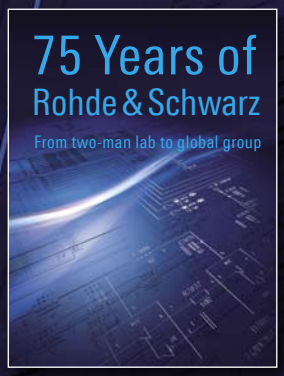
NEWS

198/08

ROHDE&SCHWARZ



With extra section covering the company's anniversary

75 Years of Rohde & Schwarz

JOURNEY THROUGH TIME: The 75 Years of Rohde & Schwarz are full of technological milestones and new ideas. How four business fields write a bit of history about innovation. **INTERVIEW:** The three members of the Executive Board discuss the company's future prospects in an interview. **TEST:** Win a trip for two to Rohde & Schwarz headquarters in Munich.
www.rohde-schwarz.com/ad/75quiz/news

GENERAL PURPOSE

Change in generations: new handheld spectrum analyzers equipped with everything the user needs

GENERAL PURPOSE

Innovative: three new signal generators for the most diverse of applications

RADIOMONITORING / RADIOLOCATION

Remote monitoring of monitoring stations – key to cost reduction

NEWS

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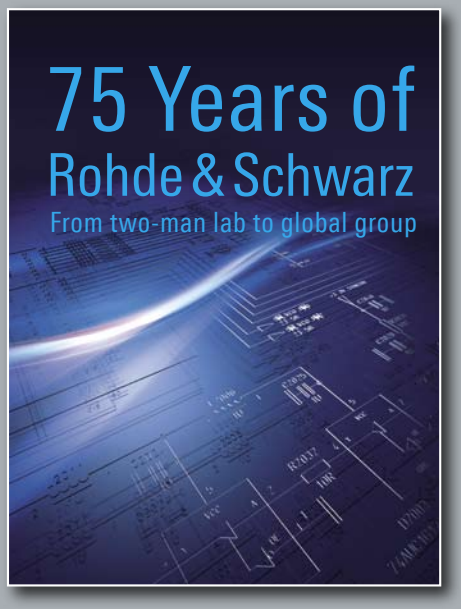
Cover feature

"75 Years of Rohde&Schwarz" focuses on past achievements and on what's to come: great breakthroughs and tough times, the successes of bygone days and visions for tomorrow. NEWS invites you to take a brief look back and a peek into the future. An extra section (after



page 42) includes a journey through the history of the individual business fields; in an interview, the three members of the Executive Board describe how the company is preparing for the future. And the rest of the magazine, as usual, presents brand new products and innovations.

Next generation: The new R&S®FSH4 and R&S®FSH8 handheld spectrum analyzers feature a series of enhancements that make them even more valuable when it comes to performing efficient measurements in the field (page 30).

WIRELESS TECHNOLOGIES

R&S®ROMES2GO is an autonomous walk test system that automatically records quality of service (QoS) data in 3GPP mobile radio networks and stores it on the data card in the test mobile phone (page 6).

GENERAL PURPOSE

The R&S®SMBV100A is the first vector signal generator in its class that not only offers excellent RF characteristics but, in particular, also features future-oriented internal baseband generation (page 36).

EMC / FIELD STRENGTH

The new R&S®SFE100 redefines the market for test transmitters in manufacturing environments: It is small and fail-safe, consumes minimum power, delivers high signal quality for all relevant broadcasting standards and also features an attractive price (page 62).

In 2008, Rohde&Schwarz celebrates its 75th anniversary. An extra section (after page 42) provides a journey through time spotlighting the numerous technological milestones that the company has achieved over the past 75 years. The picture shows the company's two founders in the 1930s: Dr. Hermann Schwarz (left) and Dr. Lothar Rohde.

BROADCASTING

RADIOMONITORING / RADIOLOCATION

MISCELLANEOUS

In an example of perfect cooperation, Austria`s telecommunications offices contributed to the smooth running of the 2008 European Soccer Championship co-hosted by Austria and Switzerland. Numerous Rohde&Schwarz instruments and systems also played their part (page 74).

FIG 1 R&S®ROMES2GO is an autonomous 3GPP walk test system that performs automatic QoS measurements in mobile radio networks.

All the trumps in one hand – with R&S®ROMES2GO

R&S®ROMES2GO is an autonomous walk test system that automatically records quality of service (QoS) data in 3GPP mobile radio networks and stores it on the data card in the test mobile phone.

Efficient, mobile, inconspicuous

The mighty midget: R&S®ROMES2GO is a walk test system that performs demanding measurement tasks with minimum effort. Whereas a conventional test system requires components such as a PC, test mobile phones and GPS receivers, R&S®ROMES2GO runs on a mobile phone (FIG 1) – which translates into key advantages in terms of size, weight and mobility.

The system is based on Nokia mobile phones (at present, models N95, 6120 and 6121) that run on the Symbian operating system and can be equipped with the Nokia test mobile phone (NTM) test software. This helps to ensure that even in the fast-paced mobile phone market, R&S®ROMES2GO can be easily and quickly adapted to future models.

Despite a mobile phone's limited performance in comparison with a PC, R&S®ROMES2GO covers the complete range of relevant measurements. The slim architecture makes it possible to show the desired measurement results in realtime on different displays, and to perform basic analyses and store them for detailed analyses at a later time. Straightforward, logically grouped lists and tables provide a clear overview of important measurement results.

Two-dimensional (2D) graphs are used to visualize measurement results whose history is important for an effective analysis. For example, the trace of the receive levels is of crucial importance for evaluating a handover. R&S®ROMES2GO not only displays their traces in a 2D diagram but also marks the exact handover time by means of the background color of the graph (FIG 2). In addition, the momentary values of the graphs as well as the associated values – such as the GSM channel belonging to the level – are displayed in the legend of the graph. The color of the legend line is displayed in the corresponding graph.

R&S®ROMES2GO supports all standards available on Nokia mobile phones (GSM, (E)GPRS, UMTS, HSDPA). Special views process the most important parameters. For example, the views for GSM provide all relevant information regarding the channel and level of the serving and neighbor cells (FIG 3). In the case of UMTS, active set and neighbor set are displayed (FIG 4), which, along with other measurement results, are visually processed in such a way that all necessary information can be read off at a glance despite the small display.

FIG 2 Graphical/numeric display of the GSM measurement report.

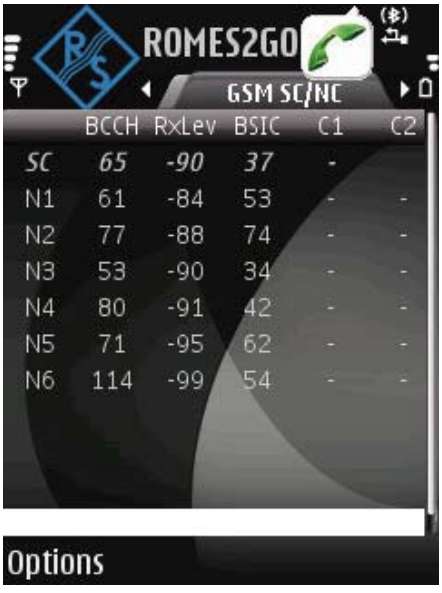


FIG 3 The GSM view provides all relevant information.

FIG 4 The active set and the neighbor set of UMTS.

FIG 5 Number of timeslots used and the coding scheme of (E)GPRS.

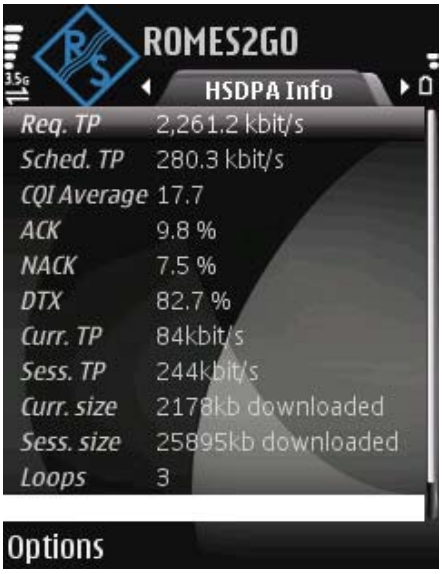


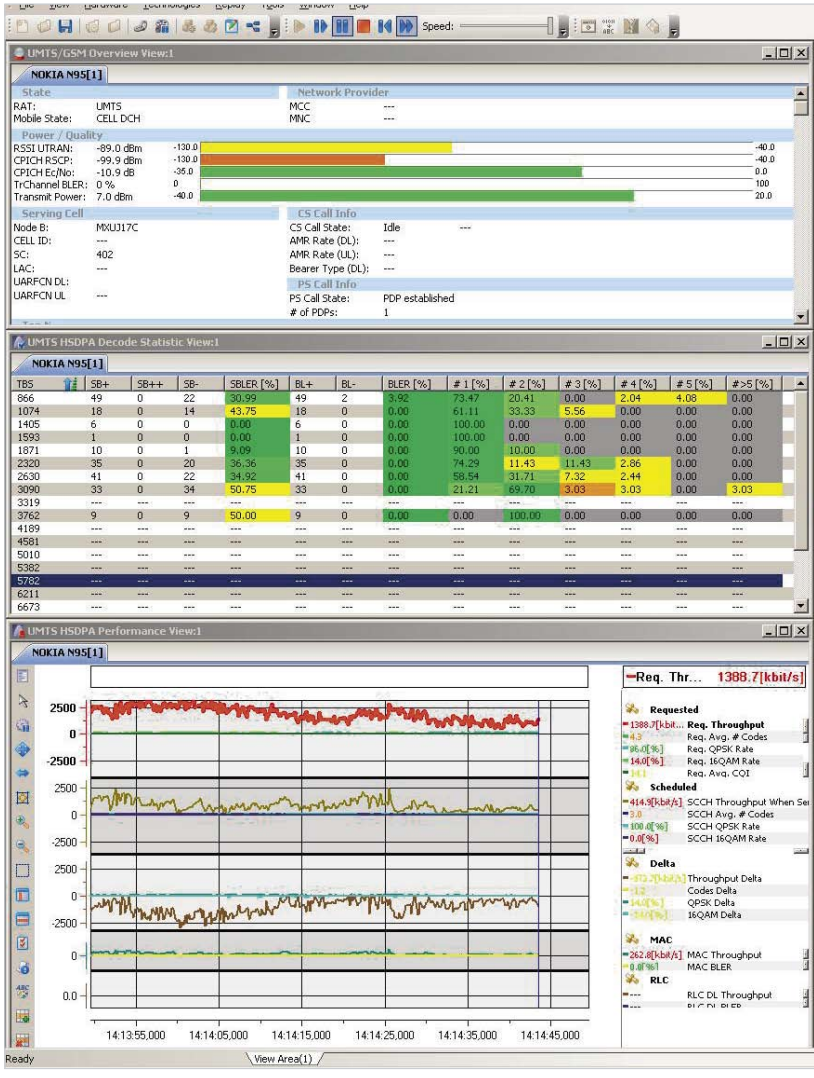
FIG 6 An HSDPA connection: All information is excellently prepared for assessment.

FIG 7 Transfer of the measurement file to a server via FTP.

To enable users to easily grasp the relationship between the air interface and the quality actually achieved in the case of packet-switched services, the layer 1 measurement results as well as the current throughput of each data service are displayed. With (E)GPRS, for example, parameters such as the number of timeslots used and the coding scheme are shown (FIG 5).

Since HSDPA connection parameters change every 2 ms, they cannot be displayed on the mobile phone in realtime. For this reason, R&S®ROMES2GO on the mobile phone calculates meaningful statistics from the large amount of data. Requested/scheduled throughput, CQI average or also ACK / NACK and DTX rates provide the information necessary for adequately assessing the connection under test (FIG 6).

In practical use, the measurement is often not started until a certain event occurs. For a complete analysis, however, the previous measurement data is also needed in most cases. Using the integrated ring buffer for measurement data, which always stores the measurement data for at least 60 seconds, R&S®ROMES2GO ensures that no measurement is started too late and that all required data is available for analysis. After completing the measurement, R&S®ROMES2GO offers users the option to automatically transfer the generated measurement file via FTP to a preconfigured server, from where the files can be immediately used for further processing (FIG 7).



In-depth analysis with R&S®ROMES

If an in-depth analysis of the generated measurement files is necessary, the established R&S®ROMES coverage measurement software is a powerful tool for this purpose. The measurement files generated by R&S®ROMES2GO are converted to RSCMD format, which R&S®ROMES can directly process. The conversion is either performed manually via the graphical user interface or with the aid of automatic batch processing, which periodically searches for new R&S®ROMES2GO measurement files. After the files have been converted, R&S®ROMES provides a large number of measured values in addition to the ones already visualized on the mobile phone. The files contain all the measurement and analysis data that corresponds to the data of an R&S®ROMES measurement using the Nokia mobile phone. This makes it possible to perform, for example, a detailed analysis of the layer 3 messages or the HSDPA transmission at the TTI level. GPS support allows the data to be positioned accordingly on the map (FIG 8).

Summary

R&S®ROMES2GO offers field engineers everything they need for fast on-site analysis. The realtime display of measurement results enables them to immediately respond to problems. Any necessary changes made to the network configuration can subsequently be verified on the spot. The inconspicuous mobile phone in combination with R&S®ROMES2GO allow measurements inside buildings or in pedestrian zones to be taken quickly and efficiently. The system is ideal for applications where electronic measuring equipment is not desired, e.g. at airports or in other security-relevant areas.

Version 1.0.4 of R&S®ROMES2GO is now available. An important pillar in the portfolio of coverage measurement equipment from Rohde&Schwarz, R&S®ROMES2GO undergoes continuous further development. New features such as indoor navigation and a data quality analyzer are planned for the coming versions.

Andreas Spachtholz

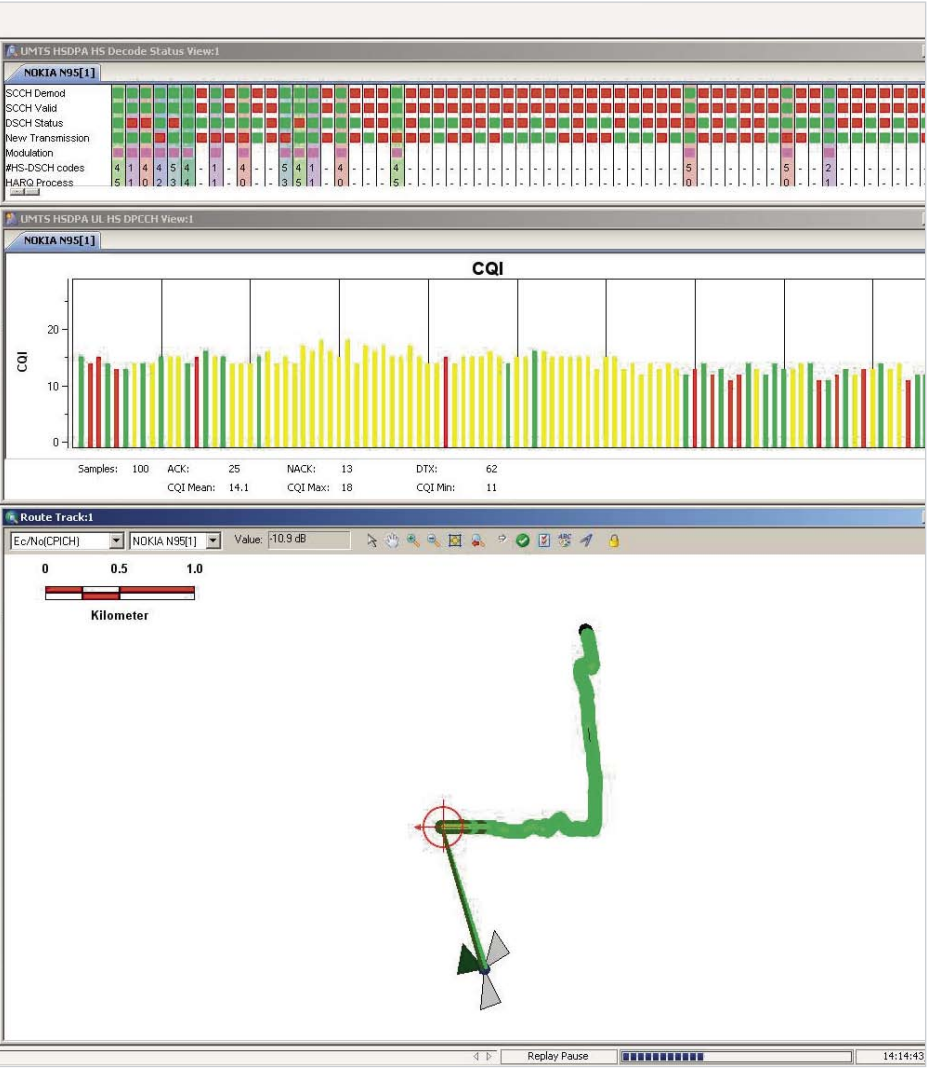


FIG 8 Converted measurement files can be analyzed in detail using the powerful analysis tool, R&S®ROMES.

PC-based protocol tester for UMTS LTE

Developments for the new mobile radio standard UMTS long term evolution (LTE) are running at full speed. Rohde&Schwarz supports the industry in this particular challenge with high-grade test equipment. The new product, the LTE virtual tester, is a powerful protocol test environment for generating LTE signaling scenarios.

The development of LTE is in full swing

The new 3GPP mobile radio standard LTE, with data rates up to 150 Mbit/s and low latency times, permits a wide variety of new broadband services. The commercial kickoff of LTE is planned for 2010 in some regions. Both the enormous increase in data rates as compared to UMTS and the significant pressure for a quick market launch are driving factors in the current development of LTE mobile radio devices. As a result, the complex functioning and performance of the higher protocol layers of user equipment (UE) must be verified very early in the development process.

What are virtual tests?

Virtual tests replace as yet unavailable hardware components, such as UE chipsets or RF output stages, with software simulations. The entire physical air interface is simulated with a virtual physical transport layer. The connection between the LTE virtual tester and the UE software is handled via an interface developed by Rohde&Schwarz. This test method permits parallel development of hardware and software and allows UE software problems to be recognized and eliminated during early phases of development — a decisive factor in ensuring the timely launch of a new mobile phone while maintaining high quality standards.

FIG 1 The LTE virtual tester is an excellent addition to the R&S®CMW500 protocol tester, because scenarios generated by it can be reused with the R&S®CMW500.

The LTE virtual tester

As part of the R&S®CMW500 family of products (FIG 1), the LTE virtual tester offers a powerful programming interface as well as advanced tools for effective analysis of UE protocol software, allowing mobile radio equipment manufacturers to verify early on that UE protocol software is being implemented in accordance with standards. Instead of using a connection via the baseband or RF interface, the message elements are exchanged between the LTE virtual tester and the UE via an IP-based interface (FIG 2). The UE protocol software can run either in a PC environment or in an environment that is embedded on the target hardware. If the target hardware does not have an IP interface for data exchange, a software adapter can be used to make the connection via USB or PCMIA (FIG 3).

FIG 2 The message elements are exchanged between the LTE virtual tester and the UE via an IP-based interface.

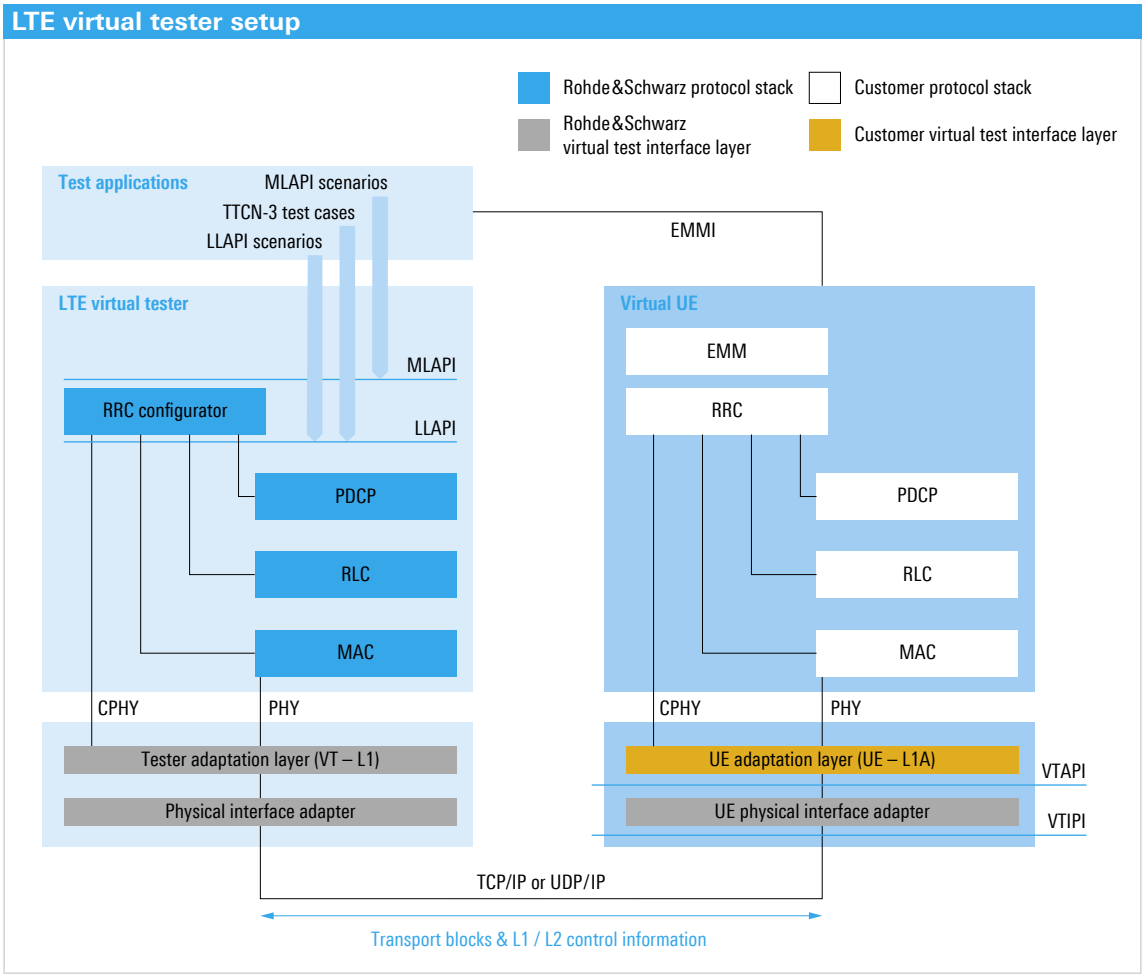
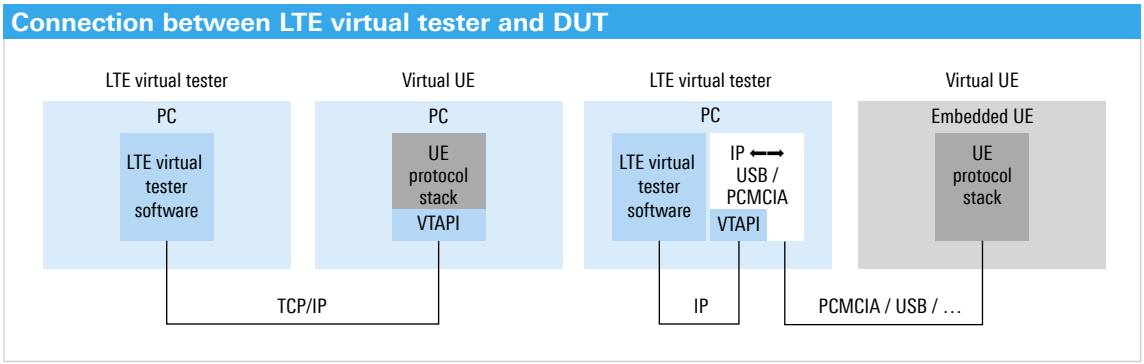


FIG 3 The connection between the LTE virtual tester and the DUT can take place via a standard IP connection as well as via a PCMCIA or USB interface.



The LTE virtual tester is made up of the following software components:

- R&S®CMW-KP502

Standard-conforming reference implementation of the EUTRAN protocol stack (layers 2/3) in accordance with 3GPP specifications, including the virtual physical layer

- R&S®CMW-KP500/-KP501

C++ programming interface for generating signaling scenarios

- R&S®CMW-KT010/-KT011/-KT012/-KT014

Powerful software tools for configuring (FIG 4) and running signaling scenarios, as well as for the detailed analysis of test results based on generated log files (FIG 5)

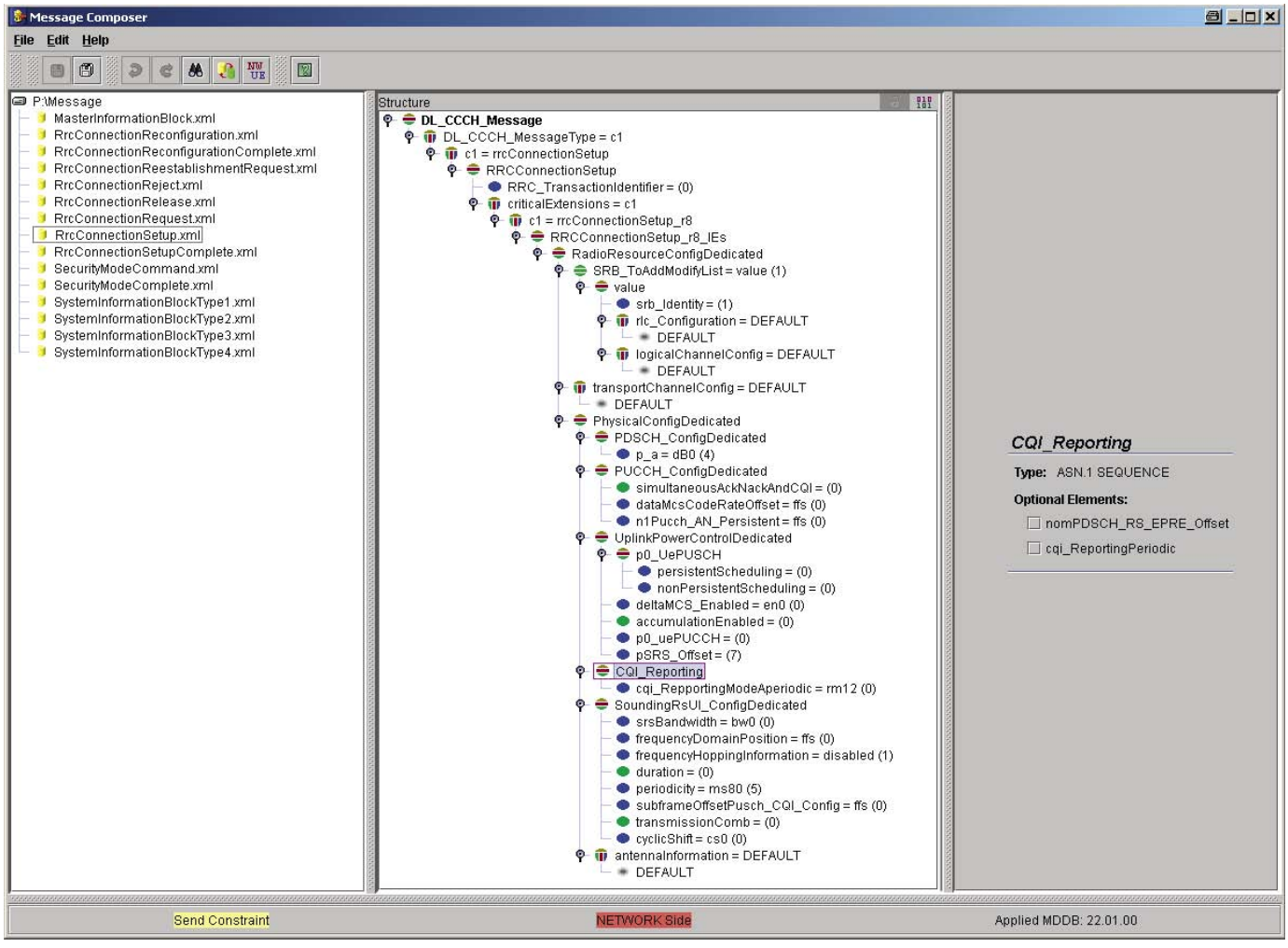
The software tools in the LTE virtual tester are identical to those in the R&S®CMW500 hardware protocol tester and cover the complete development and test process. In addition, signaling scenarios that are developed for the LTE virtual tester can be reused on the R&S®CMW500 LTE protocol tester.

VTAPI: interface for simple connection of UE stack software

The Rohde&Schwarz LTE virtual tester uses a defined set of messages and can communicate with the UE via the virtual test application programming interface (VTAPI) (FIG 2). The VTAPI interface functions are divided into two categories: protocol-independent functions for monitoring the UE connection and protocol-dependent functions for transmitting protocol information such as transport blocks.

The protocol-independent functions on the VTAPI interface allow tests in virtual system time, which means that the LTE virtual tester and the UE software under test are exclusively responsible for defining the start and end of an LTE subframe. This approach offers completely new options during troubleshooting. For example, a breakpoint can be set in order to find a software error. As soon as the UE software stops at this measurement point, the scenario stops on the LTE

FIG 4 The message composer (R&S®CMW-KT012) allows the contents of all protocol messages generated by test cases to be modified easily and without changes to the source code.



virtual tester as well. The status of the UE software can now be examined in detail. When the software continues, the test scenario also resumes on the LTE virtual tester.

The protocol-dependent functions, however, exchange transport blocks and layer 1 / layer 2 control information with the UE. In contrast to conventional test concepts, the UE CPHY configuration interface is part of the UE adaptation layer (UE L1A) and is thus independent of the VTAPI interface. This decoupling allows a flexible and rapid connection to the UE software. The UE adaptation layer always receives sufficient information via the VTAPI interface for correct communications with the RRC and the MAC layer of the UE. For the connection between the LTE virtual tester and the UE, it is therefore unimportant where the boundary between processors in the UE for layer 1 and layer 2 tasks is located.

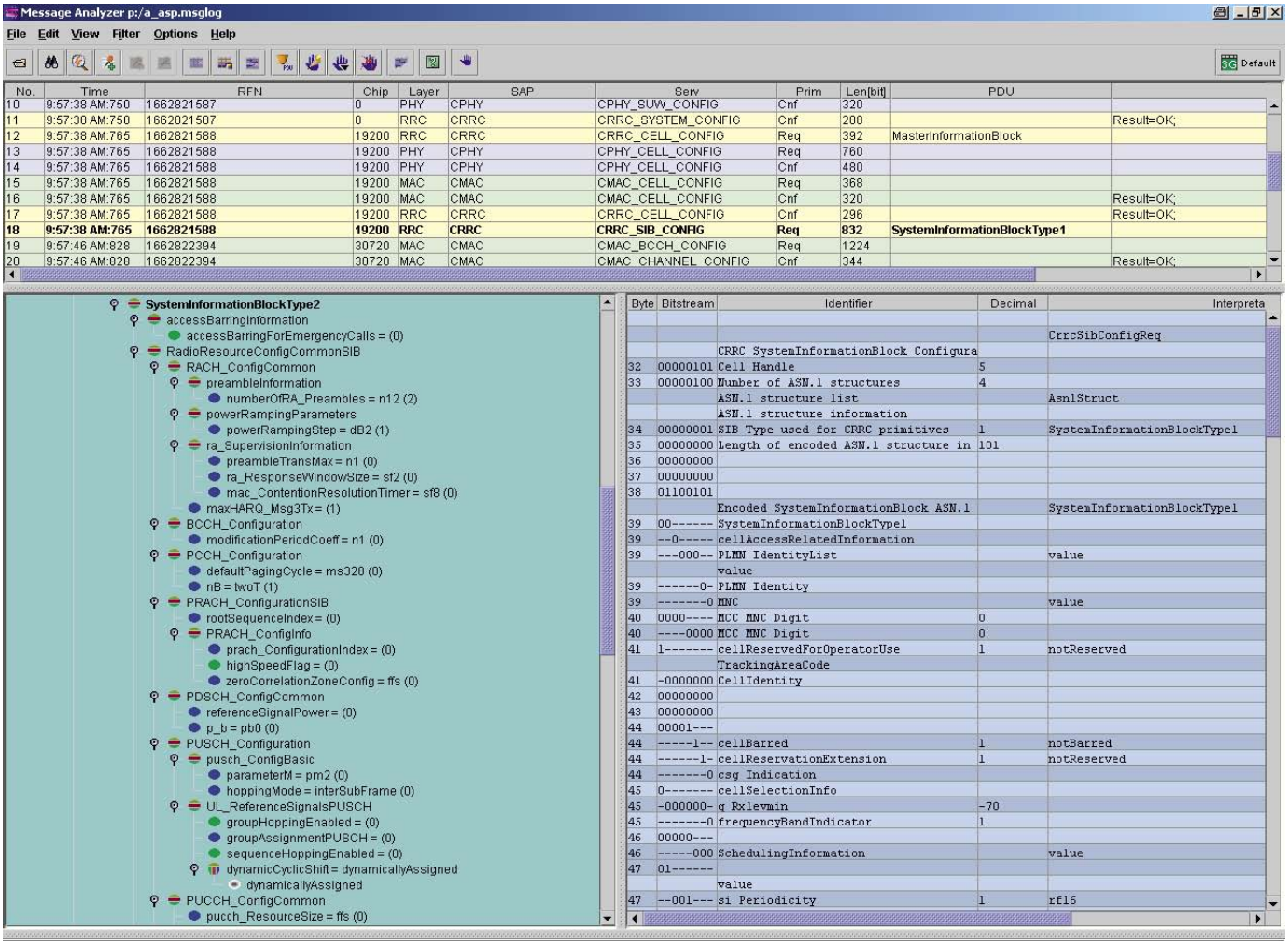
LTE virtual tester: software test environment for all phases of development

Depending on how the LTE virtual tester will be used, various C++ programming interfaces are available from Rohde&Schwarz for developing test scenarios:

The low-level application programming interface (LLAPI, R&S®CMW-KP501) makes it possible to use the LTE virtual tester in a very early phase of UE development. LLAPI is based on layer 2 of the EUTRAN protocol stack and permits direct access to the configuration interfaces of the lower protocol layers (MAC, RLC, PDCP). This means, for example, that it is possible to simulate a very specific network malfunction.

With the medium-level application programming interface (MLAPI, R&S®CMW-KP500), Rohde&Schwarz offers an interface for the efficient generation of test scenarios on layer 3. This interface takes advantage of the unique RRC configurator

FIG 5 The message analyzer (R&S®CMW-KT011) makes studying the signaling sequence of an LTE test scenario quick and convenient. It can completely decode individual messages.



Abbreviations

3GPP	Third Generation Partnership Project
CPHY	Control interface for PHY layer
DUT	Device under test
EMM	EPS mobility management
EMMI	Electrical man machine interface
EUTRAN	Evolved universal terrestrial radio access network
IOT	Interoperability testing
IP	Internet protocol
LLAPI	Low-level application programming interface
LTE	Long term evolution
MAC	Medium access control
MLAPI	Medium-level application programming interface
PDCP	Packet data convergence protocol
PHY	Physical layer
RLC	Radio link control
RRC	Radio resource control
TTCN-3	Testing and test control notation version 3
UE	User equipment
VT	Virtual test
VTAPI	Virtual test application programming interface
VTIPI	Virtual test IP interface

technology developed by Rohde&Schwarz. The protocol stack on which MLAPI is based contains not only the lower protocol layers, but also the part of the layer 3 RRC that is responsible for configuring these lower layers. RRC message elements therefore automatically ensure the consistent configuration of lower layers. As a result, the programming effort and the source code needed for a test scenario are reduced considerably. MLAPI is preferred for generating R&D and IOT test scenarios.

Additional software tools for generating and executing TTCN-3 certification test cases will be available for the LTE virtual tester in the future.

Automated regression tests with the LTE virtual tester

Regular regression tests are a mandatory part of modern software development, because they can detect program errors in previously tested parts of the software. These types of program errors typically arise when changes are made during maintenance or enhancements. The LTE virtual tester allows UE regression tests to be carried out fully automatically, even overnight. If an automatic build system is already available, the inclusion of the LTE virtual tester makes it additionally possible to test the UE protocol software. The user build system and the LTE virtual tester communicate via an IP-based, remote control interface. This makes it possible to run extensive series of tests automatically. The results are immediately visible for the user because individual log files are archived for each test case. As part of the LTE virtual tester software environment, the automation manager (R&S®CMW-KT014) can also be used to start, stop and configure the virtual UE so that the commands needed for the test case can be forwarded to the UE, including, for example, AT commands such as ATD, which starts a mobile originated call.

Summary

The LTE virtual tester is a high-performance software test environment and provides excellent support for developing hardware and software in parallel. Early testing with signaling scenarios based on LLAPI or MLAPI improves quality and ensures a timely market launch of future LTE user equipment. Rohde&Schwarz offers a continually expanding portfolio of ready-to-use scenario packages based on LLAPI and MLAPI that simulate a variety of typical applications from a real LTE network. Uniform programming interfaces ensure a trouble-free transition from virtual LTE tests to real tests using the R&S®CMW500. Scenarios generated with the LTE virtual tester can be reused on the R&S®CMW500 protocol tester, making the software an excellent addition to the R&S®CMW500 family of LTE test equipment and providing support to LTE user equipment manufacturers in handling any technical challenges that may arise.

Dr. William Powell; Roland Brunnbauer

Signals for HSPA+ tests? No problem with generators from Rohde&Schwarz

The two new K59 and K259 options allow Rohde&Schwarz generators* to generate signals for testing HSPA+-ready devices.

Ideal for HSPA+ tests

Ongoing development of the proven 3GPP standard for UMTS networks requires that the tests carried out during development, production and servicing of mobile user equipment, chipsets as well as base stations be updating. The expansions through releases 7 and 8 have led to technologies such as MIMO (see box below).

Naturally, Rohde&Schwarz signal generators are keeping up with these developments — in this case, the new K59 and K259 software options have been added to the existing options for HSDPA (K43 or K243) and HSUPA (K45 or K245).

These new options mean that all of the advantages of these generators — including, for example, the ability to automate test procedures easily using remote control functionality — are also available for HSPA+ tests.

The usual flexibility in configuring the individual 3GPP channels is also seen when generating HSPA+ signals. Multiple base stations can be set for the downlink simulation and likewise multiple mobile stations for the uplink simulation. The software options add HSPA+ functionality to the channels that have already been made part of the 3GPP standard by HSDPA and HSUPA.

* The options are available for the following signal generators: R&S®SMU200A, R&S®SMJ100A, R&S®SMATE200A, R&S®SMBV100A, R&S®AMU200A and R&S®AFQ100A.

HSPA+ at a glance

After significant expansions to the 3GPP standard through HSDPA (release 5) and HSUPA (release 6), releases 7 and 8 push the boundaries even further: The keywords HSPA+ and HSPA evolution define a set of features that make it possible to increase the peak data rate considerably while reducing latency times. The most important of these features are:

Downlink MIMO
Multiple input, multiple output (MIMO) transmission makes use of multiple transmit and receive antennas. This method takes advantage of the spatial dimension of a transmission channel (spatial multiplexing) to enlarge the channel capacity — permitting an improvement in the transmission quality or the data rate. In the case of HSPA+, two transmit antennas at the base station and two receive antennas at the user equipment (UE) (called 2×2 MIMO) increase data throughput while using the same number of WCDMA channels.

64QAM in the downlink and 16QAM in the uplink
Higher order modulation (HOM) allows higher bit rates while maintaining the same symbol rate. HSDPA has already made use of 16QAM in the downlink. With HSPA+, 64QAM is now possible in the downlink and 16QAM in the uplink (composed of four-level pulse amplitude modulation (4PAM) in the in-phase and quadrature path). Combining MIMO and 64QAM in release 8 makes downlink peak data rates of 42 Mbit/s possible.

Continuous packet connectivity (CPC)
From the standpoint of a mobile services user, it is desirable that connections be continuously maintained, e.g. in order to open an Internet site without any delay or to use chat and messenger services (always-on feeling). However, these permanent connections take up a lot of resources, and the continuous transmission of the control messages needed to keep these connections intact can also reduce the quality of other connections.

HSPA+ now allows users to remain connected to the base station with minimal use of control messages. The features developed for this are combined under the keyword continuous packet connectivity (CPC).

In order to make MIMO, higher order modulation and CPC possible, HSPA+ will also make changes to the MAC layer, the control channels and the channel coding.

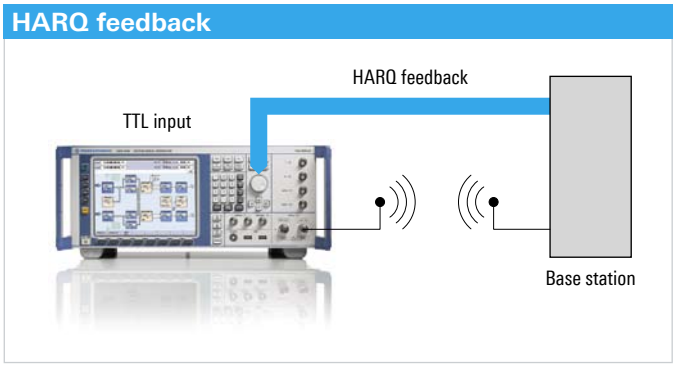


FIG 1 The signal generator receives HARQ feedback from the base station via a TTL input.

16QAM for uplink tests — also with HARQ feedback

HSPA+ uplink tests require 16QAM signals in the HSUPA data channels. The signal generators can now generate these signals and therefore also the new fixed reference channel 8 (FRC 8), which uses 16QAM. Like FRCs 1 to 7, FRC 8 is generated with complete channel coding.

When base stations receive data packets with errors, they request a resend of the transmitted packets (hybrid automatic repeat request (HARQ)). Even if the resent packets are received with errors again, the base station can often combine the received data into an error-free packet (soft combining). To test whether this complex mechanism works correctly in the base station, the R&S®SMU200A, R&S®SMJ100A, R&S®SMATE200A and R&S®AMU200A generators can receive feedback from the base station via a TTL input (HARQ feedback, FIG 1). The generator uses this feedback to determine in realtime whether new data can be sent in the FRC or whether the packets need to be resent to the base station.

Test signals for MIMO in downlink and uplink

The tried-and-tested R&S®SMU200A vector signal generator is noteworthy in that it can be equipped with two baseband generators, a 2 × 2 MIMO fading simulator and two RF paths (FIG 2). A generator equipped in this manner is ideal for HSPA+ MIMO tests. During a downlink test, the transmit signal of the first antenna of a base station can be generated in baseband A while the signal of the second antenna is generated in baseband B. The signals then run through the four paths of the MIMO fading simulator and finally reach the DUT via the two RF connectors. This means that a single signal generator can replace a complex test setup.

The generation of control messages in the HSDPA response channel HS-DPCCH during the uplink simulation has also been adapted to the requirements of HSPA+. Signal generators can now simulate mobile stations in MIMO mode, including the generation of messages regarding the desired number of transport blocks, for example. This makes it possible to verify a base station's correct response.

MIMO, 64QAM and CPC in the downlink — more flexible than the standard

64QAM is now available as a modulation method in the HSDPA data channels for generating downlink test signals. Similarly to the FRCs in the uplink, H-sets are defined in the 3GPP standard as reference configurations for downlink tests. The signal generators also generate these H-sets with complete, standard-conforming channel coding, scheduling and control information.

Besides the predefined H-sets 1 to 11 of the 3GPP standard, which already contain reference configurations for HSPA+ tests, the number of channels used, the scheduling, the modulation and all channel coding parameters can be changed as needed. Based on the familiar intuitive operating concept, these parameters are configured in a separate dialog (FIG 3). As a result, even tests that place greater demands on the DUT than the standardized tests — e.g. by using larger transport blocks — are possible. As seen in the figure, the parameters can be reset to one of the predefined H-sets at any time (by selecting *Predefined H-Set*).

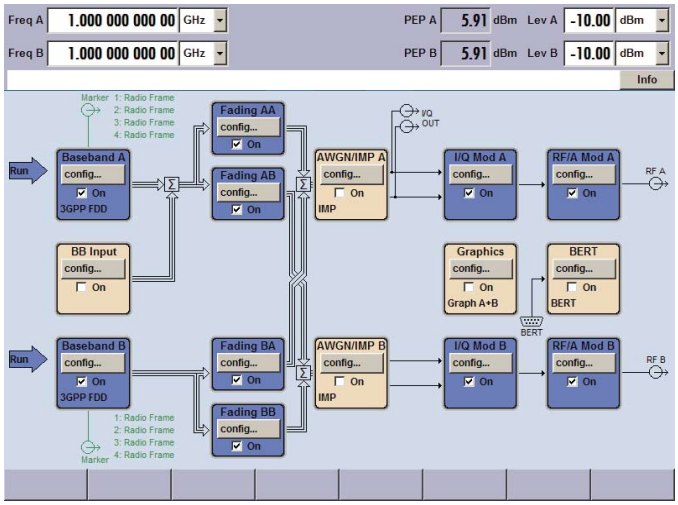
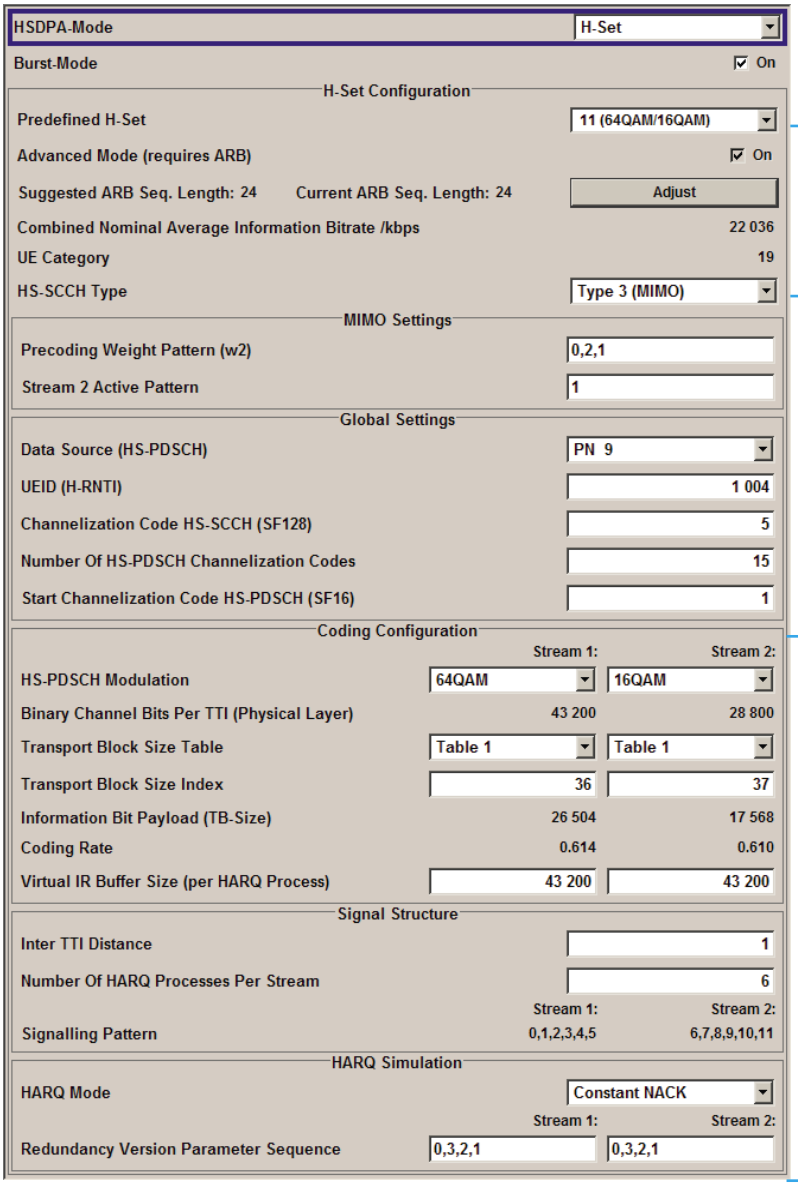


FIG 2 User interface of an R&S®SMU200A with two paths and 2 × 2-MIMO fading. The two paths (baseband A and baseband B) generate the signals of the two MIMO antennas.



The H-sets defined in the 3GPP standard can conveniently be set using the preselection.

Since the HS-SCCH type can be selected as required, even signals for CPC (*HS-SCCH less operation*) or MIMO tests can be generated.

Modulation, channel coding and scheduling can be adapted individually to place higher demands on DUTs than defined in the standardized tests.

FIG 3 The menu for selecting and adapting H-sets.

The H-sets support all three HS-SCCH types defined in the 3GPP standard. Type 1 selects an operating mode without CPC and MIMO. Type 2 performs the coding of the control information and the scheduling in accordance with the CPC feature *HS-SCCH less operation*, and type 3 selects the MIMO mode. In this mode, the weighting factor for distributing the two MIMO streams to the antennas (*Precoding Weight Pattern*) and the number of simultaneously generated transport blocks (*Stream 2 Active Pattern*) can be varied over time. All three types allow a HARQ simulation in which individual packets are sent multiple times, whereby the bit-to-symbol mapping and the channel coding are modified for every packet repetition.

Signals for all categories

The uplink FRCs and downlink H-sets can therefore be used to test all new device categories (to UE category 20 in the downlink or to UE category 7 in the uplink), making the Rohde&Schwarz signal generators capable of generating HSPA+ signals.

Bertram Fesl

LTE test signals for all phases – from development to production

LTE, the successor to the UMTS standard, is paving the way out of research labs into public consciousness. Rohde&Schwarz has accompanied the development of LTE right from the start and offers test and measurement solutions for all steps of product development – such as a wide-ranging portfolio of signal generators equipped with the R&S®SMx-K55 LTE option.

LTE – pointing the way to tomorrow today

LTE presentations of many well-known mobile phone manufacturers at trade fairs, e.g. at the 2008 Mobile World Congress, are one of the reasons that you can now read about the new technology not only in technical literature but also in the general daily press. The fact that many large-sized companies in the wireless communications industry are already putting more energy into creating LTE prototypes shows that this standard is on the verge of establishing itself. This was reinforced by the claim of the NGMN alliance that LTE is the first technology to fulfill the requirements placed on the next mobile radio generation.

Commercial products are not expected to appear on the market until early 2010, but in order to be successful later, manufacturers of wireless communications equipment must set the stage now. For successful product development, it is important to be able to rely on the reference of an independent T&M equipment provider as early as possible.

Leading LTE solutions on the market

As one of the leading manufacturers of T&M equipment for wireless communications, Rohde&Schwarz has stood up for LTE right from the start and has been successfully working on T&M solutions for LTE products since mid-2006: The company introduced the world's first LTE solution for signal generators in October 2006, channel coding and precoding in October 2007, and the R&S®SMx-K55 option as the first LTE TDD solution in May 2008.

In addition, the R&S®SMU200A vector signal generator (for measurements at the RF) and the R&S®AMU200A baseband signal generator (for measurements at the I/Q interface) are the only instruments on the market that combine signal generation and channel simulation in one instrument. Due to the dual-channel concept, only a single instrument is needed to generate a complete 2 × 2 MIMO LTE transmit signal

The R&S®SMU200A vector signal generator contains two complete signal generators with digital modulation capability in a single instrument. Its user-friendly operating concept makes it easy to keep a clear overview. For details on this generator, refer to News from Rohde&Schwarz No. 180 (2003), pp 21–27.

The R&S®AMU200A is a dual-channel baseband signal generator and fading simulator in one box. Not only can it internally generate the baseband signals of digital standards, it can also be used as a pure fading simulator (see News from Rohde&Schwarz No. 193 (2007), pp 4–8).

FIG 1 The R&S®SMx-K55 LTE option can also be used with the new R&S®SMBV100A vector signal generator, which is presented on page 36 of this issue.

including realtime fading and AWGN (see also the article entitled "Signals for HSPA+ tests? No problem with generators from Rohde&Schwarz" on page 15).

Moreover, the new MIMO functionality included in LTE confronts mobile radio manufacturers with a new challenge that did not exist with GSM and UMTS. This is also reflected in the complexity of the test setup: multiple transmit antennas, multichannel fading simulators. The complicated cabling and the effort involved in creating the correct configuration of the different instruments must not be underestimated. Reducing this complex setup to a single instrument such as the R&S®SMU200A or the R&S®AMU200A makes the test setup much simpler. The operating ease and the financial benefit of this solution are undisputed.

TDD and FDD with the same priority

Another important factor in the development of LTE is the Asian market. After the test run of TD-SCDMA at the Olympic Games in Beijing, it comes as no surprise that China is now stepping up its efforts on LTE TDD; after all, many Chinese companies are involved in developing it. Here too, Rohde&Schwarz took an early stance and, with its R&S®SMx-K55 option, has supported the TDD version of LTE with the same priority as FDD since May 2008. Good news for all interested parties is that TDD functionality entails no additional costs vis-à-vis FDD: The R&S®SMx-K55 option includes both modes.

Staying on the ball with the R&S®SMx-K55 LTE option

While more and more companies are starting to work on LTE products, the 3GPP community is working on the completion of the standard. Because many details are still missing in the standard, it is difficult for manufacturers to perform standard-conformance tests. To make it easier for them, the R&S®SMx-K55 option provides more configuration flexibility than is defined in the 3GPP standard. To comply with the current version of the standard, the option must be regularly updated. For this reason, new R&S®SMx-K55 beta versions are made available every two to three weeks – free of charge, of course.

In the further development of the R&S®SMx-K55 option, emphasis is being placed on supporting the user as best as possible – despite sophisticated configuration capabilities – in setting standard-compliant signals (test models, fixed reference channels). For this reason, a test-case wizard will soon be available for R&S®SMx-K55 – similar to the one available for the UMTS option (3GPP FDD) for the R&S®SMU200A – that will help to avoid errors in the test setup. All settings defined in the TS 36.141 3GPP specification for standard-compliant testing of base stations will then be created simply at the press of a button: the configuration of the LTE signal, the prescribed fading profile and the required AWGN. This functionality is intended primarily for users who lack the time to deal intensively with each individual LTE parameter. Nevertheless, of course, the full flexibility is available for development engineers who want to test more sophisticated scenarios than is required by the standard.

Which generator ...

Depending on the application, the available budget and requirements regarding signal quality, the R&S®SMx-K55 option can be installed in the following signal generators:

- R&S®SMU200A: dual-channel high-end vector signal generator, optionally with integrated realtime fading and a digital I/Q interface (see box on page 18)
- R&S®AMU200A: dual-channel baseband signal generator with two digital I/Q interfaces, optionally with integrated realtime fading (see box on page 18)
- R&S®SMBV100A: single-channel vector signal generator in the medium price range, optionally with a digital I/Q interface (see FIG 1 and article on page 36)

In addition, the R&S®SMx-K55 option is also available for the R&S®SMJ100A and R&S®SMATE200A signal generators and, together with the R&S®WinIQSIM2™ software, for the R&S®AFQ100A and R&S®AFQ100B arbitrary waveform generators. The R&S®AFQ100B is presented on page 50 of this issue.

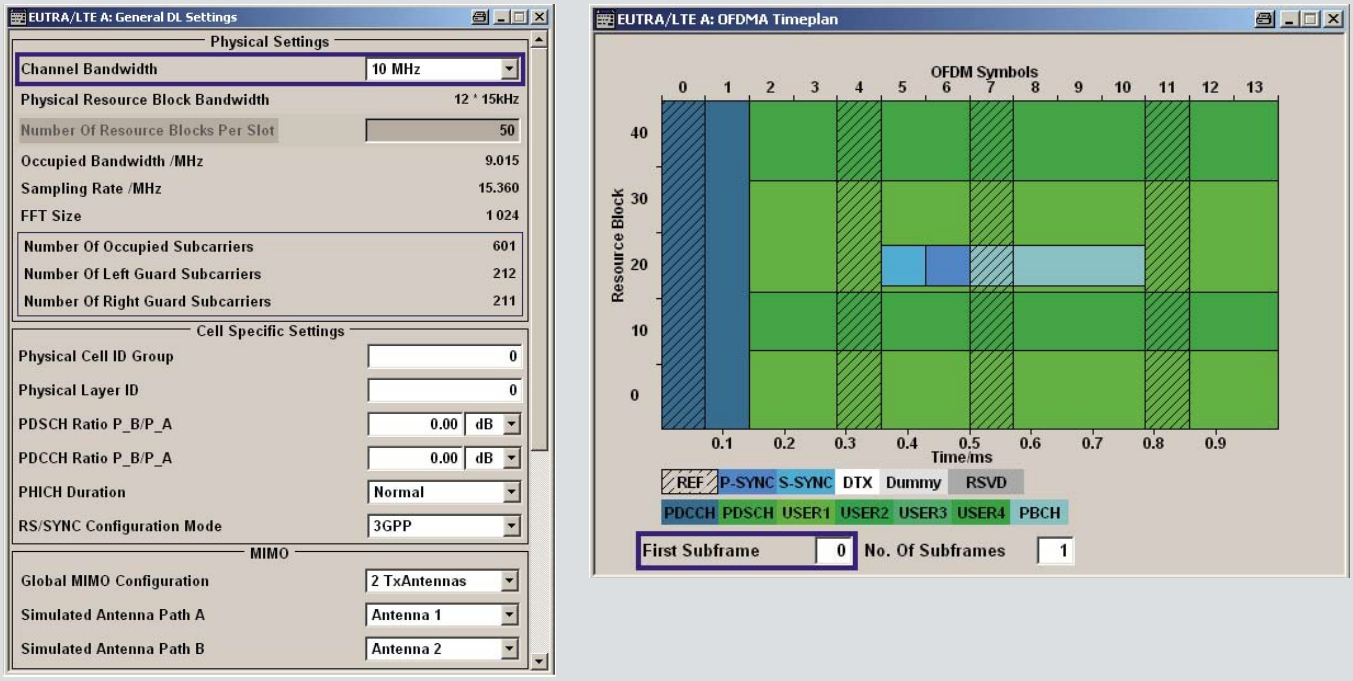
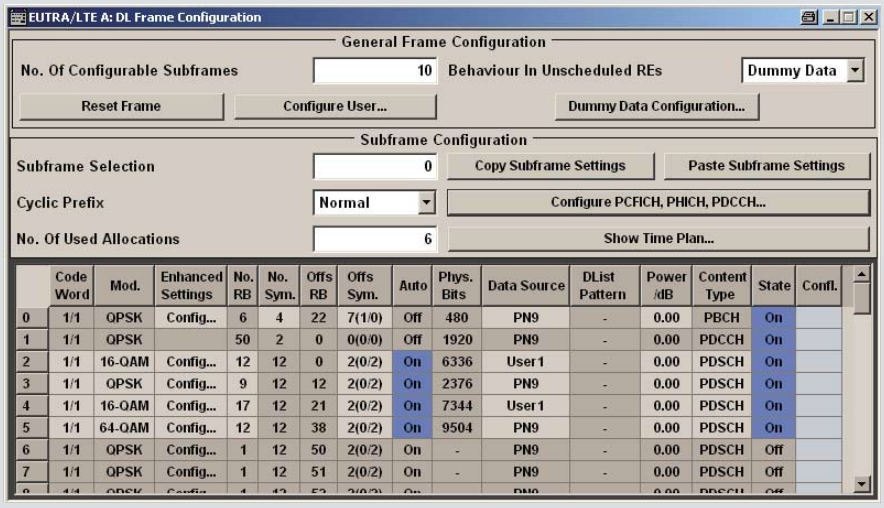


FIG 2 All signal generators from Rohde&Schwarz equipped with the R&S®SMx-K55 option have the same intuitive and straightforward user interface.



Main applications	Main applications	Remarks
Development and testing of components for base stations (e.g. power amplifiers)	R&S®SMU200A	– maximum signal quality (ACLR, EVM) – e.g. in combination with the R&S®FSQ signal analyzer
Development and testing of components for mobile phones (e.g. power amplifiers)	R&S®SMBV100A	– high signal quality (ACLR, EVM) – e.g. in combination with the R&S®FSV signal analyzer
Prototype development (receivers)	R&S®SMU200A (RF), R&S®AMU200A (I/Q interface)	– 2 × 2 MIMO in one box – high flexibility offered by the R&S®SMx-K55 option – the R&S®SMx-K55 option is quickly adapted to changes in the 3GPP standard – straightforward and intuitive operation – no external PC required
Conformance tests (receivers)	R&S®SMU200A	– vector signal generator and fading simulator in one box – test-case wizard for easy and standard-compliant configuration
Production	R&S®SMBV100A	– cost-efficient – production-optimized service concept

FIG 3 Which generator is the right one for the given application?

As signal generation is identical in all instruments (in the baseband), operation, control via SCPI as well as the overall look and feel are also the same (FIG 2). After familiarizing themselves with the software, users can soon navigate easily on all generators. Even exchanging signal configurations between different generator models or porting a test setup used for prototype development to a more favorably priced generator model in production is easy.

The LTE upgrade for the Rohde&Schwarz signal generators runs via a pure software update, as with all other supported standards.

… for which application?

Signal generators from Rohde&Schwarz equipped with the R&S®SMx-K55 option can be used for a variety of applications (FIG 3). Besides the main applications, all generators can also be used to simulate interferers (e.g. signals compliant with the UMTS, GSM, WiMAX™, WLAN and CDMA2000® standards). The R&S®SMU200A and R&S®AMU200A dual-channel generators are, in addition, able to simulate two different standards simultaneously. This makes it possible to test the interplay of different functions in a mobile phone (e.g. LTE / GPS or LTE / WLAN).

An R&S®AMU200A generator is often used for early-stage development of baseband chips. This generator model is also ideally suited as a pure fading simulator, e.g. in connection with the R&S®CMW500 wideband radio communication tester.

The signal analyzers of the R&S®FSx family are recommended for performing the required tests on the transmit side; their R&S®FSQ-K100 / -K101 LTE options harmonize excellently with the R&S®SMx-K55 option.

Summary

Customers who work together with Rohde&Schwarz as a T&M equipment manufacturer in such a promising market as LTE do not merely purchase the instruments. Customers can also profit from the company's many years of experience, which encompasses GSM and UMTS as well as other standards such as WiMAX™, CDMA2000® or WLAN.

LTE is in the offing, and mobile radio manufacturers can count on Rohde&Schwarz as a reliable partner who provides the right test equipment for each step – from prototype development to the production of LTE products that are ready for the market. The overview in FIG 3 shows which generator is suitable for which application, but is only a recommendation. The optimal solution for a specific test and measurement task can best be found by visiting the Rohde&Schwarz website (www.rohde-schwarz.com; keyword "LTE generator") or by making a personal appointment with your nearest Rohde&Schwarz representative (listed under "Sales Locations" on the start page).

Gerald Tietscher

Abbreviations

UMTS	Universal mobile telecommunications system
LTE	UMTS long term evolution
NGMN	Next generation mobile networks
FDD	Frequency division duplex
TDD	Time division duplex
3GPP	3rd Generation Partnership Project
MIMO	Multiple input multiple output
AWGN	Additive white Gaussian noise

Complex MIMO scenarios using only two generators

To maximize the benefit of the limited resource bandwidth, today's wireless communications standards implement multiantenna systems at the transmitter and receiver end. This multiantenna technology, referred to as MIMO, efficiently boosts data rates. Users need only two generators from Rohde&Schwarz to test complex MIMO systems.

Versatile use of MIMO systems

Multiple input, multiple output (MIMO) is used in mobile radio (3GPP release 7, EUTRA/LTE) but also in wireless local (IEEE 802.11n) and regional networks (IEEE 802.16, e.g. WiMAX™). The higher the statistical independence of channel characteristics, the better the data rate and transmission quality. For MIMO tests, therefore, simulating these channel characteristics is absolutely essential. Since there is one transmission from each transmitting to each receiving antenna, N^2 fading channels have to be provided in the simulator for an N × N MIMO system. Due to the geometric antenna arrangement, the channel characteristics are not independent of each other under real operating conditions. As a result, the individual channels must be intercorrelated to realistically simulate the entire transmission path.

MIMO mode	Required generators
2 × 2	One R&S®SMU200A high-end signal generator (or one R&S®AMU200A baseband generator)
1 × 3 1 × 4 2 × 3 2 × 4	Two R&S®SMU200A high-end signal generators (or two R&S®AMU200A baseband generators)
3 × 1 4 × 1 3 × 2 4 × 2	Two R&S®SMU200A high-end signal generators (or two R&S®AMU200A baseband generators with the R&S®AMU-Z7 option)

FIG 1 Required generators for the various MIMO modes.

Channel simulation with MIMO

For tests on MIMO systems up to 2 × 2, users only need one R&S®AMU200A baseband generator or one R&S®SMU200A high-end signal generator (with the K74 option) from Rohde&Schwarz. Four logical fading simulators that are correlated via the parameters in the channel matrix then have to be set within the generator. Settable correlation is essential since, with MIMO, the gain depends on the degree of correlation — the higher the independence of the transmission paths, the greater the multipath propagation benefit to be achieved by the receiver.

If the number of antennas is higher (e.g. with 2 × 4 MIMO), the number of required channel simulators also increases. Since one channel each has to be simulated from each transmitting to each receiving antenna, the actual figure is obtained by multiplying the number of antennas at the transmitter end by the number of antennas at the receiver end — i.e. eight logical fading simulators for 2 × 4 MIMO. For such scenarios, users only need two R&S®SMU200A (or R&S®AMU200A) generators, which are connected as shown in FIG 2. A 2 x 4 MIMO configuration is selected in both generators and two of the total of four output channels are assigned to one generator and two to the other. Each generator now calculates all the fading processes — the processes in the other generator are only used to determine the correlation. They will not be further evaluated. Here, a common reference clock is crucial to ensure that the generators remain in sync. Another key functionality is a common external trigger which always makes sure that a common starting point for calculating the profiles is defined.

Of course, all other MIMO modes such as 1 × 3, 1 × 4, 2 × 3, 3 × 1, 4 × 1, 3 × 2 as well as 4 × 2 can also be set up in a similar way. This means that the R&S®SMU200A or R&S®AMU200A generators can be used for all measurements on MIMO systems (FIG 1) under any scenario.

Convenient configuration

When specifying a MIMO channel, a variety of parameters is required in order to define the crosstalk that a specific channel causes on its adjacent channels. These parameters are combined in a matrix for each fader path. The R&S®AMU200A and R&S®SMU200A generators already offer the channel matrices defined in the measurement standards as their default setting. Moreover, the matrix can be entered individually. In this case, the generators can precalculate the matrix for a specific antenna correlation at the transmitter or receiver end.

Summary

By connecting the generators as shown and by using the corresponding software, users can create a convenient all-in-one solution. This solution integrates a total of eight fading simulators and four generators in only two instruments. As a result, this complex MIMO simulation environment requires only a minimum of space. Another advantage is the flexible internal architecture of the generators. They can be expanded via firmware updates to handle new tasks.

Wolfgang Kufer

2 × 4 MIMO

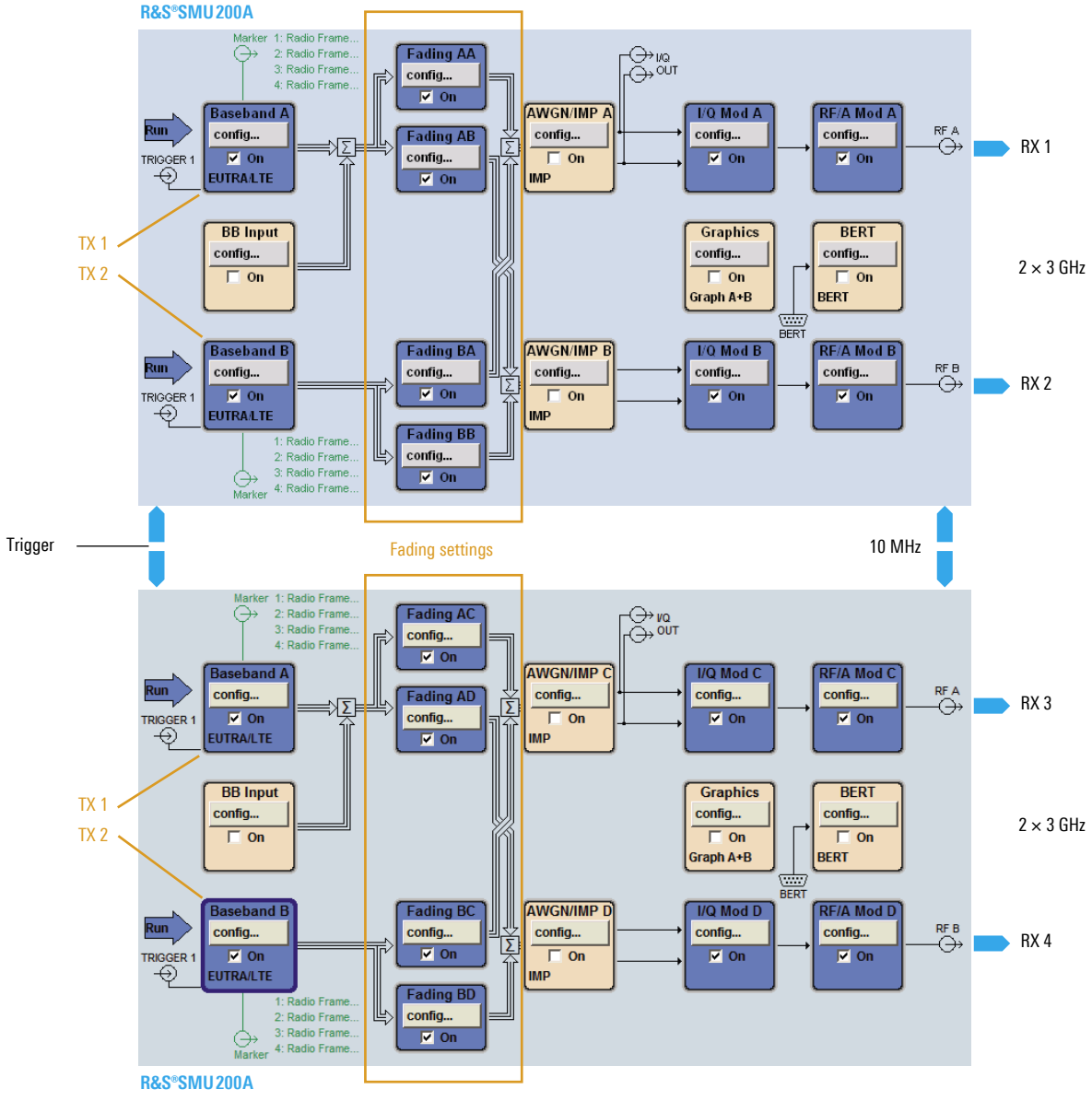


FIG 2 A 2 × 4 MIMO scenario can be set up using only two R&S®SMU200A (or R&S®AMU200A) generators.

Vector network analyzers – key components of antenna measurement systems

MI Technologies, a leading manufacturer of antenna measurement systems, offers more than 50 years of experience in every aspect of this complex test and measurement field. The company supplies a variety of products, including all important components ranging from highly accurate positioning systems up to sophisticated control and analysis software. MI Technologies also designs and implements turnkey test and measurement systems that use vector network analyzers from Rohde&Schwarz. Derek Skousen from MI Technologies explains what types of measurements are carried out and the basic principles of how antenna measurement systems are set up.

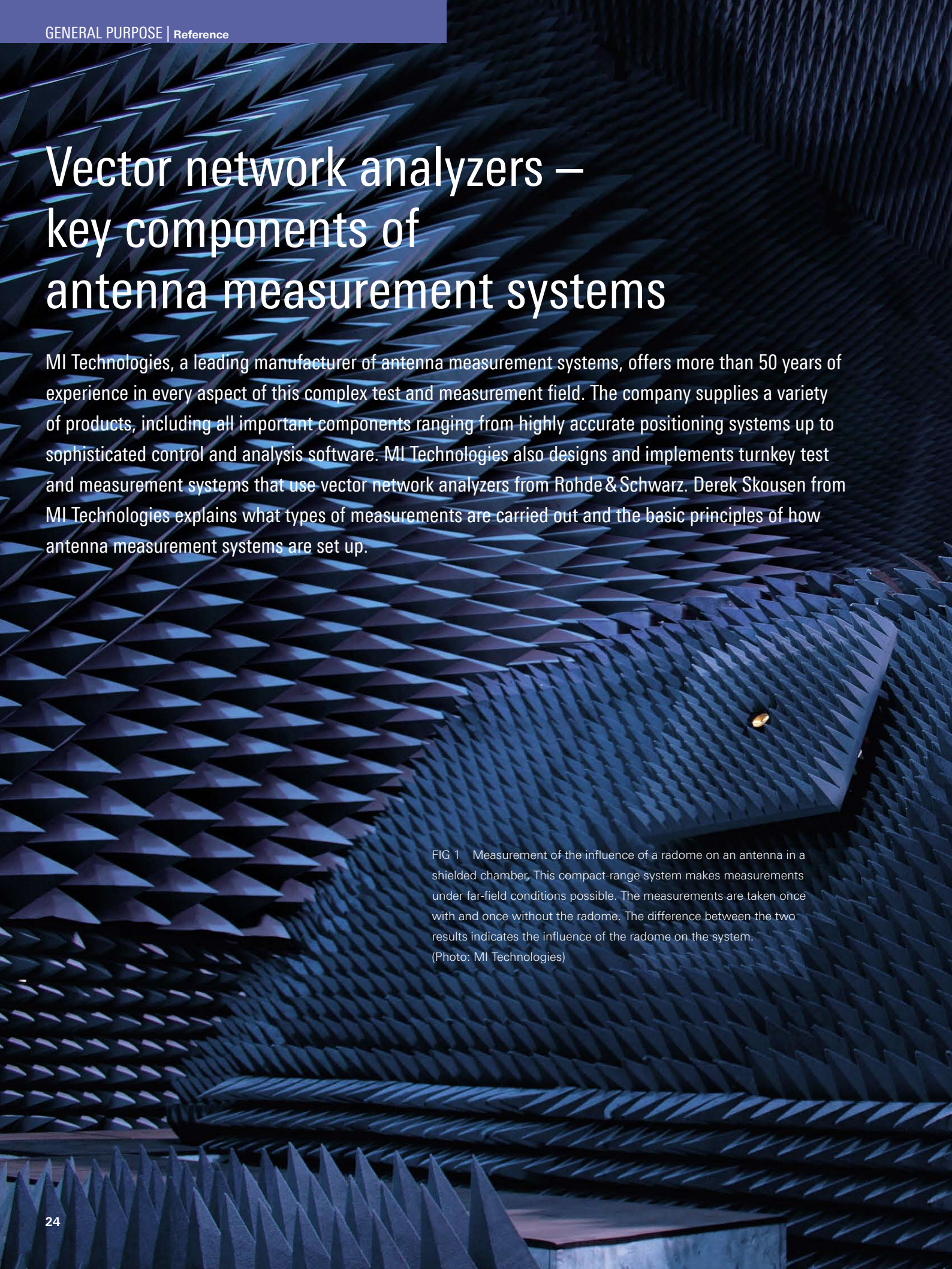
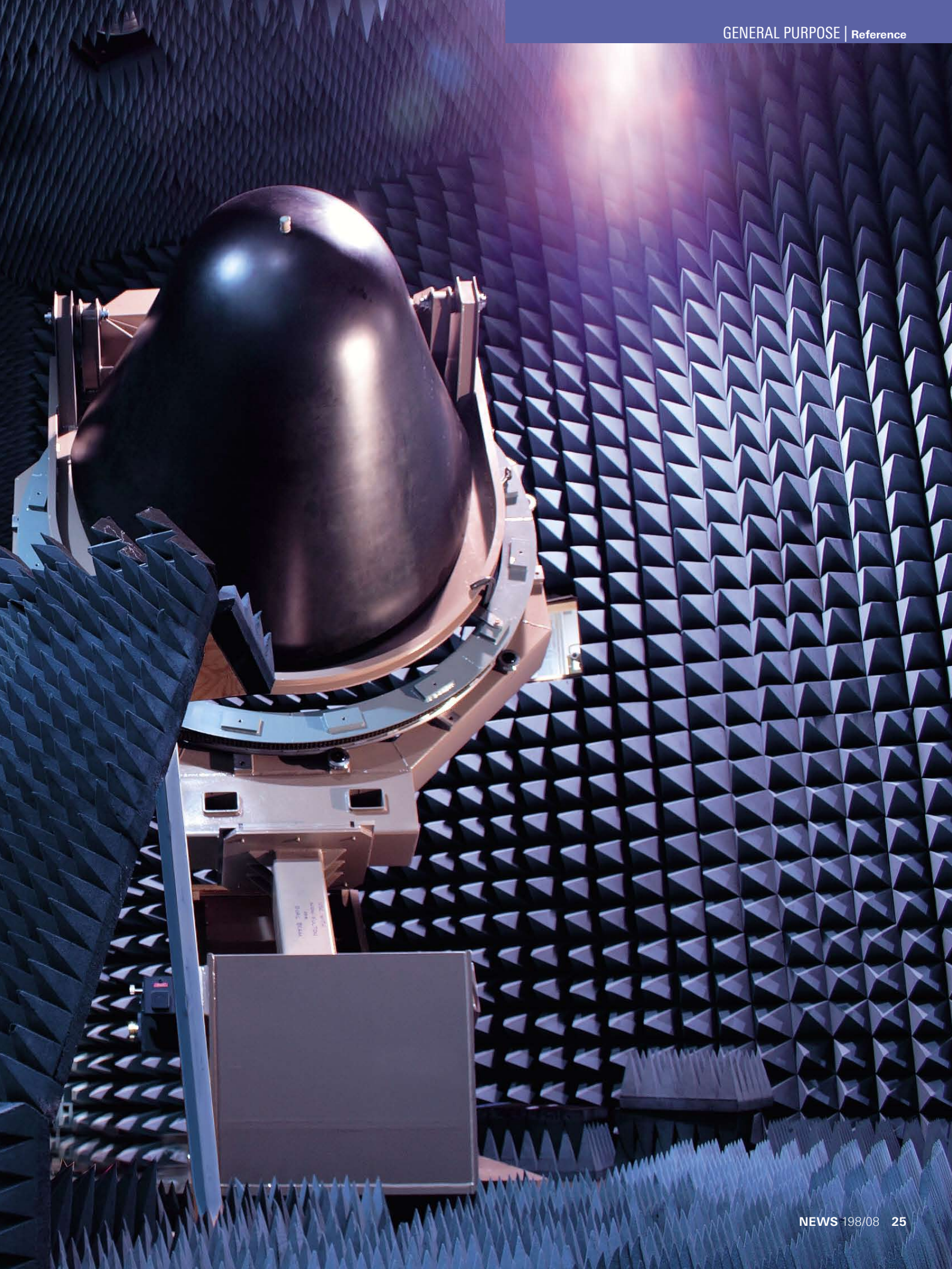


FIG 1 Measurement of the influence of a radome on an antenna in a shielded chamber. This compact-range system makes measurements under far-field conditions possible. The measurements are taken once with and once without the radome. The difference between the two results indicates the influence of the radome on the system. (Photo: MI Technologies)



Antenna measurement systems: as diverse as antennas themselves

The large variety of today's wireless applications is also matched by the demands placed on the transmitting and receiving antennas they require. Therefore, antennas are probably the most highly varied of components in wireless communications systems, with virtually no restrictions in size, shape and structure. Yet, all of these antennas serve basically the same purpose: As transmitting antennas, they must convert conducted electromagnetic waves to free-space waves, and as receiving antennas they must convert these free-space waves back to conducted waves. To determine if the antenna properties are optimally suited for the application at hand, they are precisely analyzed using antenna measurement systems. To accomplish this, several basic parameters must be determined:

The radiation pattern is a graphical representation of the radiated energy versus the radiation angle (FIG 2).
Directivity describes the distribution of the radiated antenna power. It is defined as the ratio of maximum radiation density of the antenna in the direction of the strongest radiation to the radiation density of an isotropic antenna.
The antenna gain is the product of the antenna's efficiency and directivity.
To avoid reflections, the antenna's input impedance must match the impedance of the line connected to it. This measurement can be performed as an s_{11} measurement using a vector network analyzer.
Additional measurements: In many cases, several of the above-mentioned measurements are combined. For example, radiation efficiency can be determined by calculating the ratio of antenna gain to directivity.

FIG 2 Antenna radiation pattern with high gain over an azimuth range of –180° to +180°.

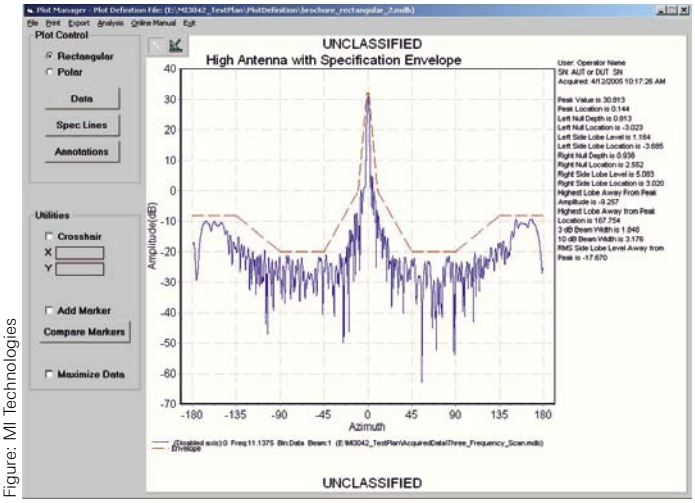


Figure: MI Technologies

Antenna measurements have a variety of applications beyond antenna characterization such as radar cross section (RCS) measurements for determining the reflection by a device under test as well as material measurements in the microwave frequency range.

Near-field and far-field measurements

When measuring antennas, the far-field characteristics of the antenna under test (AUT) are usually of primary interest. The basic parameters of an AUT are defined using the assumption that the wavefronts run parallel. The selection and configuration of an antenna measurement system therefore usually starts by choosing one of several methods for determining these parallel wavefront or far-field characteristics. A distinction is drawn between two different configurations for far-field measurements and one for the near-field.

Far-field measurements

If the distance between the transmitting and receiving antennas is large enough that parallel wavefronts arrive at the receiving antenna, the measurement is considered to be in the far field. This distance occurs when the following condition is met:

$2D^2/\lambda_0 \leq d$ where D = antenna diameter
λ_0 = free-space wavelength
d = distance

In many applications, particularly those with large antenna structures and small wavelengths, this condition is achieved only after a long distance is reached. This is why far-field measurement systems can sometimes extend over great distances.

Far-field measurements using compact range systems

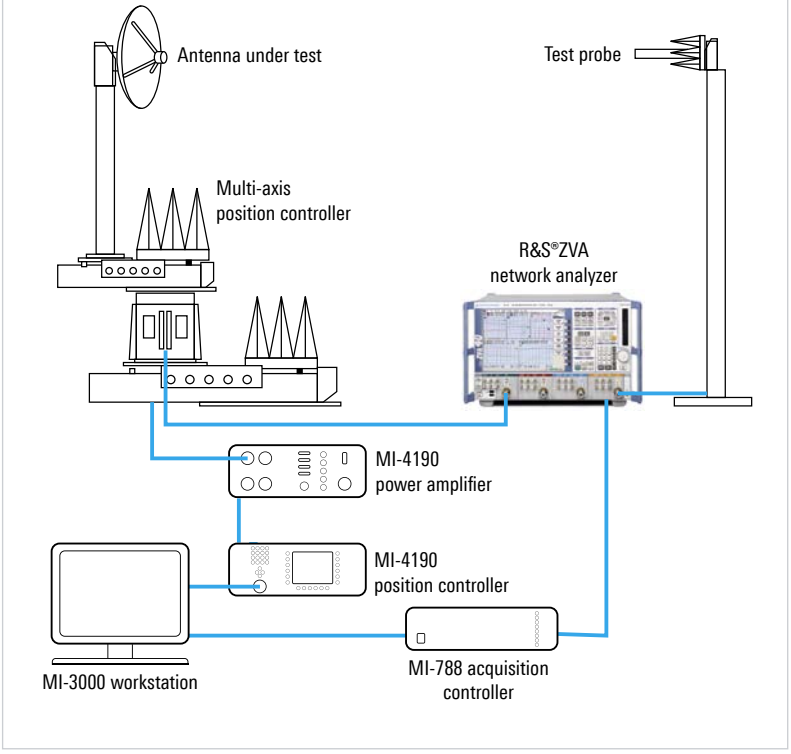
Systems for performing far-field measurements are also available in compact form. MI Technologies produces reflectors that are radiated by specially designed feeds. By using a reflector, the long signal path necessary in order to meet the far-field condition is folded in a small amount of space, thus allowing these systems to be housed indoors (FIG 1).

Near-field measurements

Near-field measurements are performed in close proximity to the AUT. To derive the far-field characteristics from the near-field characteristics, various algorithms for planary, cylindrical or spherical scanning geometries are used. Geometries are chosen based on the AUT characteristics.

FIG 3 Basic setup of an antenna measurement system for performing far-field or spherical near-field measurements.

Basic setup of an antenna measurement system



The basic components of antenna measurement systems

One engineering challenge encountered when designing an antenna measurement system is to properly select and integrate all electronic and mechanical components, the T&M equipment and the shielded chamber. Component selection largely depends on the type of AUT, and particularly on its dimensions, weight, frequency range and antenna gain. Any limitations of the measurement system must also be taken into consideration. FIG 3 shows an example of an antenna measurement system. The system consists of the following key components:

Shielded chamber with positioning system

A positioning system is used to define the positions at which the electromagnetic field must be measured in each case. The keys to obtaining conclusive measurement data are the accuracy of the position and the reproducibility of the measurements. Measurements are therefore performed in a shielded chamber lined with electromagnetic absorber material to suppress external interference signals and reduce internal reflections.

Position controller

The position controller is the interface between the mechanical positioning system (FIG 5) and the measurement system. It controls the various motion axes and provides information about the position and the required control signals.

Signal source

The signal source is the transmitting side of the antenna measurement system. Many systems use a continuous wave (CW) non-modulated signal, except for radar applications, which require pulsed signals. In many cases, additional mixers, multipliers and power amplifiers are used to produce signals with the desired frequency and power. Fast switching of the frequency is essential so as to cover as many frequencies as possible while the position of the AUT moves within a defined space.

Receiver

The receiving side of the system also uses external components such as mixers, amplifiers and multipliers to optimize the incoming signal level. Placing a mixer near the receiving antenna enables the low-loss transmission of power over long distances, for example. This is accomplished by mixing down to a lower frequency range. An antenna measurement receiving system must have a high dynamic range and short measurement cycles. This is the only way to determine the high peaks (positions with a high RX/TX ratio) and deep nulls (positions with a low RX/TX ratio) of the AUT at a variety of positions and frequencies.

Software

The heart of any state-of-the-art antenna measurement system is a complex software program that controls and coordinates all components in the test setup. An antenna measurement system scan can produce large volumes of data that

Vector network analyzers from Rohde&Schwarz offer optimum performance and functionality for use in antenna measurement systems.

The vector network analyzers of the R&S®ZVA family (FIG 4) are ideal for use in antenna measurement systems. They offer coupled generators and multichannel receivers, integrated mixer control, synchronized sweep functions and much more. They are available in the 0.01 GHz to 8 GHz, 24 GHz, 40 GHz and 50 GHz frequency ranges.

A key feature of the R&S®ZVA when used for antenna measurements, where large volumes of measurement data must be obtained, is its high measurement speed. Offering a speed of 3.5 µs per measurement point, the R&S®ZVA can perform measurements extremely fast. Therefore, it can quickly record the data at multiple frequencies for each position point.

The R&S®ZVA has a wide dynamic range of 110 dB at 10 kHz IF bandwidth, which permits the detection of even extremely weak signals. Its output power of +13 dBm and higher allows the instrument to easily handle high signal attenuation on the transmission path.

The analyzer's fast data transmission time of <0.7 ms helps ensure the rapid transfer of measurement data to the control software even as the measurement is taking place. The sweep function of the R&S®ZVA can collect measurement data in equidistant cycles without interruption by the operating system. This allows the instrument to optimally adapt to the movements of the positioning system.

FIG 4 The R&S®ZVA50 shown here is a member of the high-end series of vector network analyzers from Rohde&Schwarz. These analyzers, which are the fastest network analyzers worldwide, are available as two- and four-port versions and in various frequency ranges.

must be collected, processed, analyzed and – when required – combined. Additionally, switch control, triggering and data buffering may be needed to couple the asynchronous operating system software on the PC with the coordinated and chronologically synchronous measurement system.

Vector network analyzers – key components in antenna measurement systems

Because they contain one or more signal generators – as well as multiple receivers matched to each other – in a single instrument, vector network analyzers are a popular measurement tool in antenna measurement systems. They must exhibit outstanding characteristics in a variety of disciplines in order to accurately perform the complex measurements associated with antenna systems. The most important characteristics include:

Measurement speed Is the vector network analyzer fast enough to measure the data on the various frequencies without significantly compromising the measurement dynamic range?

Measurement dynamic range Can the vector network analyzer measure the strongest and weakest signals despite the overall loss in the system? In other words, is the range of the receivable signal level sufficient?

Output power Is the link budget being met, i.e. the sum of the gains and losses caused by all communications and measurement system components?

Data processing and control Can the vector network analyzer process the necessary trigger and control signals and provide the data in a reasonable period of time?

Depending on how complex the user's test and measurement requirements are, MI Technologies integrates spectrum and vector network analyzers from a variety of manufacturers into its antenna measurement systems. This also includes vector network analyzers from Rohde&Schwarz, because their outstanding performance is ideal for such complex test and measurement tasks (see box on opposite page).

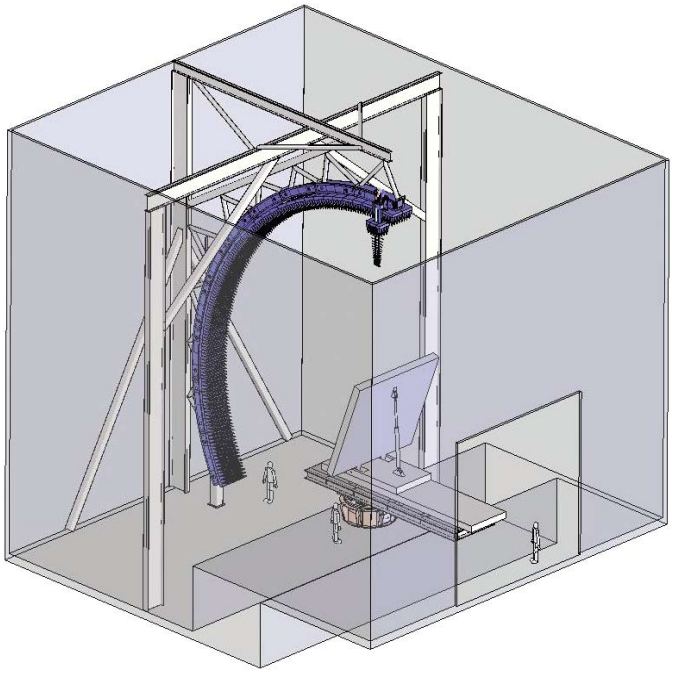


Figure: MI Technologies

FIG 5 Design of an arc-shaped positioning system for performing near-field measurements.

Summary

With more than 50 years of experience in all facets of antenna measurement systems, MI Technologies has the expertise to design and implement superior turnkey systems from highly accurate positioning systems to matching control and analysis software.

Rohde&Schwarz works hand-in-hand with leading manufacturers of antenna measurement systems. In addition to MI Technologies, this includes EADS, March Microwave, NSI and ORBIT/FR. The control of the R&S®ZVA vector network analyzers from Rohde&Schwarz is integrated into the software packages of these manufacturers. With outstanding features that make them the instruments of choice around the world, vector network analyzers from Rohde&Schwarz are ideally suited to meet these challenges.

Derek Skousen (MI Technologies);
Andreas Henkel (Rohde&Schwarz)

R&S®FSH4 / FSH8: next generation of handheld spectrum analyzers

FIG 1 Testing a wireless communications base station with the new R&S®FSH8 handheld spectrum analyzer.

The first generation of R&S®FSH handheld spectrum analyzers has become very popular among users. The analyzers are highly valued all-purpose instruments especially for the installation and maintenance of RF transmitter systems in the field. The new R&S®FSH4 and R&S®FSH8 analyzers offer the same first-rate performance as their predecessors. In addition, they have been enhanced and expanded in a variety of ways in response to customer requirements. The R&S®FSH4 / FSH8 analyzers thus prove even more valuable instruments when it comes to performing efficient measurements in mobile use.

New, yet familiar

Users will immediately be familiar with the new R&S®FSH4 and R&S®FSH8 handheld spectrum analyzers as they feature the characteristic design of the R&S®FSH family (FIG 1). They are ergonomic, easy to operate, designed to withstand the rigors of field use and, at just under 3 kg, they are among the lightest portable spectrum analyzers available. Prominent features that are visible at a glance include the 6.5" color display (now even larger and with higher resolution than in the previous generation), an SD memory card slot, USB/LAN interfaces, and a cover protecting the easy-to-replace battery. The new analyzers also have been enhanced with respect to their "inner qualities": better RF characteristics, an expanded range of functions and a built-in VSWR bridge to name just a few.

Superior RF characteristics provide dependable results

Offering very good RF characteristics, the R&S®FSH4 and R&S®FSH8 are among the best in their class. With a displayed average noise level (DANL) of –163 dBm (1 Hz) at 2 GHz, for example, and a switchable preamplifier implemented in all models, even extremely weak signals can be reliably measured. In test scenarios involving several strong signals, the analyzers' excellent large-signal immunity prevents the formation of intermodulation products. And, featuring a third-order intercept point of 15 dBm in the common mobile radio bands, the instruments compare with high-grade benchtop units. Level measurement uncertainty is low, i.e. max. 1 dB up to 3.6 GHz and max. 1.5 dB up to 8 GHz.

Display of results – straightforward, detailed, reliable

The display has a resolution of 640 × 480 pixels. The screen can be split, e.g. for the simultaneous display of two traces for the magnitude and phase in the vector network analysis mode (FIG 2). With a total of 631 test points, the analyzer detects signals reliably and provides a detailed representation of results. Poor lighting conditions are no problem for the R&S®FSH – it features adjustable color, brightness and contrast plus a monochrome mode to ensure optimal readability of the display under any circumstances.

Operating philosophy: versatility – yet focused on the essentials

New hardware and software control elements and an even more straightforward menu structure further simplify operation. For example, you can now directly access limit lines and important marker functions. The selected function can be activated immediately by pressing the Enter key in the rotary knob. The MODE key makes it easy to switch between operating modes, e.g. spectrum analyzer, vector network analyzer or power meter mode. Due to the instrument's vertical design, you can securely hold it in both hands and yet easily reach all control elements. Pressing the "camera" key will produce a screenshot of any desired content and store it as a graphics file for the purpose of documentation. New customers can quickly learn how to operate the R&S®FSH, and customers who already use a first-generation analyzer can easily find their way around in a familiar environment.

FIG 2 Simultaneous display of magnitude and phase in split-screen mode.

Built-in VSWR bridge and a wealth of additional functions

In addition to the base models, models with a tracking generator and a built-in VSWR bridge for vector network analysis are available. Adding a power sensor from Rohde&Schwarz turns the analyzer into a precision power meter. Equipped with these features, the R&S®FSH is a single-box solution offering complete functionality for installing and maintaining radio transmitter systems: transmit spectrum analysis, detection of interferers, transmit power measurement, measurement of antenna matching and testing of the amplifiers on the antenna. Plus, it can measure the quality of the cable to the antenna.

Battery supply and extensive storage capacity for standalone operation

The new R&S®FSH runs on a lithium-ion battery that offers high capacity at low weight. The battery operates for up to 4.5 hours. Thus, by changing the battery only once, you can operate your analyzer for a full workday. The battery can be conveniently changed on site.

The internal memory of the R&S®FSH4 and R&S®FSH8 models stores 256 results together with the associated instrument settings. Storage capacity can be expanded by means of an SD memory card. A 1 Gbyte card can hold at least 5000 data records; a PC is therefore needed only for subsequent result processing or archiving of data.

Up-to-date remote control

The analyzer is connected to a PC via the LAN or USB interface. Virtually all functions of the R&S®FSH can be remotely controlled, allowing the analyzer to be integrated into user-specific programs. The SCPI-compatible command set facilitates programming. For remote monitoring tasks, the R&S®FSH4 and the R&S®FSH8 can easily be integrated into a network via the LAN interface.

Main innovations at a glance

- Frequency range 9 kHz to 3.6 GHz or 8 GHz
- High sensitivity (<–141 dBm (1 Hz), with preamplifier <–163 dBm (1 Hz))
- Low measurement uncertainty (<1 dB)
- Internal tracking generator and VSWR bridge with built-in DC voltage supply (bias)
- Two-port network analyzer
- Easy-to-replace lithium-ion battery for up to 4.5 h of operation
- 6.5" color display with VGA resolution
- Optimized operating concept
- All connectors protected against contamination, dust and splash water (FIG 4)
- SD card for storage of results
- LAN and USB interfaces
- Built-in loudspeaker

The right base unit for every application

Six R&S®FSH models are available to meet individual requirements in terms of frequency range and functionality. The R&S®FSH4 and the R&S®FSH8 perform measurements up to 3.6 GHz and 8 GHz, respectively. Models with a built-in tracking generator can additionally determine the transmission characteristics of cables, filters, amplifiers, etc. Models with a built-in tracking generator plus an integrated VSWR bridge are the right choice for carrying out measurements on antenna systems, including distance-to-fault measurements on cables. All models contain a switchable preamplifier that provides enhanced sensitivity. FIG 3 lists the main functionalities provided in the various models.

Model		Frequency range	Preamplifier	Tracking generator	Built-in VSWR bridge
R&S®FSH4	model .04	9 kHz to 3.6 GHz	✓	–	–
	model .14	9 kHz to 3.6 GHz	✓	✓	–
	model .24	100 kHz to 3.6 GHz	✓	✓	✓
R&S®FSH8	model .08	9 kHz to 8 GHz	✓	–	–
	model .18	9 kHz to 8 GHz	✓	✓	–
	model .28	100 kHz to 8 GHz	✓	✓	✓

FIG 3 R&S®FSH4 / R&S®FSH8 models at a glance.

Ideal for installing and servicing transmitter systems

Providing reliable coverage is the main concern of operators of mobile radio, broadcasting and radiocommunications networks. Continuous checking of the transmitter systems is, therefore, essential. With their comprehensive range of functions, the R&S®FSH4 / FSH8 handheld spectrum analyzers are ideally suited for performing the required measurements, whether in the startup phase, during operation or after repairs of transmitter systems. The analyzers carry out all important measurements at high speed and with high accuracy, providing the following functions:

- Distance-to-fault (DTF) measurements on cables
- One-port cable loss measurements
- Two-port vector network analysis
- Assessment of signal quality
- Detection of interferers
- Precision power measurements using power sensors

FIG 4 Additional connectors, e.g. for LAN and USB, are protected by caps.

Efficient testing of antenna systems

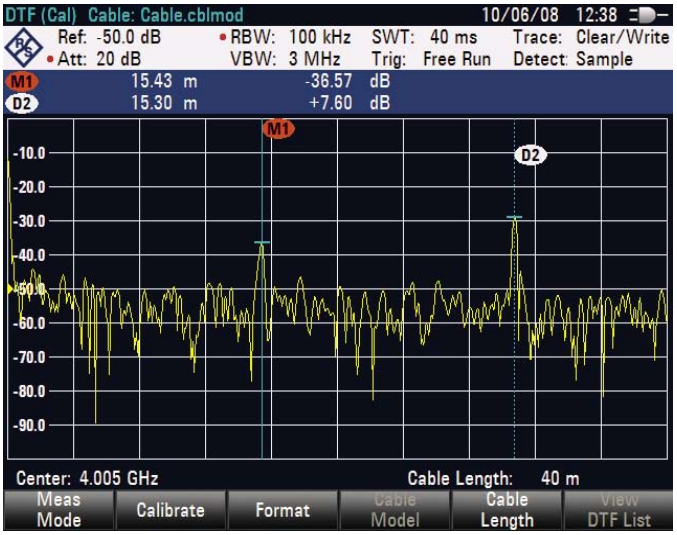
If a transmitter system does not operate properly or if transmitter power is too low, various causes are possible. The most frequent ones include antenna mismatch, defective amplifiers and high cable loss. The R&S®FSH determines the properties of RF cables quickly and precisely by means of a distance-to-fault measurement and a one-port cable loss measurement. Using the DTF measurement, the analyzer determines the distance up to a fault, which may be caused by a pinched cable or loose or corroded cable connections (FIG 5). A built-in threshold function ensures that only true cable faults, i.e. faults that exceed a tolerance limit, will be displayed. This greatly simplifies measurement evaluation.

By means of the one-port cable loss measurement, you can determine the loss of installed cables with a minimum of effort. It is sufficient to connect one end of the cable to the R&S®FSH test port. The other end is either short-circuited or left open.

If all cables are found to be in order, antenna mismatch or defective power amplifiers may be the cause of a malfunction. In a subsequent step, the transmit filter can be tested. A faulty filter may cause the base station to operate outside the required band.

To check the antenna matching and the power amplifiers, the analyzer models with a tracking generator and a VSWR bridge can be converted to a vector network analyzer simply by installing the relevant software option. Antenna matching and the transmission characteristics of filters and amplifiers can thus easily be determined in the forward and reverse direction. The system error correction involved in the vector network measurement provides a maximum of accuracy. A built-in DC bias powers active DUTs such as amplifiers via the RF cable. This feature proves especially useful in the case of mast-mounted amplifiers on a wireless communications base station.

FIG 5 Distance-to-fault (DTF) measurement on a cable.



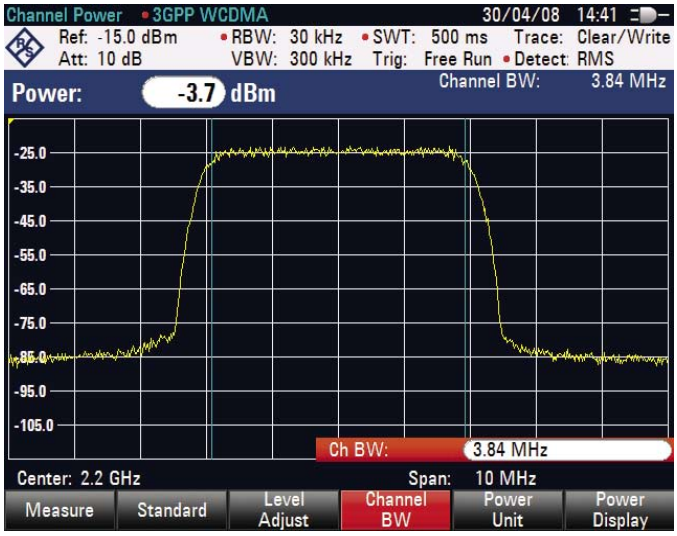


FIG 6 Channel power measurement on a 3GPP WCDMA signal.

Checking the signal quality

The R&S®FSH offers all test routines required for assessing signal quality. Using the TDMA power measurement function, for example, the analyzer determines the power of a GSM burst within a timeslot in a time-domain measurement. It can thus be verified whether the power mask of a base station complies with specifications and with stipulated minimum and maximum values.

The power of a user-definable transmission channel can be determined by means of the channel power measurement function. The R&S®FSH performs a channel power measurement for the 3GPP WCDMA, cdmaOne and CDMA2000® digital mobile radio standards at the press of a key (FIG 6).

Precision power meter

Measuring the transmitter output power is essential after the installation, re-installation or repair of a transmitter system, or if the transmitter output stages appear not to be operating at full power. For transmitter systems with an integrated power coupler, the power is coupled out and measured with one of the terminating power sensors available as accessories. For transmitter systems without a power coupler, directional power sensors are available. These power sensors enable the simultaneous measurement of the output power and the antenna matching during operation.

Detection of interferers

Even if the transmitter and the antenna are operating properly, nearby interfering signals may still have a detrimental effect on the system. Due to their high sensitivity of up to –163 dBm (1 Hz) and low phase noise (–95 dBc (1 Hz) at 10 kHz carrier offset), the R&S®FSH4 and the R&S®FSH8 easily detect interferers close to the carrier.

Measuring electromagnetic fields

The R&S®FSH also reliably detects electromagnetic fields. With its wide frequency range of up to 8 GHz, it covers all common wireless communications services, including mobile radio (GSM, CDMA, UMTS, DECT and the upcoming LTE standard), Bluetooth®, WLAN (IEEE 802.11a, b, g, n), WiMAX™, and sound and TV broadcasting. The maximum field strength is determined by means of directional antennas. The analyzer takes into account the antenna factors of the connected antenna and displays the field strength directly in dBµV/m. The non-directional resultant field strength is measured by means of the R&S®TS-EMF isotropic antenna. The R&S®FSH offers two user-definable limit lines with automatic limit monitoring for simple result analysis.

Useful also in the lab

With its stand folded out, the R&S®FSH turns into a benchtop analyzer for use in the lab. It can be used for a variety of tasks including frequency and level measurements, precision power measurements up to 18 GHz, vector network analysis to determine the characteristics of amplifiers and filters, and for running remote-controlled, automatic test sequences via LAN or USB. In conjunction with the R&S®HZ-15 near-field probes, the analyzer becomes a cost-effective diagnostics tool for locating EMC trouble spots on printed boards, integrated circuits, cables and shieldings.

Convenient documentation and archiving

The documentation and archiving of results are major aspects when performing installation and maintenance tasks. To facilitate these tasks, the R&S®FSH is supplied with the powerful R&S®FSH4View Windows® software for data processing on a PC (FIG 7). The software also helps you manage instrument settings, allowing you, for instance, to configure instrument pools in a minimum of time.

Key functions of the R&S®FSH4View software:

- Further processing of results by means of data export in ASCII or Excel® format
- Storage of graphics data in standard formats
- Comparison of results
- Automatic result storage at selectable intervals
- Remote signal monitoring via LAN by means of permanent and continuous transfer of sweeps
- Result analysis by showing / hiding and shifting markers as well as subsequent display of limit lines
- Editor for generating limit lines, antenna factors, channel lists and cable data for distance-to-fault measurements
- Transfer of instrument settings

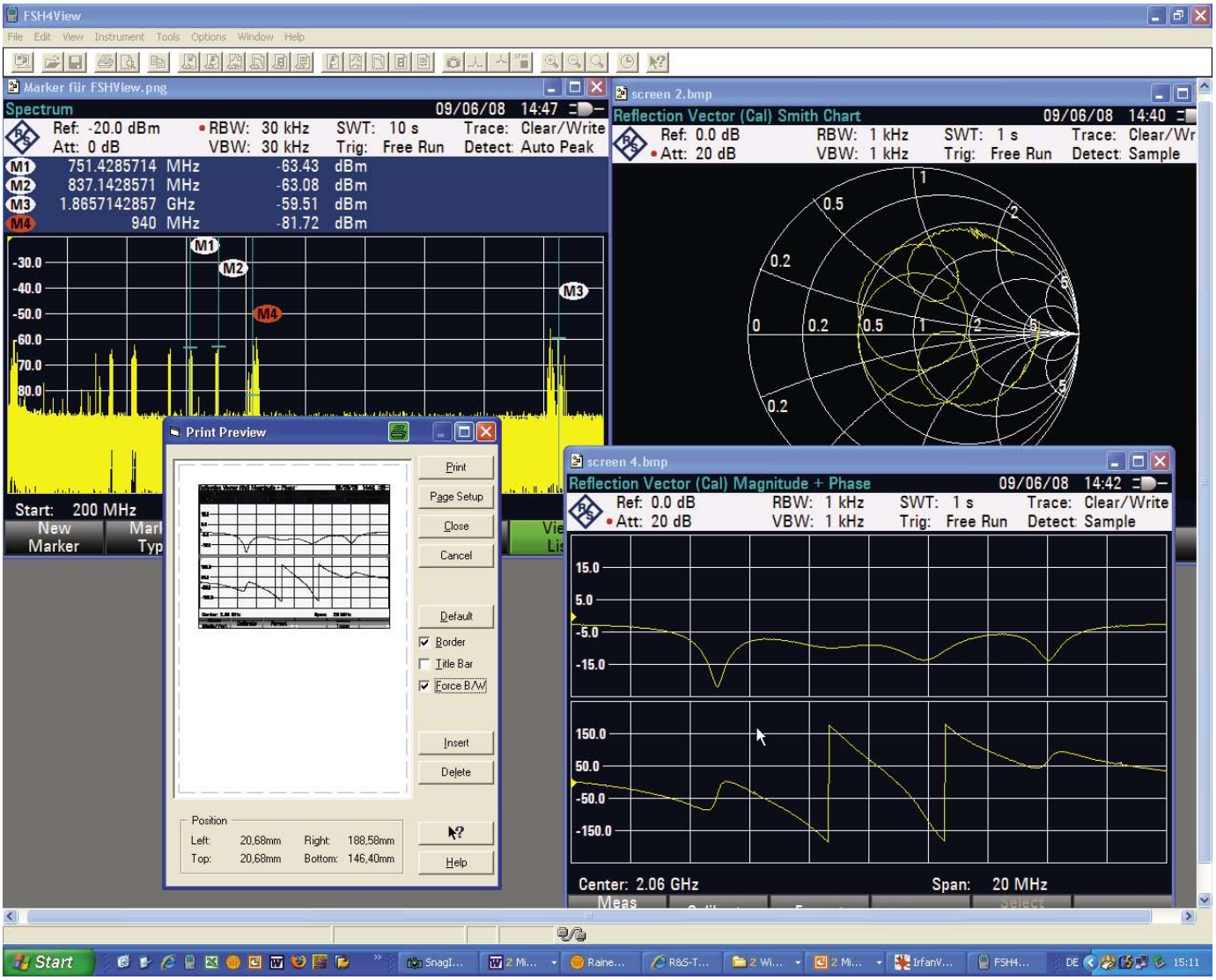
Summary

Mobility, ease of operation, superior measurement characteristics, versatility – these are the outstanding features that make working with the new R&S®FSH handheld spectrum analyzers very easy. With a weight as low as 3 kg, including the battery, and compact in size, the analyzers are ideal for mobile use. Yet, they run for up to 4.5 h on a single battery charge. To extend the operating time, the battery can easily be replaced on site. Featuring splash- and dust-proof connectors and IP51 protection, the analyzers are designed to operate reliably even under rough environmental conditions.

All these features and performance characteristics open up virtually unlimited applications for the new R&S®FSH4 and R&S®FHS8 handheld spectrum analyzers.

Rainer Wagner

FIG 7 Evaluation of results on a PC by means of the R&S®FSH4View software.



R&S®SMBV100A vector signal generator – allrounder and specialist at the same time

The attractively priced R&S®SMBV100A offers performance that was previously available only in considerably more expensive instruments. It provides an output level of typ. +24 dBm up to 6 GHz and a maximum RF bandwidth of 528 MHz. Digital standards such as WiMAX™, 3GPP FDD, HSPA and LTE can be configured directly on the instrument via its intuitive user interface. An integrated modulation generator produces baseband signals internally, eliminating the need for a PC.

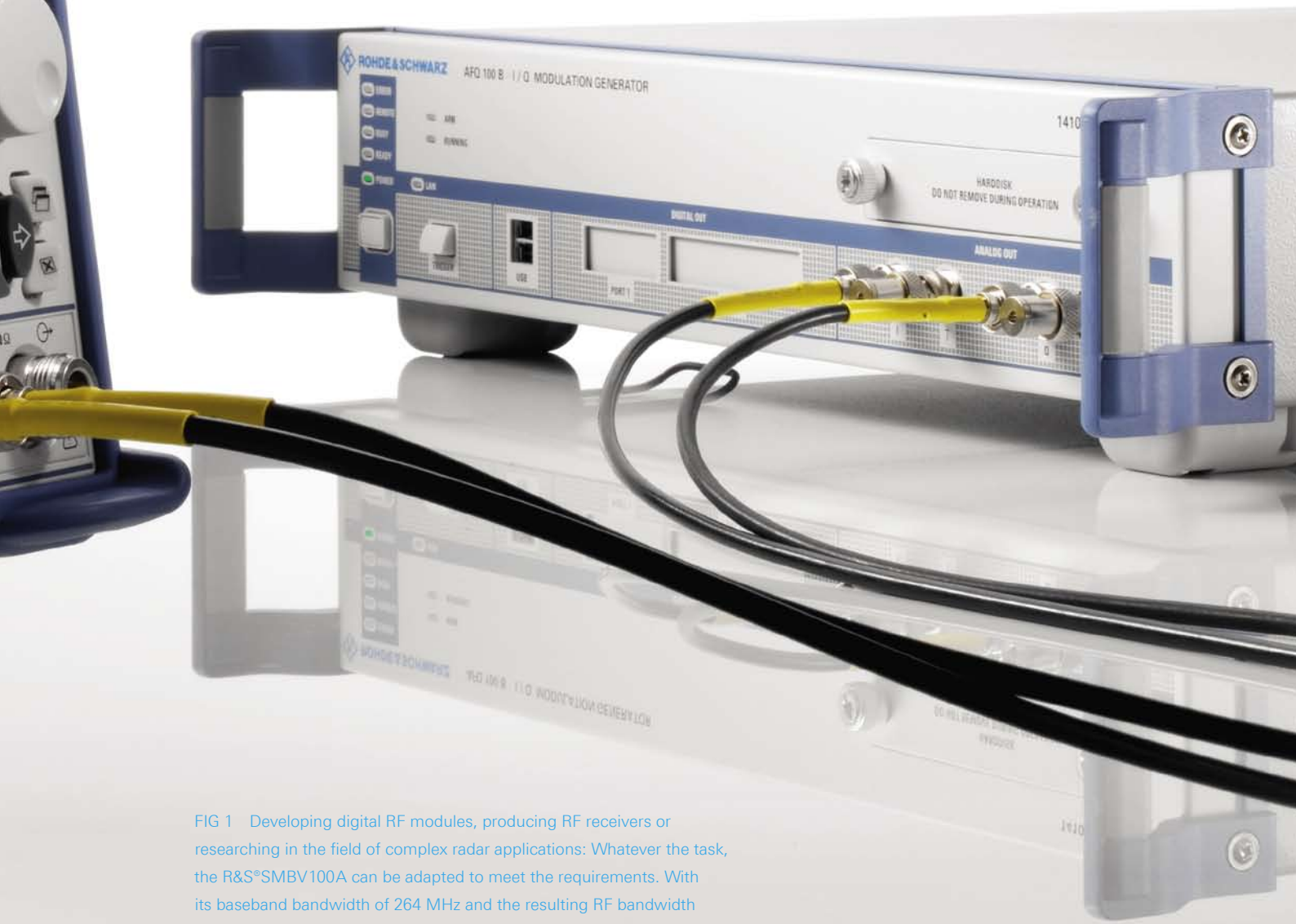


FIG 1 Developing digital RF modules, producing RF receivers or researching in the field of complex radar applications: Whatever the task, the R&S®SMBV100A can be adapted to meet the requirements. With its baseband bandwidth of 264 MHz and the resulting RF bandwidth of 528 MHz, it is suitable not only as an RF converter for UWB signals but also for complex pulsed signals as can be generated using the new R&S®AFQ100B generator (right) and the R&S®AFQ-K6 pulse sequencer software.

Signals for today and tomorrow

Testing as many different digital communications standards as possible by means of a single instrument – this is the requirement modern test equipment must fulfill, in a world where digital standards are diversifying more and more. In addition to established digital standards such as WCDMA and GSM, new ones such as LTE, WiMAX™ and WLAN IEEE 802.11n have been created, resulting in new and more stringent requirements regarding transmission rate and bandwidth. For example, LTE defines data rates of 100 Mbit/s, and IEEE 802.11n specifies bandwidths of up to 40 MHz. Likewise running in high gear is the development of mobile phones, these modern jack-of-all-trades that can also handle sound and TV broadcasting standards such as FM and DVB-T/-H and provide mobile navigation via GPS.

The R&S®SMBV100A vector signal generator (FIG 1) has been designed for this dynamic background: As a platform that is also ready for future applications, it combines the powerful RF technology of the R&S®SMB100A* generator with the innovative operating concept (FIG 2) and the flexible baseband generation of the R&S®SMx generator family. In its standard configuration, it is a purely analog vector signal generator that converts analog I/Q signals from a baseband source to the RF with an RF bandwidth up to 528 MHz. Depending on the options installed, it generates frequencies up to 3.2 GHz or 6 GHz and provides signals of high power (24 dBm), excellent spectral characteristics and very low error vector magnitude.

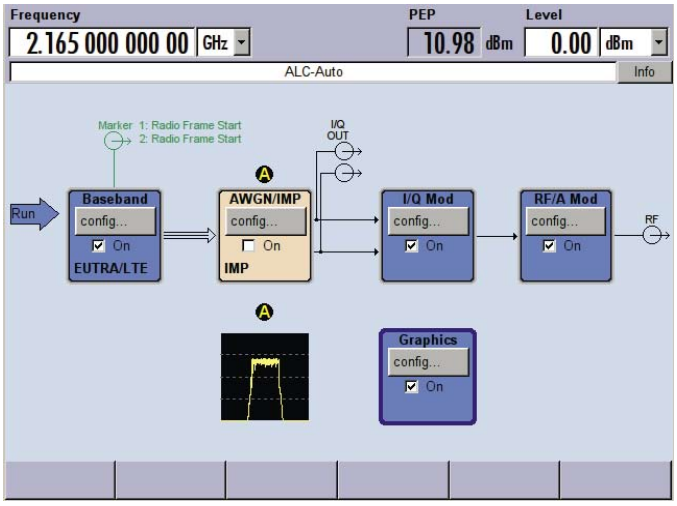


FIG 2 The user interface shows the signal flow through the relevant signal processing blocks, starting from generation of the baseband signal up to the RF. Clicking the blocks will open configuration menus for the individual functional units. The display responds to changes in the signal flow and indicates the most important settings and status messages at a glance. The graphic display provides, for example, the I/Q representation and the power spectrum as display modes for checking the signal currently output.

* R&S®SMB100A Signal Generator: Whether broadcast, ærospace and defense, or EMC: analog signals for every application. News from Rohde&Schwarz (2007) No. 194, pp 18–23.

Maximum output level

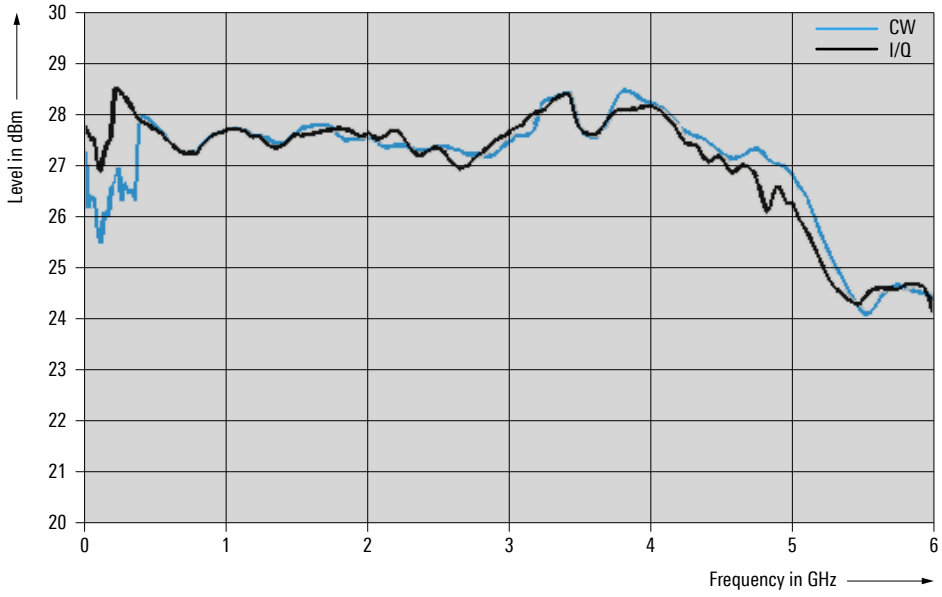


FIG 3 Measured maximum output level in the CW and I/Q modulation modes.

The R&S®SMBV100A is the only signal generator in its class that can be equipped either with an arbitrary waveform generator (ARB generator) or a realtime baseband coder. The ARB generator is scalable in terms of bandwidth (60 MHz or 120 MHz) and memory depth, allowing the R&S®SMBV100A to be optimally adapted to the task at hand.

Due to its compact size (3 HU, ¾ 19"), it is moreover the first vector signal generator that can deliver cutting-edge modulation signals in minimum time as a powerful standalone unit and still fits into tight spaces.

Highest RF output level in its class

The R&S®SMBV100A offers an RF frequency range of 9 kHz to 6 GHz as well as analog modulation modes including AM, FM, φM and fast pulse modulation. It also features excellent spectral characteristics and a powerful output stage, enabling high output levels of typically +24 dBm to be achieved over the entire frequency range up to 6 GHz (FIG 3).

Low adjacent channel power

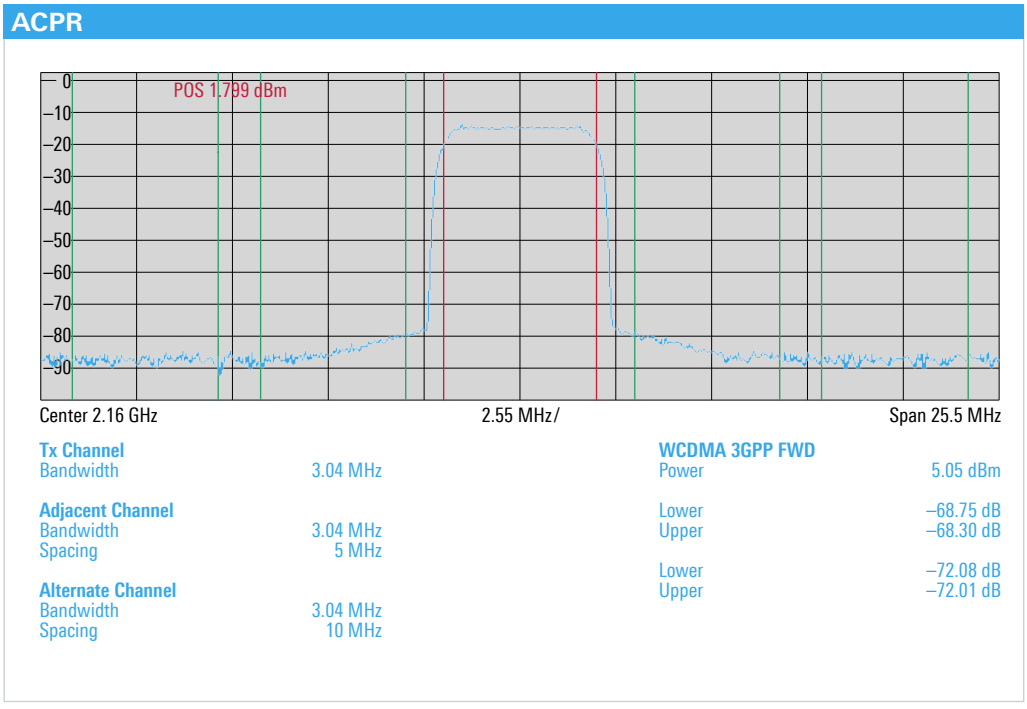
The adjacent channel power ratio (ACPR) is a measure of the linearity and the wideband noise of a signal generator with I/Q modulation. Featuring an excellent ACPR of typically –68 dBc for a 3GPP signal (test model 1-64) at 2 GHz (FIG 4), the R&S®SMBV100A not only has ample margin for testing receivers but is also suited for testing power amplifiers.

Due to the RF module's high level margin, the RF chain operates at very low distortion, and high adjacent channel power suppression is achieved for the first adjacent channel up to high output levels. Based on an internal level algorithm, the generator thus attains an ACPR value of typically –68 dBc for a 3GPP signal (test model 1-64) with a crest factor of 10.55 dB over a very wide level range up to +5 dBm channel power (FIG 5).

RF bandwidths up to 528 MHz

The input circuit of the R&S®SMBV100A is optimized for high bandwidths, making the instrument extremely future-ready. With its baseband bandwidth of 264 MHz and the resulting RF bandwidth of 528 MHz, it is suitable not only as an RF converter for UWB signals but also for complex pulsed signals, such as can be generated with the new R&S®AFQ100B UWB signal and I/Q modulation generator (page 50) using the R&S®AFQ-K6 pulse sequencer software. This is made possible by the newly developed vector board, which has as its core an ASIC with a wideband, highly linear and low-noise I/Q modulator.

FIG 4 ACPR of an R&S®SMBV100A vector signal generator at 2.16 GHz.



Low error vector magnitude

The error vector magnitude (EVM) of a signal generator results from the static vector error of the I/Q modulator (quadrature offset, I/Q imbalance and carrier leakage), the modulation frequency response and the phase noise of the modulated signal. The static vector errors are internally compensated in the R&S®SMBV100A. Together with the low modulation frequency response and phase noise of the RF module, the generator thus achieves excellent EVM values. For 3GPP test signals, the EVM is typically 0.4 % at 2.1 GHz; for GSM EDGE, it is typically 0.2 % at 910 MHz.

Scalable baseband signal generation

For applications in which precalculated signals have to be generated, e.g. for production tests, an ARB generator module (FIG 6) with outstanding characteristics is available. FIG 7 shows possible applications in which the functional diversity of the R&S®SMBV100A with a built-in ARB board becomes clear.

ACPR for 3GPP test model 1-64

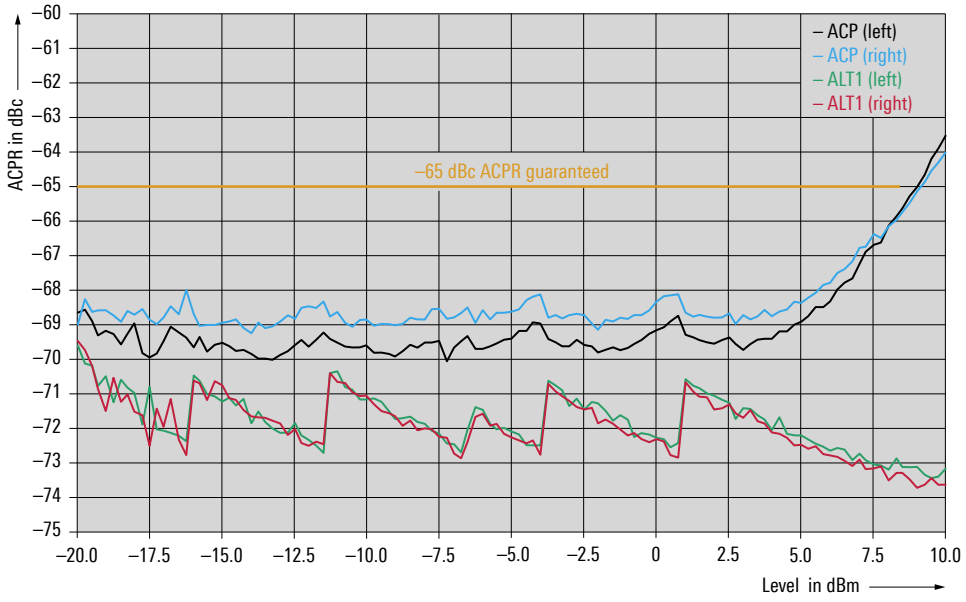


FIG 5 Measured ACPR for the 3GPP test model 1-64 at 2 GHz as a function of the output level.

Signal flow on ARB board

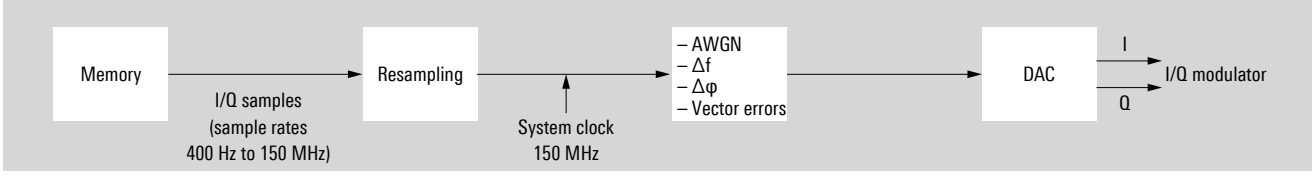


FIG 6 The I/Q data is first written from a file to the memory. The minimum required sample rate for a specific signal bandwidth can be used, i. e. the sample rate need not be synchronized to the system clock, which helps ensure efficient memory utilization. With the set sample rate, the samples are passed on from the memory to the resampler, which upconverts the sample rate to the system clock of 150 MHz. The subsequent block inserts, if desired, vector errors into the signal or superimposes noise on it. The signal is then converted from digital to analog and finally fed to the I/Q modulator, which modulates it to the desired carrier frequency.

Typical application	Feature	Description
Playback of waveforms of common digital standards such as LTE, WiMAX™ or WLAN	60 MHz RF bandwidth	ARB baseband generator (R&S®SMBV-B50 option)
Playback of waveforms of high bandwidth, to be expected with future standards such as LTE Advanced	120 MHz RF bandwidth	ARB baseband generator (R&S®SMBV-B51 option)
Playback of short waveforms, e. g. for ACP amplifier tests	32 Msample memory depth	Standard with the above ARB baseband generators
Playback of long waveforms, e. g. for broadcast standards	256 Msample memory depth	Memory extension (R&S®SMBV-B55 option)
High-speed tests using different signals	Multisegment waveform mode	Generation of different waveforms; switchover between these waveforms within a few milliseconds
Testing receivers in the presence of interference from signals on adjacent channels	Multicarrier mode	Different modulated ARB signals can be arbitrarily positioned in the spectrum within the RF bandwidth of the ARB generator
Chip tests on digital interfaces	Digital baseband output	Output of different digital protocols via the R&S®EX-IQ-Box option
Upconversion of a digital baseband signal to the RF	Digital baseband input	For example, RF modulator for the R&S®AMU200A baseband generator
Testing receiver performance with a faulty transmitter or channel	Defined signal impairment	Variation of gain, offset and quadrature as well as skew and delay
Testing receiver performance with noisy signal	AWGN	Addition of noise to the signal or pure noise (R&S®SMBV-K62 option)
Alignment of RF phase	Phase offset	Used for measurements requiring phase coherence in sync mode

FIG 7 The R&S®SMBV100A vector signal generator offers a variety of applications with the optional ARB board.

Short setting times – ideal for production

For tests in production applications, low purchase costs and, above all, the setting speed are primary considerations. A generator must therefore be able to rapidly deliver a wide variety of different test signals one after the other. The ARB generator in the R&S®SMBV100A can output precalculated signals seamlessly one after the other in multisegment waveform mode. In addition, the list mode allows level and frequency hops in less than one millisecond. In this mode, first a list containing up to two thousand level and frequency points is created, and then in a learning phase the module settings required for these list elements are calculated and saved. The elements of the list can then be called sequentially.

Multistandard realtime baseband coder

When equipped with the realtime baseband coder, the R&S®SMBV100A delivers its maximum performance, particularly in research and development. In addition to all the functions offered by the ARB board, signals of all established and future-oriented wireless communications standards can be generated and configured on the instrument. This is conveniently done in the straightforward menus on the familiar, tried-and-tested graphical user interface known from the R&S®SMx family. Precalculating signals on an external PC and transferring them to the instrument is therefore not necessary.

The range of digital standards leaves no wishes open:

- Latest 4G standards such as LTE (long term evolution) and WiMAX™
- Proven standards such as 3GPP with the HSUPA and HSPA+ enhancements, CDMA2000® and, of course, GSM
- Virtually all important sound broadcasting standards such as FM stereo (with RDS), DAB, Sirius and XM (satellite radio) will be available in the near future
- Custom digital modulation with all common modulation modes, codings and flexible settings

The advantage of generating signals in realtime (FIG 8) is that you can quickly modify parameters and immediately check the results. In addition, signals are not cyclically repeated; instead, they can potentially be infinitely long. Future standards (for realtime operation) will be added to the R&S®SMBV100A.

Frequency offset

Each of the signals set in the baseband block can be assigned a frequency offset and also be phase-adjusted. This makes it very easy to create a single-sideband signal from any signal – with the R&S®SMBV100A featuring a sideband suppression of 40 dB at a frequency offset of 60 MHz.

Ready for MIMO

Advanced mobile radio standards such as LTE offer modes with the transmitter sending different signals on multiple antennas and the receiver receiving them on multiple antennas. This technology, which is referred to as multiple input multiple output (MIMO) and is often used in conjunction with beamforming, places high requirements on the particular simulation environment: To generate the signals, you normally need a signal generator for each antenna. The generators must be phased-locked both at the RF and in the baseband, as if a single transmitter were generating the signals. When switched to sync mode, the R&S®SMBV100A provides high-precision phase-locking in the baseband and at the RF for multiple series-connected instruments (FIG 9). The basebands of phase-locked instruments are automatically synchronized, wich keeps the delay between the signals to below one nanosecond. The RF output signals are phase-locked by feeding a common LO signal to all I/Q modulators. Phase differences between the RF output signals are compensated by introducing a phase offset in the baseband signal. The overall configuration requires no extra equipment but merely two additional cables.

Impairments and AWGN

The generated signal can be influenced in the digital domain in various ways by means of the R&S®SMBV100A, either to simulate transmitter errors or to compensate for unwanted effects of the receiver. Besides the familiar gain, offset and quadrature parameters known from the R&S®SMx family, the signal can also be influenced using the skew and delay parameters. It is thus possible to shift I relative to Q in time (skew) or to shift both channels together back or forward in time (delay). Digital signal processing allows fine tuning down to one picosecond. In sync mode, the baseband of one signal generator can thus be time-adjusted with utmost precision relative to that of another signal generator (FIG 9).

To test how receivers behave if channels are noisy, the R&S®SMBV100A allows users to generate Gaussian white noise (GWN). This can be either added to the useful signal as additive GWN (AWGN) or generated as noise without a useful signal. Both the noise bandwidth and the desired signal-to-noise ratio are adjustable.

Continued on page 43 after the “75 Years of Rohde&Schwarz“ extra section.

Signal flow on realtime board

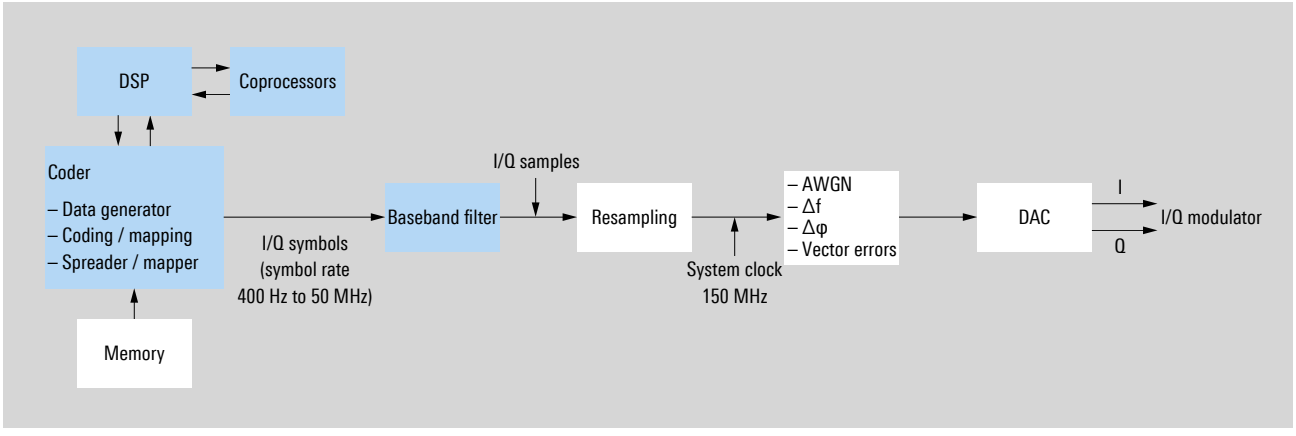
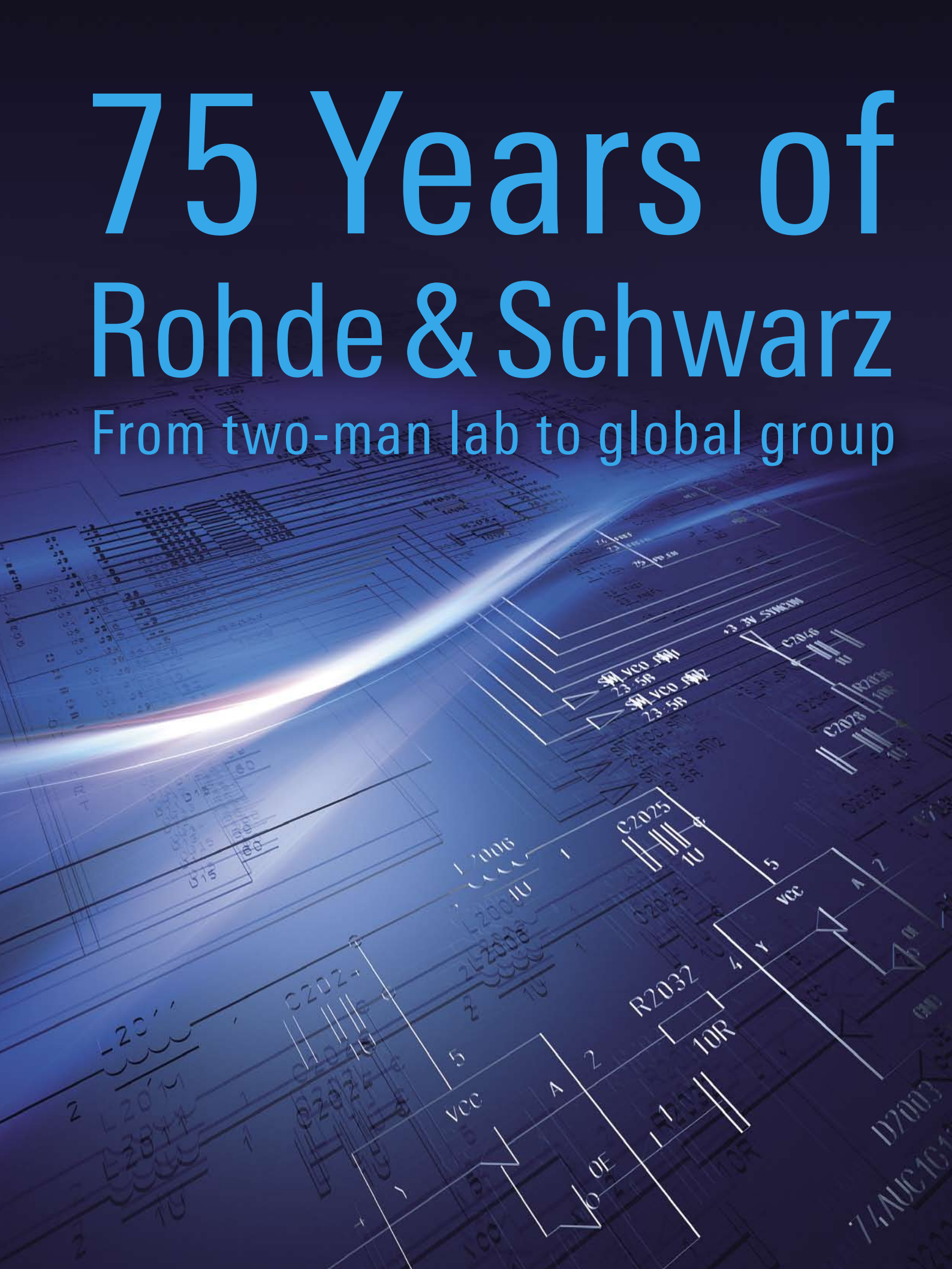


FIG 8 The data to be transmitted (e. g. for WCDMA channels) is initially in the memory in the form of a data list or is generated directly in the coder. It is then spread and channel-coded in the coder, if necessary, and mapped onto symbols. During these processes, special operations such as framing are executed on a DSP that in turn can use fast coprocessor functions. The I/Q symbols thus generated undergo pulse shaping and oversampling in the filter. The resulting samples are then put through the process already described for the ARB board (FIG 6).

75 Years of Rohde & Schwarz

From two-man lab to global group



75 years of Rohde & Schwarz: from a two-man lab to a global group

Big stories often have small beginnings – an original idea, a first step, an early success. The beginnings of Munich-based electronics group Rohde & Schwarz are to be found at the university in Jena, Germany, in the late 1920s. Two young physics students became acquainted and soon discovered a shared fascination with radiofrequency technology. Before long, they created a company, the *Physikalisch-Technisches Entwicklungslabor Dr. L. Rohde und Dr. H. Schwarz*, in a Munich apartment with just 120 square meters of floor space. During the 75 years since, the company has fostered many of the technological developments that shape and make possible our modern world of communications. This includes designing and producing measuring instruments in parallel with the latest advancements in electronics. Many milestones in the company's history are also chapters in the history of technology, including the first portable crystal clock (1938), Europe's first VHF FM transmitter (1949), the first vector network analyzer (1950), the first automatic direction finder (1955), the robust and highly accurate EK07 shortwave radio receiver (1957), the first GSM system simulator (1991) and the first professional-level, tap-proof encryption device for mobile phones (2001).

Underlying all of these successes are 75 years of research and development, 75 years of entrepreneurship, 75 years of close customer contacts and 75 years of unparalleled commitment on the part of all Rohde & Schwarz employees. From its modest beginnings as a small team made up of the two founders and two employees, the family-owned company has grown to have subsidiaries and offices in more than 70 countries, with a workforce of about 7500 employees who generate sales of EUR 1.4 billion (July 2007 through June 2008 fiscal year).
This anniversary provides the company with a welcome opportunity to cast a glance back at the past, while embracing the future. The following pages invite you to take a short trip back in time with brief histories of the development of the company's individual divisions. In addition, an interview with the three members of the Executive Board reveals how the company plans to master future challenges.

Dr. Hermann Schwarz (left) and Dr. Lothar Rohde in the 1930s.

Rohde&Schwarz today: the newest building at the company's Munich headquarters, the Technology Center. A total of € 35 million was invested in the 16,000 square meter facility in 2005, as a sign of growth and innovation.

T&M milestones

Higher, faster, more precise – the test and measurement industry is almost like the Olympics, and not just since yesterday. Numerous new technologies and increasingly higher frequencies are challenging T&M. For 75 years now, Rohde&Schwarz has successfully combined proven expertise with innovative strength, and the company's T&M solutions for wireless communications, general electronics and microwave are often ahead of their time.

The present – 2008: Munich-based Rohde&Schwarz is a leading global supplier of T&M equipment for wireless communications and electromagnetic compatibility (EMC). Every second mobile phone in use today was produced or developed using T&M equipment from Rohde&Schwarz. Electronics manufacturers around the world rely on the company's cutting-edge products, for spectrum and network analysis, signal generation and power measurement. But how did all of this start?
Let's look back to the year 1932. Even before founding the company, Dr. Lothar Rohde and Dr. Hermann Schwarz had already developed their first T&M solution, a dissipation factor meter. In autumn 1933, the company began operations under the name *Physikalisch-Technisches Entwicklungslabor Dr. L. Rohde und Dr. H. Schwarz* – known as Rohde&Schwarz since the 1940s. The company's first bestseller was the WIP interference wavemeter, developed in 1933 and sold throughout the world for more than 20 years.

Since its early days, the company's objective has been to provide customers with cost-efficient, highly integrated solutions. For example, to eliminate the need for numerous separate test instruments, in 1952 the company developed the URI electronic multimeter, a small, ten kilogram tester. Likewise in the 1950s, the T&M expert became a pioneer in network analysis, with the world's first vector network analyzer. This finally made it possible to measure the magnitude and phase of S-parameters and display them in a Smith chart. A further highlight from this era was the compact SWOB wideband sweep generator, whose successor instruments were standard equipment for the alignment of TV receivers for years to come.
Germany's *Wirtschaftswunder* (economic miracle) and the continued general evolution of technology led to a rapid increase in the number of electronic components and instruments over the following decades. EMC measurements gained in significance. Rohde&Schwarz responded logically, using its expertise in receiver development as a springboard to the field of EMC T&M. For example, in 1987/88 the company equipped Europe's largest and most advanced EMC anechoic chamber in Greding, Germany.
During this period, Rohde&Schwarz gained a solid foothold in further T&M fields step by step. In 1985, the UPA audio analyzer rapidly became standard equipment in audio engineering. In 1982, the SWP became the first synthesized sweeper on the market. The high-end SMPC frequency synthesizer also won over customers worldwide with its low single sideband phase noise and high spurious suppression. The company's entry into spectrum analysis followed in 1986 – and somewhat to the surprise of the competition, Rohde&Schwarz

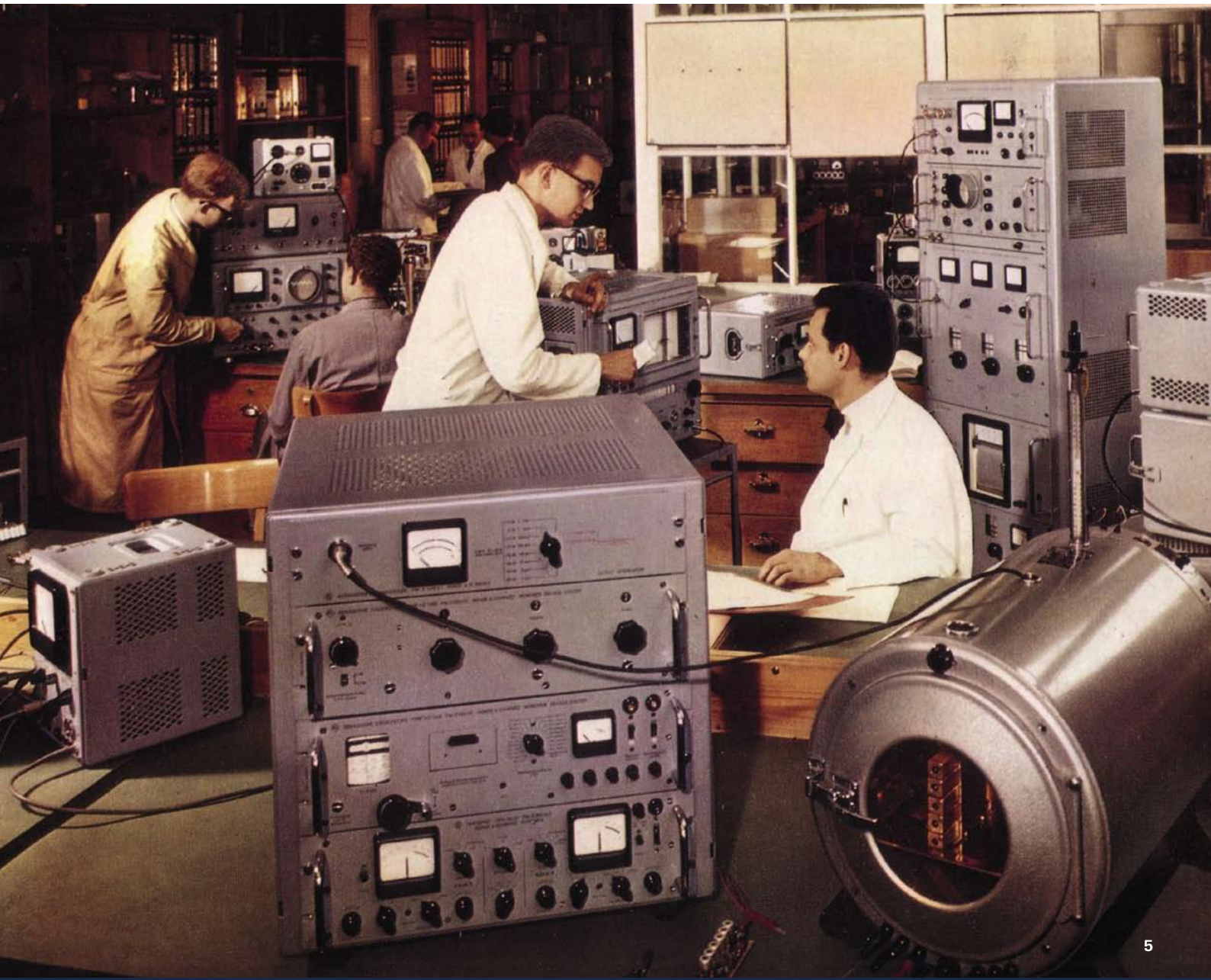
The R&S®FSV was introduced in 2008 as the fastest spectrum analyzer on the market.

bounded into the major leagues in one leap with its FSA. Moreover, the company presented numerous innovations in power and voltage measurement, one of its key business fields from the beginning. In the mid-1980s, for example, a data memory for calibration data was directly integrated into a power sensor for the first time. In 2002, Rohde&Schwarz brought the world's first USB power sensors to market.

For decades, Rohde&Schwarz has been a major player in T&M equipment for the wireless market. By introducing the first GSM system simulator in 1991, the company helped GSM conquer the world. The system helped determine whether mobile phones performed to standard. Since then, test systems and instruments from Munich have accompanied all major developments in the wireless industry.

Today, manufacturers of electronics and wireless companies value Rohde&Schwarz as a supplier of customized solutions. The company's signal generators offer dual-path capability and generate spectrally ultra-pure signals. In network analysis, the product portfolio ranges from the economy-priced R&S®ZVL vector network analyzer to high-end, four-port models up to 50 GHz. The R&S®ESIB and R&S®ESU test receivers have become fixtures in EMC labs as reference standards for compliance measurements. Users can also find everything they need in spectrum analysis, from handheld instruments for mobile use all the way up to an industry-leading 67 GHz analyzer. In the field of T&M equipment for the wireless sector, Rohde&Schwarz stands shoulder-to-shoulder with other pioneers in the next-generation wireless applications taking shape with WiMAX™ and 3GPP LTE. Most recently, in 2008, the R&S®CMW500 appeared on the market, embodying decades of combined expertise as the company's sixth-generation wireless tester.

Rohde&Schwarz not only develops and sells T&M instruments, it also uses them in its own labs (picture from 1963).



Milestones in broadcasting

TV and radio have brought the world closer together. People, events and distant regions now appear right before us, with a face and a voice. For almost six decades Rohde&Schwarz has been a fixture in broadcasting and related T&M equipment. As the world market leader in terrestrial TV transmitters, Rohde&Schwarz plays an active role in standards bodies, equipment testing and TV network setup.

The present – 2008: Rohde&Schwarz is driving the transition from analog to digital and mobile TV. The Munich-based electronics group outfits entire countries with complete TV networks in a minimum of time, from the US to Great Britain, Germany, Scandinavia or Spain, and all the way to Taiwan. Broadcasting equipment manufacturers turn to Rohde&Schwarz for its complete T&M portfolio in R&D and production. But how did this start?

When the company first entered broadcasting, no one thought that it would one day supply nearly the entire world with TV. The initial goal was modest – to bring radio to the people of Bavaria, Germany. That was in the 1940s, when broadcasting meant radio, and radio stations in Europe broadcast primarily in the medium-wave range. After the war, an international conference in Copenhagen reallocated the medium-wave frequencies. Germany was assigned very unfavorable frequencies. An alternative was needed, and one was found – very high frequency (VHF). On January 18, 1949, Rohde&Schwarz received an order from the Bavarian Broadcasting Corporation to build a VHF FM transmitter. Only six weeks later, in a race against time and the competition, the station went on the air. Rohde&Schwarz had put Europe's first VHF FM transmitter into service.

In 1963, Rohde&Schwarz installed this 6 × 10 kW VHF FM transmitter system in South Africa.

The company's broadcasting division was soon providing a full-featured portfolio of VHF FM audio broadcasting products. Stereo transmission, the radio data system (RDS) and the replacement of vacuum-tube transmitters followed in quick succession, with Rohde&Schwarz playing a major role in driving the development of all of them. In 1979, the company launched a transmitter featuring a kilowatt of power. This international bestseller featured the slogan "set up, connect, forget." Based completely on transistor technology, the new device eliminated the maintenance costs associated with vacuum-tube transmitters. In 1995, the world's largest DAB network at that time went on the air, produced jointly by Rohde&Schwarz and the Bavarian Broadcasting Corporation.

In the TV market, the company pursued another course. It initially focused not on transmitters, but on T&M instruments. Highlights such as the AMF Nyquist test demodulator in 1955 defined the T&M industry for decades to come. The AMF made changes in the transmission paths of a TV signal visible, and broadcasters long considered it standard equipment. In the early 1960s, Rohde&Schwarz began developing special TV test transmitters. The 1970s ushered in insertion test signal measurements, which enabled operators to monitor signal quality during live programming.

The first Rohde&Schwarz TV transmitter, produced in 1955, was truly small, with an output of just 20 mW. Its big brother hit the market in 1956, and the transmitter portfolio grew steadily over the following decades. Today, transmitters designed by Rohde&Schwarz are known particularly for their low energy consumption. The latest models match the transmit power of competitor equipment while reducing power needs by up to 25 %.

Today, network operators and broadcasting equipment manufacturers look to Rohde&Schwarz as a reliable and experienced partner, one that offers a full portfolio of products from a single source. Whether DVB-T, T-DMB, ATSC, MediaFLO™ or ISDB-T – broadcasting equipment and T&M solutions from Rohde&Schwarz support all leading digital and analog standards today. Manufacturers of set-top boxes, HDTV television sets and LCD screens turn to Rohde&Schwarz for the equipment that meets their needs, for R&D and for production as well. The R&S®SFU broadcast test platform is an R&D leader, and just under a year ago it celebrated the birth of a little brother, the R&S®SFE100 signal generator – an ideal instrument for production line use. In 2008, the R&S®DVSG followed as a digital video signal generator for the development and production of the newest generation of TV displays.

The new transmitters from Rohde&Schwarz (here the R&S®Nx8600) save up to 25 % in energy as compared to predecessor models.

Milestones in secure communications

Interoperable, reliable, tap-proof. This triple combination best summarizes today's expectations for radiocommunications. Ever since the iron curtain separating east and west was lifted, secure communications have become steadily more important for armed forces, government authorities, security organizations and industry. Rohde&Schwarz has been active in the radiocommunications field for some 50 years, constantly bringing groundbreaking innovations to market. Encryption and TETRA solutions have rounded out the portfolio since the 1990s.

The status quo in 2008: Terrorism and increasing numbers of small trouble spots around the world are causing shifts in threat levels and increased demand for secure communications solutions. Rohde&Schwarz is Europe's leading provider of radio systems for security and defense applications. The Munich-based electronics specialist is also Europe's market leader in high-security encryption technology, and a preferred NATO supplier.

But first let's look at the beginnings. In 1957, Rohde&Schwarz introduced the EK07 shortwave receiver. This milestone set the benchmark for precision engineering in the radiocommunications market. Frequencies could be read with high accuracy, image frequencies were a thing of the past, the receiver was immune to overload, and sound quality was above average. All this was ample reason for the German Armed Forces to adopt the EK07 as its standard communications intelligence receiver in 1962.

In 1968, Rohde&Schwarz entered the military avionics market and began developing on-board equipment for the Tornado fighter. The resulting XT3000 VHF/UHF transceiver and XK401 SSB radio are still in use after more than 30 years. In the early 1980s, Rohde&Schwarz avionics entered service in the Tornado, Alpha Jet, Phantom and a variety of helicop-

The EK07 established the standard for shortwave receivers in the 1960s. The German Armed Forces adopted it as its standard communications intelligence receiver in 1962.

ters. Moreover, the company entered the naval communications market in 1970 by equipping the German Navy with radiocommunications systems. The first major devices were the SK1 HF transmitter, which was the first to feature an automatically tuned output stage, and the XT3030 VHF/UHF transceiver.
The 1990s saw the radiocommunications business field expand to include secure communications and encryption. The company then implemented Germany's first digital trunked radio project for the German Armed Forces in 1998. The project involved enhancing an existing trunked radio system. Using *ACCESSNET*®-T, 2500 terminals were combined to create a digital TETRA system. Today, Rohde&Schwarz TETRA technology is used around the world, from the Moscow subway system, the Panama Canal and international sporting events such as the Asian Games in Qatar, to Malaysia's nationwide trunked radio network.
In 2001, Rohde&Schwarz made an international name for itself with the introduction of the first tap-proof mobile phone. A special encryption system was integrated directly into the telephone and allowed users to make encrypted calls (end-to-end). Called the TopSec GSM, it became the only mobile phone on the German market to be certified by the German Information Security Agency. A year later, the ELCRODAT 6-2 encryption system from Rohde&Schwarz was approved for the transmission of top secret and cosmic top secret information. The system relies on hybrid technology based on symmetric and asymmetric encryption. The next stage in the development of secure voice encryption was reached in 2008 with the new TopSec Mobile. This technology is compatible with nearly every mobile phone on the market, because the voice encryption device uses a Bluetooth® wireless interface to connect to the mobile phone.
Our brief journey through 50 years of Rohde&Schwarz secure communications is nearly complete. For the past decade, the software-defined R&S®M3xR family of interoperable radios has been part of the Rohde&Schwarz product line. The radios for the army, air force and navy are based on the same technology platform, and act as a bridge between the different forces during missions or in crisis situations. The solutions are also suitable for communications between the armed forces of different nations. With the R&S®M3AR radio family, which is deployed in the Eurofighter Typhoon and the new Airbus A400M transport aircraft, the company continues its dominance in the field of avionics technology, while more than 200 major airports around the world rely on air traffic control equipment from Rohde&Schwarz. In the naval communications sector, the R&S®M3SR radio is a resounding success. The company's encryption technology portfolio, to date designed primarily for use by NATO and the German government, is being expanded with solutions aimed at addressing a broader market. And the next TETRA projects are already in sight.

Radios from the R&S®M3AR family are used in the Eurofighter Typhoon and in the new Airbus A400M transport aircraft.

Milestones in radiomonitoring and radiolocation

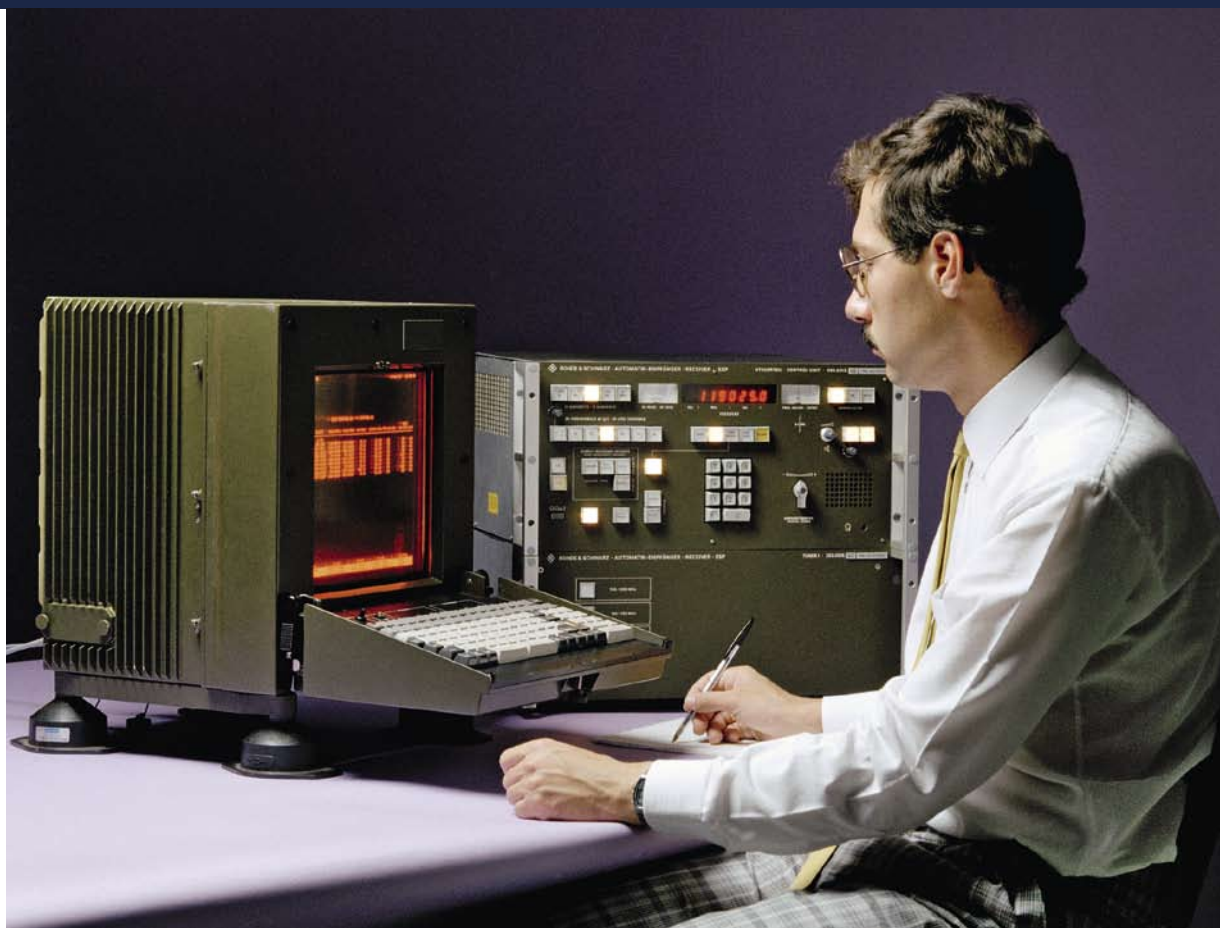
The frequency spectrum is limited, but the diversity of applications in mobile, wireless information exchange is dramatically increasing: Mobile telephony, navigation systems, audio broadcasting, television – everything must run smoothly, around the world. To ensure that it does, for seven decades Rohde&Schwarz has been developing and producing equipment for detecting, locating and analyzing radiocommunications signals. The company has long since established itself as one of the market leaders in this field.

The present – 2008: Users in public safety and national security, regulatory agencies and frequency management work with receivers, direction finders and antennas from Rohde&Schwarz. In many cases the company develops customized solutions, such as the nationwide system currently in service for the Czech Republic's regulatory agency. This system monitors frequency spectrum use fully automatically.

It all started seventy years ago, when the young Munich-based electronics company was the first in the world to present two field-strength measuring instruments, the HHF distant-zone field-strength meter and the HHN near-zone field-strength meter. The receive section of these measuring instruments was of such high quality that it was soon integrated as a key component in the ESD radiomonitoring receiver, and was produced in large quantities.
In 1949, Rohde&Schwarz began developing an entire series of new monitoring receivers. The ESM180, ESM300 and ESG were used for years in the labs of broadcasting companies and by postal and telephone authorities, for registering signals from distant over-the-horizon transmitters that could not be detected by conventional receivers. In the early 1960s, Rohde&Schwarz produced the ESUM VHF/UHF monitoring receiver, which subsequently established itself as the standard solution for monitoring military radio traffic.

In 2008, the R&S®PR100 was introduced to the market. It offers mobile radiomonitoring that is portable, precise and fast.

1986: the ESP automatic receiver in operation. It checked the occupancy of nearly 1000 frequency channels per second in a frequency range from 10 kHz to 1.3 GHz or 2.5 GHz.



Another coup was the development in the 1950s of the world's first automatic VHF visual direction finder. The NAP1 went into test operation in 1955 and entered service at Munich Airport in 1957. Further innovations followed in rapid succession, such as the NP4 introduced two years later. It was the first direction finder to work on the Doppler principle. Shortly thereafter, Rohde&Schwarz presented the PA001 – at the time the most accurate radio direction finder for monitoring marine traffic, with a system error of just 0.1° maximum deviation.

Besides improving precision, the 1970s and 1980s saw a second key development trend in radiomonitoring and radiolocation: The focus was now increasingly on automating processes. Rohde&Schwarz delivered a classic example of this technology in the ESP automatic receiver, which was able to scan nearly 1000 frequency channels per second in a comprehensive frequency range from 10 kHz to 1.3 GHz or 2.5 GHz. Another milestone was the ESM500 monitoring receiver. Introduced in 1980, it was the first broadband synthesizer receiver that allowed all functions to be controlled via a processor. Subsequently the PA2000 was launched, the first instrument on the market to combine a search receiver and direction finder. It made it possible to take the bearings of signals transmitted in frequency-hopping mode. With the introduction of the EB100 in 1985, Rohde&Schwarz began producing portable receivers of very high quality. The EB200 came out in 1999 and continued this remarkable sales success.

Today, government authorities and defense organizations know Rohde&Schwarz as a key partner for all fields of radiomonitoring. Everything comes from a single source, from the R&S®PR100 portable receiver as a mobile solution to the R&S®AU900 as a complex antenna system. And with the R&S®ESMD in its portfolio, Rohde&Schwarz also offers an instrument that combines all radiomonitoring functions in one box – reception, direction finding, measurement and demodulation of signals.

Looking ahead: an interview with the Executive Board

Mr. Vohrer, you are President and CEO, and have been familiar with the company for more than 30 years. What is your take on the company's history?

For 75 years, Rohde&Schwarz has been shaped by the philosophy that we always go the extra mile and continuously cultivate close customer relationships. The idea of the company's two founders to open up a completely new market, by developing RF test and measurement solutions, was the first step in this direction. It was quickly followed by the decision to offer products rather than patents, because customers wanted to buy instruments, not just designs. In the 1940s, the company added products for the broadcasting industry to its existing test and measurement portfolio. In the mid-1950s, Rohde&Schwarz expanded into yet two more fields, radiomonitoring and radiolocation as well as radiocommunications. It's fair to say that we have always been driven by the idea of discovering something new and bringing it to the market.

And how do you see the future?

Today, we are among the top three players in the world in each of our fields of business. Our objective is not merely to maintain that position; we want to move up to being one of the top two. Therefore, we will remain focused on the core trends driving our industries, such as higher frequencies, greater speed and even more precision. At the same time, technology cycles are becoming ever shorter, creating a demand for flexible platform concepts. Our portfolio ranges from solutions for specific applications to general-purpose systems for wide-ranging high-tech applications. Moreover, we are constantly testing the waters to see if the world offers other compelling ideas in addition to those that have already made us successful, ideas that are of interest to us and that can help us grow. Rohde&Schwarz is intent on becoming an even more important player – that much is clear.

Moreover, we are constantly testing the waters to see if the world offers other compelling ideas in addition to those that have already made us successful.

We have virtually the entire value-addition chain within the company, from the initial idea through to final testing.

Mr. Fleischmann, on the Executive Board you are responsible for Production. How prepared is Production for future challenges?

Maximum flexibility, low production costs and short turnaround times – these are the challenges we face in Production. Over the past years, Rohde&Schwarz has done a great deal in this area to position itself for the future. By introducing the just-in-time concept and switching to flow production, we have drastically reduced delivery time in transmitter production, for example: Customers now receive the products four times faster than prior to the changeover. At the same time, we have also become competitive on production costs. While keeping expenses steady, we have significantly increased the output of units, placing us above average in the German electrical industry in terms of productivity growth. If necessary, our factories can switch to three-shift operation six days a week when large orders create unexpected peaks in demand.

When your business is high tech, top quality is a must. Simultaneously, the need to protect the environment calls for sustainable production methods. How do you achieve this?

The key here is manufacturing depth. We have virtually the entire value-addition chain within the company, from the initial idea through to final testing. This lets us implement the most suitable test methods throughout the entire development and production process, and ensure the utmost quality. In addition, we keep a constant eye on environmental protection in every phase of the product life cycle – starting with a development planning process that includes measures for saving raw materials, and extending to the reduction of CO_2 emissions during transportation, plus the minimization of energy consumption during product life. Our plants are certified compliant with internationally applicable DIN standards in the areas of quality assurance and environmental protection.

Mr. Leicher, you are responsible for International Sales.
What challenges does the company face?

We do business on the world stage and have a global sales structure. Our objective is not only to ensure our competitive edge for the long term, but also to expand market shares and increase our prospects for future growth. Our customers expect us to be an expert partner with a strong local presence; companies that are increasingly shifting their focus to the global arena also expect a partnership that offers a global network.
This is why we are creating such structures in our company. Strong national subsidiaries provide expertise and stability at the local level. Our teams in Global Customer Management and Business Development address global customers and specific market segments; as support, we have established key contacts for each and we make sure that our activities are coordinated worldwide.
When it comes to developing new features or applications, we maintain close contact with our customers starting at the earliest stages. A trusting partnership enables us to do our work with an eye to the future, and to meet our customers' needs promptly. We are strengthening our development teams in important markets around the world to stay even more closely in tune with the market and to shorten decision-making paths.

You are the youngest member of the Executive Board.
What makes Rohde&Schwarz special for you?

For me, it is the exciting combination of proven values – you might call it tradition – and great innovative strength. And we clearly understand that this combination cannot be taken for granted, but that it must be cultivated. A culture of openness that creates freedom and space for creative employees, based on mutual respect. This must be lived every day, because only this kind of atmosphere lets us actively demand and foster innovations. Our repeated success in one employer ranking after the other shows that this is not merely polished rhetoric: Our employees have voted us one of Germany's best employers for the fifth time in a row, and in the field of communications engineering we were ranked the number one top employer in 2008. Our rich company culture has made us strong in the past, and will continue to do so in the future.

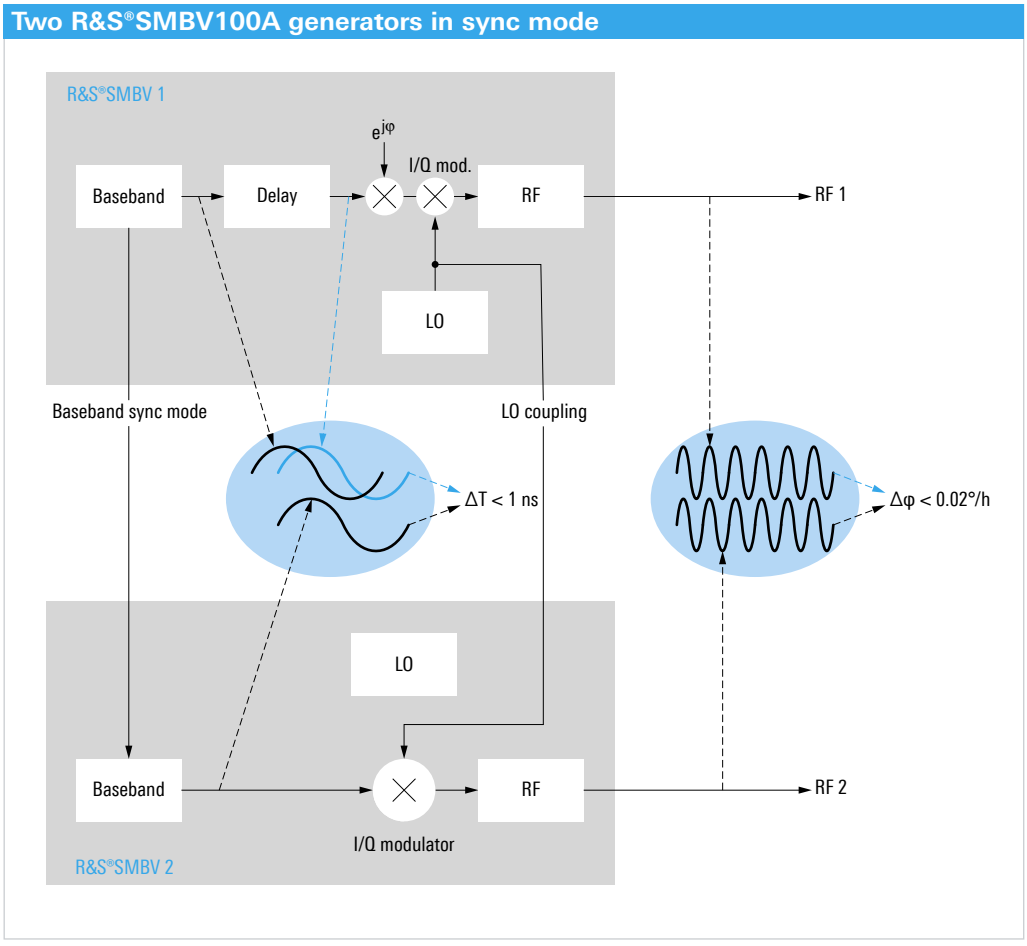
Our rich company culture has made us strong in the past, and will continue to do so in the future.

Click and win

Want to know more Rohde&Schwarz history?
Just visit **www.rohde-schwarz.com/ad/75**

And don't forget the anniversary quiz at
www.rohde-schwarz.com/ad/75quiz/news.
First prize is a week-end trip for two
to Rohde&Schwarz headquarters in Munich.

FIG 9 Synchronization of two R&S®SMBV100A vector signal generators.



Continued from page 42

User-friendly service concept

As in the development of the tried-and-tested modules of the R&S®SMB100A generator, high reliability was made a top priority also for the new modules. Designed to meet tough requirements (temperature range 0 °C to 55 °C, altitude up to 4600 m), the R&S®SMBV100A offers a long life in production or lab applications and has low failure rates. Nevertheless, if a module does fail, repair is no problem, for the module can be replaced on site.

The defective module is easily located by using the precise diagnostic functions on the instrument and following the detailed troubleshooting instructions in the service manual. The video sequences integrated in the service manual, which show all the required worksteps in detail, make it easy to replace the module. After a replacement of the RF board, the level correction values can be re-recorded and saved in the R&S®SMBV100A on site automatically and independently by using an R&S®NRP-Z91 or R&S®NRP-Z92 power sensor. This reduces downtimes considerably.

Summary

The R&S®SMBV100A is the first vector signal generator in its class that not only offers excellent RF characteristics but, in particular, also features future-oriented internal baseband generation. Offering high versatility and scalability, it is a truly all-purpose instrument. Due to its powerful digital hardware, the baseband coder can calculate even complex digital modulation modes in realtime. Plus, parameters can easily be modified on the intuitive graphical user interface. These features combine to make the generator an ideal measuring instrument for lab applications. It is also highly suitable for use in production, owing to its fast setting times and its ability to switch very fast between stored waveforms.

Dr. Joachim Danz; Eckhard Hammer; Volker Ohlen

R&S®SMC100A signal generator: best performance in the economy class

The new analog R&S®SMC100A signal generator offers superior specifications, a full set of standard features and a wide range of functions at an attractive price. All of this comes in a uniquely compact box.

FIG 2 The R&S®SMC100A comprises only four modules. In case of a malfunction, the defective module can be replaced by a certified Rohde&Schwarz service center, or users can replace the module on their own. Due to precalibrated replacement modules, the instrument will immediately be ready for use again after the replacement.

FIG 1 The size of the power sensor compared to that of the R&S®SMC100A shows how uniquely compact the new signal generator is.

Wideband noise

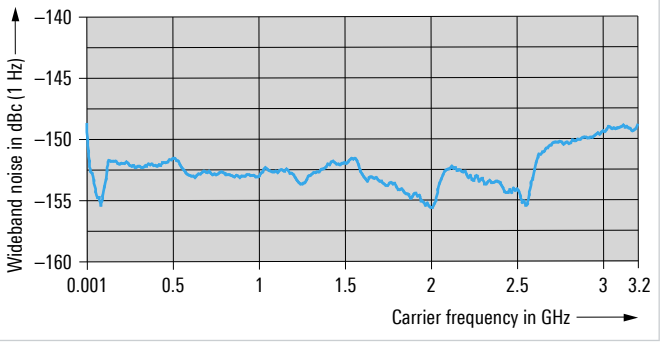


FIG 3 Wideband noise suppression at +5 dBm.

Expansion of the analog signal generator family

The tried-and-tested analog R&S®SMA100A and R&S®SMB100A signal generators cover a broad spectrum of demanding applications owing to their outstanding performance characteristics. Many day-to-day test and measurement activities, however, place simpler demands on the test signal and have to be performed in a particularly cost-effective manner. A robust and reliable generator is nevertheless essential in order to avoid the costly consequences of instrument downtime.

The new, attractively priced analog R&S®SMC100A signal generator (FIG 1), which covers the frequency range of 9 kHz to 3.2 GHz, is tailor-made to fulfill the above tasks. This is because the R&S®SMC100A features many important functions of the higher-end models, and its excellent specifications make it suitable for numerous applications. Using tried-and-tested engineering concepts, the generator has been accommodated in a uniquely compact box of only ½19" × 2 height units. This makes the instrument especially attractive for mobile applications.

Highest signal quality in its class

Despite its attractive price, the R&S®SMC100A was developed with one key criterion in mind: optimal quality of the output signal as a prerequisite for supporting a wide range of applications. For example, the single-loop synthesizer offers low phase noise of typ. –111 dBc (1 Hz; at 1 GHz and 20 kHz offset, see FIG 4). These excellent characteristics are due to the use of a highly accurate direct digital synthesizer (DDS). A special DDS technology patented by Rohde&Schwarz is used to combine outstanding frequency resolution with superior spectral purity. The concept of using a frequency synthesizer without a mixer yields excellent phase noise characteristics and minimal nonharmonics even for low output frequencies.

Nonharmonic suppression thus achieved compares to that of far more expensive instruments: With nonharmonics of typically –72 dBc at frequencies up to 1.6 GHz, the

SSB phase noise

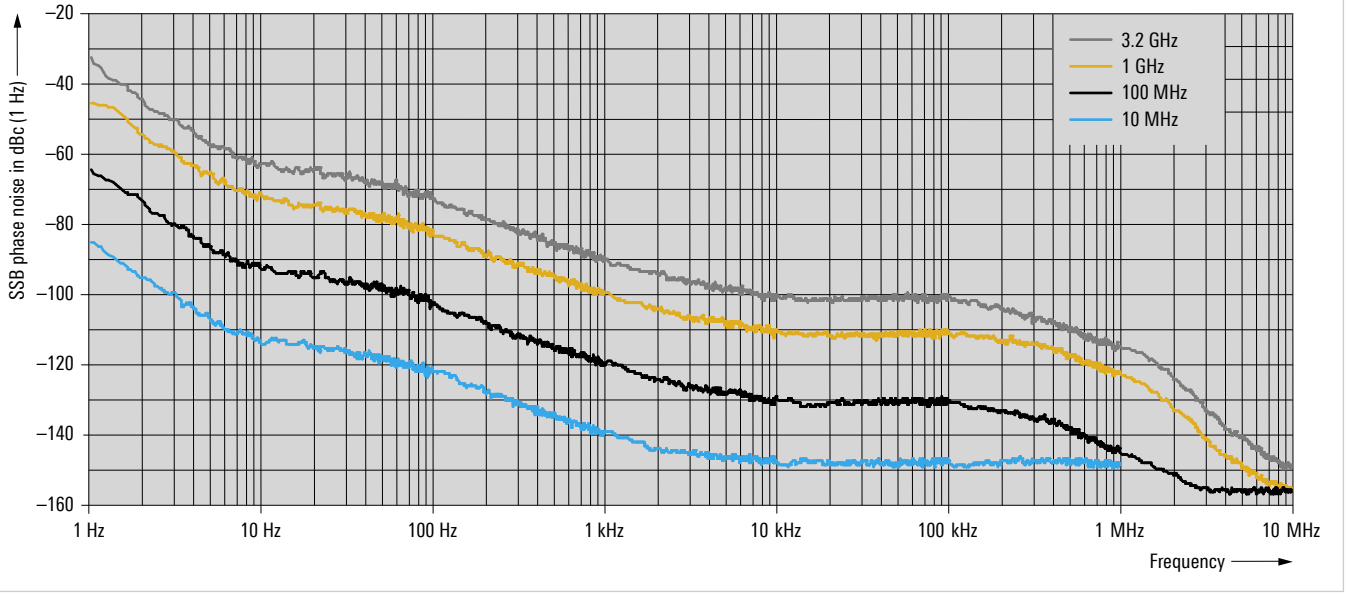


FIG 4 SSB phase noise with the internal R&S®SMC-B1 OCXO reference oscillator option.

R&S®SMC100A represents the standard in its class. For example, this outstanding signal purity makes it easier to identify spurious responses when performing receiver measurements, since there are fewer nonharmonics introduced by the signal generator itself that have to be taken into account.

Another key characteristic for many applications is wideband noise suppression. For this reason, instead of using conventional integrated amplifiers at key points in the RF signal path, special amplifier stages made up of discrete components have been implemented that ideally combine low inherent noise, high output power and frequency-independent gain (FIG 3). The low wideband noise makes it easier to perform blocking measurements on receivers for instance, as less complex or no filters at all are required to suppress the generator noise.

With an output power of typically higher than +17 dBm for frequencies starting at 1 MHz, the R&S®SMC100A has a power margin large enough to compensate for cable losses and to perform tasks that demand high power, e.g. use of the generator as a local oscillator in mixer measurements (FIG 5).

A special temperature-compensating function for the RF signal path ensures a highly stable output power across the entire operating temperature range. This means that users can rely on the accuracy of the R&S®SMC100A not only in the lab, but also under extreme conditions in the field (FIG 6).

Output power

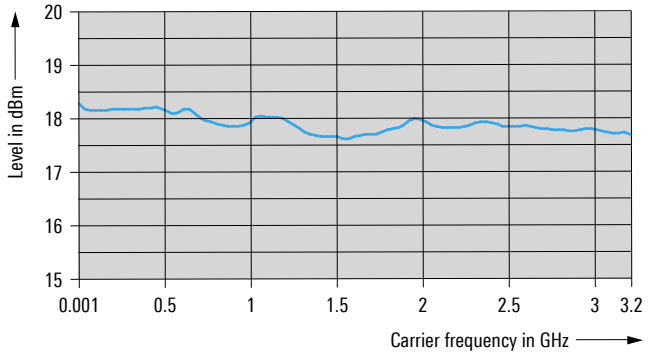


FIG 5 Measured maximum output power.

Full set of features

The newest member of the Rohde&Schwarz family of analog signal generators offers as standard a remarkably large number of features found in the higher-end members. Apart from the analog AM, FM, φM and pulse modulation modes, an internal LF generator and a universal pulse generator are implemented as standard. In conjunction with integrated functions such as frequency and level sweeps, the R&S®SMC100A becomes a flexible instrument that can also master complex measurement tasks.

Temperature stability of output power

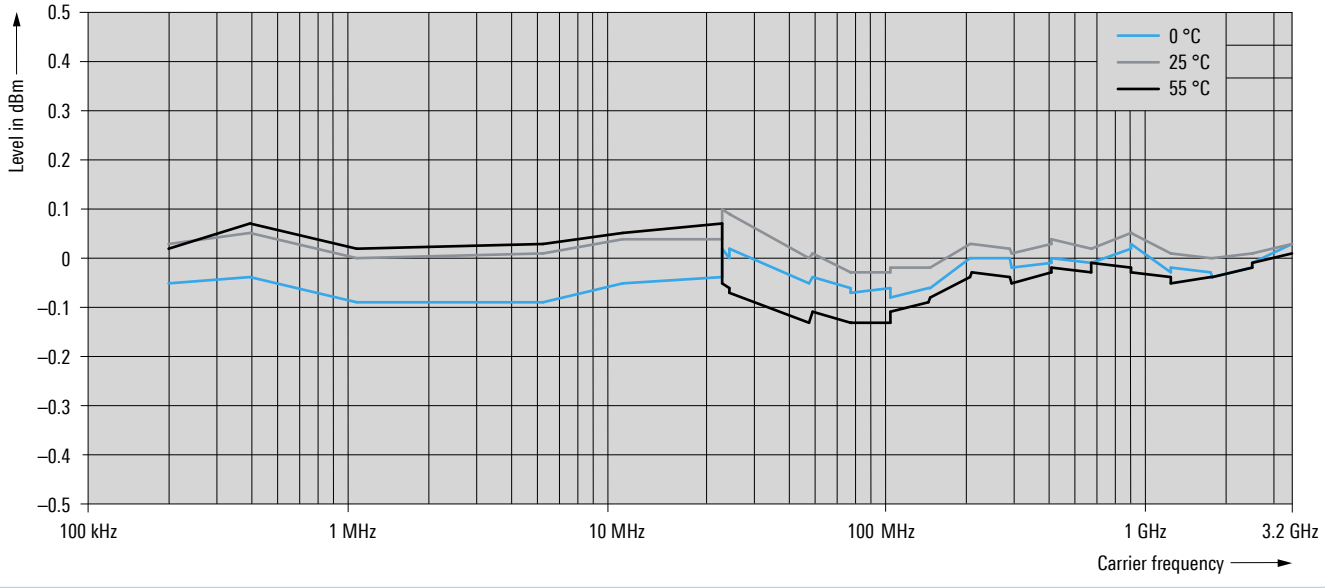


FIG 6 Output power measured at different temperatures at 0 dBm.

Connecting an R&S®NRP-Zxx power sensor to the generator's USB interface (FIG 1) adds power meter functionality to the R&S®SMC100A. The instrument is thus capable of performing high-precision power measurements also on external signals without requiring any extra equipment.

The frequency accuracy of the generator can be further increased by installing the R&S®SMC-B1 OCXO reference oscillator option. This simply requires inserting the R&S®SMC-B1 plug-in module on the rear of the instrument and activating it with a key code (FIG 7). For remote operation, the generator is equipped with all common interfaces: LAN, USB and an optional IEC/IEEE bus interface.

If required, the R&S®SMC100A can even emulate several widely used types of signal generators, and translate and implement the associated remote control commands. Legacy instruments in existing test setups can thus easily be replaced without the tedious effort of modifying the measurement software.

Compact and ergonomic

Requiring only ½ 19" and two height units, the R&S®SMC100A is ideally suited for applications where space is at a premium. Despite its best-in-class dimensions, the instrument is equipped with a full-fleatured control unit that includes a color display, an incremental rotary knob and all necessary input keys. The lightweight design (3.9 kg) together with low power consumption (typ. 40 W) makes the R&S®SMC100A the signal generator of choice for mobile applications. The instrument's dimensions are also advantageous for use in 19" racks because two generators can be installed side-by-side to save space.

As with the other signal generators currently offered by Rohde&Schwarz, the R&S®SMC100A is easy to operate due to its straightforward, dynamic graphic block diagram (FIG 1). In addition, the detailed online help facilitates the use of rarely employed functions and explains all remote control commands.

Robust design and superior service features

The compact design and attractive price of the R&S®SMC100A do not come at the expense of mechanical and electrical quality. On the contrary, its simple design and the small number of modules used make the R&S®SMC100A an extremely reliable instrument (FIG 2).

FIG 7 R&S®SMC100A connectivity options. The R&S®SMC-B1 OCXO reference oscillator option is installed here.

The electronics are also optimized for robustness and long life. The RF output is actively protected against reverse power surges, and all other signal connectors contain protective circuits to prevent damage caused by short circuits or inadvertently applied DC power. The fully electronic attenuator functions without the use of wear-prone relays. A generously dimensioned cooling system keeps the instrument's internal temperature low, thus enhancing failsafety of the instrument.

Even when a malfunction does occur, the built-in selftest helps pinpoint the cause. Defective modules can be replaced by a certified Rohde&Schwarz service center or by the users themselves. Replacement modules are precalibrated so that the instrument is immediately ready for use again after the replacement.

Summary

The R&S®SMC100A expands the successful family of signal generators from Rohde&Schwarz. It is another valuable model that combines outstanding performance data with a unique design and an attractive price. This makes the instrument an ideal choice for a wide variety of applications ranging from standard measurements in the lab and simple production applications through to use in service and training.

Jörg Nagel

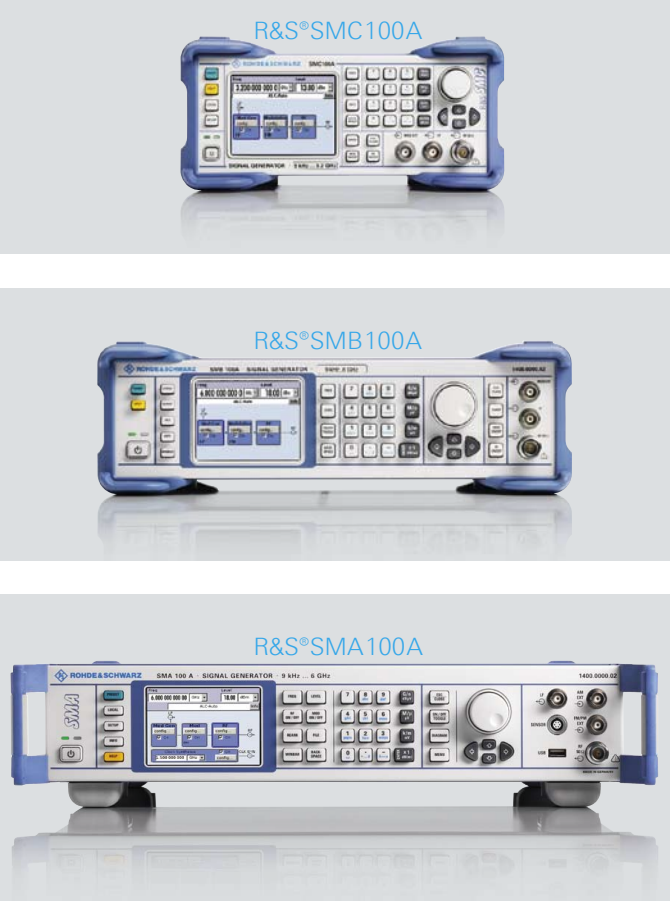


FIG 8 From compact to high-end: the analog signal generator family from Rohde&Schwarz.

Condensed data of the R&S®SMC100A

Frequency range	9 kHz to 3.2 GHz
Level range	–120 dBm to +13 dBm (typ. >+17 dBm in overrange mode)
Setting time	<5 ms, typ. 2 ms
Spectral purity (f = 1 GHz)	
SSB phase noise (carrier offset 20 kHz, measurement bandwidth 1 Hz)	<–105 dBc, typ. –111 dBc
Nonharmonics (carrier offset >10 kHz, carrier frequency ≤1.6 GHz)	<–60 dBc, typ. –72 dBc
Wideband noise (carrier offset >10 MHz, measurement bandwidth 1 Hz)	<–138 dBc, typ. –148 dBc
Modulation modes	AM, FM/φM, pulse
Sweep functions	RF frequency, RF level, LF frequency
Interfaces	IEC/IEEE bus, IEC 60625 (IEEE 488), Ethernet (TCP/IP), USB

Baseband signal generator for UWB and aerospace and defense applications

The R&S®AFQ100B is an ideal baseband signal source for use in the development and production of ultra-wideband (UWB) components. When equipped with the R&S®AFQ-K264 software option, the instrument generates all test signals required for a WiMedia UWB band. The R&S®AFQ100B is also an ideal choice for aerospace and defense applications as it can generate signals with modulated pulses or wide, nonlinear chirps for state-of-the-art radar systems, for example.

FIG 1 Featuring an RF system bandwidth of 528 MHz, the R&S®AFQ100B is ideal for use in the development and production of ultra-wideband components. The new R&S®AFQ100B is also the first choice for generating wideband radar signals in aerospace and defense applications.


AFQ100B Base Band Source (CEV)
File Setup Edit Help
Waveform LTE.multiConfig
Segment 1
Crest Factor 4.77 dB
Amplitude 600 mV
Info
Marker 1: Unchanged
2: Unchanged
3: Unchanged
4: Unchanged
Baseband
config...
On
Δf Δt
Impairments
config...
On
Equalizer
config...
On
I/Q
Output
config...
On
BB Out
I/Q BBOut
BERT
config...
On
BERT
ERATOR
1410.9000K02 LXI
HARDDISK
DO NOT REMOVE DURING OPERATION
OUT
ANALOG OUT
PORT 2

Excellent signal quality and high flexibility

Whether in the commercial or military field, excellent signal quality and high flexibility are of utmost importance when selecting a signal source. The new R&S®AFQ100B ideally meets these requirements. Featuring an RF system bandwidth of 528 MHz, the ARB-based signal source is ideal for use in the development and production of UWB components. The R&S®AFQ100B is also the first choice when it comes to generating wideband radar signals for use in aerospace and defense (A&D) applications.

Tailor-made for ultra-wideband technology

The UWB technology (see box on right) will be implemented in the next generation of Bluetooth® and in wireless USB. The development and production of UWB RF and baseband components (e.g. receivers or I/Q modulators) call for signal sources offering very large bandwidths. The R&S®AFQ100B perfectly meets this requirement. WiMedia UWB signals to be delivered by the generator can be easily and intuitively configured by means of the R&S®AFQ-K264 option. The graphical structure of the configuration menus helps the user define the packet setup and the hopping sequence, for example (FIG 2). The R&S®AFQ-K264 option comes with predefined, standard-conforming signal configurations suitable for simple tests. In addition, numerous parameters can be user-defined for configuring more complex tests.

To upconvert baseband signals generated by the R&S®AFQ100B to the RF, a vector signal generator such as the R&S®SMBV100A is required (see page 36). The I/Q modulator of the R&S®SMBV100A features an RF bandwidth of 528 MHz for externally fed signals. This permits the generation of a full WiMedia UWB band at the RF (FIG 3).

Modern wireless terminals support many different standards. UWB, WiMAX™ and 3GPP are often implemented in the same device, for example. The variety of tests that are required is just as comprehensive. The new R&S®AFQ100B therefore offers considerable versatility, because apart from generating WiMedia UWB signals, it supports numerous other digital communications standards. Among the available options are WCDMA, HSPA+, WiMAX™, WLAN and LTE.

Specialist also for A&D applications

A&D applications are also using digital baseband signals to an increasing extent. For example, state-of-the-art radar systems employ short modulated pulses or wide nonlinear chirps. The R&S®AFQ100B demonstrates its strengths in this field as well as it can generate complex radar signals with pulses of short widths and short rise and fall times. The pulse sequencer

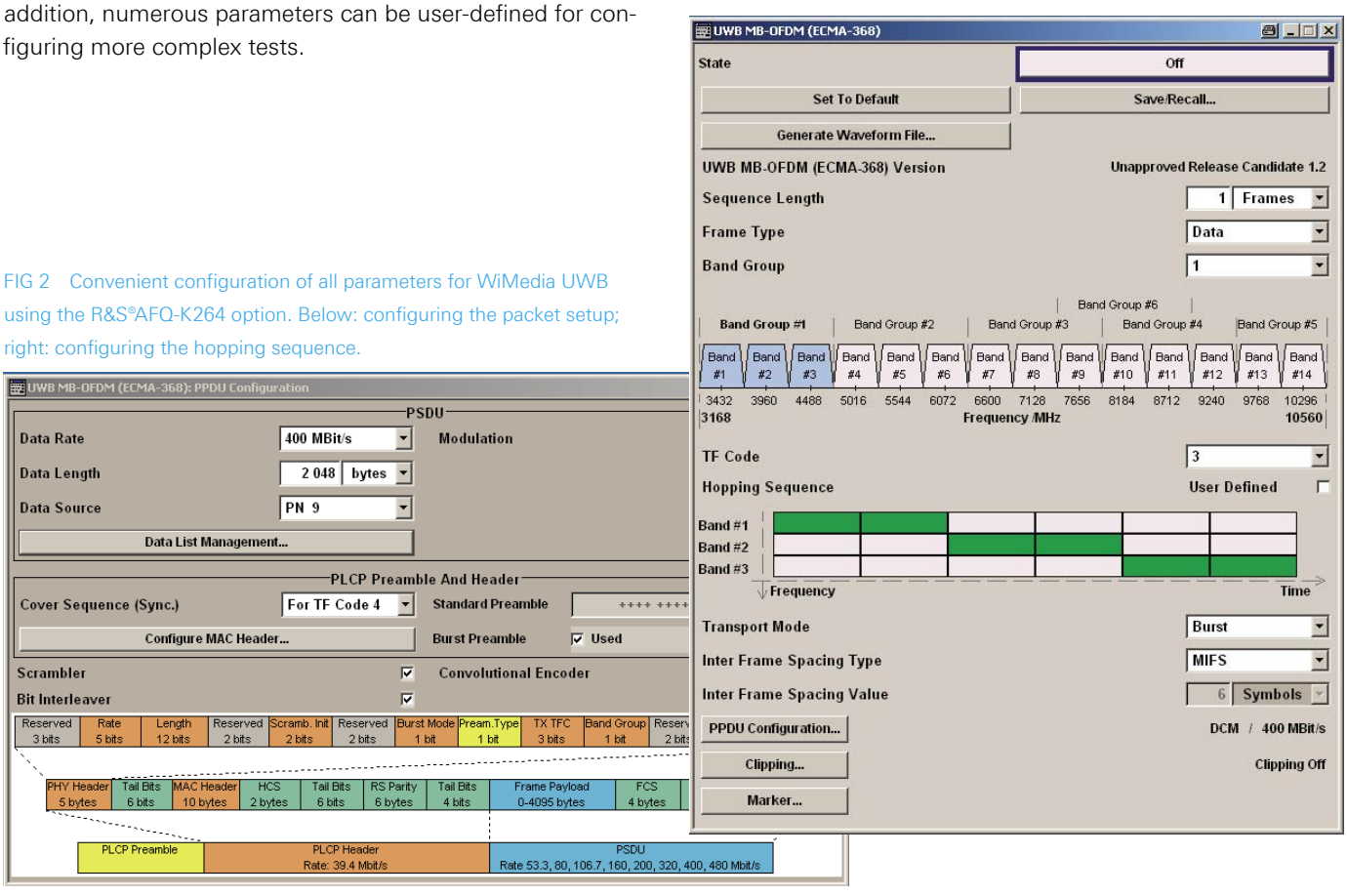


FIG 2 Convenient configuration of all parameters for WiMedia UWB using the R&S®AFQ-K264 option. Below: configuring the packet setup; right: configuring the hopping sequence.

Generation of UWB RF signals

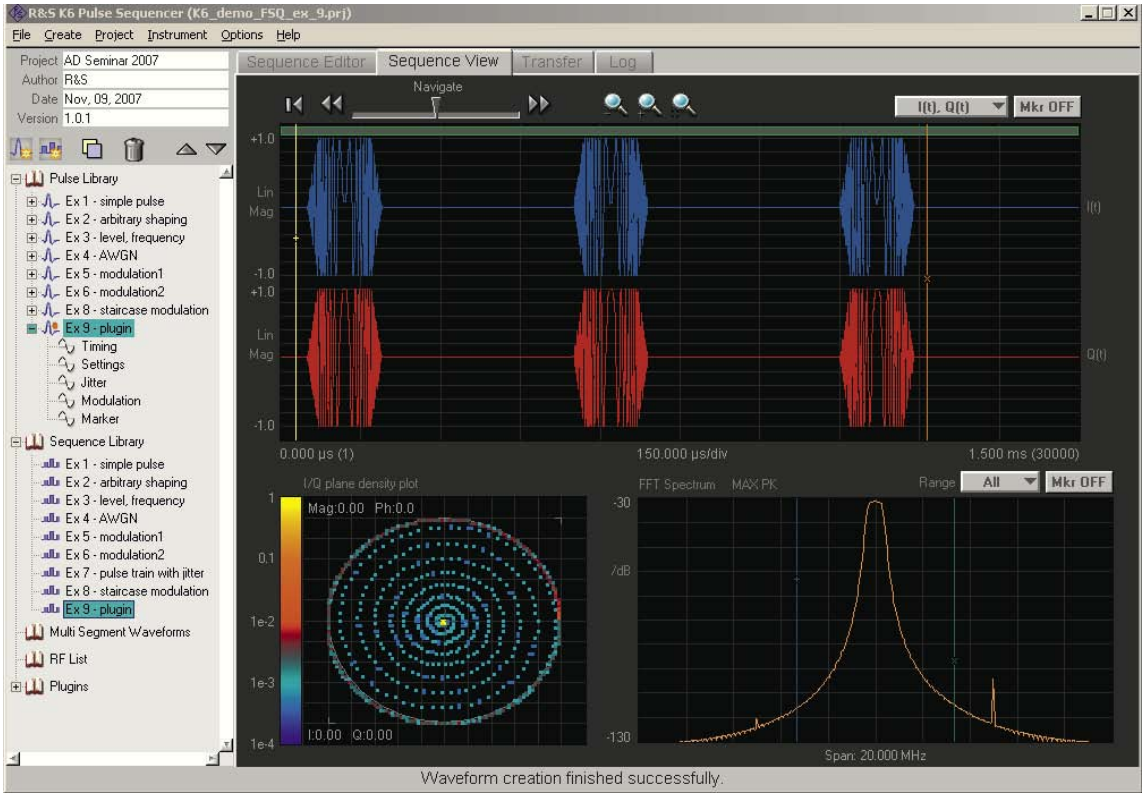
FIG 3 The R&S®AFQ100B generates UWB signals up to 6 GHz together with the R&S®SMBV100A vector signal generator.

software from Rohde&Schwarz in conjunction with the R&S®AFQ-K6 option permits easy configuration of pulsed signals, including any type of analog or digital intra-pulse modulation (FIG 4). Users can insert classified contents into pulses by means of plug-ins. Many users, especially in the A&D sector, generate the required signals themselves by means of MATLAB™, for example. Rohde&Schwarz offers a wide range of tools that make it easy to transfer such signals to the R&S®AFQ100B.

Facts about UWB

UWB is an ultra-wideband radio technology designed for short-range, high-data-rate transmissions at very low power levels. By definition, UWB signals have a bandwidth of at least 500 MHz. One example of how UWB is implemented is WiMedia UWB, which is defined by the ECMA-368 standard. The WiMedia specification divides the 7.5 GHz UWB spectrum (3.1 GHz to 10.6 GHz) into 14 bands of 528 MHz each. The 14 bands are subdivided into six band groups, each of which consists of two or three adjacent frequency bands. Switchover from one band to another in a group can be made after a symbol (length 312.5 ns) in accordance with a predefined scheme. To transmit the information, multiband OFDM (MB-OFDM) with 122 carriers per band is used. WiMedia UWB will be employed as the physical layer for the next Bluetooth® generation or for wireless USB, for example.

FIG 4 Pulse sequencer software from Rohde&Schwarz for generating complex pulse scenarios.



For users in the military sector, it is essential that no user-specific data is removed from a secured area when the instrument is sent in for calibration or repair. The R&S®AFQ100B's internal hard disk can therefore be removed whenever required to make sure that confidential data will always remain in a secured area (FIG 5). Rohde&Schwarz also offers sanitizing routines in line with the U.S. DOD-5220.22-M guideline, which can be used to permanently delete all user data.

FIG 5 The removable hard disk is a must for military applications so that confidential data remains in a secured area when the generator is being serviced.

Excellent signal quality and versatile additional functions

A universal I/Q source must provide high signal quality. The R&S®AFQ100B excels also in this respect. Owing to an optimized design and the use of state-of-the-art components, the instrument features a spurious-free dynamic range of typ. 78 dBc and an extremely flat frequency response – characteristics that are vital in wideband and multicarrier applications. The R&S®AFQ100B can also generate ultra-pure sinewave signals up to 250 MHz, as are required for testing high-grade components such as A/D converters or mixers.

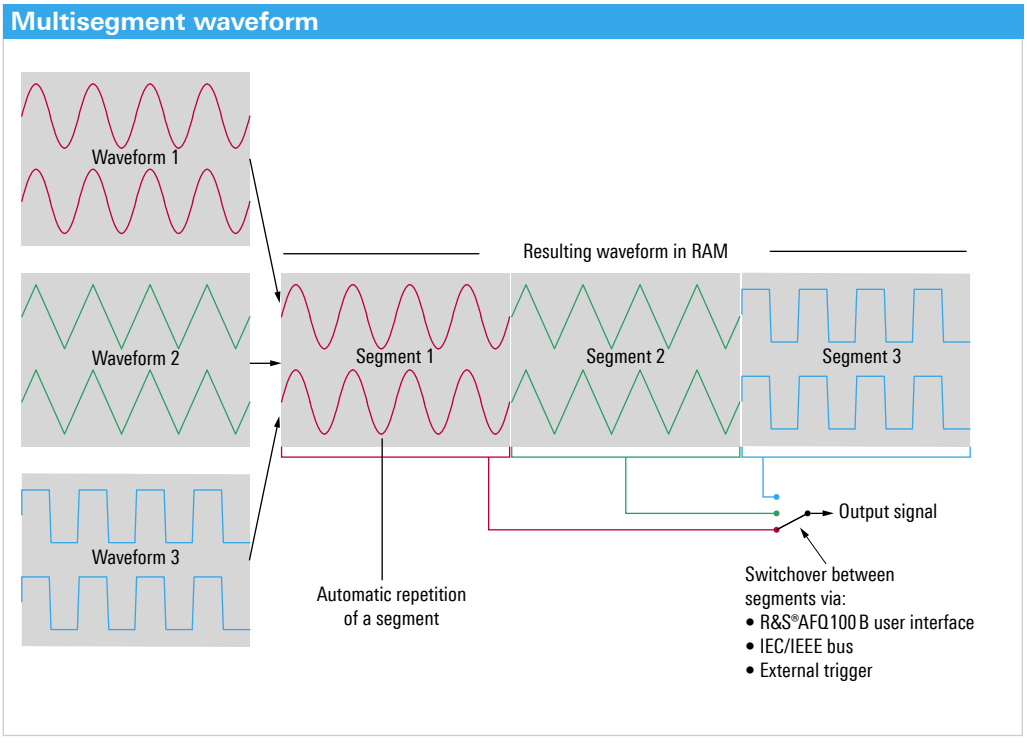


FIG 6 How a multisegment waveform is generated.

With a memory depth of up to 1 Gsample, signals of extended duration can be generated even at high bandwidths. The large memory depth also allows storing several different signals as parts of a multisegment waveform and switching between the individual waveforms within only a few microseconds (FIG 6). This boosts throughput in production tests of multistandard modules designed for GSM and UMTS, for example.

Another unique advantage of the R&S®AFQ100B is its integrated equalizer function. This function compensates for frequency response caused by connected components such as cables, filters or the DUT itself. The frequency response of the entire setup is measured by means of a power meter or spectrum analyzer and transferred to the R&S®AFQ100B. During signal output, inverse FIR filters are used to linearize the frequency response of the setup (FIG 7).

The R&S®AFQ100B also features extensive functionality for configuring the level, phase, delay and gain of the I and Q signals. These parameters can be used not only to compensate for various effects caused by external components, but also to test the performance of modulation methods and receivers by applying defined, non-ideal input signals.

The R&S®AFQ100B features balanced and unbalanced analog I/Q outputs with flexible level setting capabilities and a bias of ±2.5 V, as well as optional digital I/Q outputs. Versatile trigger and marker functions make it possible to synchronize the R&S®AFQ100B with other instruments.

The modern graphical user interface, which uses a block diagram as its central element, can be accessed via an external monitor. The space-saving signal source (two height units only) can then be easily operated via a USB mouse or keyboard.

The Remote Desktop software displays the graphical user interface on any PC in the network, allowing operation of the R&S®AFQ100B without requiring an operating manual or a remote control command set. The R&S®AFQ100B can be remotely controlled via a LAN, GPIB or USB interface. Remote control drivers for all established development platforms can be downloaded at no charge from the Rohde&Schwarz website.

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Equalizer function

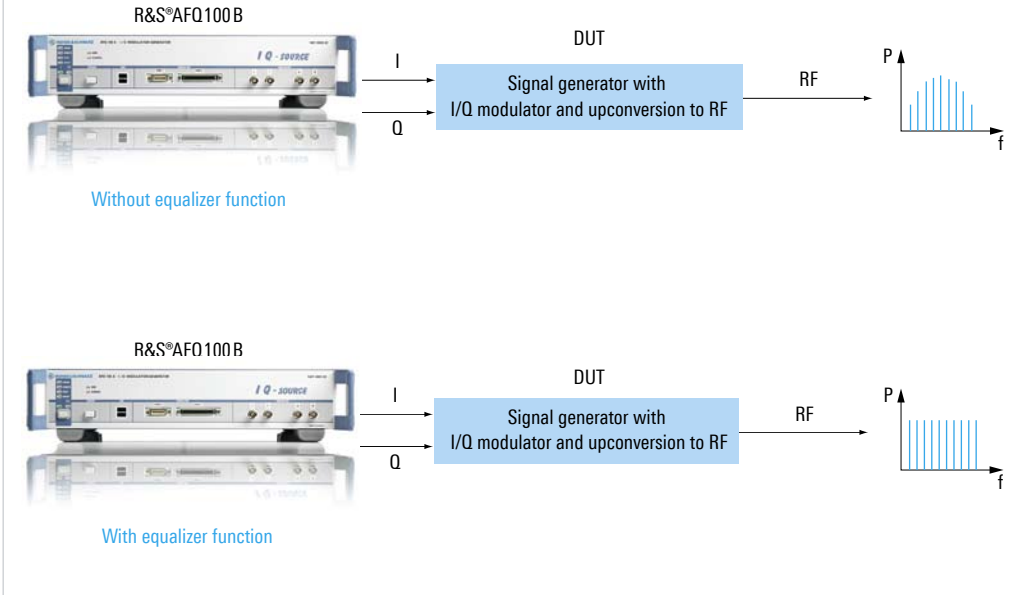


FIG 7 Above: without equalizer function. At the output of the R&S®AFQ100B, the frequency response is still flat. The output of the DUT shows a noticeable frequency response caused by the connecting cables and the DUT itself.

Below: with equalizer function. Inverse filters in the R&S®AFQ100B compensate for frequency response, yielding a signal with a flat frequency response (at the RF in this case) at the output of the DUT.

All-purpose software for any EMS measurement task

R&S®EMC32-S is a powerful measurement tool to handle EMS measurement tasks in all relevant business sectors and standards. It covers commercial measurements, specific test methods conforming to the ETSI standards for radiocommunications equipment and all other important standards in the automotive and aerospace & defense sector. Moreover, it also takes into consideration a variety of manufacturer-specific standards and national adaptations of international standards. More than 1500 licenses sold worldwide make the R&S®EMC32 software platform a market leader in EMC testing.

EMS measurements — more sophisticated and versatile than ever

Manufacturers and test houses have long been confronted with changing requirements in electromagnetic susceptibility (EMS) testing. Many EMC standards were not up-to-date and needed to be revised or adapted to meet the latest requirements: For example, the frequency ranges to be measured have been extended as a result of new wireless communications services. Moreover, products often have to comply with multiple EMC standards because many of today's instruments have been equipped with Bluetooth® or WLAN modules, for example. In vehicles, mobile communications are now part of everyday life.

Owing to its modular design, the R&S®EMC32-S EMC measurement software is specifically tailored to meet such complex requirements. It can be customized by including additional measurement functions and support other measuring instruments. This means that EMC test systems can be expanded at minimum cost at any time and modified to meet the latest requirements. FIG 1 lists the typical applications and EMC standards and provides an overview of the corresponding R&S®EMC32-S options.

The R&S®EMC32 software platform can also be expanded to include EMI measurement tools and a test sequencer for performing individual measurements sequentially*. It thus covers the entire range of EMC measurements — from simple lab applications through to complex test sequences in EMC test chambers.

* All modules for the R&S®EMC32 software platform are listed in FIG 7 on page 61.

FIG 1 Applications, relevant standards and the expansion modules available for the R&S®EMC32-S EMC measurement software.

Application	Standards (Examples)	Required software options*
Industrial and domestic appliances	IEC / EN 61000-4-3, EN 61000-4-6	R&S®EMC32-S
Information technology	CISPR24 / EN 55024 IEC / EN 61000-4-3, EN 61000-4-6	R&S®EMC32-S
Medical appliances	EN 60601-1-2 / EN 60601-2-x	R&S®EMC32-S
Mobile communications	ETSI EN 301489-x / ETSI EN 300826	R&S®EMC32-S and R&S®EMC32-K2 (R&S®EMC32-K4 recommended)
Automotive	ISO 11451, ISO 11452 SAEJ 1113, SAEJ 551 2004/104/EC GMW3097 Feb 2004 Ford ES-XW7T-1A278-AC	R&S®EMC32-S and R&S®EMC32-K1 (R&S®EMC32-K4 recommended)
	Reverberation chamber EN 61000-4-21 GMW3097 Feb 2004 Ford ES-XW7T-1A278-AC	R&S®EMC32-S, R&S®EMC32-K1, -K3 and -K4
Aerospace & defense	MIL-STD-461E/F CS101, CS114, RS101 and RS103	R&S®EMC32-S and R&S®EMC32-K1 (R&S®EMC32-K4 recommended)
	MIL-STD-461E/F CS103, CS104, CS105	R&S®EMC32-S, -K1 and -K6 (R&S®EMC32-K4 recommended)
	RTCA / DO-160	R&S®EMC32-S and R&S®EMC32-K1 (R&S®EMC32-K4 recommended)

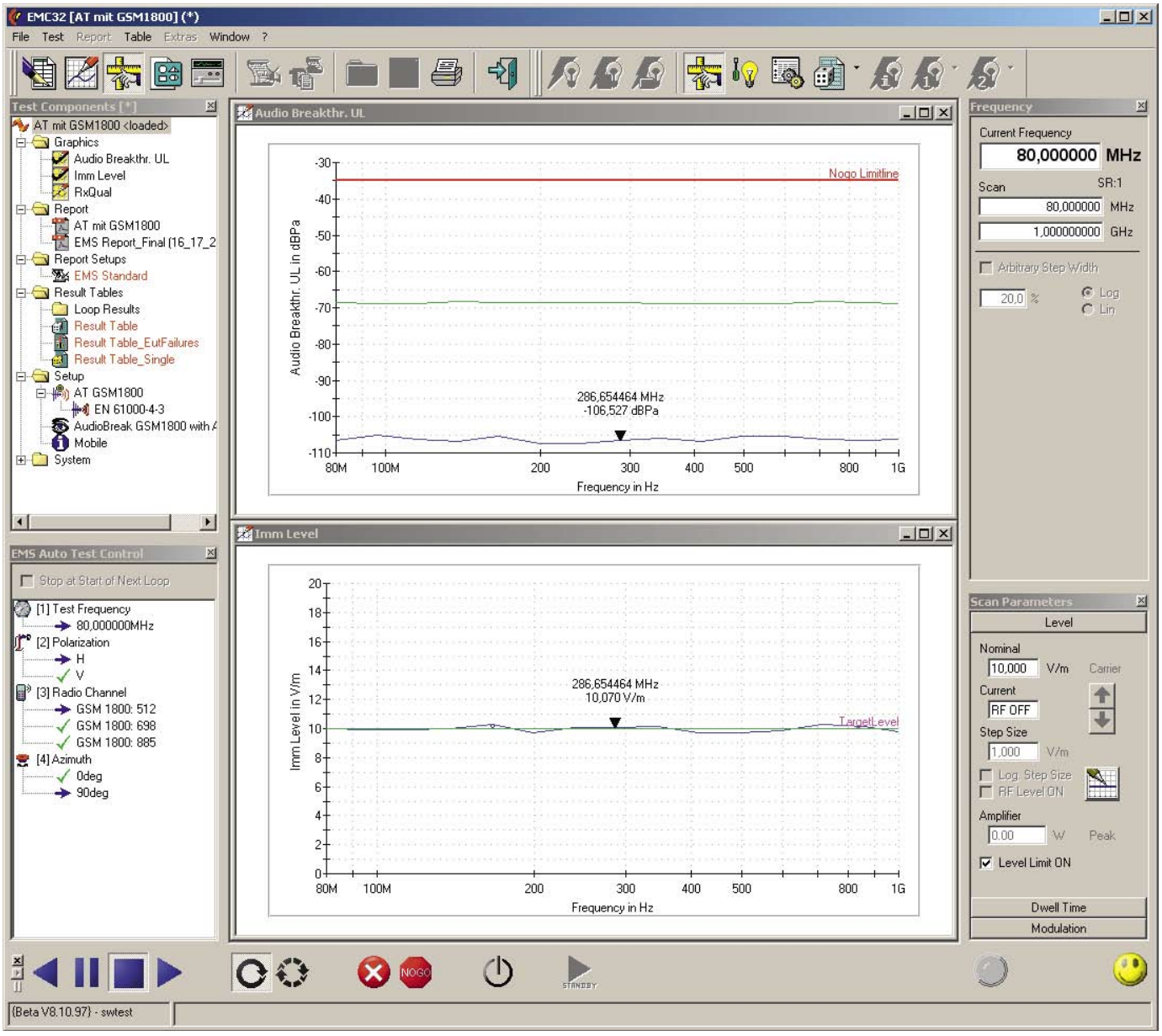


FIG 2 Clear and convenient: the R&S®EMC32-S EMC measurement software during an audio breakthrough measurement.

R&S®EMC32-S EMC measurement software: versatile tool offering a variety of functions

R&S®EMC32-S is a leading software tool for determining immunity to conducted and radiated electromagnetic disturbance signals. Its intuitive GUI makes learning and operating the instrument quick and easy (FIG 2). The software is the ideal tool for both compliance and batch testing in scenarios with high EUT throughput. Likewise, it is used for measurements accompanying development where its versatility makes it irreplaceable. It comes in handy in applications that range from development and conformance testing through to production and quality assurance. Its key functions are as follows:

Structured test sequence owing to test templates

The test parameters for disturbance signal generation and EUT monitoring — like test report templates and EUT information (type, serial number, measurement conditions) — are centrally stored in a template library customized for the individual test setup. This makes tests reproducible and efficient. When starting the test, users simply need to select and combine the required templates. Even less experienced users quickly become familiar with the clear and easy operation.

EUT-oriented measurement data storage with open data structure

R&S®EMC32-S makes the task of archiving and further processing measurement data particularly convenient: The measurement software stores all results (tables, graphics, log files) as well as the associated test templates for testing an EUT in an EUT-oriented directory in the Windows™ file system (FIG 3). Since all necessary settings are automatically documented, tests can be reproduced and repeated at any time.

Convenient compilation of test reports and versatile post-processing of measurement data

The report editor in R&S®EMC32-S supports the user in compiling comprehensive test reports in RTF, HTML and PDF format. Moreover, measurement data and measurement settings (test templates) are stored in Unicode (ASCII) format and measurement graphics in WMF format. They can thus be imported into applications such as Microsoft™ Word. The software also provides important information such as path and file names in an information file for synchronizing the data transfer using a Microsoft™ Word macro. In order not to block the measurement system controller during test report compilation, a free-of-charge installation of R&S®EMC32 may be used.

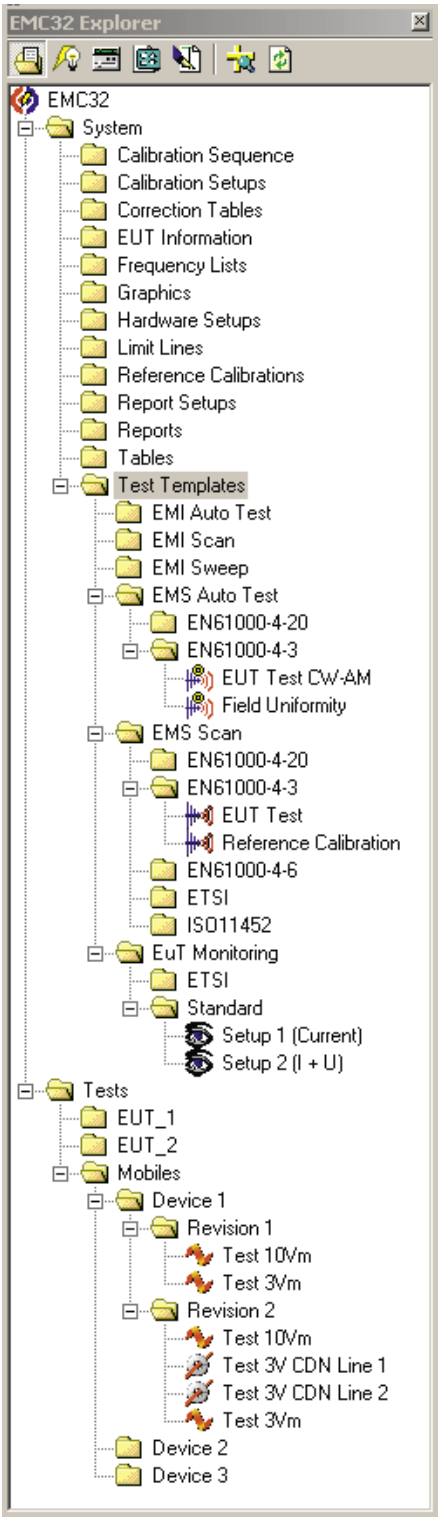
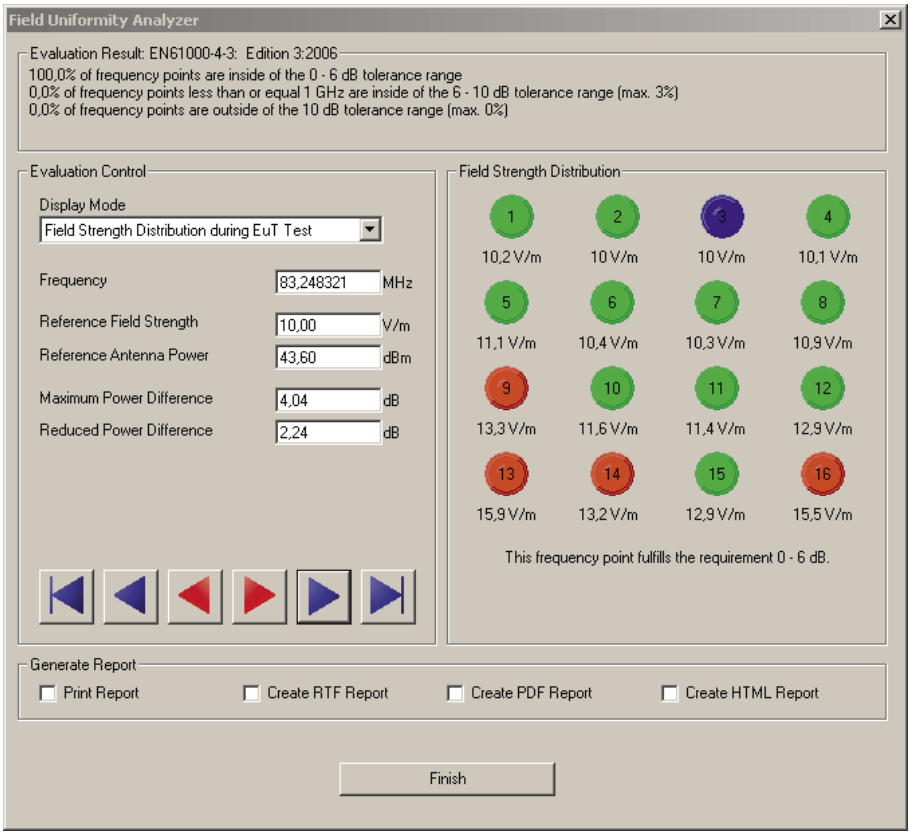


FIG 3 The software stores all the results in an EUT-oriented directory structure.

FIG 4 Graphical field uniformity analyzer.



Monitoring options

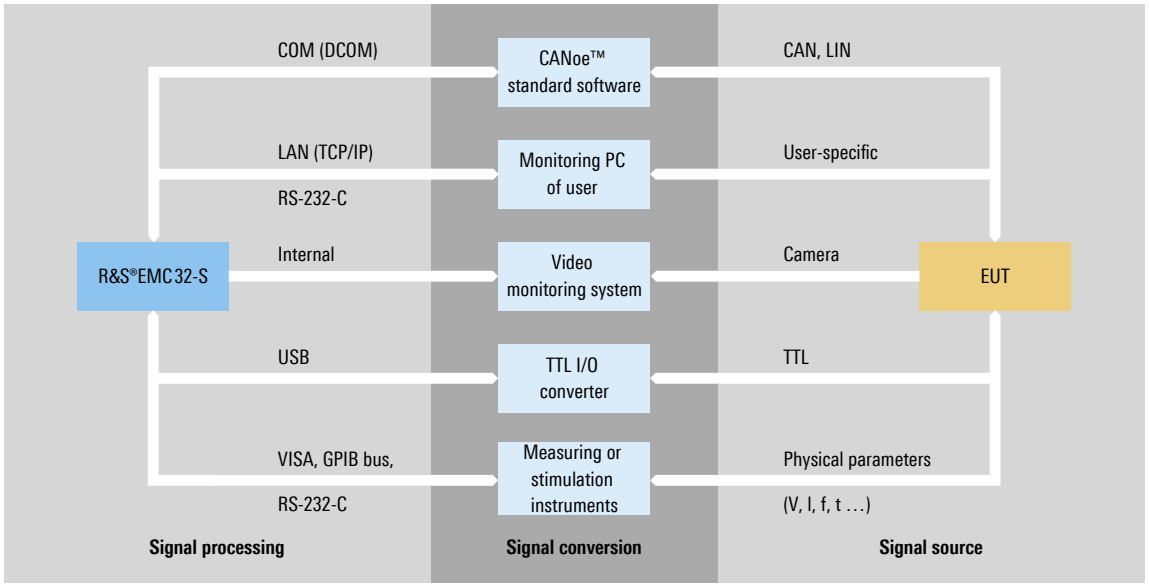


FIG 5 Overview of monitoring options using the R&S®EMC32-S EMC measurement software.

Efficient measurement, calibration and monitoring functions

An efficient algorithm allows the fast generation of disturbance signals in accordance with the common substitution and closed-loop methods. The test run can be performed either automatically or in the single-step mode. Automatic runs are ideal for overview measurements and acceptance tests. In contrast, the single-step mode supports analysis by enabling the user to interactively change the frequency, level or modulation of the disturbance signal.

The straightforward calibration concept covers complete signal path calibration with a calibration sequencer as well as transducer and reference calibration. This helps ensure the easy replacement of system components, if required. The integrated device test, an amplifier test (max. power and amplifier saturation) and the system monitoring function activated during a test run round out the monitoring functions.

Intensive backup through worldwide support

The R&S®EMC32-S EMC measurement software supports the user with a comprehensive, context-sensitive online help facility. It also includes application notes for performing the tests in accordance with the most important EMS standards. Further backup is provided 24 hours a day worldwide by the Rohde&Schwarz support centers.

Measurements in line with IEC / EN standards (commercial)

The basic configuration of the R&S®EMC32-S software fully supports EMS measurements in line with the generic EN 61000-4-3 standard (electrical field in absorber chamber) and EN 61000-4-6 (disturbance voltage/current with coupling / decoupling network (CDN) and bulk injection current clamp) and offers the following key functions:

Comprehensive evaluation of field uniformity

The software allows a standard-compliant graphical evaluation of field uniformity (FIG 4). It also provides important auxiliary information (e.g. reference point and field-strength distribution) that is essential for weighting the performance of the test chamber. The R&S®EMC32-K4 option enables the user to automate the reference calibration across all measurement points. In this case, the field probes are either automatically put into place by using a positioning device or interactively by the user.

Synchronization with external monitoring software

Apart from EUT monitoring with measuring instruments (FIG 5), the software also supports communications with external EUT monitoring software. R&S®EMC32-S sends current disturbance signal data (frequency, level, polarization,

etc.) to the external monitoring software via a command-based interface (TCP/IP, RS-232-C) and, in return, receives the EUT status. In the simplest case, this is a Go/NoGo message but can also involve comprehensive information. If required, the external monitoring software can deactivate the disturbance signal via the interface and then set the EUT to a defined state. Another application of this function is to insert disturbance signal parameters into a video signal, for example, by using appropriate hardware.

User-definable actions during the test run
By user-definable actions, the test run can be adapted to the requirements of the EUT or test (e.g. at the start / stop of a test or at each test frequency). Such actions may, for example, include controlling or resetting the EUT, outputting comments or operating instructions, starting other applications and sending network messages.

Measurements in the automotive sector

The R&S®EMC32-K1 option expands R&S®EMC32-S by EMS measurements on automotive components and vehicles in line with ISO 11451 / ISO 11452, SAE and relevant manufacturer-specific standards. Both for disturbance signal generation and EUT monitoring, this includes the following specific functions:

Integrated method for disturbance level control
The test specifications for conducted susceptibility BCI (bulk current injection) provide for the measurement of amplifier harmonics and the limiting of the current disturbance level. R&S®EMC32-S controls the monitoring of the harmonics by means of a spectrum analyzer or measuring receiver.

The R&S®EMC32-K1 option can generate special radar pulse signals and measure their power as stipulated by some test specifications (e.g. GM and Ford standards, see FIG 1).

Automatic determination of immunity thresholds
Even in the development phase, it is important to determine the maximum susceptibility versus frequency. The R&S®EMC32-K1 option offers extensive monitoring capabilities to automate this measurement task. It separately detects EUT errors during a measurement and determines the immunity threshold.

Automation by means of sequential measurements for different modulation modes
By means of sequential measurements, the R&S®EMC32-K4 option supports the automation for multiple modulation modes (e.g. CW / AM / FM), different antenna polarizations, turntable positions and EUT states. The software performs a worst-case analysis of all EUT errors.

Monitoring wireless connections

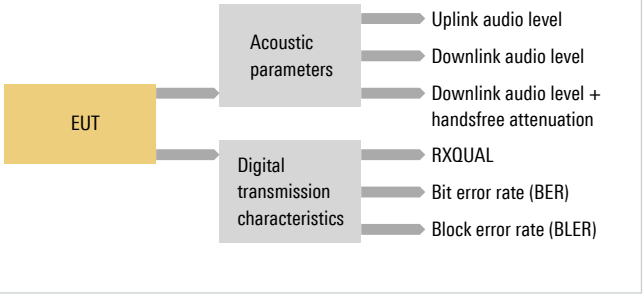


FIG 6 The R&S®EMC32-S EMC measurement software offers a variety of alternatives for monitoring the wireless connections of an EUT.

Flexible CAN and LIN bus monitoring
In state-of-the-art vehicles, electronic subassemblies communicate primarily via CAN or LIN bus systems. These buses are used to monitor the functions of the individual components and those of the overall system. The R&S®EMC32-K1 option provides an interface to the CANoe™ standard software (FIG 5) via which data can be sent to a specific subassembly on the bus and parameters such as wheel / engine rpm or indicator light frequency can be queried.

Measurements on wireless terminals

EMS measurements on wireless terminals are carried out in accordance with the ETSI EN 301489 family of standards (FIG 1). To do so, the disturbance signal is generated in line with the generic standards EN 61000-4-3 and EN 61000-4-6. Depending on the relevant wireless communications standard (e.g. 2G, 3G, WLAN, WiMAX™, Bluetooth®), the R&S®EMC32-K2 software extension allows the measurement to be performed using the following functions:

Automatic setup and monitoring of communications
The device drivers integrated in the R&S®EMC32-K2 option for the R&S®CMU200, R&S®CMW270, R&S®PTW70 and R&S®CBT communications testers from Rohde&Schwarz help ensure the defined setup of communications (voice and data) when the testers are started and help monitor active communications during the measurement.

Easy audio calibration for audio breakthrough measurements
As the first step, EMS measurements of voice connections require an audio calibration during which the reference AF levels are measured at a defined useful audio level. The integrated audio calibration wizard supports the user when measuring the uplink and downlink reference level as well as the headset offset. The measurement results are stored in the EUT information file together with the EUT information.

Comprehensive monitoring of EUT functions

Depending on the type of connection (data or voice connection), the monitoring function of the R&S®EMC32-S EMC measurement software supports the measurement of the corresponding parameters by using the relevant communications tester or audio analyzer (FIG 6). As for voice connections, the audio reference values for the specific wireless communications standard are automatically taken from the EUT information file. If a measured value exceeds the permissible limit, the standard describes a method used to assess whether this failure only occurs in a narrowband frequency range or if it is broadband. For this purpose, the disturbance frequency is reduced and increased by defined offsets and the measurement is repeated. The software automatically varies the frequency and enters a note in the result table indicating whether the effect is narrowband or broadband, since narrowband interferers may be neglected.

Automatic tests covering multiple wireless communications frequency bands

The R&S®EMC32-K4 option further automates wireless communications measurements by defining additional loops for wireless communications band, polarization and turntable position to be included together with the measurement loop for test frequencies. An automatic handover is performed when the wireless communications frequency band is changed.

Measurements on components from the aerospace & defense sector

EMS measurements on military equipment and aircraft components in line with the major EMC standards MIL-STD-461E/F and DO-160E place exacting demands on the measurement software since, during these measurements, various disturbance signals have to be generated over a wide frequency range using different methods. The R&S®EMC32-K1 option smooths out these measurements so that they are no problem at all.

Easy intermodulation measurements on transmitting and receiving equipment

The R&S®EMC32-S software together with the R&S®EMC32-K6 option supports the measurement method for intermodulation measurements in line with sections CS103 / 104 / 105 of MIL-STD-461E/F. It controls up to three signal generators in parallel that generate the required useful signal for the EUT as well as a simulated external disturbance signal.

Alternative EMS measurement in reverberation chambers

Reverberation chambers are an alternative to anechoic chambers as they allow high field strengths to be generated at a favorable price. A reverberation chamber is basically a cavity resonator in which a statistically homogeneous and isotropic electrical field is generated by a stirrer. If the R&S®EMC32-K3/-K4 options have been installed, the R&S®EMC32-S software supports these measurements in line with MIL-STD-461E/F and the commercial generic EN 61000-4-21 standard. Chamber calibration (unloaded / loaded), loading the chamber by the EUT (for each new EUT setup) and the actual EUT test are included.

Summary

Owing to its intuitive operating concept, the R&S®EMC32-S EMC measurement software allows users to easily perform EMS measurements in any EMC-relevant sector. This applies to measurements accompanying development and also to acceptance tests and certification measurements. The wide range of options enables users to modify an EMC test system to meet the latest requirements. Various alternatives for monitoring the EUT allow largely automated immunity testing, thus reducing costs and increasing throughput in the EMC lab or test house. Since the tried-and-tested option concept (FIG 7) also includes expansions to handle emission measurements, investing in R&S®EMC32-S is definitely worthwhile and future-oriented.

Robert Gratzl; Xaver Sutter

Further information at www.emc32.rohde-schwarz.com

Type	Application
R&S®EMC32-S	Basic package for EMS measurements
R&S®EMC32-K1	Enhanced EMS functionality for automotive / aerospace / MIL measurements
R&S®EMC32-K2	Measurement of audio breakthrough and spurious emissions in the wireless communications sector
R&S®EMC32-K3	Expansion modules for performing measurements in reverberation chambers in line with EN 61000-4-21 (R&S®EMC32-K4 also required)
R&S®EMC32-K4	EMS automatic test functionality
R&S®EMC32-K6	Measurements in line with MIL-STD-461E CS103 / 4 / 5
R&S®EMC32-K7	Generic driver for RF generators, power meters and oscilloscopes
R&S®EMC32-EB	Basic package for emission measurements
R&S®EMC32-K10	EMI automatic test functionality
R&S®EMC32-K11	Sequencer for EMC measurements
R&S®EMC32-K21	Application interface

FIG 7 Modules for the R&S®EMC32 software platform.

Powerful and favorably priced test transmitter for use in manufacturing

Breathtaking: It is small in size and fail-safe, consumes minimum power, provides high signal quality for all relevant broadcasting standards and is favorably priced. These key features enable the new R&S®SFE100 to set new standards in manufacturing environments.

R&S®SFE100: developed for use in centralized transmitter room systems

Manufacturing facilities for panels, LCD TVs or mobile TV receivers and their components include several production lines. These production lines are run in parallel to produce devices for handling different TV and sound broadcasting standards, as required. As this involves multiple test signals for different transmission standards on various frequencies and different contents, a central multisignal generation system is often more economical than a solution consisting of standalone instruments. Signal generators required for such systems are normally accommodated in a centralized transmitter room system. All RF output signals are combined in

FIG 1 Minimum space requirements and low power consumption — just two of the benefits that make the R&S®SFE100 test transmitter indispensable in manufacturing.

a coupling network and distributed to the individual test stations in the factory via cable, sometimes over considerable distances. And this is the very environment for which the R&S®SFE100 test transmitter (FIG 1) was developed.

Quality, efficiency and reliability in manufacturing

Available in various models, the R&S®SFE100 single-standard test transmitter covers all relevant analog and digital TV and sound broadcasting standards. Owing to the transmitter's intelligent implementation, the latest standards such as DTMB — the new Chinese terrestrial transmission standard — can easily be covered. Other models for handling DVB-SH and CMMB are currently being prepared. The R&S®SFE100's very good RF characteristics with regard to frequency range, output power, phase noise and dynamic range are reflected by a modulation error ratio (MER) of >40 dB, which is excellent in this class.

A further unique advantage is the compact design of the R&S®SFE100: Besides the RF modulator, a baseband generator and a 0.5 W power amplifier are accommodated in a cabinet that takes up only one height unit. Still, the overall power consumption of 70 W is surprisingly low, and it is only 100 W if a built-in power amplifier is included. Comparable products often require six or more height units in a 19" rack because they are designed as standalone instrument solutions to handle baseband generation, modulation and amplification. Their overall power consumption is two to three times greater than that of the Rohde&Schwarz solution.

As the number of RF channels in such centralized transmitter room systems typically amounts to several dozen, adequate air conditioning is a must. The higher the dissipated power of the instruments, the more powerful the air-conditioning system must be, thus driving up costs considerably. The R&S®SFE100 helps the customer rein in these costs: Owing to its low power consumption and reduced cooling requirements, it offers a lower cost of ownership than feasible with existing solutions. Considering the long life of the overall system, the R&S®SFE100 quickly pays for itself.

Just as versatile in the baseband

Rohde&Schwarz offers transport stream libraries for its baseband generators to meet the requirements of various standards. Each generator comes with a factory-installed base library to cover the most common standards. Moreover, libraries for HDTV, H.264, ISDB-T, DVB-H and ATV are available. The list of supported standards is really impressive: Analog standards such as PAL, NTSC and SECAM as well as digital standards such as MPEG-2, H.264 (MPEG-4/AVC), (HE-)AAC and Dolby AC-3 are covered. And since user-specific test scenarios often vary widely, transport streams can of course be adapted correspondingly.

System solutions from a single source

The seamless integration of all instruments into the overall system is crucial for smooth and trouble-free manufacturing. Rohde&Schwarz customers have a distinct advantage here: They obtain instruments and system solutions from a single source (FIG 2). The Rohde&Schwarz sales and service network, which covers virtually the entire world, provides fast and reliable support that includes consulting, integration and service.

The compact passive solutions for coupling networks from Rohde&Schwarz help ensure low-loss signal combination while providing high signal quality in manufacturing environments — harmonics, intermodulation and interference

System configuration

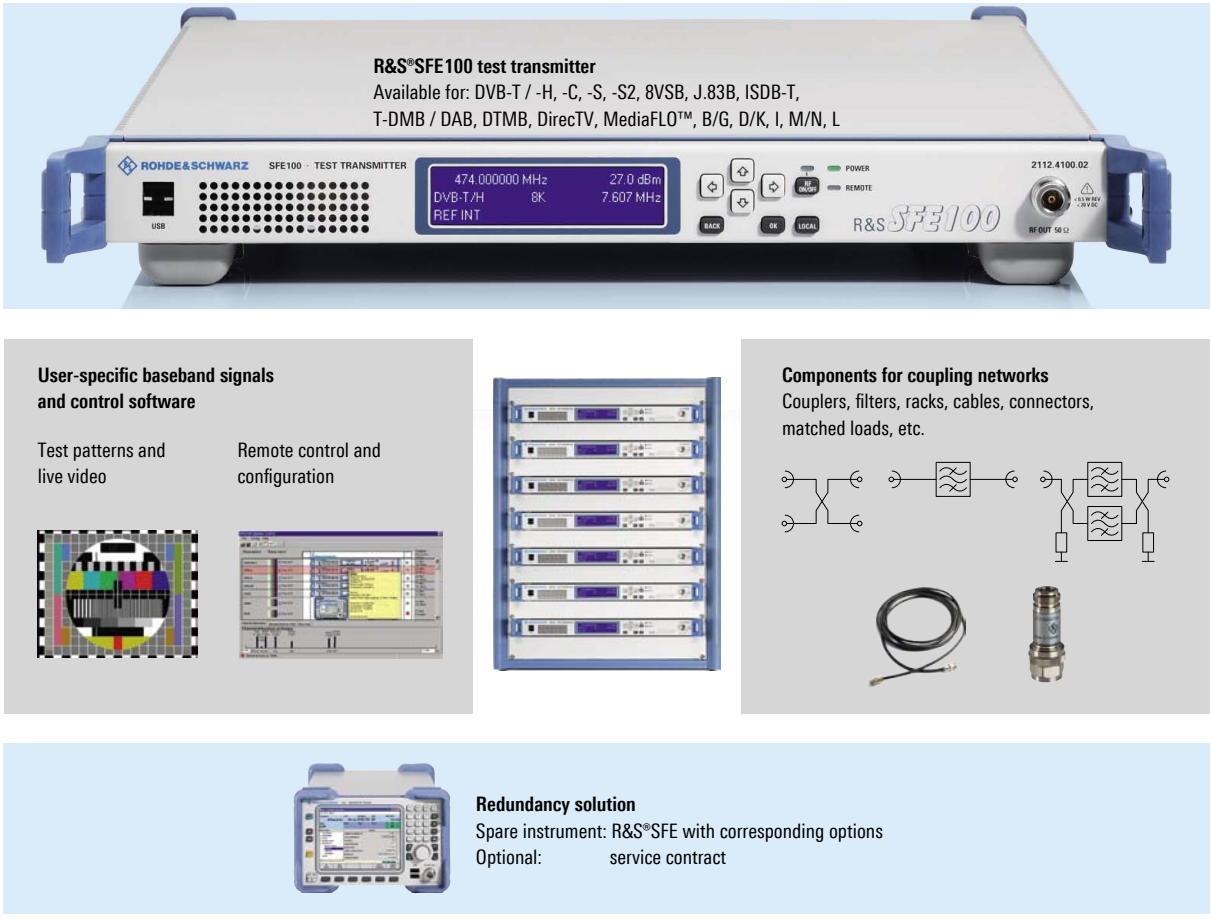


FIG 2 Rohde&Schwarz offers and installs turnkey centralized transmitter room systems from a single source.

signals pose no problem at all. Another crucial asset in manufacturing is that the overall system can be quickly reconfigured to meet constantly changing requirements. Reliable configuration management is also indispensable for comparing the quality of finished components and instruments over extended periods of time by using T&M tools. All this is handled by the system's integrated control software, which stands alongside the already remarkable remote control features offered by the R&S®SFE100.

Summary: strong trio in broadcast testing

As far as quality and performance are concerned, the R&S®SFU broadcast test system has been unrivaled in research and development for four years. Manufacturers of TV receivers and components therefore regard it as a de facto standard. At the end of 2007, the R&S®SFU's little brother was introduced — the R&S®SFE, a multistandard generator at an attractive price. Now, the new R&S®SFE100 test transmitter is joining the two instruments to form a strong and powerful trio. Specifically designed for use in manufacturing, the R&S®SFE100 offers a level of performance and efficiency never before seen in this field.

Harald Gsödl

Test signals for the new CMMB and DVB-SH mobile TV systems

With the arrival of the new CMMB and DVB-SH standards, the next generation of mobile TV systems is just around the corner: hybrid terrestrial / satellite-based networks. To develop receivers for these standards, manufacturers of consumer electronics require appropriate test signals. Two new realtime coder options for the R&S®SFU broadcast test system from Rohde&Schwarz (FIG 1) now meet these requirements – as always, in high quality.

Hybrid terrestrial / satellite-based mobile TV

How many TV transmitters are needed to cover an entire country? The answer, of course, depends on a large number of factors, both technical and geographical. Only one thing is certain – there are many. And they cost a lot of money. An alternative is offered by satellite TV, which can illuminate a number of countries with a single transponder. However, there is also a drawback: The same programs will be broadcast in the entire coverage area, i.e. regional programs are not possible. Furthermore, satellite reception in the Ku band requires a directional antenna and a direct line-of-sight link to the satellite, which is hardly possible with mobile TV. What is required, therefore, is a technology for a mobile TV system that can cover an entire country at a reasonable cost and whose signals can be received by small antennas also

FIG 1 The R&S®SFU broadcast test system, the reference signal source for all major broadcast standards, also generates signals for the new CMMB and DVB-SH standards.

indoors. The solution is a hybrid terrestrial / satellite-based network like the one shown in FIG 2. A satellite transponder provides the umbrella cell and ensures nationwide coverage. In thinly populated rural areas, it is the only signal source. In cities and areas with poor satellite reception, terrestrial repeaters are used in addition to retransmit the satellite signal, which in particular improves indoor reception. The repeaters also make it possible to feed in regional programs. This principle is already being commercially utilized today in the USA's XM Radio™ and Sirius™ digital radio systems. Two new standards were recently developed for mobile TV: The Chinese CMMB (China mobile multimedia broadcasting) and the European DVB-SH (digital video broadcasting for satellite services to handheld devices).

CMMB in the UHF and S bands

The Chinese CMMB standard uses different frequency bands for the two transmission channels. The satellite downlink operates in the S band, the terrestrial repeaters in the UHF band. Since the range is larger in the UHF band, fewer transmitters are required than with a network in the S band. Receivers, however, become more complex, for with this concept they need a dual-band tuner. Program contents are coded into a multiplex and transmitted as a multiplex-frame transport stream, where three elementary streams (one each for video, audio and data) form a program. Depending on the data rate, multiple programs can be combined into a service. A CMMB multiplex can theoretically contain up to 39 services. Each service is assigned to a logical channel. The individual logical channels can be coded differently, giving each service individual error protection (FIG 3). For example, SDTV programs for basic coverage can be broadcast with strong error protection. In addition, an HDTV program can be transmitted in the same multiplex with high data rate and proportionately lower error protection. The error protection in the CMMB standard takes place in two stages: outer Reed-Solomon coding with four different code rates, and inner low-density parity check (LDPC) coding with two different code rates. At the RF, OFDM is used as the modulation type, with a 4K mode for 8 MHz channels and a 1K mode for 2 MHz channels (FIG 4).

CMMB trial operation during the Olympic Games

CMMB was tested in six cities in a pilot project during the Olympic Games in China. Seven TV and two audio programs were broadcast. According to the plans of the Chinese State Administration of Radio, Film and Television (SARFT), CMMB

Principle of a hybrid mobile TV system

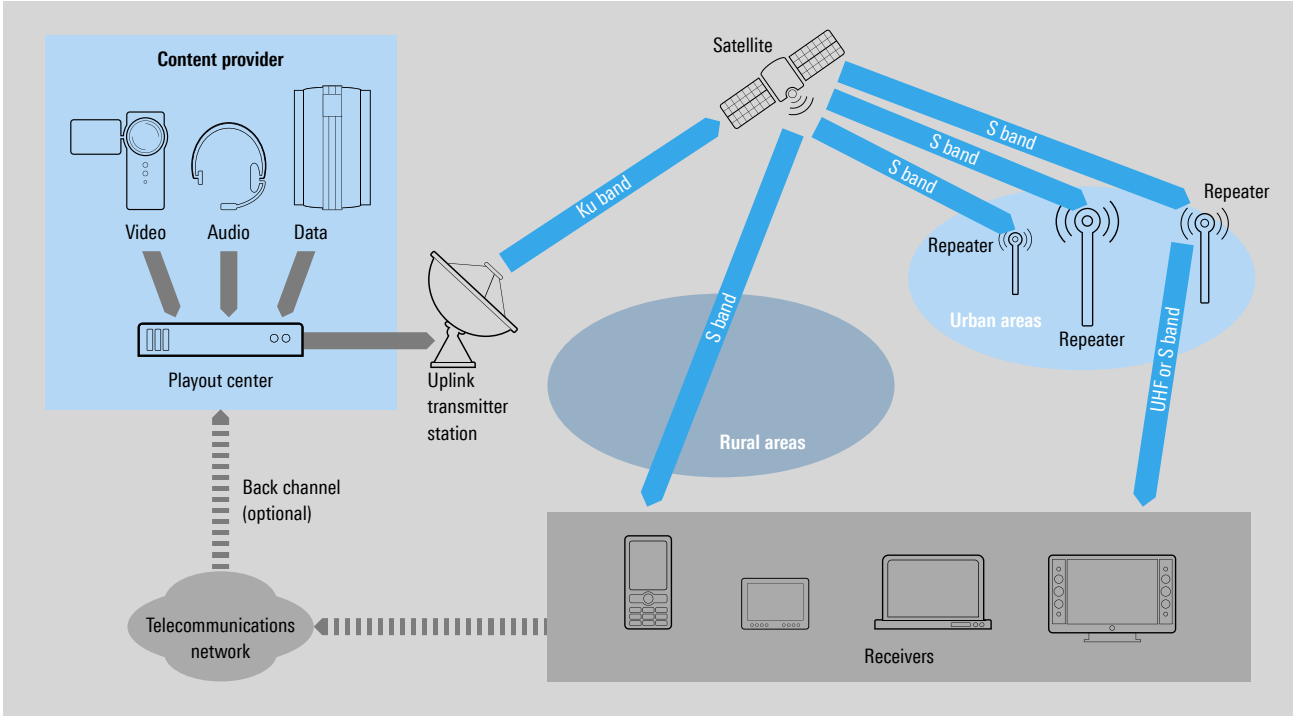


FIG 2 System architecture of a hybrid terrestrial / satellite-based network.

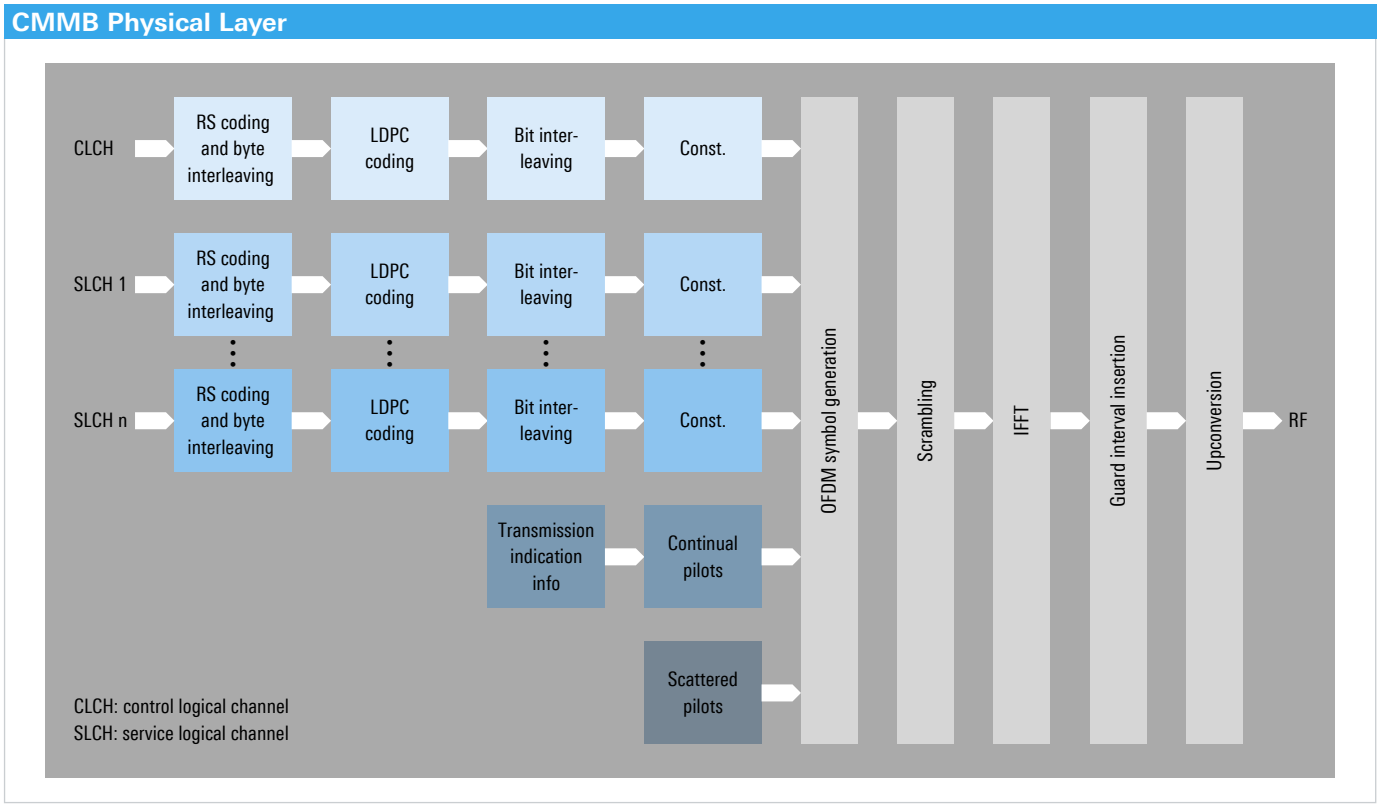


FIG 3 CMMB physical layer with logical channels.

is scheduled to be available in 200 cities by the end of 2008. Pilot operation is limited to only the terrestrial part of the network in the UHF band; a satellite is expected to be launched in the first quarter of 2009.

Similar yet different – the European DVB-SH standard

Although the concept is similar, the European DVB-SH standard differs from CMMB in several major aspects. In the case of DVB-SH, the network also consists of a satellite component (SC) and a complementary ground component (CGC). Unlike CMMB, however, the satellite component is the main component in DVB-SH and must be present in every network. In this way, DVB-SH ensures full coverage starting on day one. Both network components transmit in the S band, between 2170 MHz and 2200 MHz – a frequency range that the European Commission has allocated for operating mobile satellite systems (MSS).

Use of tried-and-tested technologies

The DVB-SH standard specifies two different operating modes. In the SH-A mode, both the satellite and the terrestrial repeaters transmit OFDM signals and can be operated as a single-frequency network. In the SH-B mode, the satellite transmits a time division multiplex (TDM) signal with single-carrier modulation. Using this type of modulation, the satellite transponder achieves higher efficiency. The terrestrial network uses OFDM also in the SH-B mode. DVB-SH specifies three types of terrestrial transmitters. *Simple repeaters* receive, amplify and retransmit the satellite signal, and serve primarily to improve reception indoors. *Transposers*, in contrast, decode

IFFT mode	4K	1K
Channel bandwidth	8 MHz	2 MHz
Signal bandwidth	7.512 MHz	1.536 MHz
OFDM carriers	4096	1024
Number of useful carriers	3076	628
Guard interval	1/8	
Constellation	BPSK, QPSK, 16QAM	

FIG 4 CMMB modulation parameters.

the receive signal and remodulate it before retransmitting it. *Mobile repeaters*, finally, are used to supply trains and buses with DVB-SH signals. Transposers and mobile repeaters can insert local content (e.g. regional programs, or advertisements and announcements in public transit vehicles) into the program. This is done either by replacing part of the received content or by superimposing local content onto the original signal by means of hierarchical modulation.

DVB-SH relies to a large extent on technologies that have already been tried and tested. For example, OFDM modulation is identical to that of DVB-H, except that a new 1K mode for 1.7 MHz channels has been added (FIG 5). The TDM technology is similar to that of DVB-S2 satellite TV. Baseband signal processing is largely the same as with DVB-H, allowing much of the DVB-H infrastructure to be taken over. However, DVB-SH adds an optional extended MPE FEC (multiprotocol encapsulation – forward error correction) with interleaving lengths of several seconds. This makes it possible to compensate slow fading effects occurring on the satellite downlink. And as with UMTS, turbo coding is used as error protection.

Pilot projects in Europe and the USA

The DVB-SH technology was successfully tested last year in an initial pilot project in southern France, where a helicopter hovering at a high altitude simulated the satellite. A pilot project in northern Italy is currently underway. Interest in DVB-SH is also growing outside of Europe. In April 2008, a private operator in the USA launched a satellite with which a pilot project is being run initially in the cities of Las Vegas and Raleigh. Later the service is to be offered nationwide.

Peter Lampel

	OFDM (SH-A and SH-B)				TDM (SH-B)
IFFT mode	8K	4K	2K	1K	–
Channel bandwidth	8 / 7 / 6 / 5 MHz			1.7 MHz	8 / 7 / 6 / 5 / 1.7 MHz
Signal bandwidth	7.61 / 6.65 / 5.70 / 4.75 MHz			1.52 MHz	roll-off 0.15 / 0.25 / 0.35
OFDM carriers	8192	4096	2048	1024	–
Number of useful carriers	6817	3409	1705	853	–
Guard interval	1/4, 1/8, 1/16, 1/32				–
Constellation	QPSK, 16QAM ($\alpha = 1$), 16QAM ($\alpha \neq 1$)				QPSK, 8PSK, 16APSK

FIG 5 DVB-SH modulation parameters.

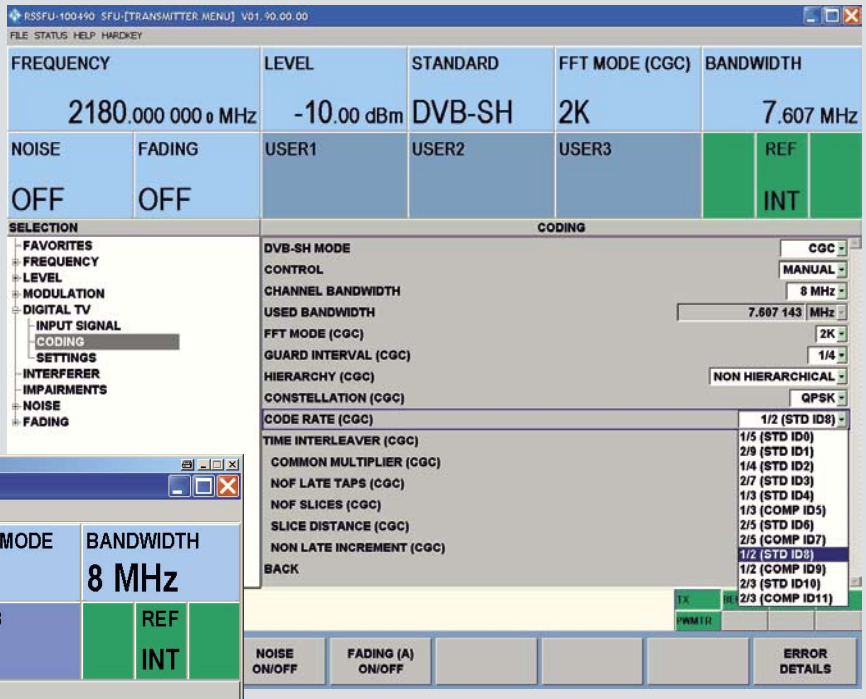
Realtime signal generation with the R&S®SFU

Since its market launch, the R&S®SFU broadcast test system (FIG 1) has firmly established itself in the consumer electronics industry as the reference signal source for digital and analog broadcast standards. Rohde&Schwarz is now expanding the package of transmission standards for the R&S®SFU by adding two new coder options for realtime signal generation for the CMMB and DVB-SH standards. The realtime coders accept video and audio data in the form of a transport stream, code the data and modulate the RF signal in accordance with the respective standard (FIG 6). In the case of CMMB, the coder detects the control information transmitted in the transport stream's MF0 frame and sets the coding for the individual services accordingly (FIG 7). This automatic setting is the main advantage of realtime coding as implemented in the broadcast signal generators from Rohde&Schwarz. Vector signal generators with arbitrary waveform functionality are unable to do this.

Simulating transmission channels realistically

In the development of CMMB and DVB-SH receivers, it is especially important to realistically simulate interference in the transmission channels. In hybrid terrestrial/satellite-based systems, the specific characteristics of both channels must be taken into account. During terrestrial transmission, interference is primarily due to multipath propagation; in the satellite channel, the greatest problem is the enormous attenuation. The R&S®SFU simulates these effects using a fading simulator and a wideband noise source. In addition, impulsive noise caused by electric appliances disturbs reception indoors. Plus, the phase noise of the satellite transponder diminishes the signal quality, especially that of TDM signals. Equipped with the impulsive noise option and the phase noise option, the R&S®SFU can simulate these effects, too. Last but not least, especially in the S band, reception may be disturbed by UMTS signals originating either from base stations or, in the case of 3G mobile TV phones, from the phone's own transceiver. Here, too, the R&S®SFU provides a solution: With its unique interferer management option, it simulates adjacent channel occupation without additional external equipment (FIG 8). The R&S®SFU broadcast test system therefore has what it takes to become, for the new CMMB and DVB-SH mobile TV standards, what it already is for today's broadcast standards: the reference signal source.

FIG 6 DVB-SH realtime coding with the R&S®SFU.



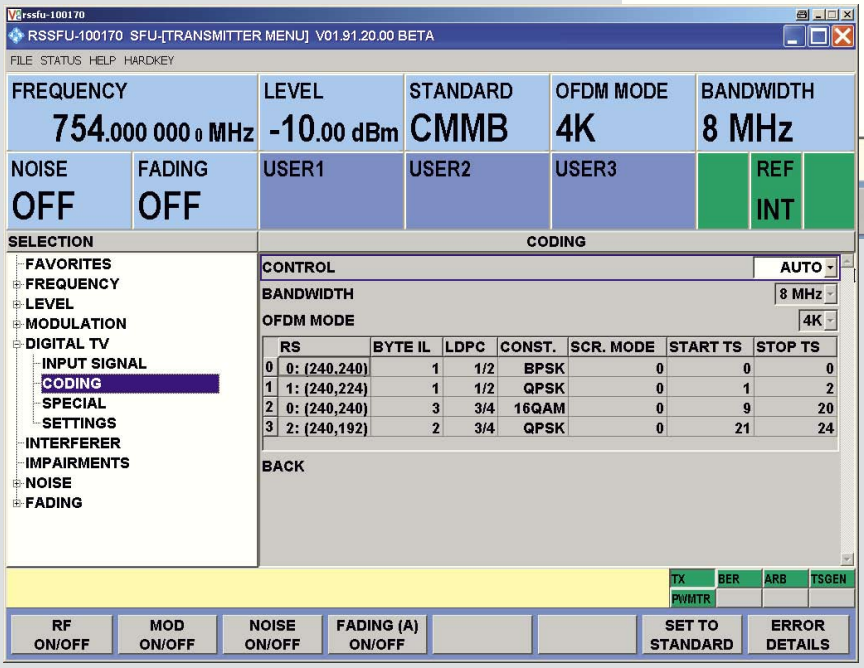
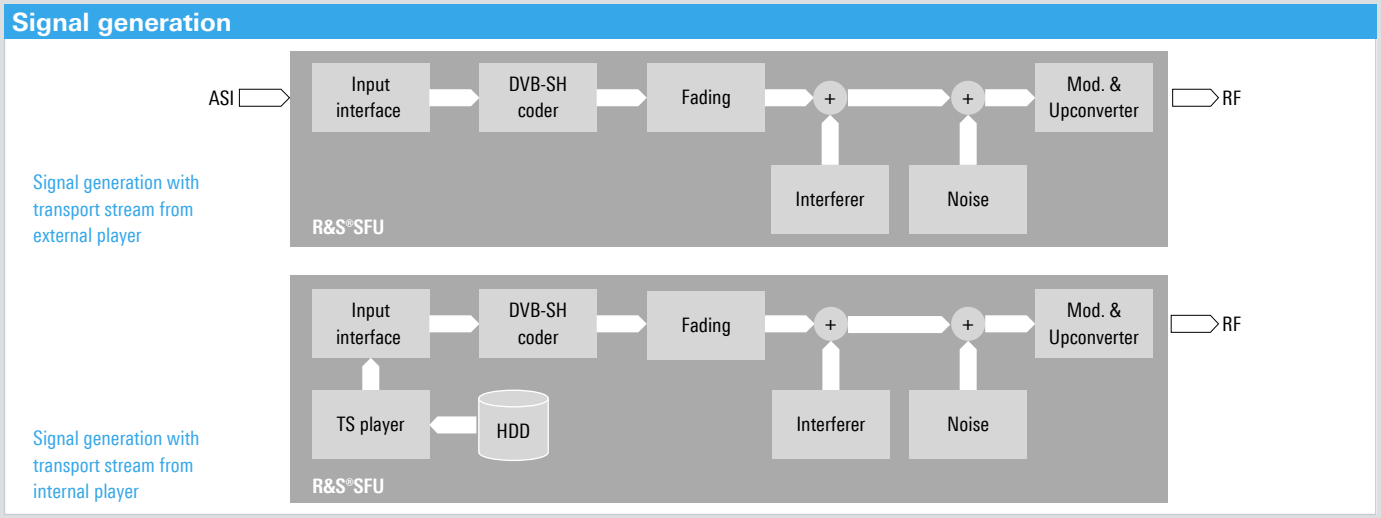


FIG 7 Automatic setting of coding parameters with CMMB.

FIG 8 Signal-generation and channel-simulation principle of the R&S®SFU.



Optimizing DVB-T/-H single-frequency networks with the R&S®ETL TV analyzer

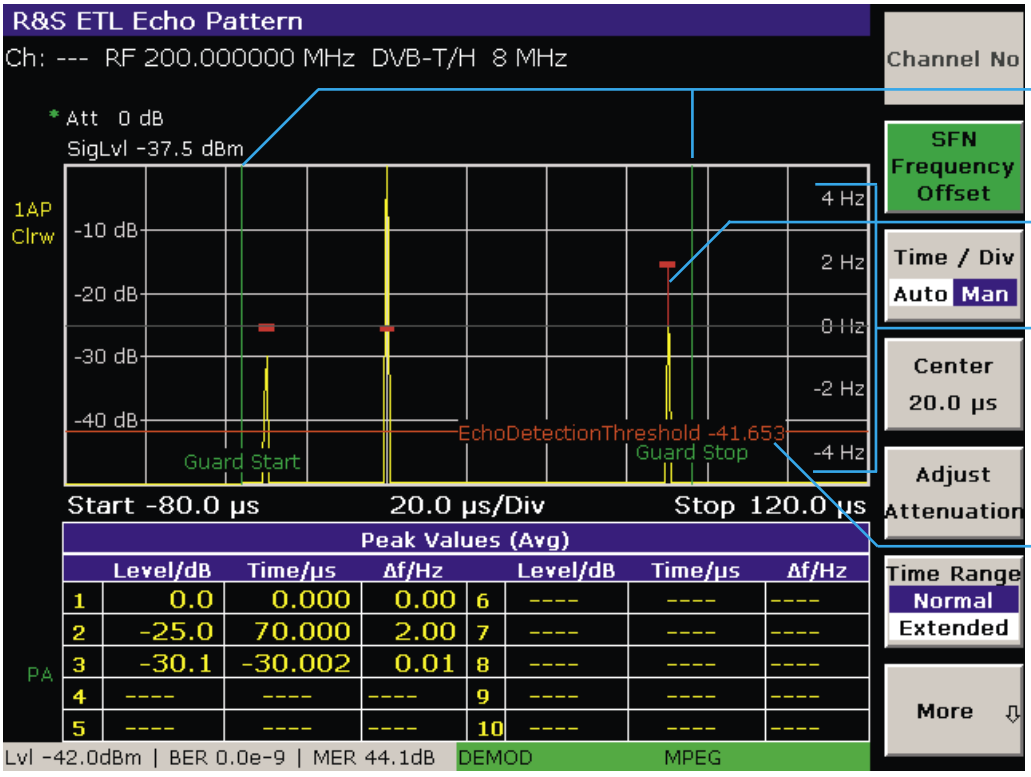
Keeping a DVB-T/-H single-frequency network (SFN) running smoothly not only requires that every single TV transmitter in the network functions properly – network performance criteria in the coverage area also have to be strictly complied with. Offering an extensive range of easy-to-operate analysis functions, the R&S®ETL TV analyzer helps operators to ensure that the required high level of transmission quality is maintained both at the transmitter stations and in the coverage area.

Precisely defined performance criteria in single-frequency networks

The principal advantage of OFDM-based digital TV transmission standards is that they allow a TV transmitter network to be operated as a single-frequency network. SFNs provide enhanced reliability of coverage especially in densely populated areas. To ensure trouble-free operation within an SFN, certain criteria have to be precisely met. For example, all DVB-T / DVB-H transmitters in a network must broadcast their signals at exactly the same frequency, with permissible deviation not exceeding 1 Hz (VHF / UHF). Greater deviations will result in time-variant channels in the area of reception, with the consequence of a poorer bit error ratio (BER) in the case of stationary receivers, accompanied by a decrease in range.

The DVB-T / -H standard further defines guard intervals with durations depending on the selected transmission mode. DVB-T / DVB-H receivers can compensate differences in delay between the SFN transmitter signals received via the direct path and those received via multiple paths due to reflections. This is possible on condition that the differences in delay between the individual transmitters do not exceed the duration of the guard interval. Measures taken to optimize SFNs include defined delays being set on each transmitter to ensure that the guard interval will be maintained at any location within the network. Violation of the guard interval in the order of a few microseconds can cause problems similar to those encountered in the case of deviations from the transmit frequency, especially in large coverage areas.

The R&S®ETL TV analyzer is a versatile platform that has been mainly designed for installing, putting into operation and servicing TV transmitters, for carrying out coverage measurements on terrestrial TV networks, and for performing measurements on cable headends (see News from Rohde&Schwarz No. 195 (2008), pp 48–55).



Guard interval after automatic positioning of the FFT window.

Frequency deviation of a signal relative to the selected main transmitter.

Frequency axis for the display of the frequency deviation.

Signal paths above this threshold are taken into consideration when determining the position of the FFT window.

FIG 1 The DVB-T / -H SFN frequency offset option indicates deviations from the center frequency with high precision; the option expands the echo pattern (amplitude) graph by displaying frequency deviation in addition.

Moreover, the receive level must be high enough to yield a signal-to-noise ratio sufficiently large to ensure error-free reception. The R&S®ETL offers precise analysis functions for each of the three criteria – transmitter frequency, differences in delay and receive level – and presents results in a single measurement window.

SFN analysis at a glance

The R&S®ETL's *Echo Pattern* measurement window (FIG 1) reveals at a glance whether the above criteria are complied with in an SFN. It provides straightforward time-domain display of the individual single-frequency transmitters and of reflections. Two green lines mark the beginning and the end of the selected guard interval. A zoom and center function facilitates navigation within a trace, allowing even extremely narrow pulses and pulses located closely together to be analyzed in detail. In addition, up to four markers can be activated to compare performance characteristics of the individual transmitters, e.g. different transmitter delays, in the time domain. A particularly valuable aid is the result table displayed below the diagram. It lists up to ten pulses according to level or delay. Level values are displayed as relative values referenced to a user-selected main pulse. As the absolute levels of echo signals at the site of reception are also of interest, especially in the case of coverage measurements, the R&S®ETL allows you to choose between relative or absolute level display.

DVB-T / DVB-H signals contain scattered pilots that support channel estimation in the receiver. These pilot carriers are unmodulated and, after interpolation in the time domain, are available on average at every third OFDM carrier as reference points in the frequency domain. The echo pattern is created by means of an inverse fast Fourier transform (IFFT) that transforms the channel frequency response into the time domain. Since a reference point is available only at every third OFDM carrier, the echo pattern displayed in the time domain extends only over one third of the OFDM symbol duration. Pulses with delays outside this range – which may occur in the case of overshoot – are subsampled in the

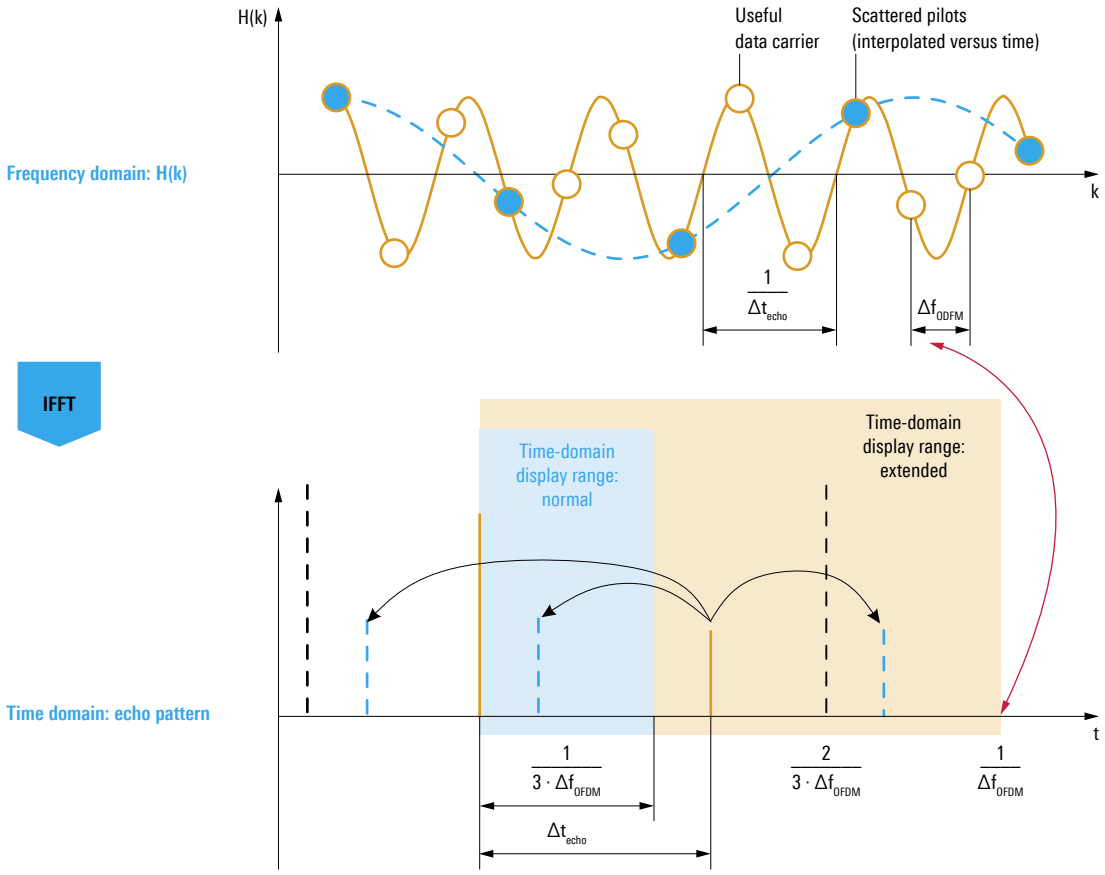
frequency domain by the pilot carriers (aliasing). This usually leads to a pulse with a short delay (image pulse) being erroneously displayed in the echo pattern (FIG 2). The R&S®ETL offers, as a special feature, time domain display of the echo pattern up to the OFDM symbol duration (patent application for Rohde&Schwarz filed). The extended display range allows low-level pulses caused by overshoot to be correctly displayed as post-echoes. Problems resulting from overshoot can thus be clearly identified and echoes unambiguously allocated.

Immediate detection of frequency deviations

To ensure that all transmitters within an SFN operate at exactly the same frequency, each transmitter of the network is locked to a GPS reference signal. To verify whether all transmitters actually transmit at the same frequency, it was previously necessary to measure the frequency at each and every transmitter location – a time-consuming method. The test receiver used for this purpose was itself required to be locked to a precision reference frequency to ensure that measurements were performed with the stipulated accuracy. A patented method developed by Rohde&Schwarz now provides the solution to this problem. The R&S®ETL-K241 DVB-T / -H SFN frequency offset option indicates, for each signal, the frequency deviation relative to the main pulse with an accuracy of <0.3 Hz (FIG 1). As the frequency deviation is determined as a relative value, a reference frequency is not necessary, which greatly facilitates measurements. The R&S®ETL will immediately indicate, at an arbitrary reception site in the coverage area, whether the frequency of one or more transmitters in the network deviates from that of the main transmitter.

FIG 2 Subsampling of the channel frequency response by the scattered pilots (blue) in the DVB-T / DVB-H signal, caused by an echo pulse with a very long delay. This normally leads to the distant echo being misinterpreted as a near echo. A special method implemented in the R&S®ETL complements the channel frequency information by including reference points at all OFDM carriers. This expands the time-domain display range for the echo pattern up to the OFDM symbol duration (orange).

Display of post-echoes on the R&S®ETL



Stable synchronization even under adverse reception conditions

In-depth analysis of a DVB-T / DVB-H signal is possible only if the TV analyzer is reliably synchronized. The R&S®ETL features a special DVB-T / DVB-H demodulator developed by Rohde&Schwarz. Based on a novel concept, the demodulator ensures stable synchronization even under adverse reception conditions. To extract the OFDM carriers, the FFT window is customarily placed such that the start of the guard interval coincides with a symbol changeover of the main pulse or the first pre-echo. With dynamically changing reception conditions, however, this may quickly lead to a loss of synchronization.

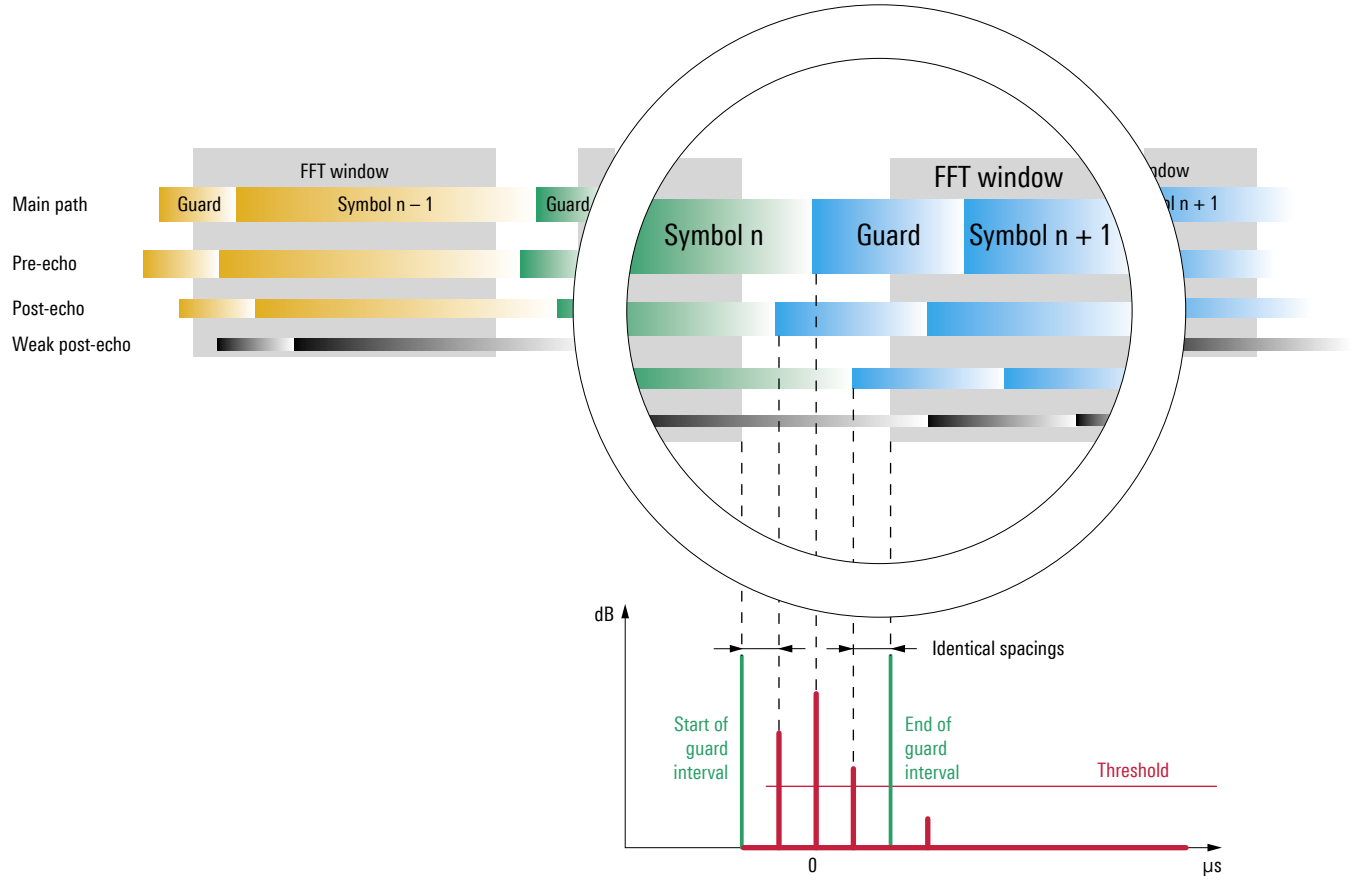
This is different in the case of the R&S®ETL: The TV analyzer continuously and automatically defines a decision threshold as to where the FFT window should be placed. This is done as a function of the signal quality and the selected receive mode (*Fast/SFN* or *Mobile*). The decision threshold is inserted as a red line in the echo pattern diagram (*EchoDetectionThreshold*, see FIG 1). All echo paths with signal powers above the threshold are considered in the decision. Based on this decision, the R&S®ETL positions the FFT window with equidistant spacing, i.e. such that the distance between the symbol changeover of the earliest echo path relative to the start of the guard interval and the distance between the symbol change of the last echo path relative to the end of the guard interval are identical (FIG 3). This greatly enhances reliability of synchronization even in busy signal scenarios. This exceptional feature makes the R&S®ETL an ideal choice also for mobile measurements.

The R&S®ETL TV analyzer again proves that it offers, in a single box, all the test functionality required to optimize your single-frequency network.

Werner Dürport; Martin Hofmeister

FIG 3 The R&S®ETL features an innovative method for positioning the FFT window, which ensures that the analyzer always remains synchronized even under adverse reception conditions.

Positioning of the FFT window on the R&S®ETL



2008 European Soccer Championship – also a technical challenge

The backbone of any large-scale event is well-functioning telecommunications. Guided by this principle, Austria's telecommunications offices, in an example of perfect collaboration, made their contribution to the smooth running of the 2008 European Soccer Championship, which was co-hosted by Austria and Switzerland. A variety of instruments and equipment from Rohde&Schwarz helped them perform their tasks.

Outstanding international cooperation

UEFA EURO 2008™ – the European Soccer Championship – was held in Austria and Switzerland from June 7 to June 29, 2008. Telecommunications in the two countries are regulated by two different national legal systems. Radio operators therefore had to take into account the respective laws and regulations and contact the relevant authorities in both countries. Without control and coordination by the authorities, the radio systems provided by different operators might interfere with one other, making smooth radiocommunications impossible. The intensive cooperation of Switzerland's Federal Office of Communications (BAKOM), the Austrian Telecommunications Authority and the Union of European Football Associations (UEFA) ensured that the administrative aspects were handled smoothly and effectively.

Hands-on approach to controlling radio traffic

In Austria alone, 4800 frequencies were coordinated, licenses for roughly 7000 additional individual radios were granted and 173 satellite uplink stations were authorized prior to and during the tournament. The operators came from 26 different nations. Licensing of their radio equipment was simplified as much as possible. For example, the Austrian Telecommunications Authority set up a website on the Internet portal of the Federal Ministry for Transport, Innovation and Technology (BMVIT) which provided, for example, application forms that could be completed electronically.

FIG 1 Test vehicles positioned in the vicinity of stadiums in spots especially suitable for conducting radio measurements were integrated into the DF and monitoring network (here outside the Ernst Happel Stadium in Vienna).

FIG 2 The direction finders and receivers from Rohde&Schwarz in the monitoring stations and test vehicles didn't miss a thing in the complex radio scenario.

To allow even last-minute registration of devices such as radio cameras, radio microphones and voice and data radiocommunications equipment, on-the-spot licensing for the issue of radio permits was offered directly in the stadiums on the days of the matches. Radiomonitoring engineers checked the operating frequencies and important technical parameters of the radio equipment on site. The personnel in the media center, equipped with laptops, online connections and portable printers, coordinated the operating frequencies and issued approvals immediately.

In accordance with the customary labeling requirement in defined security zones at large-scale international events, all radios were labeled with color-coded stickers. It was thus possible, for example, to see at a glance whether a device was approved for use in both countries, in all stadiums of one country or only for a specific stadium.

State-of-the-art T&M equipment and monitoring systems from Rohde&Schwarz

For security reasons, UEFA, using mobile luggage X-ray devices, checked the entire equipment of all media representatives and radio operators when they entered the soccer stadiums' security zones. The radiomonitoring team also checked each system and performed frequency checks to make sure that only coordinated frequencies and only approved radios were used in the security zones surrounding the stadiums. Measurements and checks were also performed on the equipment of operators in the fan zones, as interference with radiocommunications in the security zones was expected due to the short distances.

Fourteen stationary DF systems from Rohde&Schwarz were deployed, ranging from the R&S®PA055/R&S®PA010 Doppler direction finders to the latest digital monitoring direction finders (R&S®DDF05E). To increase density in the DF and monitoring network, the radiomonitoring team positioned large test vehicles near the stadiums (FIGs 1 and 2). These vehicles were equipped with R&S®DDF190 direction finders and

on-loan R&S®DDF195 direction finders as well as a variety of measuring and monitoring receivers from Rohde&Schwarz. All direction finders were remote-operated via a network using the R&S®DDF control software together with customer software. Network accesses via mobile radio (GPRS and UMTS) for all fixed and mobile test stations provided a complete overview of the RF scenario and of unidentified emissions at all times.

DF vehicles (FIG 3) equipped with compact R&S®DDF190/R&S®DDF195 direction finders and with R&S®ESMC and R&S®ESMB receivers were positioned in the vicinity of the stadiums. On-site support was provided by the T&M specialists of the Austrian radiomonitoring crew, who performed mobile direction finding using the portable R&S®EB200 miniport receivers. The modern R&S®FSH to R&S®FSQ40 spectrum analyzers as well as R&S®NRP power meters and R&S®ESCI EMI test receivers from Rohde&Schwarz were used at the checkpoints in the stadiums (FIG 4).

Photo: BMVIT

FIG 3 DF vehicles equipped with compact R&S®DDF190/R&S®DDF195 direction finders supported the stationary systems.

Continuing the fruitful cooperation

Due to the systematic and thorough work done during the runup to the tournament, there were no critical communications problems and only a minimal number of disturbances. The radiomonitoring team of the Austrian Telecommunications Authority, a suborganization under the BMVIT, was able to ensure the smooth running of the large-scale event, not least with the aid of state-of-the-art T&M equipment from Rohde&Schwarz.

As a result of the positive experience made with instruments and systems from Rohde&Schwarz, and due to the excellent cooperation at various events, the assigned technical department in the BMVIT plans to further expand the Austrian radiomonitoring network in the medium term by adding stationary and mobile R&S®DDF05E and R&S®DDF225 digital direction finders, modern R&S®EM550 and R&S®ESMD digital monitoring receivers and new R&S®PR100 portable wideband receivers.

Robert Matousek

Photo: BMVIT

FIG 4 Specialists of the Austrian Telecommunications Authority setting up the T&M equipment from Rohde&Schwarz at a checkpoint in Klagenfurt's Wörthersee Stadium.

Keeping a close eye on monitoring stations with R&S®ARGUS SIS

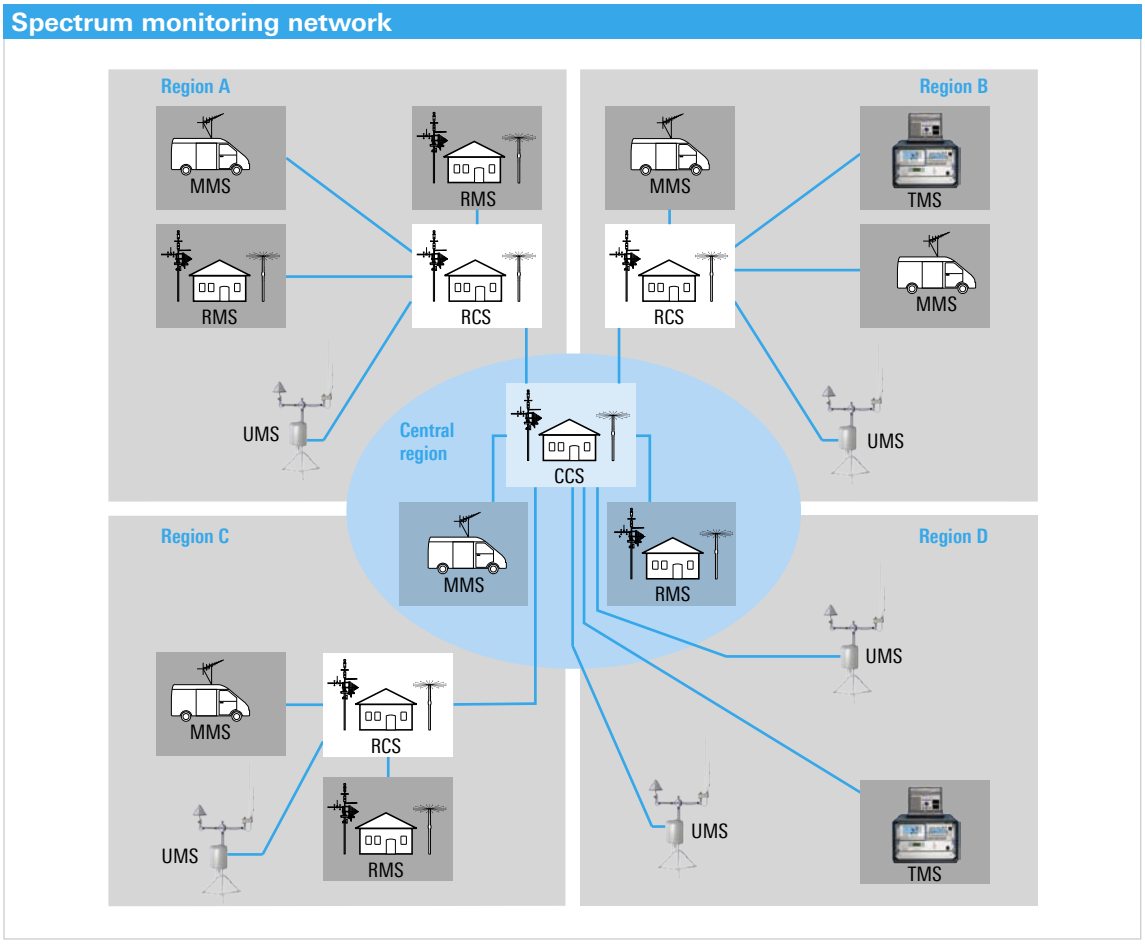
Are all unattended monitoring stations working properly? – This is a source of constant concern for anyone responsible for monitoring networks. The new status information system (SIS) module for the R&S®ARGUS spectrum monitoring software now handles this task – providing detailed, up-to-date status information at a glance.

Remote monitoring and control – the key to cost reduction

To do their jobs, national regulatory authorities have to operate a spectrum monitoring network that keeps them up to date about what is going on in the radio spectrum. Such networks usually include a national central control station (CCS), regional control stations (RCS), fixed remote monitoring stations (RMS), mobile monitoring stations (MMS), transportable monitoring stations (TMS) and universal monitoring stations (UMS) (FIG 1). Setting up and operating a national monitoring network requires large investments. Cost reduction is therefore a major consideration.

The CCS and the RCSs are usually attended by staff working in shifts. They keep track of the situation in the radio spectrum round the clock, monitor automatic measurements, and handle any interference reports. TMSs or MMSs, by contrast, are as a rule set up temporarily when and where required for the purpose of solving interference problems at critical spots. Automatic, fixed RMSs and UMSs are used for long-term monitoring.

FIG 1 Typical configuration of a nationwide spectrum monitoring network.
CCS: central control station
RCS: regional control station
RMS: remote monitoring station
MMS: mobile monitoring station
TMS: transportable monitoring station
UMS: universal monitoring station.



The fixed monitoring stations in particular are the ones that quickly deliver information about the radio spectrum if required. Plus, they can take the bearings of interferers and fix their positions. Such stations are frequently installed at high altitudes – on mountains and at locations that are difficult to access – to cover as large an area as possible. To scale down labor costs, fixed monitoring stations are remotely controlled from a central station.

Remote signaling and control systems for fixed, unattended monitoring stations

Fixed, unattended stations are usually remote-controlled via a broadband wide area network (WAN), which enables fast data exchange. If the remote link with these stations goes down due to a power failure or other malfunctions, communication with these stations is lost, and they can no longer be operated. In such a case, a service team is needed on site to put the station back into operation.

This effort can be avoided by deploying a fully autonomous remote signaling and control system based on R&S®SA129 station monitoring units (FIG 3). For this purpose, one R&S®SA129 is installed in the remote station to be monitored and another in the CCS or an RCS. The R&S®SA129 in the CCS / RCS can control and manage up to four remote stations. The basic configuration is shown in FIG 2.

The R&S®SA129 station monitoring unit in the remote station is connected to sensors that monitor the station's operating status and can respond to events or status conditions such as the following:

- Fire / smoke
- Open doors or windows
- Power supply o.k. / failed
- Status of air-conditioning system
- Status of generator
- Fuel level in generator tank
- Status of obstruction and hazard lighting for aircraft

If any changes are signaled by a sensor, the R&S®SA129 automatically transmits the information to its peer unit in the control station. The R&S®SA129 in the control station displays a message to indicate the status change. Status changes in remote stations can additionally be signaled by an optical and / or acoustic alarm in the control station. The staff at the control station can now access the remote station via

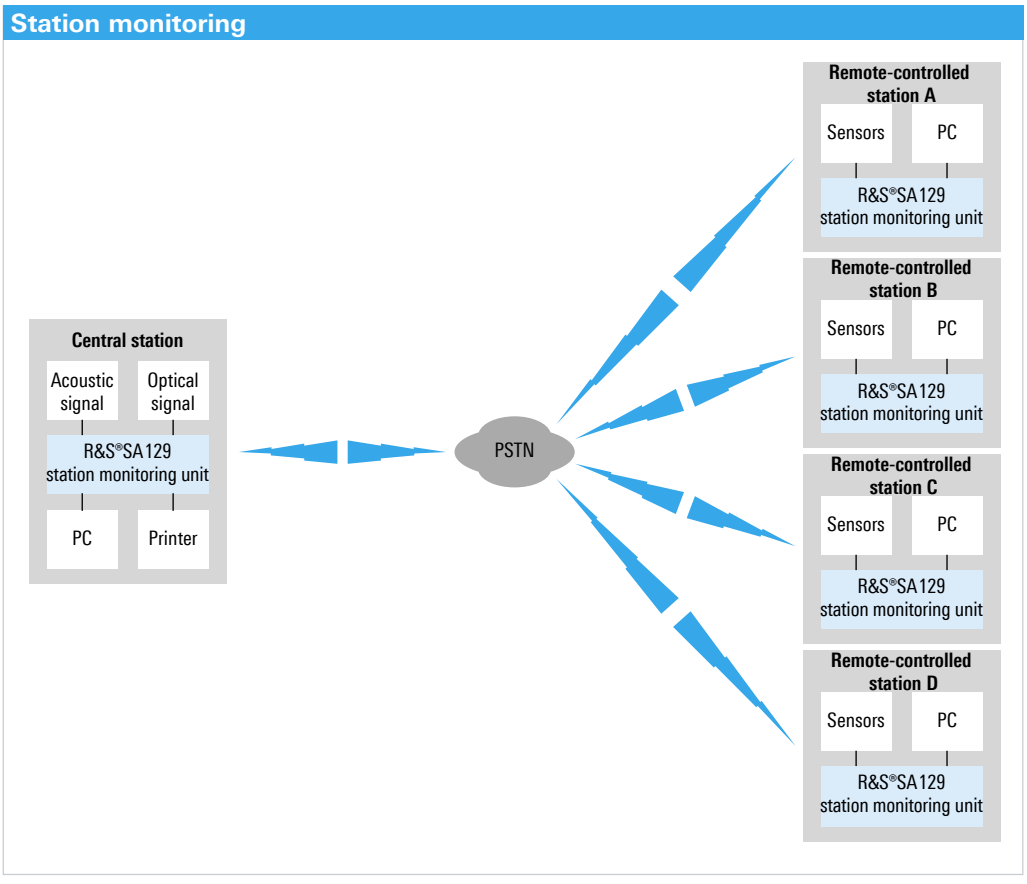


FIG 2 Station monitoring concept using R&S®SA129 station monitoring units.

FIG 3 The R&S®SA129 station monitoring unit contains a built-in power supply and is thus accessible via the public telephone network also in case of a power failure.

the public telephone network and take the required action to restore the proper operating status of the station. This process is completed in a matter of minutes and may involve the following:

- Restoring broadband communications
- Resetting the controller
- Manually starting up a generator
- Automatically shutting down the station in case of fire / smoke
- Activating the fire extinguishing system
- Switching on indoor and outdoor lighting as well as webcams

The R&S®SA129 station monitoring unit contains a built-in power supply, which ensures that the unit is operative also in case of a power failure. Despite its wide range of functions, the R&S®SA129 comes in a compact box of 19" and two height units.

Integration of R&S®SA129 station monitoring units into R&S®ARGUS monitoring systems

The new status information system (SIS) module for the R&S®ARGUS spectrum monitoring software provides – within a map display – a fast, straightforward and reliable overview of the status of all fixed monitoring stations (FMS) operating in a country. FIG 4 shows a simplified monitoring network in Germany with one CCS near Munich (two green status marks), one unattended monitoring station (FMS1, yellow and green status marks) close to the Frankfurt airport and another unattended monitoring station (FMS2) approx. 70 km southeast of Hamburg (red and white status marks). Double-

FIG 4 Map showing a simplified example of a monitoring network.

clicking a status mark, e.g. that of station FMS1, opens a window with detailed status information (FIG 5).

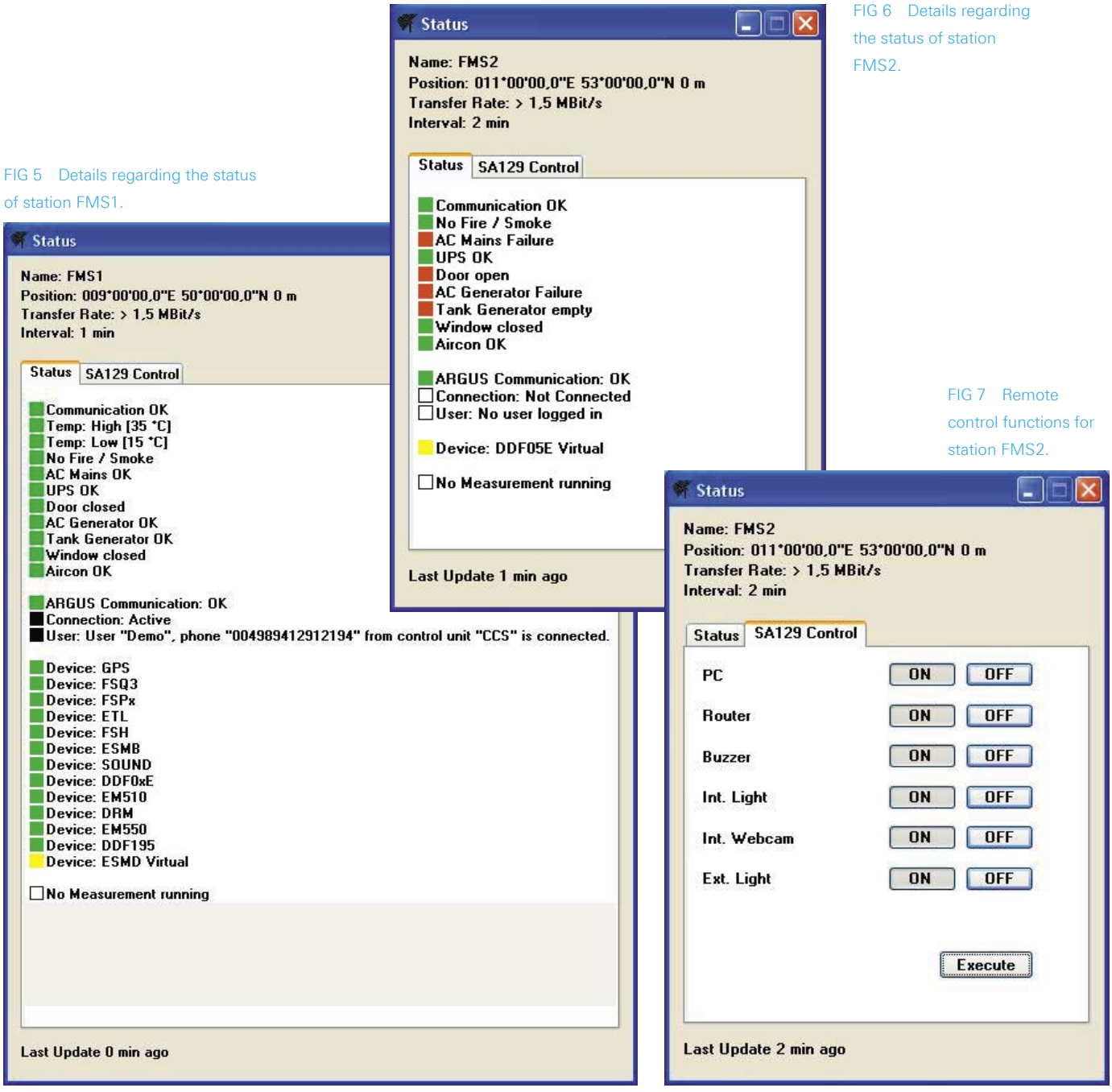
The displayed information reveals that a user named "Demo" with telephone number 0049-89/4129-12194 is operating the CCS. The communications system, the AC power supply, all measuring instruments, the GPS receiver and the R&S®DDF195 direction finder are working properly. The R&S®ESMD wideband monitoring receiver is in the virtual mode. Moreover, the status display indicates that no measurement is currently being performed at the station.

FIG 6 shows the status of station FSM2. The AC power supply has failed, the door to the monitoring station is open, and the standby generator is not operational because the fuel tank is empty. However, since the communications system is functional, the display indicates that the station is now running on the uninterruptible power supply. It further indicates that no user is logged onto the station and no user is connected to the station. The R&S®DDF05E direction finder is in the virtual mode, and no measurement is currently being performed at the station. All this data retrieved by remote control yields the same scenario that a service team would discover on site. In addition, capabilities for remote control are provided (FIG 7).

FIG 6 Details regarding the status of station FMS2.

FIG 5 Details regarding the status of station FMS1.

FIG 7 Remote control functions for station FMS2.



Availability, equipment supplied, system configuration

The new SIS module is available starting with version 5.3.0 of the R&S®ARGUS software. The module includes general maps of all countries. The user can integrate customized maps in BMP or JPG format, and reference them geographically by means of the known coordinates of reference points. If the map is superimposed on a Google map, a highly detailed map as shown in FIG 8 is obtained, for example. This provides administrators of monitoring networks with virtually unlimited map display capabilities.

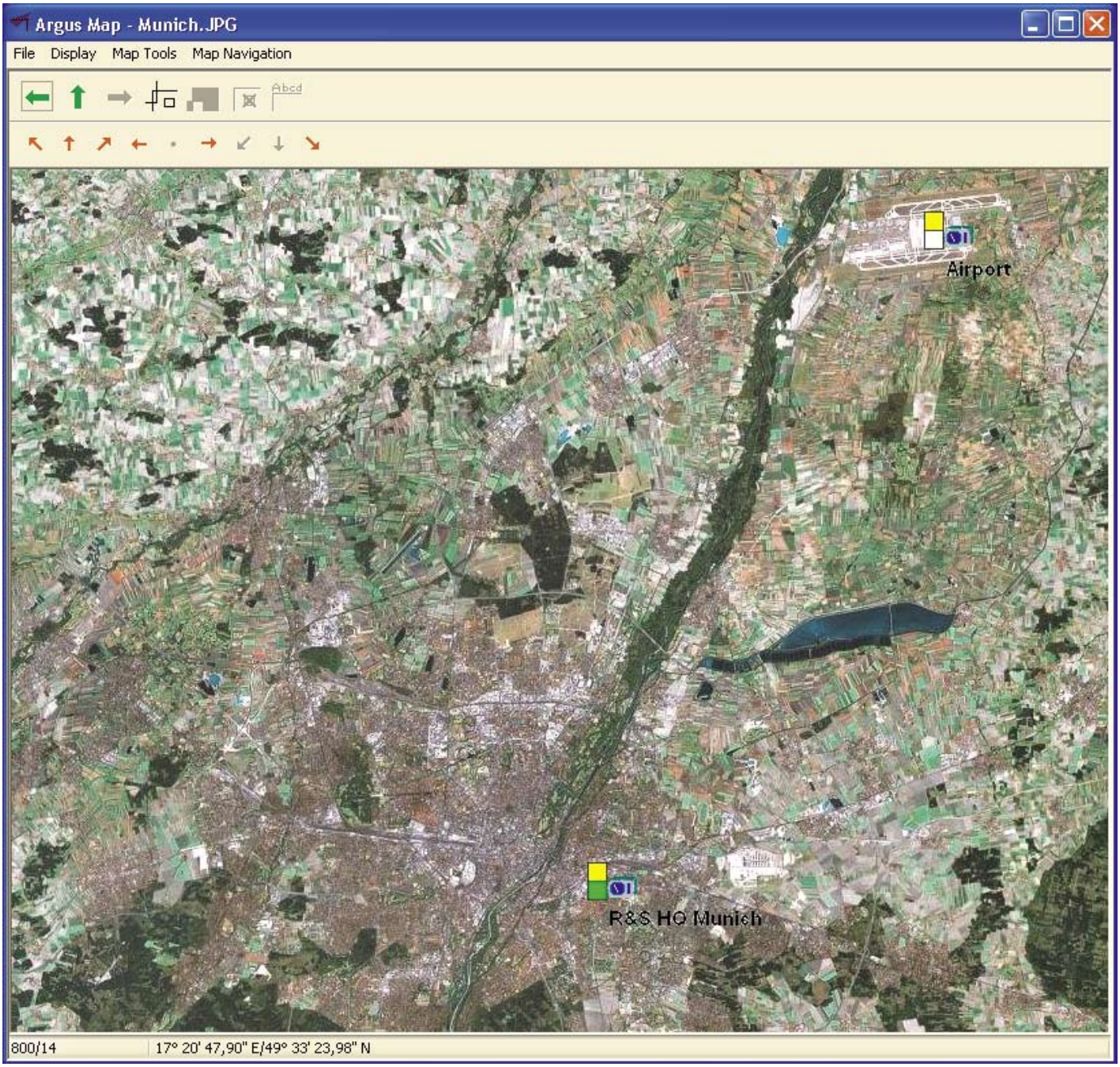
Further innovations are in the pipeline ...

Future issues of News from Rohde&Schwarz will present further innovations in the R&S®ARGUS software:

- Pulse measurement mode (PMM) for measuring pulsed signals
- Macro recorder for simplifying manual operating sequences

Michael Braun

FIG 8 Detailed map superimposed on a Google map.



New production facilities in operation in Teisnach since July.

New building makes Teisnach ready for the future

The company's Teisnach site now has an additional production hall for manufacturing transmitters. With just under 2000 square meters of floor space, the new production facility is already running at full speed. The site's 1100 employees now have a total of 44,300 square meters of production space to do their jobs.

Rohde&Schwarz extends free-of-charge invitation to Mobile World Congress 2009

The world's largest and most significant convention in the wireless communications industry will take place from February 16 to February 19, 2009, in Barcelona. Rohde&Schwarz will present innovations in the fields of wireless communications testing and mobile TV at the Mobile World Congress. The company's portfolio includes test solutions for LTE, WiMAX™ and MIMO, as well as transmitters for mobile broadcasting. To enable knowledgeable visitors with an interest in these fields to obtain a first-hand look at the company's innovations, Rohde&Schwarz will provide free-of-charge passes to convention visitors. The passes can be requested at www.mwc.rohde-schwarz.com starting on December 1, 2008 (as long as supplies lasts).

Rohde&Schwarz a top employer among tomorrow's communications engineers

In 2008, Rohde&Schwarz has once again strengthened its image as an employer among engineers and university students majoring in electrical and communications engineering. In a recent survey conducted by the "Trendence" institute, tomorrow's communications engineers even ranked the Munich-based electronics group number 1 among their top 100 favorite employers.

Mexico and Brazil interested in LTE and WiMAX™

As part of the network operator initiative in Latin America, the subsidiary in Mexico organized a network operator day for its customers. In addition to topics such as LTE and WiMAX™, new instruments were introduced to the more than 70 participants. For example, participants were able to attend workshops covering everything about drive tests using the R&S®TSMQ and R&S®TSMW. In June, the subsidiary in Brazil had already successfully staged a similar event.

Ulrich Rohde receives honorary senator award from the German armed forces university (Bundeswehr-Universität) in Munich

The president of the German armed forces university in Munich, Merith Niehuss, presents the university's highest award to Professor Dr.-Ing. Dr. h.c. mult Ulrich L. Rohde: the Honorary Senator Award. The committee was particularly impressed by Professor Rohde's contributions to promoting and shaping electrical engineering in the field of high frequencies and his many years of dedication to academic teaching. Furthermore, his numerous patents, more than 60 scientific publications and five books are proof of Rohde's great enthusiasm for radio engineering – a passion that he shares with his father, Dr. Lothar Rohde, one of the company's two founders.

Born in Munich, Rohde studied electrical engineering in the 1960s and began his professional career as a development engineer. From 1968 to 1974, he held the position of Technical Director for Military Communications Systems at AEG Telefunken Ulm. He has been a partner at Rohde&Schwarz since 1973. From 1974 to 1982, he served as head of the Rohde&Schwarz subsidiary in Fairfield / USA. Subsequently, he worked as Managing Director of the radiocommunications systems field of business at RCA. In 1985, he took over the reins at Compact Software, which he led until 1997. In addition, he serves as Chairman of Synergy Microwave. Now 68 years old, he is currently honorary professor for high frequency and microwave engineering at the university in Cottbus (Germany), and he carries the title of Full and Guest Professor many times over at universities in the USA and Europe.

Professor Dr. Ulrich L. Rohde.

First DVB-T single frequency network in Latin America

Viewing the new transmitters in Sao Paolo (left to right): Raul Faller (Kathrein Brazil); Gonzalo Martinez Pasman (Antina); Massimo Dolce (Rohde&Schwarz Latin America).

The Argentinean TV provider Antina has been broadcasting digital television in line with the European DVB-T standard since November 2008 using three new broadcasting stations. With a total of five stations, Latin America now has its first SFN that is based on more than 80 DVB-T transmitters from Rohde&Schwarz. Gonzalo Martinez Pasman, technical director at Antina, remarked, "The Rohde&Schwarz transmitters offer a clear competitive edge for Antina. The transmitters require significantly less space and energy, and they minimize the cooling problems and the noise level in the broadcasting stations." Antina offers more than 60 general and field-specific channels such as Gol TV, Space, CNN in Spanish, TNT, and HBO. Moreover, it produces its own content such as live sports broadcasts.

Rohde&Schwarz transmitters for DVB-T network in Ireland

Ireland's public broadcaster RTÉNL selected transmitters made by Rohde&Schwarz when it decided to expand its digital broadcasting network. New energy-efficient, high- and medium-power transmitters are being used at 12 sites. The transmitters help reduce operating costs. By the end of 2010, approximately 90 % of the Irish population is scheduled to have digital TV coverage.

Sweden continues to rely on DVB-T transmitters from Rohde&Schwarz

The Swedish service provider Teracom is expanding its DVB-T network in Sweden by deploying transmitters from Rohde&Schwarz. This will include installing a total of 50 high-power transmitters of the new energy-efficient R&S®NV8600 model. Rohde&Schwarz has already delivered transmitters for Teracom's existing DVB and DAB networks.

Transmitters from Rohde&Schwarz win "CSI Product of the Year" award

At IBC 2008, the international trade magazine "Cable and Satellite International" handed out award for the R&S®Nx8600 high-power transmitter, the R&S®Nx8300 medium-power transmitter and the R&S®NV8303VO outdoor transmitter. The energy-efficient transmitters won in the category "Best Terrestrial Wireless Transmitter Solution." This award-winning concept significantly reduces cost of ownership as compared to products already available on the market. Rohde&Schwarz was able to increase energy efficiency by 15 % to 25 % by implementing a new amplifier technology and an optimized cooling system.

The CSI magazine is one of the most important publications covering the cable, satellite, terrestrial broadcasting and IPTV industries. Each year, it presents awards for exceptionally well-engineered products that promise innovation. The jury consists of leading engineers and managers from the world's most important network operators, respected consultants and senior analysts.

Thomas Loichinger (left), head of product management for terrestrial broadcasting systems, accepts the award from Anver Anderson, independent industry consultant and jury member.

Road-ready

The new R&S®FSH4/R&S®FSH8 handheld spectrum analyzer – ideal for use in the field

- Flexibility – spectrum analysis, vector network analysis, distance-to-fault and power measurements
- Easy handling – low 3 kg weight, handheld design optimized for operation on the move
- Mobility – up to 4.5 h operation with field-replaceable Li-ion battery, and SD memory card for large volumes of data
- Reliability – ruggedized, dust- and splash-proof design, easy-to-read screen under all lighting conditions
- Convenience – internal tracking generator and VSWR bridge, R&S®FSH4View software for easy documentation of results

With the R&S®FSH4/R&S®FSH8, you'll be road-ready.
Find out more at www.rohde-schwarz.com/ad/FSH4

The Driving Force in
Spectrum Analysis

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