NEWS

196/08

ROHDE&SCHWARZ

First on the market:

All-in-one tester for cost-effective mass production of WiMAX mobile stations

WIRELESS COMMUNICATIONS

UMTS LTE protocol tester for development and wireless-device production

BROADCASTING

Innovative amplifiers: TV transmitters with identical footprint but 50 % more output power

RADIOMONITORING

PC-based, single-channel signal-analysis and signal-processing software

At a glance

No time. You all know the phenomenon: One meeting after another, the telephone won't stop ringing, e-mail messages keep piling up in your mailbox. In this hectic environment, you want to be able to grasp things quickly and make quick decisions. This is why the new Rohde&Schwarz design uses clear structures and a modern look. Since its establishment 75 years ago, the company has evolved from a two-man lab into a corporate group with a global presence. Top quality, maximum precision and solid know-how go into every single product. The new corporate design highlights these characteristics – unmistakable, straightforward and exact. So that customers can see at a glance who they are dealing with.

NEWS has also been redesigned. The top priority: easy orientation and reader-friendliness. For example, our fields of business are color-coded in the table of contents and in the magazine. So that you can see immediately where to page to. And although the magazine has not become thicker, the new look creates more room and space for our topics and products.

On this note, enjoy reading!

Your NEWS editorial team

NEWS

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Cover feature

Rohde&Schwarz is always among the first on the market to offer T&M solutions for future standards. This also applies to the WiMAX standard, which in addition to LTE is an important step toward higher data rates in wireless communications. The R&S®TS8970 con-

formance test system and the wide-ranging family of signal analyzers and signal generators for development are already successfully established on the WiMAX market. In time for the start of mass production of WiMAX components, Rohde&Schwarz is now introducing the R&S®CMW270, the first WiMAX communication tester that combines in a single box the three most important functions for calibration and final testing of WiMAX mobile stations: test signal generation, test signal analysis and realtime signaling. It is the first real all-in-one solution for cost-effective production (page 22).

New options turn the R&S®CMW500 into a UMTS LTE protocol tester that can simulate an LTE radio access network for the development of wireless devices (p. 10).

The R&S®EX-IQ-Box digital interface module provides digital baseband inputs and outputs for Rohde&Schwarz signal generators and signal analyzers (p. 28).

WIRELESS COMMUNICATIONS

As the first real all-in-one tester for cost-effective mass production of WiMAX mobile stations, the R&S®CMW270 is being introduced at exactly the right moment (p. 22).

GENERAL PURPOSE

The R&S®VH8300A1 amplifier module has identical dimensions and connectors to the predecessor model but generates 50 % more output power (p. 44).

BROADCASTING

The new R&S®XLx8000 low-power transposers close gaps in digital TV networks economically (p. 46).

RADIOMONITORING

The R&S®GX430 PC software analyzes and processes analog and digital HF/VHF/UHF signals together with a Rohde&Schwarz receiver (p. 48).

MISCELLANEOUS

No more excuses for mobile phones in weak networks – new test method determines benchmark figures

With conventional certification tests, network operators have limited options for comparing mobile phones. Consequently, they need additional methods to test mobile phones at their RF limits to be able to compare their performance with respect to specific receive characteristics. A new automated test method for the R&S®TS895xG/W 2G/3G RF conformance test system family (FIG 1) fulfills these needs.

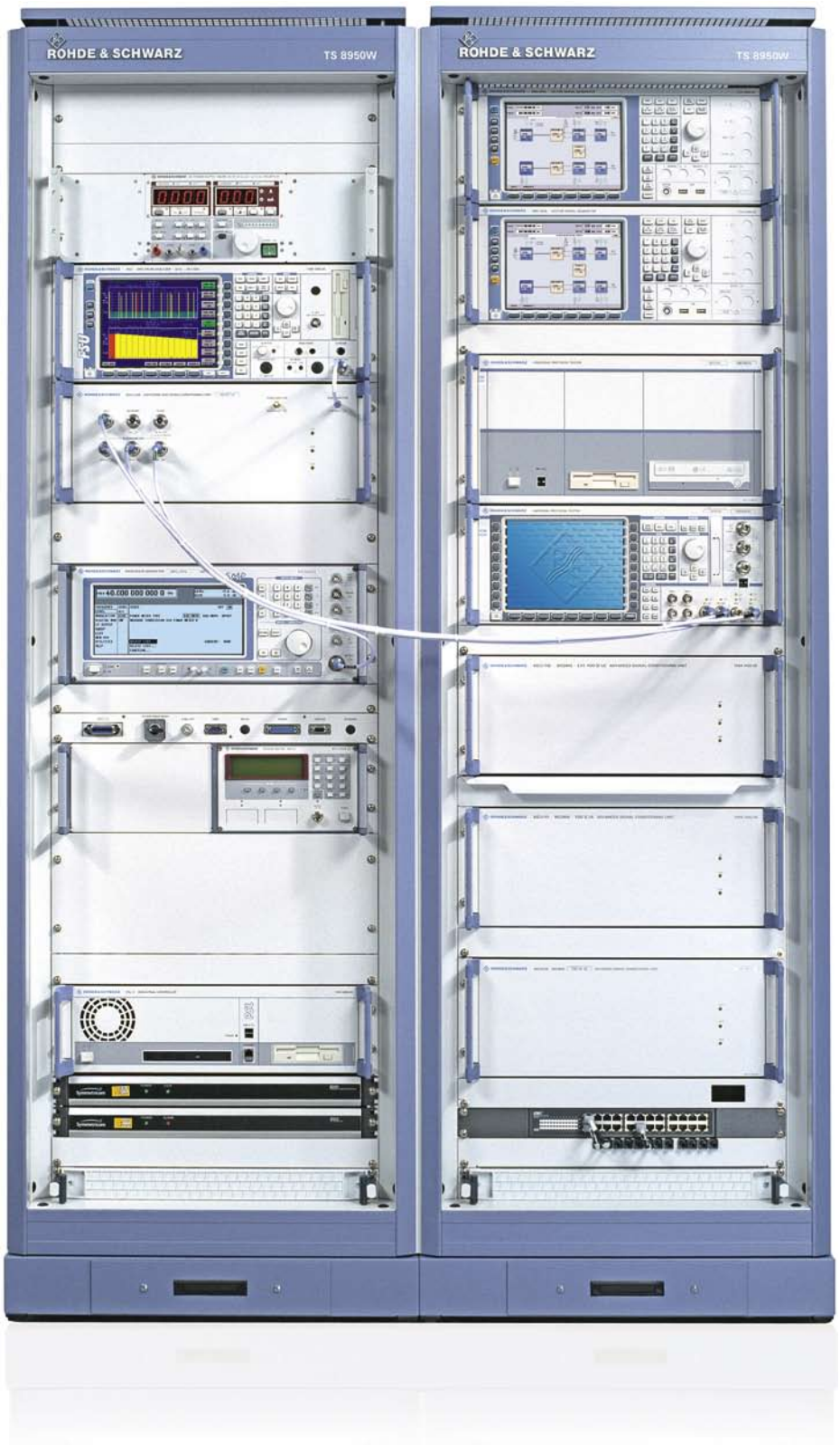


FIG 1 The R&S®TS8950W RF conformance test system.

Conventional measurements no longer sufficient

Conventional RF receiver measurements on mobile phones determine the BER and the BLER under conditions as stipulated in the 3GPP TS51.010-1 V7.0.0 and TS34.121 V7.0.0 test specifications. These specifications serve as a basis for certification tests. They describe different scenarios involving, for example, the downlink level and interference, which are then simulated during the measurements. FIG 2 shows an example of a conventional test in which the conditions are specified in the form of test parameters for adjacent channel selectivity. In this case, the measured bit error ratio is compared with the specified limit value of BER ≤ 0.1 %.

Such measurements are satisfactory for pure conformance tests. Network operators however need more in-depth tests that they can use to investigate the behavior of mobile phones in networks with unfavorable receiving conditions. Such tests should, for example, determine the receive characteristics of mobile phones when exposed to degraded conditions resulting from poorer reception of the base station, greater interference from adjacent cells and increased fading. The test should further allow a conclusive comparison of results.

Similar requirements arise when developing mobile phones and chipsets. Optimization of the design requires determination of how far the measured values are from the specified limits.

Required: margin-specified limits

Benchmark tests are necessary to improve the receive characteristics of mobile phones. Comparing different designs also requires methods that make it possible to assess the RF performance in different scenarios. As their result, such tests should deliver a value that shows to what extent a variable parameter (e.g. downlink level) must change to attain a certain target condition (e.g. BER = 0.1 %). A result in the form of a dB value serves as a measure for the improvement and can be used directly as a benchmark figure.

A test method that finds parameter values by means of which a specified bit error ratio is attained meets these requirements. It varies the values of certain parameters until the desired bit error ratio is reached. Values determined in this manner can be used as benchmark figures. Some parameters that are typically varied in practice are the downlink level, the interference level and the fading profile.

Parameter	Level / Status	Unit
DPCH_Ec	–103	dBm / 3.84 MHz
$\hat{I}_{or}$	–92.7	dBm / 3.84 MHz
I_{oac} mean power (modulated)	–52	dBm
F_{uw} (offset)	–5 or +5	MHz
UE transmitted mean power	20 (power class 3) 18 (power class 4)	dBm

FIG 2 Test parameters for adjacent channel selectivity (3GPP TS34.121, test case 6.4).

Abbreviations

BER	Bit error ratio
BLER	Block error ratio
DPCH_Ec	Average energy per PN chip for the dedicated physical channel
F_{uw} (offset)	Frequency offset of adjacent channel interferer
I_{OR}	Received power density of transmitted signal at antenna input to device under test
I_{oac}	Received power density of adjacent frequency channel at antenna input to device under test
TC	Test case
UE	User equipment
3GPP	3rd Generation Partnership Project

New test method finds benchmark figures

Until now, users could not implement tests of this kind using the R&S®TS895x test systems without additional test steps that they had to edit on their own. This meant the process of test preparation and execution was slow and complicated. Evaluation of results was also time-consuming due to the manual effort required.

You can now simplify this sort of work with the newly developed "margin search" method provided by the RS-PASS (parametric application software for systems) system software which automatically determines the relevant benchmark figures. This software provides an implementation of the relevant test steps using a sophisticated algorithm:

1. Execution of standard test case
2. Early interpolation phase (fewer samples) until a PASS/FAIL point is found
3. Interpolation with a smaller step size and higher accuracy (more samples)

Graphical user interface for easier operation

Users can configure test cases with a convenient graphical user interface. Test results are presented in text format and also in graphical form. FIG 3 shows the input mask with additional search parameters used to reduce the test time. The following parameters are available

- Maximum number of test steps
- Minimum number of samples
- Initial test step size

FIG 4 shows an example with the result from test case TC 6.4A (adjacent channel selectivity). The interferer level is increased from the starting value of –52 dBm until a BER of approx. 0.1 % is reached. This target value is attained for a level of –32.6 dBm which yields a margin to the limit of 19.4 dB.

FIG 5 shows a report for test case 3GPP 34.121 TC 7.2 (demodulation in static propagation conditions) as a graphical presentation. The downlink level starts at –60.7 dBm.

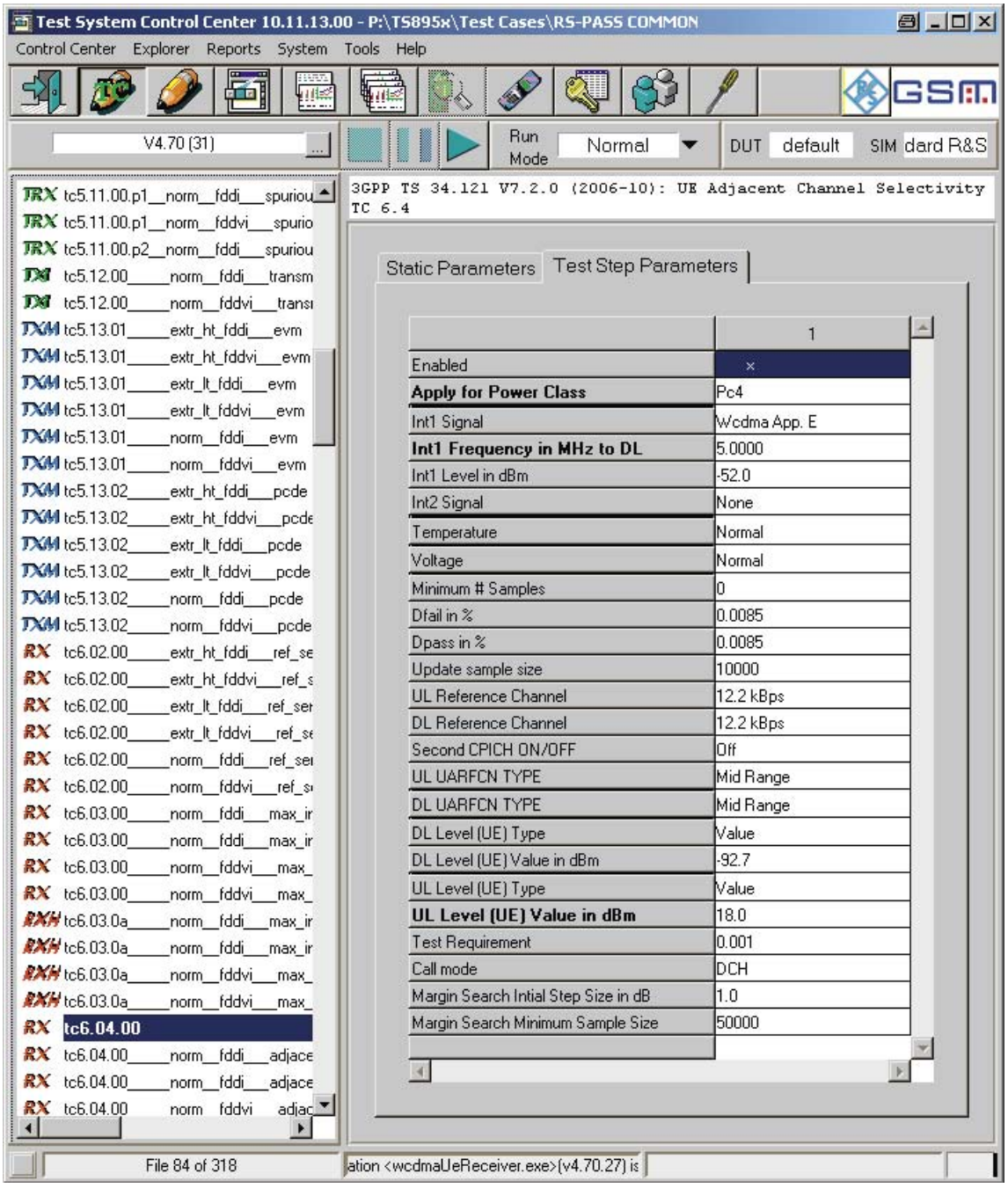


FIG 3 Graphical user interface with margin search parameters.

After seven test steps, the target value for the BER of 1 % is reached at –63.0 dBm. The margin to the limit is therefore 2.3 dB.

Further areas of application

Manufacturers of chipsets and mobile phones can impress their customers by emphasizing the margins to specified test-case limits (in addition to the PASS/FAIL results from the test cases). On the other hand, design optimizations can be carried out to reduce production costs based on insight into these margins.

Test houses can now expand their testing services in addition to actual certification of mobile phones. For example, it is possible to generate conclusive test reports about RF quality or make faster measurements during development with the margin search feature.

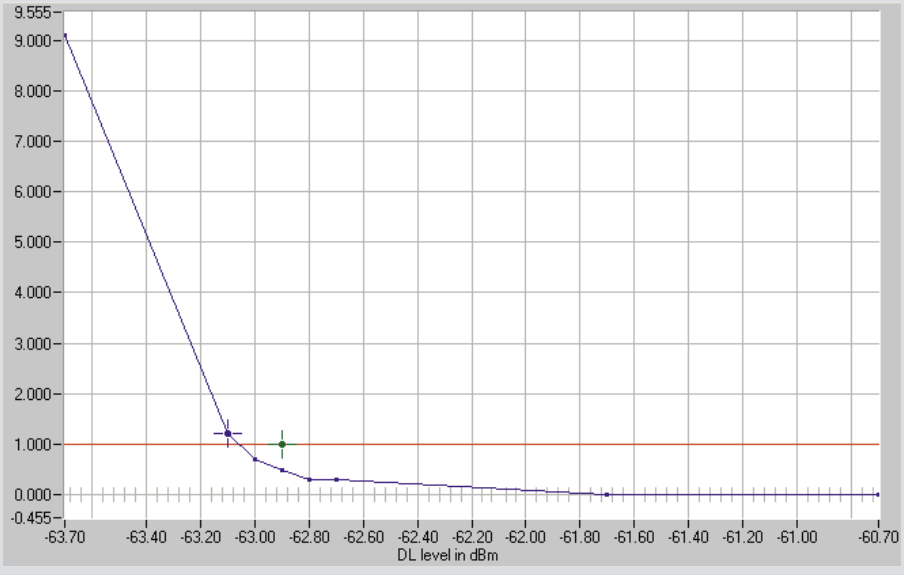
The new method for receiver test cases is available as an option for the R&S®TS8955GW and R&S®TS8950GW test systems.

Stefan Ballmann

Search step	BER [%]	Downlink level [dBm]	Interferer level [dBm]	Limit [%]	Interim result
0	0.000	–92.70	–52.00	0.10	Inside
1	0.000	–92.70	–51.00	0.10	Inside
2	0.000	–92.70	–50.00	0.10	Inside
3	0.000	–92.70	–49.00	0.10	Inside
4	0.000	–92.70	–48.00	0.10	Inside
5	0.000	–92.70	–47.00	0.10	Inside
6	0.000	–92.70	–46.00	0.10	Inside
7	0.000	–92.70	–45.00	0.10	Inside
8	0.000	–92.70	–44.00	0.10	Inside
9	0.000	–92.70	–43.00	0.10	Inside
10	0.000	–92.70	–42.00	0.10	Inside
11	0.000	–92.70	–41.00	0.10	Inside
12	0.000	–92.70	–40.00	0.10	Inside
13	0.000	–92.70	–39.00	0.10	Inside
14	0.000	–92.70	–38.00	0.10	Inside
15	0.000	–92.70	–37.00	0.10	Inside
16	0.000	–92.70	–36.00	0.10	Inside
17	0.000	–92.70	–35.00	0.10	Inside
18	0.000	–92.70	–34.00	0.10	Inside
19	0.000	–92.70	–33.00	0.10	Inside
20	0.122	–92.70	–32.00	0.10	Outside
21	0.148	–92.70	–32.20	0.10	Outside
22	0.124	–92.70	–32.50	0.10	Outside
23	0.036	–92.70	–32.60	0.10	Inside

Result
Search step 0 is the standard test case
Total margin search step: 23
Interferer margin: 19.40 dB (at interferer level –32.60 dBm)

FIG 4 Result from test case TC 6.4A (adjacent channel selectivity): 23 test steps were required to determine the margin to the limit.



Result
Total margin search step: 7
DL level margin: 2.30 dB (at downlink level –63.00 dBm)

FIG 5 Graphical result from test case 3GPP 34.121 TC 7.2.

UMTS LTE protocol tests for all pha

The R&S®CMW500 wideband radio communication tester has been expanded with additional options to make it a UMTS LTE protocol tester. It simulates an LTE radio access network for the development of wireless devices. And it covers every stage from development to conformance tests.

R&S®CMW500 wideband radio communication tester: very first tester to meet latest standards

Manufacturers of mobile radio infrastructures and mobile phones are currently working very hard on the next big step in the development of the universal mobile telecommunications system (UMTS): long term evolution (LTE). This standard can help transform UMTS into the cellular wideband communications system of the future. Featuring data rates of up to 150 Mbit/s, LTE helps ensure that UMTS remains competitive while giving users a simpler means of mobile wideband Internet access. The first commercial LTE networks can be provided by 2010. Manufacturers, therefore, will need suitable test solutions at an early stage of development to verify their implementations and to successfully launch their products. Protocol testers are indispensable for performing complete end-to-end testing of LTE-compatible wireless devices. This opens up a new field of application for advanced instruments such as the R&S®CMW500 wideband radio communication tester (FIG 1). With new options installed, it becomes a powerful UMTS LTE protocol tester.

ses of development

FIG 1 Powerful new options make the R&S®CMW500 wideband radio communication tester a UMTS LTE protocol tester that can simulate an LTE radio access network for the development of wireless devices.

UMTS LTE at a glance

The network and protocol architecture of UMTS had to be thoroughly revised in order to meet LTE requirements. LTE uses a lean, exclusively packet-based network architecture to attain high data rates and to reduce latency. FIG 2 provides an overview of the LTE network elements and interfaces between them. The LTE base station, which is also referred to as eNodeB (eNB), assumes an important role. It manages the radio resources, performs the scheduling of subscribers and initiates connections on the air interface. This eliminates the UMTS radio network controller (RNC), which significantly reduces the number of network-internal interfaces. The eNB basically assumes the functions previously handled by the RNC.

Many of the mechanisms commonly used in UMTS have been further simplified for LTE: As for data transmission, LTE makes exclusive use of the shared channel principle. This principle, which allows multiple users to dynamically access the air interface, is ideal for packet-oriented services. In contrast to conventional circuit-switched operation, an LTE network does not assign air interface resources to a user for the entire duration of a connection. It only assigns a resource when a data packet is to be transmitted. When no data is being transmitted, this resource can be assigned to other subscribers.

The performance of the shared channel can be further increased by combining the shared channel principle with procedures for link adaptation. Plus, the base station can make frequency-dependent scheduling decisions such as whether a user would have better connection quality in a specific range of bandwidths. The scheduling mechanism is therefore very complex but significantly determines the performance of an LTE system. The stringent timing requirements are of particular importance because the base station has to make a new scheduling decision every millisecond.

The integration of LTE into existing mobile radio networks of the 3G WCDMA and 2G/2.5G GSM/GPRS/EDGE standards is an important aspect, particularly from the point of

UMTS LTE network architecture

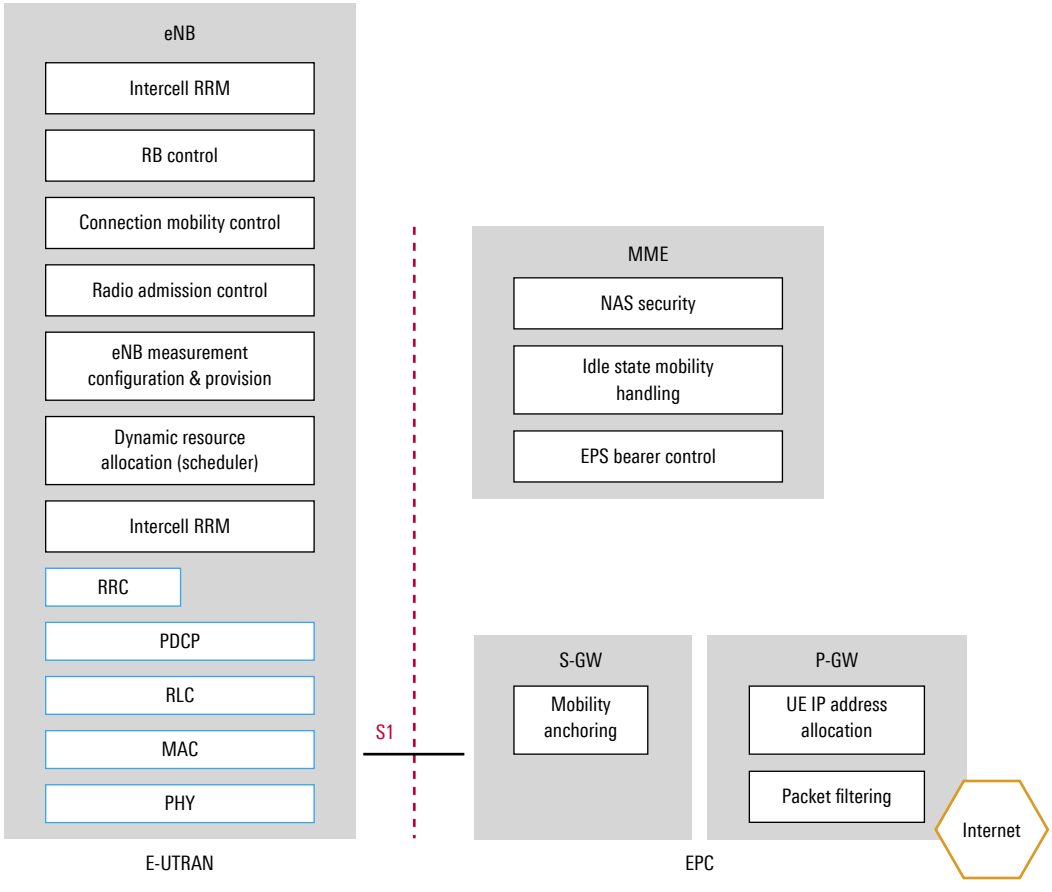
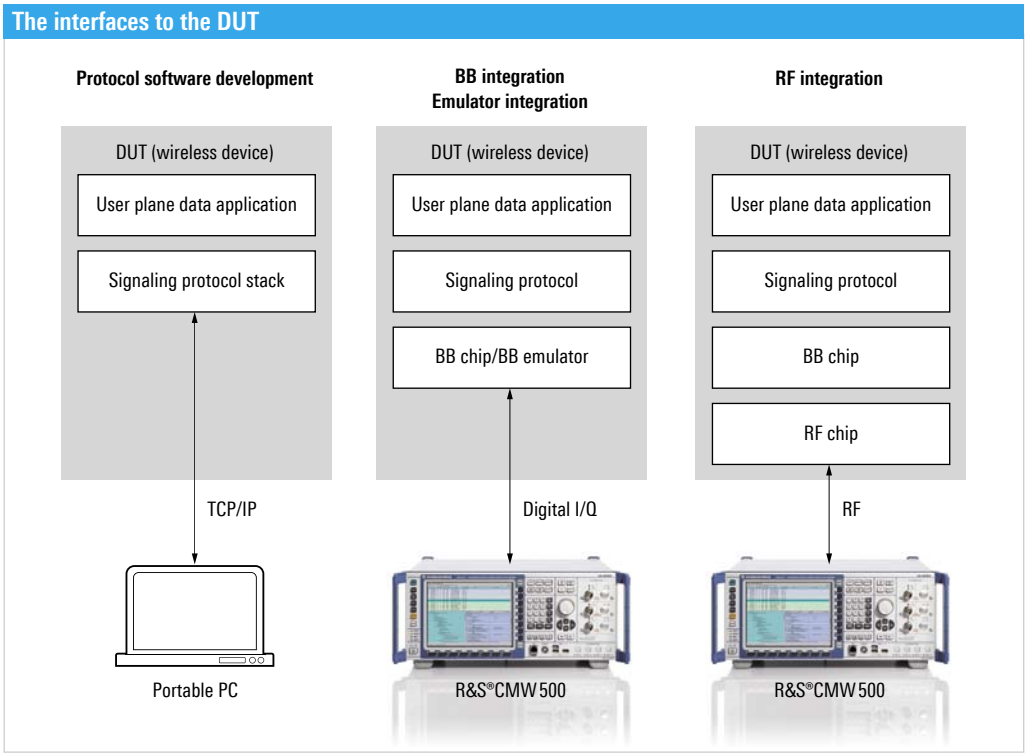


FIG 2 The lean, exclusively packet-based network architecture of LTE helps ensure high data rates and reduces latency.

FIG 3 The R&S®CMW500 used as network simulator: The wireless device or the chipset to be tested is connected via an RF connection or, in future, via a digital baseband I/Q interface.



view of network operators. They need a smooth and trouble-free means of handover between LTE networks and networks based on other standards so that the handover is not noticed by mobile radio subscribers. Suitable handover mechanisms are currently being specified by 3GPP.

In contrast to the present UMTS, LTE does without the compressed mode as this procedure is quite difficult to implement. In LTE, the base station now has to provide individual subscribers with the scheduling pauses that are required to perform measurements in other technologies.

Protocol tests using the R&S®CMW500

Manufacturers of LTE chipsets and wireless devices use protocol test solutions during the early phases of development to thoroughly check their implementations. The focus is on tests that help ensure that the basic functioning of the protocols on the air interface complies with the 3GPP LTE specifications. In later development phases, engineers should also address performance aspects, e.g. the data throughput of LTE wireless devices that is measured under various propagation conditions.

Depending on the integration of the protocol layers, various approaches for performing protocol tests can be used. If a layer 1 implementation is not yet provided or if integration has not yet been performed, the LTE virtual test software (for PC) from Rohde&Schwarz can be used to test exclusively the protocol software. The LTE virtual test software (for PC) emulates the behavior of the radio protocol layers at the network end, whereby an abstract layer 1 is used. The software sets up an IP connection to the protocol stack to be tested. It then runs through special signaling test scenarios that verify the behavior of the protocol stack at the wireless device end. All essential functions of the layer 2 and layer 3 protocols can be verified in the virtual test environment. The R&S®CMW500 wideband radio communication tester is used after layer 1 has been implemented. With the appropriate options installed, it can be used as a powerful LTE protocol tester.

The wireless device or the chipset to be tested is connected to the R&S®CMW500 – which acts as a network simulator (FIG 3) – via an RF connection or, in future, via a digital baseband I/Q interface. The DUT again runs through special signaling scenarios that are used to check the implementation behavior and to find potential deviations from the standard specification. The test scenarios created by the LTE virtual test software remain unchanged and can be reused in the protocol tester. Plus, unlike the LTE virtual test software, the R&S®CMW500 covers test cases that additionally include layer 1 functionality. Of particular interest are the test cases that are able to test downlink/uplink interactions. The connection to the user plane – for example, to a video streaming server – is important for throughput measurements. Actual user data can therefore be processed in the protocol test scenario.

LTE must be able to interoperate with other mobile radio standards. This is an important aspect in protocol testing, as network operators cannot roll out LTE everywhere right from the start. The R&S®CMW500 is also rated for inter-RAT handover tests. A great challenge for implementing wireless devices is the successful support of various standards. Protocol test solutions that are specifically tailored to meet these requirements are thus extremely beneficial to manufacturers.

Test scenarios for development

One of R&D's main requirements is to have protocol test solutions for LTE at hand starting at an early phase of development. Another is maximum flexibility so that numerous test scenarios can be covered and complex sequences can be recorded. This is no problem at all for the C++-based programming interface: The R&S®CMW500 distinguishes between the low-level application programming interface (LLAPI) and the medium-level application programming interface (MLAPI), depending on whether the interface accesses to layer 2 or layer 3.

The LLAPI offers users direct access to protocol layers 1 and 2 and thus extra flexibility in programming the R&S®CMW500. Plus, the LLAPI is available at an early stage as it does not require layer 3 functionality, which is currently being specified in the 3GPP standardization bodies.

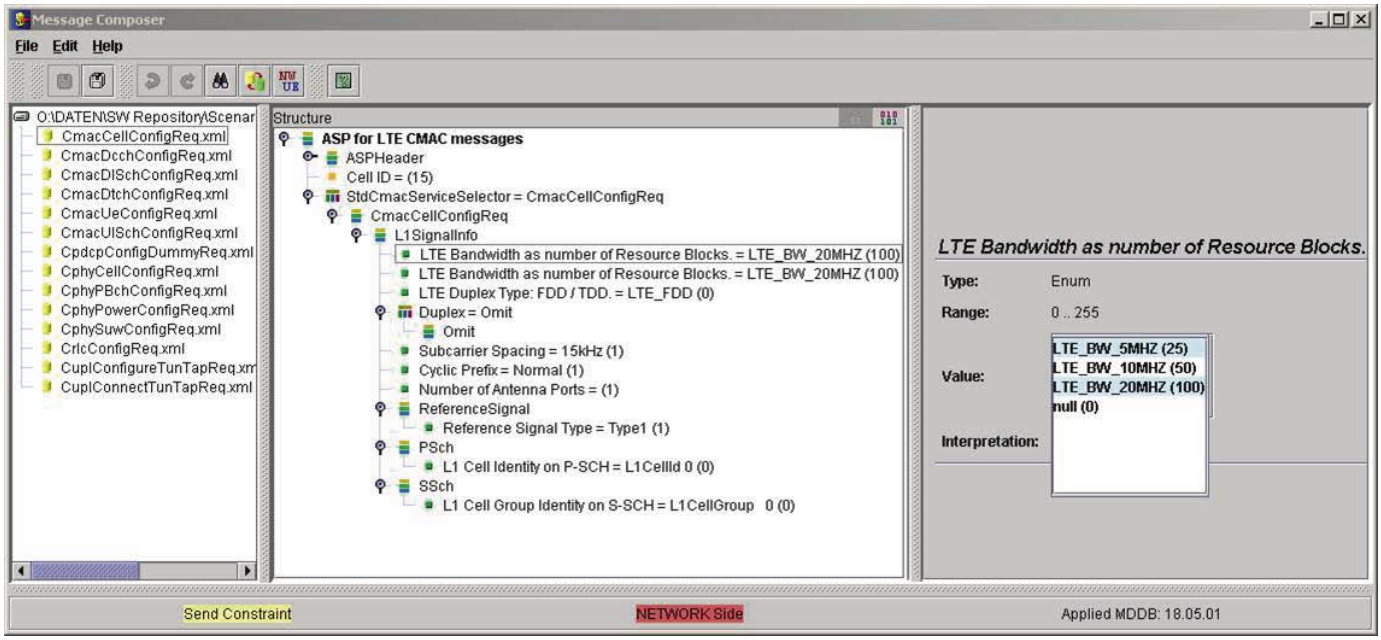
As soon as the layer 3 specification is available, the MLAPI will be a particularly efficient approach. The user does not have to bother about the tedious layer 1 and 2 configuration at the tester end – layer 3 messages will handle that task automatically. The only thing the user has to do is to specify the desired message sequence of the protocol test scenario and the contents of the layer 3 messages, for example, for setting up the connection. Convenient Rohde&Schwarz software tools are provided for editing the messages (FIG 4).

Since state machines are used, scenarios are set up modularly. In other words, the individual test sections can easily be reused in other tests. Once a test scenario has been traversed, the signaling messages between the R&S®CMW500 and the DUT are analyzed by means of log files. FIG 5 shows a suitable analysis tool.

Interoperability test scenarios

In 2009, the first LTE-compatible wireless devices will be tested in network trials. To optimally prepare these field tests, manufacturers of chipsets and wireless devices are provided with special interoperability test scenarios allowing an almost exact simulation of the real network conditions on the R&S®CMW500. As a result, implementation errors can be spotted right away, which saves valuable time and money. In the unlikely event that problems occur during these field tests, the scenarios can be simulated again in the laboratory by using the R&S®CMW500.

FIG 4 The R&S®CMW-KT012 message composer software is a convenient tool for editing layer 3 messages, for example.



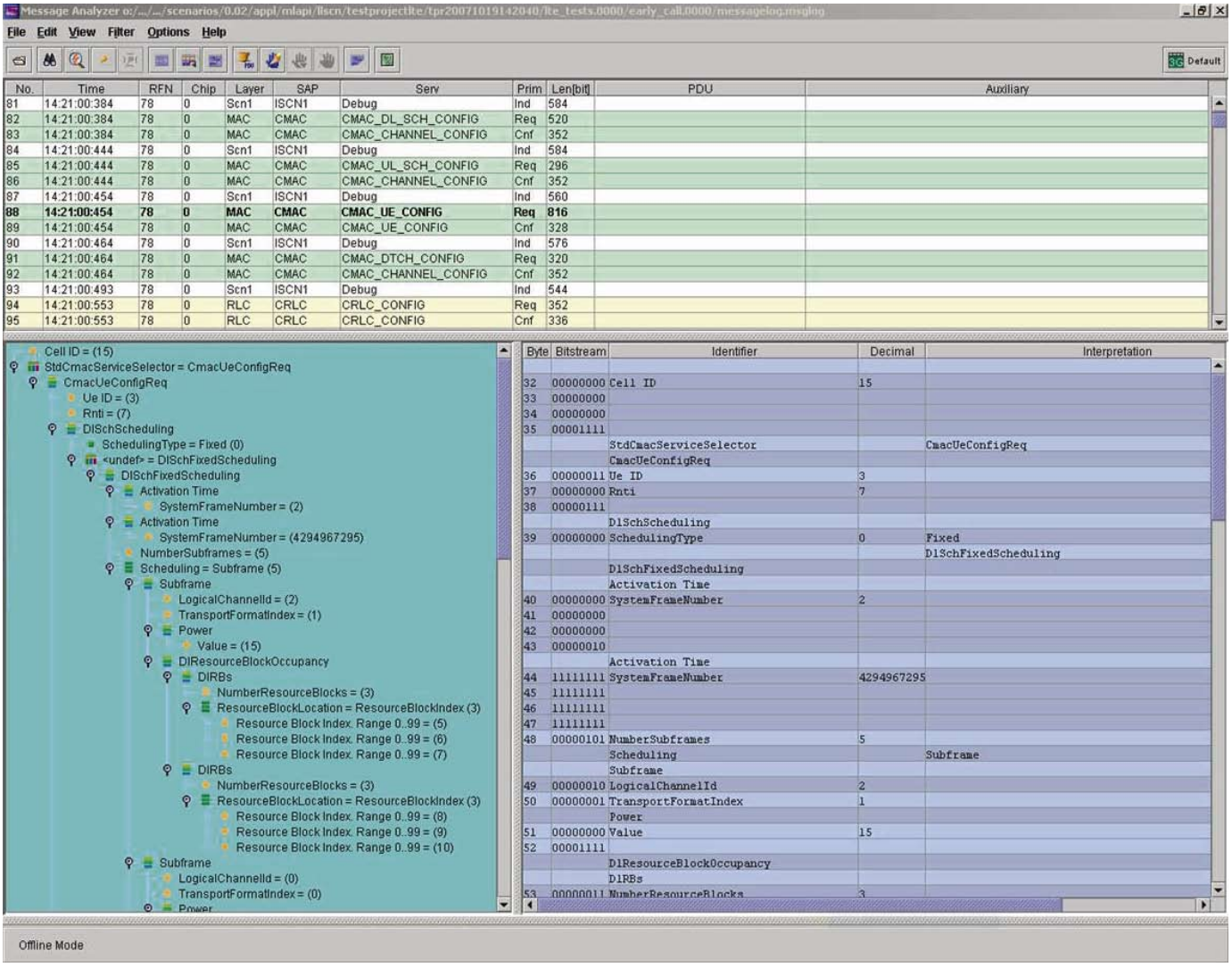


FIG 5 The R&S®CMW-KT011 message analyzer analyzes signaling sequences between the protocol tester and the DUT.

Conformance test cases in accordance with 3GPP specifications

3GPP is currently preparing LTE test specifications that form the basis for the certification of wireless devices in order to help ensure the worldwide interoperability of LTE terminals and networks. In addition to test cases for RF and radio resource management, numerous layer 2, layer 3 and non-access stratum signaling test cases will be available and will also be supported by the R&S®CMW500. 3GPP agreed upon writing these test cases in the testing and test control notation version 3 (TTCN-3), a programming language for the specification and implementation of test cases. The required software tools for creating and preparing these test cases will be provided by the R&S®CMW500.

Summary

LTE involves numerous technical changes for UMTS. Developers of LTE-compatible chipsets and wireless devices must perform comprehensive protocol tests to detect errors at an early phase of implementation, thus saving time and money. The R&S®CMW500 wideband radio communication tester, which offers options for LTE protocol tests, is a powerful solution for every development phase. It also covers the certification of wireless devices and is exactly tailored to meet user requirements with regard to operability and flexibility.

Christina Gessner; Reiner Götz

Testing Bluetooth® stereo headphones in development and production

In labs and in manufacturing, the R&S®CBT and R&S®CBT32 Bluetooth® testers can carry out comprehensive RF measurements. Fitted with new audio options, they can now also be used for simple, fast audio tests of Bluetooth® stereo headphones.

Everything you need for testing analog audio components

Modern mobile phones with built-in Bluetooth® radio interface usually support the corresponding A2DP stereo profile for wireless connection to stereo headphones. These headphones generally have an integrated microphone for phone conversations, which means that the user can listen to stereo music from the mobile phone's MP3 player and also make phone calls without having to take the headphones off.

As the A2DP stereo profile can only transmit audio signals in one direction, it is not suitable for phone conversations. The headphones are therefore also fitted with headset or hands-free profiles. Both of these profiles were developed for speech-quality connections to Bluetooth® headsets and hands-free car units, and are not suitable for high-quality music transmission.

Usually, no analog audio components are necessary for playing MP3 music files with a mobile phone and transmitting them via the Bluetooth® interface. The entire signal processing within the mobile phone through to the Bluetooth® SBC stereo codec is purely digital, and the associated audio parameters can thus be precisely calculated by means of computer simulation. The situation for Bluetooth® stereo headphones is quite different, where D/A converters, filters, amplifiers and acoustic transducers are at the end of the signal transmission chain. All of these analog components significantly affect the audio quality of the headphones, and must therefore be optimized during development. When it comes to high-quality products, equivalent audio tests for verification purposes are also recommended in production.

The audio options for the R&S®CBT (FIG 1) and R&S®CBT32 Bluetooth® testers provide all the measurement functions required for the audio tests on Bluetooth® stereo headphones:

- Two multifrequency audio generators and analyzers (R&S®CBT-B41 option) for generating audio test signals and for measuring audio parameters
- A2DP profile with SBC codec (R&S®CBT-K52 option) for activating and testing the stereo functionality of headphones
- Headset and hands-free profiles (R&S®CBT-K54 option) for activating and testing built-in microphones

FIG 1 A powerful tool, both in the lab and in production: The R&S®CBT Bluetooth® tester carries out comprehensive measurements of RF characteristics, but can also examine audio parameters.

FIG 2 In order to test the microphone and the analog components, the audio generator 1 generates a test signal for the loudspeaker of an artificial head or for a reference loudspeaker. The DUT returns the recorded signal to the tester for analysis.

Setup for microphone tests

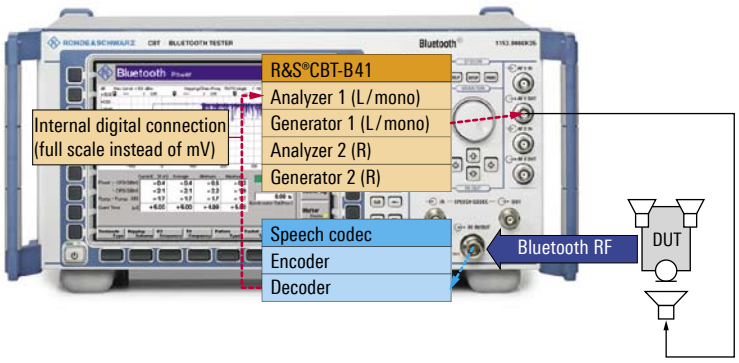
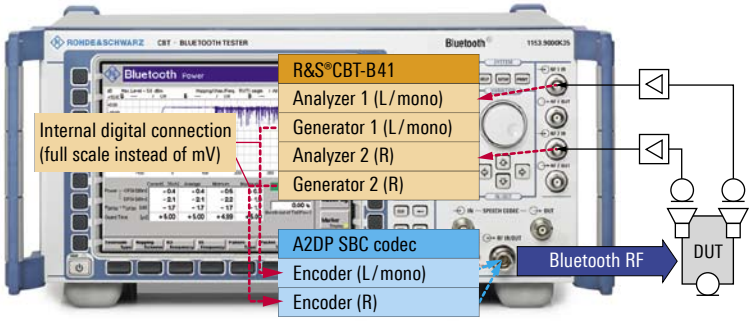


FIG 3 The two audio generators 1 and 2 independently generate test signals for the left-hand and the right-hand channels of the stereo signal. In this way, the two acoustic transducers in the stereo headphones are tested, as well as the analog components that are connected ahead.

Setup for audio testing stereo channels



Testing microphone characteristics

In order to test the audio characteristics of the built-in microphone and the associated analog components, the audio generator 1 generates a test signal that is output by the R&S®CBT through a BNC socket on the front panel (FIG 2). The signal is fed to the loudspeaker of an artificial head or a reference loudspeaker, for example, and the sound is picked up by the microphone of the DUT. By using the headset or hands-free profile, the R&S®CBT establishes an audio connection to the DUT and in response the DUT sends the coded audio signal via the Bluetooth® connection to the tester. The tester decodes the signal in the R&S®CBT speech decoder and transmits the decoded audio signal to the integrated audio analyzer 1, which then performs a range of different audio measurements.

The R&S®CBT can measure the frequency response very quickly with the aid of a multitone signal (FIG 4). The individual frequencies and limit values are user-definable. In addition to the peak and RMS levels, the Bluetooth® tester also measures a variety of distortion figures in single-tone mode. It displays all absolute levels referenced to the maximum digital signal level using the full scale (FS) unit.

Testing music replay characteristics

In order to test the two acoustic transducers in the stereo headphones, including the analog components that are connected ahead, the two audio generators 1 and 2 independently generate test signals for the left-hand and right-hand channels of the stereo signal (FIG 3). The absolute audio

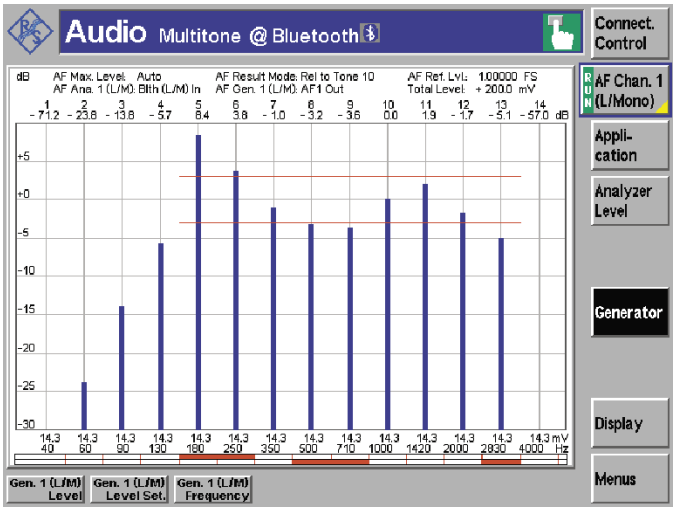


FIG 4 Frequency response measurement of a built-in microphone.

level is again defined in FS units to ensure that the full range of the digital signal level is used for the measurements. The R&S®CBT now uses the A2DP profile to establish an audio connection to the DUT and feeds the two audio test signals to the internal Bluetooth® SBC stereo codec. The test signal is routed to the decoder of the stereo headphones via the Bluetooth® connection. The decoded, audible sound signals are then picked up by an artificial head or by two reference microphones, and transmitted via two amplifiers to the two audio analyzers in the R&S®CBT via two BNC sockets.

The audio analyzer in the R&S®CBT measures the two channels simultaneously in stereo mode, displaying the measurement results one above the other in two windows (FIG 5 illustrates this, using the total harmonic distortion measurement as an example).

When things get tricky use an external audio analyzer

The R&S®CBT-B41 audio option provides the key audio measuring functions for quick verification of the DUT. To solve particularly tricky measurement problems, however, the use of an external audio analyzer might be a good approach. If, for example, the distortion values are unexpectedly high, an audio analyzer will allow the cause to be pinpointed by means of an FFT signal analysis. The R&S®UPV audio analyzer, for example, is ideal for this task (FIG 6). The R&S®UPV generator signals pass through the digital audio interface (R&S®CBT-B42 option) to the R&S®CBT. In this example, the two audio signals from the DUT are analyzed directly by the R&S®UPV audio analyzer, without taking the acoustic transducers into consideration. The R&S®UPV displays the spectrum of the audio signals via FFT, allowing conclusions to be drawn about possible internal sources of interference in the DUT.

Dieter Mahnken

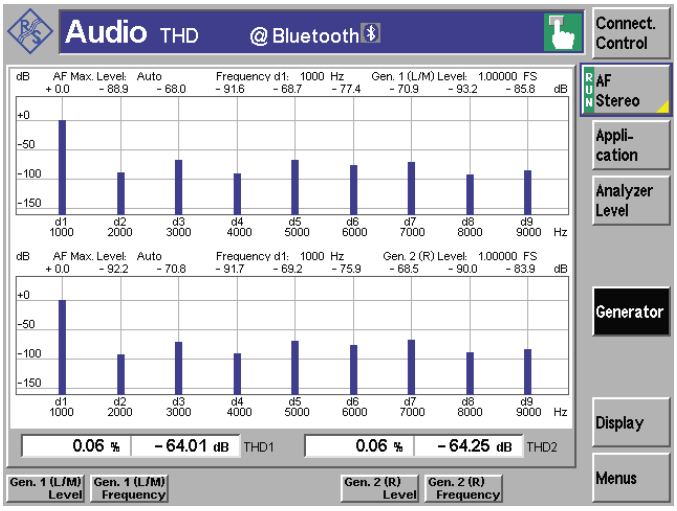


FIG 5 THD measurement of the two stereo channels.

For special measurement problems: R&S®UPV audio analyzer

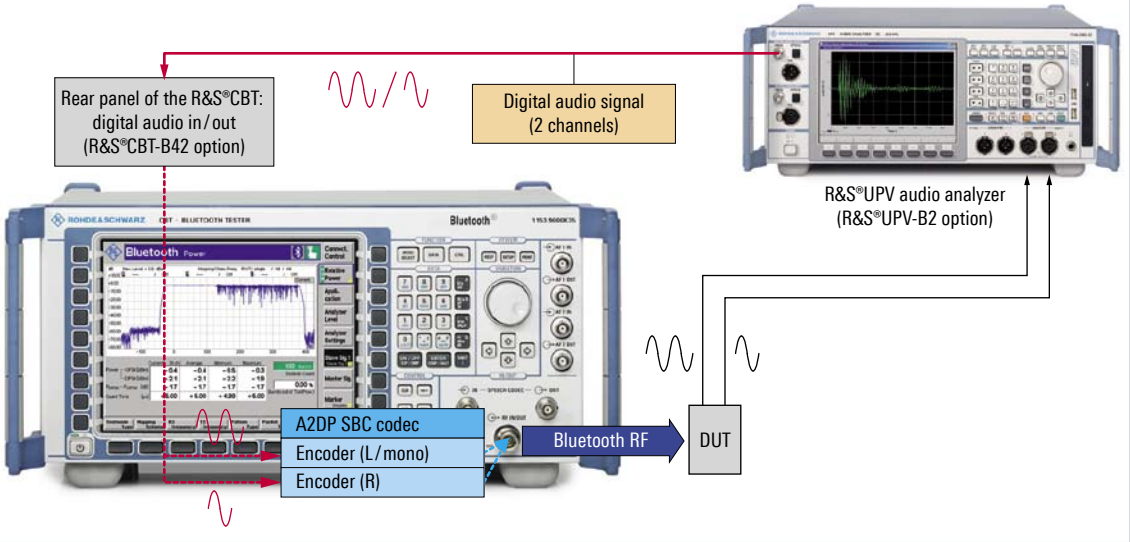


FIG 6 It can be helpful to use an external audio analyzer in order to solve particularly tricky measurement problems. An example of coupling an audio analyzer to the R&S®CBT via the digital audio interface is shown here.

A-GPS and SUPL tests with the R&S®CRTU protocol test platform

The complex interaction between GPS functionality in mobile radio terminals and the related services in a network needs to function flawlessly. Rohde&Schwarz offers complete test solutions from a single source in this area.

GPS services will soon be a "must have" in wireless communications

The widespread use of GPS-based navigation systems is also having an impact on wireless communications, where position-dependent services are gaining significance. This trend has been reinforced by statutory provisions adopted by national regulatory authorities such as Regulation E911 issued by the US Federal Communications Commission (FCC), which requires the capability to signal the position of a caller who makes an emergency call in a wireless communications network. Complex systems of this kind work properly only if the GPS functionality in the mobile terminals interacts perfectly with the corresponding services provided by the infrastructure.

For A-GPS (assisted GPS) in WCDMA and GSM networks and for SUPL (secure user plane), Rohde&Schwarz now offers complete test solutions from a single source using the R&S®SMU200A signal generator as the satellite simulator and the R&S®CRTU protocol test platform as the system simulator. For SUPL tests, the R&S®CMU200 universal radio communication tester can also be used instead of the R&S®CRTU.

Seeking the exact position

There are different methods that can be used to determine the position of mobile terminals in wireless communications networks. They range from a coarse position estimate based on the radio cell (with the positioning accuracy determined by the cell size) to triangulation using three base stations and satellite-based position fixing by means of GPS.

GPS is a satellite-based system where the satellites transmit their orbital parameters and timing information. The data is divided into two groups which differ, for example, in terms of repetition rate. Complete transmission of all data takes 12.5 minutes. A complete data set is needed to determine the position.

In wireless communications networks, the coordinates of the base station in whose radio cell the mobile terminal is located can be used to make an initial approximation of the position. This information is transmitted to the mobile terminal as part of the assistance data to considerably shorten the time until exact GPS position data is available (FIG 1).

Tests for A-GPS and SUPL

Suitable data must be transmitted to and from the mobile terminal for determining its position in a wireless communications network by means of GPS. For A-GPS, the signaling protocol is extended to include the required messages. Since signaling is dependent on the standard, there is A-GPS for GSM and A-GPS for WCDMA. They essentially differ only in that they use different structures for the signaling protocol.

Another method of transmitting position data is to use an IP connection. This approach is used with SUPL. For applications involving an IP connection, it is irrelevant how data is transmitted, meaning they are *bearer agnostic*.

Basic setup for A-GPS/SUPL

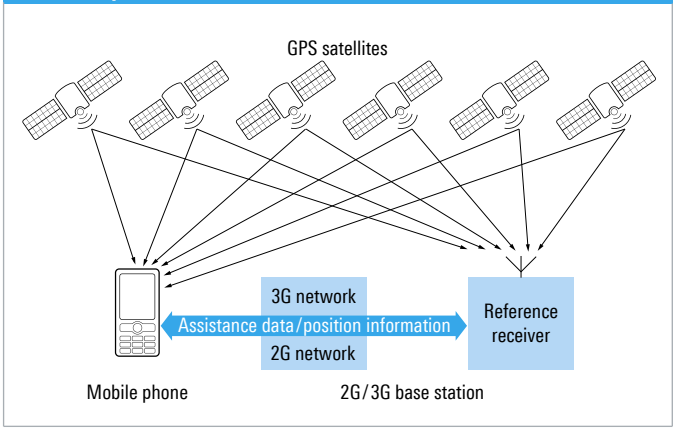


FIG 1 To reduce the time until exact GPS position data is available, the mobile phone is provided with the base station coordinates (via the assistance data) to enable a coarse position estimate.

Tests for A-GPS and SUPL include *signaling* and *minimum performance* tests.

Signaling tests check whether the messages that are exchanged comply with specifications in terms of type and format. Since these are highly dependent on the standard, separate (very different) test specifications exist for A-GPS for GSM, A-GPS for WCDMA and for SUPL. There are also separate work items (WI) for the different specifications for conformance tests in accordance with the Global Certification Forum (GCF) (FIG 2).

Minimum performance tests basically verify whether a mobile terminal is capable of determining its own position with a defined accuracy within a specified time interval. These tests were initially defined only for WCDMA. However, they also make sense for A-GPS for GSM and for SUPL, which is why the test specification for WCDMA has been applied to GSM. Analogous discussion has now begun for SUPL. It is still unclear to what extent multimode terminals that support, for example, A-GPS for GSM and for WCDMA will require the A-GPS minimum performance tests for all of the supported technologies.

Signaling	**Minimum performance**
Positioning information exchange	
3G	3G
Test specification: TS34.123	Test specification: TS34.171
GCF work item 15	GCF work item 30
2G	2G
Test specification: TS51.010	Test specification: TS51.010
GCF work item 16	
SUPL	SUPL
Test specification: OMA-ETS-SUPL-V1	Test specification: none
GCF work item 58	

FIG 2 Overview of test specifications and GCF work items.

Test solutions from Rohde&Schwarz

Rohde&Schwarz is the only manufacturer to offer a A-GPS and SUPL test solution from a single source. When equipped with the R&S®SMU-K65 software option, which is the A-GPS extension for the R&S®SMU-K44 standard GPS software option, the R&S®SMU200A signal generator meets all requirements that exist for the simulation of GPS satellite signals for A-GPS/SUPL test cases. The test cases that involve signaling to the wireless communications network are executed on the R&S®CRTU protocol test platform. This platform also controls the R&S®SMU200A, where it starts a satellite scenario for a specific location or path and a specific time and date (FIG 3). This can be one of the preconfigured scenarios for the conformance tests. It is also possible to run configurations with up to eight satellites for user-defined locations or paths. The R&S®SMU200A computes the associated assistance data and forwards it to the protocol tester. This ensures that the simulated satellite positions are consistent with the assistance data.

The R&S®CRTU protocol test platform is available in two variants: the R&S®CRTU-G for GSM signaling and the R&S®CRTU-W for WCDMA signaling. The R&S®CRTU-GW protocol tester combines both standards. Either one can be selected when the instrument is powered up. A configuration consisting of the R&S®CRTU-GW and R&S®SMU200A thus covers all A-GPS and SUPL test requirements for conformance tests.

A-GPS tests

With the R&S®CRTU-GC10 and R&S®CRTU-GC16 test packages for GSM A-GPS signaling and the R&S®CRTU-WE10 test package for WCDMA A-GPS signaling, a fully validated test solution has already been available for some time on the R&S®CRTU platform. The R&S®CRTU-WF02 packages now adds the minimum performance tests for WCDMA A-GPS, while the R&S®CRTU-GF02 provides GSM A-GPS test capability.

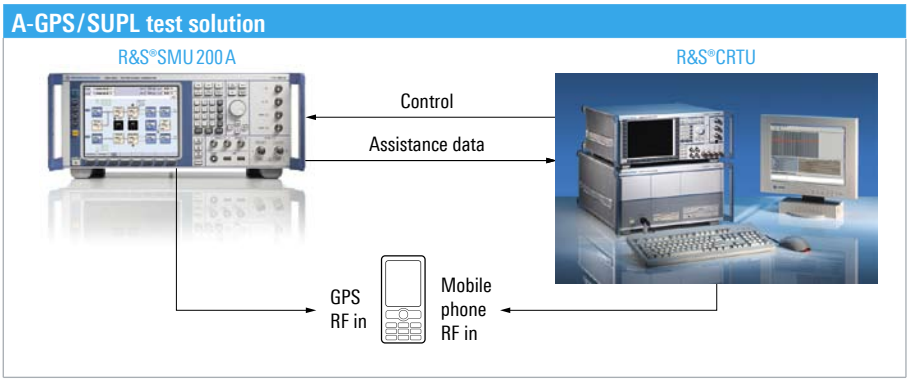


FIG 3 The R&S®SMU200A signal generator simulates the satellite signals, while the R&S®CRTU protocol test platform executes the test cases that involve signaling to the wireless communications network.

For all of the A-GPS tests, the familiar user interface of the R&S®CRTU-G/-W is available with its powerful analysis tools. Since minimum performance tests are based on the statistical evaluation of individual measurements, the distribution of measurement results is also presented graphically (FIG 4).

SUPL tests

With the R&S®CA-AC06 SUPL test package, Rohde&Schwarz is the first manufacturer to reach the 80% threshold for the corresponding GCF WI 58 and thus attain the test entry criterion from which these tests are mandatory.

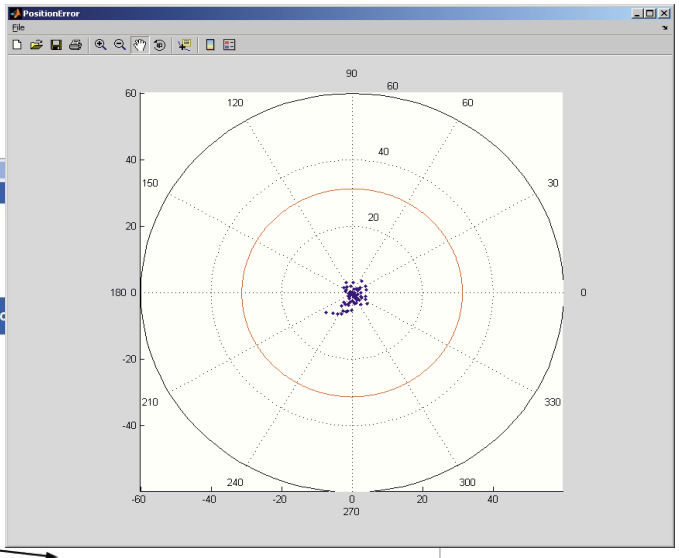
For the test configuration in FIG 3, there is another variant for SUPL which is possible due to the special structure of these tests. SUPL is an application that uses a TCP/IP connection. This means that the requirements imposed on the system simulator are less demanding, so that the R&S®CMU200 universal radio communication tester can be used instead of the R&S®CRTU. In this case, the test application runs on an external PC. SUPL is one of several applications that fall into the category of *application testing*. All of these applications are based on an IP connection and are thus *bearer agnostic*. The common framework for these applications is provided by the R&S®CRTU-AP01 ATE software, and the user interface and analysis tools are based on the corresponding elements of the R&S®CRTU environment (FIG 5).

Summary

The R&S®CRTU protocol test platform and the R&S®SMU200A signal generator provide users with a comprehensive A-GPS/SUPL test solution from a single source. This solution covers an extremely wide range of tests with a minimum of hardware. For customers who already use the R&S®CRTU, these tests are an additional application that runs in a familiar work environment, wich reduces the time needed to learn the new test application. Since the entire range of A-GPS test capabilities is structured in a modular way, it is possible to find a cost-effective solution for any requirement that arises in the lab.

Wolfgang Kalau

FIG 4 Distribution of positioning results during a minimum performance test.



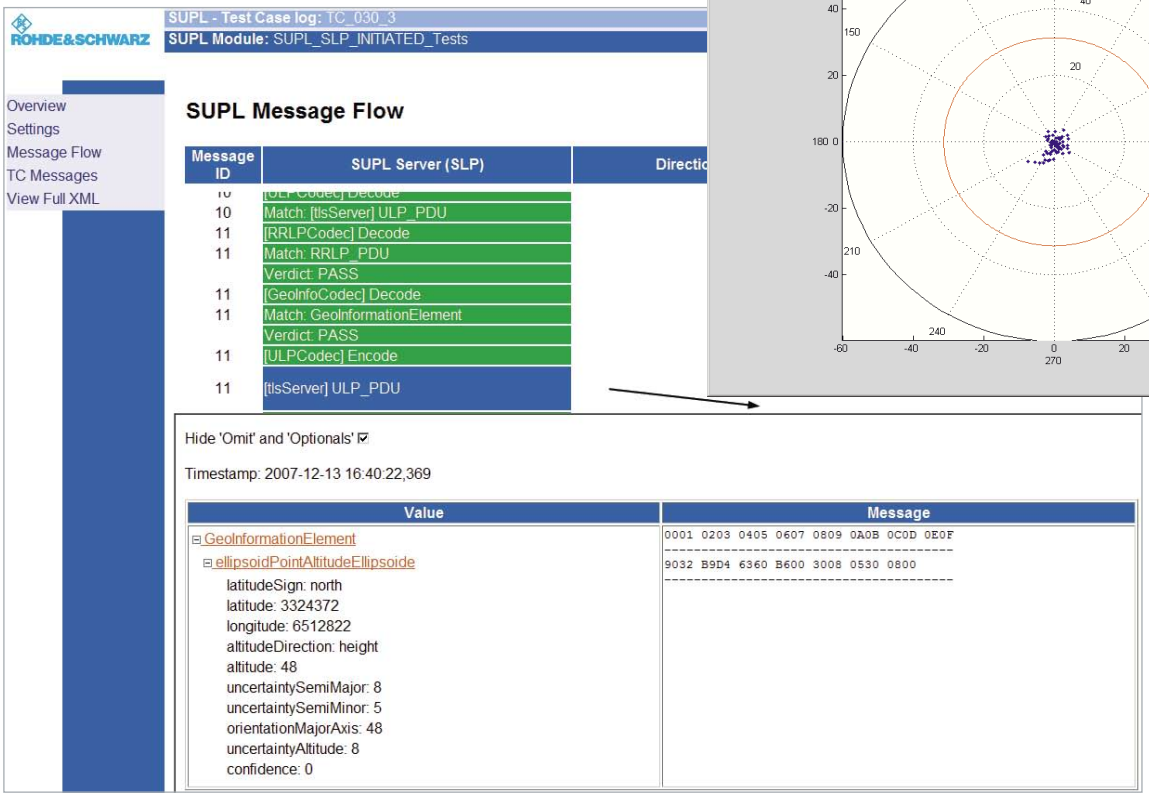


FIG 5 A familiar user interface: SUPL Message Flow.

All-in-one tester for WiMAX mobile

Mobile WiMAX in accordance with the IEEE 802.16e-2005 standard – the first wireless communications system based on orthogonal frequency division multiplex (OFDM) for wireless broadband access in DSL quality – is about to be implemented. As the first real all-in-one solution for cost-effective mass production of WiMAX mobile stations, the R&S®CMW270 WiMAX communication tester is being introduced at exactly the right moment.

A single box – scalable for various applications

The certification process of WiMAX mobile stations and base stations is in full swing [1] and thus the first commercial products are about to be launched. Rohde&Schwarz has actively supported WiMAX technology by offering dedicated R&D measurement equipment [2] as well as an RF certification platform [3]. Now, the company's R&S®CMW270 WiMAX communication tester (FIG 1) is being introduced at exactly the right moment – the first real all-in-one solution for the cost-effective mass production of mobile stations.

Three functions are needed for the calibration and final testing of WiMAX mobile stations in production: test signal generation, test signal analysis and base station emulation. The new R&S®CMW270 WiMAX communication tester from Rohde&Schwarz is the first market solution that combines all these functions in a single box. The R&S®CMW270 is specially designed for testing WiMAX mobile stations based on the IEEE 802.16e-2005 standard. It offers fast measurement functions for evaluating WiMAX signals, e.g. burst power, error vector magnitude (EVM), center frequency error and spectrum flatness (FIG 2). Its integrated base station emulator allows you to check the functionality of WiMAX mobile

station production

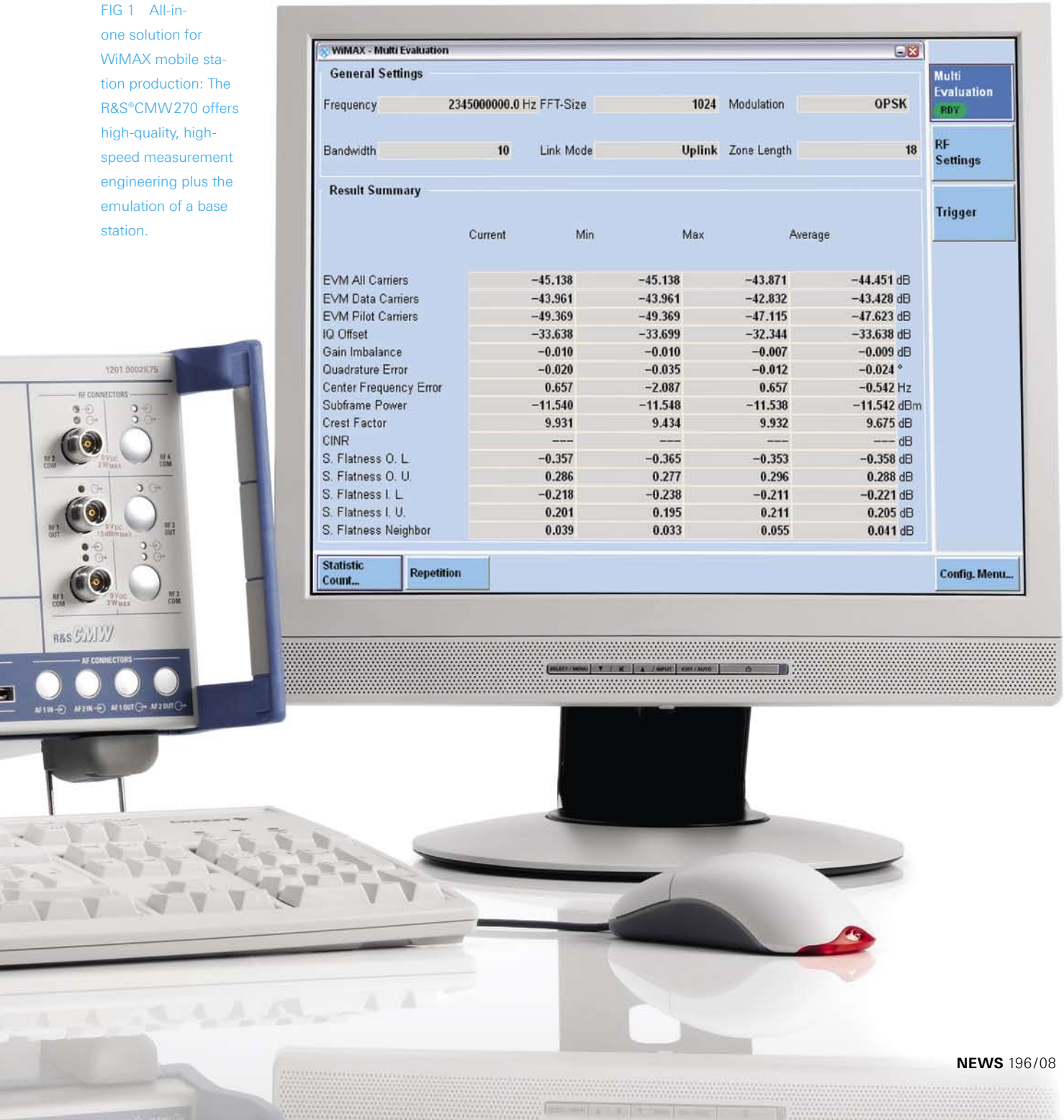


FIG 1 All-in-one solution for WiMAX mobile station production: The R&S®CMW270 offers high-quality, high-speed measurement engineering plus the emulation of a base station.

stations under realistic WiMAX network conditions. Its integrated general-purpose RF generator and RF power meter make it ideal for a variety of measurement tasks. Owing to the tester's two bidirectional RF connectors and a high-power output, WiMAX mobile stations can directly be connected. External RF combiners or RF relays are not required. This means you do not need extra equipment for common applications – which reduces costs for test setup while simultaneously increasing accuracy and reliability.

Since the R&S®CMW270 has a modular platform concept, it can be conveniently configured to meet the individual test requirements in production, service and quality assurance. Moreover, hardware and software options, e.g. for WiMAX signaling, can easily be retrofitted. A Gigabit LAN interface and a USB 2.0 interface allow remote control of the tester via an external PC. Operation via the conventional IEEE/IEC bus interface is also possible. The R&S®CMW270 can also be remote-controlled within a LAN using the Windows® XP *Remote Desktop* application.

Non-signaling – tested and optimized calibration functions for WiMAX chipsets

An important step in the production of WiMAX mobile stations is the alignment of RF components such as RF transceiver, filter and power amplifier. These components exhibit variations in frequency and level characteristics – both in the transmit and receive path. To help ensure that the IEEE802.16e specification with regard to RF level accuracy is met during later operation, variations must be eliminated by alignment procedures during production. This includes measuring deviations from the ideal value, finding correction values and storing the values in the mobile station. All this is usually done in the non-signaling mode. The DUT is run in a specific test mode. The required settings are performed via test commands. Many single measurements with different DUT and measuring instrument settings have to be performed both during alignment and verification (FIG 3). To automate this task, a test sequencer, which controls the calibration process, is used (FIG 4).

FIG 3 Typical test sequence for WiMAX mobile stations in non-signaling mode.

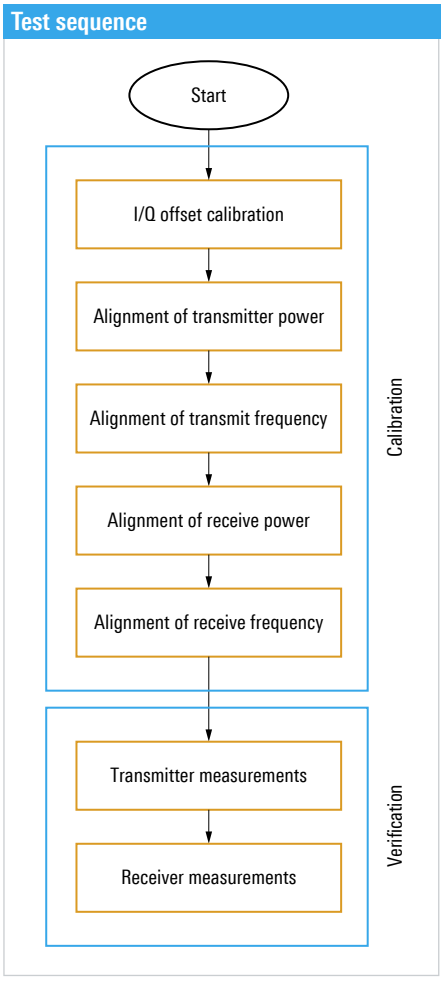
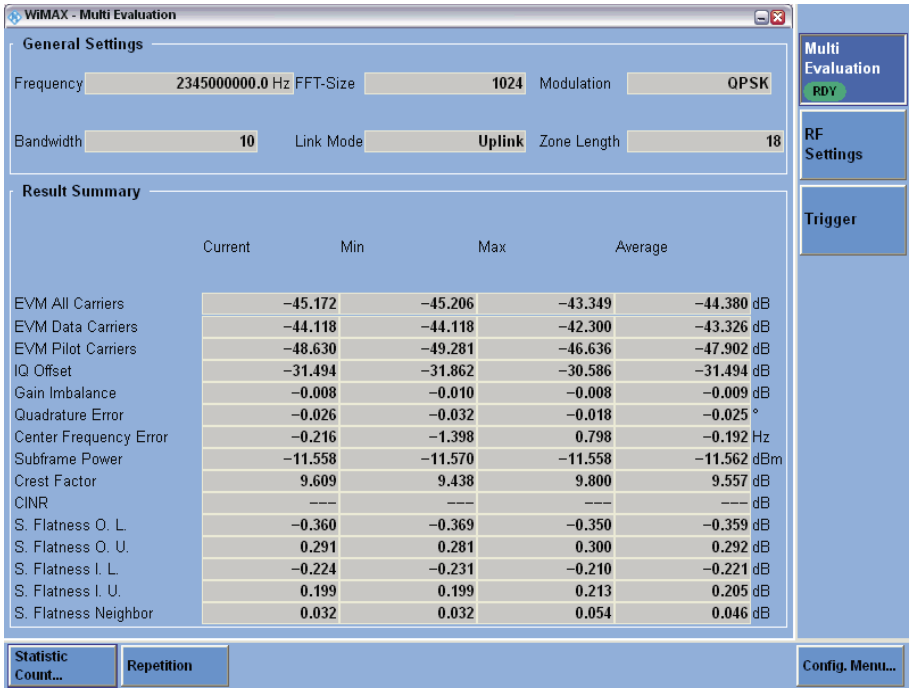


FIG 2 Measuring a WiMAX UL subframe: The R&S®CMW270 provides fast measurement functions.



In close cooperation with the leading WiMAX chipset manufacturers, the control, RF calibration and RF verification of chipsets were carried out with chipset reference designs serving as a basis and using the R&S®CMW270 as a measuring instrument. This joint effort yielded time-optimized function libraries for a variety of chipsets, and the libraries can be easily integrated into the end user's production test software.

Signaling in realtime – tests under realistic conditions

During final testing in production, both the physical layer (PHY) and the protocol functions in the medium access control (MAC) layer of the mobile station have to be tested under realistic conditions. This test is carried out by means of the R&S®CMW270 – which emulates a WiMAX base station – using realtime signaling. This simulation is initiated with the network entry process, during which the mobile station is checked for correct synchronization and frequency correction. After the network entry process has been completed successfully, a functional test with various test scenarios can be performed via WiMAX signaling (FIG 5).

The most important parameters that can be set are as follows:

- Preamble code
- MAC address
- Number of DL symbols
- OFDMA frame settings
- Modulation type and coding rate

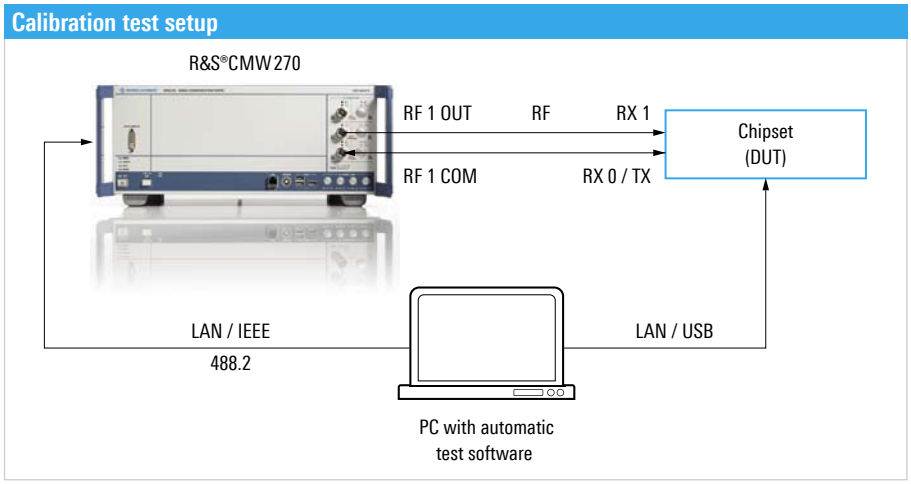


FIG 4 Basic design of an automated calibration test setup. A test sequencer controls the calibration process.

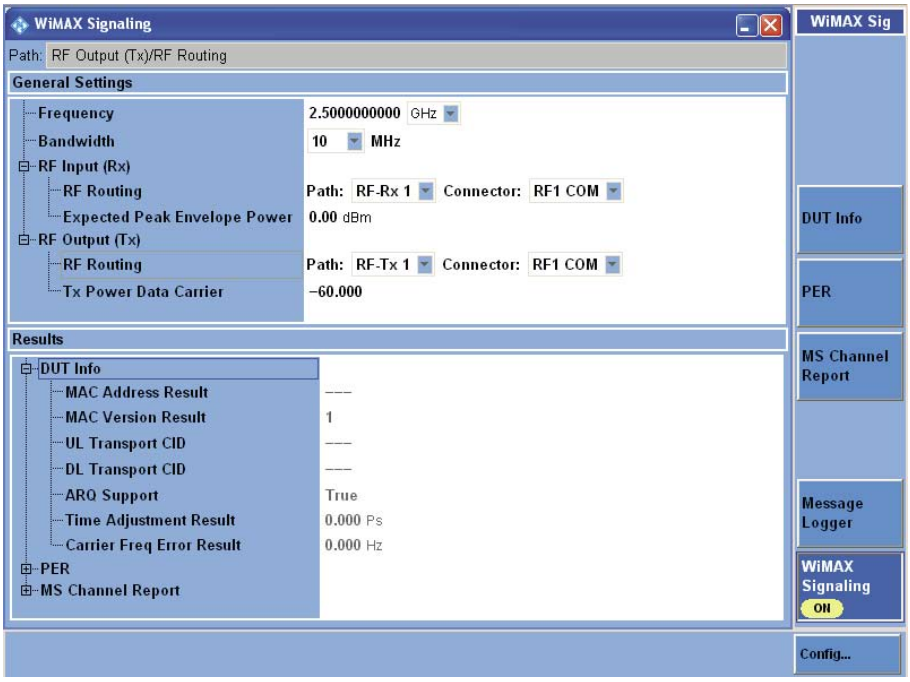


FIG 5 User interface for WiMAX signaling.

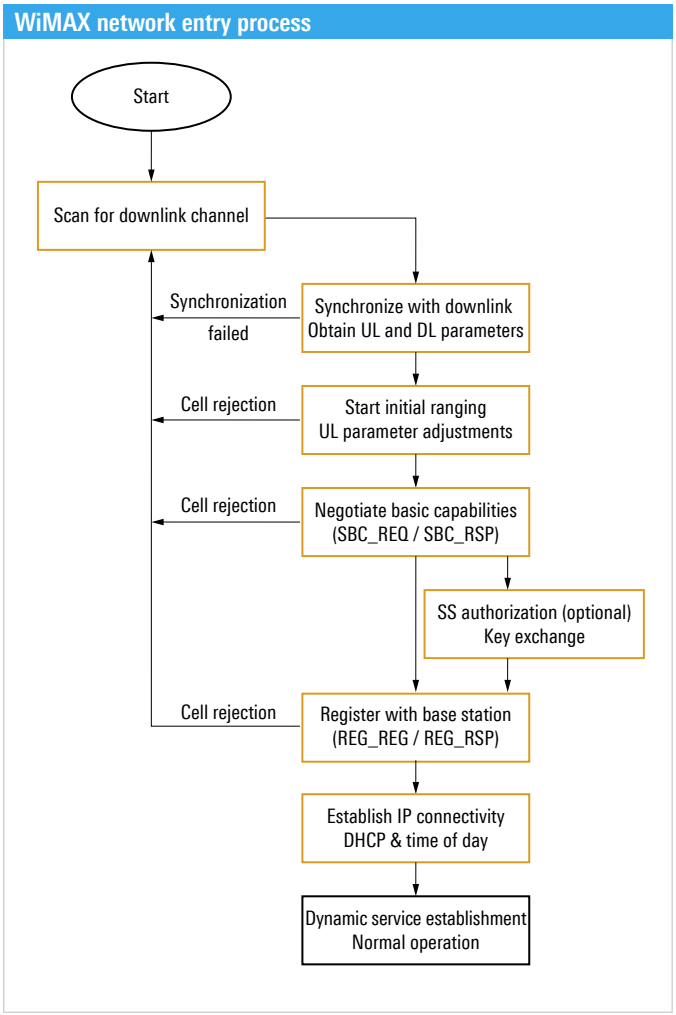


FIG 6 Message flow during network entry process.

Message logger

During the network entry process as well as during RF verification with signaling, complex data communications take place in the physical layer and in the MAC layer of a WiMAX mobile station (FIG 6). Errors may occur, for example, during the ranging process or a connection may drop completely. The R&S®CMW270 message logger (FIG 7) records all messages between the WiMAX mobile station and the tester emulating a base station.

The message logger records the following data:

- Time stamp with 1 ms resolution
- Link direction (UL/DL)
- MAC management type (e.g. DL map, UL map, DCD, UCD)
- Connection identifier (CID)
- Status (success, continue)
- Number of bytes
- Offset frequency adjust
- Power level adjust

Signaling errors of the WiMAX mobile station can thus be recognized quickly and easily as they can be reproduced. Latencies in the message flow can immediately be recognized with the connection set up. This is due to time stamps and the display of repeated messages.

Self test monitors hardware

Fully tailored to the requirements in production, the R&S®CMW270 WiMAX communication tester offers a built-in self-test (BIST) to monitor the internal hardware. The BIST functions are menu-controlled and allow you to perform diagnostics on the RF generator and RF analyzer. Plus, the internal bus systems of the tester as well as the plug-in modules are checked for correct function. The BIST functions can be remote-controlled and integrated into the test program. When applied regularly and combined with the statistical evaluation of results, these BIST functions will detect any deviation from the R&S®CMW270 basic functions at an early stage – an important preventive measure in avoiding the costs caused by a loss of production as a result of long downtimes.

Well-prepared for future WiMAX requirements

The R&S®CMW270 is also fully ready to meet future WiMAX standard expansions. Owing to its continuous frequency range from 70 MHz to 6 GHz, the R&S®CMW270 already supports all current RF profiles of the WiMAX Forum®. The WiMAX IEEE 802.16e standard defines a variable signal bandwidth, where the first WiMAX products are initially specified only up to 10 MHz. Featuring a channel bandwidth of 40 MHz for the analyzer and 70 MHz for the generator, the R&S®CMW270 has enough margin to handle adjacent-channel measurements, for example. Plus, the tester is ready to accommodate a second measurement channel for testing MIMO applications.

Summary

The R&S®CMW270 is the first comprehensive all-in-one solution for WiMAX mobile station production: a high-quality, high-speed tester together with the emulation of a WiMAX base station in a single box and a shared user interface. It can be remote-controlled and its flexible hardware and software architecture makes it ideal for the production environment. Plus, the R&S®CMW270 WiMAX communication tester is well prepared to handle future WiMAX developments such as new profiles, operating frequencies, bandwidths as well as the MIMO multiple antenna technology.

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Abbreviations

DCD	Downlink channel descriptor
DSL	Digital subscriber line
DUT	Device under test
EVM	Error vector magnitude
MIMO	Multiple input multiple output
OFDM	Orthogonal frequency division multiplex
PER	Paket error rate
UCD	Uplink channel descriptor
WiMAX	Worldwide interoperability for microwave access

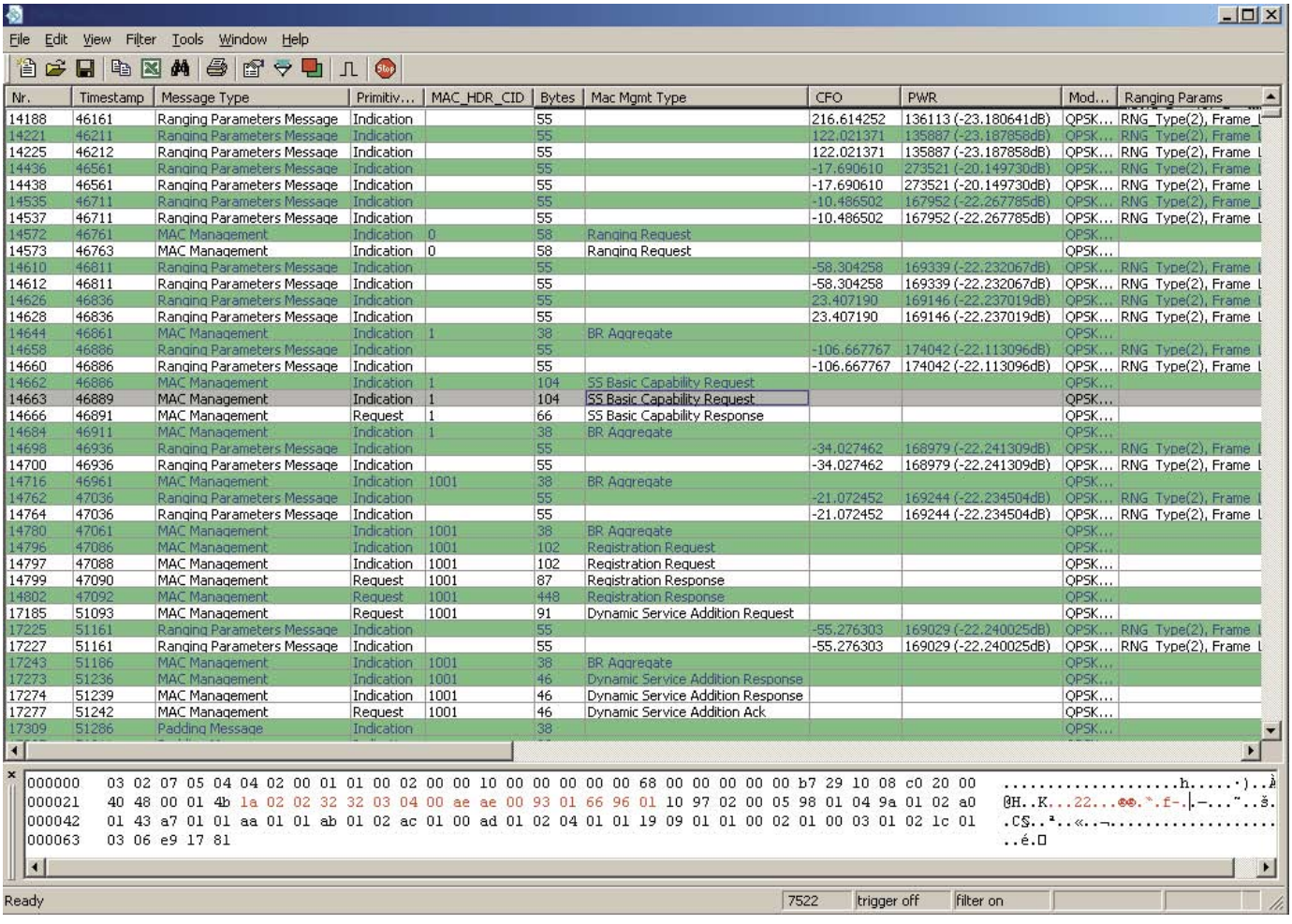
References

[1] 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.

[2] R&S®SMx Signal Generators / R&S®FSQ / R&S®FSL Analyzers: WiMAX goes mobile – new T&M solutions are required. News from Rohde&Schwarz (2006) No. 190, pp 24–27.

[3] 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.

FIG 7 The message logger clearly displays the message flow of a WiMAX connection and allows convenient analysis.



Bidirectional digital I/Q interface with flexible user configuration

The R&S®EX-IQ-Box is a digital interface module that provides flexible digital baseband inputs and outputs for signal generators and signal analyzers from Rohde&Schwarz.

High-end T&M equipment from Rohde&Schwarz for the digital baseband

Signal generators and analyzers from Rohde&Schwarz have exactly the features needed to meet all the requirements encountered in the research, development and production of modern, digital communications systems. Whether EUTRA/LTE, 3GPP FDD with HSPA+, WLAN or WiMAX – the instruments from Rohde&Schwarz offer extensive capabilities for testing base stations, terminal equipment and modules. The R&S®EX-IQ-Box (FIG 1) now extends measurement capabilities even further. The digital interface module provides flexible digital baseband inputs and outputs for signal generators and signal analyzers from Rohde&Schwarz. Using this interface, a vector signal generator from Rohde&Schwarz delivers realistic digital baseband signals for testing transceivers or other components. The generator thus not only covers all state-of-the-art standards, but also provides user-defined signals and effects such as fading, AWGN and impairments. A signal analyzer from Rohde&Schwarz used together with the R&S®EX-IQ-Box can analyze digital baseband modules. Parameters can conveniently be set via the user interface of the signal generator or analyzer.

FIG 1 The R&S®AMU200A baseband signal generator and fading simulator with the R&S®EX-IQ-Box.

Standard-compliant digital baseband signals with signal generators from Rohde&Schwarz

Via the R&S®EX-IQ Box, signal generators from Rohde&Schwarz with digital baseband outputs (e.g. the R&S®SMU200A, R&S®SMJ100A or R&S®AMU200A) provide digital baseband signals for all important wireless communications standards. All functions of the generators for creating signals can also be used for generating digital baseband signals. Plus, all signal processing functions to yield effects such as fading, AWGN or impairments are also available. This allows bit and block error ratio measurements on baseband receiver modules to be performed accurately and reproducibly (FIG 2).

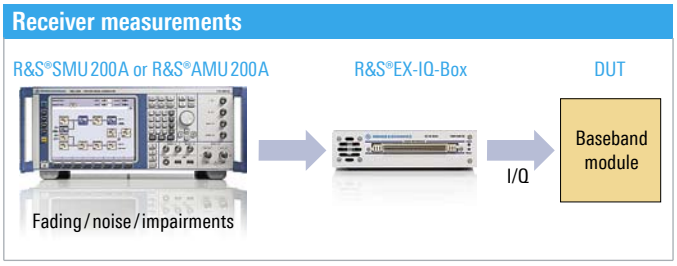


FIG 2 Receiver measurements, e.g. the determination of the BER and the BLER of a baseband module, can be performed accurately and reproducibly.

Simple conversion of digital baseband signals to analog RF signals

If the R&S®EX-IQ-Box is used with an R&S®SMU200A signal generator with digital baseband inputs, baseband signals from a device under test (DUT) can be upconverted to the RF (FIG 3). The generator can thus simulate the RF section of a transmitter, enabling the baseband section to be tested independently of the RF section. All the functions of the generator for introducing signal effects are also available in this configuration.

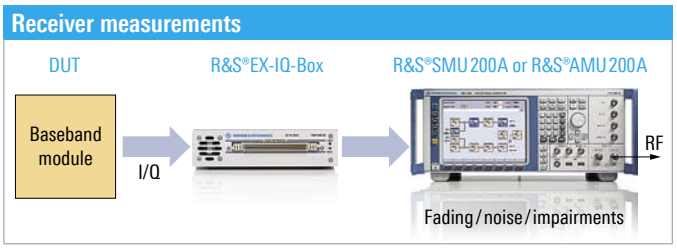


FIG 3 The generator simulates the RF section of a transmitter, enabling the baseband section to be tested independently of the RF section.

Vector signal analysis of digital baseband signals

When operated together with the R&S®EX-IQ-Box, the R&S®FSQ, R&S®FSG and R&S®FMU signal analyzers from Rohde&Schwarz can analyze digital baseband signals of all important state-of-the-art standards. The analyzers' wide range of functions, including modulation and code domain analysis, is available in this application (FIG 4). Moreover, I/Q signals can be stored for postprocessing, e.g. for BER analysis.

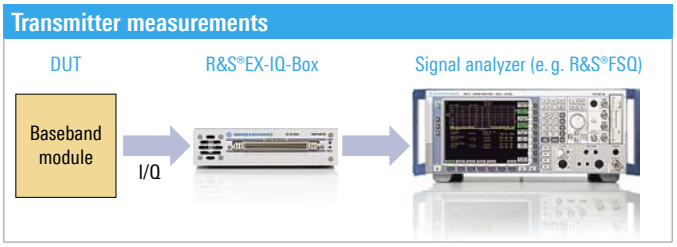


FIG 4 The analyzers' wide range of functions for analyzing digital baseband signals of all important standards is available, for example, for performing transmitter measurements on baseband modules.

These Rohde&Schwarz signal analyzer in conjunction with the R&S®EX-IQ-Box can be used as realtime RF digitizers, e.g. to replace an RF frontend not yet completed, or simply to record RF signals over extended periods of time (FIG 5).

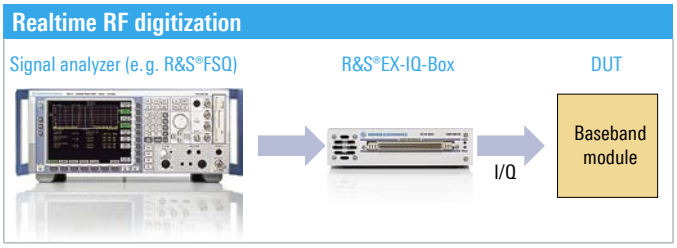


FIG 5 Signal analyzer used to replace an RF frontend or to record RF signals over extended periods of time.

Variable signal interface and flexible data formats

The R&S®EX-IQ-Box provides a flexible interface to the DUT offering comprehensive configuration options to accommodate a wide variety of present and future interface designs. The signal interface to the DUT supports the LVTTL, CMOS and LVDS logic standards. Moreover, the R&S®EX-IQ-Box supports parallel and serial buses, single data rate (SDR) and double data rate (DDR), as well as I/Q and Q/I interleaving. The user can select the bit order and the word alignment as well as the numeric format (two's complement or binary offset). The word size for I and Q is selectable between 4 bits and 20 bits.

Variable resampling of the data rate can be performed with the Rohde&Schwarz instrument connected. This means that the user can simply use the data rate of the DUT and does not have to bother about data rate adaptation. The R&S®EX-IQ-Box comes with different breakout boards to match the most common connectors.

Flexible clock generation

Clock generation can also be flexibly adapted to the measurement task. The R&S®EX-IQ-Box can be operated with an internal clock signal and deliver the clock signal to the DUT, or it can be synchronized with a clock signal from the DUT or another external source. The phase and delay of the clock signal can be varied with respect to the data signal, e.g. to compensate for different cable lengths or to test a receiver's response to clock variations. The R&S®EX-IQ-Box supports clock rates of 1 kHz up to 100 MHz for parallel and up to 400 MHz for serial formats. It is thus possible, for example, to perform measurements on hardware emulators with I/Q signals slowed down deliberately (slow I/Q signals).

Intuitive operation

The R&S®EX-IQ-Box is operated from the Rohde&Schwarz instrument. The control of the box is integrated into the instrument software. A box connected to the instrument is automatically detected and preconfigured as required for the instrument. All settings required for the R&S®EX-IQ-Box and the instrument – from the signal parameters to the interface format – can be made on the instrument, e.g. the R&S®AMU200A, which acts as a master. The user also benefits from the numerous convenient control and display functions offered by the graphical user interface. From the block diagram displayed by the R&S®AMU200A, for example, the user can immediately identify active digital I/Q interfaces as well as any R&S®EX-IQ-Box connected to the generator (FIG 6).

Summary

The R&S®EX-IQ-Box provides a versatile bidirectional I/Q interface that offers comprehensive configuration options for all important parameters. The R&S®EX-IQ-Box makes the wide scope of functions of the Rohde&Schwarz generators and analyzers now also available for measurements via digital I/Q interfaces. The instruments only have to be upgraded with the appropriate option for the digital baseband interface. This concept safeguards investments already made, and considerably expands the instruments' test capabilities. Specifications and detailed information about the options can be found in the data sheet on the Rohde&Schwarz website.

Andreas Hecht

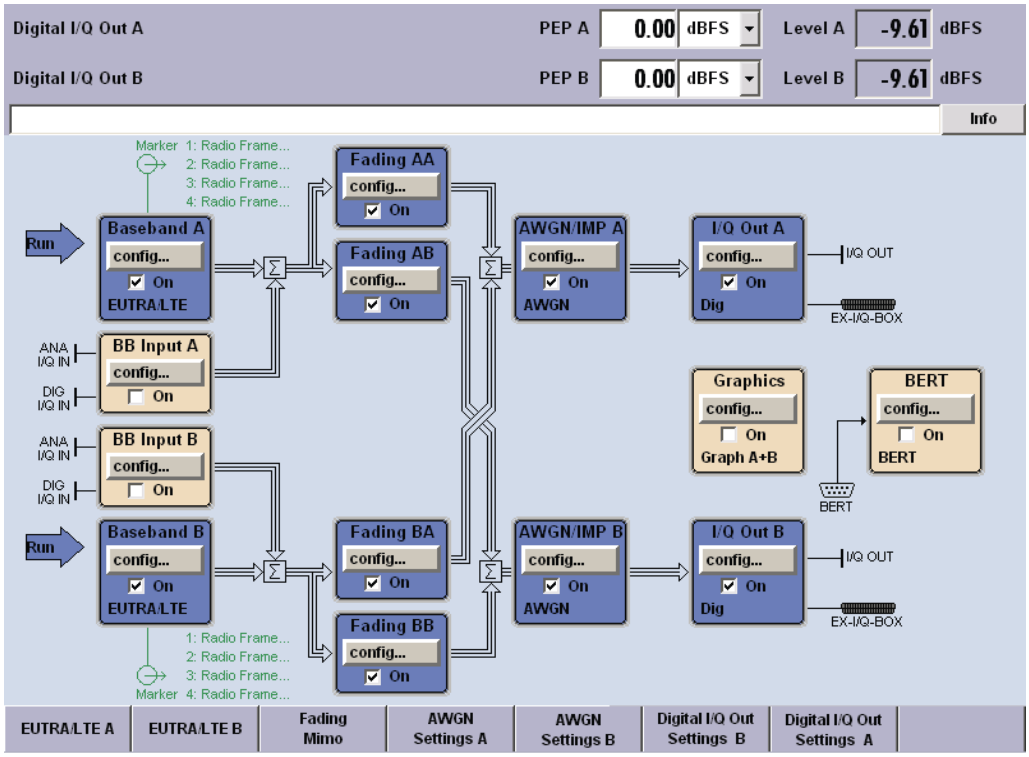


FIG 6 Convenient operation: block diagram displayed by the R&S®AMU200A baseband signal generator and fading simulator, here with an R&S®EX-IQ-Box connected to each of its digital I/Q outputs A and B.

Testing OFDM-based transmission methods using Rohde & Schwarz signal analyzers

The new R&S®FSQ-K96 OFDM vector signal analysis PC software for the R&S®FSQ and R&S®FSG signal analyzers is the world's leading solution for demodulating general OFDM signals. The software performs standard-independent analysis and can be user-configured. Thus, it can be optimally adapted to the individual signal.

OFDM vector signal analysis at a glance

Many radiocommunications systems today make use of orthogonal frequency division multiplex (OFDM) multicarrier modulation. In the case of OFDM, information is distributed to multiple carriers. As a result, signals are less sensitive to interference and echoes than in other modulation methods. If you want to analyze the modulation quality of OFDM signals, specialized measuring equipment is required. The solutions currently available on the market can only be applied to specific OFDM standards such as WLAN or WiMAX.

In contrast, the new R&S®FSQ-K96 OFDM vector signal analysis PC software for the high-end R&S®FSQ and R&S®FSG signal analyzers from Rohde&Schwarz is an all-purpose tool – it can determine the modulation quality of almost all OFDM signals (FIG 1). Plus, owing to their low phase noise and excellent demodulation characteristics, these two signal analyzers meet the most stringent of requirements. Depending on their configuration, the signal analyzers can measure OFDM signals with a bandwidth of up to 120 MHz. The R&S®FSQ with a frequency range of up to 40 GHz also covers microwave applications. The R&S®FSQ-B71 analog baseband inputs allow you to perform measurements directly in the baseband. If the R&S®FSQ-B17 digital I/Q interface is applied, digital subassemblies can be analyzed without having to make use of analog components (FIG 2).

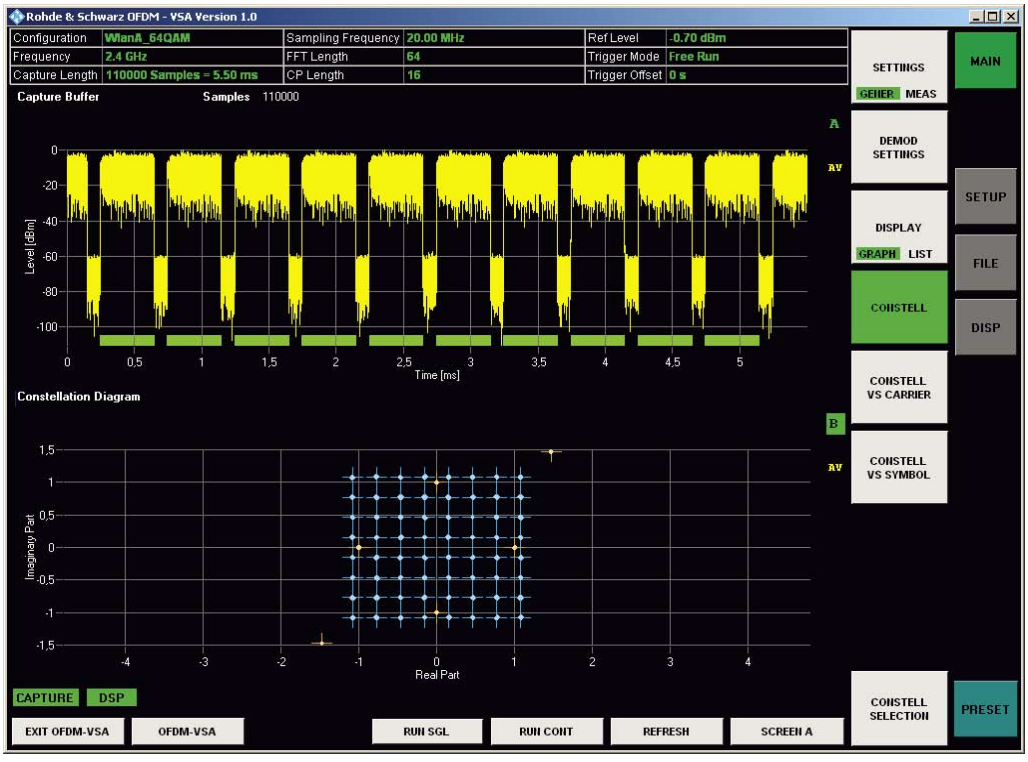


FIG 1 The upper part of the display shows the recorded signal in the time domain. The lower part shows the constellation diagram with the in-phase and quadrature components over the entire range of the measured input data. It can be displayed either for all carriers or for selected carriers. Color coding makes identification of the different modulation formats easy.

	R&S®FSG	R&S®FSQ
Frequency range	50 MHz to 8 GHz 50 MHz to 13.6 GHz	50 MHz to 3.6 GHz 50 MHz to 8 GHz 50 MHz to 26.5 GHz 50 MHz to 40 GHz
EVM (WiMAX)	<–46 dB	<–48 dB
Demodulation bandwidth	28 MHz	28 MHz, 120 MHz optional
Analog baseband inputs	–	optional
Digital I/Q interface	optional	optional

FIG 2 The R&S®FSQ-K96 OFDM vector signal analysis PC software can be used in conjunction with the R&S®FSQ or R&S®FSG signal analyzers. The instruments have to run on firmware version 4.35 or later.

Suitable for a wide range of applications

No matter whether you need a solution in development or in production, R&S®FSQ-K96 from Rohde&Schwarz is the ideal tool for numerous fields of application:

Wireless communications
Usually, no specialized measuring solutions for new OFDM standards are available in the initial phases of development. But things are quite different with the R&S®FSQ-K96 OFDM vector signal analysis PC software – Rohde&Schwarz supports the dynamic development of forthcoming wireless communications standards right from the start. Component manufacturers profit from the application software: They can now apply user-defined OFDM signals to test modules such as amplifiers and are no longer dependent on standard-conforming test signals.

Broadcasting
In broadcasting, too, transmission signals need to be measured or receivers need to be tested and analyzed in detail. New TV standards such as DVB-T or DVB-H are based on OFDM and can now for the first time also be analyzed with the R&S®FSQ and R&S®FSG signal analyzers.

Proprietary systems
Especially in military applications, OFDM systems deviate from digital standards and are often proprietary systems. Even the slightest deviations from standard make signal analysis using conventional software impossible. R&S®FSQ-K96 offers a high degree of freedom in the selection of test parameters and can also demodulate OFDM signals that have not been standardized.

Universities and research institutes also profit from the versatile OFDM demodulation software.

Comprehensive configuration options

R&S®FSQ-K96 offers comprehensive setting capabilities for optimally adapting the measurements to the signals to be analyzed. In addition to frequency or level, the user can set general OFDM parameters such as offset from carrier, number of carriers, sampling rate or guard interval length via the user interface. A configuration file defines further parameters in detail so that the software can synchronize and demodulate almost any OFDM signal. The file contains user-definable information about the structure of the preamble, the position and value of the pilot carriers as well as the position and modulation format of the data carriers. R&S®FSQ-K96 supports any PSK and QAM modulation mode of the individual carriers and can also demodulate OFDMA signals. Rohde&Schwarz provides predefined configuration files for the WLAN 802.11a, 802.11g OFDM, WiMAX 802.16 OFDM, DVB-T and DVB-H standards.

In addition to the parameters in the configuration file, parameters such as synchronization and tracking can also be set manually. This facilitates error analysis – you can find power drops within a burst by means of level tracking, for example. Or you can compensate for frequency variations in measurement results by means of phase tracking.

Numerous evaluation functions

After the OFDM demodulator has been configured, the analyzer measures all relevant parameters that characterize OFDM signals and displays the results in a table. One important parameter is error vector magnitude (EVM), which allows the assessment of modulation quality. Owing to its low phase noise, the R&S®FSQ signal analyzer provides accurate EVM measurement results, even if the number of carriers is high. In addition to a numeric table, numerous graphical displays facilitate signal analysis – for example, the signal flow chart (FIG 3) or the power display of each carrier and symbol (FIG 4).

Perfect match: the vector signal generators from Rohde&Schwarz

To characterize modules/instruments that are based on OFDM transmission standards, you need both signal analyzers and signal generators. The vector signal generators from Rohde&Schwarz, which include an arbitrary waveform generator (ARB), can generate general OFDM signals and OFDMA test signals. For example, you can generate signals using mathematical tools and then load these signals into the ARB. As the generators have a large memory capacity, high resolution and sampling rates up to 300 MHz, they can generate accurate OFDM signals over the entire bandwidth supported by the R&S®FSQ-K96 software.

Summary

Rohde&Schwarz offers an all-in-one measurement solution for generating and analyzing OFDM signals. The R&S®FSQ-K96 OFDM vector signal analysis PC software expands the R&S®FSQ and R&S®FSG signal analyzers' scope of applications for analyzing general OFDM signals. R&S®FSQ-K96 from Rohde&Schwarz is truly unique: It is the only solution worldwide that is able to demodulate standard-conforming signals as well as proprietary OFDM and OFDMA signals.

Dorothea von Droste; Dr. Gregor Feldhaus

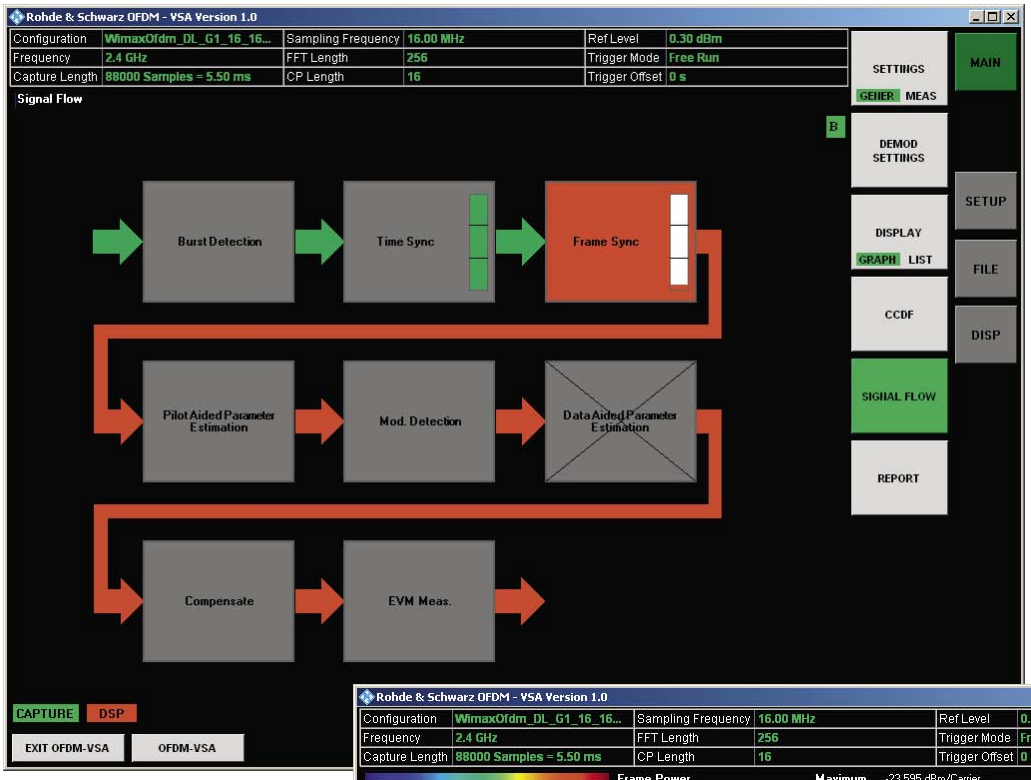


FIG 3 The signal flow chart describes the current measurement status in detail. It also offers information about the area in which the signal to be analyzed is faulty or deviates from the settings. The signal flow chart is a powerful tool for troubleshooting problems in the modulation of the signal. In this example, the pilot cells of the signal do not match the configurations. Unused blocks are crossed out.

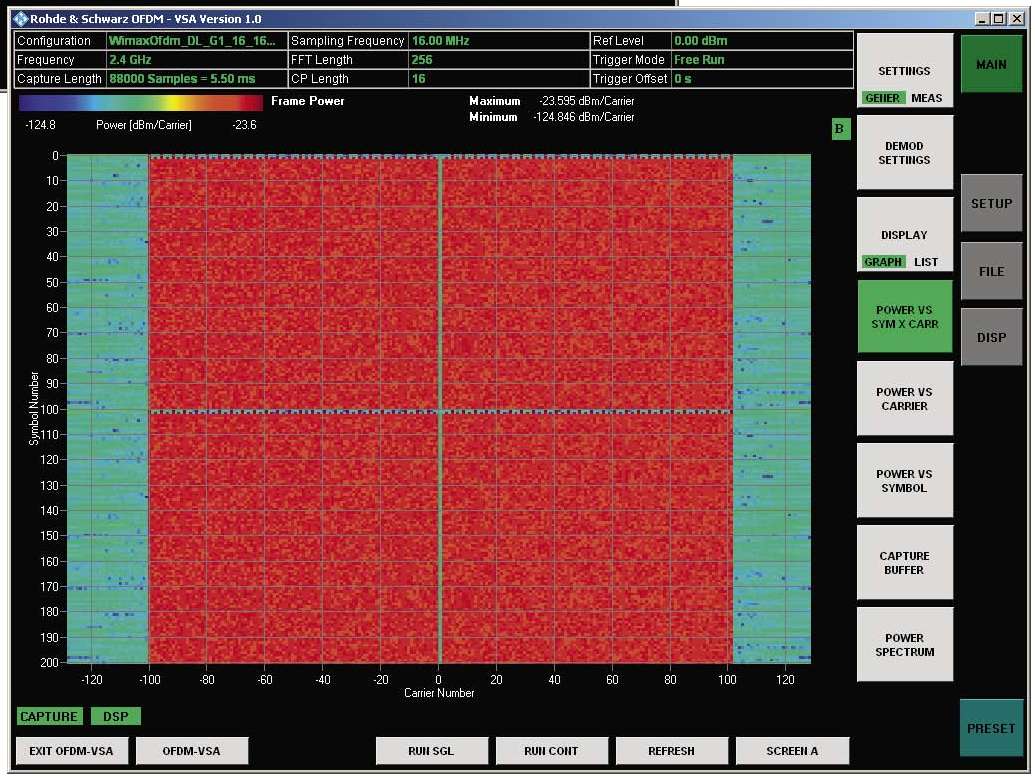


FIG 4 The diagram shows the power of each carrier and symbol of the received frames in dBm for each carrier. The values are color-coded in accordance with a table of colors that is displayed in the upper area of the measurement window.

Analysis of VOR and ILS signals – reliable and highly accurate

The new R&S®FS-K15 measurement demodulator adds the analysis of VOR and ILS signals to the comprehensive facilities of the Rohde&Schwarz R&S®FSMR, R&S®FSU and R&S®FSQ analyzers.

A full range for VOR/ILS

VOR (VHF omnidirectional range) and ILS (instrument landing system) are aircraft navigation aids based on analog modulation, and are in use worldwide. ILS, in particular, is without competition. Because ILS supports the particularly critical landing approach, the requirements for precision, reliability and trustworthiness are extremely high. This applies to both the ground equipment and the on-board equipment.

The R&S®FS-K15 option completes the Rohde&Schwarz portfolio of special measuring equipment for VOR/ILS by adding instruments for use in the calibration laboratory and in development. The R&S®SMA signal generator with the R&S®SMA-K25 option for receiver testing, and the portable R&S®EVS300 ILS/VOR analyzer, the "specialist" for measuring the radio fields on the airstrip and for application in inspection aircraft, are both already in wide use [1], [2].

The R&S®FSMR, together with the new R&S®FS-K15 option, makes a calibration measuring receiver available for the first time. It allows complete and highly precise calibration of the transmission signals from nav/com testers used to test on-board equipment. In addition to the special VOR/ILS signals, it also calibrates general amplitude, frequency or phase-modulated signals and measures the output level of generators with extremely high accuracy. Its accuracy is in fact so good that even signal generators such as the R&S®SMA, which is used together with the R&S®SMA-K25 option as a highly accurate signal source for tests on radionavigation receivers, can be tested.

In the R&S®FSU and R&S®FSQ spectrum and signal analyzers, the R&S®FS-K15 option offers the perfect analysis tools for development, verification or regular maintenance checks of ILS transmitters. It provides the same range of functions and the same accuracy as the R&S®FMAV VOR/ILS modulation analyzer, used as a reference in many laboratories. Its operation is particularly easy. The user only has to enter the frequency and the level, and to choose whether a VOR signal or an ILS signal is to be measured. After having measured all the relevant parameters, the option displays them in a clear table. The important parameter for the system concerned is

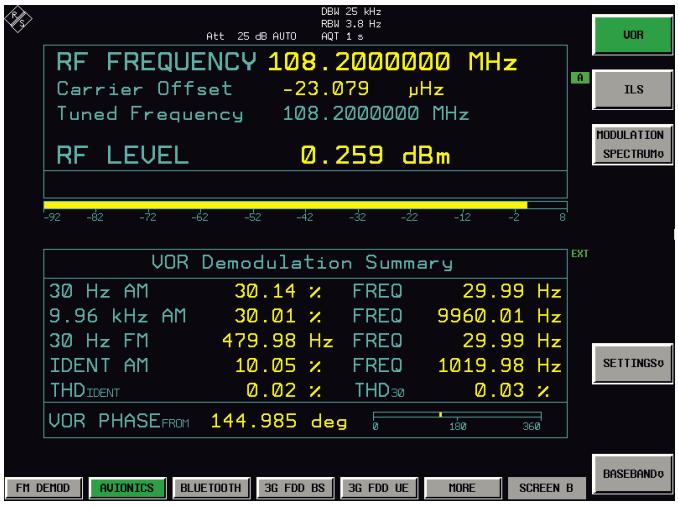


FIG 1 Example of the analysis of a VOR signal.

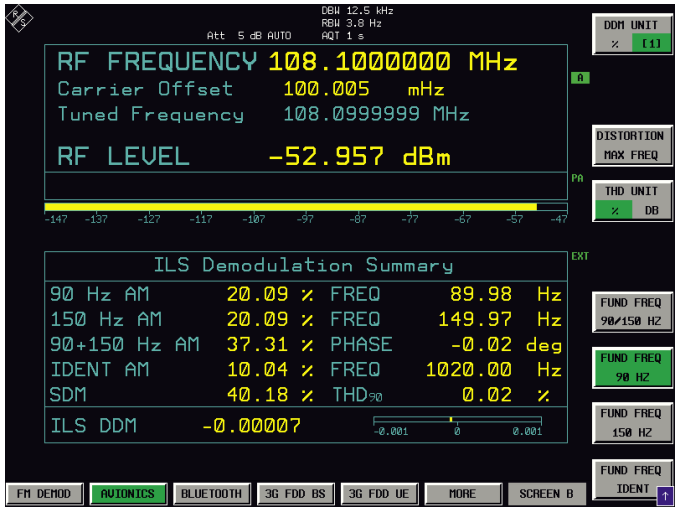


FIG 2 Example of the analysis of an ILS signal. The display is stable and accurate even at a signal level of –50 dBm. –50 dBm is a typical signal level used for testing aeronautical radio receivers; signal generators for receiver tests must therefore be calibrated even at this low level.

emphasized – for ILS this is the difference in depth of modulation (DDM), the measure of the deviation from the ideal landing path, while for VOR it is the phase. This parameter is also visually displayed by a bargraph (FIGs 1 and 2).

As in the R&S®FMAV, analysis with the R&S®FS-K15 is based on the purely digital processing of a digitized IF signal. The non-linearities, frequency responses and phase errors of analog demodulators and audio filters are absent. The measurement uncertainty only results from the linearity of the A/D converter and the influences of the IF selection. The demodulation bandwidth is 8 MHz for the R&S®FSMR and R&S®FSU, while it is 28 MHz for the R&S®FSQ; this bandwidth is considerably larger than the modulation frequency range of the VOR and ILS signals, so that their effect can be neglected.

The influence of the A/D converter and of the IF selection filters are already tested in the base unit by means of other parameters. Nevertheless, all the measurement parameters for VOR and ILS are separately calibrated once again. The R&S®FS-K15 option thus excellently satisfies the requirements for accuracy, reliability and trustworthiness placed on ILS and VOR measurements. The VOR/ILS analysis is performed in the entire frequency range of the particular base unit used. In the case of the R&S®FSMR and R&S®FSQ with the baseband input option (R&S®FSQ-B71) it is also carried out directly on a modulation signal.

Summary

The R&S®FS-K15 option in the R&S®FSMR enables calibration laboratories for the first time to calibrate all the relevant parameters of VOR/ILS generators using a single instrument. In the R&S®FSU and R&S®FSQ, the option expands the already versatile range of applications of these analyzers, combining extremely accurate analog modulation measurements with universal facilities for analyzing digitally modulated signals. The importance of such signals is also set to grow in the aeronautical radio field.

Herbert Schmitt

References
[1] R&S®EVS300 ILS/VOR Analyzer: The specialist for terrestrial radionavigation analysis. News from Rohde&Schwarz (2005) No. 188, pp. 32–35.
[2] R&S®EVS300 ILS/VOR Analyzer: High-precision level and modulation analysis of ILS and VOR signals. News from Rohde&Schwarz (2007) No. 194, pp. 30–33.

ILS measurement parameters

- DDM (difference in depth of modulation), the difference in the modulation depth of the 90 Hz and the 150 Hz signals
- SDM (sum of depth of modulation), the arithmetic sum of the modulation depths of the 90 Hz and the 150 Hz signals
- Total depth of modulation
- Modulation depth of the 90 Hz signal, the 150 Hz signal, and of the identifier signal
- Phase between the 90 Hz and 150 Hz signals
- THD, selectable for a fundamental frequency of 90 Hz, 150 Hz, for both, or for the identifier signal
- Display of the modulation spectrum for the separate analysis of distortion products (FIG 3)

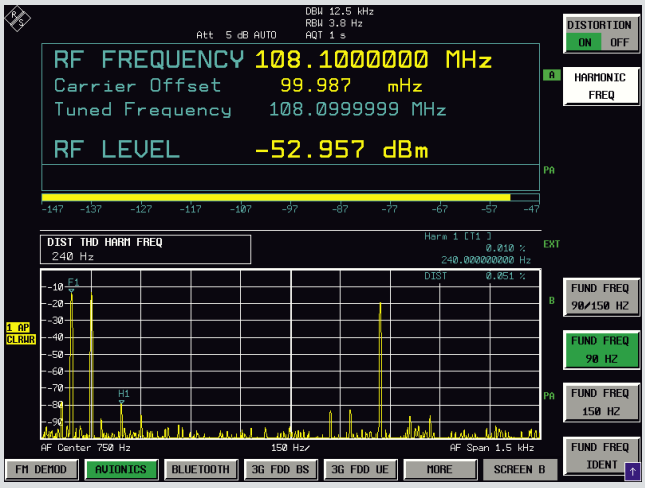


FIG 3 Distortion analysis of an ILS signal. The sum signal derived from 90 Hz and 150 Hz is at 240 Hz, and produces a total harmonic distortion of 0.5 %.

VOR measurement parameters

- VOR phase
- Modulation depth and modulation frequency of the 30 Hz signal, the 9.96 kHz subcarrier, and of the identifier signal
- Deviation and modulation frequency of the 9.96 kHz auxiliary carrier
- THD (total harmonic distortion), selective for the 30 Hz fundamental frequency and for the identifier signal

Condensed data of the R&S®FS-K15

Frequency range	107 MHz to 120 MHz and 319 MHz to 341 MHz specified, usable in the frequency range of the base unit
Level range	–60 dBm to +30 dBm
DDM measurement range	0 to 0.4 DDM
DDM measurement uncertainty	0.0002 DDM + 1 % of measured value
VOR phase	0 to 360°, resolution of 0.1°
VOR phase measurement uncertainty	0.003°

Audio analysis in production: saving time with 16 measurement channels

The compact R&S®UPV audio analyzer masters all measurements that crop up in the audio world. Two plug-ins on the rear panel allow the instrument to be adapted to meet new requirements. The R&S®UPV-B48 analog multichannel interface card, two of which can be accommodated on the instrument, is a new option that turns the R&S®UPV into an analyzer with 8 or 16 channels. Parallel processing of all channels makes it possible to save a lot of time in the production of surround-sound equipment, for example, and in particular with multichannel amplifiers for the automotive sector.

Stereo becomes surround sound – and the number of channels increases

Surround-sound technology is becoming more and more popular in homes. In home living rooms there used to be two loudspeakers, but now there are often six to eight, depending on whether you are satisfied with the conventional 5.1 technology or have already invested in the future of 7.1 systems.

In addition, your favorite music should also have the perfect sound in your car. The difficult acoustic conditions in an automobile and the little space available for accommodating the sound transducers prompted manufacturers of modern car hi-fi systems already some time ago not only to split up the audio frequency range among several loudspeakers but also to control the speakers via separate amplifier branches. The use of DSP-controlled sound-optimization circuits further

FIG 1 Speedy production: The new multichannel interface card enables the R&S®UPV audio analyzer to process up to 16 channels simultaneously.

perfected this technology, so that, even for stereo transmission split between the front and rear, up to eight amplifier channels are installed. Switching to surround-sound technology in vehicles can result in as many as 10 channels, while 7.1 surround-sound systems require up to 16 loudspeakers and amplifier channels.

In the production of music systems of this type, it has been customary up to now to measure two channels at a time and then to switch to the other channels one after the other. The R&S®UPV audio analyzer together with the R&S®UPZ audio switcher performed this task quickly and reliably. However, shorter turnaround times are required, above all in the automotive sector.

R&S®UPV – always up-to-date with plug-ins

In the design of the R&S®UPV audio analyzer, importance was placed right from the start on being able to meet future requirements by simply expanding the hardware. Therefore, the rear panel of the instrument has two slots for accommodating expansion cards. To follow up the R&S®UPV-B41* I²S interface option for direct measurements on integrated components, Rohde&Schwarz has developed the R&S®UPV-B48 multichannel interface card, which can measure up to eight analog signals simultaneously (FIG 1). And since the audio analyzer has two slots, the new option can also be used two at a time. Every R&S®UPV is thus upgradeable – also by retrofitting – to a 16-channel measuring instrument.

Specialist for requirements in the automotive sector and surround-sound technology

The multichannel interface card was specially developed to meet the requirements of surround-sound technology and the needs of the automotive sector. Complex signal preprocessing as is implemented for dual-channel mode to fulfill extreme dynamic range requirements was deliberately omitted. Using high-grade A/D converters, the new interface card immediately digitizes the eight analog audio input signals after appropriate amplification or attenuation and passes them on to the instrument's analysis unit. The input voltage range extends up to 50 V, which means that this option is already designed for the 42 V on-board supply systems of future vehicle generations. The analysis bandwidth is 40 kHz – which is another step into the future of broadband audio systems.

Condensed data of the R&S®UPV-B48

Inputs	8 × analog, 25-pin D-Sub (Tascam pin allocation), balanced
Bandwidth	DC / 20 Hz to 40 kHz
Level range	0.1 µV to 50 V (rms, sine); automatic or fixed measurement range, selectable for each channel or coupled
Level error	±0.05 dB at 1 kHz
Frequency response (referenced to 1 kHz)	±0.1 dB (20 Hz to 20 kHz)
THD+N	typ. –100 dB (20 Hz to 20 kHz)
Crosstalk attenuation	>100 dB (10 Ω), up to 20 kHz
Measurement functions	rms wideband/selective, peak, S/N, DC, FFT, THD, THD+N, Mod Dist, DFD, DIM, polarity

Of course, the input circuits of this new card retain the familiar R&S®UPV features; they too automatically set the measurement range – separately for each channel. An important characteristic, for depending on the applied frequency, the output voltages of the surround-sound main channels and the subwoofer channel may be quite different. Each measurement channel can be set individually to AC or DC coupling; for relative measurements or for phase- and group-delay measurements, each channel can be selected as reference channel.

When equipped with the new multichannel interface card, the audio analyzer also handles all standard measurements from frequency response through S/N ratio and distortion measurements to FFT analysis (FIG 2). Since the new option is primarily designed for use in production, great importance was placed on remote control ability. All functions are remote-controllable, and all measurement results are remote-retrievable. If two cards are inserted in the instrument, it is even possible to read out the results of up to 16 complete FFT analyses, e.g. via the IEC/IEEE bus.

Class-D amplifiers – a new technology is gaining ground

Use of the new class-D amplifiers is increasingly spreading, primarily in surround-sound applications and the automotive sector. The large interfering power of these amplifiers above the audio bandwidth, caused by switching pulses and noise

References
* R&S®UPV Audio Analyzer: Interface for the I²S serial data bus. News from Rohde&Schwarz No. 185 (2005), pp 22–24.

up into the range of several hundred kilohertz, is too much for the input circuits of many analysis instruments to cope with. Measurements on these amplifiers with traditional audio measuring instruments can only be performed using expensive and complex external filter circuits.

This is not the case with the R&S®UPV audio analyzer. Its input circuits easily master the challenges presented by class-D amplifiers. Expensive external filters such as those in other audio measuring equipment are not necessary; class-D power amplifiers can be directly connected and measured. And, of course, the new eight-channel card also employs this technology. Here, too, all you need to do is simply connect and measure. After all, no one wants to have to invest in 8, 12 or even more expensive filter circuits, particularly in the case of multichannel applications.

Summary

The new R&S®UPV-B48 multichannel interface card can pick up eight analog signals simultaneously and measure them in parallel. Users can easily retrofit the option themselves and thus turn a dual-channel audio analyzer into one with eight channels. It can also be operated together with the R&S®UPV-B41 I²S interface option. If two multichannel interface cards are fitted, 16 parallel analog measurement channels are available.

Klaus Schiffner

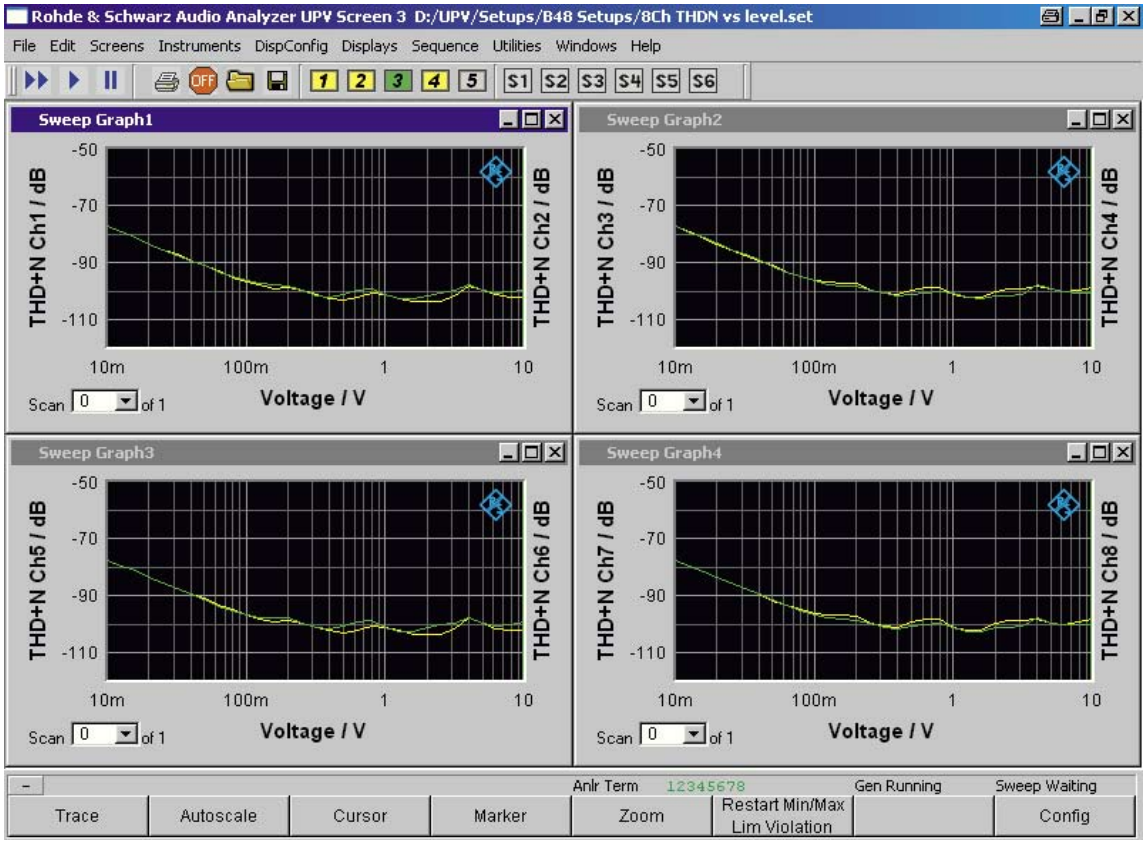


FIG 2 Graphical display of an eight-channel THD+N measurement.

Monitoring DVB-H signals with ESG analysis

The DVB-H measurement functions of the R&S®DVM family for DTV measurements have been greatly expanded. They now contain comprehensive ESG analysis and permit uninterrupted monitoring of DVB-H signals for the first time.

A complex structure: the electronic service guide in DVB-H

The electronic service guide (ESG) transmitted as part of the DVB-H standard allows viewers to navigate among DVB-H programs and to select programs. The receiver cannot select programs if the ESG is faulty. Whereas with DVB-T access to the individual programs is controlled through the data in the PAT and PMT tables, the structure used in DVB-H is a good deal more complex, as in this case the transport stream (TS) level and the Internet protocol (IP) level are interwoven. At the TS level, all the IP addresses used must be linked with the packet IDs (PID) of the transport stream packets via the IP/MAC notification table (INT). The INT contains target and operational descriptors that lead to the correct PID reference in the correct PMT using the service ID and the component tag. This is the link between the IP world and the MPEG world.

The ESG now makes it possible to navigate within the DVB-H IP streams at the IP level. In the first place, it describes programs (services) and assigns video/audio streams to them, but it also offers a large number of further functions for displaying TV contents on a mobile phone, such as:

- Display of the program provider with logo, name, link to website, etc.
- List of transmitted programs with title, time, background information, program clips, etc.
- Data for the decoder required for access to the program via the session description protocol (SDP) (IP address, ports, coding parameters, etc.)
- Data relating to encryption of the content and for communications with the service provider in order to pay for the service
- Data for interactive facilities (voting, home shopping, etc.)

The R&S®DVM family of instruments for monitoring and analyzing DTV signals

The instruments in the R&S®DVM family unite all the functions required for complete monitoring and analysis of DTV signals. A large number of RF interfaces, including the new DVB-S2 satellite standard, and a Gigabit Ethernet interface for IPTV applications are available. The instruments support comprehensive measurements for monitoring and analyzing signals. This involves not only the RF and IP levels, but also the transmitted MPEG-2 transport stream, including its content. The detailed analysis of video and audio elementary streams (MPEG-2, MPEG-4/AVC/H.264, AAC and AC-3), of various data services such as teletext, subtitles and system software updates (SSU) as well as of DVB-H signals is easily possible. A hardware decoder for SD and HD signals allows fast, easy visual checking of video content that is encoded in line with MPEG-2 or MPEG-4/AVC/H.264. The instruments are extremely compact, and feature flexible configuration. Only one instrument is needed to analyze all the levels of a DTV signal; the simultaneous monitoring of several signals or of different standards is also supported. This saves space in monitoring applications and allows portable use for analysis tasks. A large number of supplementary functions are implemented, particularly for monitoring applications: user administration including rights management, measurement value query, full remote operation over a network, and many more.

The R&S®DVM100L takes up only one unit in height, but can monitor up to four signals simultaneously.

There are at present two ESG standards: the *IPDC standard* from DVB (the broadcasting organization), and the *BCAST standard* from the Open Mobile Alliance (OMA), an association of leading service and product providers from the wireless communications field. Under both standards, the primary purpose of the ESG is to provide references to the programs, but the ESGs differ in the additional functions they provide. Their common characteristics are as follows:

- IP/UDP/FLUTE protocols for transferring data (files)
- A bootstrap format allowing both standards to be used in one transport stream
- Container structures that support selective access to the data elements
- XML used as syntax for the service guide
- The use of IDs or URLs for linking the various elements
- The SDP as an access (or acquisition) element to other IP addresses, e.g. for the video/audio player, as well as to logos and other data (FLUTE sessions)

The complexity of the electronic service data clearly shows that a thorough analysis of the ESG is essential for fast verification and fault determination.

The new ESG analysis functions

The new analysis functions for the ESG support both the *IPDC* and the *BCAST standards*. They automatically detect and analyze all the ESGs contained in a transport stream, check all the links, and organize the data. Two windows make it easy to get an overview. The *ESG Service View* clearly displays the programs (services) of a DVB-H platform plus the associated information, e.g. the current and scheduled content (FIG 1). Everything of interest to the viewer is shown here, including of course the video and audio content that can be played with the player that is included in the R&S®DVM. The individual DVB-H signals are simply selected for decoding by mouse click.

The *ESG Transport Analysis* view displays the structure of the transmission (transport) of the ESG, e.g. the container, image and SDP files as well as the associated file description table (FDT), and the division of the overall data into the bootstrap and other FLUTE sessions (FIG 2). This display is of particular interest for fault finding. It is very straightforward and permits direct access, by mouse click, both to the transmitted files (containers, image files, SDP files, etc.) and to lower-level contents (container fragments such as XML elements). These files, just like the analysis report can, of course, also be saved to the hard disk.

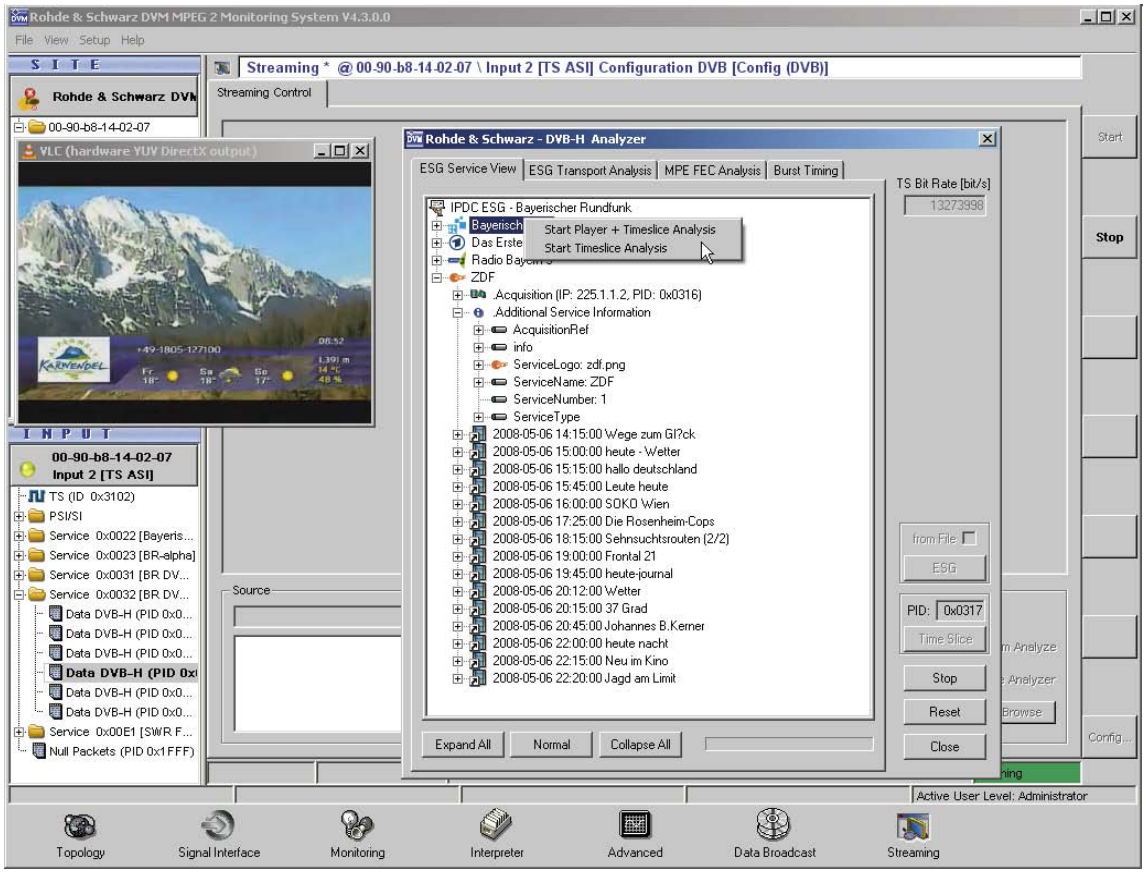


FIG 1 Overview of the services of a DVB-H platform.

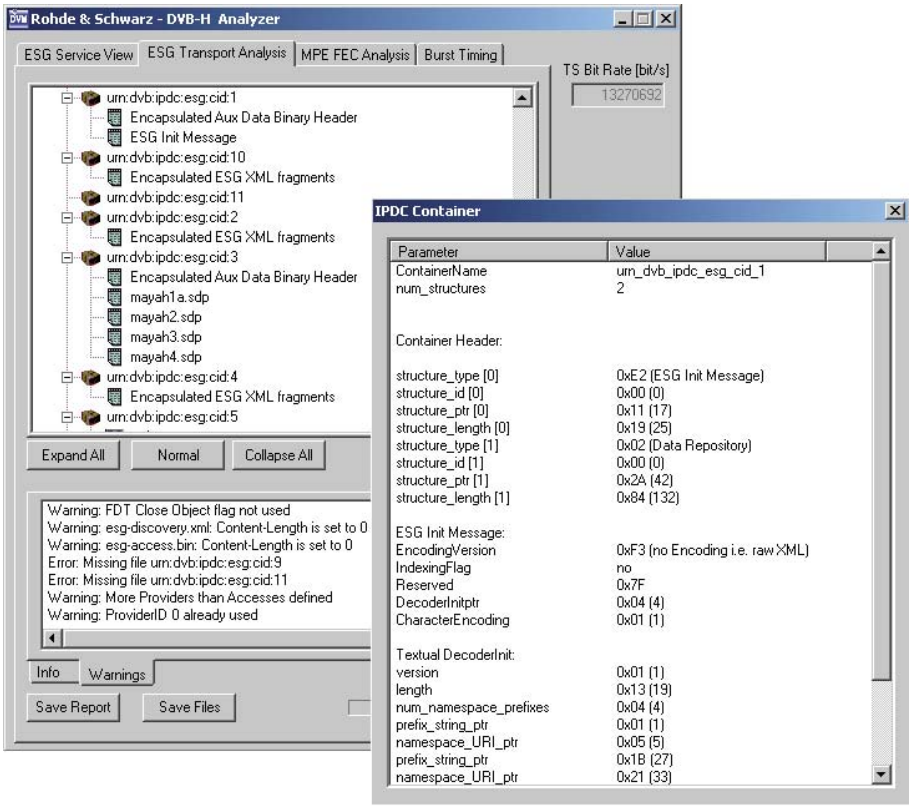


FIG 2 Transport analysis of a DVB-H platform. Left: the structure of the ESG's FLUTE sessions; right: structure of a container.

The system also determines all the burst-specific measurement parameters (DVB-H being transmitted via bursts), analyzing the timing and magnitude of the bursts as well as the signaled timing parameters. The graphic display of the bursts provides a quick overview. The structure of the MPE FEC with its columns, rows and puncturing is displayed in an additional window. The MPE FEC analyzes the faults that have occurred in a transmission, and determines whether they can be corrected.

Monitoring functions

In addition to the detailed analysis and visual check of the DVB-H signals, the R&S®DVM can also seamlessly monitor important parameters, allowing it to detect faulty programs at an early stage and minimize downtimes. The system monitors all the DVB-H signals in all the transport streams at the same time and checks whether the time slicing is in line with specifications, and whether the transmitted contents have been received completely and without errors.

When time slicing is monitored, the burst and the constant bit rate are monitored and the value of the transmitted Δt margin is compared with the measured value. The system checks for the completeness of a DVB-H program and its freedom from errors by checking whether the sections are complete and by determining the number of faulty packets.

Summary

With its new functions for DVB-H, the R&S®DVM is ideally suited for analyzing and monitoring DVB-H signals. The ESG, which is necessary for displaying the programs on the receiver, is analyzed completely and displayed in a simply readable manner. Automated evaluation of the SDP file allows the transmitted video to be viewed directly on the R&S®DVM at the push of a button. These functions are extremely valuable in research and development, but are also helpful for analyzing DVB-H signals on air.

The DVB-H-specific monitoring functions are an important facility. They detect and report faults in the transmitted signal immediately. This allows the provider to take action straight away, so minimizing downtimes. This function makes the R&S®DVM the ideal tool for continuously monitoring DVB-H networks.

Thomas Tobergte; Harald Weigold

The new functions are available now. The data broadcast analysis option (R&S®DVM-K11) is required to use the analysis functions and display the picture. Only the basic TS monitoring function (R&S®DVM-K1) is required to use the DVB-H-monitoring functions.

Compact mobile TV transmitter – versatile and ready for the road

Rohde&Schwarz's already extensive portfolio of transmitters has just gotten bigger: It now includes a mobile TV transmitter that is housed entirely in a car trailer for fast, uncomplicated setup and operation on-site.

Mobile transmitters: true "first aid" in many cases

There are many possible applications for mobile TV transmitters. For example, stationary broadcast transmitters (whether digital or analog) need to be up and running around the clock. If one of these transmitters fails for a longer period of time and causes viewers to miss programs, network operators run the risk of significant penalties. However, there is a solution. A mobile backup transmitter can now be up and running quickly and easily when a stationary transmitter fails.

However, besides emergency applications, compact mobile transmitter systems are also useful for interim usage and for training purposes. Since they are largely independent of existing infrastructures, they can also be used in hard-to-access locations. Since they can be installed very quickly, they are also ideal for setting up new mobile TV networks or trial networks. They can also be used to close coverage gaps at a minimal cost.

Compact solution in a car trailer

Following a call for bids from MEDIA BROADCAST GmbH, Rohde&Schwarz received an order in July 2007 to implement and deliver a mobile transmitter system of this kind. The

FIG 1 The R&S®NV8606V TV transmitter is installed on a mounting plate with guide rollers. It can be easily transported without any additional equipment due to its total weight of under 400 kg.

FIG 2 The complete box structure of the car trailer can be hydraulically lowered whether the trailer is attached or not.

FIG 3 The heat exchanger with the coolant pump is compact and easy to transport.

two companies cooperated closely on the design and blazed some new routes. The objective of the project was to create a DVB-T transmitter system with 4 kW transmit power which could be quickly transported and put into operation at any site without significant installation effort.

At the heart of the system is the R&S®NV8606V transmitter (FIG 1), a member of the R&S®NH/NV8600 family of liquid-cooled high-power transmitters, which are known for their high efficiency and low space requirements [*]. The transmitter is installed on a mounting plate with guide rollers. It can be easily transported without any additional equipment due to its compact dimensions of 600 mm × 1800 mm × 1100 mm (W × H × D) and total weight of under 400 kg. The state-of-the-art processing of the modulation signals and the broadband design of the high-power amplifiers ensure that it can be set to the required channel very quickly, helping to minimize downtime for the affected stations.

To keep installation and transport as simple as possible, the coolant pump is mounted horizontally on the 14 kW heat exchanger for the most compact design possible with total dimensions of 600 mm × 1400 mm × 1300 mm (W × H × D) (FIG 3). With a total weight of under 270 kg, the heat exchanger can also easily be transported without any additional equipment due to the guide rollers. After connecting the pump unit to the transmitter and hooking up the two supplied power cables, everything is ready for operation immediately. The pump unit does not need to be drained since the 1½" snap-lock couplers can be actuated under pressure with no problems.

The complete box structure of the trailer (FIG 2) can be hydraulically lowered whether the trailer is attached or not. A tandem axle with additional shock absorption in conjunction with a safety clutch and a stabilizer ensures safe driving at speeds up to max. 100 km/h. The completely hot-galvanized longitudinal support frame combined with fully covered hydraulic cylinders on the axles makes the trailer unsusceptible to adverse environmental conditions.

The result of this joint effort is very impressive: In a 4.5 m² area, there is room for everything needed for fast setup and operation (FIG 4). Besides the R&S®NV8606V transmitter and the heat exchanger, the trailer also accommodates all accessories, including the power, control, modulation and signal cables, the $1^5/_8$" RF cable, hose lines, all standard adapters from $1^5/_8$" EIA to $^7/_{16}$" through $1^5/_8$" EIA to $3^1/_8$" EIA, the filling pump with accessories as well as the complete documentation.

Burkhard Dahms (MEDIA BROADCAST GmbH);
Johann Fritz (Rohde&Schwarz)

References
* R&S®NH/NV8600 UHF Transmitter Family: High efficiency reduces energy costs by up to 25%. News from Rohde&Schwarz (2007), No. 194, pp. 37–39.

FIG 4 The trailer has room for the complete transmitter system with accessories.

50 % more output power due to innovative amplifier technology

New power amplifiers offer new capabilities. Based on the R&S®NH / NV8200 family of air-cooled, medium-power transmitters, which have been well established on the market for some years now, a new family of transmitters has been developed: the R&S®NH / NV8300 (FIG 1). Although it has an identical footprint, this new family offers 50 % more output power for analog and digital television in band IV/V.

Increased output power and higher efficiency

Compared to the predecessor model (the R&S®VH8200A1, which was used in the R&S®NH/NV8200 medium-power transmitters), the new R&S®VH8300A1 power amplifier module (FIG 2) generates 50 % more output power for all digital and analog television standards. This increase in output power and the accompanying 15 % improvement in efficiency are due to innovative circuit technology and advanced LDMOS transistors. These transistors have proven their worth for one year now in the R&S®VH8600A1 liquid-cooled amplifiers. The resulting reduction in power dissipation made it possible to retain the tried-and-tested transmitter cooling concept used in the R&S®NH/NV8200 medium-power transmitters despite the significantly higher output power. Since the new power amplifier module has identical dimensions and connectors to its predecessor, it is possible to increase the output power of already installed R&S®NH/NV8200 medium-power transmitters by up to 50 % simply by replacing the existing amplifiers with the new generation.

Optimized decoupling of all transistors and RF modules in the amplifier prevents changes in the overall transmitter characteristic in case one of these components fails. All the power transistors maintain their precisely specified operating point so that the set transmitter precorrection does not need to be adjusted. All the operating parameters of the transmitter output stage are sent to the R&S®NetCCU800 transmitter control unit where they can also be accessed remotely.

FIG 1 The R&S®NV8306V is equipped with six amplifier modules and provides an output power of 1.8 kW for DVB-T / -H.

Easy connection: single-phase or three-phase

Two different power supplies are available for the new power amplifier modules for three-phase or single-phase AC networks. The power supply for public single-phase networks is useful in cases where no three-phase power is available, e.g. in outdoor applications, when using the equipment as a gap filler or in shelters.

The transmitters can be shipped with single-phase or three-phase power distributions. The single-phase power distribution is used for operation with asymmetrical systems, i.e. with 230 V AC (L1 to N) common in Europe and also with symmetrical systems with 240 V AC (L1 to L2), which are common in the United States, for example. The three-phase power distribution is designed for 400 V three-phase systems.

Condensed data of the R&S®NH/NV8300

Standards	
Analog	B/G, I, M, N, K
Color transmission	PAL, NTSC, SECAM
Sound modulation	IRT dual sound, mono, stereo, NICAM
Digital	DVB-T/-H, ATSC, MediaFLO™, ISDB-T, AVSB, ISDBT$_B$
Output power	
Digital TV	300 W to 1800 W
ATSC	400 W to 1800 W
Analog TV	600 W to 2700 W
RF connector	EIA $1^5/_8$"
Dimensions (W x D x H)	600 mm × 800 mm × 2000 mm
Power connector	
Three-phase supply	400 V ±15%, 50 / 60 Hz
AC supply	230 V ±15%, 50 / 60 Hz, L1 to N 240 V ±15%, 50 / 60 Hz, L1 to L2

Keeping what already works

The new generation of air-cooled transmitters is designed for use in transmitter stations with forced-air cooling, but can also be operated with ambient-air cooling. In such cases, the air filter is built into the transmitter. For digital TV, output powers up to 1.8 kW are available. For analog TV, output powers up to 2.7 kW (analog combined) are available. The bandpass required for analog TV is integrated into the transmitter rack.

In addition, the transmitters come with all the features already included in the R&S®NH/NV8600 high-power transmitters, including active efficiency improvement, frequency-response-compensated directional couplers, exclusively broadband RF modules for band IV/V and a modular amplifier concept. Of course, all the normal redundancy systems (e.g. active, passive, (n+1) standby) are also available.

Uwe Dalisda

FIG 2 The R&S®VH8300A1 amplifier module has identical dimensions and connectors to its predecessor but produces 50% more output power.

Economical low-power transposers for wide-area application

The new R&S®XLx8000 low-power transposers close gaps in digital TV networks economically – because they receive the broadcast signal from a master transmitter.

Full coverage: a necessity

A large number of gap fillers with relatively low power is needed to close the coverage gaps that remain after the first phase of setting up a digital TV network. But there are always some areas left over that can only be served at great expense using conventional transmitter technology, as it is difficult or impossible to feed in the signal. In such cases, transposers offer significant advantages because they receive the signal to be transmitted from another transmitter, thus avoiding expensive signal feed. These devices must be highly reliable and of good quality to avoid the need for country-wide exchange or modification with high costs, as any servicing needed on isolated stations is disproportionately expensive.

The new R&S®XLx8000 transposer family for all major TV standards

Due to these circumstances and these challenges the product designers and developers at Rohde&Schwarz developed a new, robust, and highly flexible family of low-power transposers, based on their decades of experience with television and sound broadcast transmitters. The objective was to use the high-quality components and mature technologies from existing families of transmitters in order to implement a highly compact solution that meets exacting demands for quality and offers a marketable price/performance ratio.

And the result is convincing: The R&S®XLx8000 (FIG 1) transposer family for all major TV standards and the R&S®SLx8000* transmitter family received the STAR 2007 award of the *TV Technology* trade magazine for their outstanding technical concept.

Future-proof owing to digital processing

The new family of transposers at present supports the standards and services listed in FIG 2. The predominantly digital signal processing provides a high degree of future-proofness, as moderate modifications and improvements of established standards, and even new standards, can simply be implemented by updating the firmware – locally or remotely. The country-wide network can thus easily be kept up-to-date with the latest standards.

FIG 1 The ultra-compact R&S®XLx8000 low-power transposer, with an output power (in this example) of 10 W for DVB-T/-H, 16 W for ATSC or 25 W for analog TV in a housing of only two height units.

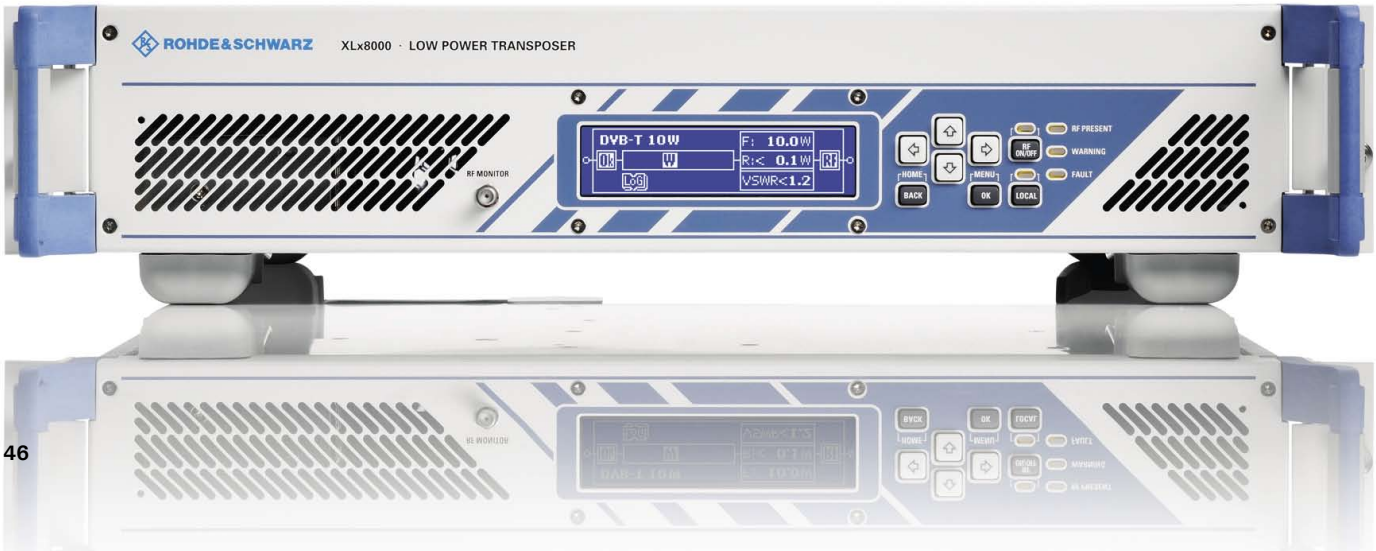


FIG 2 Standards implemented at present in the R&S®XLx8000 transposers, their power ranges and height units (width 19").

Standard	UHF	VHF	Height units
DVB-T / -H	R&S®XLV 8000 2 W to 100 W	R&S®XLW 8000 25 W to 200 W	2 or 3
ATSC	R&S®XLV 8000 3 W to 150 W	R&S®XLW 8000 40 W to 320 W	2 or 3
Analog TV	R&S®XLV 8000 5 W to 250 W	R&S®XLW 8000 50 W to 500 W	2 or 3
DAB / T-DMB	–	R&S®XLW 8000 75 W to 300 W	3 or 4

Operation as usual

The transposers are operated via the front panel and its display, or via a computer running a commercial standard web browser including JAVA™ technology. As an option, the transposers can be remotely monitored and controlled via SNMP or floating contacts.

Goodbye to interference from adjacent sources

A carefully balanced mixture of analog and digital filters reliably removes interfering adjacent channels from the received signal. The transposer's digital signal processing makes its performance in respect of essential parameters (e.g. short transit time versus high selection) ideal for a wide range of application scenarios.

Echo canceller for operation in single-frequency networks

The optional high-performance echo cancellers make the new transposers ideal for operation in single-frequency networks. Two different versions are available. The basic version is used under moderate echo conditions, while the extended echo canceller can even suppress echoes that are many times stronger than the wanted input signal.

Equalization made easy

The innovative factory-based equalization minimizes the equalization effort and allows the transposers to be put into operation quickly. After the transmission frequency and power have been entered, the automatic equalization facility selects the appropriate equalization data for the power amplifier from an internal database. The tried-and-tested digital equalizer from Rohde&Schwarz then completes the job, as a result of which each channel can be attenuated by up to 10 dB without requiring any manual equalization of the power amplifiers.

Options for many applications

Numerous options allow the range of functions of the R&S®XLx8000 transposer family to be enhanced for specific applications. The housing offers enough room in spite of being so compact. An accurate GPS receiver, for instance, serves as a reference frequency source, while a monitoring receiver for DVB-T/-H signals monitors signal quality at the input and output. Appropriate power supply options allow the transposers to be operated both on heavily fluctuating AC power sources or on DC power (–48 V networks). SAW filters of various bandwidths can, if necessary, provide even stronger suppression of adjacent channels.

Summary

Due to its compact, robust design, the R&S®XLx8000 family of transposers, which has been praised in the technical press, is suitable for even remote stations. The built-in operating convenience and the well-thought-out innovations such as factory-based equalization make the transposer family suitable for wide-area application in both analog and digital transmitter networks. The internal production capacity at Rohde&Schwarz ensures short delivery times, so that high demands for denser packing of existing networks can be met.

Josef Meier; Peter Mühlbacher

References
* R&S®SLx8000 Low-Power Transmitter: Compact low-power transmitters for all important TV standards. News from Rohde&Schwarz (2008) No. 195, pp. 56–58.

Powerful, PC-based signal analysis

The R&S®GX430 software is a single-channel solution from Rohde&Schwarz for the analysis and processing of analog and digital HF/VHF/UHF signals. Together with a modern Rohde&Schwarz receiver such as the R&S®EM510 or the R&S®EM550, it allows the received signals to be detected, classified, demodulated and decoded on a (Windows®) PC. The results obtained can be passed to a radiomonitoring system solution for further evaluation.

and signal processing

Compact, single-channel solution

The functional-oriented options for the R&S®GX430 software allow the user to choose the optimum functions for each workplace (e.g. classification, production, manual or automatic procedures). The software is installed on a PC (Windows® XP/Vista) (FIG 1). Several options are available for connecting it to the signal source. Modern receivers from Rohde&Schwarz that support the transmission of digital IF over a LAN, such as the R&S®EM510, are connected to the R&S®GX430 computer via an Ethernet LAN. It is possible to transmit an IF with a bandwidth of up to 1 MHz. For instruments without LAN interfaces, it is possible to connect the audio output of the receiver to the line-in input of the soundcard of the R&S®GX430 computer. Depending on the quality of the soundcard used, signals with a bandwidth of up to

FIG 1 The right instrument for every task can be found in the comprehensive range of receivers from Rohde&Schwarz. Modern receivers such as the R&S®PR100, R&S®ESMD, R&S®EM510 or the R&S®EM550 are connected to the R&S®GX430 computer via LAN. The R&S®GX430 software controls the receivers' functions. The user can alternatively control the equipment by means of the user interfaces supplied with the receivers. Receivers with no digital interface are linked to the soundcard of the R&S®GX430 computer via their audio output.

a few kilohertz can be processed in this way. WAV files saved by other receiving devices can be imported into R&S®GX430, where they can be played and processed using the built-in playback function.

Signal search, classification and recording

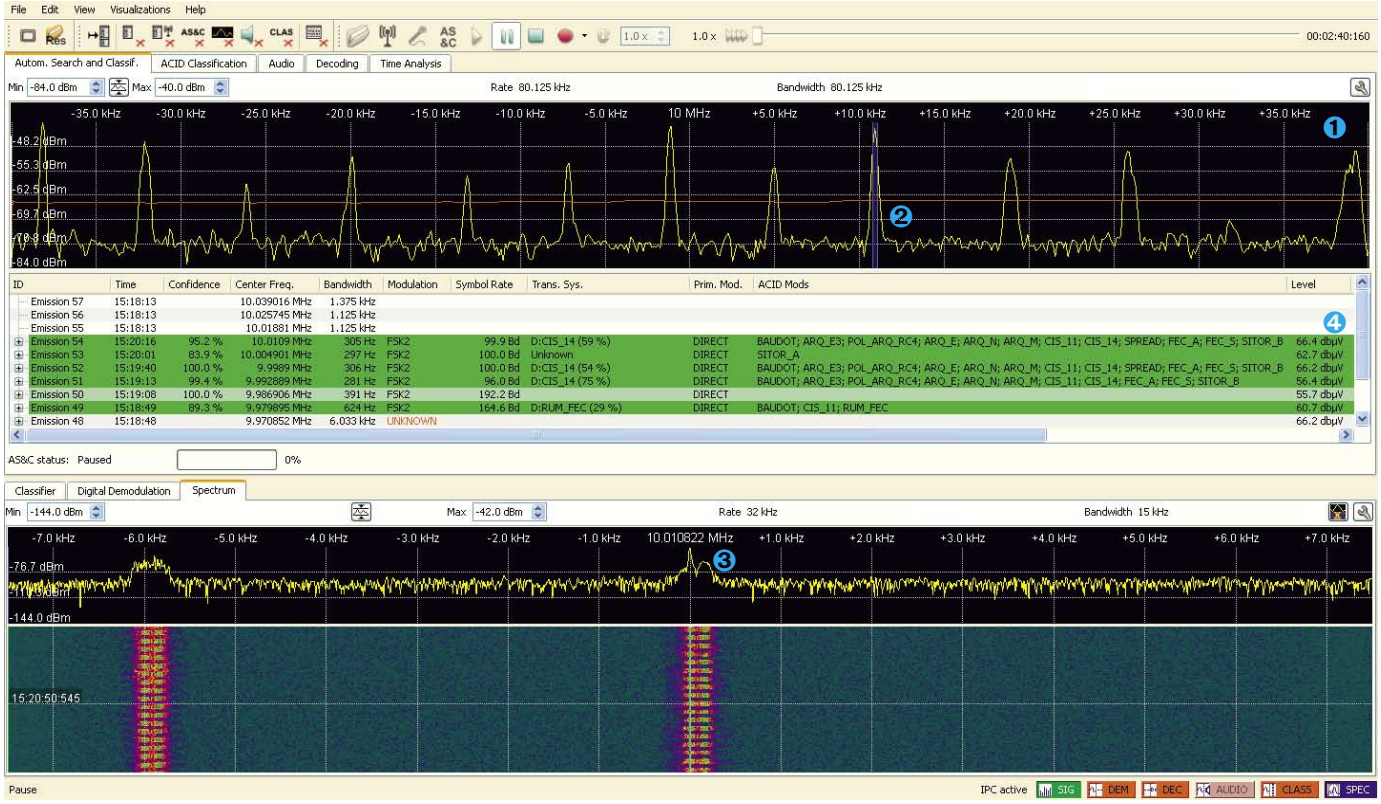
R&S®GX430 offers a choice between automatic or manual signal search.

To perform an automatic search the user selects the Rohde&Schwarz receiver that is to be used, the search frequency range, and the search signal bandwidth, as well as the wanted classification depth. As regards the classification depth, the user can choose between energy detection, modulation mode recognition, and method detection. The receiver runs through the search frequency range, and the R&S®GX430 software detects the spectral energy. If detected signals are found to be within the specified range of signal bandwidths, they are inserted into the queue of signals to be classified. A classifier automatically processes the signals in this list, determining the technical parameters in accordance with the desired classification depth (FIG 2). The list of results can be used for subsequent further processing (e.g. the production of a signal).

The spectrum/waterfall display is used for the manual search (FIG 3). The received signal scenario is displayed at up to 1000 spectra/s. The user selects the signal for further processing (classification, demodulation, decoding or analysis) from the spectrum display.

The R&S®GX430 modulation mode detector analyzes a selected signal automatically, and can recognize the following modulation modes, for example: A3E, J3E, ASK2, FSK2, FSK4, multitone and multichannel systems, MSK/GMSK, OQPSK, PSK2 / 4 / 8 (A and B variants in each case), 16QAM and burst methods. It provides the following technical parameters as measurement results: center frequency, bandwidth, modulation mode, plus additional parameters such as shift, symbol rate, number of channels, channel spacing and burst length. It adds time information and a quality figure to each result. The classification of the bitstream or method checks the demodulated signal for characteristics in order to determine a code or the method.

FIG 2 The fully automatic search and classification application detects all signals in a specified frequency range on the basis of their spectral energy (❶), automatically points the classifier to these signals in sequence (❷), classifies each signal (❸), and stores the result in a list (❹).



The digital IF data supplied by the receiver can be saved to the hard disk of the R&S®GX430 computer. The storage capacity depends on the free space available on the hard disk. 10 Gbyte is sufficient for about 500 minutes at 20 kHz bandwidth, or for 25 minutes if the bandwidth is 1 MHz.

These recorded signal scenarios can be replayed directly in R&S®GX430 (without using the receiver), and the signals contained in them can be processed. All the measurement and analysis facilities remain available in replay mode.

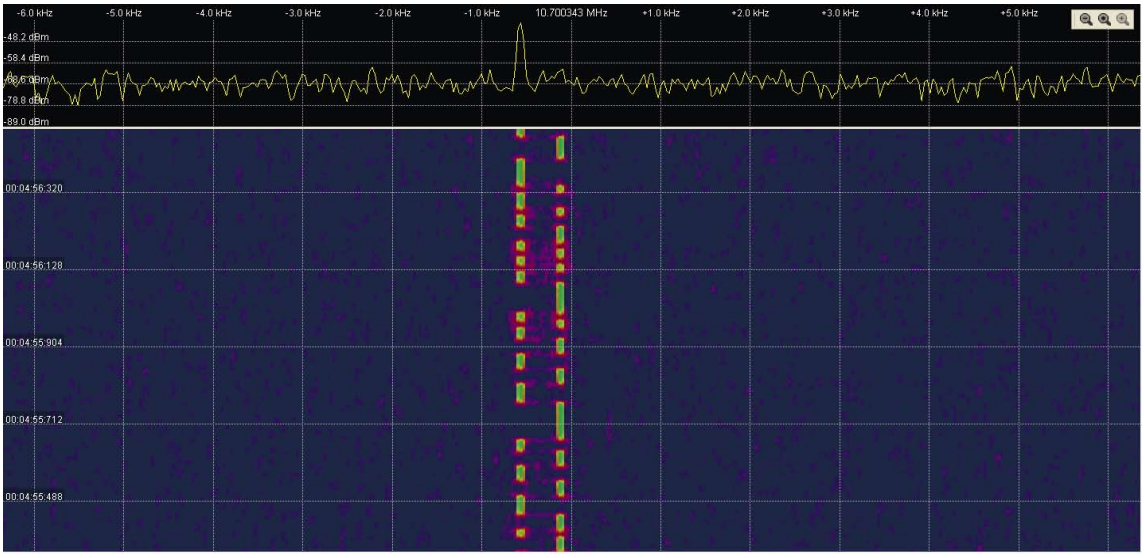


FIG 3 The speed of the spectrum calculation can be set to between 20 and 1000 FFT lines per second. As a result, the waterfall display has a time resolution of up to 1 ms, as can be seen here in the case of a signal with FSK2 modulation and a symbol rate of 50 baud.

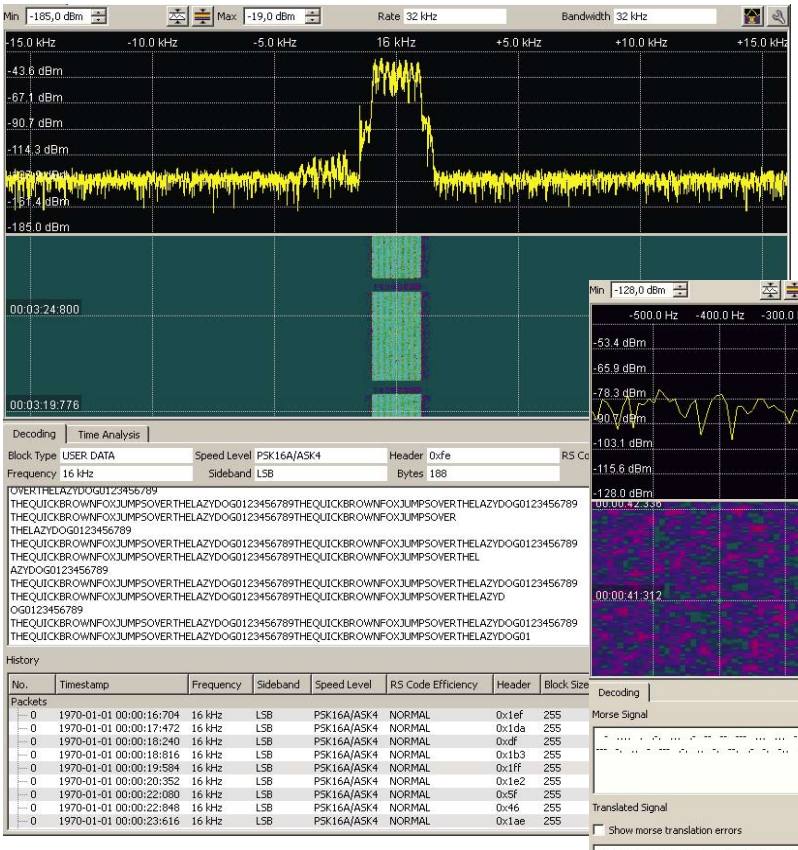
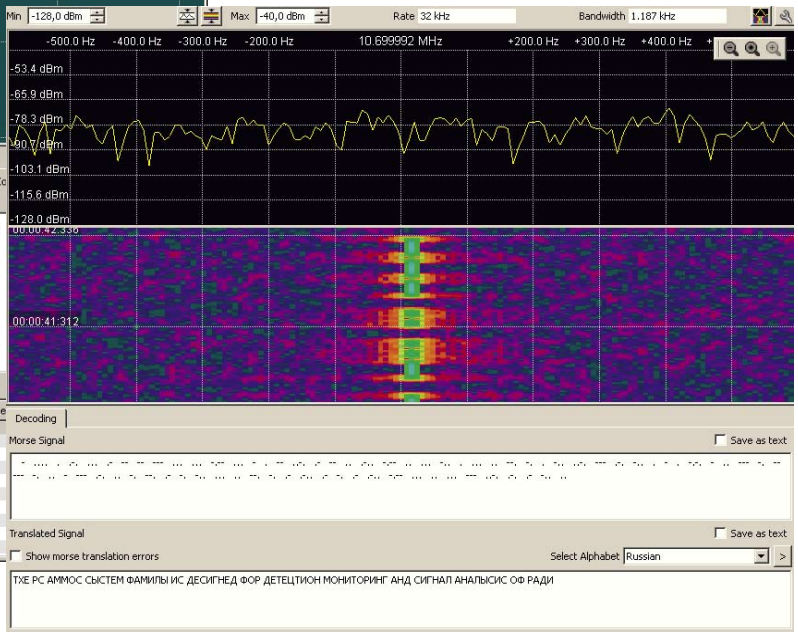


FIG 4 Production example (obtaining contents): HF CLOVER 2000.

FIG 5 Production example (obtaining contents): HF morse with the Cyrillic alphabet.



Production and analysis

After successful classification, or when the method parameters are known in advance, the software sets the appropriate digital/analog demodulator and the appropriate decoder in order to generate the contents of the signal (FIGs 4 to 7). All the content data is stored in R&S®GX430 and is available for subsequent processing. The R&S®GX430's method library covers HF and VHF/UHF processes, and is continually expanded by Rohde&Schwarz. The open interface concept of R&S®GX430 allows process modules (demodulators, decoders) programmed by the user to be integrated and operated.

In addition to automatic processing, it is possible to analyze the time signal manually. A selected signal can be displayed for this purpose in the following diagrams (FIG 8):

- Spectrum/waterfall
- Envelope (amplitude versus time)
- Frequency versus time
- Baseband and envelope spectrum of different moments
- I/Q and eye diagram (of the demodulator)

Tools for manually measuring the technical parameters are available in these views.

The data obtained from the demodulation (symbol streams/bit streams) is stored in R&S®GX430. A powerful bit stream analyzer, the R&S®CA250, is available for the examination of unknown bit streams (bit structures, block codes, convolution codes, etc.).

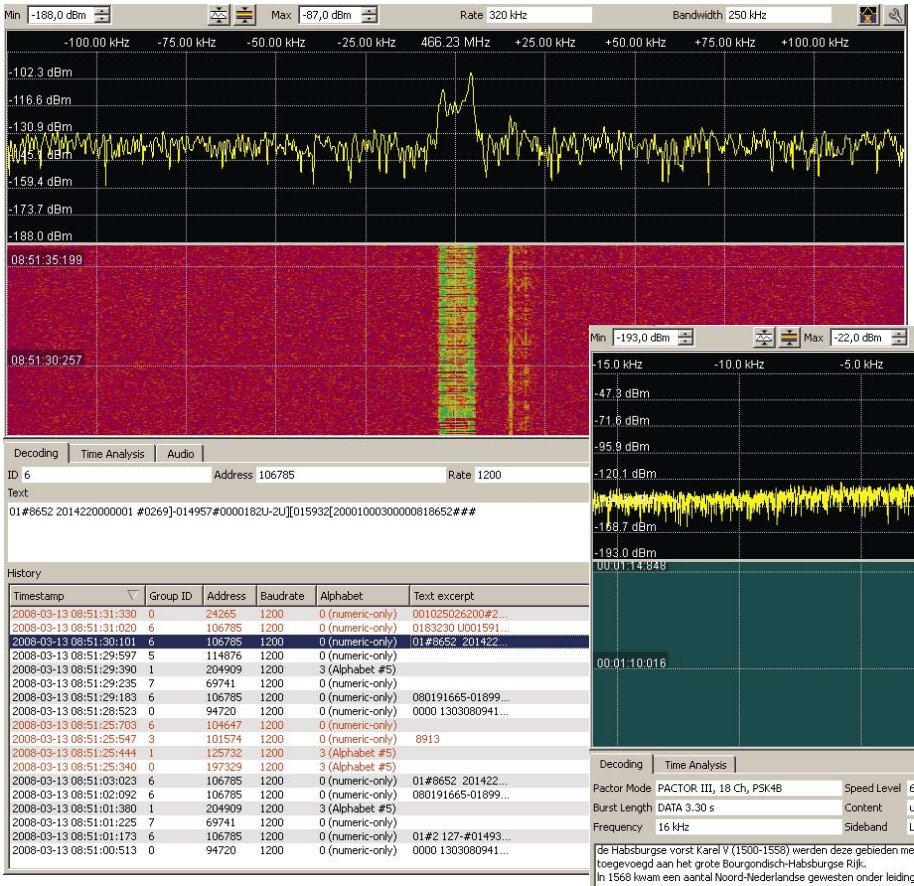


FIG 6 Production example (obtaining contents): VHF / UHF POCSAG.

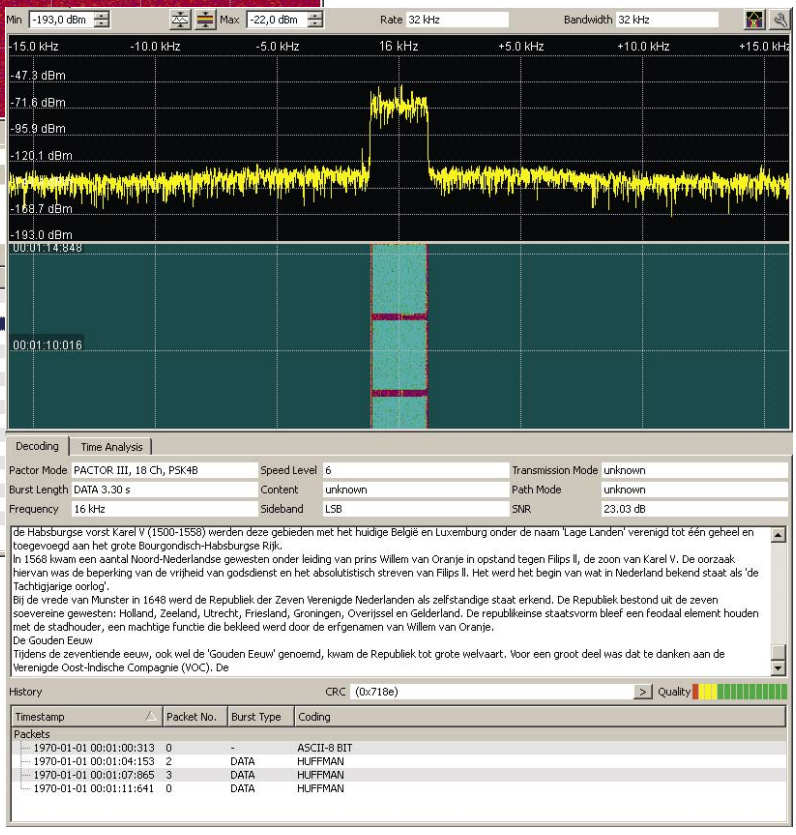


FIG 7 Production example (obtaining contents): HF PACTOR III.

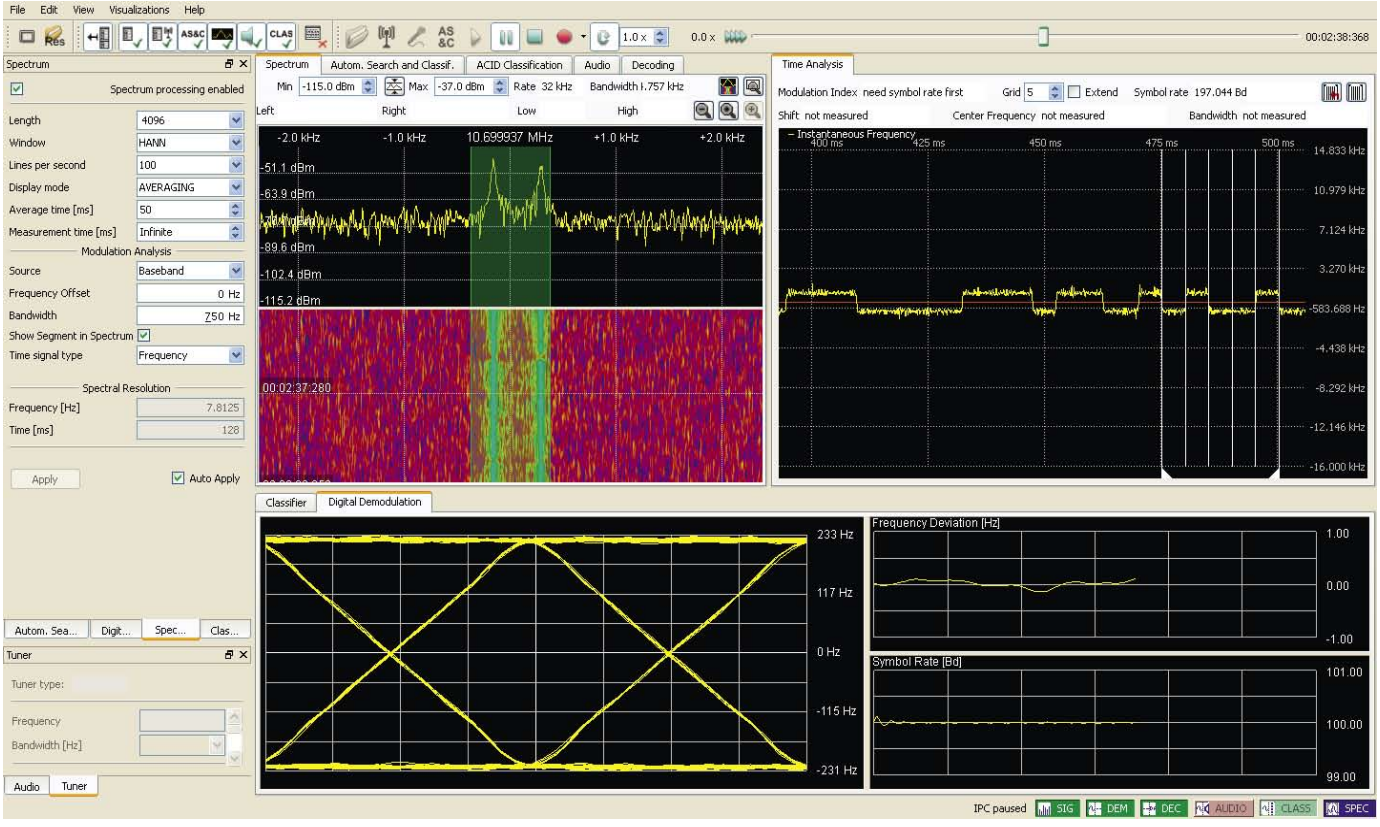
Summary and outlook

The R&S®GX430 PC software is a single-channel solution for radiomonitoring that is quick to set up and simple to operate. For the in-depth analysis of unknown signals, the user can export signal samples recorded by R&S®GX430, and supply them for further processing to the R&S®GX410 AMLAB [1] technical analysis solution. The R&S®GX430 method libraries and measurement functions are being continuously enhanced (e.g. in future all the measurement functions in line with ITU Recommendation ITU-R SM.1600), which, together with the automatic procedures, offers the user a modern, powerful solution for single-channel radiomonitoring. The R&S®AMMOS R&S®GX400 [2] system family is available for multichannel radiomonitoring.

Jürgen Modlich

References
[1] R&S®AMMOS Laboratory R&S®AMLAB: Compact system for wideband interception and technical analysis. News from Rohde&Schwarz (2007) No. 194, pp. 60–65.
[2] R&S®AMMOS Automatic Modular Monitoring System: Seeing clearly through the thicket of signals. News from Rohde&Schwarz (2003) No. 178, pp. 56–60.

FIG 8 In addition to processing with the classifier or demodulator/decoder, the user can mark a signal within the spectrum for analysis (displayed visually by a green frame). Manual analysis options such as higher-order spectra or time signal analysis (amplitude versus time / frequency versus time) are available for this signal.



Also a major topic in Japan – 180 participants wanted to know everything about LTE.

LTE Forum great success for Rohde & Schwarz Japan

The event on March 12, 2008, in Tokyo, which was hosted by Rohde & Schwarz Japan, focused on LTE. The Japanese subsidiary welcomed 180 participants in the Shinagawa Conference Center, including employees of network operators, manufacturers, test houses and research facilities. The lectures gave a detailed overview of LTE technology, standardization status and current test and measurement technology. The Rohde & Schwarz solution for LTE MIMO measurements and the R&S®CMW500 LTE protocol tester were presented during two practically oriented sessions. Rohde & Schwarz once again proved its LTE expertise at this successful event.

Another office in Russia

At the end of 2007, Rohde & Schwarz opened a new office in Saint Petersburg. The office belongs to Rohde & Schwarz RUS OOO Moscow. The team from Moscow will handle sales support until the local sales staff has been built up. Three to five employees will work in this office. Saint Petersburg is one of Russia's high-tech locations.

New momentum for Asia

On April 18, 2008, Rohde & Schwarz inaugurated its regional headquarters in Singapore, thus establishing a regional decision and competence center. Since almost a third of the total turnover is now generated in Asia, Rohde & Schwarz has been setting up a comprehensive sales network and local R&D centers on-site over the last ten years. As important decisions must be made every day, it is necessary to quickly and directly combine know-how and thus help to shape current and future technological developments. Contact to standardization committees and government agencies is also extremely important. In future, Dr. Erich Freund will act directly from Singapore in his function as Managing Director of Marketing and Sales for Asia/Pacific. The new center will help Rohde & Schwarz Asia to easily satisfy the growth requirements of the coming years.

The calm before the storm – about 500 visitors came to the trade fair booth.

Great interest in broadcasting in Dubai

Rohde & Schwarz Emirates LLC's participation at CABSAT 2008 in Dubai was a success. The trade fair for the Middle East, Africa and South Asia regions registered a growth of 30 % in comparison to the previous year. This is a sign of the great interest in broadcasting, from which Rohde & Schwarz Emirates also benefits. The coverage measurement systems also went down well with the visitors. Another highlight was a live DVB-H demonstration in cooperation with *Nagravision*, the market leader for pay TV encryption systems. Among the almost 500 booth visitors were employees of the Ministries for Information from Saudi Arabia, Kuwait and Oman.

Visiting Rohde&Schwarz SIT

In mid-April, members of the German Science Journalists' Association (WPK) visited Berlin-Adlershof, the science and business center. The WPK is, in its own words, "an independent association of active, competent, critical science journalists representing print, radio and television." Fifteen members of this delegation attended a two-hour event staged by Rohde&Schwarz SIT, where they obtained information about cryptological methods and how they can be applied. The live presentation of current SIT products especially attracted their attentions. Making encrypted phone calls was a totally new experience for the journalists.

Impossible to tap phone calls – listeners hear only noise.

Rohde&Schwarz products on the red carpet

Wolfgang Hascher (right), editor of the magazine *Elektronik*, presents the reader prize to Michael Hiebel from Rohde&Schwarz.

Coveted prizes

The true differential mode in the R&S®ZVA/ZVT network analyzers received a prize in Germany. At the annual "Product of the Year" competition, the instruments were awarded third place in the test and measurement category by the readers of the German trade journal *Elektronik*.

The readers of the German trade journal *E&E* from the *Publish Industry Verlag* were also highly impressed by Rohde&Schwarz. At the *E&E Best Product Award 2007*, they gave third place to the R&S®TSMQ radio network analyzer in the test and measurement and EMC category (from a total of 56 products).

The R&S®ETL TV analyzer won the *TV Technology STAR 2008* at the NAB show in Las Vegas. The STAR awards are among the most treasured prizes in the broadcast field. The panel of judges consisted of editors from the internationally renowned *TV Technology* magazine. From a large number of contenders they selected the most outstanding innovations – products that contribute to the technological advancement of the broadcast industry and help to produce and distribute infotainment across the entire media spectrum. The R&S®ETL has recently been expanded by new options for MPEG-2 transport streams and is now a universal measurement platform.

Subhranshu Sekhas Das from Frost&Sullivan (left) presents the award to Joseph Soo, Managing Director of Rohde&Schwarz Malaysia Sdn Bhd.

A&D award for Rohde&Schwarz Asia

Companies based in the Asia/Pacific region and active in the field of aerospace&defense are annually honored with prizes for their special success by the US market research institute Frost&Sullivan. Rohde&Schwarz won the award in the category of original equipment manufacturers (OEM) of military communications equipment. Frost&Sullivan thus honors the company's continuous commitment and successful market and development strategy in this region.

R&S®FSMR measuring receiver convinces metrologists

The Chinese National Institute of Metrology (NIM) holds an annual competition for all suppliers of measuring instruments in China. In this contest, the level and frequency accuracy of the different instruments are compared. The competition was supported by the national quality assurance office. The R&S®FSMR measuring receiver, which was sent into the race by Rohde&Schwarz China, scored excellently. It not only passed the test requirements but also outclassed the other measuring instruments. The R&S®FSMR received a certificate from the NIM for its performance.

The right solution from specification to network maintenance

Rohde & Schwarz offers wireless communications network operators the right test and measurement equipment for GSM, UMTS, HSPA, LTE, WiMAX, CDMA2000®, 1xEV-DO, as well as mobile TV applications for the following areas:

- Installation and maintenance
- Network engineering
- BSS and terminal tests

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