NEWS

200/10

ROHDE&SCHWARZ

World's first coaxial power sensors up to 67 GHz

Thermal power sensors featuring exceptional impedance matching, high accuracy and easy handling – for a wide range of applications

GENERAL PURPOSE

Unique: spectrum analyzer measures noise figure and gain in the 60 GHz range

BROADCASTING

For an efficient future: new liquid-cooled, VHF high-power transmitters

SECURE COMMUNICATIONS

TETRA professional mobile radio: get started economically – and expand as needed

NEWS

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Cover feature

State-of-the-art technology is no longer conceivable without powerful sensors. In ABS, in anti-collision radar and also in simple laundry dryers, these sensors measure the process parameters of interest directly at the site of occurrence.

In microwave applications, sensors help to ensure that the physical dimension “power” can be measured directly at the source. This approach keeps any influences that might invalidate the results to a minimum. During the last ten years, Rohde&Schwarz has helped to ensure that yesterday’s simple transducers have evolved into powerful miniature measuring instruments such as the new R&S®NRP-Z57 thermal power sensor.

The sensor has a continuous frequency range from DC to 67 GHz, and, in the application shown above, is used to perform power measurements at the chip level using embedding.

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Articles not published in this issue are available as PDF files in German, English and French at:
http://www.newsmag.rohde-schwarz.com.

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■ **LTE drive tests in one of Germany's first research mobile radio networks**
The Technical University of Dresden is using an LTE research mobile radio network to investigate the range of individual sectors and the optimum tilt angles of antennas and to characterize individual channels by evaluating the channel impulse response. The R&S®TSMW universal radio network analyzer and a PC running the R&S®ROMES4 drive test software were installed in a test vehicle to obtain key data for this study.
..... PDF file **N200_TSMW_e**

■ **R&S®ROMES2GO 3GPP walk test solution: significantly expanded in version 2.0**
R&S®ROMES2GO is an autonomous walk test solution that automatically records quality of service (QoS) data in 3GPP mobile radio networks and saves the data on the data card of a mobile phone. The latest version 2.0 of the R&S®ROMES2GO 3GPP walk test solution is a consistent follow-on development toward a coverage measurement system with significantly enhanced functionality.
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Group delay measurements on frequency converters for which the local oscillators of the mixers are not accessible
Group delay measurements of frequency converters without access to the local oscillator(s) of the mixers? Rohde&Schwarz has developed the ideal solution for this type of measurement: the two-tone technique. The R&S®ZVA-K9 option makes this technique available in the R&S®ZVA and R&S®ZVT network analyzer families.
..... PDF file **N200_ZVA-K9_e**

Spectrum/signal analyzers

■ **Unique: convenient measurement of noise figure and gain in the 60 GHz range**
The R&S®FSU67 is the only spectrum analyzer on the market for performing measurements in the frequency range above 50 GHz. Together with the R&S®FS-K30 firmware option and the 60 GHz noise figure test set from Noisecom, it is the most powerful, yet easiest-to-operate system on the market

GENERAL PURPOSE

for measuring the noise figure and gain of components in the microwave range around 60 GHz.
..... PDF file **N200_FS-K30_e**

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Signal generators

■ **Automated measurements of picture and sound quality of state-of-the-art TV sets**
The R&S®DVSG digital video signal generator supports the development and quality assurance of latest-generation TV sets and projectors. As a favorably priced one-box solution, it generates all audio and video signals required for deep color equipment with a color depth of up to 12 bit. For assessing sound quality, it offers numerous audio generator functions.
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SECURE COMMUNICATIONS

Professional mobile radio

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Radio conformance test systems ready for MIMO

Future mobile communications systems will have to provide high transmission rates for Internet and video applications. Advanced spatial multiplexing techniques such as MIMO offer the capabilities required. Now, the first RC test systems are available from Rohde&Schwarz for testing the corresponding base stations and terminal devices.

Combating data jams with MIMO

Multiple input multiple output (MIMO) systems represent a solution for increasing data rates for advanced mobile Internet and video applications and for improving error protection. These systems use multiple antennas at both the transmitter and receiver end (see box below).

Ready for MIMO: R&S®TS8970 WiMAX™ RCT as an example

The Worldwide Interoperability for Microwave Access (WiMAX™) wireless standard offers effective transmission rates of up to 30 Mbit/s (see article on page 12). In order to ensure this high-speed data transmission even under fading

MIMO – a brief overview In contrast to single input single output (SISO) systems, which use only one antenna each for the transmitter and the receiver, MIMO systems use multiple antennas for both the transmitter and the receiver (FIG 1). This means that they enable the use of (radio) space (spatial division multiplexing) for coding the transmitted signal. During transmission, the different signals reach the receiving antennas in different ways, and they are subjected to different attenuation and fading factors along the path. Under ideal circumstances, all transmitted signals arrive at all receiving antennas. In real transmission channels, however, each signal undergoes superposition at the receiver due to multipath propagation. In a worst-case scenario, this can completely suppress a signal. Under such conditions, reception would no longer be possible in a SISO system. This is where the advantages of MIMO systems come into play: Their receiving antennas allow them to receive multiple signals with different delays so that the bit stream can even be decoded when one of the signals is suppressed.

When the R&S®AMU200A baseband signal generator and fading simulator is equipped with the R&S®AMU-K74 fading split mode option [1] and two external I/Q inputs, it is possible to emulate a complete 2×2 MIMO channel by using two RF output stages. MIMO-typical merging of the transmitted signals at the receiving antennas takes place in the R&S®AMU200A after the fading modules (FIG 2).

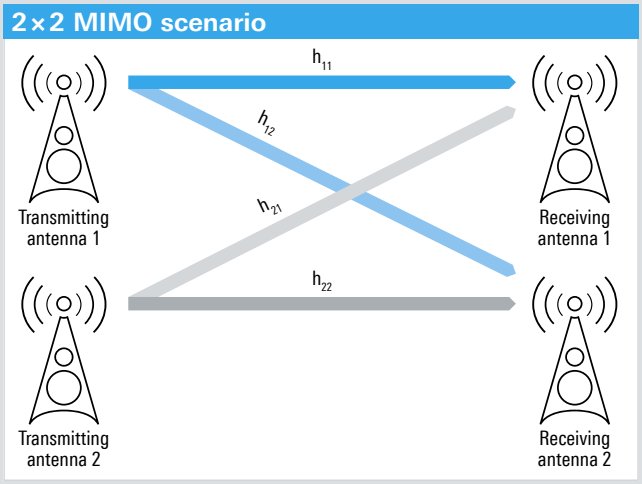


FIG 1 2×2 MIMO: two antennas at the transmitter and two antennas at the receiver. Both receiving antennas receive the signals from both transmitting antennas. This leads to four different transmission paths, which can have different fading and attenuation characteristics. These paths are described by the MIMO channel matrix *H* with the elements h_{11}, h_{12}, h_{21} and h_{22}.

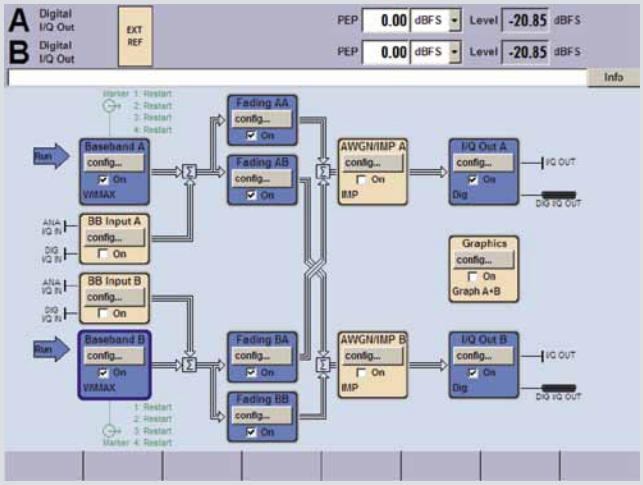


FIG 2 Representation of a 2×2 MIMO transmission on the display of an R&S®AMU200A: The two transmitted baseband A and B signals each pass two fading modules, which represent the two transmission paths from one transmitting antenna to the two receiving antennas. The paths are then linked to simulate typical MIMO transmission paths.

conditions, WiMAX™ employs the MIMO technique. For testing mobile stations and base stations under fading conditions, the Rohde&Schwarz portfolio includes, for example, the R&S®TS8970 Mobile WiMAX™ radio conformance test system (FIG 3). It was the first test system with MIMO measurement functionality on the market.

The WiMAX Forum® integrated all the required tests into the Mobile Radio Conformance Test Specification (MRCT) [2]. For WiMAX™, MIMO 2×2 (two transmitting and two receiving antennas) is specified for the downlink with two different MIMO transmission methods:

- Transmit diversity with space time coding according to Alamouti (Matrix A) [3]
- Spatial multiplexing (Matrix B) [4]

When using Matrix A, the signal is changed slightly and transmitted by both transmitting antennas. When channel conditions are unfavorable, this dual transmission provides a better error protection than SISO systems. Matrix B, however, sends different signals via the two transmitting antennas. When channel conditions are very good, the Matrix B method makes it possible to transmit data twice as fast as with SISO systems.

In the WiMAX™ MS 22.2 test case, for example, the packet error ratio (PER) and the physical carrier to interference plus noise ratio (PCINR) are used as the quality criteria for MIMO transmission. The transmission conditions vary for this test case, for example, in the following parameters:

- Fading profile (pedestrian, 3 km/h; motor vehicles, 60 km/h and 120 km/h)
- Correlation of MIMO channels
- Modulation
- Code rate

The MS 22.2 test case consists of two parts (A and B) with a total of six test cases that allow all kinds of configurations to be tested using Matrix A and Matrix B:

- Part A: measurement of the packet error ratio (PER)
  - Test case A1: Matrix A (same power levels received at both antennas)
  - Test case A2: Matrix B (same power levels received at both antennas)
  - Test case A3: Matrix B (different power levels received at the two antennas)
  - Test case A4: mode selection: selection of Matrix A and Matrix B through mobile station feedback depending on the channel status
- Part B: measurement of the signal quality (PCINR) using an interfering signal
  - Test case B1: Matrix A
  - Test case B2: Matrix B

WiMAX™ MS 22.2 test case, part A

The first two test cases, A1 and A2, examine the capability of a WiMAX™ mobile station to demodulate and decode a MIMO signal using Matrix A or Matrix B. In test case A3, the power received at one of the two receiving antennas is moreover reduced by 4 dB. As a result, half of the symbols sent are transmitted via a lower-quality channel. Under certain circumstances, the mobile station is not able to decode disrupted symbols, which increases the packet error ratio. Due to the use of Matrix B, the mobile station is not able to reconstruct the faulty symbols from the signal received by the other antenna.

FIG 3 Example: The R&S®TS8970 WiMAX™ radio conformance test system with MIMO test functionality.

Simulation of a radio channel

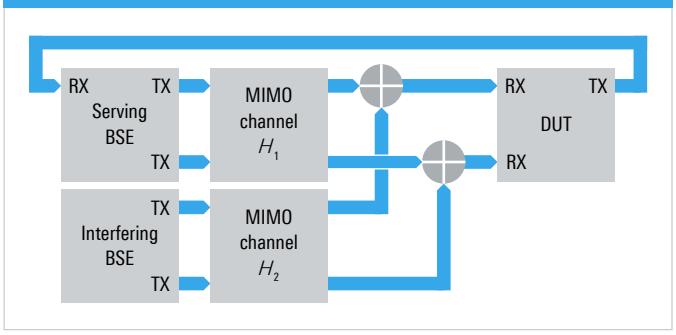


FIG 4 Simulation with a wanted MIMO signal and an interfering MIMO signal.

Combination of signals

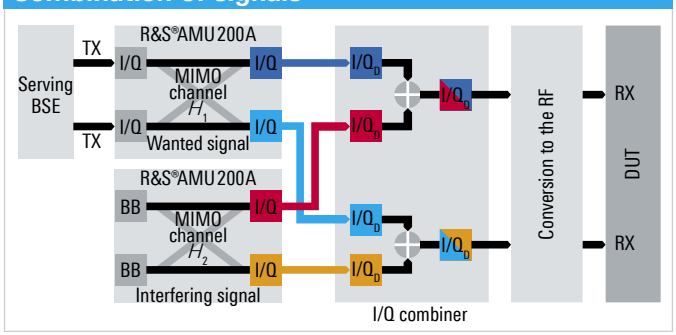


FIG 5 The software-controlled I/Q combiner in the test system is able to automatically set all of the signal paths required for SISO or for MIMO.

Matrix A and Matrix B offer different advantages depending on the channel quality. When channel conditions are unfavorable, Matrix A reduces the transmission error ratio. Matrix B boosts data throughput when channel conditions are good. With test case A4, the MIMO transmission method is adapted to the channel conditions. The base station transmits part of the data in burst 1 with the modulation, channel coding and MIMO method that the mobile station suggests for the given channel quality. The remaining transmission data uses the corresponding settings in burst 2 with the next-highest spectral efficiency; consequently, it exceeds the required error ratio. The packet error ratios, which are determined separately for the two bursts, decide whether or not the mobile device has passed test case A4.

WiMAX™ MS 22.2 test case, part B

The test case in which both the wanted signal and the interfering signal are transmitted to the device under test (DUT) via a MIMO transmission link with specific fading profiles presents a particular challenge for simulating the radio channel (FIG 4). Here, four MIMO signal paths (wanted and interfering signal) have to be mapped on two antennas. In the R&S®TS8970, two R&S®AMU200A signal generators simulate the MIMO channels (H_1, H_2) with the required fading profiles.

Turn four into two: I/Q combiner merges signals

The resulting four digital I/Q streams at the R&S®AMU200A's two outputs contain the information for the H_1 and H_2 MIMO channels. In the next step, the I/Q data is passed on to an I/Q combiner, which adds the wanted signal and the interfering signal for the corresponding antenna configuration (FIG 5). In the final step, the data is converted to the RF before finally being fed to the DUT.

Summary

The R&S®TS8970 test system generates MIMO signals, including fading, for the receiving antennas of the DUTs. Signal generation in the baseband enables the use of a compact, software-controlled I/Q combiner that automatically sets the required signal paths for both SISO and MIMO. In addition, the system configuration contains all components for testing wanted signals for up to 4×2 MIMO scenarios. The R&S®TS8970's MIMO measurement functionality and the possibility of using it for future test cases safeguards the investment in the long term.

The upcoming Long Term Evolution (LTE) wireless communications standard also employs MIMO for boosting the data rate. The R&S®TS8980 LTE test system can test mobile devices in accordance with the RF test specification [5] for LTE, which defines test cases for 4×2 MIMO scenarios. Rohde&Schwarz offers customers who are using the R&S®TS8970 test system inexpensive conversion to the R&S®TS8980 for LTE.

Dr. Thomas Brüggen; Siegfried Friesinger

References
[1] R&S®SMU200A / R&S®AMU200A generators: MIMO receiver tests. News from Rohde&Schwarz (2007) No. 193, pp. 9–10.
[2] Mobile Radio Conformance Tests (MRCT), Specification 2.2.1, p. 179 pp., WiMAX Forum® 2008.
[3] From SISO to MIMO – taking advantage of everything the air interface offers (part 1). News from Rohde&Schwarz (2007) No. 192, pp. 16–19.
[4] From SISO to MIMO – taking advantage of everything the air interface offers (part 2). News from Rohde&Schwarz (2007) No. 194, pp. 4–7.
[5] Test specification 3GPP 36.521-1, "User Equipment (UE) conformance specification, radio transmission and reception, Part 1: Conformance Testing".

World's first 3GPP and IMT-2000 scanner now also "understands" LTE

The R&S®TSMW-K29 LTE scanner option expands the R&S®TSMW universal radio network analyzer to meet 3GPP LTE requirements. It is the only scanner capable of simultaneously measuring the parameters of six mobile radio standards for all three ITU regions worldwide in the frequency range from 30 MHz to 6 GHz.

Six mobile radio standards with one scanner

Owing to its new option, the R&S®TSMW can handle six mobile radio standards in parallel: LTE FDD and TD-LTE, WCDMA, GSM as well as CDMA2000®, 1xEV-DO and WiMAX™. This makes it ideal for setting up and optimizing 3GPP LTE networks, and in particular for integrating the new LTE standard into existing 3GPP and IMT-2000 networks. Especially during the initial network setup phase – long before handheld wireless devices or test mobile phones are available – the R&S®TSMW is the most important and reliable source for drive test data. This data is required to analyze both coverage and interference.

Network operators, regulatory authorities and base station manufacturers will profit from the scanner's high degree of automation, which simplifies the analysis of LTE mobile radio networks. For example, the 3GPP LTE synchronization channels do not have to be entered manually, since signal scan and measurements run automatically. Featuring high sensitivity (up to –127 dBm), the radio network analyzer is capable of detecting even the weakest signals. Due to its signal-to-interference ratio from –20 dB to +40 dB, detection is even possible when the frequency channel experiences fading and interference. For LTE (both FDD and TDD) and CDMA2000®/1xEV-DO, as well as for GSM/WCDMA, the universal radio network analyzer also demodulates the system information in order to identify the source of interference within the networks – in the individual

An article on an LTE research project carried out at the Technical University of Dresden, Germany, shows the successful deployment of the R&S®TSMW and the R&S®ROMES drive test software in the initial LTE networks (PDF file **N200_TSMW_e** on the Internet, see page 4).

The R&S®TSMW universal radio network analyzer is a high-performance mobile radio scanner for optimizing all common mobile radio networks. It was specially developed for applications requiring fast measurement and analysis of digital baseband data. For more detailed information, see NEWS 197/08 (pp. 6–8).

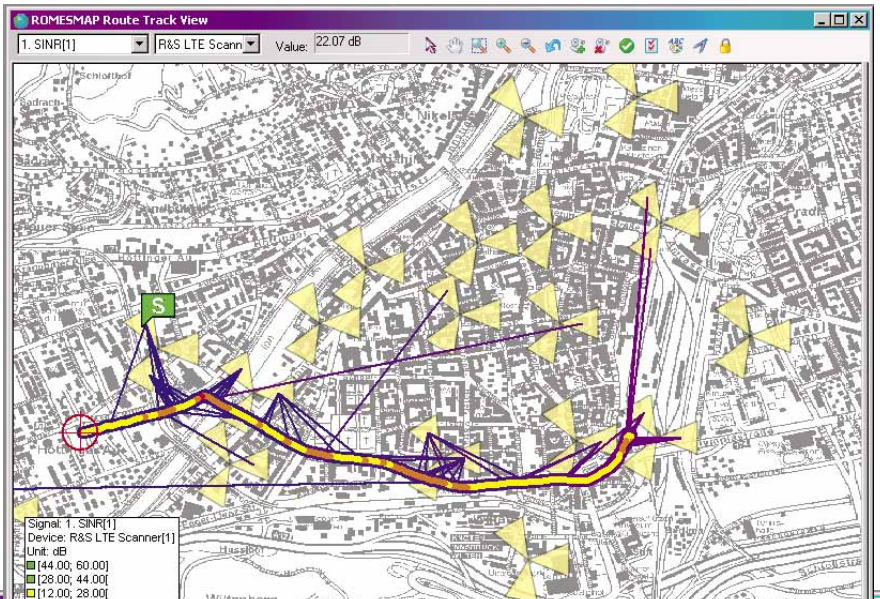
RF performance

- LTE FDD und TD-LTE/WCDMA/GSM/CDMA2000®/CDMA2000® 1xEV-DO/WiMAX™
- No band limiting, fully covered frequency range from 30 MHz to 6 GHz
- Two independent receivers with preselection and an IF bandwidth up to 20 MHz
- Intermodulation-free dynamic range
- Signal-to-interference ratio with LTE from –20 dB to +40 dB

LTE performance

- High degree of automation with code power measurements
- Demodulation of system information (MIB)
- Measurement of the channel impulse response (CIR) up to the eight-fold guard interval (normal cyclic prefix)
- Adaptive measurement that combines high selectivity with high measurement speed
- Sensitivity up to –127 dBm, synchronization up to –125 dBm
- Up to 200 measurements per second (up to 80 km/h for Lee criterion)
- Channel measurements and fading analysis for Doppler frequencies up to ±100 Hz

FIG 1 The map view provides an example of the signal-to-interference-plus-noise ratio (SINR) along the route and displays the base station with the highest received signal code power.



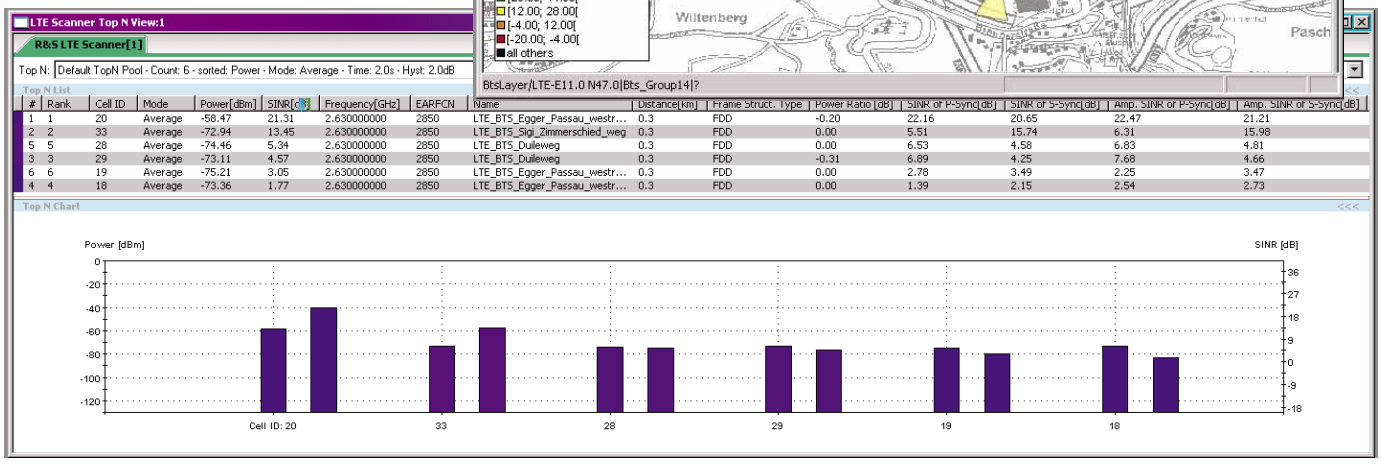


FIG 2 The LTE Top N view displays the N-strongest signals with code power and SINR.

network but also across borders. Together with the integrated spectrum measurement, the R&S®TSMW thus enables a comprehensive analysis of the air interface regarding to coverage and LTE network issues (FIGs 1 and 2). Offering a measurement speed of up to 200 measurements per second, complete network coverage testing can be carried out even if driving at high speed.

A key factor for setting up LTE networks is the measurement of the channel impulse response up to 35 µs duration (8-fold guard interval) (FIG 3). In the OFDM modulation mode, which is used with LTE, the guard interval serves as protection against reflections (intersymbol interference) that might occur on buildings or mountains, for example. If the guard interval is impacted as a result of longer delay reflections, data throughput can be considerably impaired, a problem that neither test mobile phones nor conventional scanners can detect (FIG 4).

In addition to a GPS receiver, the R&S®TSMW also has two built-in independent receivers with separate antenna inputs, allowing users to flexibly combine and simultaneously measure signals of different standards or frequency bands. Despite the wide frequency range and the high measurement bandwidth of up to 20 MHz, the R&S®TSMW is fully protected against interference and intermodulation. This is due to an adaptive preselection that filters out all disturbing influences outside the wanted frequency bands.

Two measurement modes were developed for LTE measurements:

- Streaming mode, in which the two RF frontends are able to pick up one or two RF channels simultaneously. This fast measurement mode with up to 200 measurement results per second is available only for LTE and cannot be combined with other measurements

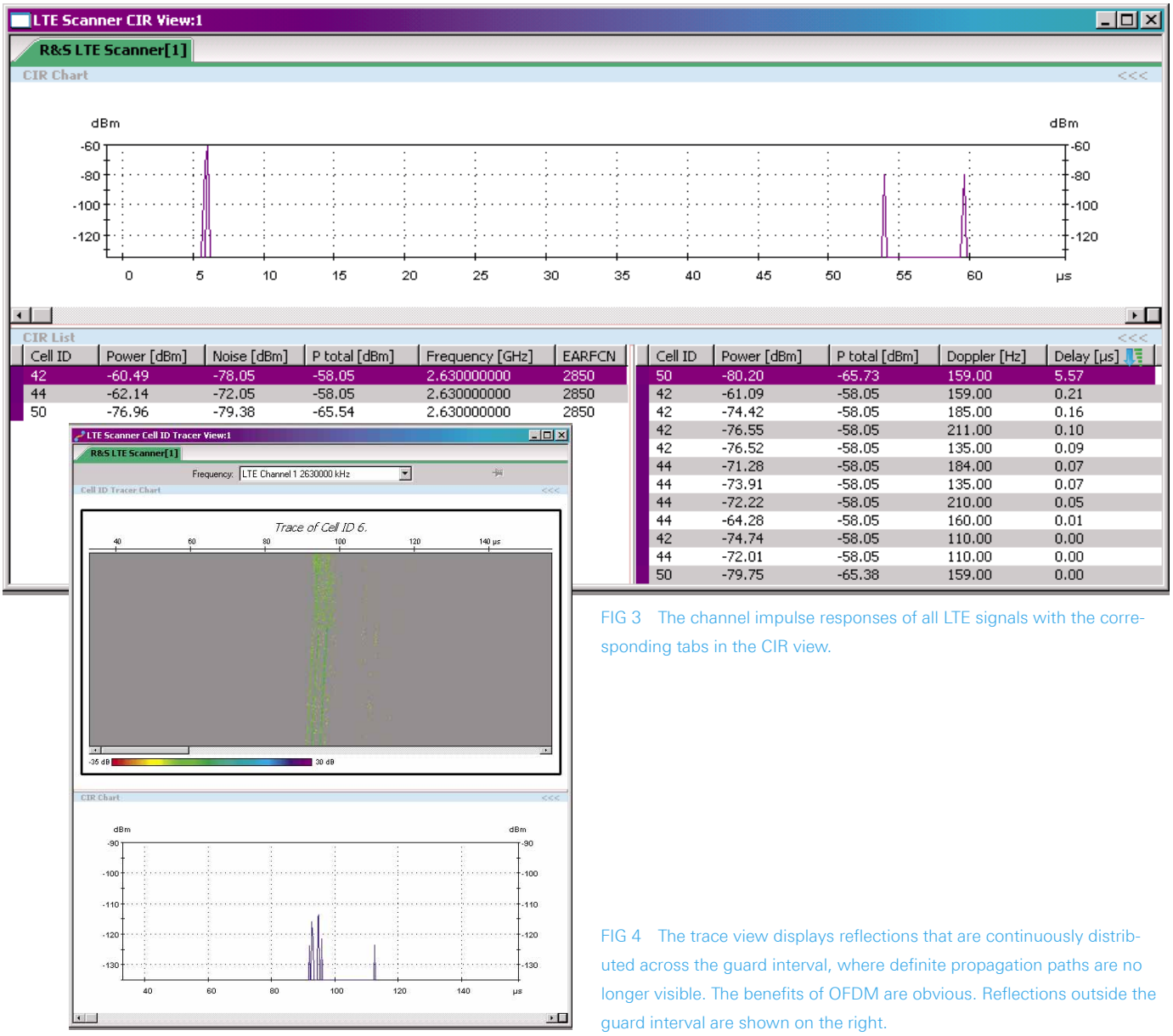


FIG 3 The channel impulse responses of all LTE signals with the corresponding tabs in the CIR view.

FIG 4 The trace view displays reflections that are continuously distributed across the guard interval, where definite propagation paths are no longer visible. The benefits of OFDM are obvious. Reflections outside the guard interval are shown on the right.

- Block mode, in which up to 64 RF channels can be picked up using the multiplex method (also with up to 200 measurement results per second). In this mode, all other measurements for CDMA2000®/CDMA2000® 1xEV-DO as well as for GSM/WCDMA or WiMAX™ can be added in parallel, reducing the measurement rate for each standard correspondingly.

Moreover, the high measurement speed allows pilot power measurements (measured separately for each base station) in accordance with the Lee criterion (50 measurement results per 40-wavelength distance) up to a speed of 80 km/h. In the case of GSM, for example, this could previously be achieved only by using high-quality test receivers that performed analog power measurements without any reference to the base stations.

The R&S®TSMW is controlled by the R&S®ROMES4 drive test software, which supports all of the scanner functions. An option has been developed for the R&S®ROMES network problem analyzer software (R&S®ROMES4NPA) for conducting postprocessing and problem-spot analysis in LTE coverage measurements.

The R&S®TSMW is a future-oriented and scalable multi-standard platform that fully covers the frequency range from 30 MHz to 6 GHz. Rohde&Schwarz will continue to enhance the new R&S®TSMW-K29 LTE scanner option because it is an important element in the coverage measurement portfolio that will help keep pace with future requirements.

Wolf Seidl

WiMAX™ data throughput measurements with the R&S®CMW270

The R&S®CMW270 not only allows the theoretical data rates on a WiMAX™ air interface to be measured, but it also makes it possible to perform any kind of data throughput measurement. This includes, for example, testing of an application – using the R&S®CMW270 as a WiMAX™ base station emulator – and inspection of individual wireless modules in development and production.

Data throughput – a term with several definitions

Ask several experts what the highest possible data throughput is for a wireless broadband interface, such as a WiMAX™ air interface, and you will probably receive different answers that are, nevertheless, correct. This is because there are different ways to define data throughput. For example, users who pay for a commercial broadband network are only interested in the application-specific payload data rate, i.e. the data throughput available for "their" application. Developers of wireless modules are more interested in the data rate that can be achieved across the module as a function of the modulation or channel coding scheme, for instance. Consequently, it is always necessary to differentiate between an application-specific end-to-end (e2e) payload data rate (e.g. the throughput between FTP server and client) and the data rate that can be achieved across a specific (air) interface. The R&S®CMW270 WiMAX™ communication tester enables all interested parties to perform the throughput measurements that are important for their requirements.

Data throughput via WiMAX™

Prior to testing the quality of a WiMAX™ wireless module implementation or evaluating an application's throughput on a WiMAX™ interface, it is necessary to determine the theoretical maximum data throughput that can be achieved with WiMAX™ and to establish the reference values in this way. This requires some insight into WiMAX™ transmission. The WiMAX™ wireless broadband interface transmits data with 2M QAM using CP-OFDM transmission [1] [2] in both directions. This means that the available transmission bandwidth is used by a defined number (N_{data}) of orthogonal data subcarriers. Each of these subcarriers transmits a modulation symbol of the order M, i.e. M bits. Therefore, the maximum instantaneous data rate R across the duration of a symbol (T_{symbol}) is as follows:

$$R = \frac{M \cdot N_{data}}{T_{symbol}}$$

FIG 1 shows the data rates calculated for a WiMAX™ air interface standardized in line with IEEE 802.16™ as a function of the nominal bandwidth (BW). However, these values do not

The R&S®CMW270 WiMAX™ communication tester is the first real all-in-one solution for the cost-optimized mass production of WiMAX™ mobile stations. An article in NEWS 199/09 (pp. 21–23) described how to use this tester to perform extensive end-to-end performance tests.

BW (MHz)	N_{used}	T_{symbol} (µs)	QPSK (M = 2) (Mbit/s)	16QAM (M = 4) (Mbit/s)	64QAM (M = 6) (Mbit/s)
10	720	102.9	14	28	42
8.75	720	115.2	12.5	25	37.5
7	720	144	10	20	30
5	360	102.9	7	14	21
3.5	360	144	5	10	15

FIG 1 Maximum SISO instantaneous data rate in the PUSC mode with a CP ratio of 1/8 as a function of the nominal bandwidth (BW).

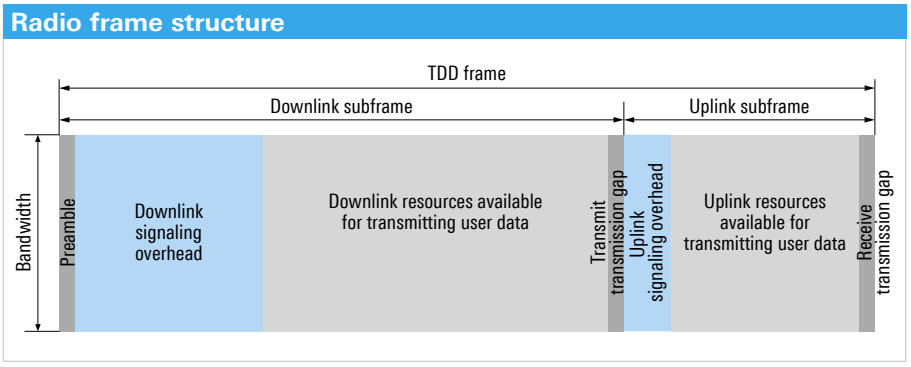


FIG 2 WiMAX™ radio frame structure in time division duplex.

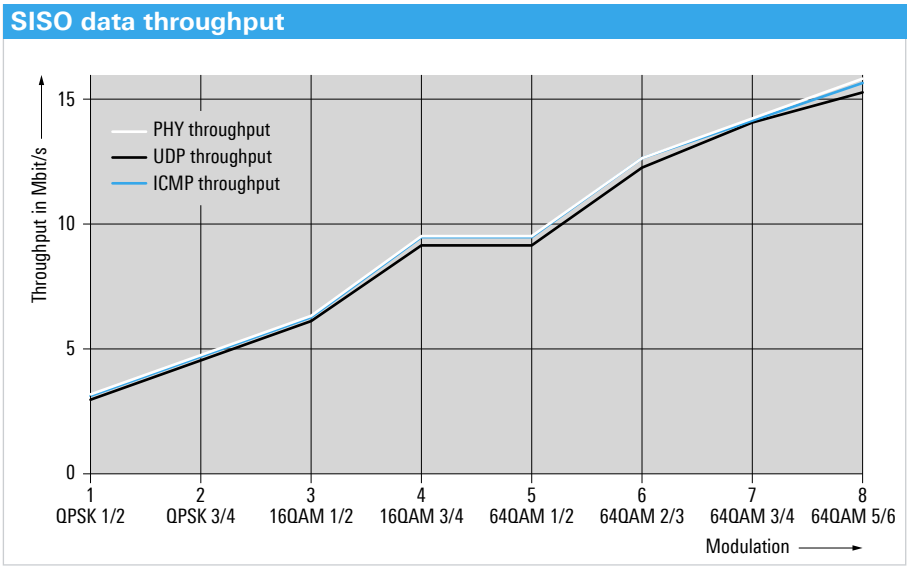


FIG 3 Results of a SISO data throughput measurement with the R&S®CMW270.

correspond to the maximum possible payload data rate. The payload data rate depends on numerous other parameters such as the channel coding rate and the duplex scheme. For instance, when a convolutional code with the coding rate 2/3 is used, the two bits at the input turn into three bits at the output. This means that channel coding alone increases the data rate by 50 %.

In addition, the duplex scheme employed has a significant influence on the data throughput. FIG 2 shows the basic structure of a WiMAX™ radio frame in time division duplex (TDD). The available resources are first divided between downlink and uplink. When the resources required for the reference signals (e.g. the preamble) and for general signaling (for instance, for transmitting system information) are subtracted, only a portion of the resources remains available per radio frame for transmitting payload data in both directions. The WiMAX Forum® defines the exact distribution of resources for the different bandwidths in the profile document [3].

FIG 3 shows an example of the maximum throughput on the physical layer (PHY throughput) determined with the aid of the R&S®CMW270 as a function of the modulation mode and the coding rate. The results are based on a channel with a nominal bandwidth of 10 MHz and a downlink signaling overhead (see FIG 2) of 12 OFDMA symbols. They show that the maximum PHY throughput of 15.84 Mbit/s is achieved with 64QAM and a coding rate of 5/6. This data rate could be increased further by reducing the downlink signaling overhead, but this is not possible in real-world networks. In the lab, however, this reduction is definitely of interest, and it can be accomplished with the R&S®CMW270. It is also possible to achieve a noticeable increase by employing space division multiplexing. In this way, a 2×2 antenna configuration (Matrix B MIMO [4]), for instance, can be used to double the data rates. An R&S®CMW270 with two channels is even able to implement this configuration without requiring additional T&M instruments.

Data throughput measurement

FIG 4 Test setup for data throughput measurements with the R&S®CMW270 WiMAX™ communication tester.

Data throughput measurements with the R&S®CMW270

FIG 4 shows the basic test setup for performing data throughput measurements with the R&S®CMW270. Here, the tester acts as a WiMAX™ base station emulator. An application – such as a UDP data stream or an FTP file transfer – is implemented using a server PC at the network end and a client PC at the WiMAX™ DUT end. The R&S®CMW270 routes the server data to the WiMAX™ air interface's downlink; the WiMAX™ DUT receives this data and forwards it to the application layer. In the case of UDP, a protocol for unidirectional connectionless data transmission without acknowledgement, the maximum data rates are obtained after deduction of the protocol overhead, as can be seen from the measurement results in FIG 3. The same holds true for throughput measurements at the ICMP level. Using a connection-oriented protocol with acknowledgements (such as TCP or FTP) reduces the payload data rate with decreasing packet size and increasing latency (round trip time).

Summary

The R&S®CMW270 WiMAX™ communication tester enables users not only to achieve the theoretical data rates on a WiMAX™ air interface, but also allows them to perform any type of data throughput measurement. This includes, for example, testing of an application – using the R&S®CMW270 as a WiMAX™ base station emulator – or inspection of individual wireless modules in development and production. All technical background information on this topic and additional details about WiMAX™ throughput measurements using the R&S®CMW270 are covered in detail in an application note [5] from Rohde&Schwarz. This application note is available for free download on the Rohde&Schwarz website.

Heinz Mellein

Abbreviations

BW	Bandwidth (nominal)
CP	Cyclic prefix
DUT	Device under test
FTP	File transfer protocol
ICMP	Internet control message protocol
MIMO	Multiple input multiple output (multiple transmit and receive antennas)
OFDM	Orthogonal frequency division multiplex
QAM	Quadrature amplitude modulation
QPSK	Quadrature phase shift keying
SISO	Single input single output (one transmit and one receive antenna)
TCP	Transfer control protocol
TDD	Time division duplex
UDP	User datagram protocol
WiMAX™	Worldwide interoperability for microwave access

References

[1] IEEE 802.16™ Revision 2, Draft 8.
[2] IEEE Communications Magazine, October 2008.
[3] WiMAX Forum® Mobile System Profile, Rel. 1.0 (Revision 1.7.0: 2008-09-18).
[4] Complete test solution for WiMAX™ applications. News from Rohde&Schwarz (2005) No. 187, pp. 33–37.
[5] Mobile WiMAX™ throughput measurements using the R&S®CMW270. Application Note 1SP10 (2009) from Rohde&Schwarz.

Additional literature about WiMAX™

– IP-based application testing on WiMAX™ mobile stations. News from Rohde&Schwarz (2009) No. 199, pp. 21–23.
– RC test systems ready for MIMO (in this issue).
– R&S®SMx signal generators / R&S®FSQ / FSL analyzers: WiMAX™ goes mobile – new T&M solutions are required. News from Rohde&Schwarz (2006) No. 190, pp. 24–27.
– R&S®TS8970 WiMAX™ radio conformance test system: Benchmark for the certification of WiMAX™ end products. News from Rohde&Schwarz (2006) No. 191, pp. 26–28.
– R&S®TS8970 WiMAX™ radio conformance test system: State-of-the-art – all WiMAX™ RF certification tests. News from Rohde&Schwarz (2007) No. 194, pp. 15–17.

Thermal power sensors up to 50 GHz and 67 GHz

Rohde&Schwarz is further strengthening its position in microwave T&M by launching the world's first coaxial power sensor up to 67 GHz with a 1.85 mm connector (R&S®NRP-Z57) as well as a coaxial power sensor up to 50 GHz with a 2.4 mm connector (R&S®NRP-Z56).

FIG 1 The R&S®NRP-Z56 and R&S®NRP-Z57 thermal power sensors.

Taking the lead in technology

State-of-the-art thermal power sensors offer numerous advantages over their diode-based counterparts. They feature higher accuracy, tolerate any type of modulation, and easily handle harmonics in the test signal. They are therefore the preferred choice for demanding applications. In the microwave range, these superior characteristics are complemented by significantly better impedance matching, which ensures sufficiently high measurement accuracy even with poorly matched sources (DUTs).

Rohde&Schwarz took a radically new approach (see box on page 16) in designing the new products (FIG 1) by developing thermal power sensors that outperform competitive products in terms of accuracy and ease of handling. Going beyond the capabilities of conventional power sensors, they are full-featured measuring instruments and can thus be operated on any PC, the R&S®NRP power meter and many other instruments from Rohde&Schwarz.

Featuring excellent impedance matching, high measurement accuracy and straightforward handling, the two sensors can be used in a wealth of applications, e.g. as high-precision power references for metrological applications, for power calibration on signal generators, network and spectrum analyzers, and for a wide variety of applications in radiocommunications.

Excellent impedance matching

The accuracy of an instrument can generally be increased by determining its measurement errors during calibration and using the results to correct the measured values. This method fails, however, in the case of effects that cannot be handled through calibration and therefore often have to be left unconsidered. These include stochastic effects such as noise and reproducibility of the RF connector and, most importantly, the measurement uncertainty resulting from mismatch of the power sensor.

Impedance matching of power sensors

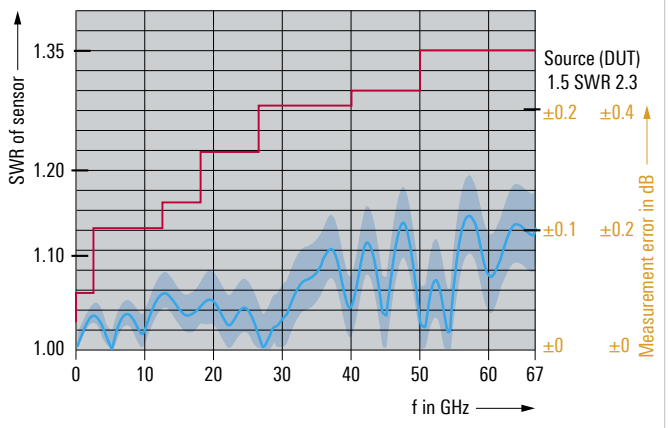


FIG 2 Impedance matching (SWR) of the R&S®NRP-Z56 and R&S®NRP-Z57 thermal power sensors: specified limits (red) and measured data for the R&S®NRP-Z57 (blue) with measurement uncertainty shown in light blue. The labeling in orange on the vertical axis to the right shows the maximum possible measurement error caused by mismatch for two sources (DUTs) with an SWR of 1.5 and an SWR of 2.3.

Minimizing mismatch uncertainty has therefore been one of the primary goals in development. This goal has been reached by implementing the best impedance matching currently achievable with coaxial power sensors for the frequency range in question (FIG 2). While potential mismatch uncertainties cannot be ignored, they are so small that they usually do not impair measurements. For highly demanding applications, it may be necessary to reduce mismatch uncertainties even further. The two new sensors also meet this requirement by means of their gamma correction function.

High stability under all environmental conditions

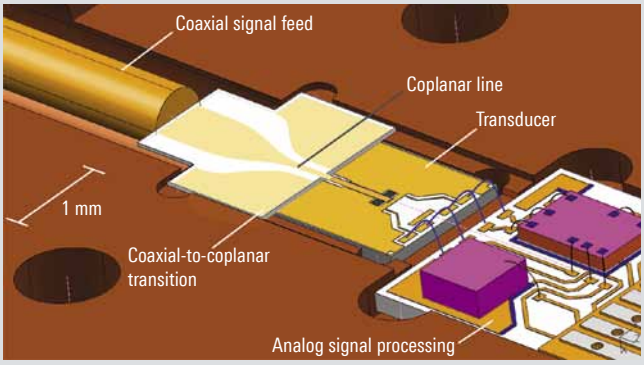
Especially for precision measuring instruments such as thermal power sensors, high reproducibility of results is a vital requirement. This also calls for immunity of the sensor with respect to changes in environmental conditions. The factor that has the most detrimental effect on a thermal sensor is – inherently – temperature. A change in temperature will have two effects: First, as the temperature difference between the sensor and its environment grows, zero drift will occur. This will be followed by a change in the sensitivity of the thermoelectric transducer as the transducer heats up or cools down. While the second effect can be largely eliminated by measuring the sensor temperature and applying suitable correction algorithms, zero drift cannot really be corrected using a mathematical approach.

State-of-the-art technology – patent pending

Thermal power sensors convert the applied power into heat and measure the resulting increase in temperature. Their main elements are, therefore, a broadband, well-matched termination and a temperature-sensing device. State-of-the-art microwave power sensors and their predecessors are worlds apart, however, when it comes to design. This holds true for the physical dimensions of the transducer, which has shrunk to the size of a pinhead as higher and higher frequency ranges have opened up, as well as for the temperature-sensing device. The sensitivity of this device has been continuously improved. Plus, rather than measuring the absolute temperature of the termination, only its increase in temperature is measured using a thermocouple pile, which delivers results that are less dependent on ambient temperature.

If the objective is to extend the frequency range up to 50 GHz or 67 GHz, as in the case of the two new products, and achieve excellent impedance matching at the same time, further miniaturization alone will not produce the desired effect. The problem lies with the mechanical tolerances of lathed or milled parts.

FIG 3 RF frontend (patent pending) of the R&S®NRP-Z56 and R&S®NRP-Z57 thermal power sensors.



With a 1.85 mm connector system, which is required for attaining the 67 GHz frequency limit, a classic design consisting of a large number of individual components would yield a less-than-optimal result. For the two new power sensors this meant reviewing the design of the entire RF signal path.

The result of this effort is a considerably simplified and radically new topology, where the transition from the connector's coaxial line structure to the transducer's coplanar line structure has been implemented by means of photolithography (FIG 3). Due to its small structural tolerances in the order of a micrometer, the transition exhibits highly reproducible performance. At the same time, it provides excellent thermal isolation. This offers the advantage that in the event of temperature differences between the DUT and the thermoelectric transducer, only very small amounts of heat will enter the sensor.

The transducer itself is a Rohde&Schwarz development based on thin-film technology with a measurement range from –35 dBm to +20 dBm. The increase in temperature of the termination is in the order of 10^{-4} K at the lower measurement limit, reflecting the stringent demands placed on heat management. The new power sensors are DC-coupled in the same manner as the predecessor models. As a result, they feature a continuous frequency range from DC to the upper measurement limit, plus they can be linearized with ultra-high accuracy using DC voltages.

For this extremely high linearity to be supported throughout the sensor's signal processing chain, processing of the full power measurement range by the A/D converter without any switchover was required. What is impossible to achieve with classic power meters could be easily implemented by employing the concept of an integrated power meter, i.e. using a low-noise amplifier tailored to the transducer and an integrating 24-bit A/D converter. The resulting linearity of 0.007 dB sets standards.

To minimize zero drift, therefore, an elaborate heat management is needed. The new sensor topology has enabled significant improvements in this area, reflected by a considerably reduced zero drift and a lower measurement limit of –35 dBm, which represents an improvement by a factor of three. This is good news for users, as it means an enhanced reproducibility of results and an infrequent need for zero adjustment even under varying environmental conditions (FIG 4). Due to the minimal zero drift, the zero correction carried out in production will in many cases be entirely sufficient.

Accurate calibration

Whereas with most commercial thermal power sensors only a frequency-dependent calibration factor for absolute measurement accuracy is determined, calibration of the R&S®NRP-Z56/-Z57 also covers linearity, impedance matching and zero offset. In conjunction with hardware offering high long-term stability, this yields ultra-high measurement accuracy, which is reflected, for example, by excellent linearity. A specified value of 0.007 dB across the full power measurement range makes the new sensors an ideal choice for performing high-precision relative measurements.

Calibration of absolute measurement accuracy from DC to 50 GHz is directly traceable to primary standards of Germany's National Metrology Institute (Physikalisch-Technische Bundesanstalt, PTB) [1], and above 50 GHz to the relevant standards of the US National Institute of Standards (NIST). Gamma correction yields specified measurement uncertainties in the order of 0.15 dB (50 GHz) and 0.25 dB (67 GHz) [2].

Long-term measurement

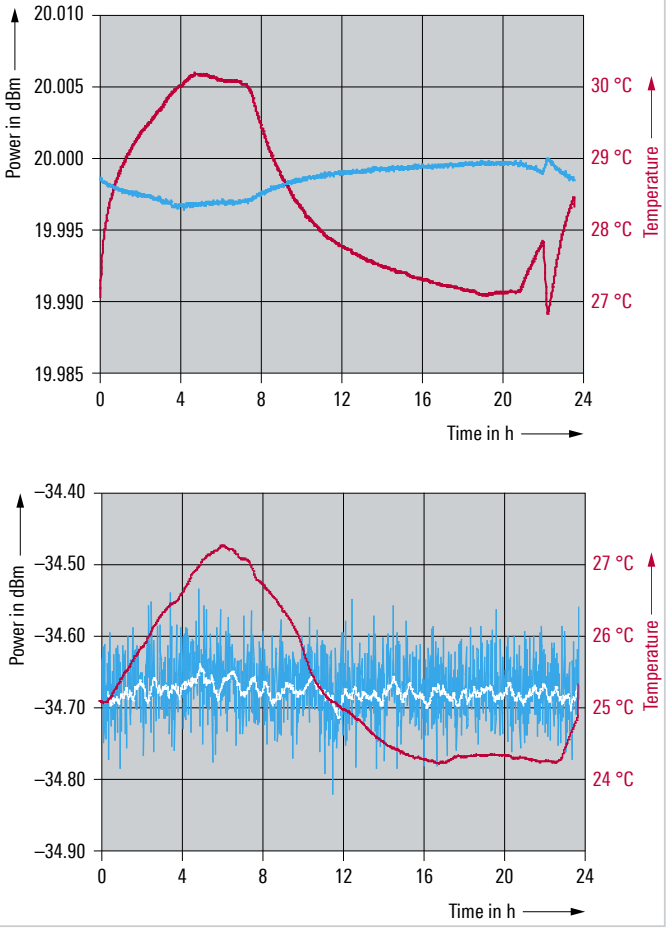


FIG 4 Long-term measurement with an R&S®NRP-Z56 thermal power sensor in a typical work environment. Blue (white): results of power measurement. Red: ambient temperature.

High reliability

Rohde&Schwarz has implemented a special verification function in the R&S®NRP-Z56/-Z57 sensors. This function covers all essential components of the signal path. The thermoelectric transducer therefore contains, in addition to the RF termination, a second heating element which can be fed from an internal, highly stable DC source. Using a test routine, the sensor's response to the applied DC power is measured and compared against the value stored during the previous calibration. With reproducibility in the order of a few thousandths of a dB, highly reliable results will be obtained, providing information about the functionality and accuracy of the power sensor. Two further advantages: The power sensor can remain on-site during verification, and verification can even be performed while another measurement is carried out.

An important component could not be included in the verification loop: the connector and its RF characteristics. Because wear and tear can impair connector performance and result in poor reproducibility and even failure of the power sensor, Rohde&Schwarz has added a truly tangible product innovation: A coupling nut with a ball bearing keeps the connector interfaces from twisting relative to each other during tightening, thus preventing premature wear.

Thomas Reichel;
Dr. Werner Perndl

References
[1] Dr.-Ing. Rolf Judaschke, Physikalisch-Technische Bundesanstalt (National Metrology Institute of Germany): Traceability of RF measurement quantities to national standards. News from Rohde&Schwarz (2009) No. 199, pp. 28–33.
[2] Dr. Gerhard Rösel: RF power calibration at Rohde&Schwarz. News from Rohde&Schwarz (2009) No. 199, pp. 34–37.

Connect once and fully characterize active components

To fully characterize active components, a wide variety of parameters has to be measured: from gain and matching to compression, harmonics and intermodulation. For many DUTs, these measurements have to be performed in pulse mode. With the new R&S®ZVAX24 extension unit, all this can be done with a single test setup.

A modular extension unit makes complex measurements simple

The R&S®ZVAX24 extension unit is of modular design and, depending on the application, contains various components such as pulse modulators, harmonic filters, high-power couplers and/or a combiner. Connected to the R&S®ZVA24 vector network analyzer – or any other network analyzer of the R&S®ZVA or R&S®ZVT family – it provides a measurement system that allows the full characterization of active components in the linear and nonlinear range (FIG 1). The extension unit acts as a part of the network analyzer as it is integrated into the analyzer's signal path and is completely controlled by the analyzer. Depending on the measurement task, the individual components can be activated or deactivated via a graphical user interface on the analyzer (FIG 2). For example, the combiner can be activated to generate a two-tone signal for intermodulation measurements. The advantage: There is no need to reconnect the DUT for any measurement. All parameters can be measured using the same test setup, because the required signal paths are created by making the appropriate connections in the extension unit. This is of decisive importance in on-wafer measurements, for example, as these require all parameters to be determined under exactly the same conditions.

Measuring in pulse mode

For DUTs that can be operated and tested only under pulsed conditions, e.g. amplifiers, the extension unit delivers pulsed test signals – external add-on hardware is superfluous. For this purpose, switchable pulse modulators in the R&S®ZVAX24 generate a pulsed test signal from the CW test signal supplied by the network analyzer. The pulse modulators are controlled by the pulse generators in the network analyzer. Continuous pulses with widths down to nanoseconds as well as single pulses and arbitrary pulse sequences (referred to as pulse trains) can be generated. These test signals are of interest primarily for amplifier testing in the aerospace & defense sector and can be user-defined via a graphical user interface. A sync generator can control the amplifier before the measurement is started and put it into the required state of operation.

In addition to the common high-PRF method (PRF = pulse repetition frequency) or point-in-pulse measurement, the R&S®ZVA network analyzer offers a unique pulse profile measurement with 12.5 ns resolution for analyzing extremely short pulses.

FIG 1 Connecting the R&S®ZVAX24 extension unit to the network analyzer is easy: The extension unit is placed under the network analyzer, and the RF ports of the two units are connected by means of semi-rigid cables. The extension unit is controlled via USB directly from the network analyzer.

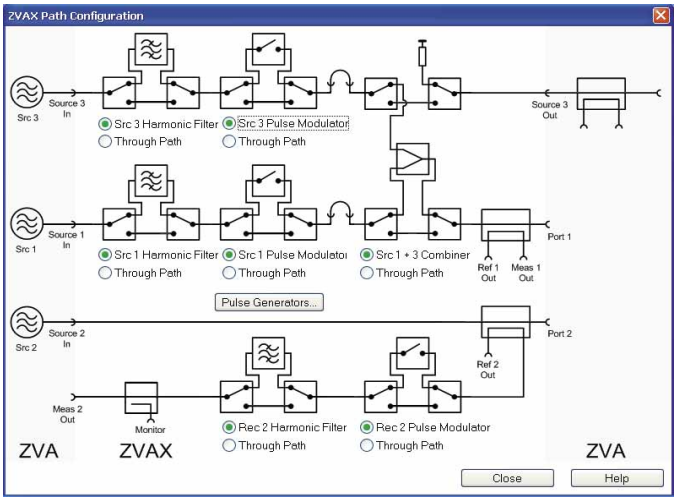


FIG 2 The components in the extension unit are configured via the graphical user interface on the network analyzer.

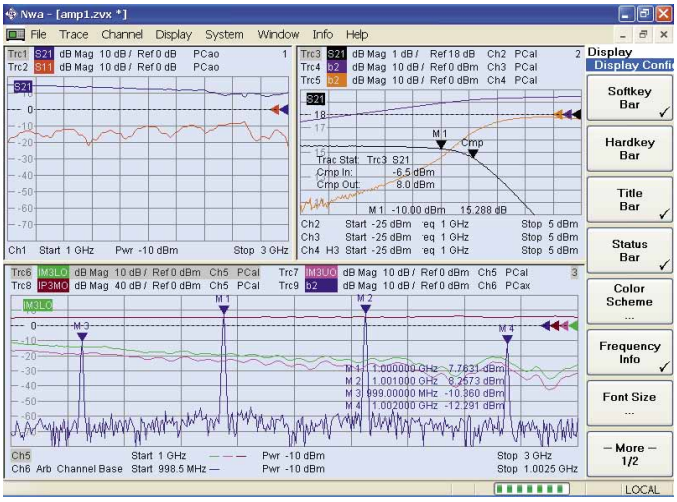


FIG 3 Characterizing an amplifier: S-parameters, harmonics, intermodulation.

Analyzing intermodulation

A two-tone signal is used to measure the intermodulation products of nonlinear DUTs. For this measurement, two signal sources, e.g. the network analyzer source and an additional signal generator, are combined to form a two-tone signal. This can be done more conveniently using a four-port model of the R&S®ZVA network analyzer family. These models feature two internal signal sources that are connected to the combiner in the extension unit so that a two-tone signal is present at the test port. The intermodulation wizard helps to display results directly as traces on the network analyzer, i.e. the third-, fifth- and higher-order intermodulation products as well as the values for IP3, IP5, etc. (FIG 3).

Measuring harmonics

Two switchable harmonic filters increase the spectral purity of the analyzer's two internal generators. They suppress the third harmonic down to 70 dBc. Harmonics measurements are performed at the touch of a button, as the network analyzer automatically determines and sets the appropriate frequencies. A filter can also be activated in the receiver path in order to increase the dynamic range.

High-power test set and monitor output

Two high-power couplers in the R&S®ZVAX24 extension unit allow power measurements up to 43 dBm, e.g. on high-power amplifiers. The high-power couplers are used instead of the couplers built into the R&S®ZVA24, which are designed for up to 27 dBm. Amplifiers connected to the rear of the extension unit increase the output power to 43 dBm. A coupler can also be inserted in the receiver path to enable the connection of a spectrum analyzer or a power meter. This allows monitoring of the DUT power simultaneously with the measurement.

Summary

Combining an R&S®ZVA or R&S®ZVT network analyzer with the R&S®ZVAX24 extension unit allows active DUTs to be characterized in the linear and nonlinear range without requiring additional hardware or having to reconnect the DUT. Depending on the requirements, the extension unit can be equipped with pulse modulators, a combiner for intermodulation measurements, harmonic filters and high-power couplers. The R&S®ZVAX24 enables accurate and stable test results. It thus provides manufacturers from the wireless communications, automotive or aerospace & defense industries with a powerful tool for developing active components and testing them in production.

Andreas Henkel

R&S®FSV: versatile modulation analysis from MSK to 64QAM

Owing to its innovative operating concept, the new R&S®FSV-K70 vector signal analysis application for the R&S®FSV signal and spectrum analyzers makes it astoundingly easy to analyze digitally modulated single carriers and determine modulation parameters.

Obtaining precise measurement results quickly and easily

Due to the complex areas in which the R&S®FSV-K70 option is used, development of this new vector signal analysis application focused on easy-to-learn operation that allows users to concentrate on their tasks. Operation is based on a completely new concept and therefore differs largely from purely instrument-oriented setting procedures. Basically, the new operating concept rests on three mainstays:

- Description of the signal to be analyzed
- Signal-flow-oriented operating sequence
- Consistent use of the touch screen

Instead of having to think about the instrument parameters that have to be set, the user first describes the signal to be analyzed. This includes, for example, the modulation type, modulation rate, filtering as well as whether the signal is continuous or consists of bursts. All relevant parameters are entered in one place and not across different menus. For the most important mobile radio standards such as WCDMA, GSM, EDGE and TETRA, the signal description is already predefined.

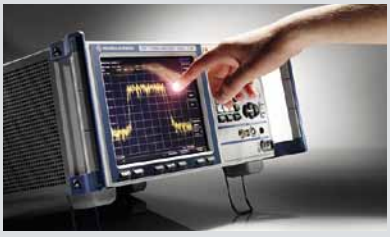
The signal description is integrated into a signal-flow-oriented operating sequence. The graphical representation of the different signal analysis levels which resembles a block diagram shows exactly which parameter acts at which point and thus provides transparency (FIG 1). A preview window that is adapted to the respective block in the signal flow diagram immediately shows the effects of the selected setting, facilitating the correct choice of the parameters (FIG 2).

All these convenient operating processes consistently use the capabilities of the touch screen on the R&S®FSV. A simple touch on a block in the signal flow diagram is sufficient to access the appropriate setting parameters. The user can zoom in on individual points in a constellation diagram by enlarging a rectangle on the touch screen, for example. The field of interest can thus be scaled to the required size considerably faster than by repeatedly entering axis scaling values. Especially users who only sometimes need these functions will appreciate this convenience. But this feature even benefits experienced users who regularly use vector signal analysis functions.

Versatile tools for detailed signal analysis and identifying error sources

Up to four measurement windows that can be displayed simultaneously are user-configurable with different contents, providing comprehensive analysis at a glance (FIG 4). Constantly recurring, personally preferred or task-related combinations can be easily saved and quickly restored.

With its many custom-tailored applications for all conventional mobile radio standards, the R&S®FSV signal and spectrum analyzer offers a unique price/performance ratio. For more details, refer to NEWS 196/08 (pp. 18–23).



Condensed data of the R&S®FSV-K70

Modulation formats	MSK/GMSK, DMSK, BPSK, QPSK, 8PSK, DQPSK, D8PSK, π/4-DQPSK, 3π/8-D8PSK, 16QAM to 64QAM
Signal analysis bandwidth	28 MHz, optional 40 MHz (with R&S®FSV-B70)
Symbol rate	up to 11 MHz or 32 MHz with the R&S®FSV-B70 40 MHz analysis bandwidth extension
Analysis length	up to 50,000 symbols
Inherent EVM	1 % for a QPSK signal with 10 MHz symbol rate

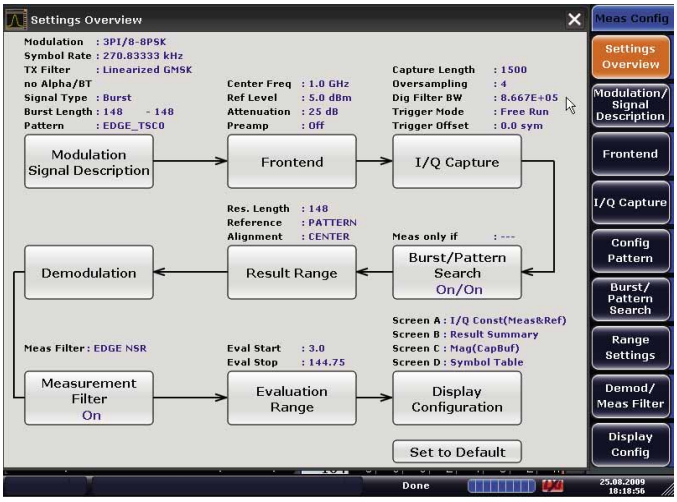


FIG 1 Simply touch the screen: The block diagram of the signal flow provides a quick overview and direct access for operating the functions of the respective blocks.

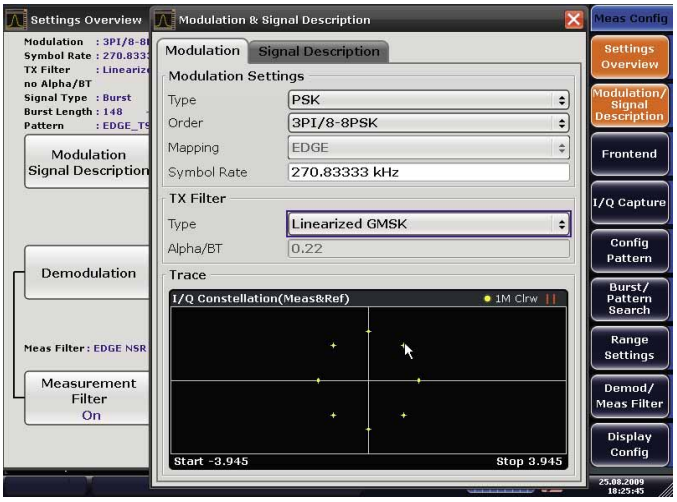


FIG 2 A preview window immediately shows the effect of settings – in this example, of the modulation / signal description block.

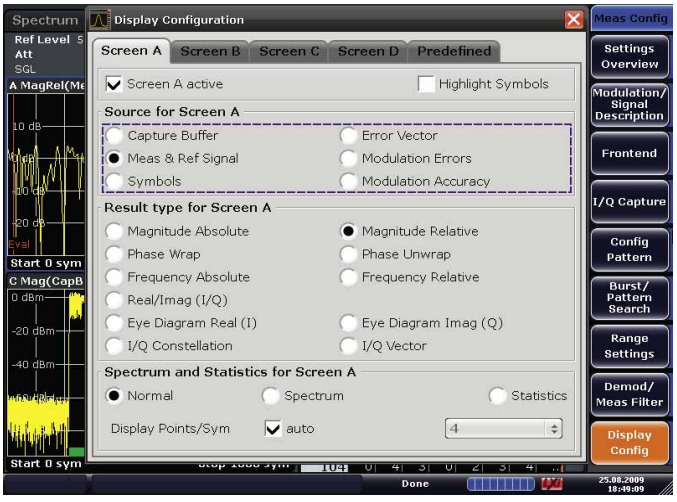


FIG 3 Displays for the measurement and reference signal.

FIG 3 shows an example of the versatile display options, including vector and constellation diagram for the measurement and reference signal. Similar display options are available for amplitude, phase and frequency errors and error vector display. Where useful, a time domain display, FFT spectrum and a function for statistical evaluation for further analyses are provided.

Error causes such as discrete spurious or incorrect filtering can be easily determined in the error spectrum, even if they cannot be detected in the constellation diagram (FIG 4). The raw data spectrum (I/Q capture) provides information about the symbol rate used if it is unknown.

The statistical distribution of the measurement or error signal allows further conclusions to be drawn about the type of modulation error (e.g. noise, sinusoidal interference, signal compression). The R&S®FSV shows the distribution either as probability density function (PDF) or as cumulative probability function (CPF). Furthermore, the statistics function determines the 95:th percentile value – a measurement value that is often required in many standards in addition to the RMS EVM or peak EVM (FIG 5).

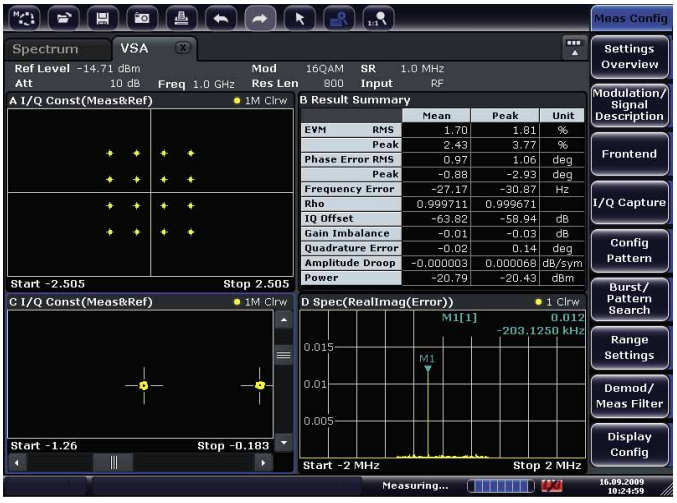


FIG 4 Four measurement windows that can be displayed simultaneously provide a comprehensive overview. In this measurement example, the zoomed constellation diagram and the spectrum of the error vector point to a sinusoidal interferer as cause of the increased EVM value.

Triggering and burst search

The R&S®FSV-K70 option can be triggered both by means of an external trigger (e.g. frame trigger) and, in the case of pulsed signals, by rising or falling RF power (IF power trigger). This accelerates the burst search because data recording is already synchronized to the burst – which, in turn, increases the measurement speed.

A flexible burst search allows the analysis of complex signal combinations, e.g. of short bursts or of signal mixes – a feature that goes beyond the scope of many signal analyzers. By specifying the exact burst length, the user can filter and measure a specific burst from a mix, for example.

Of course, synchronization to data patterns (patterns, midambles or preambles, training sequences), as is necessary for many standard-compliant measurements, is also possible. The most important synchronization sequences for the predefined standards are already included. Separate data patterns can be entered and saved, allowing the user to search also for defective data patterns, for example.

Synchronization is already done by correlating I/Q data and not on bit level after complete demodulation. This provides two advantages:

- Since synchronization takes place very early in the signal flow, data compression can also be performed very early, thus accelerating the measurement
- Correlation is more insensitive to spurious and functions even with poor signal-to-noise ratios. This also helps when measuring bursts at low signal levels, which can be reliably identified (FIG 6) in this way

Seamless integration into the wide range of functions of the R&S®FSV

With signal-flow-oriented operation and consistent use of the touch screen, the new option is seamlessly integrated into the overall operating concept of the R&S®FSV signal and spectrum analyzers. The option increases their versatility and, in combination with numerous further R&S®FSV applications, offers greater benefits for users. For example, a problem such as excessive phase noise in the constellation diagram can be immediately checked and quantified by using the R&S®FSV-K40 phase noise measurement application.

Herbert Schmitt

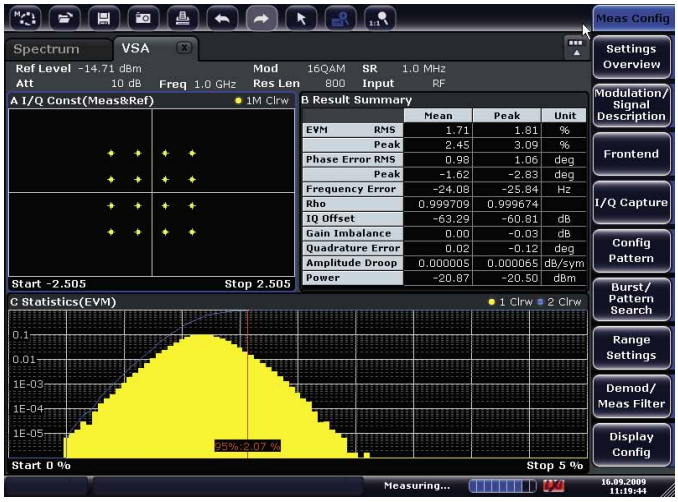


FIG 5 Distribution density function of the error vector with display of the 95:th percentile value.

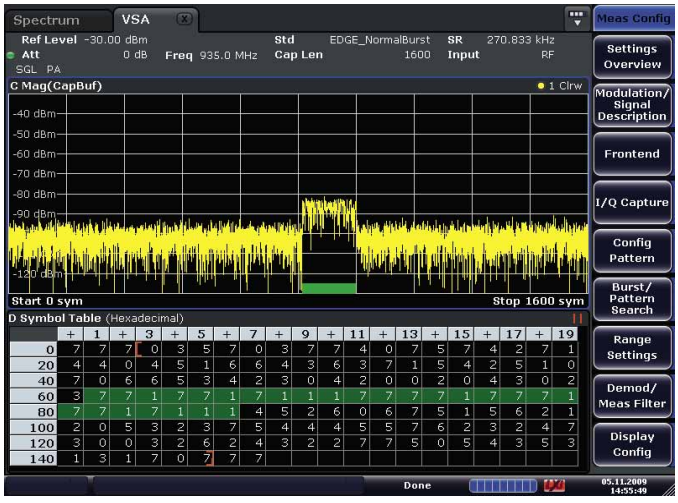


FIG 6 Synchronization to a signal with low signal-to-noise ratio.

FIG 7 Tabular overview of the measured modulation parameters and display of the bit stream.

R&S®ESCI7: measuring disturbance up to 7 GHz in line with the latest standards

Starting in October 2011, disturbance measurements up to max. 6 GHz on information technology equipment (ITE) will become mandatory in the European Union in line with amendment A1:2007 of product standard EN 55022:2006. Even right now, the new R&S®ESCI7 EMI test receiver allows manufacturers to avoid costly, time-consuming reengineering and enables test houses to adapt their range of services to future requirements.

R&S®ESCI7: standard-compliant disturbance measurements, and much more

With the use of ever higher frequencies, e.g. in IT equipment such as computers, modems and printers, the issue of protecting radiocommunications frequencies against disturbance is becoming more important. In the frequency bands above 1 GHz, for example, even printed-board ground leads of slightly excessive length in this type of equipment or small slots in shielding cabinets can easily cause unwanted RF leakage. The frequency extension to 6 GHz in amendment A1:2007 to ITE product standards IEC/CISPR 22 [1] and EN 55022 [2] takes this development into account.

The R&S®ESCI7 EMI test receiver (FIG 1) was designed as a fully compliant radio disturbance measuring receiver for the frequency range from 9 kHz to 7 GHz. It supplements the R&S®ESCI EMI test receiver (9 kHz to 3 GHz) already established on the market [3]. Like the R&S®ESCI, it also reflects the latest version of the CISPR 16-1-1 basic standard, including the latest weighting detectors "average with meter time constant (CISPR-average)" and "RMS-average" [4].

The main field of application of the R&S®ESCI7 is product certification in line with applicable commercial EMC standards. With its integrated preselection, a 20 dB preamplifier up to 7 GHz and its highly linear frontend, it meets the requirements of standards such as CISPR, EN, FCC, ETS, ANSI and VCCI. Time-saving automatic test sequences support the user's work and reduce effort as well as the risk of measurement errors. Its additional analysis capabilities provide valuable assistance in disturbance measurements, including:

- Determining the timing behavior of disturbances, e.g. for optimal determination of the measurement time for intermittent disturbance (time domain analysis) or for click-rate measurement in line with product standard CISPR 14
- Representing the spectrum surrounding the receiver frequency in parallel with numeric measurement, evaluation and graphic level display (mixed mode)

These features allow faster identification and analysis of disturbance signals. The measuring receiver can be precisely tuned to the local maximum disturbance, which considerably simplifies the detection of drifting signals, for example. Using add-on near-field probes and test antennas from Rohde&Schwarz, the R&S®ESCI7 is a multifaceted measurement tool, e.g. for radiated disturbance measurements, even during the design and integration phase of a product. Extra efforts during product development to verify compliance with EMC limits are a thing of the past.

FIG 1 Measurement of radiated disturbance in line with the product standard CISPR 22:2005 A1:2005/EN 55022:2006 A1:2007 for IT equipment in the range from 1 GHz to max. 6 GHz using the R&S®ESCI7 EMI test receiver and the R&S®HF907 double-ridged waveguide horn antenna.

Highest frequency occurring in the device (f)	Measurement of radiated disturbance up to …
f < 108 MHz	1 GHz
108 MHz ≤ f < 500 MHz	2 GHz
500 MHz ≤ f < 1 GHz	5 GHz
f > 1 GHz	5 × f or 6 GHz * *whichever is lower

FIG 2 Overview of the maximum measurement frequency for disturbance measurements in line with amendment A1:2005 to product standard CISPR 22:2005 (ITE); implemented for the EU in A1:2007 of EN 55022:2006.

Typical displayed average noise level of the R&S®ESCI7

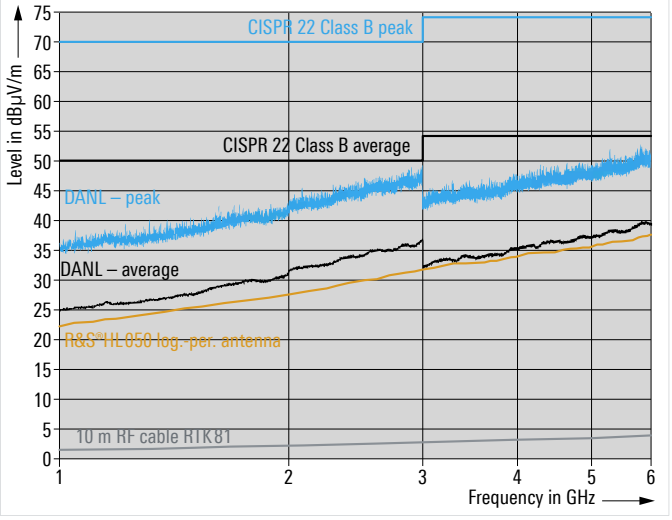


FIG 3 Measurement of the typical displayed average noise level of the R&S®ESCI7 with the R&S®EMC32-EB EMI measurement software for peak detector (blue trace) and average detector (black trace) in the range from 1 GHz to 6 GHz. The figure shows the limit lines in accordance with CISPR 22:2005 A1:2005/EN 55022:2006 A1:2007 for Class B (residential areas) as well as the antenna factor (here for the R&S®HL050 log.-per. antenna) and cable loss (10 m RF cable).

Versatile use in the RF development lab thanks to an integrated spectrum analyzer

Like all modern Rohde&Schwarz EMI test receivers, the R&S®ESCI7 has an integrated spectrum analyzer. This combination's strengths are fast overview and preview measurements for detecting and analyzing disturbance behavior in the various phases of product development. In addition, it is ideal for performing many of the standard measurements encountered in RF development labs. Custom add-on functionality, such as adjacent channel power (ACP) measurement, determination of the third-order intercept point or of the occupied bandwidth, as well as statistics functions (APD, CCDF) make the R&S®ESCI7 suitable for applications beyond disturbance measurement.

Ready for the future – measurements in line with CISPR 22/EN 55022 up to 6 GHz

Amendment A1:2005 to the CISPR 22 international product standard for information technology equipment, such as PCs, modems and fixed-line telephones, defines measurements up to max. 6 GHz, depending on the highest frequency that is generated, used or tuned in the product (FIG 2). This CISPR standard has been published in the European Union as amendment A1:2007 to product standard EN 55022:2006. In August 2009, the European Commission set October 1, 2011, as the mandatory date for the standard to come into force. For the 1 GHz to 6 GHz frequency range, limit values for the peak detector were established, and also for the new CISPR-average detector in line with CISPR 22:2008. The product standard distinguishes between Class A limits for industrial areas and Class B limits for residential areas. The limits for residential areas are 6 dB lower than those for industrial areas. In addition, the standard specifies a minimum signal-to-noise ratio of 6 dB with regard to the relevant limit line. For disturbance measurements in residential areas, this requirement places particularly high demands on the sensitivity of the measuring receiver. With its integrated, low-noise preamplifier, the R&S®ESCI7 can easily meet this requirement and even offers ample margin (FIG 3). As a result, users must invest less in expensive low-loss cables, high-sensitivity antennas or other external preamplifiers that negatively affect the dynamic range.

Hans Schlecht; Karl-Heinz Weidner

References
[1] IEC / CISPR 22:2005 Amendment 1:2005: Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement.
[2] EN 55022:2006 + A1:2007: Information technology equipment – Immunity to radio interference – Limits and methods of measurement.
[3] R&S®ESCI EMI test receiver: Compact test receiver for full-compliance measurements up to 3 GHz. News from Rohde&Schwarz (2004) No. 182, pp. 40–43.
[4] IEC / CISPR 16-1-1:2006 Amendment 2:2007 Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus.

Ready for takeoff: test signals for DVB-T2, the coming generation of digital TV

Equipped with the R&S®SFU-K16 realtime coder option, the R&S®SFU broadcast test system is the first full-fledged DVB-T2 signal generator in the world.

HDTV via terrestrial channels

Flat-screen television sets have completely replaced cathode ray tube (CTR) TVs in the last few years, and the diagonal screen size is steadily increasing. The 720 × 576 pixels of the current DVB-T standard are no longer sufficient, and the image looks coarse and "pixellated". The 720 or even 1080 lines of the state-of-the-art flat screens are not optimally used. This is why HDTV programs are in demand – not only via cable or satellite but most recently also via the terrestrial VHF/UHF TV channels. With DVB-T2, a transmission system that is tailor-made for these requirements has now been standardized for the first time.

The definition of DVB-T2 began with a study conducted by the DVB organization in 2006. The organization stipulated several conditions for the DVB-T2 standard in comparison with DVB-T, including the following:

- At least 30 % higher transmission capacity
- Program-specific error protection mechanism
- Continued usability of the existing DVB-T private antennas and transmitter sites
- More efficient single-frequency networks
- Optional procedures to reduce the crest factor and thereby the transmitter operating costs

The results of the specification of the DVB-T2 standard were published as DVB Bluebook A122 at the end of June 2008 and submitted to the ETSI in order to be formally standardized [1]. This standardization is expected to be completed by the end of 2009.

FIG 1 shows the block diagram of a DVB-T2 modulator. The programs to be transmitted are fed as transport streams (MPEG-2 or generic streams). In a first block (mode adaption and stream adaption), the data packets are preprocessed and temporally arranged before they reach the actual modulator via the modulator interface (T2-MI). At the modulator, the "byte interleaving, coding and modulation" functional unit inserts the error protection. The third block (frame builder and OFDM generation) finally generates the OFDM symbols and converts the signals to the transmit frequency. FIG 1 also illustrates the functionality of the new R&S®SFU-K16 DVB-T2 realtime coder option.

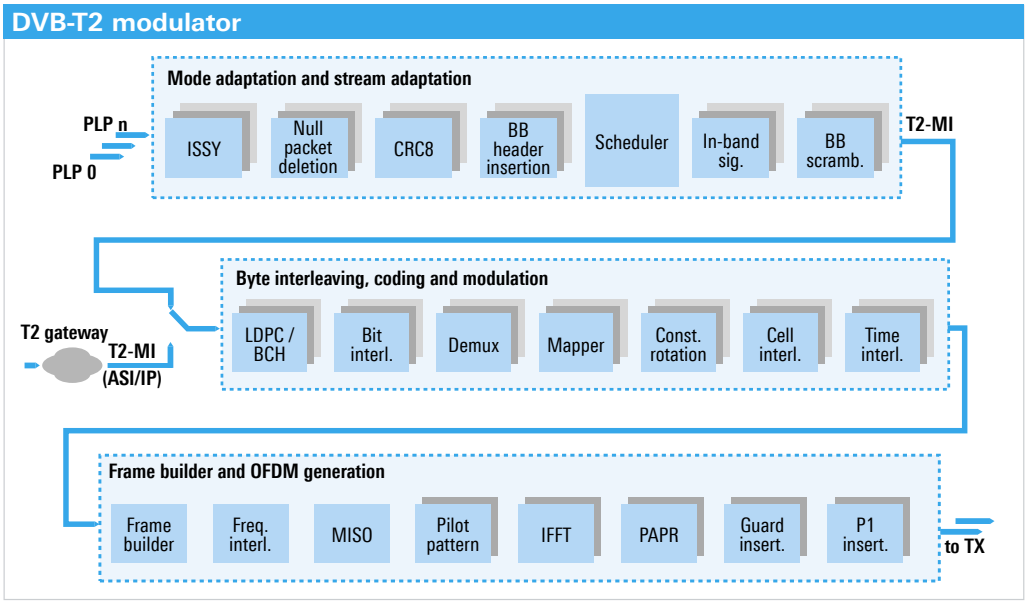


FIG 1 Block diagram of a DVB-T2 modulator. Its functionality is basically the same as that of the new R&S®SFU-K16 realtime coder option.

The R&S®SFU broadcast test system has firmly established itself in the consumer electronics industry as the reference signal source for broadcasting standards. The selection of transmission standards is continuously being expanded: Two new coder options appeared in 2008 for the CMMB and DVB-SH standards [2]; equipped with the R&S®SFU-K16 realtime coder option, the R&S®SFU is now the first full-fledged DVB-T2 signal generator in the world.

Combination of innovative and tried-and-tested technologies

Of course, not all the functional blocks had to be redefined for the DVB-T2 standard. The technologies utilized for DVB-T2 can be classified in three categories. Firstly, the technologies used for DVB-T were consistently enhanced. Like almost all digital terrestrial TV systems, DVB-T2 uses OFMD modulation. In comparison with DVB-T, a 256QAM constellation and the longer FFT modes 16k and 32k have been additionally introduced. This increases the data rate and, if the guard interval length remains constant, reduces the overhead. The R&S®SFU-K16 DVB-T2 option supports the 256QAM constellation as well as the longer FFT modes. Besides tried-and-tested concepts from DVB-T, DVB-T2 also uses technologies from other DVB standards. These include primarily error protection by means of LDPC coding, which was specified originally for DVB-S2, as well as the use of baseband frames. The R&S®SFU-K16 DVB-T2 option can generate all LDPC code rates of the DVB-T2 standard.

Furthermore, DVB-T2 uses not only known and advanced technologies but also some brand-new concepts in broadcasting. DVB-T2 makes program-specific error protection possible for the first time. This means that an operator can choose between data rate and transmission security individually for each program to be transmitted. For this purpose, the encoder assigns the programs to physical layer pipes (PLP) whose coding parameters can be individually defined. For example, SDTV programs can be provided with strong error protection for basic coverage, while HDTV programs with a high date rate can be transmitted with weaker error protection in the same RF channel.

This principle is shown in FIG 2. The receiver only decodes the content of the desired PLP and ignores all other PLPs. The R&S®SFU-K16 DVB-T2 option currently allows the modulation of one PLP (single PLP mode, FIG 3). The option will be expanded to multi-PLP mode in future firmware.

Reduced crest factor and rotated constellations

OFDM signals normally have a high crest factor. This reduces the transmitter's efficiency and thus ultimately increases its operating costs, as the transmitter must be designed to handle the peak power of the signal. The DVB-T2 standard defines two entirely new techniques for reducing the crest factor of the transmit signal. For this purpose, the DVB-T2 modulator can change the DVB-T2 signal by suitably modulating unused OFDM carriers (reserved tones) or by shifting the points of the constellation diagram (adaptive constellation extension) so that lower peak values occur. As these two methods require relatively high computing effort, they are defined as optional in the DVB-T2 standard. The R&S®SFU-K16 DVB-T2 option can simulate the reserved tones method. Another brand-new

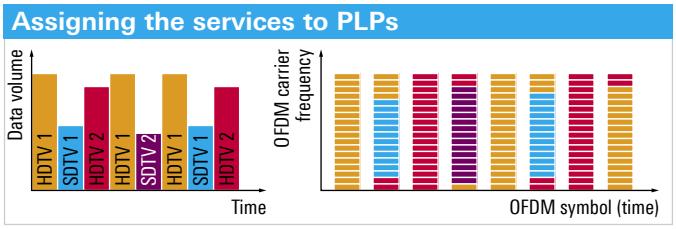


FIG 2 The receiver decodes only the content of the desired PLP and ignores all other PLPs.

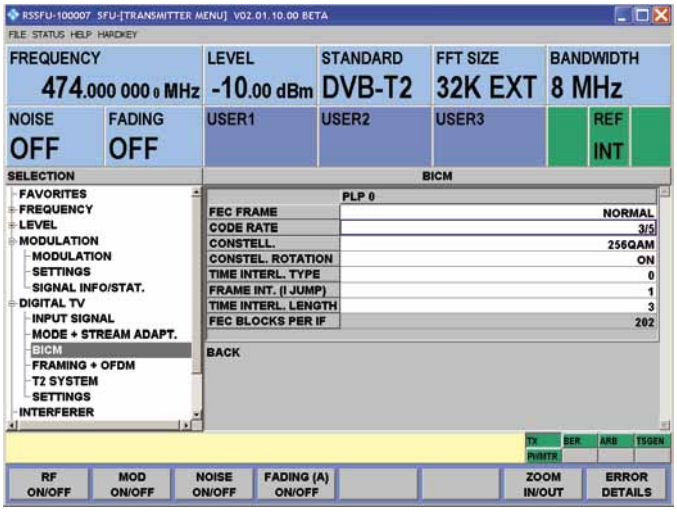


FIG 3 Single PLP coding and modulation menu of the R&S®SFU-K16 DVB-T2 realtime coder option.

technology, which is utilized in DVB-T2 for the first time, uses rotated constellations. The modulator rotates the constellation diagram by a defined angle relative to the I/Q coordinate system (FIG 4). In this way, part of the I information is mapped onto the Q-axis and vice versa. In addition, the Q information to be transmitted is delayed by several symbol lengths compared to the I information. As a result, related I and Q values are not transmitted in the same symbol and thus not on the same OFDM carrier. By combining these two measures (Q-delayed rotated constellation), a symbol can be reconstructed even if the related OFDM carrier has been completely impaired. This significantly increases transmission security in the selective channel. The R&S®SFU-K16 DVB-T2 option supports optional rotation for all constellations of the DVB-T2 standard.

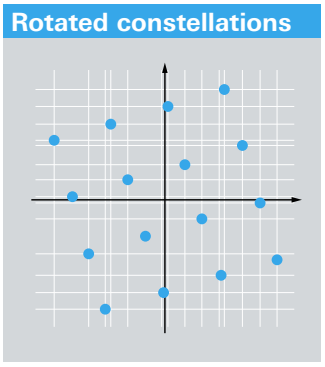


FIG 4 Rotated constellation diagram for 16QAM: The modulator rotates the diagram by a defined angle relative to the I/Q coordinate system.

Development of DVB-T2 receivers with the R&S®SFU broadcast test system

DVB-T2 is a standard that makes efficient terrestrial HDTV transmission possible. Along with the broadcast network operators, the consumer electronics industry must now act so that fully developed DVB-T2 receivers are launched on the market in time. The first receivers will probably be set-top boxes that convert DVB-T2 signals for existing TV sets. As in the case of DVB-T and DVB-C, DVB-T2 tuners will, however, increasingly be permanently integrated into TV sets as the DVB-T2 standard becomes more widespread and manufacturing costs decline. Equipped with the new R&S®SFU-K16 real-time coder option, the R&S®SFU broadcast test system is the perfect solution for developing and testing DVB-T2 receivers. Its integrated fading simulator, noise generator and simulator of adjacent channel interference make it an indispensable tool for the development of digital TV receivers as well as for signal generation. The simulation functions in particular are the R&S®SFU broadcast test system's main strength. The 40-path fading option and the interferer management option are able to simulate virtually all conceivable channel conditions in a reproducible way. The noise generator options generate not only white noise, but also pulse-like noise and phase noise. Especially phase noise is a critical parameter for the new 32k FFT mode and the 256QAM constellation of DVB-T2. The R&S®SFU broadcast test system has all the functions required for developing and testing DVB-T2 receivers.

Peter Lampel

References
[1] DVB Document A122: Frame structure channel coding and modulation for a second generation digital terrestrial television broadcasting system (DVB-T2).
[2] Test signals for the new CMMB and DVB-SH mobile TV systems. News from Rohde&Schwarz (2008) No. 198, pp. 65–69.

First regular DVB-T2 operation in England

As with the introduction of DVB-T a number of years ago, the British Broadcasting Corporation (BBC) is again playing a leading role with DVB-T2. At the end of 2009, the first regular DVB-T2 operation in the world will start in northwestern England in the region around Manchester, Liverpool and Preston. A multiplex with three HDTV programs from the BBC, ITV and Channel 4 is going to be broadcast from the Winter Hill transmitter in Lancashire. Other regions will follow, up until the 2010 Soccer World Cup. The operator needs a high data throughput for the HDTV package. FIG 5 shows an overview of the intended coding parameters, which are consistently designed for high data throughput. With these settings, DVB-T2 achieves an impressive increase of almost 50 percent in data throughput compared with DVB-T. The use of a powerful source coding with H.264 and HE-AAC increases the information data rate even more.

Parameter	DVB-T	DVB-T2
Modulation	64QAM	256QAM
FFT size	2k	32k
Guard interval	1/32	1/128
FEC	2/3 CC + RS	3/5 LDPC + BCH
Scattered pilots	8.3 %	1.0 %
Continual pilots	2.0 %	0.53 %
L1 overhead	1.0 %	0.53 %
Carrier mode	standard	extended
Capacity	24.1 Mbit/s	36.1 Mbit/s

FIG 5 Overview of the DVB-T and DVB-T2 coding parameters used in the United Kingdom.

For an efficient future: new liquid-cooled, VHF high-power transmitters

The liquid-cooled VHF high-power transmitters of the new R&S®Nx8500 family are energy-efficient and compact. This family of transmitters serves as a worldwide multistandard platform for analog, digital and mobile television as well as digital audio broadcasting. It provides safety of investment due to its ease of upgradeability to future standards such as DVB-T2.

FIG 1 The R&S®Nx8500 transmitter family delivers top reliability through consistent use of tried-and-tested components.

A future-safe investment

The new R&S®Nx8500 family of liquid-cooled VHF transmitters (FIG 1) is versatile and can be used worldwide: In addition to analog TV, it supports the DVB-T, ATSC, ISDB-T/ISDB-T_B and DTMB digital TV standards. The transmitters also cover mobile TV standards, i.e. DVB-H, T-DMB, MediaFLO™ and ATSC Mobile DTV, as well as DAB/DAB+ digital audio broadcasting. Their compact system design and high energy efficiency help to reduce infrastructure and life cycle costs.

As the market leader, Rohde&Schwarz offers its customers maximum safety of investment for their products. For example, the software-based signal processing used in the transmitters allows network operators to respond flexibly to extensions to existing standards and quickly integrate them into installed networks. The transmitter family is already prepared to handle the DVB-T successor standard DVB-T2 (see also page 25 in this issue) and simplifies the transition.

The R&S®NA8500 transmitter family is also impressive in the area of digital audio broadcasting: For DAB/T-DMB, the transmitters together with the R&S®Sx801 exciter provide an outstanding signal-to-noise ratio of typically 36 dB which, when measured using the R&S®ETL TV analyzer, corresponds to an MER value of typically 33 dB.

Users of the R&S®Nx8500 transmitter family also benefit from the cross-platform module concept of the R&S®Nx8000 generation of transmitters. Important components such as exciter, transmitter control unit and liquid cooling system are used in a consistent manner in the different transmitter families for TV and digital audio broadcasting in the VHF and UHF bands. Network operators who deploy different transmitters from a single family or from the transmitter generation require less spare parts and can lower the training costs for their operating personnel.

FIG 2 The new R&S®ZK820S2 pump unit supplies up to two fully equipped transmitter racks and requires only a minimum of space for installation.

Compact, efficient cooling

In the case of terrestrial broadcast networks, operating costs quite often exceed the cost of the investment, making the efficiency of the overall system a critical factor. Accordingly, the focus was on energy savings when designing the R&S®Nx8500 transmitter family. The liquid-cooling system makes a substantial contribution in this area. In the pump unit, two powerful pumps with low energy consumption operate in active standby. Additional energy savings are achieved by having the control unit regulate the speed of the fans on the heat exchanger as a function of the ambient temperature. The electronically commutated fans in the heat exchangers reduce energy costs by up to 30 % compared to conventional fans.

The closed cooling circuit helps to minimize external influences. Precisely setting the flow rate for the coolant to match the individual system configuration increases the efficiency, while the intelligent automatic monitoring of the cooling system ensures stable, continuous operation of the transmitter.

Rohde&Schwarz has developed the additional R&S®ZK820S2 pump unit which, despite its small footprint and low energy consumption, can supply two fully equipped transmitter racks with the necessary coolant (FIG 2). The integrated liquid distributor reduces installation effort as well as material costs. This is the most compact cooling system on the market.

Axel Menke

Reduced infrastructure costs

The carefully planned concept underlying this family of transmitters significantly reduces the infrastructure costs over the product life cycle. Per rack, for example, the R&S®Nx8500 transmitters generate output power levels of up to 10 kW for analog TV, up to 4.0 kW for COFDM TV standards, up to 5.8 kW for ATSC and 4.1 kW for DAB(+)/T-DMB. Due to their 19" width and rack depth of 1200 mm, they take up only a minimum of space at the transmitter site.

The new pump unit can be installed on the floor, the wall or on a second pump unit. Heat exchangers are available for vertical and horizontal installation. The sophisticated installation concept provides perfect harmonization of the design of all components and ensures that the system can be flexibly adapted to the individual conditions at any transmitter site.

Condensed data of the R&S®NM/NW/NA8500

General	
Dimensions (W × H × D)	600 mm × 1200 mm × 2200 mm
Power connection	3 × 400 V ±15 %, 47 Hz to 63 Hz
R&S®NM8500	
Standards	B/G, I, M, N, K
Color transmission	PAL, NTSC, SECAM
Sound modulation	IRT dual sound, mono, stereo, NICAM
Output power	4.0 kW to 20 kW
R&S®NW8500	
Standards	DVB-T/-H, DVB-T2 (prepared), ATSC, ATSC Mobile DTV, DTMB, ISDB-T/ISDB-T_B
COFDM output power	1.0 kW to 7.8 kW
ATSC output power	1.5 kW to 11.5 kW
R&S®NA8500	
Standards	DAB, DAB+, T-DMB
Output power	1.0 kW to 8.0 kW

DTV: transmission perfect – transport stream correct?

This is an important question for any operator of digital television transmission networks since the signals must be transmitted properly and the transported content must be error-free. As an all-in-one test instrument that is unique worldwide owing to its concept, compact design and wide range of measurement capabilities, the R&S®ETL TV analyzer with its new MPEG analysis functions provides answers to such questions.

DTV signal and TS analysis in one instrument

In digital television (DTV), an MPEG-2 transport stream (TS) is transmitted over the air or via cable using a digital modulation technique. The TS contains one or more programs (services) consisting of video, audio and auxiliary information. The stream's complex structure must conform to defined rules so that it can be properly processed by the receiver.

The R&S®ETL TV analyzer is prized by broadcasters and cable network operators as a reference receiver for in-depth investigation of the RF quality of DTV signals. Equipped with the new MPEG options, it can now also provide pinpoint monitoring of the MPEG-2 transport streams arriving at and leaving transmitters and cable headends and perform parallel analysis of the details in a way that was previously possible only with special, professional MPEG-2 analyzers (FIG 2). This compact, all-in-one test instrument is unmatched worldwide with its combined analysis of DTV signals and transport streams.

Options for TS analysis basic functions

The R&S®ETL-B280 MPEG processing board is the main module for MPEG analysis. It can also be installed in existing instruments (FIG 1). It has one internal and one external transport stream input. The external input can be defined as an ASI or SMPTE310M input. The board also has an additional ASI transport stream output as well as a DVB common interface.

The R&S®ETL-K282 MPEG analysis/monitoring software option enables users to access the basic functions for MPEG-2 transport stream analysis. The software provides a clear overview of the underlying structure of the transport stream under analysis. Individual TS elements can be selected quickly and easily for more in-depth examination. The software analyzes the conditions in accordance with DVB test specification TR101290, which classifies errors into priority levels 1, 2 and 3 (FIG 3). This also applies analogously to the ATSC and SCTE standards, which the software can handle

The R&S®ETL TV analyzer is a versatile platform designed especially for commissioning, installing and servicing TV transmitters, performing coverage measurements for terrestrial television and testing cable headends.

Please refer to NEWS 198/08 (pp. 86–89) for a report on how the R&S®ETL TV analyzer with its extensive analysis functions can help ensure high transmission quality for both transmitters and DVB-T/DVB-H single-frequency networks.

This article presents the new MPEG analysis functions.

FIG 1 The R&S®ETL TV analyzer with the built-in R&S®ETL-B280 MPEG processing board.

as well. Besides the parameters of priority levels 1 to 3, the software also measures the repetition rates for the individual information tables (e.g. PAT, PMT) as well as the transfer rates for the individual services, and checks whether they comply with the defined limits. Each of these parameters can also be monitored separately. If an error occurs, the software enters a message into the report saved internally in the instrument or outputs the message via the R&S®ETL's LAN interface.

Detailed MPEG TS analysis

For more comprehensive analysis, the R&S®ETL-K283 in-depth analysis software option provides further information about the bits and bytes in the individual TS elements. The table interpreter provides a clear, easily readable overview of the table contents (FIG 4). This makes it simpler to identify faulty references between the different tables, for example. Another important test criterion is the presence of elementary auxiliary information such as the program clock reference (PCR), decoder time stamp (DTS) and presentation time stamp (PTS).

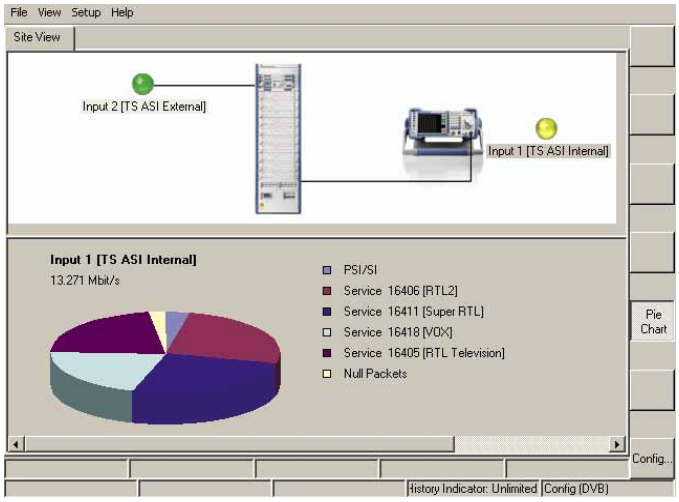


FIG 2 Parallel monitoring of two MPEG-2 transport streams.

FIG 3 MPEG analysis in line with TR101290.

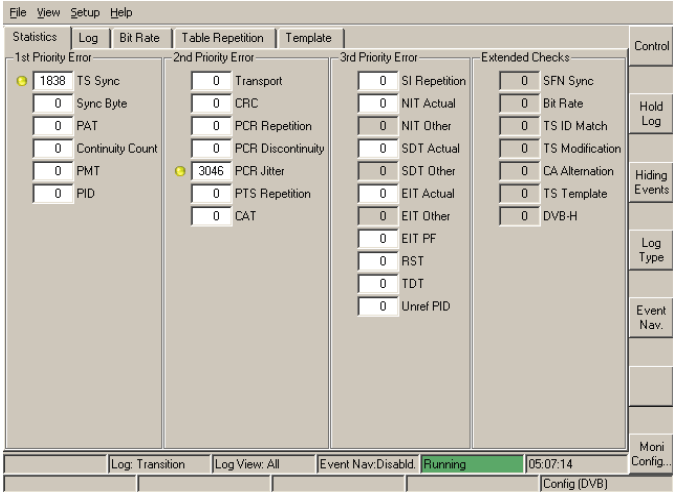
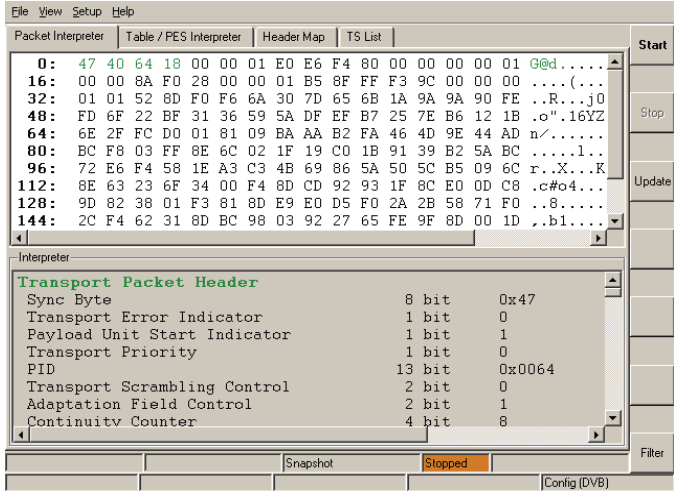


FIG 4 Table interpreter for analysis down to the byte level.



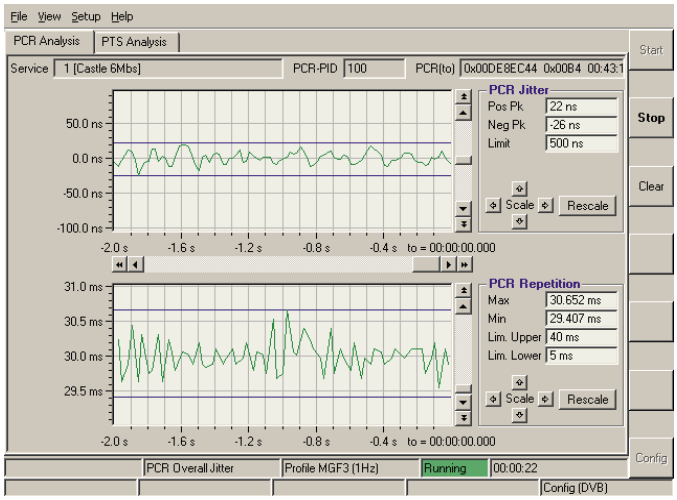


FIG 5 Tracking down PCR jitter.

The in-depth analysis option graphically indicates whether this auxiliary information is received regularly within the applicable limits (repetition) and whether the spacing is constant (e.g. PCR jitter, FIG 5) because tolerance violations can make it impossible for the decoders in receivers and set-top boxes to output video and audio. Such problems can also disrupt lip synchronicity.

A bit-by-bit look at data services and mobile TV

Viewers have come to expect today's DTV to provide video and audio as well as certain auxiliary services known from the Internet world. For example, this includes information about the current program, an electronic program guide and even firmware updates for receivers and set-top boxes. In recent years, mobile TV standards such as DVB-H that are customized for use with mobile user equipment have also come into play.

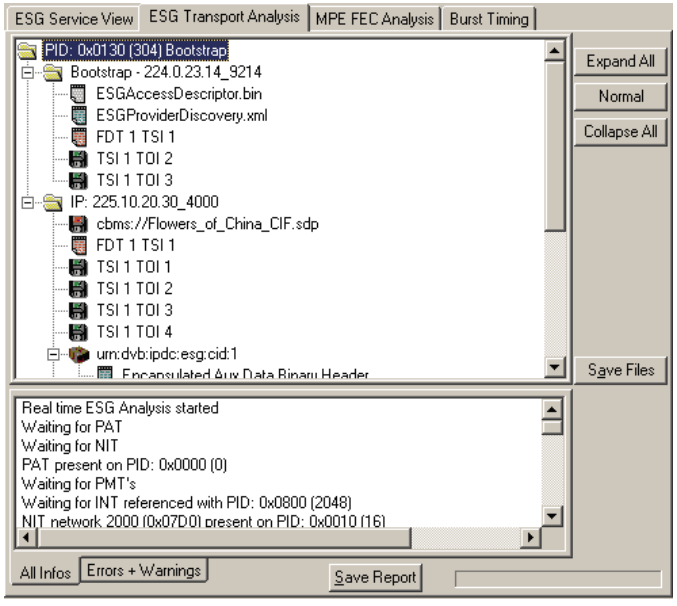


FIG 6 Structure of an electronic service guide (ESG).

Data services and mobile TV are both based on transmission of data packets using the Internet protocol (IP). The relevant mechanisms were developed early on and are referred to as data carousel and object carousel. The data to be transmitted is inserted into a special section within a transport stream known as digital storage media command and control (DSM-CC). The actual IP data inserted into the DSM-CC section is divided into packets using multiprotocol encapsulation (MPE) in accordance with the relevant protocols. One special feature of DVB-H is that the packets also undergo forward error correction (FEC).

The R&S®ETL-K284 data broadcast analysis software option can be used for analyzing data services and DVB-H content. This option allows presentation of the protocol structures and individual components of selected data packets using clear tree views. The interpreter presents the data in plain text, e.g. individual lines of the teletext. Of course, the option also allows a detailed look at the raw data. Operators can document individual data rates to prove their guaranteed data transfer rates for individual data services.

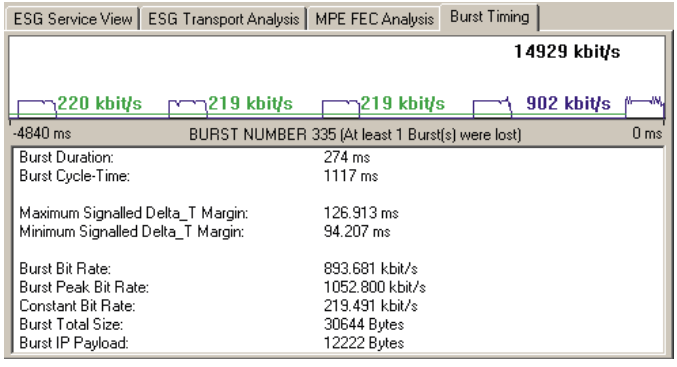


FIG 7 Burst timing for a DVB-H transmission.

For DVB-H, the R&S®ETL-K284 option offers a number of additional analysis functions. For example, all details of the electronic service guide (ESG) are analyzed for structural errors, and the structure is displayed (FIG 6). In the "MPE FEC Analysis" view, numerous parameters provide information about the transmission quality and bandwidth. The analysis functions for DVB-H are supplemented by a display of the burst timing (FIG 7). This view graphically presents the measured timing conditions for the TV programs that are distributed among time slices for transmission purposes.

Fast analysis through comparison

Using the R&S®ETL-K285 TS template monitoring software option, it is possible to monitor the transport stream by comparing a currently selected transport stream with another one that was previously specified as the reference. The reference TS is known as the golden transport stream. The software compares the data and table structures, user-specific private tables, program names, and much more. Unlike conventional MPEG analysis, it also detects certain differences that would normally go unnoticed. For example, a change in the arrangement of programs in the transport stream would not necessarily generate an error message as long as the data is consistent. By contrast, a fast comparison of program names using the template function immediately triggers an error message before any viewers have a chance to complain.

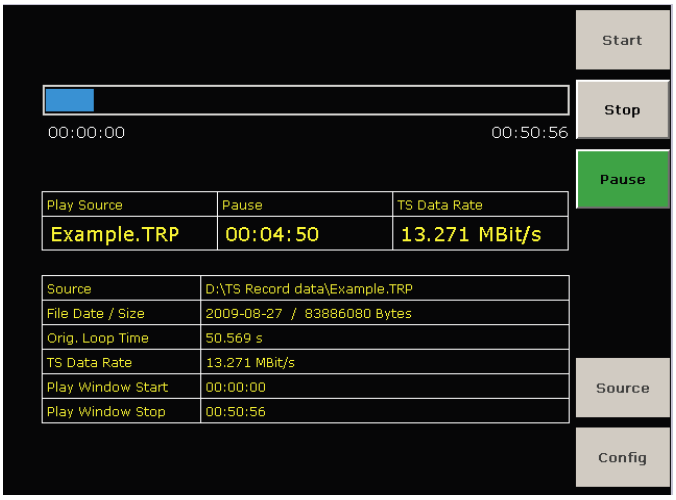


FIG 8 MPEG-2 transport stream generator.

TV picture in addition to analysis functions

Despite the availability of extensive, highly detailed analysis functions, many technicians prefer to just look at the TV picture. For displaying unencrypted TV pictures on the R&S®ETL's screen, a software-based media player is available to reproduce programs selected via the ESG in SD resolution. For reproducing programs in HD quality on an external monitor, the R&S®ETL-B281 hardware decoder can be added to the MPEG processing board. The HDMI interface of the R&S®ETL-B280 option is available on the instrument's rear panel for connection of an HD-ready display. Moreover, the picture is output in SD quality via the base unit's video output (CCVS) and the audio signals are output via two audio outputs.

Encrypted programs can be decoded using the hardware decoder in conjunction with a suitable CA module and smart card. The MPEG processing board includes a DVB common interface for this purpose.

Integrated TS generator/recorder

The R&S®ETL TV analyzer can also be extended to include TS generator and TS recorder functionality by means of the R&S®ETL-K280 software option, which requires the presence of the MPEG processing board and the R&S®ETL-B209 hard disk. When equipped in this manner, the R&S®ETL makes installation and maintenance work significantly easier. Regardless of whether the work at hand involves testing the functioning of a transmitter or a modulator, the TS generator function provides suitable baseband signals without the need for an external signal source (FIG 8). For the TS generator, Rohde&Schwarz offers a number of libraries that include transport streams for DVB, DVB-H, ATSC and ISDB-T in SD or HD quality and with different data rates and configurations.

The TS recorder is very useful during troubleshooting. An MPEG-2 transport stream from the demodulator or an external source can be recorded on the internal hard disk for documentation and analysis purposes and then replayed whenever required. In order to analyze the recorded transport stream by means of the MPEG analyzer provided in the R&S®ETL itself, the TS generator output just needs to be connected to the TS input.

Summary

The R&S®ETL TV analyzer has been enhanced to include important analysis and measurement functions for MPEG-2 transport stream signals. The instrument is now also capable of generating and recording MPEG-2 transport streams. This makes the R&S®ETL an ideal tool for operators of terrestrial or cable networks as well as for manufacturers of broadcasting equipment. The R&S®ETL is an all-in-one test instrument that is unmatched in the global marketplace thanks to its concept, compact design and wide range of measurement capabilities.

Werner Dürport

ACCESSNET®-T Campus IP – a compact way to get started with TETRA professional mobile radio

The ACCESSNET®-T Campus IP system presented at the TETRA World Congress 2009 in Munich is a compact TETRA system that unites exchange, base station and interfaces in a single box. It is well suited for small to medium-sized companies, for operators of event sites and for security services.

Begin economically and scale up as required

The new ACCESSNET®-T Campus IP mobile radio system is an economical entry-level solution for TETRA digital radio, and it is ideal for replacing existing analog radio systems. The successor to the ACCESSNET®-T Campus system launched in 2007 offers all the benefits of the European TETRA standard (EN 300 392-2 TETRA V+D) used around the world. This includes, for example, the advantage of high spectral efficiency, with four channels sharing a single frequency.

The ACCESSNET®-T Campus IP is a full-fledged TETRA mobile radio system for small networks with up to three base stations and 21 voice channels. Due to its outstanding scalability, operators are able to expand their networks at any time to meet growing requirements. Beginning with a base station with one TETRA carrier (one control channel and three voice channels), the system can be expanded to 21 voice channels. Should additional channels become necessary, the system can economically be expanded by adding components from the ACCESSNET®-T* program to create a large ACCESSNET®-T network.

The ACCESSNET®-T Campus IP in the basic version: exchange, radio base station and interfaces in a 19" rack that is just 18 units high.

Compact and IP-capable

The ACCESSNET®-T Campus IP contains a radio base station, an exchange and interfaces in a compact 19" rack that is 18 units high, which minimizes space requirements and energy costs.

The system's IP capabilities are reflected in all components. Telephone systems are connected via voice over IP (VoIP) using the advanced session initiation protocol (SIP). The individual ACCESSNET®-T Campus IP components and all applications are networked via IP connections.

Easy to configure and put into operation

During the development of the ACCESSNET®-T Campus IP, particular emphasis was placed on ensuring simple configuration and operation. Using an intelligent configuration tool, it takes only a few steps to set up the system and put it into operation, which keeps staff costs low. Another cost-reducing factor is the capability of performing remote maintenance work, because this eliminates the necessity of providing complex training to on-site staff.

* The ACCESSNET®-T Campus IP is part of the ACCESSNET®-T product family from Rohde&Schwarz. This family also contains the components needed for establishing networks for large regions or even nationwide networks.

Extensive range of applications ensures versatility

The ACCESSNET®-T common application programming interface (A-CAPI) makes it possible to tailor the system to individual requirements or to map operational processes within the TETRA system. The interface has already been in use in large ACCESSNET®-T systems for a long time, and it enables application vendors to gain easy, in-depth access to the TETRA system's data and services via standardized interfaces and protocols. Applications can be remotely distributed via LAN/WAN. The Rohde&Schwarz application catalog contains more than 20 independent companies that have already developed numerous applications for specific purposes. Examples include control centers/dispatchers and systems for voice recording or for GPS-based location of terminals (automatic vehicle location, AVL). Another example is the TETRA Secury System (TSS) offered by the application partner Funkwerk Security Communications GmbH. This application is sold exclusively with the ACCESSNET®-T Campus IP. TSS offers fast help in dangerous situations and is equipped with the standard TETRA-SDS method plus additional messaging functions. In the control center application, it provides detailed information about emergency situations that have been reported. Furthermore, it locates the position of the person(s) calling for help and delivers information on precise areas or zones, which is a prerequisite for providing immediate and reliable assistance. TSS is already being employed in law enforcement, psychiatric facilities and in areas of industry where individual staff members might be exposed to special dangers.

With all these functions and advantages, the ACCESSNET®-T Campus IP offers an ideal way to enter the world of digital TETRA mobile radio and is an optimal basis for digital professional mobile radio.

Markus Oltmanns

Rohde&Schwarz equips state-run refineries in Kuwait with professional TETRA mobile radio

Rohde&Schwarz Professional Mobile Radio supplies an ACCESSNET®-T TETRA network to the state-operated Kuwaiti oil company KNPC, which already in the past received analog radio technology in line with the MPT1327 standard. One particularly important factor in the supplier selection process was the fact that Rohde&Schwarz as a system partner was able to provide a complete solution tailored to the customer's requirements and wishes. The order also includes intrinsically safe portable terminals for 1650 users from Rohde&Schwarz's partner Funkwerk Security Communications GmbH. This company has upgraded its new FT4 Ex TETRA terminal for use in explosion-prone environments to include features that were designed and implemented in accordance with the customer's wishes.

This order from one of the world's largest oil companies further solidifies the leading position of Rohde&Schwarz Professional Mobile Radio GmbH on the international market as a supplier of communications infrastructure and system solutions for the oil and gas industry.

Saxony's Highway Department is using ACCESSNET®-T IP

In early 2009, the Highway Department of the German state of Saxony decided in favor of the ACCESSNET®-T IP TETRA mobile radio system following a call for bids. "Rohde&Schwarz submitted the best offer in every respect and impressed us in the assessment criteria of technical value and price as well as service and maintenance costs," explained the Saxony Highway Department with regard to its decision.

With levels of traffic constantly rising, the local highway maintenance stations and control centers need to respond with ever increasing speed and mobility. In order to reliably network the control center, the support sites and the teams, communications mainly take place via radio: In this way, the control center is able to direct short-term maintenance activities, road gritting services during the winter and clean-up activities after accidents. The analog technology that has been in use up until now is no longer sufficient for these mobile service operations.

To reduce costs and optimize system use, the interlinking of all components via the existing IP infrastructure is particularly important for the Highway Department. Here, ACCESSNET®-T IP offers advantages, because all the connections between the network elements as well as all couplers and interfaces to telephone systems and applications are based on the Internet protocol.

The system's excellent application capabilities also played a decisive role in the decision for ACCESSNET®-T IP. Via A-CAPI, customer-specific applications use the data and services of the TETRA system for localizing vehicles and displaying their position visually in the control center as well as for indicating the status of the vehicles (such as the tank contents for road gritting vehicles).

Each local highway maintenance station has its own exchanges, which enables them to operate independently in the event of failures at other sites. This distributed architecture of the ACCESSNET®-T IP ensures a high level of system availability and failsafety.

Ready for the Olympics: Rohde&Schwarz provides expertise and T&M solutions for Beijing 2008

Rohde&Schwarz has a lot of experience with major sports events: During the Beijing Olympics, interference-free radiocommunications contributed to the Games' success.

The challenge: radiomonitoring

With a population of more than 17 million, Beijing has to cope with an extremely crowded frequency spectrum. Even on ordinary days, frequency management and radiomonitoring in the city are an enormous task for the regulatory authorities. But during the 2008 Summer Olympic Games, as the need to communicate – and with it the quantity of radio equipment – sharply increased, they grew into a veritable challenge.

In 2004, therefore, the Beijing Olympic Games Radio Management Committee (BOGRMC) was established to ensure secure radiocommunications during the Olympic Games. The committee began planning and preparation early on and gathered information and experience from other countries that had organized events of similar proportions. Between August 2007 and June 2008, numerous test events were held ("Good Luck Beijing"), where radiomonitoring procedures were tested, potential interference was detected and frequency request coordination was prepared.

More than 11,000 athletes took part in the 2008 Olympics, which were held in 36 stadiums in Beijing, as well as in the cities of Tianjin, Shenyang, Qinhuangdao, Shanghai and Qingdao. Altogether, the BOGRMC deployed more than 300 experienced engineers. They examined 7800 different communications devices and issued more than 10,000 labels to mark those devices that had passed the compliance test. In addition, 9037 license applications had to be processed and more than 21,000 frequencies assigned.

During the Games, seven fixed frequency monitoring stations, 32 test vehicles (FIG 1) and about 3000 portable monitoring and test devices were deployed in Beijing. In the other cities, approximately 50 fixed and mobile stations were utilized. More than 40 unauthorized transmissions and sources of radio disturbance that could have endangered the Games' smooth operation were detected, located and examined. And in the end, it all succeeded: There was no trouble, and not one critical situation occurred.

Photo: author

FIG 1 Rohde&Schwarz mobile direction finders supported the fixed systems from test vehicles.

Photo: author

FIG 2 The R&S®PR100 portable receiver and R&S®HE300 directional antenna modules help to trace interfering signals quickly and efficiently.

Expertise and T&M solutions from Rohde&Schwarz

As a main supplier, Rohde&Schwarz worked closely with the BOGRMC from the early planning phase to the end of the Games. Rohde&Schwarz made full use of its comprehensive technical experience and operational knowledge, which it had already gained at other major sports events, such as the 2004 Olympic Games in Greece and the 2008 European Soccer Championship in Germany.*

Numerous Rohde&Schwarz radiomonitoring and T&M solutions supported the engineers during the Olympic Games. Not only classic products, such as the R&S®ESMB/ESMC/EB200 receivers and the compact R&S®DDF195 direction finder, but also digital direction finders such as the R&S®DDF05E and the R&S®EM550 digital wideband receiver helped them accomplish comprehensive tasks.

Many fixed and mobile systems worked with the tried-and-tested R&S®ARGUS software. And just in time, the new R&S®PR100 portable receiver (FIG 2) was launched on the market and won users over: Its compact size, as well as its outstanding functions and technical characteristics, optimally met their needs. Thanks to its versatility, the receiver could be used successfully in a multitude of situations.

Rohde&Schwarz was also involved in the technical and operational training. In January 2008, the China representatives set up a support team for the Olympic Games to deal immediately with emergency and spare parts management, as well as other important issues. Starting in July 2008, every stadium had a 24-hour support team at the ready.

An Olympic achievement

The BOGRMC was greatly satisfied with the products and support from Rohde&Schwarz. As recognition, the Rohde&Schwarz representatives received two awards: one from the Beijing RMC local regulatory authority for their "Great Contribution to The Olympic Games for Radio Security" and another from the Qingdao RMC for "Selfless Support and Excellent Service". Naturally, the team was delighted with the awards and saw them as excellent qualifications for future success with systems and services in China.

Limin Li

* 2008 European Soccer Championship – also a technical challenge. NEWS from Rohde&Schwarz (2008) No. 198, pp. 74–75.

EEEfCOM innovation award for MIMAX project

For the seventh time in a row, Rohde&Schwarz and Gerotron Communication GmbH have bestowed the EEEfCOM innovation award. The prize is aimed at promoting innovative, hands-on research and development. In addition, it serves to recognize and motivate engineers and scientists in the field of information transmission technology and electronics. The award acknowledges solutions from industry, research institutes and universities.

First place went to Ralf Eickhoff, Frank Ellinger and Uwe Mayer (Technical University of Dresden), Rolf Kraemer (IHP Frankfurt/Oder) and Ignacio Santamaria (University of Cantabria) for their application-oriented MIMAX project (RF MIMO systems for maximum reliability and performance of wireless radios). On behalf of the winning team, Prof. Dr. Frank Ellinger of the Technical University of Dresden officially accepted the main prize, which was sponsored by Rohde&Schwarz: an R&S®ZVL6 vector network analyzer.

The R&S®ZVL6 was presented by Rohde&Schwarz in Munich (from left): Alexander Wörner, Rohde&Schwarz; Cornelia Wiedermann, Gerotron; Prof. Dr. Frank Ellinger, Technical University of Dresden; Lutz Balluschk, Rohde&Schwarz; Georg Schmidt, Gerotron.

Rohde&Schwarz USA appoints new COO

Scott Bausback has been appointed Chief Operating Officer at Rohde&Schwarz, Inc. USA, replacing Jack Cowper. Bausback has been in the test and measurement business since 1983. The electronics engineer occupied various managerial positions at Tektronix and was also responsible for the sales cooperation with Rohde&Schwarz from 1993 to 1997. During this time, he helped Rohde&Schwarz successfully gain access to the US market. He later held managerial positions at LeCroy from 2001 to 2007, followed by a series of management consulting assignments for various T&M companies.

Scott Bausback is new Chief Operating Officer at Rohde&Schwarz, Inc. USA.

Radiomonitoring system for Mexico

Rohde&Schwarz has won a bid from Cofetel, the Mexican telecommunications regulatory authority. The order is worth US$ 3.5 million and has four phases. In the first phase, Rohde&Schwarz Mexico will deliver a system for civil radiomonitoring. Over the coming two years, further fixed stations as well as mobile units will follow. The project is expected to stimulate business in the region.

Rohde&Schwarz USA again receives lab accreditation

The American Association for Laboratory Accreditation (A2LA) has again accredited Rohde&Schwarz, Inc. USA. The scope was extended to 18 GHz by adding additional parameters. Rohde&Schwarz can now offer accredited calibrations and is moving toward the 50 GHz certification.

R&S®SMB signal generator for the US military

Rohde&Schwarz, Inc. USA has achieved another success for the R&S®SMB on the aerospace and defense market. The US Army Aviation&Missile Command has already ordered 4000 units. RSA will also deliver 800 R&S®SMB100N to the US Naval Inventory Control Point in Virginia.

German federal authorities rely on secure mobile communications from Rohde&Schwarz SIT

The Federal Republic of Germany will equip its top federal authorities with state-of-the-art encryption devices for mobile phones by July 2010. The procurement office of the German Federal Ministry of the Interior (BMI) has concluded a framework agreement with Rohde&Schwarz SIT GmbH covering the delivery of several thousand TopSec Mobile devices. The mobile encryption device provides tap-proof calls on mobile phones. For many years, German authorities have relied on the German market leader in the field of IT solutions for high and ultra-high security requirements for phone calls made over wireline networks and via mobile phones.

The TopSec Mobile encryption device.

Henan TV tower to broadcast with Rohde&Schwarz

Rohde&Schwarz is equipping the new TV tower in Henan, China, with high-power TV transmitters. In the first phase of the project, transmitters for analog terrestrial television will be installed to go on the air in time for the Chinese New Year celebrations in 2010. Transmitters for digital terrestrial television using the Chinese DTMB standard will follow later.

In spring 2009, the company agreed to deliver TV transmitters for the new TV tower in the city of Shenzhen. New digital terrestrial transmitters as well as upgradeable analog systems are now being installed on Wutong Mountain

The Henan TV tower will broadcast using high-power TV transmitters from Rohde&Schwarz.

Electromobility from Teisnach

Rohde&Schwarz Teisnach is producing charging stations for electric vehicles on behalf of RWE AG. In September 2008, this major German energy company launched the nationwide electromobility project. The Teisnach plant is responsible for part of the development work, as well as for the complete design and production of the charging stations. So far, 56 charging stations have been installed in Berlin, and more cities will follow this year. The long-term goal is a comprehensive charging-station network covering all of Europe.

Carolin Reichert, Area Manager for Electromobility at RWE, presents a charging pillar together with Torsten Frieb-Preis, Sales Manager (middle), and Johann Kraus, Plant Manager of Rohde&Schwarz Teisnach.

TETRA for European Soccer Championship stadium

Rohde&Schwarz Professional Mobile Radio is equipping the new ultra-modern Donbass Arena in Donetsk, Ukraine, the site of the 2012 European Soccer Championship Tournament, with a TETRA digital radio system. The system will provide communications for security personnel and stewards in the stadium and its immediate surroundings.

TETRA network for petroleum company in Kuwait

Rohde&Schwarz Professional Mobile Radio and the Kuwait National Petroleum Oil Company (KNPC), one of the world's largest oil companies, signed a contract in spring 2009 for the delivery of a TETRA radio system (see also box on page 35). Setup of the network is scheduled to be completed by April 2010. KNPC employees will communicate using the digital radio system from Rohde&Schwarz, ensuring fault-free and safe operation of the refineries.

Compact and digital – the future of professional mobile radio

The new ACCESSNET®-T Campus IP system from Rohde&Schwarz is the economical solution for beginners and experienced staff new to the field of digital professional mobile radio (PMR) based on TETRA:

- First integrated solution on the market with exchange and base station in one rack
- Easy installation and operation (plug & play)
- Support of operational processes with comprehensive data services
- Cost-efficient networking over IP links
- Compatibility with all TETRA terminals
- High quality – made in Germany

The new ACCESSNET®-T Campus IP enables you to easily enter the world of digital PMR – cost-effectively and ready for the future.

www.rohde-schwarz.com/ad/campus-ip

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