approval procedures can be avoided and installation time drastically cut. The prefabricated buildings are set up on continuous footing; they are composed of several layers of insulating material and can be entered immediately after setup to complete their interior. The interior resembles a conventional transmitter room, which means that the transmitter and the peripheral equipment (power cabling, modulation processing equipment, fire detectors, antenna coupling networks and so forth) can be installed like in conventional transmitter buildings. The lightweight buildings provide numerous benefits:

- Fast planning
- Short project-completion times
- Building and all equipment from a single source
- Purpose-optimized building with a long service life
- Variable setup
- Easy expandability

Specialists from Rohde&Schwarz help you with any questions you may have about systems and measurement equipment. Furthermore, they ensure that every phase of the project runs smoothly up through on-schedule startup and that the system is functioning safely when it goes into regular operation.

Franz Harrer

FIG 1 **State-of-the-art container transmitter with eight 800 W DVB transmitters.**

FIG 2 **Lightweight two-story transmitter building.**

UHF TV Transmitters R&S®NH/NV8200

Air-cooled transmitters for the medium-power segment

In addition to the global market for liquid-cooled high-power TV transmitters that Rohde&Schwarz successfully covers with the R&S®NH/NV7000 transmitter generation [1, 2], there is also significant demand for air-cooled transmitters in the medium-power segment. The new R&S®NH/NV8200 transmitter family has been designed for this market, offering TV signals with power up to 2.0 kW with analog combined and up to 1.2 kW with DVB-T/-H or ATSC.

Standardized design for analog and digital TV

The new air-cooled R&S®NH/NV8200 transmitter family (FIG 1) has been designed for all analog TV standards (B/G, D/K, M/N, I, SECAM, PAL, NTSC) as well as for all digital TV standards (DVB-T, DVB-H, ATSC and so forth). LDMOS transistors in the amplifiers ensure high output power while requiring only minimum space. As usual, all components are fully broadband within the UHF band IV/V (470 MHz to 862 MHz) and are suitable for analog and digital TV without any restrictions. A special innovation is the state-of-the-art TV Exciter R&S®Sx800, which occupies only one height unit.

The Control Unit R&S NetCCU®800 handles internal and external communications including all control functions. Only two height units suffice to implement the functions of a transmitter control unit plus an IP interface.

Control Unit R&S NetCCU®800

The Control Unit R&S NetCCU®800 clearly shows the current status of the transmitter system on a color display (FIGs 2 and 3). Internal communications with the connected components (amplifiers, rack controllers, other transmitter racks) are via CAN bus. Via Ethernet, the R&S NetCCU®800 communicates with externally connected components and with the exciter. All transmitter and/or amplifier parameters required for diagnostics can be retrieved locally as well as remotely via standard (IP) protocol and standard software (web browser, SNMP) from anywhere in the world. The status of the transmitter system in unattended stations can thus be accurately diagnosed, and possible servicing optimally prepared. The transmitter control unit can be optionally equipped with a receiver module (page 34).

TV Exciter R&S®Sx800

By using the latest switching technology, the multistandard TV Exciter R&S®Sx800 can be accommodated in a housing of only one height unit. It includes full signal processing ranging from video / audio input for analog TV and the ASI transport stream input for digital TV to the standard-compliant RF output signal. Its flexible concept ensures high safety of investment. The transmitters can be converted from analog to digital at any time, involving only a minimum of effort.

The TV Exciter R&S®Sx800 (FIG 2) features the following special characteristics:

- Suitable for single-frequency networks (SFN) and multifrequency networks (MFN)
- Hierarchical modulation
- Seamless input switching
- MIP monitoring
- All ASI modes
- SMPT310M
- DVB-H, DVB-T, ATSC
- All analog TV standards
- Built-in linear and nonlinear precorrection
- Optionally automatic precorrection (DTV), NICAM

REFERENCES
[1] UHF Transmitter Family R&S®NV/NH7000: Liquid-cooled TV transmitters for terrestrial digital TV. News from Rohde&Schwarz (1999) No. 165, pp 11–13
[2] VHF/UHF TV Transmitters R&S®NM7000C/NH7000C: Securing your investments. News from Rohde&Schwarz (2004) No. 182, pp 44–45

FIG 1 The R&S®NV 8206 UHF TV transmitter.

FIG 2 Two TV Exciters R&S®Sx 800, the Control Unit R&S NetCCU® 800, and the Amplifier R&S®VH 8200 A1.

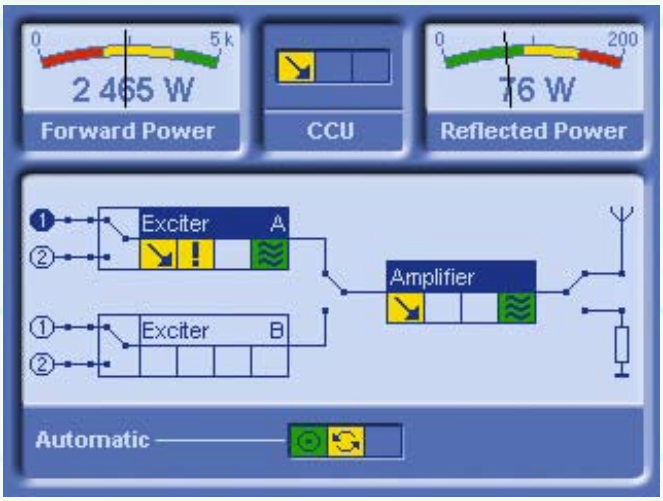


FIG 3
The current transmitter status is clearly displayed in the main menu.

Important abbreviations

ASI	Asynchronous serial interface
BER	Bit error ratio
CAN	Controller area network
IP	Internet protocol
LDMOS	Lateral diffused metal oxyde silicon
MER	Modulation error ratio
MFN	Multifrequency network
MIP	Megaframe initialization packet
SFN	Single-frequency network
SNMP	Simple network management protocol
TPS	Transmission parameter signaling

Condensed data of the R&S®NH / NV 8200

Frequency range		470 MHz to 862 MHz
RF output power	analog TV	500 W to 2.0 kW combined
	digital TV, DVB-T / -H	200 W to 1.2 kW
	digital TV, ATSC	300 W to 1.2 kW
TV standards	analog TV	B / G, D / K, M / N, I
Color transmission		PAL, SECAM, NTSC
Sound transmission		dual sound in accordance with IRT
		FM 1 sound and NICAM 728 (–13 dB / –20 dB)
		FM 1 sound (–10 dB)
		BTSC multiplex channel
Dimensions (W × H × D)		600 mm × 2000 mm × 800 mm

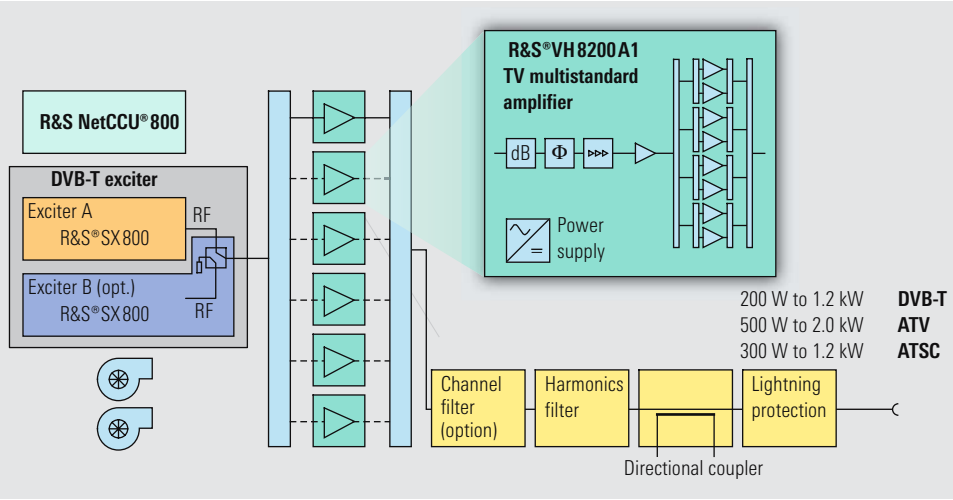


FIG 4 Block diagram of the R&S®NH/NV8200 UHF TV transmitter.

The R&S®VH8200A1 – a TV multistandard amplifier

The air-cooled R&S®VH8200A1 TV broadband multistandard amplifier (FIG 2) operates in the range from 470 MHz to 862 MHz. Its output power depends on the modulation mode; it exhibits the following values:

- With DVB-T/DVB-H: **200 W**
- With ATSC: **300 W**
- With analog TV combined: **500 W**

The extremely compact amplifier also contains the power supply. It can be used both for analog and digital TV without requiring any adjustments, which makes it especially efficient in terms of logistics for operators of mixed transmitter networks.

If an amplifier has to be replaced, phase and amplification need not be optimized via control units on the front panel – an asset which further facilitates operating and servicing the transmitter system. Needless to say, a self-protective device against overheating, VSWR, overvoltage and AC errors is included.

All relevant operating parameters and fault messages are transferred to the transmitter control unit via the integrated CAN bus interface. This data can, of course, also be retrieved via the IP interface of the R&S NetCCU®800.

In addition to technical aspects, network operators are particularly interested in the overhead costs of a transmitter system (current drain, efficiency). This is where the transmitter family provides a special feature: The efficiency of all amplifiers and thus of the entire transmitter system can be centrally adjusted via the CCU to the specific on-site situation of the transmitter system by taking into account the desired output power, transmit frequency and modulation mode. This protects resources, thus contributing to environmental protection and reducing overhead.

Solutions for all transmission tasks

In addition to outstanding technical parameters, the transmitters excel with high operational reliability, ease of servicing, minimum space requirements and high flexibility. The built-in fans operate in active standby and can be easily replaced.

All conceivable combinations of air ducting can be implemented (air inlets on top or bottom, exhaust air toward top or bottom). The optimized heat sink of the amplifier as well as its cooling concept have been designed for 24-hour operation under full-load conditions (ATSC and/or analog TV all-black picture). Thus, the amount of air with DVB-T operation can be significantly reduced, which positively affects the transmitter system's power consumption and noise development.

An innovative, nearly wireless power distribution eliminates wiring errors already during assembly. External contacts are connected with protection against reversal of polarity.

The channel filter integrated in the transmitter (for analog operation), the frequency-response-compensated directional coupler and the built-in lightning protection round out the R&S®NH/NV8200 transmitter family (block diagram FIG 4). By switching transmitter racks in parallel, virtually any transmitter powers can be implemented.

To ensure particularly high operational reliability, the following standby concepts are feasible:

- Exciter standby (FIG 2)
- Active output stage standby
- Passive transmitter standby
- Passive exciter and output stage standby
- (n+1) standby

Uwe Dalisda; Reinhard Scheide

43848/6

TV Test Receivers

Quality assurance in DVB-T networks

DVB-T networks are being set up, tested or used in regular operation all over the world. Irrespective of the particular stage of a transmitter network, you should always have detailed knowledge of its properties. For this purpose, TV test receivers are the prime choice.

Matching TV test receiver and application

Digital TV is increasingly gaining ground worldwide. While some countries have been successfully operating DVB-T transmitter networks for some years now, other countries are still in the process of testing them, setting them up or putting them into operation. Ultimately, all operators pursue the same objectives: The new networks must run reliably, meet high quality standards and operate at low costs. For this purpose, measurable parameters must be optimized, monitored and recorded. TV test receivers optimized to meet such challenges help to achieve this. This article will provide you with an overview of the various receivers from Rohde & Schwarz and the tasks for which each of them is best suited.

Correctly dimensioning and optimizing DVB-T networks

The transition from analog to digital TV presents designers and operators alike with a scope of new parameters such as MER, BER, code rate, guard interval or impulse response, to mention just a few. Plus, there are new technical challenges such as reception in moving vehicles or indoors with portable devices via room antenna – these are all situations that were of minor importance with analog TV.

It is quite a challenge to correctly dimension a DVB-T network: You have to use comprehensive tests to determine the most favorable modulation parameters for reliable full-coverage reception while simultaneously minimizing the number of transmitters required for this purpose.

This is not possible unless you have detailed knowledge of the signal quality and system margins. For this purpose, we recommend using the high-end TV Test Receiver R&S®EFA, model 43 (FIG 1).

Putting DVB-T transmitters into operation

Designers and manufacturers of DVB-T components and TV transmitter network operators value the R&S®EFA because of its numerous and precise measurement capabilities (FIG 2). Model 43 has two selective inputs (50 Ω and 75 Ω) and a broadband demodulator input (50 Ω). Using this demodulator input, you can perform direct measurements on DVB-T transmitters at maximum performance, e.g. amplitude and phase errors as well as group delay in the channel, combined with a constellation and MER display versus all OFDM carriers (FIG 3). These measurements are ideally suited for detecting and analyzing problems in the modulator.

To ensure optimum modulation of a DVB-T transmitter, the TV test receiver provides the amplitude distribution display, the complementary cumulative distribution function (CCDF) and crest factor determination.

Frequently, analog TV channels and DVB-T channels have to coexist for some time. In this case, it is vital to meet specific requirements placed on the level values at the channel limits. Here too, the R&S®EFA will provide support: In the frequency spectrum of the DVB-T channel displayed, the shoulder distances can be accurately measured in accordance with ETSI TR 101 290.

As you can see, model 43 of the TV Test Receiver R&S®EFA effortlessly handles all measurements required for putting DVB-T transmitters into operation. Needless to say, this makes the R&S®EFA also the ideal partner for subsequent servicing and maintenance. And this is by no means all it has to offer – it is also ideal for single-frequency networks.

DVB-T single-frequency networks (SFN)

When planning a DVB-T SFN and subsequently putting it into operation, various aspects need to be taken into account. Above all, the timing of all DVB-T transmitters involved in the SFN must be within the guard interval, plus the transmitters must transmit on exactly the same frequency. To be able to verify and ensure these requirements, the impulse response must be accurately displayed. Model 43 of the TV Test Receiver R&S®EFA displays the impulse response (echo display) both graphically and as a table versus a DVB-T signal received by an antenna. One of the selective receiver inputs is used for this task. The guard interval is inserted into the display in accordance with the selected OFDM parameters.

The new option R&S®EFA-K10 enhances this display in a unique way (FIG 4). Based on a complex evaluation of the impulse response, frequency deviations (referenced to the main impulse) can be shown within ±5 Hz with an error of only ≤0.3 Hz. Each deviation resembles an additional Doppler shift that renders reception more difficult and may thus adversely affect range.

Owing to its comprehensive measurement functions, the R&S®EFA is ideal for virtually any measurement application. By the way, also analog receiver models can be combined or upgraded with the R&S®EFA-B10 DVB-T option.

Monitoring regular operation

If a DVB-T transmitter network is in regular operation, the individual transmitters must be monitored and possible failures recognized early on. This is where another receiver from Rohde&Schwarz joins the scene: the DTV Monitoring Receiver R&S®ETX-T (FIG 5), which has been specifically designed for setup at the transmitter site. It continuously monitors and records the main parameters such as level, MER, BER (before Viterbi and Reed-Solomon decoder) and MPEG TS synchronization.

The R&S®ETX-T can be easily integrated into monitoring systems via TCP/IP and SNMP. A standard web browser with access to the receiver's HTTP server suffices to operate the receiver (FIG 6).

FIG 5 The DTV Monitoring Receiver R&S®ETX-T will be featured in one of the next issues.

FIG 1
The TV Test Receiver R&S®EFA not only handles all measurements required for putting DVB-T transmitters into operation, it is also ideally suited for servicing and maintenance.

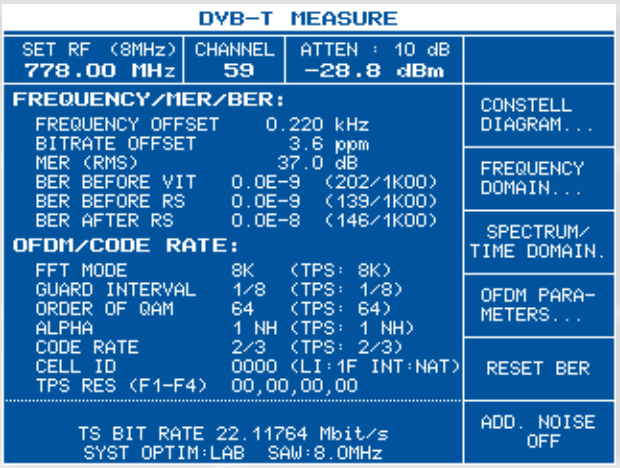


FIG 2 The TV Test Receiver R&S®EFA excels with a wide variety of measurement functions.

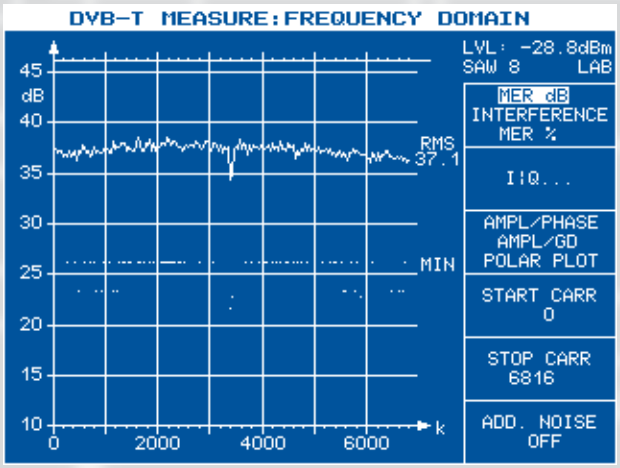


FIG 3 The TV Test Receiver R&S®EFA: MER display versus all OFDM carriers.

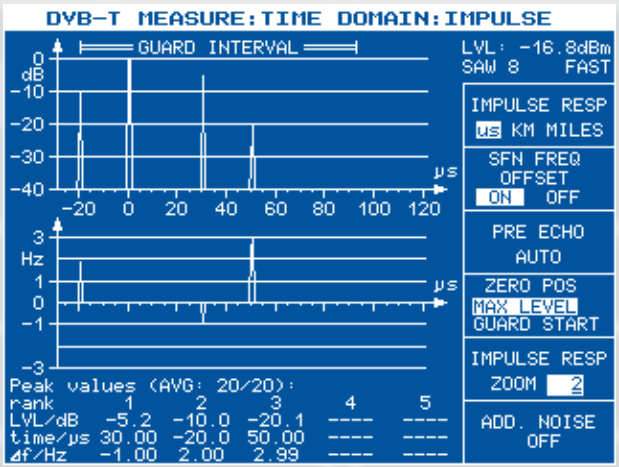


FIG 4
Based on a complex evaluation of the impulse response, the option R&S®EFA-K10 shows frequency deviations (referenced to the main impulse) within ±5 Hz with an error of only ≤0.3 Hz.

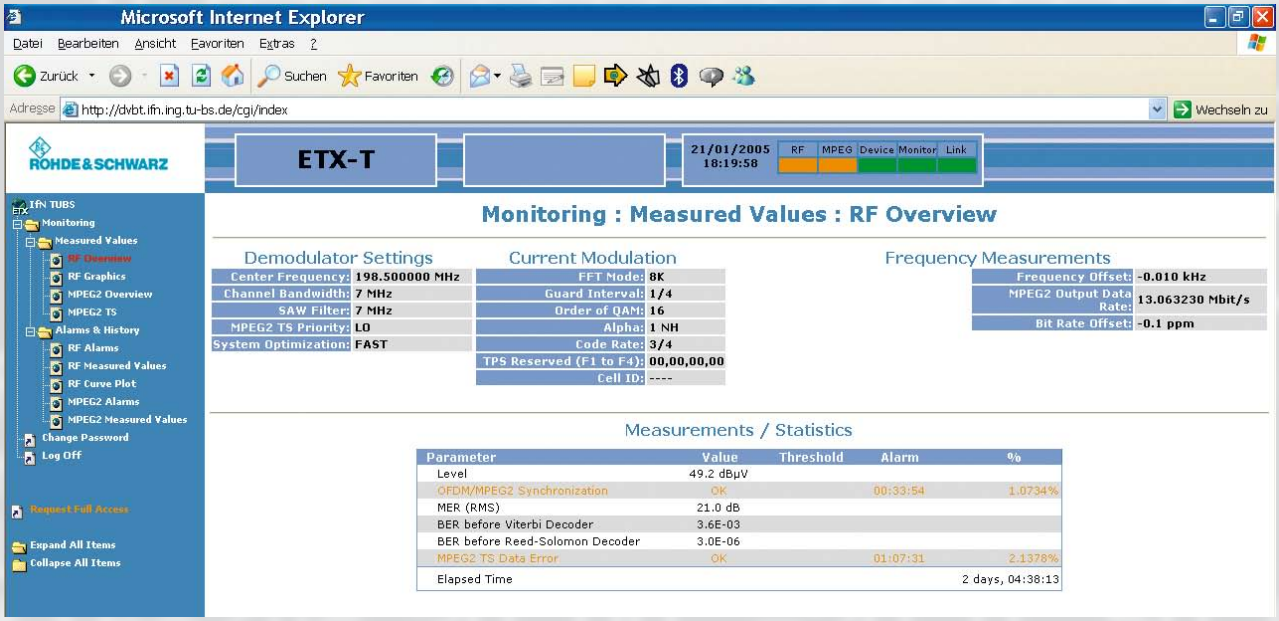


FIG 6
The DTV Monitoring Receiver R&S®ETX-T can be operated via a common web browser.

An administration process integrated as standard controls access and different user rights. The user interfaces are specifically matched to meet the tasks at hand, thus facilitating operation.

The main application of the R&S®ETX-T is to generate SNMP traps whenever defined limits are overranged or underranged; these traps signal the current problem to central management software. In cases like this, a special benefit of the receiver comes into play: It is not just a monitoring receiver but also a TV test receiver with outstanding measurement accuracy. Thus, the main screenshots of measurement results can be retrieved as graphics via the web browser without requiring a technician on-site to analyze the reasons for the error (FIG 7). For clarification purposes, recorded measured values can also be retrieved and forwarded for internal or external evaluation. Thus, you can detect possible problems early on and analyze actual interference.

The R&S®ETX-T can be set to Scanner mode, in which it then sequentially processes individual frequencies from a table. Measured values and traces as well as alarms can be retrieved separately for each frequency. It is thus not necessary to assign a specific receiver to each DVB-T transmission if several transmissions have to be monitored at a site.

Checking the signal quality at the reception site

A functioning DVB-T transmitter network by no means ensures smooth reception everywhere in the network. The portable SAT TV FM Test Receiver R&S®EFL 100 is ideal for detecting critical receive conditions (FIG 8). Its battery permits mains-independent operation of the instrument for up to one hour. This allows you to detect receive conditions fast and on the move indoors or in the field. In addition to the level, MER and BER parameters, a constellation is displayed that marks the frequency distribution of the individual symbols in color (FIG 9). This is very useful for aligning antennas, for example. A built-in MPEG decoder makes it possible to select and display unscrambled programs on the TFT display (FIG 10).

Summary

TV test receivers for DVB-T from Rohde & Schwarz provide all the measurements vital for optimizing and ensuring signal quality – and this at all stages during network setup and subsequent regular operation. The table below provides you with an overview of the TV test receivers and their applications. Visit the Internet pages of Rohde & Schwarz for detailed information about the TV test receivers.

Werner Dürport

More information, data sheets and articles in News from Rohde & Schwarz at www.rohde-schwarz.com (search terms: EFA, ETX-T, EFL100)

The TV test receivers and their applications at a glance:

Application	R&S®EFA	R&S®ETX-T	R&S®EFL 100
Research and development	●		
Quality assurance in production	●		
Transmitter measurements	●	●	
Service and maintenance	●		●
Putting DVB-T transmitter networks into operation	●		
Transmitter and SFN monitoring	●	●	
Coverage measurements	●		●
Installation of receiving antennas			●

Important abbreviations

BER	Bit error ratio
DTV	Digital TV
DVB-T	Digital video broadcast terrestrial
MER	Modulation error ratio
OFDM	Orthogonal frequency division multiplexing
SNMP	Simple network management protocol
TCP/IP	Transmission control protocol/Internet protocol

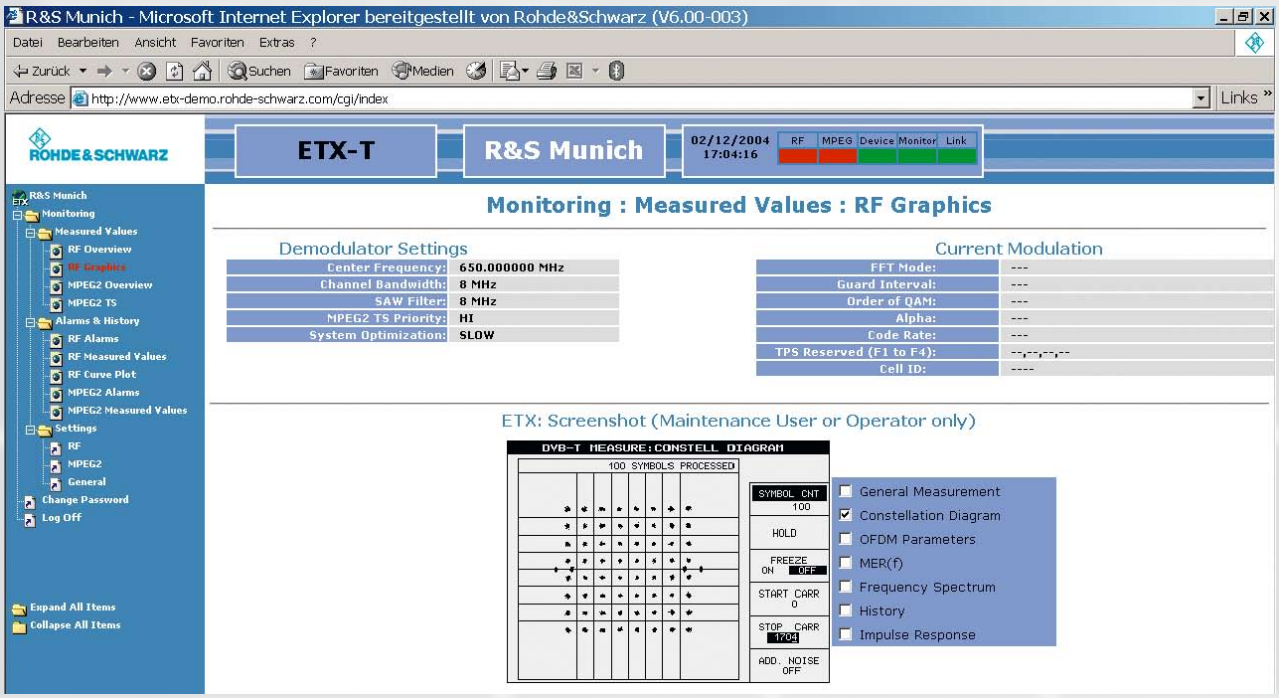


FIG 7
The R&S®ETX-T allows you to retrieve important screenshots via the web browser.

FIG 8
The portable SAT TV FM Test Receiver R&S®EFL100 specializes in detecting critical receive conditions.

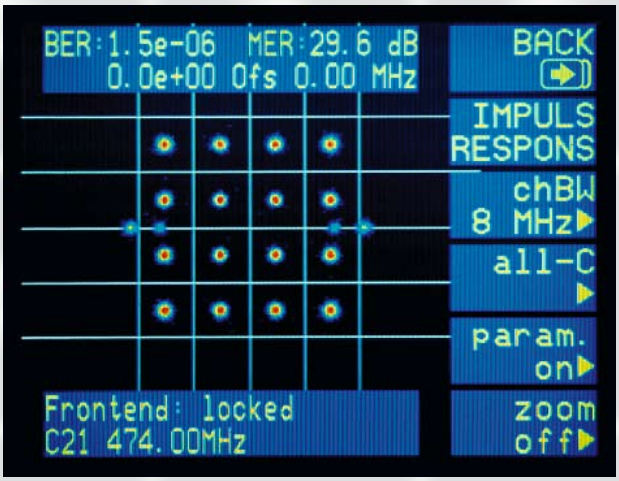


FIG 9 Constellation diagram in the R&S®EFL100; the frequency distribution of the individual symbols is marked in color.

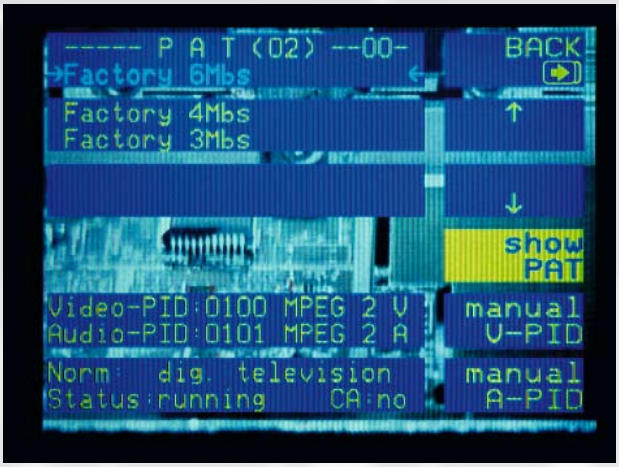


FIG 10
With the R&S®EFL100 with built-in MPEG decoder, unscrambled programs can be selected and displayed.

Spectrum Monitoring and Management System R&S®ARGUS-IT

Nationwide radiomonitoring system for Greece

The Olympic Summer Games 2004 in Athens were a great success not just from an athletics point of view; enormous communications challenges were also successfully mastered with the contribution of the new nationwide radiomonitoring system from Rohde & Schwarz.

Powerful system for sophisticated tasks

Long before the Olympic Games in Athens were opened, the National Telecommunications and Post Commission (EETT) decided to establish a nationwide spectrum monitoring and management system. During the international invitation to tender, Rohde & Schwarz won out against very strong competitors in November 2002. Just over a year after the order had been placed, the system started operation and excelled in every aspect.

The spectrum monitoring system consists of five fixed stations (three in the Athens area and two in the Thessalonica area), seven test vehicles plus several portable and transportable systems. National headquarters and a regional control center were set up in the Athens area.

Tried-and-tested equipment from Rohde & Schwarz such as the R&S®ESMB and R&S EB200® receivers, the R&S DDF®195 direction finder and the R&S®FSP30 spectrum analyzer are used. In addition, transportable monitoring systems of type R&S®TMS210, R&S®TMS500 and R&S®TMS-C are employed for mobile applications. In conjunction with the appropriate antennas, the system covers the frequency range from 9 kHz to 30 GHz.

Seven test vehicles support headquarters; they can also be connected via the GSM network.

Thoroughly tested at the Olympic Summer Games

Even during "normal" times, radiomonitoring a city the size of Athens is an immense task for the regulatory authorities. During large events such as the Olympic Games, it becomes a veritable challenge since radiocommunications drastically increase.

Systems for the wireless transmission of audio, video and data streams are the key to successfully presenting the Games in the media. These systems include innumerable cameras and microphones at the sports venues, transmission vehicles that forward the information via satellite all over the world, as well as laptops with *Bluetooth*® or WLAN access. And, of course, all visitors want to send their families and friends live reports via mobile phones. The security of all persons involved was paramount. A large number of special forces monitored the Games. Secure and reliable communications had top priority.

In view of the above, EETT started planning and coordinating the frequency requests well in advance. Anyone who wanted to use such equipment professionally during the Olympic Games could easily and conveniently apply for a temporary transmission license via the Internet. A total of 7860 license requests from 108 countries were licensed by EETT. A significant number of unauthorized transmissions, which could have influenced the smooth operation of the Olympic Games, were successfully located and managed.

To also meet all tasks in terms of staff, the number of EETT employees was considerably expanded; approx. 60 additional employees were trained on the new system within a minimum of time. Throughout the Games, approx. 150 employees worked virtually round the clock at all sports sites. They were supported by experienced specialists from Rohde&Schwarz who were present at all times.

The outcome was impressive – the new spectrum monitoring and management system met all requirements: The numerous media representatives and other users were able to work without significant technical glitches; unavoidable minor problems were immediately eliminated. During the Paralympics, which were held soon after, the EETT employees were again involved and once more excelled at their task.

All equipment is controlled via Monitoring Software R&S®ARGUS, which has been used in numerous countries for nearly two decades and is, of course, continuously updated and always state-of-the-art. Automated measurement sequences and communications with the national frequency management database for mutual use of data are feasible.

The unattended fixed stations can be remote-controlled via radio links with data rates of up to 6 Mbit/s. National and regional headquarters in Athens and Thessalonica are connected via leased lines. The vehicles can be integrated via the GSM network, which is important if several direction finders have to be operated synchronously for exact localization of interferers, for example.

Rohde&Schwarz was the overall project leader. The project was implemented in close cooperation with the company's Greek representative Mercury. Subcontractor LStelcom supplied the entire spectrum management system.

In February 2004, the project was presented to the Greek public during a ceremonious event. In their speeches, the Greek Prime Minister, the Minister of Transportation and Communications at that time as well as the President of the Regulatory Authority emphasized the importance of the system. It had to master its first acid test during the Olympic Summer Games and the Paralympics (box above).

The next Olympic Summer Games will be held in Beijing in 2008. The Chinese regulatory authority is already using a spectrum monitoring network from Rohde&Schwarz.

Thomas Krenz

More information about the entire radiomonitoring portfolio from Rohde&Schwarz at www.rohde-schwarz.com

Changes to Rohde & Schwarz's Executive Board and Corporate Management

As of January 2005, Rohde & Schwarz has two new Executive Board members in the role of President and COO as well as two new members of Corporate Management. Christian Leicher (35) and Manfred Fleischmann (51) have each been appointed President and COO. Moreover, the Executive Board named Mario Paoli (36) and Gerolf Wonisch (62) each as Head of Division. These measures will ensure long-term continuity in the company's management.

Leicher began his career at Ericsson in Düsseldorf. He is a Rohde & Schwarz shareholder and grandson of company founder Dr Hermann Schwarz. Fleischmann joined Rohde & Schwarz in 1985 and became Head of the Production and Materials Management Division in July 2001.

Former President and COO Reinhard Bruckner (64) retired on 31 December 2004. The Executive Board now consists of President and CEO Friedrich Schwarz, Michael Vohrer, Fleischmann and Leicher.

The new Head of the Production and Materials Management Division is Gerolf Wonisch. Also effective 01 January 2005, Mario Paoli became Head of the Finance and Information Technology Division. Richard Bauer (64), the former Head of the Commercial and Financial Management Division, retired at the end of 2004.

Christian Leicher

Manfred Fleischmann

Broadcast Test System R&S®SFU wins 2005 "Best in Test" award

Test result: Very Good! The editors of the American technical magazine Test & Measurement World have reached a decision. They were so enthusiastic about the R&S®SFU system platform that they declared it the 2005 winner in the "digital video test" category.

The annual award goes to products that are especially innovative or beneficial. Companies and users were allowed to nominate products launched between November 2003 and October 2004 in 12 different categories.

The Broadcast Test System R&S®SFU won the award primarily on the basis of its universality. The instrument combines a test transmitter, a signal generator and recorder for transport streams, a channel simulator, a digital AWGN generator and an ARB generator in one platform. Thus, it can be used for all current digital TV standards. Future standards can be added at any time. The R&S®SFU now has the chance to be selected product of the year by the readers.

Test & Measurement World is one of the market's leading T&M trade journals. With a circulation of 65 000, the magazine is distributed mainly in North America and five percent worldwide.

Russian railway expands TETRA system

In November 2004, the Russian railway management awarded R&S BICK Mobilfunk, a Rohde & Schwarz subsidiary, a contract to provide radio coverage for yet another railway line. Since 2003, the Sverdlovsk railway management has been successfully operating the *ACCESSNET*®-T TETRA radio system.

An expansion of the system is now planned. Thus, *ACCESSNET*®-T once again won out over GSMR technology. The TETRA mobile radio network will cover some 300 km of railway lines and additional lines around Yekaterinburg (formerly Sverdlovsk).

Rohde & Schwarz joins LXI Consortium

Rohde & Schwarz has joined the LXI Consortium as a strategic member. Rohde & Schwarz thus becomes one of the companies supporting the development and introduction of the LXI (LAN Extensions for Instrumentation) standard. LXI is a LAN-based T&M bus standard for automated test systems.

LXI measurement modules have standardized sizes and communicate via the cost-effective and widely used Ethernet LAN standard. Any standard PC that controls the measurements and displays the results via an Ethernet connection can be used as a controller. The LXI standard supports the seamless exchange of software between traditional T&M equipment using a LAN interface and LXI modules. This safeguards existing investments since available software can continue to be used.

The LXI Consortium currently has 24 leading players from the T&M field.

TETRA radio system deployed in tsunami disaster area

To support rescue work in the tsunami disaster area of Banda Aceh (Indonesia), Siemens Austria is collaborating with Rohde & Schwarz to provide a mobile radio container as well as a team of technicians.

The TETRA radio station and its 100 mobile radio terminals will support the Indonesian police in their clean-up and rebuilding operations. The container, which is equipped with the *ACCESSNET*®-T mobile radio system from R&S BICK Mobilfunk, will remain in operation for at least three months and replace the partly destroyed communications infrastructure in Banda Aceh. If requested by the local authorities, a system covering the entire region will be set up.

Employees of the Indonesian office of Rohde & Schwarz helped to set up the radio system on site. The mobile TETRA radio system has a range of 20 km and can be operated independently or in combination with other radio stations.

DVB-T in Bavaria with transmitters from Rohde & Schwarz

Digital TV will debut in Bayern on 31 May 2005 using transmitters from Rohde & Schwarz. Bayerischer Rundfunk (Bavarian Broadcasting Corporation) and T-Systems have placed an order with Rohde & Schwarz to supply digital terrestrial transmitters.

The order is for 21 high-power transmitters, with output power ranging from 1.7 kW to 9.3 kW. A DVB-H pilot project will be started in Munich at the same time. The purpose of this project is to test TV signal transmission to mobile terminals. Rohde & Schwarz will apply its know-how from the areas of mobile radio and broadcasting.

The transmitters for the digital terrestrial TV network will be installed on Wendelstein mountain in the Bavarian Alps, the Munich Olympic Tower and on the Nuremberg and Dillberg telecommunications towers. This will provide coverage for the densely populated areas of Munich and Nuremberg as well as for parts of Upper Bavaria and Franconia.

General Kujat, Chairman of the NATO Military Committee, speaks with Achim Klein, member of Rohde & Schwarz Corporate Management and Head of the Radiocommunications Systems Division.

Number one in security

Rohde & Schwarz at the Berlin Security Conference, November 2004

The main topic at the 3rd European Security Conference in Berlin was the promotion of a common security and defence concept for Europe. Rohde & Schwarz introduced itself as a technologically skilled partner to the more than 800 participants from the fields of politics, security and the military. Rohde & Schwarz delivered presentations on "The Role of Modern Mobile Communications in the Transformation of Armed Forces", "Modern Radiocommunications for International Operations", and "Network Centric Warfare".

In his speech, Friedrich Schwarz noted that the development of military communications is being driven by the rapid technological progress in civil mobile radiocommunications. He placed special emphasis on the fact that European industry can make a significant contribution in this area.

Synergies and differences between civil and military use in mobile radio and the requirements demanded of future military transceivers were the focus of the presentation by Achim Klein, member of Rohde & Schwarz Corporate Management and Head of the Radiocommunications Systems Division, during the discussion forum on "Technical Aspects for International Missions".

At a separate discussion forum titled "Network Centric Warfare 2010", Henning Krieghoff, President of Rohde & Schwarz SIT GmbH, explained the significance of IT security, which must be incorporated from the outset: "… because adding security technologies at later stages makes the system vulnerable."

The contributions by the group of companies were presented in a parallel exhibit. Rohde & Schwarz's efforts paid off: It won the conference award for best interactive communications concept.

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