# News from Rohde & Schwarz

Handheld spectrum analyzer adds mobility to Rohde & Schwarz T&M quality

Future-proof protocol testers for conformance testing of WCDMA terminals

Transportable monitoring and DF systems for use at varying sites

2002/III
175

ROHDE & SCHWARZ

43 888/29

**Fast, cost-efficient and highly accurate signal characterization: These are the strengths of the Handheld Spectrum Analyzer R&S FSH3. For the installation or maintenance of mobile radio base stations, on-site analyses of faults in RF cables or a thousand and one other applications in service and development (page 20).**

**The Protocol Tester R&S CRTU-W simulates one or more WCDMA base stations for testing terminals. With the integrated test cases that meet the 3GPP specifications, the tester is designed for conformance testing in test houses or for quality testing (page 4).**

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**Testing state-of-the-art components for high-speed technologies such as Gigabit Ethernet or Fiber Channel calls for test methods that conventional bit error rate test sets no longer cover. The Transmission Analyzer D 3371 from Advantest together with new options such as jitter tolerance enables effective tests on modern components (page 26).**

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## MOBILE RADIO


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## GENERAL PURPOSE


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Digital audio broadcasting (DAB) networks are being implemented all over the world. They are highly popular with audio program transmission and data services alike. The R&S DSIP020 not only inserts IP-based data into DAB transmission signals, but also generates complete DAB signals (page 35).

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The new transportable Monitoring and Direction Finding Systems R&S TMS complete the tried and tested spectrum monitoring and management systems from Rohde & Schwarz and meet a host of additional requirements (page 47).

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**FIG 1 The Protocol Tester R&S CRTU-W is a flexible test platform for the development and certification of WCDMA terminals.**

**The R&S CRTU-W features maximum flexibility and convenience for testing 3rd generation mobile radio terminals. Its integrated software components are also available in a modified form as a standalone virtual 3GPP tester (page 8).**

### Protocol Tester R&S CRTU-W

# Future-proof tool for testing WCDMA terminals

## Wide range of applications

The Protocol Tester R&S CRTU-W (FIG 1) simulates one or more WCDMA base stations for testing terminals and also possesses two independent RF channels. With the integrated test cases that meet the 3GPP specifications, the tester is designed for conformance testing in test houses or for quality testing. It also has a wide range of applications in development and integration since the user can easily modify the supplied test cases or simply generate new ones.

The Protocol Tester R&S CRTU-W excels not only as a standalone tester but is also the core of the Conformance Test System TS 8950 W from Rohde & Schwarz.

## Powerful hardware

The protocol tester consists of the two units CRTU-RU and CRTU-PU (FIG 3). The Radio Unit CRTU-RU contains the RF components that also ensure high accuracy and quality of the RF output signal in the GSM Protocol Analyzer CRTU-G [1] and in the Universal Radio Communication Tester R&S CMU200 [2]. Different RF inputs allow the R&S CRTU-W to be connected to DUTs with various RF levels.

The Protocol Unit CRTU-PU includes three hardware consoles operating independently of each other. A slot CPU together with a Pentium III processor and the Windows™ 2000 operating system organizes the user interface without making use of the resources required for the test sequence.

The power PC board ensures the real-time protocol behaviour of layers 2 and 3, and specially developed software provides the high data throughput required for WCDMA.

Layer 1 boards equipped with DSPs and FPGAs ensure the complexity of the physical layer.

In the normal mode, the layer 1 boards can simultaneously simulate 16 independent channels of one cell. A maximum data rate of 384 kbit/s is possible. Tests have shown that a rate increase to 2 Mbit/s will be possible in future.

For test cases requiring a simulation of up to six cells, the layer 1 modules can be loaded with special software allowing the simulation of two other cells. Thus, two Protocol Testers R&S CRTU-W are sufficient for implementing the RRM test cases.

## Flexible software structure

The basic model of the R&S CRTU-W provides several reference implementations of the UTRAN side (FIG 2). Layers, physical link, MAC, RLC and RRC are available as independent software modules that communicate with each other by means of specification-conforming interfaces called service access points. All information transmitted via these service access points and the status messages of the different layers are stored in a log file. This data allows complete analysis of the test results.

A central database for all coding and decoding functions rounds out the software concept and minimizes the occurrence of systematic errors when decoding operations are modified.

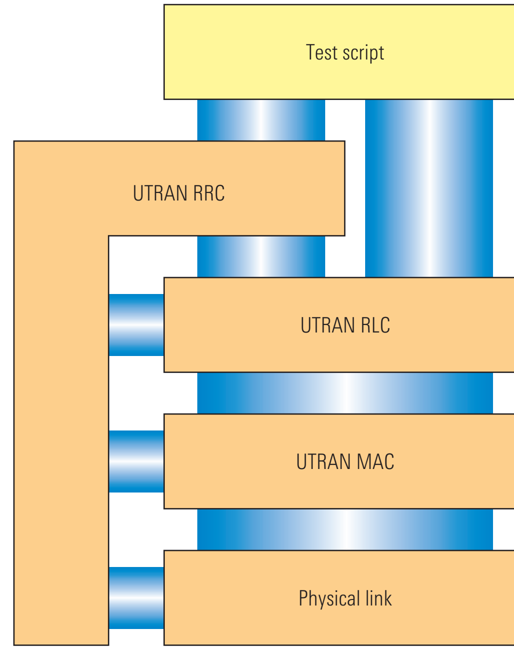



**FIG 2 Software structure of the R&S CRTU-W.**

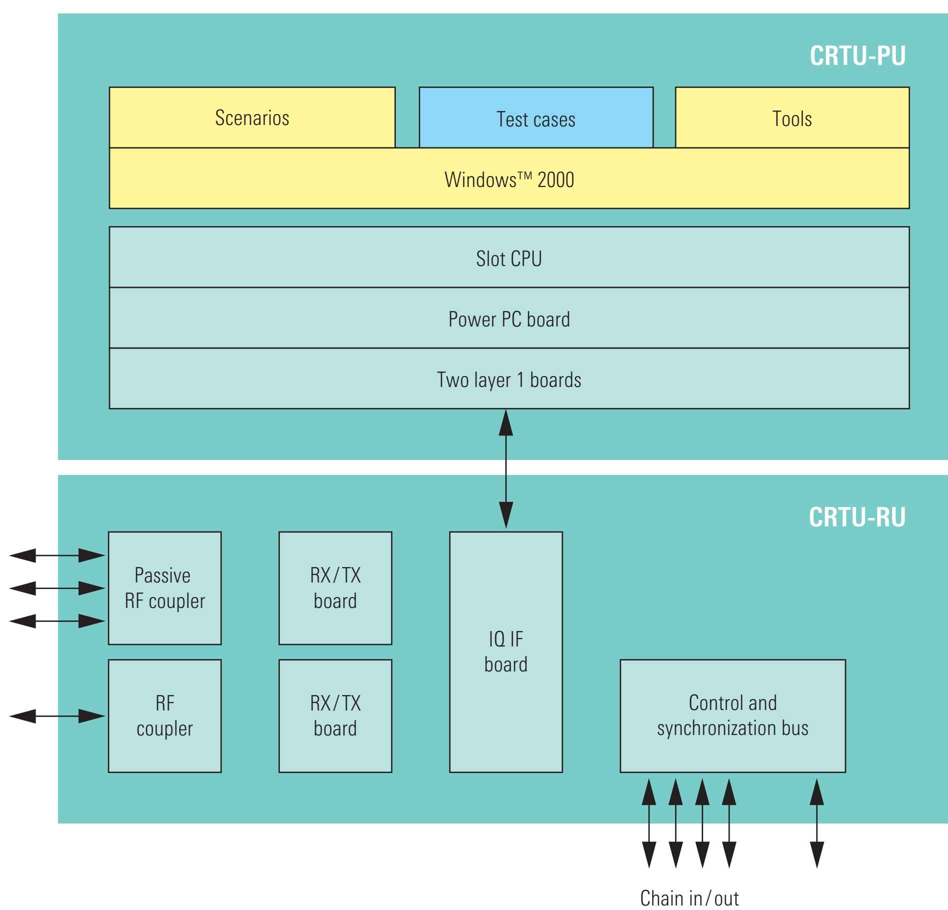



**FIG 3 Schematic hardware setup of the Protocol Tester R&S CRTU-W.**

The separate hardware modules for user interface and protocol simulation ensure maximum computing power for the required tasks.

The R&S CRTU-W is configured under Windows™2000. A convenient graphical representation provides the user with all interfaces of the protocol tester for parameterization.

The processes for storing and analyzing the test results with the message analyzer also run under Windows™2000 in the R&S CRTU-W. Extracts from the result file can be copied as an image and inserted into a test report via the Windows clipboard, if required. In addition, the results can be converted to HTML format.

A comprehensive toolbox (FIG 4) is available for editing TTCN test cases and analyzing the result files. All tools for test configuration and result analysis were developed in Java. The tools are entirely installed in the R&S CRTU-W, but they are also available as independent programs for the installation on any workstation controller. The protocol tester can thus be used efficiently since the analysis can be performed independently of the tester.

## TTCN or C / C++ ?

The official 3GPP-T1-Sig protocol test committee set the test language TTCN as standard at the very beginning so that only test cases based on the TTCN source code of the 3GPP specification TS34-1.2.3 can obtain the "validated" label.

However, the Global Certification Forum GCF (see box on right) which works independently of the 3GPP committee is now discussing the conditions in detail for a GCF test-case validation. Various members think that it would be enough if test cases meet the specification.

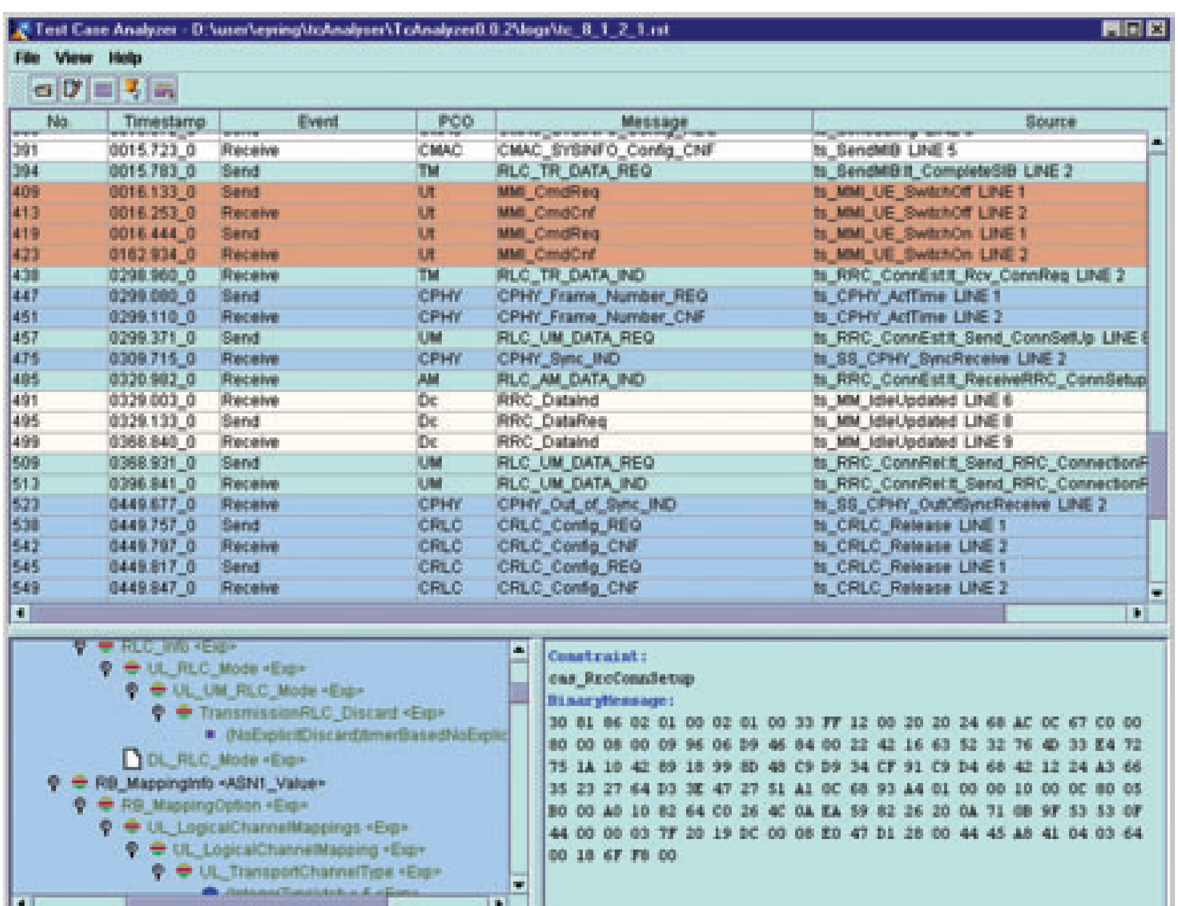



**FIG 4**
**The analysis tool for test cases in the R&S CRTU-W.**

## The Global Certification Forum (GCF)

The GCF is a voluntary association of worldwide operating network operators and manufacturers of terminal equipment. The forum defines the required test specification for the terminal approval in the associated networks. Other companies such as test houses and manufacturers of test equipment can participate in meetings as observers and make proposals for test solutions. However, the network operators and manufacturers of terminal equipment have the final power of decision.

The language for implementing the test cases should be at the discretion of the test equipment manufacturers. The type of test-case implementation that will gain acceptance is thus still unresolved.

The users of the R&S CRTU-W can calmly await these decisions since the flexible software structure of the protocol tester conveniently supports the two possibilities. The graphical user interface allows configuration with either TTCN or C / C++ as the test language. Executable TTCN test cases and test scenarios in C / C++ are already provided.

## Abbreviations used

| | |
|---|---|
| 3GPP | 3rd Generation Partnership Project |
| ASN.1 | Abstract Syntax Notation One |
| CDMA | Code Division Multiplexed Access |
| DSP | Digital Signal Processing |
| FPGA | Field Programmable Gate Array |
| GCF | Global Certification Forum |
| MAC | Medium Access Control |
| RLC | Radio Link Control |
| RRC | Radio Resource Control |
| RRM | Radio Resource Management |
| TD-SCDMA | Time Division Duplex Synchronous CDMA |
| TTCN | Tree and Tabular Combined Notation |
| UTRAN | UMTS Terrestrial Radio Access Network |
| WCDMA | Wideband Code Division Multiple Access |

## Everything in flux? No problem for the CRTU-W!

The 3GPP WCDMA standard is still in the development phase. Several modifications of the baseline are expected in the near future.

In 2001, the committee in charge froze the 3GPP specification release 99 in the edition of June 2001. With this decision, the committee intended to establish a clear and generally valid basis for the test specification to be prepared. In February 2002 a postponement was deemed necessary and the specification was shifted to the March 2002 version.

Thus everything is in flux and it is of paramount importance for future-proof 3GPP measuring instruments that they can quickly be adapted to new conditions. The R&S CRTU-W also excels in this aspect with its central database for coding and decoding functions. If, for example, modification of the ASN.1 coding is required, this is achieved by modifying the central database. The new function is then immediately available both in the protocol layers and the analysis tools.

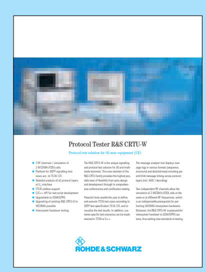
## Comprehensive user support

Users of the new Protocol Tester R&S CRTU-W are not left to fend for themselves. Rohde & Schwarz offers them comprehensive support worldwide. The Customer Support Center will answer technical questions and also questions concerning support contracts any time. Moreover, the Rohde & Schwarz website provides a special sector for registered customers.

The R&S CRTU-W has been developed for the stringent requirements within the wide range of 3rd generation mobile radio applications. The combination of planned extensions to tried-and-tested hardware and a flexible new software concept provides a reliable platform for successful future implementations of complex test scenarios.

Jörg Deiß

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





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[1] GSM Protocol Analyzer R&S CRTU-G – Changing of the guard: after more than 10 years, a new GSM reference system. News from Rohde & Schwarz (2001) No. 171, pp 4–9

[2] Universal Radiocommunication Tester R&S CMU 200 – On the fast lane into the mobile radio future. News from Rohde & Schwarz (1999) No. 165, pp 4–7

3G Virtual Protocol Test System R&S CRTU-VT

# Virtual testing of 3G mobile radio terminals

**The new 3G mobile radio standard UMTS is on its marks and Rohde & Schwarz supports the industry in this particular technical challenge with high-grade test equipment. The new 3G Virtual Protocol Test System R&S CRTU-VT combines a complete TTCN software development environment, verified 3G signalling test cases and powerful analysis tools for the simulation and testing of 3G UE protocol stacks. The virtual tester is based on modified software installed on the Protocol Tester R&S CRTU-W (page 4) and is an excellent complementary tool to this tester, the R&S CRTU-VT being able to carry out the early-stage comprehensive test of signalling sequences in 3G networks.**

For abbreviations refer to page 12

## What is a virtual test?

The new 3G (UMTS) mobile radio standard will enable a wide range of services such as videotelephony and mobile Internet access. These services require high data rates of up to 2 Mbit/s with the simultaneous efficient and flexible use of the available frequency spectrum. The development of 3G mobile radios is presently characterized by technical requirements that are much more complex than for existing GSM / GPRS networks and by the time pressure as regards the market-launch deadline. Therefore, the testing of software components such as protocol stacks begins at very early development stages. Software simulations replace hardware components such as chipsets and RF frontends. A layer 1 shortcut simulates the complete physical air interface, layer 1. This test method is called *virtual testing* and is indispensable for the parallel development of hardware and software.

## 3G Virtual Protocol Test System R&S CRTU-VT

The R&S CRTU-VT is a powerful all-in-one solution for virtual software testing of 3G UE protocol stacks. It is delivered as a pure software product on a CD-ROM and runs on any modern PC.

The supplied signalling conformance test cases defined in the TTCN language constitute a key component of the virtual tester (see box below). The R&S CRTU-VT comprises the following components:

### TTCN signalling conformance test cases

The 3G mobile radio standard defines the protocol sequences for the radio access network (specification 3GPP TS 25.xxx) and the associated signalling conformance tests (3GPP TS 34.108, 3GPP TS 34.123). These test cases are binding for 3G network operators and the manufacturers of mobile radio equipment. The tests are first specified in textual form by the T1/SIG working group and then integrated into the test specification language TTCN by the MCC160 task force at ETSI.

At present, more than 650 test cases in the TTCN version 1.40 are available on the 3GPP baseline 2002-03. These tests cover all protocol layers from layer 2 of the 3G radio access networks (RAN) up to the higher layers 3 and 4 in the non-access stratum. Circuit-switched and packet-switched services are tested in the same way.

Rohde & Schwarz contributed substantially to the specification at T1/SIG, the TTCN implementation at ETSI and the subsequent verification on the testers R&S CRTU-VT and R&S CRTU-W. The TTCN test cases verified by Rohde & Schwarz are integrated into the R&S CRTU-VT.

- Integrated TTCN development environment with graphical editor, test case builder and compiler for creating new or modifying the supplied TTCN test cases
- R&S reference implementation of the UTRAN protocol stack in line with the 3G specifications including the layer 1 simulation
- Powerful software tools for the configuration and execution of signalling test cases as well as for the detailed analysis of test results using the generated log files
- Signalling conformance test cases in TTCN according to 3GPP TS 34.123-3

The software tools of the CRTU-VT are identical to those of the "hardware" Protocol Tester R&S CRTU-W and cover the entire development and test process (FIG 1). The R&S CRTU-VT thus has everything the user needs for early conformance testing of 3G UE protocol stacks before integration into the physical layer.

The user connects the software stack to the R&S CRTU-VT via TCP/IP network links. Powerful programming interfaces in the form of class libraries in C++ are provided for this purpose.

A large number of different test cases for protocol procedures such as connection management, mobility management and call setup can be supplied with the R&S CRTU-VT. The TTCN test case and the UTRAN protocol stack simulate the 3G network. The R&S CRTU-VT records the responses of the protocol stack under test, compares them with the protocol behaviour defined in the 3G specifications and checks them for conformance (FIG 2).

**FIG 1**
**The virtual verification process.**

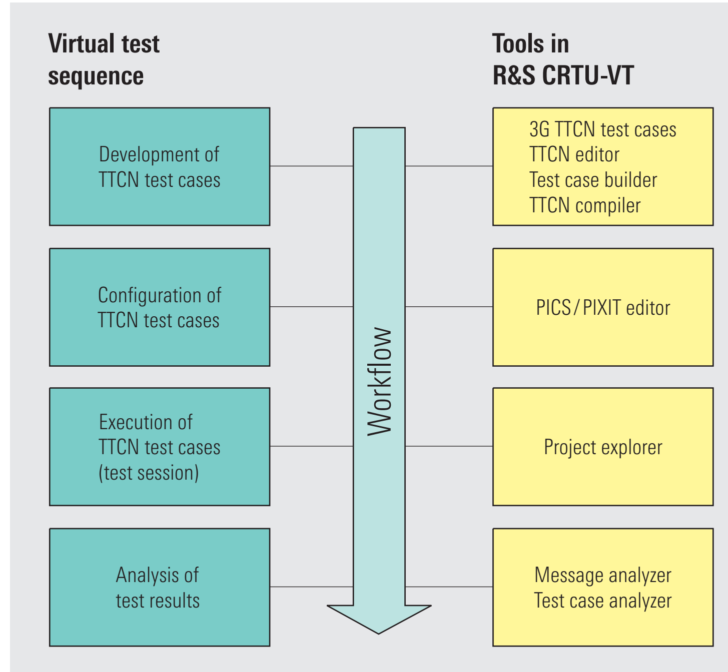
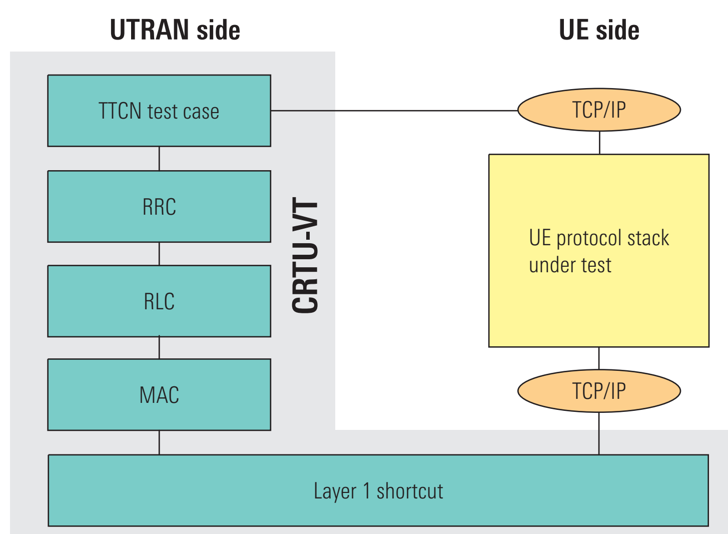



**FIG 2**
**The interfaces for virtual testing.**




## Reduction of development time

The early use of the R&S CRTU-VT – even if the layer 1 and RF components are not yet available – allows the parallel development and testing of layer 1 and the protocol stack, thus increasing the quality and reliability of 3G mobile phones. The development costs for the integration of protocol software and hardware for 3G mobile radios are reduced since well-tested software components exist. The execution speed of signalling tests can be varied in wide ranges (soft timing). A test case can be run for regression tests, for example, several hundred times faster than in practice but also slowed down or even stopped for troubleshooting in the protocol stack of the terminal equipment.

## Development of 3G applications

The testers presently available on the market do not support 3G applications satisfactorily. How is the application affected by a change in the quality of the radio link and the data rate, for example? Does the application exhibit stable behaviour when the radio bearers are reconfigured? These questions can easily and quickly be answered by means of simulations performed with the R&S CRTU-VT.

## TTCN editor Leonardo Pro

The user-friendly and powerful TTCN editor Leonardo Pro that has proven its value in the Bluetooth™ Protocol Tester R&S PTW60 is provided for creating and modifying TTCN test cases. This editor (FIG 3) is completely integrated into the TTCN development environment and enables the display of protocol errors in the TTCN source text, for example. This considerably reduces the processing time during test case development.

## TTCN compiler

The TTCN compiler automatically translates the 3G TTCN test suites into C code. The C code is then compiled and linked to the R&S-specific 3G libraries. The TTCN compiler facilitates the development of test cases by means of a comprehensive syntax check. The ASN.1 BER/PER encoding of messages, which is important for 3G protocols, is also fully supported. A graphical frontend developed by Rohde & Schwarz and named test case builder controls the make/build process of the compiler and makes generating 3G test cases very convenient.

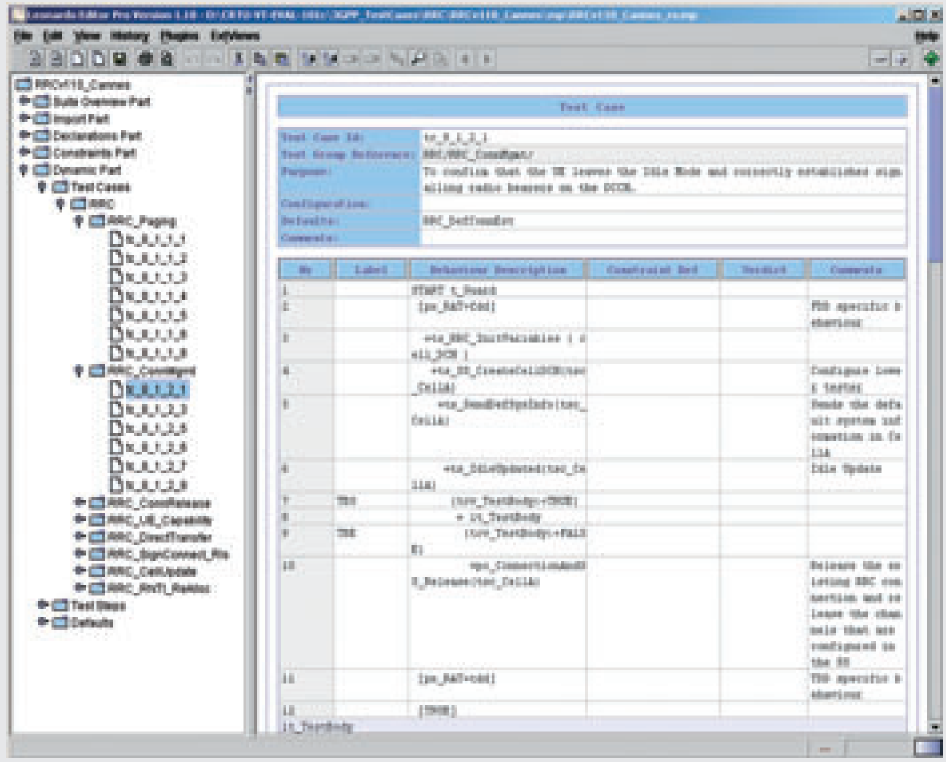


**FIG 3 The TTCN editor Leonardo Pro.**

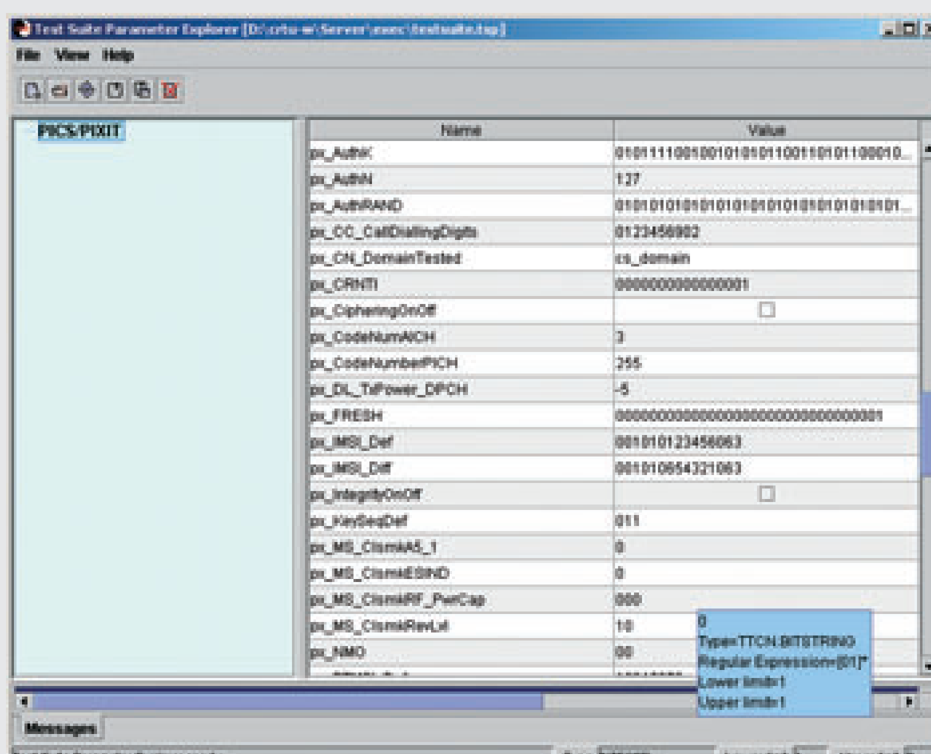



**FIG 4 The PICS/PIXIT editor.**

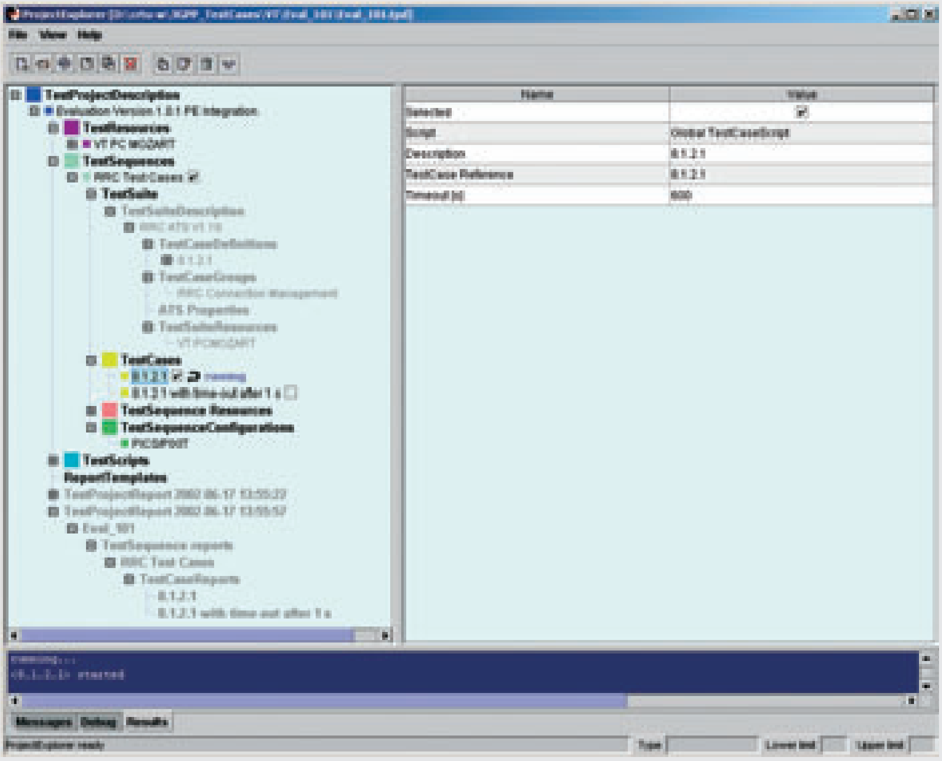


**FIG 5 The project explorer during the execution of test cases.**

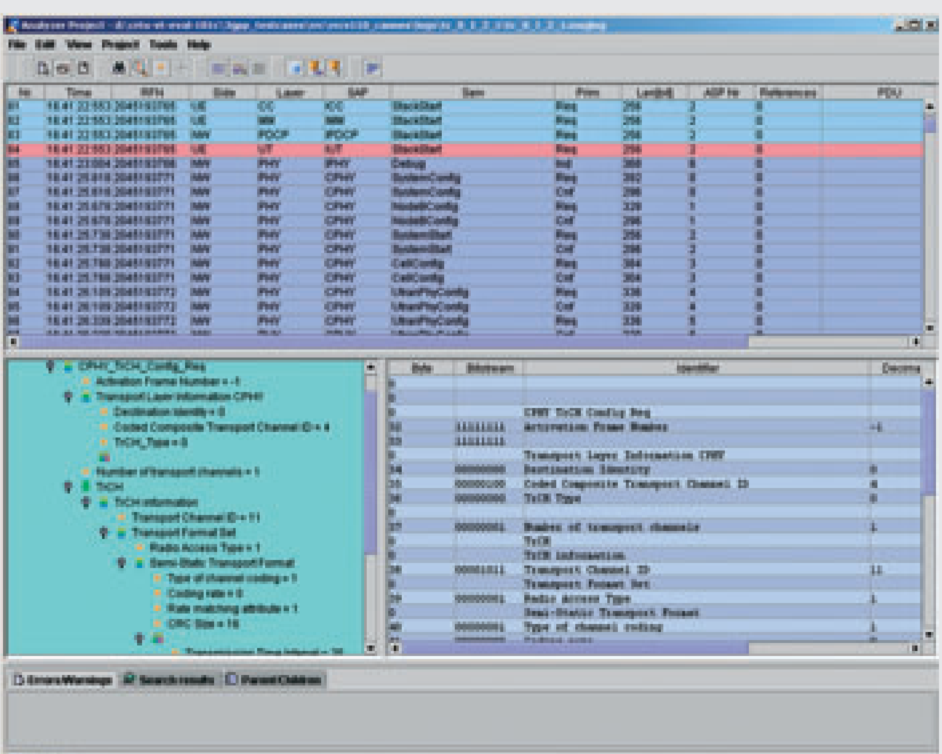


**FIG 6 The message analyzer.**

## PICS/PIXIT editor

The graphical PICS/PIXIT editor (FIG 4) facilitates generating and editing the PICS/PIXIT parameters that enable test cases to be configured prior to their execution. This tool simplifies the input of parameters, a task that was previously time-consuming and error-prone.

## Project explorer

The project explorer (FIG 5) is responsible for the execution of test cases. With this tool, test cases are easily combined to form complete test sessions and the UTRAN protocol stack is correctly configured. During execution the current status of individual test cases can be followed and the project explorer displays the verdict, i.e. the result obtained. The user can start the analysis tools via hyperlinks in the test case reports and analyze the log files.

## Message analyzer

The highlight of the R&S CRTU-VT is the message analyzer (FIG 6). It records all messages exchanged between the virtual tester and the protocol stack under test as well as the message flow of the UTRAN protocol stack during the execution of a test case in a central log file. This is followed by detailed analysis of signalling sequences with the user-friendly and powerful message analyzer. The message analyzer fully automatically decodes the messages, displays them in tabular form or as a graphical message sequence chart (MSC) and presents the structure of messages in easily readable form down to the individual bit. Powerful functions such as filtering and searching message elements, the coloured coding of message types and the parent-child view for viewing relationships between messages support the analysis of the complex 3G signalling sequences.

## Test case analyzer

In addition to the message analyzer, the test case analyzer visualizes the automatically generated trace files of TTCN test cases. The test case analyzer displays the messages to and from test case PCOs, the timer configuration and constraint matching in tabular form. Hyperlinks allow direct access to the TTCN source text in graphical format. The test case analyzer and the message analyzer have a similar composition and operating concept.

## Summary

The R&S CRTU-VT is an excellent support tool for the parallel development of hardware and software. Early testing with a large number of standardized TTCN conformance test cases increases the quality and interoperability of 3G mobile phones. The easy transition from virtual software testing with the R&S CRTU-VT to real testing with the R&S CRTU-W is ensured by a uniform software environment and identical test cases which reduces investment costs, development time and time-to-market.

The R&S CRTU-VT is thus an excellent complement to the 3G test equipment family from Rohde&Schwarz and supports the manufacturers of 3G mobile radios in meeting the enormous technical challenge.

Thomas Moosburger; Dr Thomas Eyring

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

## Abbreviations used

| | |
|---|---|
| 3G | 3rd Generation |
| 3GPP | 3rd Generation Partnership Project |
| ASN.1 | Abstract Syntax Notation |
| BER | Binary Encoding Rule (ASN.1) |
| CC | Call Control (Layer 3) |
| MAC | Medium Access Control (Layer 2) |
| MM | Mobility Management (Layer 3) |
| MSC | Message Sequence Chart |
| PCO | Point of Control and Observation (interface of the TTCN test case) |
| PER | Packed Encoding Rule (ASN.1) |
| PICS/PIXIT | Protocol Instance Conformance Statement / Protocol Information Extra Implementation for Testing (configuration parameters of TTCN test cases) |
| RAN | Radio Access Network |
| RLC | Radio Link Control (Layer 2) |
| RRC | Radio Resource Control (Layer 3) |
| TTCN | Tree and Tabular Combined Notation (formalized language for the definition of test cases) |
| UE | User Equipment |
| UMTS | Universal Mobile Telecommunications Standard |
| UTRAN | UMTS Terrestrial Radio Access Network |

R&S CRTU-G / R&S CMU200/300

# Optional IQ and IF interfaces for new applications

**The new options provide the Protocol Tester R&S CRTU-G [1] and the Universal Radio Communication Tester R&S CMU200/300 with analog IQ and IF interfaces and thus offer new applications in the development of mobile radio modules.**

## Technical concept

With the options CMU-B17 and CRTU-B7, analog IQ and IF interfaces are available for the transmit and receive signal path. The module is connected between the RF section and the digital section. The IQ signals are obtained by conversion of the internal IF signals. The IF frequencies are in the range of 7.68 MHz to 13.85 MHz as required by the application. If the IQ and IF interfaces are not required, the transmit and receive signals can be looped through in the bypass mode without being affected by the interface module and without the specifications of the measuring instruments being modified.

## Standards and applications

Currently, the standards GSM / GRPS/EDGE are available for the R&S CMU200/300 with software V3.10, and IS136 mobile station tests as well as the RF functional group are supported. Tests in accordance with WCDMA, CDMA and CDMA2000 will follow in the near future.

## Fading

A fading simulator is required for development or conformance tests on mobile radio equipment for determining the receiver characteristics. If the measuring instrument and the DUT are connected with a line – which is similar to an ideal RF channel – the simulator can add the fading effects occurring under real outdoor conditions.

With the option SMIQB14 for the Signal Generator R&S SMIQ and the Baseband Fading Simulator R&S ABFS [2], Rohde & Schwarz has provided a prerequisite for the generation of fading profiles (FIGs 1 and 2). Cost-effective baseband fading can be implemented with the new IQ interfaces for the R&S CMU 200 / 300 or even in dual-channel configuration for the R&S CRTU-G.

An application note [3] describes the use of the R&S CMU 200 in conjunction with the Baseband Fading Simulator R&S ABFS as well as with the Signal Generator R&S SMIQ. This applies analogously to the R&S CRTU-G.

## IQ generator

Another important application is the generation of IQ signals meeting the relevant standards. The user can generate complex signals that may even originate from a real signalling sequence. Most mobile radio chipsets comprise an RF chip and a baseband chip that communicate with each other via an analog IQ interface. This interface can then be used to access the two chips (FIG 3). In mobile radio development, different teams are often required for this purpose and the new testing feature via the IQ interfaces allows development work to be divided in space and time.

## IQ analyzer

If IQ signals are applied to the receive section of the tester, signal analysis can be performed in the same manner as when feeding an RF signal. In this connection, modulation analysis, for example, is useful since it evaluates the quality of an IQ signal. Modulation analysis yields analysis results such as IQ offset and IQ imbalance, which directly affect IQ signals, or even more complex evaluations such as error vector magnitude (EVM) or, in the case of WCDMA, the peak code domain error (PCDE).

A useful complement to the IQ interfaces (in the WCDMA functional group which can also be used independently of the

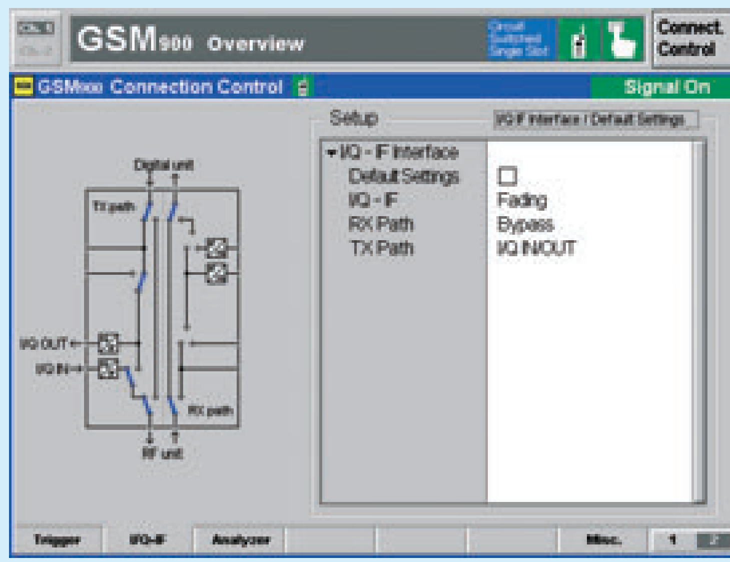



**FIG 1** Menu in the R&S CMU 200 for fading applications.

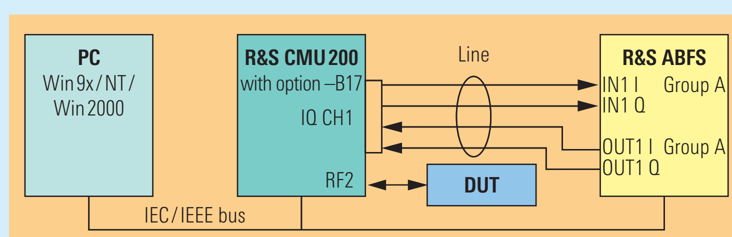



**FIG 2** Fading test with the R&S CMU 200 and the R&S ABFS.

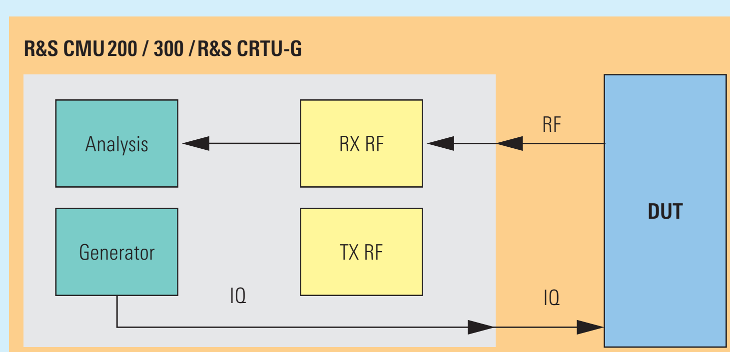



**FIG 3** The DUT, e.g. an RF module, is driven with an IQ signal of the mobile radio tester. The RF signal thus generated can then be analyzed with the tester.

interfaces) is the new IQ analyzer measurement mode in the R&S CMU 200. In this mode, the modulation quality (EVM) and the constellation, vector and eye diagrams can be displayed graphically (FIGs 4 and 5). The user can thus perform a quantitative and qualitative analysis of the signal characteristic in the IQ domain.

### Remote control interface

It is of course possible to query the test results and the original IQ samples via the remote control interfaces. This enables further analysis of the received signal. For example, the signal power distribution (CCDF diagram) can be calculated from the IQ samples. Another application is the statistical evaluation of a test sequence over a long period of time.

## Summary

The new IQ and IF interfaces extend the range of applications of the R&S CMU 200/300 and R&S CRTU-G, particularly for the development of mobile radio modules and telephones. The complex signals of different mobile radio standards can be generated and evaluated in the IQ domain. An application of special interest is the generation of fading profiles for mobile radio signals with a baseband fading simulator.

Gottfried Holzmann

**More information and data sheets at www.rohde-schwarz.com**


REFERENCES

[1] GSM Protocol Analyzer R&S CRTU-G – Changing of the guard: after more than 10 years, a new GSM reference system. News from Rohde & Schwarz (2001) No. 171, pp 4–9

[2] Baseband Fading Simulator R&S ABFS – Reduced costs through baseband simulation. News from Rohde & Schwarz (1999) No. 163, pp 11–13

[3] 3GPP User Equipment Tests Under Condition of Fading with R&S CMU and R&S SMIQ/ABFS. Application Note 1MAA_54


### Condensed data of options CMU-B17 and CRTU-B7

| | |
|---|---|
| Standards | GSM, GPRS, EDGE, IS136 as of CMU 200 SW V3.10; planned for CDMA, CDMA2000, WCDMA (3GPP-FDD, UE test and BTS test) |
| IQ interfaces | analog outputs and inputs for the transmit path and receive path of a CMU/CRTU channel |
| IQ level | max 0.5 V, peak |
| Impedance | 50 Ω |
| IQ bandwidth | up to 2.5 MHz |

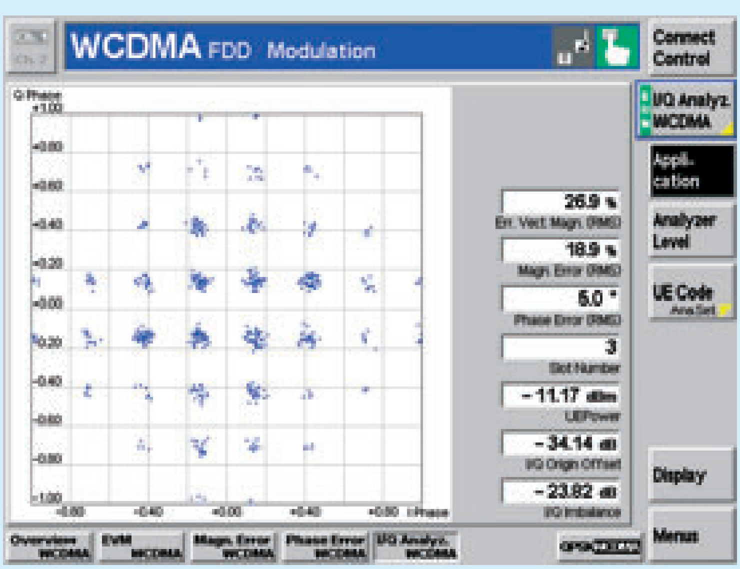



FIG 4 Constellation diagram of a WCDMA signal.

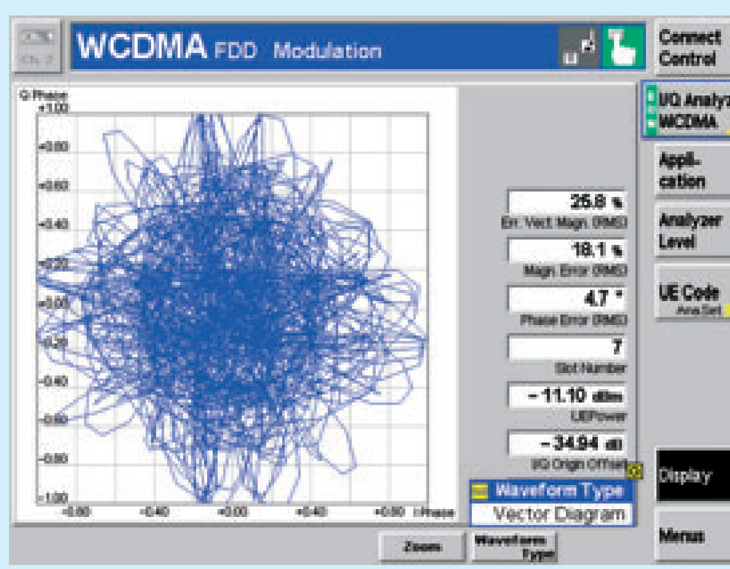



FIG 5 Vector diagram of a WCDMA signal.


Spectrum Analyzers R&S FSU / R&S FSP

# Firmware for 3G code domain measurements

**Owing to their flexible design, the Spectrum Analyzers R&S FSU [1] und R&S FSP [2] are developing into powerful 3G signal analyzers. Current add-ons are the WCDMA code domain analyzer for base stations (R&S FS-K72) and user equipment (R&S FS-K73) as well as the code domain analyzer for base stations (R&S FS-K82) for the competing 3G technology CDMA2000.**

## Important new measurements

The R&S FS-K72/-K73/-K82 firmware packages offer all important transmitter measurements in one menu and expand the spectrum analyzers for code domain measurements:

- Peak code domain error
- Composite EVM
- EVM vs slot
- Channel table
- Rho (only CDMA2000)

The table on page 17 (FIG 5) shows the key specifications at a glance.

## Evaluating CDMA signals

Code division multiple access (CDMA) systems use different codes, instead of separate frequencies or times as do frequency division duplexing (FDD) or time division duplexing (TDD) systems. The signals of each subscriber are transmitted on the same frequency.

The quality of the transmitted signal cannot be evaluated purely by spectrum analysis. For a detailed analysis of the CDMA signal power, the signal must be despread before the quality of every individual code can be evaluated.

## Code domain analysis

The R&S FS-K72/-K73/-K82 firmware packages are primarily used to determine the code domain power for the different physical channels. The power ratios between the individual channels can be checked for compliance with the nominal values, for example. This measurement is also a highly efficient tool for detecting impairments such as clipping or intermodulation effects.

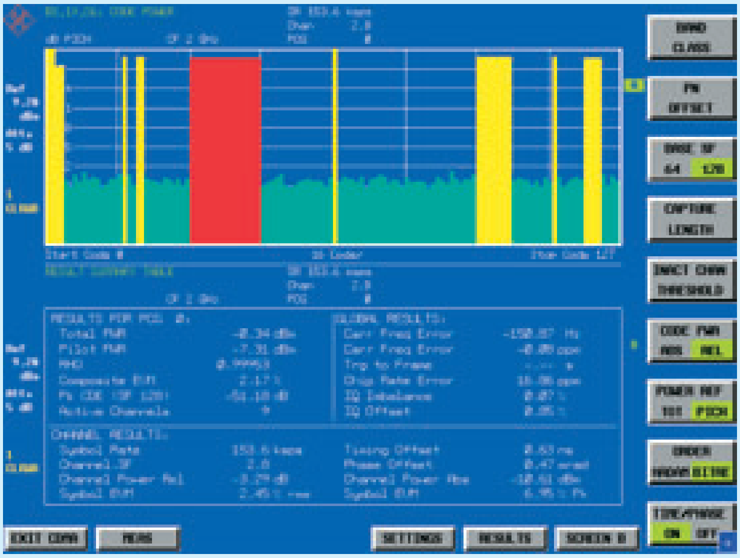


**FIG 1**
**Code power of a CDMA2000 signal which is displayed in reversed bit order.**

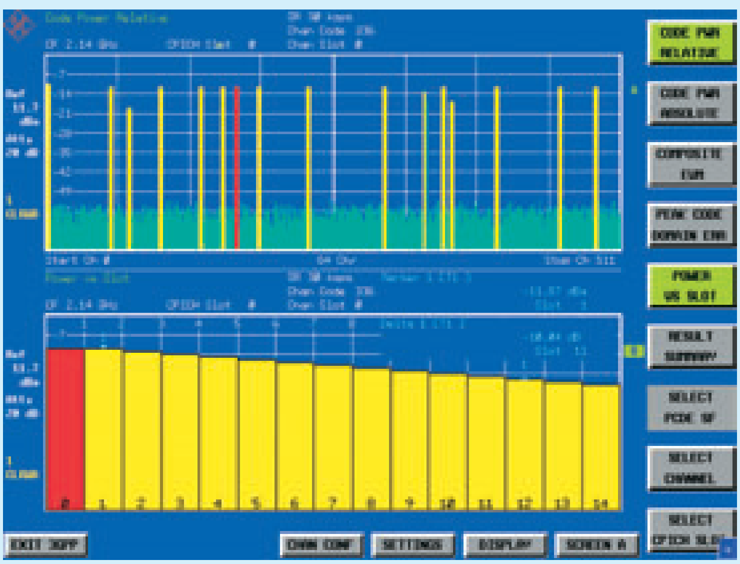


**FIG 2**
**Example of the power control of a WCDMA base station signal. The power difference of a code (highlighted in red in the code domain overview) is measured.**

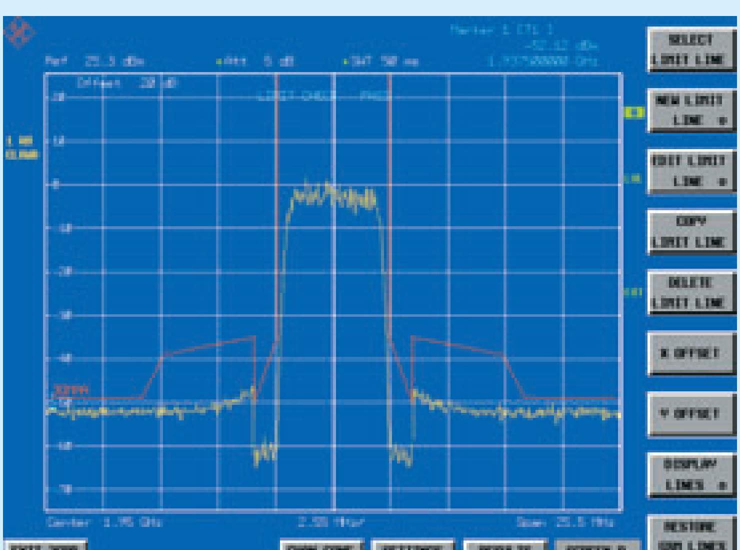


**FIG 3**
**Spectrum emission mask measurement of a WCDMA terminal with automatic PASS/FAIL evaluation in accordance with 3GPP specifications.**

## WCDMA and CDMA2000 – similar, yet different

The two key 3G technologies resemble each other in many aspects since both use the fundamental CDMA technology. However, coding, modulation and bandwidth differ. The CDMA2000 standard is backwards-compatible with the related 2G IS-95, whereas WCDMA is not compatible with any other 2G system.

The channelization codes fulfill the same basic functions in both systems, i.e. to separate the subscribers from each other in a cell, but they are designed differently. WCDMA uses the orthogonal variable spreading factor (OVSF), CDMA2000 Walch-Hadamard codes. Furthermore, CDMA2000 is a synchronous system that must consequently comply with stringent timing requirements, whereas WCDMA is an asynchronous system.

Differences between the uplink and downlink signals also exist even within the systems. Those of a mobile phone (uplink) on a spectrum analyzer strongly resemble the signals of a base station (downlink), but their code domains are completely different.

**FIG 4**
**Band class selection for CDMA2000 ACLR measurements.**

| BAND CLASS SELECTION |
| --- |
| √Band Class 0 (800 MHz Band) |
| Band Class 1 (1900 MHz Band) |
| Band Class 2 (TACS Band) |
| Band Class 3 (JTACS Band) |
| Band Class 4 (Korean PCS Band) |
| Band Class 5 (450 MHz Band) |
| Band Class 6 (2 GHz Band) |
| Band Class 7 (700 MHz Band) |
| Band Class 8 (1800 MHz Band) |
| Band Class 9 (900 MHz Band) |

| Measurements | WCDMA base stations (R&S FS-K72) | | WCDMA user equipment (R&S FS-K73) | | CDMA2000 base stations (R&S FS-K82) | |
|---|---|---|---|---|---|---|
| | R&S FSU | R&S FSP | R&S FSU | R&S FSP | R&S FSU | R&S FSP |
| Code domain power measurement uncertainty | <0.4 dB | <0.6 dB | <0.4 dB | <0.6 dB | <0.4 dB | <0.6 dB |
| EVM | <1.5% | <2% | <1.5% | <2% | <1% | <1.5% |
| Peak code domain error | −50 dB | −60 dB | −50 dB | −60 dB | −50 dB | −60 dB |

**FIG 5 Key specifications at a glance.**

## Automatic code determination

The firmware automatically determines the data rates of each code by searching through all possible combinations; the subscriber does not need to know them. Higher data rates in CDMA systems occupy the major part of the code domain. Due to the coding scheme used with CDMA2000, a high data rate is spread across the code domain (Hadamard sequence). It can be difficult to assign the different codes to the respective users of high data rates. If the reversed bit sorting order is selected, the firmware automatically collects the codes of the individual subscribers (FIG 1).

Power control is an essential feature of CDMA systems. Since all subscribers use the same frequency, they interfere with each other. To reduce this interference to a minimum, the power of each mobile and each base station is continuously controlled: with WCDMA 1500 times per second, while the power control rate for CDMA2000 is 800 Hz.

A code domain analyzer is used to measure the power of each individual code in the code domain and determine the accuracy of the power control levels. FIG 2 shows an example of a WCDMA base station signal.

## Adjacent channel leakage power ratio

The ACLR is an important design parameter in CDMA systems. It affects the system performance and defines the transmitter linearity for the design engineer. The Spectrum Analyzers R&S FSU and R&S FSP come with default settings for this measurement.

Since CDMA2000 systems are used worldwide in different frequency bands, the standard defines different ACLR requirements for the different regions. The R&S FS-K82 allows the subscriber to define the band class; the limits are then set accordingly (FIG 4). They can, of course, be changed, or new limits can be specified.

## Spectrum emission mask

The 3GPP standard defines a spectrum emission mask to ensure coexistence of the different systems (FIG 3). The measurement bandwidth must accordingly be changed from 30 kHz at 3.5 MHz offset from carrier to 1 MHz. The usual Gaussian filters of the spectrum analyzers do not provide the required selectivity; the standard enables the use of more narrowband filters which in turn increase the measurement time.

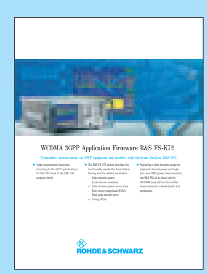
By using special channel filters, the R&S FSP and R&S FSU can utilize a 1 MHz filter instead of the often used 30 kHz filters and so perform the measurement in record time.

## Multistandard platforms for 3G

With the optional R&S FS-K5 application firmware, the spectrum analyzers also support GSM and EDGE. All applications can be installed together to form versatile multistandard platforms.

Johan Nilsson

**More information and data sheets at www.rohde-schwarz.com (search terms: K72 / K73 / K82)**



Data sheet
R&S FS-K72 /-K73 /-K82

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[1] Spectrum Analyzer R&S FSU – Best RF performance: third generation of high-end analyzers. News from Rohde & Schwarz (2001) No. 171, pp 20–25

[2] Spectrum Analyzer R&S FSP – Medium class aspiring to high end. News from Rohde & Schwarz (2000) No. 166, pp 4–7

43915/1

FIG 1 Practical and indispensable: Antenna Coupler R&S CMU-Z10 and Shielding Cover R&S CMU-Z11.

Antenna Coupler R&S CMU-Z10 / Shielding Cover R&S CMU-Z11

# Practical and indispensable accessories for testing mobile phones

**Service, quality assurance, development and production are often faced with the same problem: A suitable adapter cable is not available for the telephone under test or there is no connector at all on the telephone. A universal aid in such a situation is the Antenna Coupler R&S CMU-Z10, which also protects the DUT from unwanted interference in conjunction with the Shielding Cover R&S CMU-Z11.**

## High-quality measurements

Although the functional principle of a coupler may seem quite simple at first glance, the case is actually the opposite: Signals are transmitted between two points by means of antennas, and a large number of requirements have to be taken into consideration because the ultimate goal is to perform high-grade measurements with the coupler. First, the coupler should absorb the power radiated by the mobile phone with minimum loss to prevent the signal-to-noise ratio from being degraded. And this should apply to telephones of all different types and standards (e.g. cdmaOne, GSM or WCDMA) since users are not prepared to change the test setup for each new DUT. Thus, the focus is on large bandwidth, low-loss adaptation and high efficiency coupled with maximum independence from the phone position on the coupler since this is necessary to ensure a high level of repeat accuracy in measurements.

## Determining attenuation values

The Antenna Coupler R&S CMU-Z10 (FIG 1) is ideal for meeting all these requirements. Owing to the instrument's special design, for which a patent is pending, its coupling factor is nearly constant over a large area (FIG 2). However, a list of attenuation values for various mobile phone types cannot be predefined. It should be at the user's discretion to determine the typical values one time for the telephones under test, to store these values and to retrieve them as required.

A reliable telephone that best meets the nominal parameters is used to measure the telephone-specific attenuation values. In the uplink (transmit path of the mobile), the user requests a transmit level by means of signalling on three different channels for each band and reads the result on the radio tester connected. The difference determined between the transmit and receive level is to be set as the attenuation on the tester.

In the downlink, the procedure is the opposite. The radio tester sends a signal to the telephone and the RSSI (radio signal strength indication) sent by the mobile is read out again on the tester.

Different results are obtained with different models and designs. If the exact position in the adapter is noted down in addition to the telephone-specific attenuation values, it is easy to obtain a repeat accuracy of less than 0.5 dB.

## Protecting from interference

The Shielding Cover R&S CMU-Z11, available as an option to the R&S CMU-Z10, protects the DUT from interference. Experienced users choose the complete system because only this setup can ensure that the displayed result is truly from the DUT and is not influenced by interference. The Antenna Coupler R&S CMU-Z10 can easily be retrofitted with the Shielding Cover R&S CMU-Z11.

The combination formed by the R&S CMU-Z10 and the R&S CMU-Z11 can, of course, be used as a shielding chamber. An RF feedthrough is available for this purpose to directly connect the mobile, provided the mobile has an RF connector. A 15-pin D-SUB connector is available for reading out data or remotely controlling the telephone. It is recommended to use the supplied high-grade connecting cable for all measurements. An adapter is pre-mounted for conveniently fixing the mobile in place. If larger modules are to be measured, the base plate with adapter can be replaced by a supplied base plate without adapter.

Users who want to test the *Bluetooth* interface at the same time can install the optional *Bluetooth*™* Antenna R&S CMU-Z12 in the coupler.

## Summary

Using the universal Antenna Coupler R&S CMU-Z10 and the Shielding Cover R&S CMU-Z11 can save time and money since it is not necessary to search for suitable cables and adapters and reproducible results are obtained quickly. Several test sequences and final measurements can be omitted since the shielding cover efficiently protects the DUT from interference and the power radiated by the telephone is absorbed by the coupler with minimum loss.

Gerhard Götz

* *Bluetooth* is a trademark owned by Bluetooth SIG, Inc., USA and licensed to Rohde & Schwarz.

**More information and data sheet at www.rohde-schwarz.com (search term: CMU-Z10)**

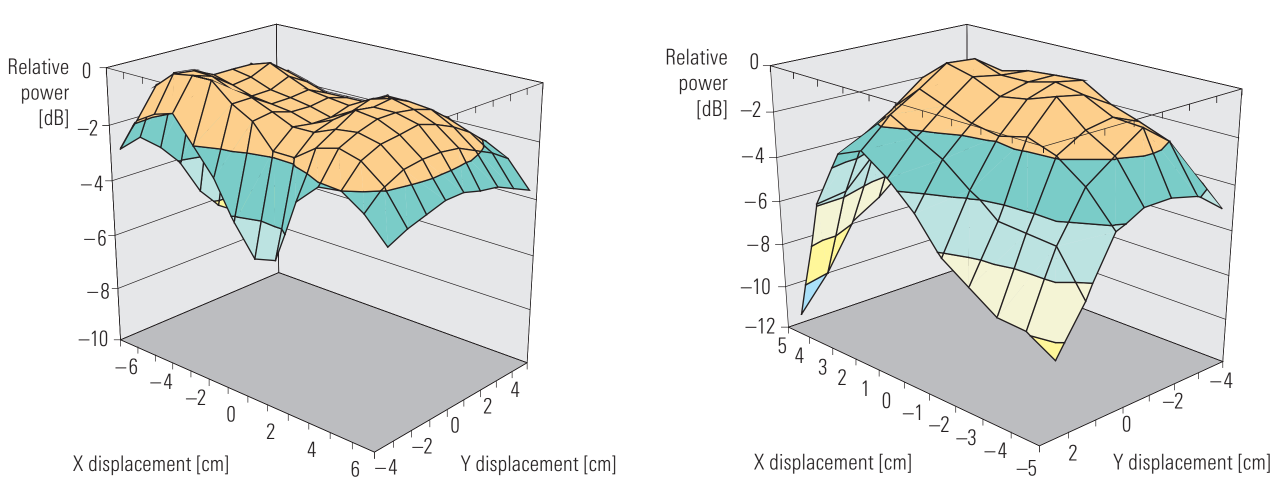


**FIG 2** **Power measurement with the Antenna Coupler R&S CMU-Z10 (without R&S CMU-Z11) at different positions: left GSM 900, right: GSM 1800.**

43 888/12

**FIG 1**
**The R&S FSH 3 is designed as a portable, robust spectrum analyzer for field operation.**

**Fast, cost-efficient and highly accurate signal characterization: These are the strengths of the R&S FSH 3 – the ideal instrument for the installation or maintenance of mobile radio base stations, on-site analyses of faults in RF cables or a thousand and one other applications in service and development.**

### Handheld Spectrum Analyzer R&S FSH 3

# New mobility in spectrum analysis

## Universal measuring instrument for RF technicians

Experience gained from the progressive digitization of the high-end and general-purpose Spectrum Analyzers R&S FSU [1] and R&S FSP [2] as well as the integration of various complex functions into ICs led to the development of the Handheld Spectrum Analyzer R&S FSH 3 (FIGs 1 to 3). The R&S FSH 3 provides outstanding features that you would usually expect only from desktop models. Its low weight, robust design, long operating time per battery charge and numerous measurement functions make the R&S FSH 3 a versatile RF measuring instrument for simple lab applications, service and on-site field use.

The R&S FSH3 is available in two versions:

- Pure spectrum analyzer for 100 kHz to 3 GHz
- Spectrum analyzer with tracking generator for scalar network analysis

Various add-ons transform the R&S FSH3 into a power meter or a cable analyzer that can be stowed in a carrying bag with all its accessories. The key functions required by RF technicians for everyday use are thus available in a compact and mobile unit.

## Sophisticated interior – highly integrated

With the R&S FSH3, Rohde&Schwarz has created a high-end spectrum analyzer in handheld format that is distinguished by low weight, low power consumption for long battery time, excellent RF performance and operation so simple that even non-experts can use it. These characteristics could only be achieved through high and thorough integration of the analog RF section, the detector circuits and the processor.

The R&S FSH3 is enclosed in a sturdy housing without air openings (as protection against environmental effects) to ensure that it will function properly even under extreme ambient conditions. Despite the enormous variety of functions this compact spectrum analyzer offers, power consumption is limited to max. 7 W to prevent the internal temperature from exceeding tolerable levels even at a maximum ambient temperature of 50°C. This low power consumption also enables an operating time of up to 4 h with just one battery charge, and this time can be extended by means of the power down mode which ensures automatic shutdown of the unit either 5 or 30 minutes after the last operation and displays the last settings when the unit is switched on again. If the battery is depleted before the work day is over, it can easily be recharged from a cigarette lighter socket in a vehicle.

Key to the compact design and low power consumption are six different Rohde&Schwarz application-specific integrated circuits (ASIC). Two synthesizer ICs, a prescaler and a divider for fractional division factors determine the frequency processing of the first local oscillator. The receive path of the R&S FSH3 is designed as a threefold converting superheterodyne receiver with high first intermediate frequency and a superimposed local oscillator (approx. 4 GHz to 7 GHz). The synthesizer ICs ensure a frequency sweep synchronized to the internal TCXO reference frequency. The analyzer thus represents the measurement signals at the correct frequency even in the case of large spans, e.g. 3 GHz. The frequency inaccuracy is solely a function of the pixel resolution of the display.

The RF input is particularly well protected by a combination of overvoltage arrester, PIN diodes and capacitive cou-

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**FIG 2 For optimal display viewing angle, the R&S FSH3 is equipped with a fold-out stand for placement on a desktop.**

**FIG 3 Connectors in the carrying handle (left to right): AC power supply connector, generator output, power sensor connector, trigger input, RF input**

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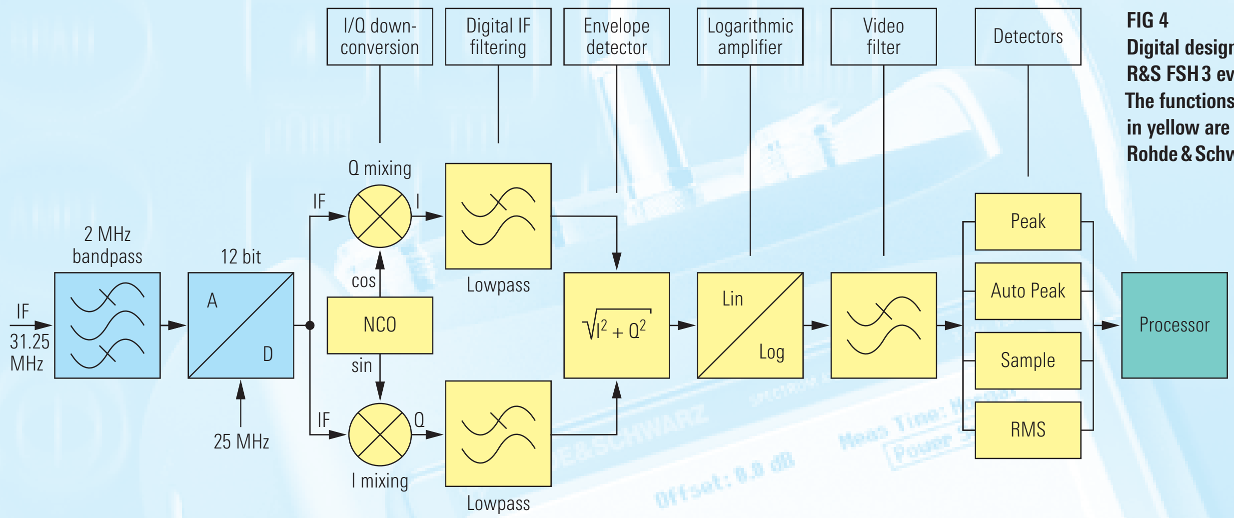



**FIG 4**
**Digital design of the R&S FSH3 evaluation section. The functions highlighted in yellow are implemented in Rohde & Schwarz-specific ICs.**

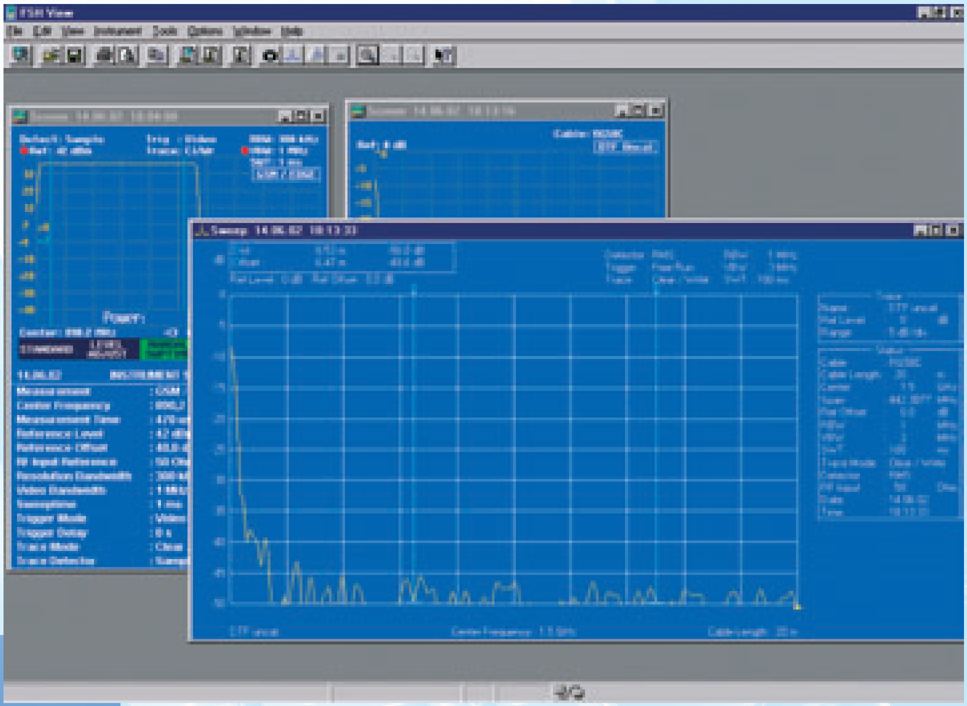


**FIG 5 Powerful Control Software R&S FSH View.**


**FIG 6**
**R&S FSH3, an all-in-one instrument for installation and on-site maintenance. Top left: measurement with Power Sensor R&S FSH-Z1, bottom left: measurements on mobile radio equipment.**

pling so that the electronic attenuator or the input mixer will not be damaged if high voltage is inadvertently applied or if electrostatic discharge occurs. Despite low power consumption, the R&S FSH3 achieves remarkable dynamic range characteristics easily comparable to lab desktop models. The third-order intercept point is 15 dBm typ. at a noise figure of approx. 32 dB. High overload immunity ensures that inherent intermodulation products of high-level signals do not simulate signals from the DUT.

Signal processing starting at the last intermediate frequency is purely digital (FIG 4). An A/D converter digitizes the 31.25 MHz IF signal. Integrated circuits perform all further processing steps such as IF filtering, IF envelope detection, logarithmation, video filtering and signal detection in realtime. The main processor, also an ASIC-integrated RISC processor, retrieves and displays the configured data.

Because of this concept, functions and characteristics usually provided only in desktop units are implemented on a small footprint:

- Resolution bandwidths from 1 kHz to 1 MHz in 1/3 sequence as common with spectrum analyzers
- Video bandwidths of 10 Hz to 1 MHz also in 1/3 sequence
- Different detectors for signal weighting (Auto Peak, Peak, Sample and the RMS detector, which is ideal for the power measurement of modulated signals)

The digital design concept makes these functions stable and reproducible. Thus, the error that occurs when switching the bandwidth is negligible, for example. The display linearity depends exclusively on the linearity of the A/D converter, whose linearity error is also inconsequential in practice. The level measurement uncertainty is almost exclusively a function of the absolute gain of the IF section and of the frequency response of the attenuator and the input mixer. The R&S FSH3 corrects both parameters during measurement. The frequency response to all settings of the RF attenuator is stored in the analyzer and the display level is corrected for each frequency. The analyzer also monitors its internal temperature and corrects the total gain accordingly. All these measures ensure a total level measurement uncertainty of max. 1.5 dB.

Another advantage of the integrated digital design concept is the relatively high measurement speed in spite of low power consumption and the resulting limitation of processor power. Compared to the analog design concept, the ASICs process IF data in realtime despite the relatively low power consumption. The minimum sweep time of the R&S FSH3 when displaying the entire frequency range is only 100 ms, with measurements in the time domain (0 Hz span) only 1 ms.

## On-site documentation of measurement results

Documentating and archiving measurement results play a pivotal role – particularly in regular on-site maintenance (FIG 6) – when determining changes over time. The analyzer is able to store up to 100 measurement results and their settings internally and output the screen content and the associated measurement settings via a printer. Control Software R&S FSH View (FIG 5), which is included with the equipment supplied, communicates with the PC via an optical RS-232-C interface and offers convenient functions for documenting and archiving the measurement results:

- Transfer of the measurements stored in the R&S FSH3 to the controller; all results are either transferred together, or the user selects individual results
- Transfer of measurement settings from the PC to the analyzer; for example, all service staff can be furnished with identical settings (which can be blocked against modifications in the unit)
- Storage of measurement results in common graphics formats (BMP, WMF, PCX, PNG), as text files or in Windows™ Excel format
- Easy definition of parameters for distance-to-fault measurements on the PC and their subsequent transfer to the R&S FSH3
- Display of an in-progress measurement on the PC screen

## Functional versatility

To handle the diverse measurement tasks in RF technology, the R&S FSH3 offers all RF measurements important in everyday work – in addition to spectrum analysis. Particular emphasis was placed on the installation and maintenance of RF transmission equipment (FIG 6).

Spectrum measurement provides an active and a reference trace. The level is measured by means of a marker and a delta marker. At the position of the marker, the R&S FSH3 can also measure the signal frequency with a resolution of 1 Hz or the noise power in dBm/(1 Hz) or demodulate the input signal via the AM/FM demodulator.

Equipped with the Power Sensor R&S FSH-Z1, the R&S FSH3 becomes a highly accurate power meter up to 8 GHz (FIG 7). A wide dynamic range (–67 dBm to +26 dBm) ensures low sensor level error (<2%).

The R&S FSH3 supports selective power measurements on modulated signals by means of functions for channel power measurement or power measurement over a specified time section, e.g. a timeslot in TDMA systems such as GSM

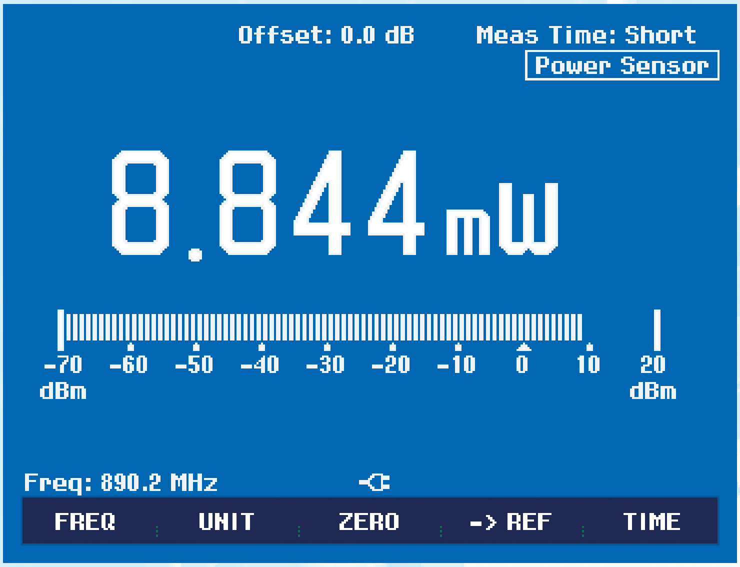



FIG 7 Power measurement using the Power Sensor R&S FSH-Z1.

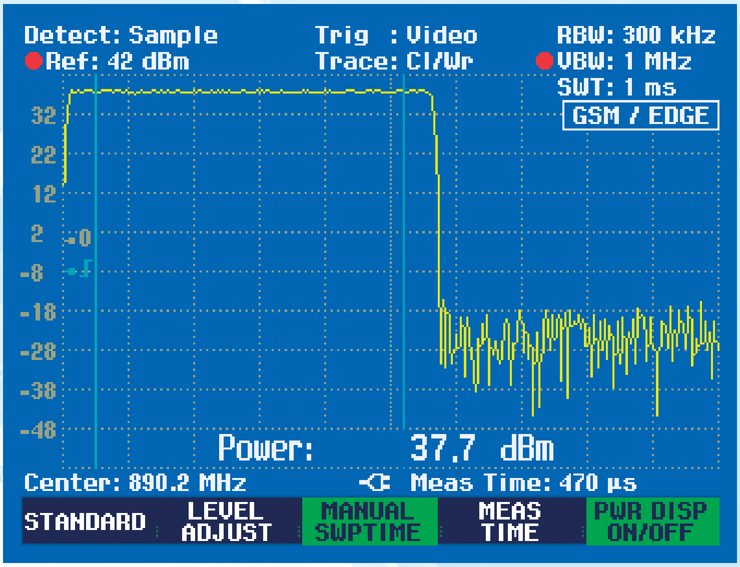



FIG 8 Power measurements in a GSM signal timeslot.

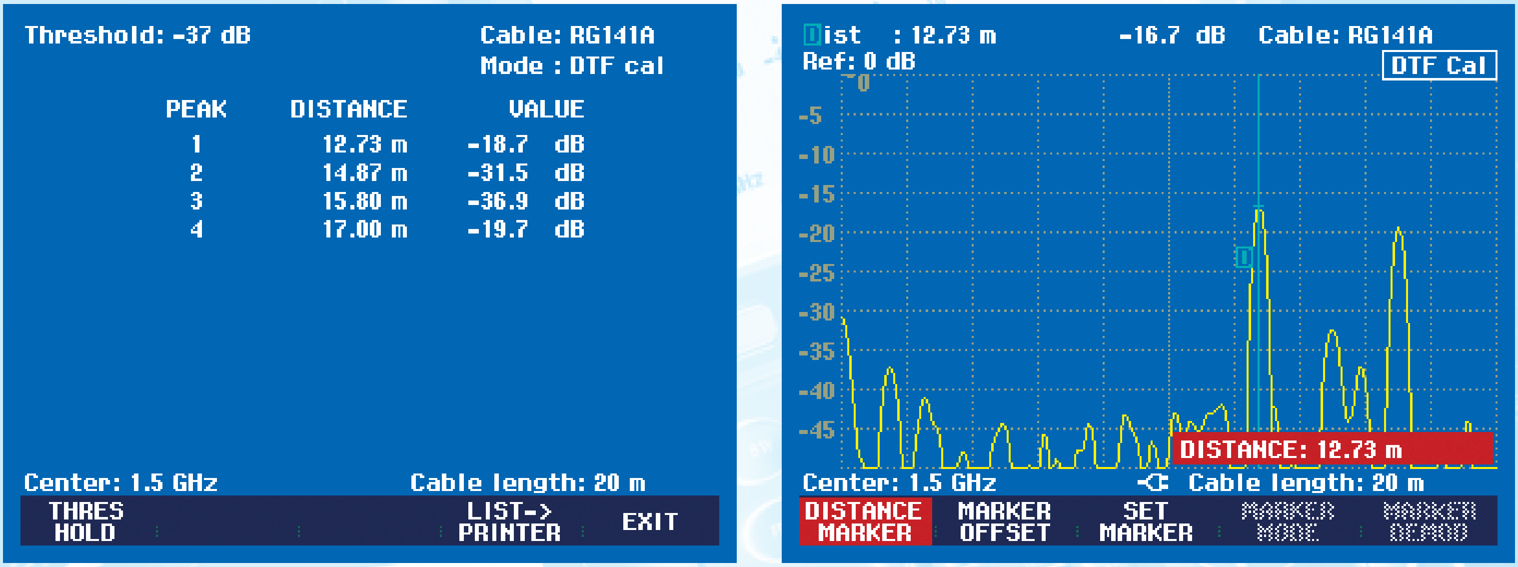



FIG 9 Identification of RF cable faults. Measurement results are output either in a table with selectable threshold (left) or in graphical format (right).

## Condensed data of R&S FSH3

| | |
|---|---|
| Frequency range | 100 kHz to 3 GHz |
| Resolution bandwidths | 1 kHz to 1 MHz, in 1/3 sequence |
| Video bandwidths | 10 Hz to 1 MHz, in 1/3 sequence |
| Amplitude measurement range | –115 dBm to 20 dBm |
| Amplitude display range | 20 / 50 / 100 dB, linear |
| Level measurement uncertainty | 1.5 dB |
| Detectors | Peak, Auto Peak, Sample, RMS |
| Display | 14 cm (5.7") colour LCD |
| Operating time | 4 h per battery charge |
| Dimensions (W x H x D) | 170 mm x 120 mm x 270 mm |
| Weight | 2.5 kg |

or EDGE. The measurement parameters are set by selecting the transmission standard.

The R&S FSH3 sets the optimum level at a keystroke (FIG 8). The internal video trigger or an external trigger signal is responsible for triggering in response to a TDMA burst. For channel power measurements, the R&S FSH3 uses the RMS detector, which is ideal for providing reproducible measurement results in a single sweep.

The applications of an R&S FSH3 with tracking generator include scalar network analysis. The analyzer measures the transmission characteristics of two-ports without requiring any other accessories. Fitted with the VSWR Bridge and Power Divider R&S FSH-Z2, it can also measure return loss or VSWR of antennas, for example.

Controlled by the analyzer, the R&S FSH-Z2 can be switched to a 6 dB power splitter. The optional distance-to-fault measurement transforms the R&S FSH3 into a cable analyzer, measuring faults of cables with a length of up to 300 m with the aid of the frequency domain reflectometer (FDR) method and displaying them graphically or in a table (FIG 9).

All RF measurements required for the installation of transmission equipment are bundled into a single unit. The R&S FSH3 does not need to be recalibrated every time the measurement mode is changed, e.g. after switchover from antenna VSWR measurement to distance-to-fault measurement. A single calibration covers both measurements.

## Easy operation for field engineers

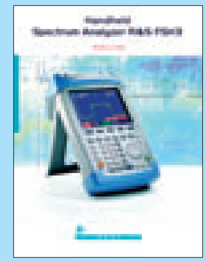
Under difficult conditions, e.g. maintenance and service in the field, operation should be simple and straightforward. Due to the ergonomically arranged keys and direct access to all basic functions at a keystroke without softkey control, the R&S FSH3 is very user-friendly. If you hold the instrument with both hands, you can effortlessly reach all keys and the rotary knob with your thumbs. All measurement information is clearly displayed on the 14 cm colour display (5.7"), which can easily be read even from a longer distance. All messages and instructions, e.g. for scalar network analysis calibration, are available in nine different languages. The R&S FSH3 can store up to 100 settings together with their measurement results. The names of the measurement settings or results can easily be entered by means of the numerical keypad, which carries the same lettering as mobile phones. For adjustment tasks, the R&S FSH3 can be hung on the door of a rack by means of its stable handle. For desktop use, the fold-out stand ensures optimum access to control elements (FIG 2).

## Summary

The R&S FSH3 is the ideal spectrum analyzer for fast, cost-efficient and highly accurate signal characterization. The versatile measurement functions of the analyzer offer a broad scope of applications – ranging from installation or maintenance of a mobile radio base station and on-site analyses of faults in RF cables to applications in development and service.

Josef Wolf

**More information, data sheet and analyzer simulation can be downloaded at www.rohde-schwarz.com (search term: FSH3)**



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43 899

**FIG 1 Transmission Analyzer D 3371.**

**Testing state-of-the-art components for high-speed technologies such as Gigabit Ethernet or Fiber Channel calls for test methods that conventional BER test sets no longer cover. The Transmission Analyzer D 3371 (FIG 1) together with new options such as jitter tolerance enables effective tests on modern components.**

### Transmission Analyzer D 3371 from Advantest

# Versatile tool for testing modern high-speed components

## Testing up to 3.6 Gbit/s

At high bit rates, even minimal interoperability problems of individual components can greatly impair the transmission quality of an entire system. It is therefore important to detect possible errors already at the development stage by using a suitable instrument such as the transmission analyzer. The D 3371 has been designed for use in the research, development and production of high-speed components and systems for the communications sector:

- LAN technologies: Gigabit Ethernet
- SAN technologies: Fiber Channel, InfiniBand
- WAN technologies: ATM, SDH, 10GbE

**For abbreviations refer to page 28**

Components such as the serializer/deserializer (SerDes), electro-optical converters or chips for frame generation as well as their interaction are tested.

The D 3371 offers a maximum test data rate of 3.6 Gbit/s, exceeding the common STM-16 systems (2.5 Gbit/s SDH) and Gb Ethernet bit rates, and provides sufficient overhead for FEC applications. It also covers the XAUI internal interface at 3.125 Gbit/s, important for 10GbE.

## Standard test functions

The standard configuration of the Transmission Analyzer D 3371 includes all functions of a typical bit error rate tester (BERT). It offers different evaluation facilities for the wide variety of test patterns, e.g. error count, bit error rate or error intervals.

The excellent quality of the test signal, which in the case of the D 3371 features steep clock rise and fall times (40 ps), is a prerequisite for effective testing. And currently unique on the market is the optional expansion of the output amplitude range to 3 V, which is crucial in some applications (e.g. measurements on EA modulators).

BER measurements are a suitable tool for optimizing the tuning of individual components and verifying the functionality. But the D 3371 offers a lot more: easy-to-use optional tools such as *jitter tolerance*, *flexible pattern* and *error phase analysis*.

## Up to the limits of jitter compatibility

Jitter refers to clock fluctuations of data signals. High-speed components in particular must be able to handle a certain amount of jitter without produc- ▶

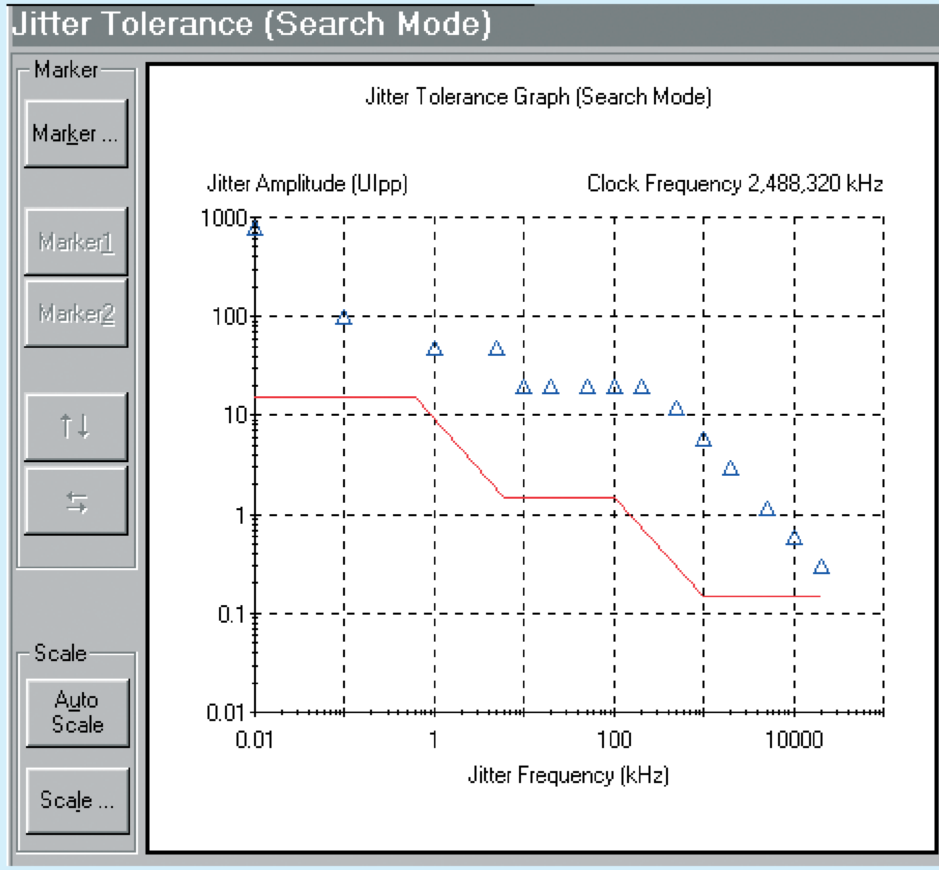



**FIG 2** **The jitter tolerance values are compared to a tolerance mask ("acceptable" as shown here).**

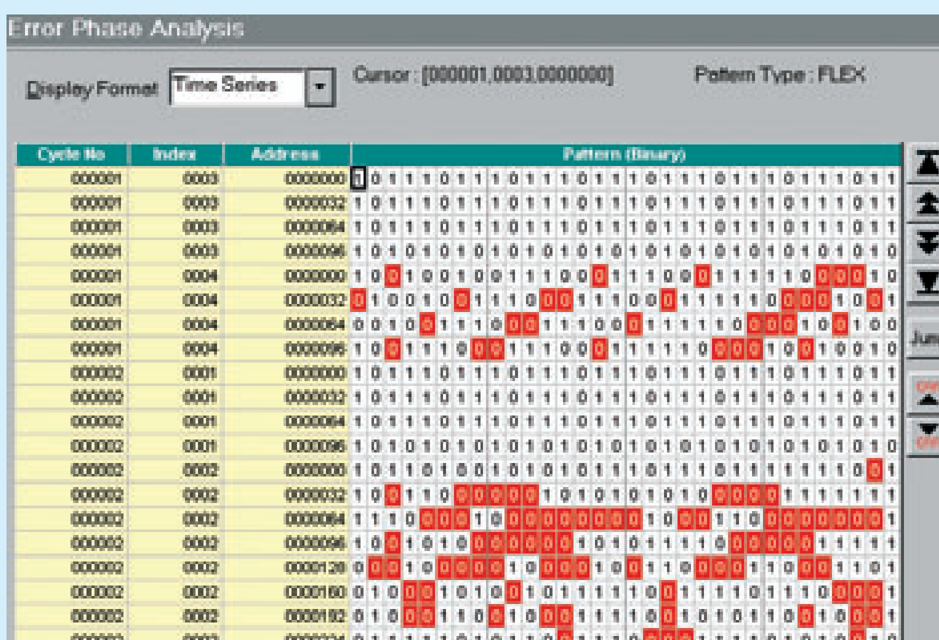



**FIG 3** **Bit-accurate display of error locations by means of error phase analysis.**

ing bit errors or totally losing the signal. By using the *jitter tolerance* option, the D3371 is able to test the limits of jitter compatibility. The analyzer simulates jitter by means of phase modulation on the test signal, with various jitter frequencies and amplitudes being available. Standardized tolerance masks (e.g. from ITU-T) implemented in the analyzer are helpful tools for these measurements. In the search mode (FIG 2) the analyzer automatically detects the jitter frequency or jitter amplitude combinations where the initial bit errors occur. In production applications, a simpler Yes/No response is often sufficient, as is possible in the quick sweep mode.

## Realistic simulation

Pseudo random bit sequences (PRBS) as test signals cover only part of the signal characteristics that actually occur. Signal structures with overhead and payload are an important criterion in every communications technology, whether Ethernet, ATM or SDH. The optional *flexible pattern* allows the definition of test sequences of user-defined patterns and PRBS. For this purpose, the D3371 is supplied with a convenient pattern editor that includes various standardized overhead structures. The user can thus better match the test signals and the actual signals, and obtain more realistic measurement results.

## More accurate error characterization

Do bit errors in structured signals occur in large numbers at specific locations, or are they statistically independent? This type of question cannot be answered by determining the absolute BER. The D3371 handles this problem by offering the *error phase analysis* function for bit-accurate error location determination (FIG 3). If it turns out that bit errors occur more often in the overhead than in the payload, for example, the user can effectively pinpoint the error source.

## Summary

With the above options, the D3371 provides tools that yield a decisive added value in high-speed components testing. The analyzer has a lot more to offer than BER measurements and is therefore correctly referred to as a transmission analyzer.

Jochen Hirschinger

## Abbreviations used

| | |
|---|---|
| 10GbE | 10 Gbit/s Ethernet |
| ATM | Asynchronous transfer mode |
| BER | Bit error rate |
| EA | Electro-absorption |
| FEC | Forward error correction |
| ITU-T | International Telecommunications Union – Telecommunications Standardization Sector |
| LAN | Local area network |
| SAN | Storage area network |
| SDH | Synchronous digital hierarchy |
| SerDes | Serializer/deserializer |
| STM | Synchronous transport module |
| PRBS | Pseudo random bit sequence |
| WAN | Wide area network |
| XAUI | 10 Gbit/s attachment user interface |

**More information and data sheet at www.rohde-schwarz.com (search term: D3371)**

Audio Analyzer R&S UPL

# Multichannel audio measurements on surround sound decoders

**Fitted with the new option R&S UPL-B23, the Audio Analyzer R&S UPL generates AC-3-coded test signals (Dolby Digital) directly with the built-in generator. This makes for convenient measurements on surround sound decoders when used with the Audio Switcher R&S UPZ.**


**Multichannel measurements on audio/video receiver.**

## Coded audio signals

In the multichannel methods surround sound and 5.1 playback, the six channels commonly used are data-reduced for transfer and then decoded in the consumers' surround sound decoders for analog and multichannel replay. Up to now, measuring these decoders necessarily involved defining and storing coded test sequences on a DVD or the PC hard disk. The test signals were then decoded in the DUT and measured on the analog outputs by means of an audio analyzer. Since the test files and the measurements ran on different instruments, synchronization was difficult, leading to extended measurement times.

The R&S UPL is the only audio analyzer so far to generate AC-3-coded test signals directly with the built-in generator.

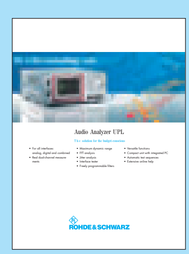
## The new option R&S UPL-B23 offers numerous advantages:

- The internal synchronization enables considerably faster measurements
- Test sequences can be combined much more flexibly since the number of channels, frequency or level sweep, start and stop frequency / level as well as the number of sweep points can be set directly
- The test signals are no longer recorded on DVD / PC, thus saving time previously spent on combining and coding them
- Additional hardware, such as a PC or DVD player, is not required

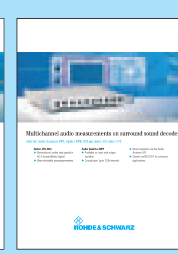
To test 5.1 decoders, the six channels are connected to the Audio Analyzer R&S UPL via the Audio Switcher R&S UPZ (FIG). The R&S UPL controls the R&S UPZ directly via an RS-232-C interface. For professional surround applications, the Audio Switcher R&S UPZ comprises eight channels, with two output channels for simultaneous use of the two R&S UPL measurement channels.

Klaus Schiffner

**Comprehensive data sheets "Multichannel audio measurements on surround sound decoders" and "R&S UPL" at www.rohde-schwarz.com**



Data sheet R&S UPL



Data sheet Multichannel audio measurements…

Precompliance Test Receiver R&S ESPI

# Measurement of conducted EMI when using a switching power supply

**A new firmware module has been developed for the R&S ESPI (FIG 1) that further facilitates EMI emission analysis. The advantages of the new functions are demonstrated by means of conducted EMI on a PC power supply. An external DC power supply and a battery pack are available for network-independent measurements (see box on right).**

**FIG 1 The Test Receivers R&S ESPI combine the advantages of analyzers and conventional test receivers.**

43665/12

## Successful multitalents

The precompliance Test Receivers R&S ESPI3 and R&S ESPI7 [*] were introduced in 2001 as multitalents and fulfilled all expectations. They not only handle standard spectrum analyzer applications and thus basic measurement tasks – they are also used to prepare for EMI certification in your own lab. The market has responded very positively to such versatility coupled with numerous intelligent functions in the medium price range.

An application example consisting of an EMI measurement using a PC switching power supply is presented here to highlight important integrated functions of the R&S ESPI models. These time-saving instruments considerably simplify everyday measurements without compromising the required measurement reproducibility. On the basis of these precompliance measurements and the results obtained, confirmation by standard-conformant final tests at an accredited test house will be strictly a formality.

## Overview measurements save time and costs

The appropriate means of interference suppression is determined by performing EMC testing of conducted EMI. Adequate suppression of conducted EMI should always be ensured before interference fields, i.e. radiated EMI, are analyzed.

The switching power supply in a PC or laptop is the main source of interference. To ensure that the switching power supply has proper EMC, it is designed, for example, with lowpass filters consisting of series inductance and case capacitance. However, frequent improvements to circuit design or layout are very time-consuming and expensive. The R&S ESPI can drastically reduce this effort because it allows you to perform quick and easy overview measurements that can be used to record and evaluate the effects of precompliance interference suppression due to components, filters and shielding. Together with the V-Network R&S ESH3-Z5, initial overview measurements can be easily performed on the lab bench to determine critical frequencies. Ideal test conditions, however, call for the use of a screened room, especially with a view to unimpaired reproducibility of test results (FIG 2).

## Limit values specified in European standard

The European EN55022 standard for limit values for maximum permissible EMI applies to switching power supplies in laptops. There are two limit values with parallel run and 10 dB offset for conducted EMI evaluation using the quasi-peak (QP) detector and the average (AVG) detector. To make sure that the limit lines are not exceeded in production, an offset of –3 dB to –6 dB from the limit lines is advisable to compensate for the production tolerances of the switching power supplies. To be on the safe side, a larger offset from the limit values should be selected in the case of lab bench results (safety margin for setup and parameter scatter). A higher offset, i.e. lower EMI, is desirable, but requires increased suppression and consequently higher production costs and is therefore economically not viable.

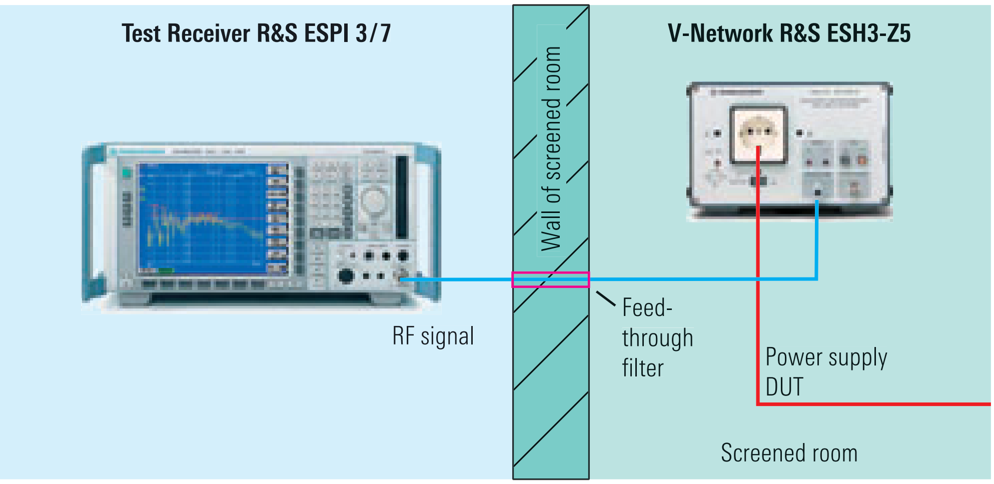



**FIG 2 To perform interference-free reproducible measurements, a test setup with screened room is recommended.**

ence conductor) are used to attenuate asymmetrical interference up to several megahertz. Mismatches of a symmetrical low-impedance interference source can be improved by inserting series inductance (current-compensated toroidal core inductor). Unsuitable setups on the lab bench with open printed boards may cause coupling problems at high frequencies that will diminish once the boards are mounted in metal enclosures and have optimum ground connection.

Since the measurement is performed initially only with the setting to phase L1 or to phase N of the artificial mains network, it is necessary to determine whether the amplitudes of the other phase are higher. In some cases, the test sequences have to be repeated several times. The artificial mains network, which is controlled via the TTL level on the USER PORT of the test receiver, is set in the PRESCAN PHASES submenu of the RECEIVER-FINAL MEAS menu. Analogously, the phases for the final test must be set under FINAL PHASES.

## Quick overview measurements during development

Overview measurements performed with the peak detector and the parallel average detector in the 150 kHz to 30 MHz frequency range produce fundamentals and harmonics. Suppression by connecting the source of interference to X capacitors, which is usually carried out in several steps, results in the attenuation of primarily the symmetrical interference in the low-frequency range. At higher frequencies, interference becomes increasingly asymmetrical. Y capacitors against ground (refer-

## New DC supply and battery options for the R&S ESPI and R&S FSP families

With the Battery Pack R&S FSP-B31 and the Spare Battery Pack R&S FSP-B32, the optional DC Power Supply R&S FSP-B30 (FIG below) makes network-independent measurements possible. The input voltage range is 10 V to 28 V DC, thus allowing operation by connection to a standard car battery. The typical operating time of the 3 GHz models in battery mode is approx. 2 h. The options can be retrofitted; the DC Power Supply R&S FSP-B30 can be attached to all R&S FSP and R&S ESPI units, whereas options R&S FSP-B31/-B32 can only be used with units that are equipped with the robust R&S FSP-B1 option, including shock protection and carrying strap. Together, both options add 4.3 kg to the normal receiver weight of approx. 11 kg. Options R&S FSP-B30 / -B31 are charged from a separate power supply. The built-in load controller protects against overload.

### Condensed data of R&S FSP-B30

| | |
|---|---|
| Input voltage range | 10 V to 28 V DC |
| Current drain R&S FSP3 / ESPI3 | typ. 6 A |
| R&S FSP30 | typ. 8 A |
| Operating temperature range | 0 °C to 50 °C |
| Weight | 0.6 kg |

### Condensed data of R&S FSP-31

| | |
|---|---|
| Output voltage | 13.2 V |
| Capacitance | 200 Wh |
| Charging time | approx. 5 h |
| Operating time | approx. 2 h |
| Operating temperature range | 0 °C to 50 °C |
| Weight | 3.7 kg |

During phase switchover, all artificial mains networks can exhibit voltage peaks that may damage the RF input section. To protect the input against signal levels that are too high, use pulse-resistant 10 dB or 20 dB attenuator pads or the Pulse Limiter R&S ESH3-Z2.

The excellent technical features of the R&S ESPI, such as wide dynamic range, high sensitivity and test speed, threefold detector and a variety of resolution bandwidths (10 Hz to 10 MHz RBW and 200 Hz, 9 kHz, 120 kHz, 1 MHz CISPR bandwidths), are beneficial even during the overview measurements. The amplitude measurement error specified at <±1.5 dB also remains below the ±2 dB value stipulated in the EMC basic standard CISPR16-1. The Preselector/Preamplifier R&S ESPI-B2 improves the protection against overload caused by unwanted broadband signals; this and improved sensitivity by switching in the preamplifier, if necessary, produce a higher S/N ratio and thus increased measurement accuracy. Compared to other precompliance test receivers in this price range, the R&S ESPI with its outstanding features is clearly the best of the field (see also EMC-relevant features in [*]).

## Data reduction shortens measurement time

The critical measurement values obtained in the quick overview measurement (precompliance measurement) have to be double-checked by using standard detectors during an appropriately long test period; only then can they be compared to the limit lines of the EN55022 standard. Since the precompliance measurement also yields a lot of measurement results that are far below the limit values and therefore are not likely to exceed them even during long final measurements, the user can draw up a shorter frequency list by means of data reduction. The new PEAK SEARCH function can be used for this purpose; it utilizes the value specified for No. of PEAKS and/or the value for MARGIN (safety margin from limit lines) (FIG 3).

Since the trace may produce unwanted scatter plots, equidistant subranges (SUBRANGES) can be used to define a different constellation. This ensures that only one value per subrange and trace is listed for the final tests. In this example, we recommend that 25 points and a limit value of –6 dB be entered in a first attempt. The 25 highest peaks of trace 1, measured with the peak detector, and the 25 highest level values of trace 2, weighted by means of the average detector of the precompliance test files, will then be listed in the prescan result list (FIG 4).

The table can then be modified as required. For this purpose, the MARKER

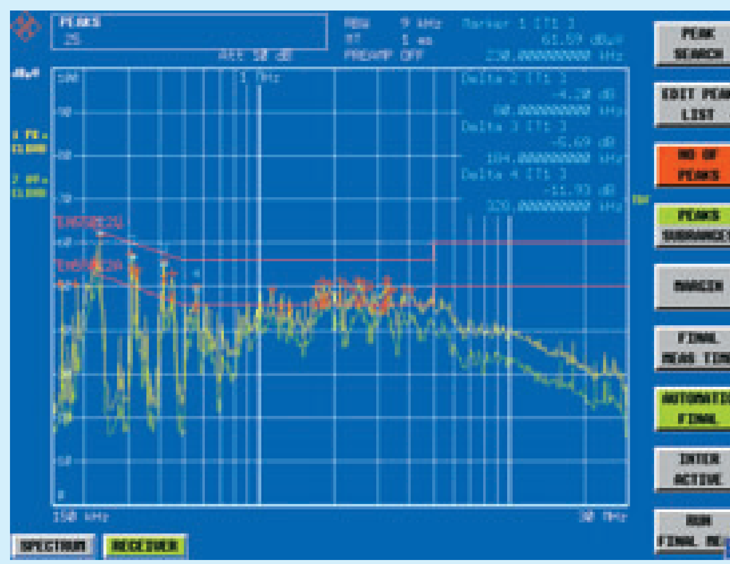
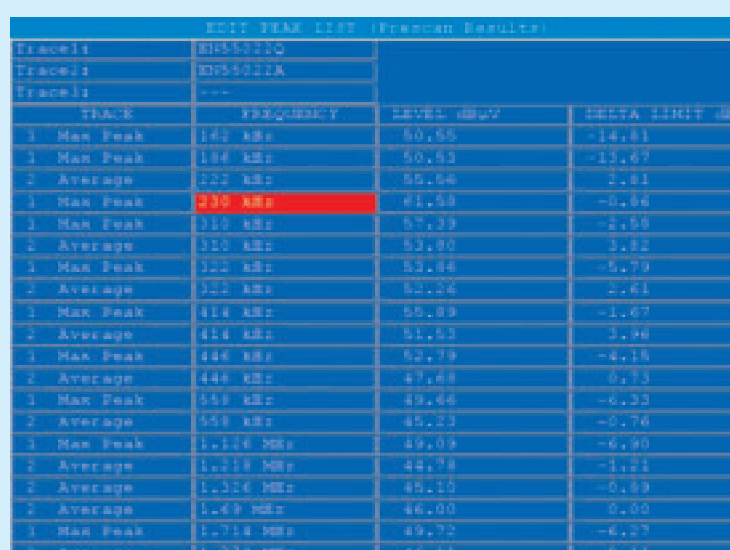



**FIG 3 Peak search with 25 peak values.**



EDIT PEAK LIST (Prescan Results)

| | |
|---|---|
| Trace1: | EN55022Q |
| Trace2: | EN55022A |
| Trace3: | --- |

| TRACE | FREQUENCY | LEVEL dBµV | DELTA LIMIT dB |
|---|---|---|---|
| 1 Max Peak | 162 kHz | 50.55 | -14.81 |
| 1 Max Peak | 184 kHz | 50.53 | -13.67 |
| 2 Average | 222 kHz | 55.56 | 2.81 |
| 1 Max Peak | 230 kHz | 61.58 | -0.66 |
| 1 Max Peak | 310 kHz | 57.33 | -2.58 |
| 2 Average | 310 kHz | 53.80 | 3.82 |
| 1 Max Peak | 322 kHz | 53.84 | -5.79 |
| 2 Average | 322 kHz | 52.26 | 2.61 |
| 1 Max Peak | 414 kHz | 55.89 | -1.67 |
| 2 Average | 414 kHz | 51.53 | 3.96 |
| 1 Max Peak | 446 kHz | 52.79 | -4.15 |
| 2 Average | 446 kHz | 47.68 | 0.73 |
| 1 Max Peak | 558 kHz | 49.66 | -6.33 |
| 2 Average | 558 kHz | 45.23 | -0.76 |
| 1 Max Peak | 1.114 MHz | 49.09 | -6.90 |
| 2 Average | 1.218 MHz | 44.79 | -1.21 |
| 2 Average | 1.326 MHz | 45.10 | -0.89 |
| 2 Average | 1.49 MHz | 46.00 | 0.00 |
| 1 Max Peak | 1.714 MHz | 49.72 | -6.27 |
| 2 Average | 1.778 MHz | 46.11 | 0.11 |

**FIG 4 Table with prescan results.**

menu (MKR) contains several functions that enable straightforward operation, aided by the rotary knob (FIG 5). MARKER to PEAK, NEXT PEAK, SEARCH NEXT LEFT / RIGHT, ADD to PEAKLIST, to name just a few useful functions, ensure maximum efficiency when compiling the frequency list for the final tests.

TUNE to MARKER defines the marker frequency as the receive frequency and can be displayed as a single measurement with a maximum of three detectors simultaneously (FIG 6). This coupling remains active with MARKER TRACK. The AM or FM demodulator can be applied simultaneously for acoustic EMI identification. If MARKER TRACE is used, the active MARKER is also active on other trace contents it was assigned to.

It is precisely this mix of automatic data reduction with regard to limit lines, safety margin (MARGIN) and manual post-processing that makes working with the R&S ESPI so effective. In addition, the user can decide during the SCAN precompliance test to interrupt the measurement at specific frequencies (HOLD SCAN) and to determine in each case whether the frequency in question is critical. Moreover, the zoomed split-screen display in the upper part of the screen allows higher resolution with completely independent parameters, e.g. for measurement bandwidth, span and RF attenuation. The measurement can either be continued at the point where it was interrupted (CONTINUE AT HOLD) or it can be set to resume at a previous lower frequency by overwriting the frequencies that are repeatedly measured (CONTINUE AT REC FREQ).

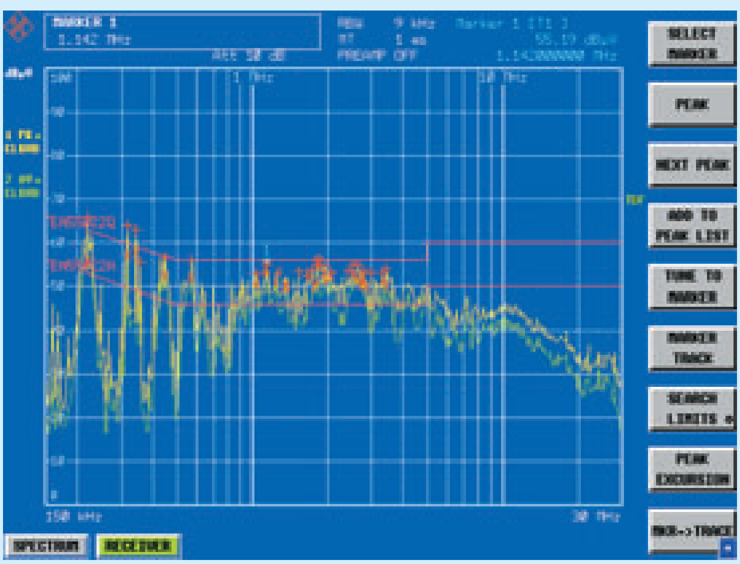



**FIG 5**
**Marker functions help the user to modify the frequency table and to mark the QP and AVG values in the diagram.**

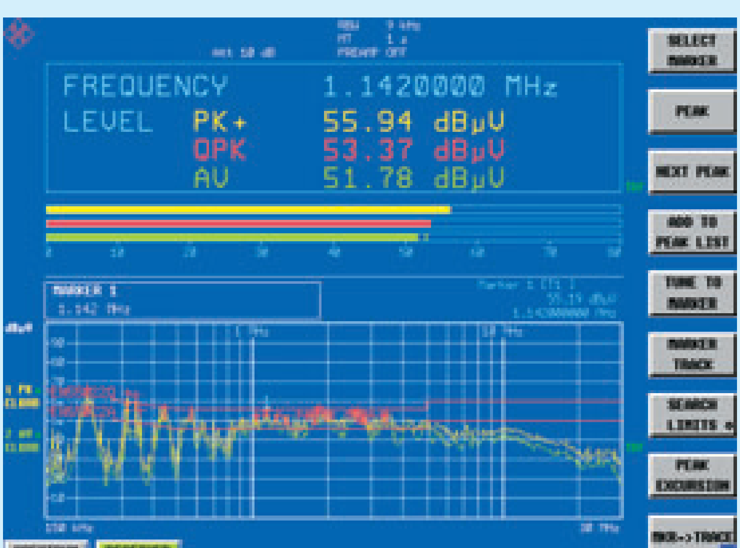



**FIG 6**
**Split-screen display with marker-coupled threefold detector.**

The variety of functions offered meets almost every requirement, because the user can choose from any analysis option conceivable. To provide a straightforward overview, the QP values are marked by + and the AVG values by x (FIG 5) in the graphical display.

## Final measurement, automatic or manual

The final analysis of the measurement results by means of the compiled table (FIG 7) is started by merely selecting RUN FINAL MEAS from the submenu for the receiver settings. In the AUTOMATIC setting, the R&S ESPI remeasures all listed frequencies from trace 1 or trace 2 using the QP or AVG detector in all four settings of the artificial mains network and at a measurement time of 1 s. With approx. 50 test points with four settings each, the measurements take approx. 200 s to 220 s. This is tremendously timesaving compared to measurements without data reduction, which would require from four to six hours depending on the step width of the predefined scan settings.

EDIT PEAK LIST (Final Measurement Results)

| | |
|---|---|
| Trace1: | EN55022Q |
| Trace2: | EN55022A |
| Trace3: | --- |

| TRACE | FREQUENCY | LEVEL dBµV | DELTA LIMIT dB |
|---|---|---|---|
| 1 Quasi Peak | 162 kHz | 42.17 L1 f1 | -23.18 |
| 1 Quasi Peak | 186 kHz | 44.88 L1 f1 | -19.33 |
| 2 Average | 222 kHz | 54.32 L1 gnd | 1.58 |
| 1 Quasi Peak | 230 kHz | 57.33 L1 f1 | -5.11 |
| 1 Quasi Peak | 310 kHz | 56.08 L1 gnd | -3.88 |
| 2 Average | 310 kHz | 47.58 N gnd | -2.39 |
| 1 Quasi Peak | 322 kHz | 55.73 N f1 | -3.92 |
| 2 Average | 322 kHz | 48.30 N gnd | -1.35 |
| 1 Quasi Peak | 414 kHz | 55.19 L1 f1 | -2.37 |
| 2 Average | 414 kHz | 48.90 N gnd | 1.33 |
| 1 Quasi Peak | 446 kHz | 53.29 L1 gnd | -3.65 |
| 2 Average | 446 kHz | 48.66 N gnd | 1.71 |
| 1 Quasi Peak | 558 kHz | 47.58 N gnd | -8.41 |
| 2 Average | 558 kHz | 45.10 N f1 | -0.89 |
| 1 Quasi Peak | 1.126 MHz | 49.60 L1 f1 | -6.39 |
| 2 Average | 1.218 MHz | 48.07 N gnd | 2.07 |
| 2 Average | 1.326 MHz | 40.45 L1 f1 | -5.54 |
| 2 Average | 1.69 MHz | 47.39 L1 gnd | 1.39 |
| 1 Quasi Peak | 1.714 MHz | 48.37 L1 f1 | -7.62 |
| 2 Average | 1.778 MHz | 45.79 N f1 | -0.20 |

**FIG 7 Table with the results of the final measurement showing phase and protective earth settings.**

The interactive mode is used for cases where automatic final measurements are not advisable. The frequency is set on the receiver, where it is selected from the list along with all associated settings such as bandwidth, measurement time, preamplification and RF attenuation. The marker is also set to this frequency in the scan diagram. The receiver parameters can still be varied. If the maximum value (user-defined) is displayed and MEASURE is selected, the measurement is final-weighted and the values entered into FINAL FREQ. LIST. This process is repeated for all frequencies to be set until the complete list has been processed.

You can, of course, print all scan, transducer, limit lines, test result tables and graphs that are relevant for the measurement and documentation and store them in file format on either hard disk or diskette. You can also transfer them to a separate PC via the LAN Ethernet (R&S FSP-B16) option. To export measurement results, ASCII formatting can be defined using either a decimal point or a comma as a separator.

The EMI software packages R&S ES-K1 and R&S EMC32 offer further documentation options. With the R&S EMC32, for example, documents can also be generated in HTML, RTF or PDF format.

Volker Janssen

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

Data sheet R&S ESPI

REFERENCES

[*] Precompliance Test Receiver R&S ESPI: Multitalent in the development lab. News from Rohde & Schwarz (2001) No. 171, pp 33–38

Digital Sound Broadcast Data Inserter R&S DSIP 020

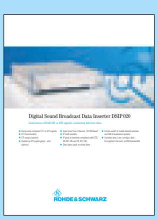
# DAB signals with flair: embedding data and auxiliary services

**Digital audio broadcasting (DAB) networks are being implemented all over the world. They are highly popular with audio program transmission and data services. The R&S DSIP 020 not only inserts IP-based data into DAB transmission signals, but also generates complete DAB signals.**

43 786/2

**FIG 1 The R&S DSIP 020 can generate entire DAB signals.**

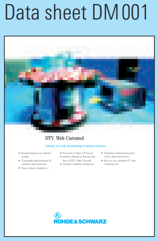
More information and data sheets at www.dbc.rohde-schwarz.com or www.datacasting.rohde-schwarz.com



Data sheet DSIP 020

Data sheet DM 001

Data sheet Web over DTV™



Data sheet DTV WebCarousel™

REFERENCES


[1] Web over DTV – Cost-attractive service through DVB: Transmission of extra data in Web format. News from Rohde & Schwarz (2000) No. 166, pp 18–19

[2] Web over DTV – Broadcasting and the Internet: convergence through new applications. News from Rohde & Schwarz (2001) No. 170, pp 24–26


## DSB – for data as well

Digital sound broadcasting (DSB) is highly reliable; mobile reception of emissions is excellent. The audio programs can be enhanced not only by program associated data (PAD). Additional non-program associated data (NPAD) services make new applications possible, e.g. transmitting computer data or applications directly into moving vehicles. Cars, trains, public transport and mobile users can thus be supplied with extra digital services.

The Internet protocol (IP) provides the basic requirements for transporting disparate data such as websites, computer games, databases, MP3 sound files, or even MPEG4-compressed video sequences and films.

The DSB Data Inserter R&S DSIP 020 (FIG 1) is used for these purposes – in accordance with the standard it inserts data to be transferred from computer networks via DAB transmission networks into the signals that are to be transmitted.

## STI or ETI – whichever you require

The R&S DSIP 020 is basically a generator producing a DAB-conformant output signal in which IP data is embedded as packet mode data in compliance with the standards (ES 201735 and TS 101759). It supports the new future-oriented service transport interface (STI) as standard. The service providers consequently enjoy maximum flexibility. When used with the DAB Multiplexer R&S DM 001, a dynamic configuration of audio and data programs for DAB can be implemented via the STI protocol.

The R&S DSIP 020 can be optionally expanded to output ensemble transport interface (ETI) signals, which are emitted by the DAB transmitters. The DSB data inserter can thus be connected directly to a transmitter without requiring other multiplexers. This makes for favourably priced DAB-based data transmitters. Transmission capacity can be stretched up to the maximum capacity of the ETI signal at approx. 1.5 Mbit/s for user data.

## Modularly extendible up to enhanced data casting system

Several software components complement the DSB data inserter, ensuring that it provides a technical interface for the broadcasting system and supports a variety of other services [1, 2].

The *WebCarousel*™ software transmits information that is available as files or is to be transmitted in file format, whereas *StreamConnector*™ is used to emit streaming media, i.e. files of infinite length or information generated live (from MPEG cameras or MP3 sound). Streaming shortens the delay because media is output as soon as the first packets arrive and the user does not have to wait until the complete file has been received.

*MediaRouter*™ supports the transition of IP networks to digital broadcasting as well as the management and quality of service (QoS) of the different services.

All modules can be combined: IP inserter and data generator with the complementary software system components, or all the way up to a multimedia object transfer protocol (MOT) carousel. A datacasting system with open interfaces for the flexible management of dynamic data services can thus be implemented. This enhanced datacasting system (EDS) will set new standards in digital broadcasting (FIG 2).

## DAB signals for test purposes

The commissioning and testing of systems and data also requires the generation of test signals. It is too expensive to set up a complete mini DAB network in the lab or production plant just to test a receiver or the correct installation in vehicles, for example.

Equipped with the optional ETI player, the R&S DSIP020 can also be used as a DAB signal generator. In this case, data is not inserted, but an entire correct transmit signal (ETI) is generated, which users can select like a test pattern and configure to their requirements. Services with common audio test signals are available for use as standard test patterns. But it is also possible to simulate entire DAB ensembles with PAD data services as well as labels, traffic announcements and auxiliary services.

The DAB test patterns are emitted in a continuously repeating loop with the inserter directly connected to a transmitter or modulator.

An optimal solution is the use of the data inserter functioning as an ETI player in conjunction with the Test Transmitter R&S SDB601. These two small units allow the simulation of a complete DAB signal that is similar to those used in

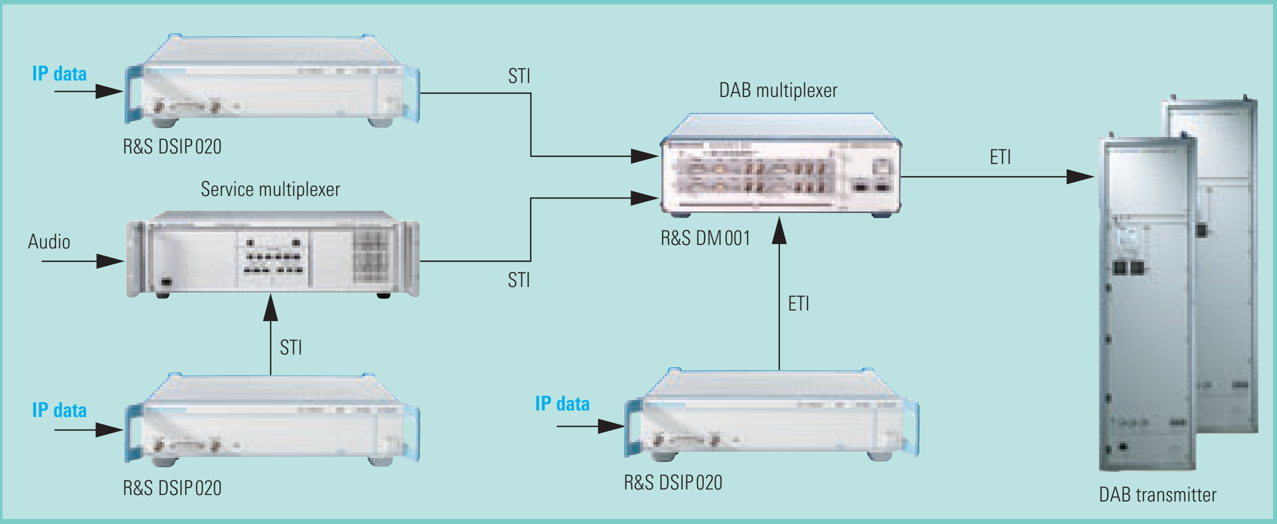



**FIG 2 The DSB data inserter offers a wide variety of applications in DAB transmitter networks.**

large transmitter networks and that covers both band III and the L band (FIG 3). If the test system is complemented by an external I/Q modulator (e.g. with the R&S SMIQ), simulation of transmission channel interference such as echo, fading or noise is also possible.

## Integrated PC

The R&S DSIP020 is a PC-based inserter with Embedded WindowsNT™ as the operating system. Connected to a keyboard and monitor, it can be configured like a PC and is able to control instruments such as the Test Transmitter R&S SDB601 via a serial interface. The units can also be set by a remote administrator.

The *WebCarousel*™, *MediaRouter*™ and *StreamConnector*™ applications can be directly installed and run on the R&S DSIP020. In this case, the DSB data inserter is integrated like a PC into a computer network, and the data to be transmitted, e.g. files, is exchanged.

The R&S DSIP020 can store DAB test signals as files on its hard disk, which can later be selected and activated via the graphical user interface.

## Versatile applications

The R&S DSIP020 expands DAB systems with:

- distribution of computer data and files via DAB
- mobile Internet services
- auxiliary data in line with the MOT streamer
- broadcasting of high-end compressed sound files (MP3, MP4)
- transmission of packed videos to vehicles (MPEG4)
- provision of program-independent additional information (traffic service, local news, instant news radio)

The DSB data inserter can be used directly in combination with a transmitter without mulitplexer for a DAB-based data broadcasting system, e.g. for inhouse coverage or mobile services.

The ETI player option is also of interest for:

- testing of receivers
- checking of receiver installations, particularly in vehicles
- lab testing of new DAB services
- field testing of DAB transmitters via test signals

All R&S DSIP020 options can be activated independently of each other. The data inserter can be software-converted at any time from a test unit (ETI player) into an operational device (IP inserter). Subsequent expansion of existing DAB systems is no problem.

The R&S DSIP020 complements the datacasting solutions from Rohde & Schwarz, which can be used system-independently based on open interfaces both for DVB and DAB systems.

Torsten Jäkel

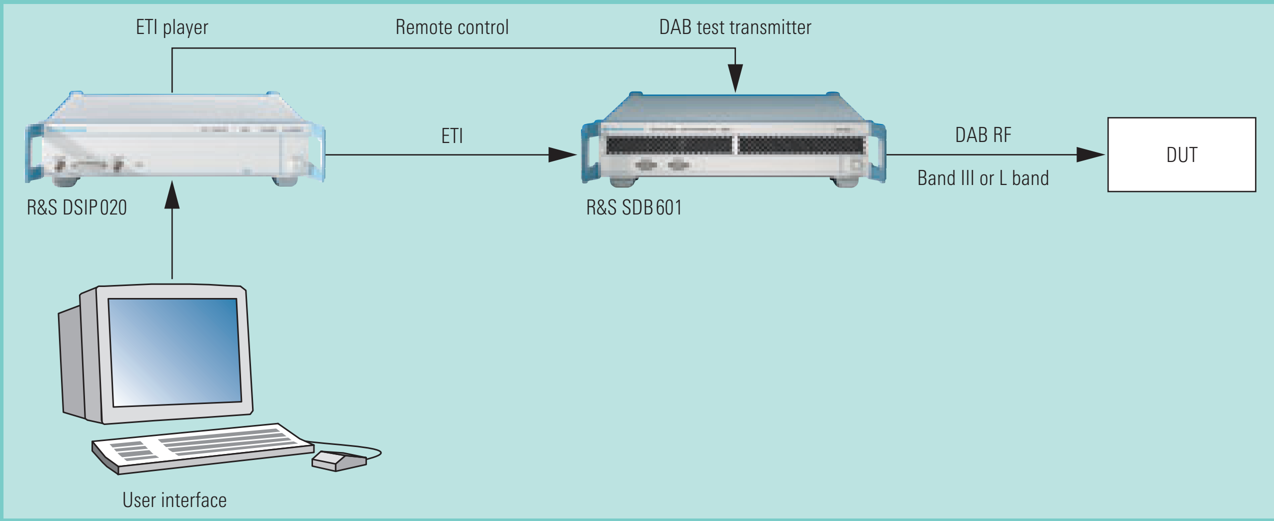



**FIG 3 DAB simulation with R&S DSIP020 and DAB Test Transmitter R&S SDB601.**

Vector Signal Generator R&S SMIQ03S

# Test equipment for satellite-supported broadcasting systems XM and SIRIUS

**SIRIUS and XM now enable satellite-supported digital broadcasting also in the US, allowing nationwide reception in CD quality. Rohde&Schwarz thus added these two standards to the well-known allrounder, Vector Signal Generator R&S SMIQ.**

## What are SIRIUS and XM?

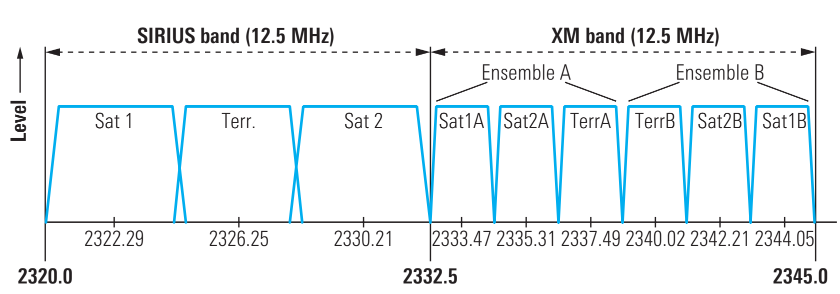
Back in 1998, Worldspace (www.worldspace.com) launched the ambitious project to provide full coverage of high-quality audio programs on the African, Asian and Latin American continents. Already at that time Rohde&Schwarz supplied the necessary test equipment [*].

Based on this technology, a satellite-supported broadcasting system was designed for the US to enable nationwide reception in CD quality. This meant that the frequency was transferred from the L band (1.4 GHz) to the S band (2.3 GHz) and at the same time the bandwidth increased by 5 from 2.5 MHz to 12.5 MHz. This higher bandwidth is used primarily for transmit diversity, a method that transfers the user data several times via different channels. This is of particular importance for this system since it was designed for mobile reception in cars where receiving conditions are particularly unpredictable. For example in US cities with skyscraper-lined streets, it is difficult to transmit signals with only a single satellite.

XM Radio (www.xmradio.com) and SIRIUS (www.siriusradio.com) each obtained a license to implement this project. Both had come up with similar solutions to the problem: two satellites to cover the area and regions with few buildings as well as additional terrestrial repeaters (currently approx. 1500) to bridge coverage gaps in the cities. Both systems come with sophisticated channel coding where successive data bits are transmitted separately over long periods of time (interleaving) and so ensure interference-free reception in cars even if all receive paths briefly fail at the same time (e.g. when driving under an expressway bridge).

The main difference between the two systems is the division of the available bandwidth of 12.5 MHz into the two satellite bands and the repeater band as well as the satellite order (FIGs 1 and 2). Another important difference is that with SIRIUS all 100 channels are simultaneously available, whereas XM divides them into two ensembles with 50 channels each. As a consequence of this division, the bands for the satellites and the repeater are also partitioned, resulting in reduced hardware complexity (half the data rate) in the receiver.

**FIG 1 Frequency bands for XM and SIRIUS.**




## Glossary

| | |
|---|---|
| ACP | Adjacent channel power (interference power in the adjacent channel) |
| AMBE | Advanced multiband excitation (codec for speech) |
| COFDM | Coded orthogonal frequency division multiplex. Bits modulate the subcarriers in the spectral range. The signal will then be determined by an inverse FFT. Often referred to as OFDM. |
| MCM | Multicarrier modulation (synonymous with COFDM) |
| PAC | Perceptual audio coder (codec for music and speech) |
| QPSK | Quadrature phase shift keying. A simple digital modulation where two bits are combined to form a symbol which is modulated by one out of four phases. |
| SDARS | Satellite digital audio radio services (generic term for XM and SIRIUS) |
| TDM | Time division multiplex. The individual (audio) signals are transmitted on the same frequency in different timeslots. |
| TWTA | Travelling wave tube amplifier |

## The allrounder: R&S SMIQ03S and software

Rohde & Schwarz provides the necessary T&M equipment for both standards. The following information refers to XM receiver tests.

FIG 3 shows the production test setup. This is based on the Vector Signal Generator R&S SMIQ 03 S, which is able to generate the satellite signal (QPSK) without further modification. Two hardware extensions were developed to generate standard-conformant repeater signals (COFDM): A modulation coder for the COFDM modulation (alternating operation with the standard Modulation Coder R&S SMIQ-B20) and a special bandpass filter (MCM filter) for compliance with the stringent ACP requirements. The RF test signal can then be applied to the DUT, if necessary in combination with an AM/FM test signal.

Application Software R&S SMIQ-K4 runs on the PC driving the R&S SMIQ. It was specifically designed for testing XM receivers and supports the user at all stages, from producing audio test signals through coding audio data (PAC/AMBE encoder), combining audio streams into a satellite/repeater signal to driving up to six generators. This is important in development or quality assurance because all Sat1A, Sat2A, TerrA, TerrB, Sat2B and Sat1B partial signals must be generated simultaneously to obtain a realistic signal.

All relevant parameters of the vector signal generator can be set intuitively and quickly, with a focus on interference simulation, which includes fading, noise and non-linear distortion – of particular importance in the TWTA output stages of the satellites.

| | XM | SIRIUS |
|---|---|---|
| **Channels** | 100 for music (approx. 70 in CD quality) and approx. 30 for news/talk | |
| **Reception** | Mainly mobile in cars | |
| **Monthly subscription fees** | 9.95 US$ | 12.95 US$ |
| **Satellites** | Two satellites, geostationary. Two RF signals per satellite, QPSK modulation | Three satellites, earth synchonous on 8-shaped orbits (usually the two most favourable satellites are used). One RF signal per satellite, QPSK modulation |
| **Terrestrial repeaters** | Two RF signals, COFDM modulation | One RF signal, COFDM modulation |

**FIG 2 XM and SIRIUS – similarities and differences.**

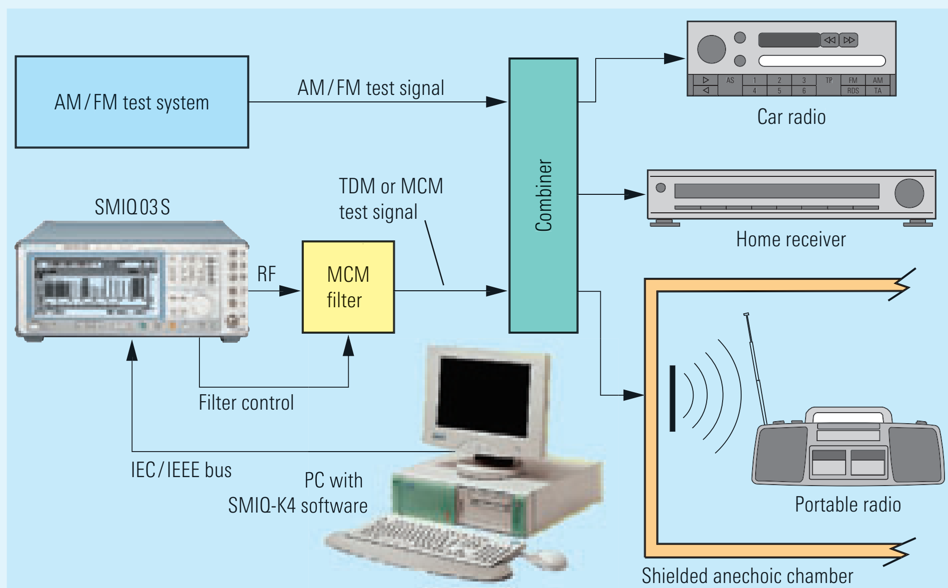


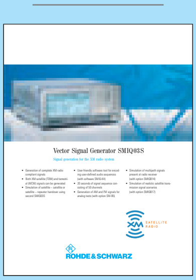

**FIG 3 Test system setup for receivers, using XM as an example.**

## Preview

Both systems are currently experiencing a boom; XM alone already had 76 000 subscribers on 1 April 2002. The test solution from Rohde & Schwarz detailed in this article will contribute its share to achieving the planned subscriber number (500 000 by the end of this year).

Thomas Braunstorfinger; Wolfgang Kufer

**More information and data sheet at www.rohde-schwarz.com (search term: SMIQ03S)**



Data sheet SMIQ 03 S

REFERENCES


[*] Vector Signal Generator SMIQ 02 W / SMIQ 03 W: Test signals for digital WorldSpace satellite sound broadcasting. News from Rohde & Schwarz (1998) No. 160, pp 7–9

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**FIG 1 The allrounder Vector Signal Generators R&S SML and R&S SMV03 generate stereo-modulated RF signals to standard by means of the new stereo/RDS coder option.**

Signal Generators R&S SML / R&S SMV03

# Stereo-modulated RF signals to standard with stereo/RDS coder

**Conventional VHF FM stereo transmission is still the mainstay of sound broadcasting. Suitable receivers will thus remain a much sought-after commodity for a long time to come. Every year, millions of car radios are produced, and even mobile phones are increasingly fitted with stereo receivers. Large-scale production calls for reliable, accurate signal sources with short setting times.**

## Stereo modulation

Fitted with the new option Stereo/RDS Coder R&S SML-B5, the signal generators of the tried and tested R&S SML [1] and R&S SMV [2] (FIG 1) families generate stereo-modulated RF signals to standard for use in production, development and service. At the core of this option is a digital signal processor (DSP) that generates stereo, RDS and ARI signals of outstanding quality (FIG 2), which is fully sustained owing to the excellent FM modulators in the generators. FIG 4 shows the typical AF frequency response (0.2 dB between 20 Hz and 15 kHz). The typical values of crosstalk attenuation (55 dB at 1 kHz audio frequency), distortion (0.05%) and S/N ratio (75 dB, A weighted, rms) also fulfill every requirement. The stereo/RDS coder is designed in such a way that the pilot tone does not need to be switched off for resettings as is the case with many simpler stereo coders. With pilot tone interruptions, the stereo decoders of the connected DUTs would become out of sync, causing a drastic increase in measurement time. This would be intolerable especially for production test setups.

Stereo modulation may be generated either via the internal AF generator or external analog or digital modulation sources. The internal AF generator that is part of every basic R&S SML and R&S SMV03 configuration is ideally suited for simple basic receiver tests without additional external signals (FIG 3). Measurements can be performed in the L, R, L = R and L = –R operating modes.

## Quick test system

The inputs for external modulation signals on the new option are tailored to operations using the Audio Analyzer R&S UPL. This applies both to the analog L and R inputs and the digital S/P DIF interface. The combination of R&S SML and R&S UPL creates a fast universal test system for mass production of stereo receivers (FIG 5).

The advantage in speed with this instrument combination is achieved because both the generation of test signals and their evaluation in the audio analyzer are performed in one and the same instrument. Thus, test signal generation and evaluation are optimally timed, unlike when separate instruments are used.

The audio analyzer can perform measurements in the L, R, L = R and L = –R operating modes via the analog L and R inputs. If the R&S UPL is fitted with the optional Digital Interface R&S UPL-B29, the stereo/RDS coder can also be controlled via the digital modulation input. In this operating mode, the audio analyzer is able to generate different L and R signals. It is possible, for example, to feed a fixed audio frequency to the first channel while a frequency sweep is being performed in the second channel.

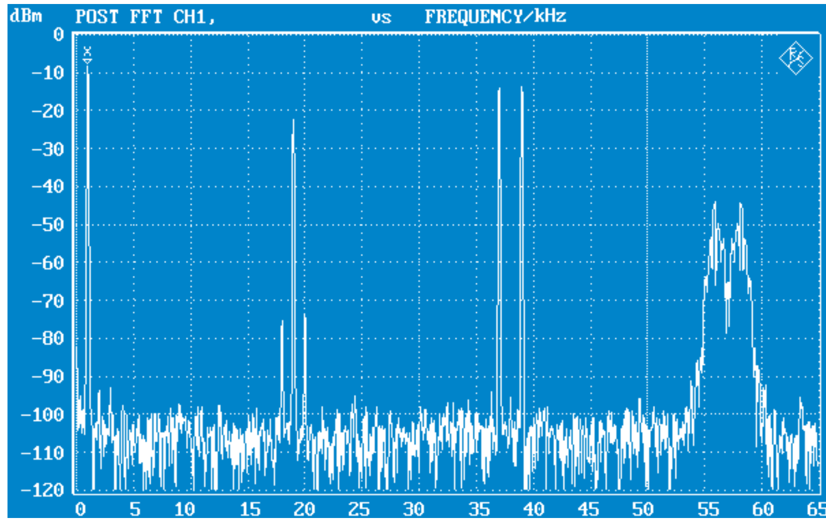



**FIG 2 Output signal of the stereo/RDS coder.**

## Measurements to standard

If the optional Universal Sequence Controller R&S UPL-B10 and a suitable measurement program are installed in the audio analyzer, tuner measurements in accordance with the international IEC 315-4 standard can be performed. The user can, of course, also program any other measurement sequence. For this purpose, all functions of the stereo / RDS coder are remote-controllable via the IEC/IEEE bus or RS-232-C interface. As an alternative to the universal sequence controller in the R&S UPL, any other external controller with an IEC / IEEE bus interface can be used.

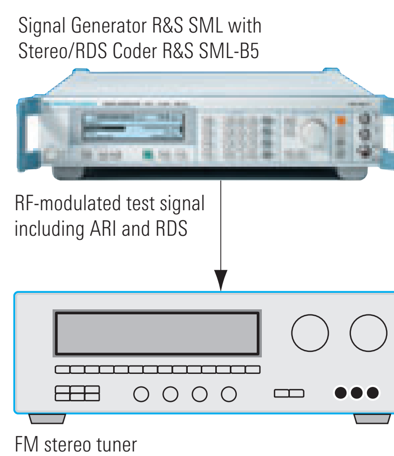



**FIG 3 Operation with internal AF generator of the R&S SML or R&S SMV03.**

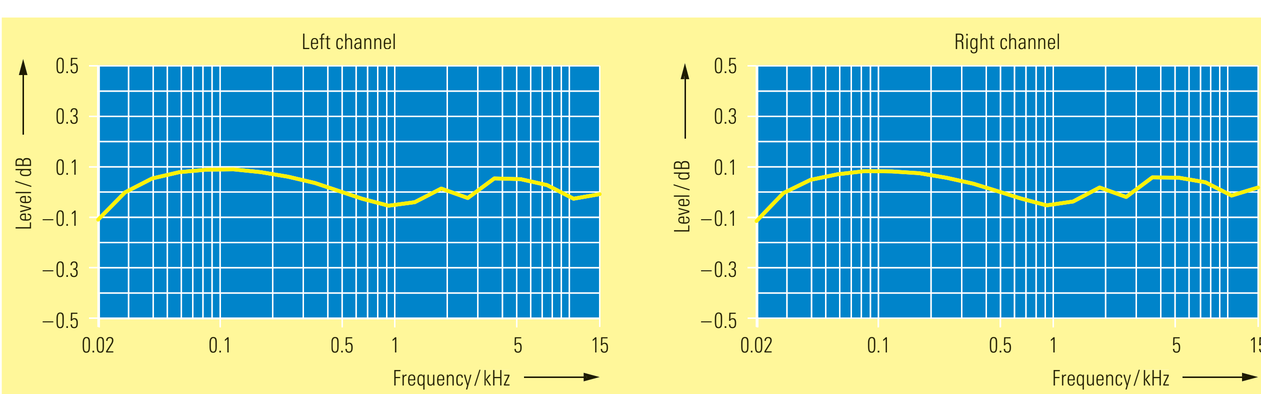



**FIG 4 Typical AF frequency response of the stereo/RDS coder.**

## ARI and RDS

The new option also generates ARI and RDS signals to standard. All ARI and RDS functions are remote-controllable. With ARI, all functions can be operated manually, whereas RDS allows manual operation only with RDS on/off, frequency deviation setting of the RDS subcarrier, traffic program (TP), traffic announcement (TA) and the selection of one of five RDS data sets. The five RDS data sets can be loaded via remote control into the signal generator with a maximum length of 64 Kbyte. Each of these data sets contains:

- PI (program identification)
- PS or scrolling PS (program service name)
- TP
- TA
- PTY (program type)
- PTYN (program type name)
- DI (decoder information)
- MS (music /speech)
- CT (clock time)
- RT (radio text, two text blocks with 64 symbols each)
- AF (alternative frequencies, maximum of five lists with 25 frequencies each)
- TMC (traffic message channel)
- EON (enhanced other networks, eight PS with five EON AF lists each)

The user can also transmit free format groups (FFG), groups in transparent mode (any group content fed by the controller) and four predefined binary test patterns. The command set for remote control of the RDS functions contains virtually all commands in accordance with the international IEC 62106 RDS standard.

Wilhelm Kraemer

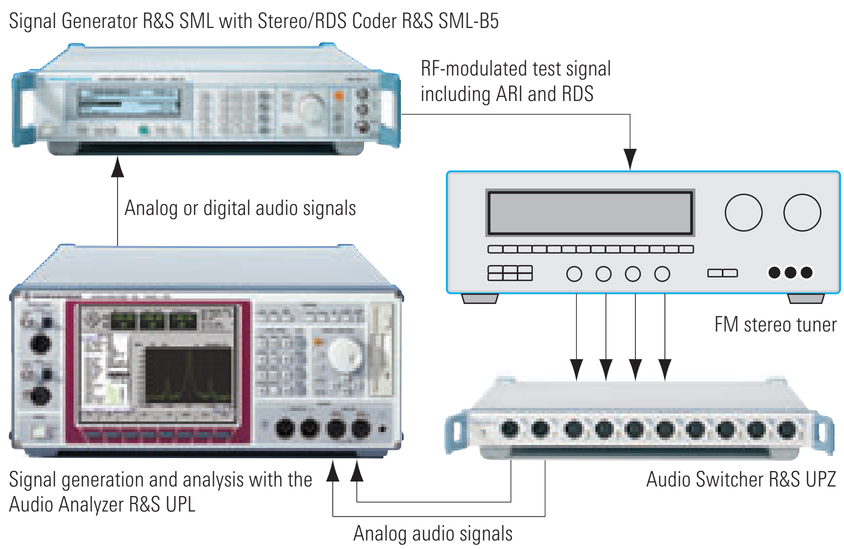
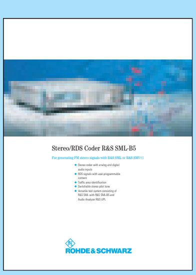



**FIG 5 Test system for stereo receiver with R&S SML and R&S UPL.**

**More information and data sheets at www.rohde-schwarz.com (search terms: SML-B5 and UPL)**



REFERENCES

[1] Signal Generator R&S SML01: Top-class economy generator. News from Rohde & Schwarz (1999) No. 165, pp 8–10

[2] Vector Signal Generator R&S SMV03: All-rounder with excellent vector modulator. News from Rohde & Schwarz (2001) No. 172, pp 24–26

### Condensed data of R&S SML / SMV03 with stereo/RDS coder

Specifications apply to the frequency range from 66 MHz to 110 MHz.

| | |
|---|---|
| Operating modes | internal with modulation generator<br>external analog (L, R inputs)<br>external digital (S/P DIF input) |
| Frequency deviation | 0 Hz to 80 kHz |
| Frequency response (L and R signal) | <0.3 dB (20 Hz to 40 Hz)<br><0.2 dB (40 Hz to 15 kHz) |
| Stereo crosstalk attenuation | >45 dB (AF = 1 kHz) |
| Distortion | <0.1% (at 67.5 kHz deviation, AF = 1 kHz) |
| S/N ratio | >60 dB (ITU-R, weighted, quasi-peak)<br>>70 dB (ITU-R, unweighted, rms)<br>>70 dB (A weighted, rms) |
| Preemphasis | off, 50 µs, 75 µs |
| Pilot tone (frequency / deviation) | 19 kHz ±2 Hz / 0 Hz to 10 kHz |
| ARI / RDS subcarrier (frequency / deviation) | 57 kHz ±5 Hz / 0 Hz to 10 kHz |
| ARI identification | off, DK, BK, DK + BK |
| RDS traffic program | off / on |
| RDS traffic announcement | off / on |
| RDS data set | selection of an RDS data set 1 to 5,<br>data set loadable via IEC/IEEE or RS-232-C interface (max. length 64 Kbyte) |

# Impulsive noise EMC measurements on set-top boxes

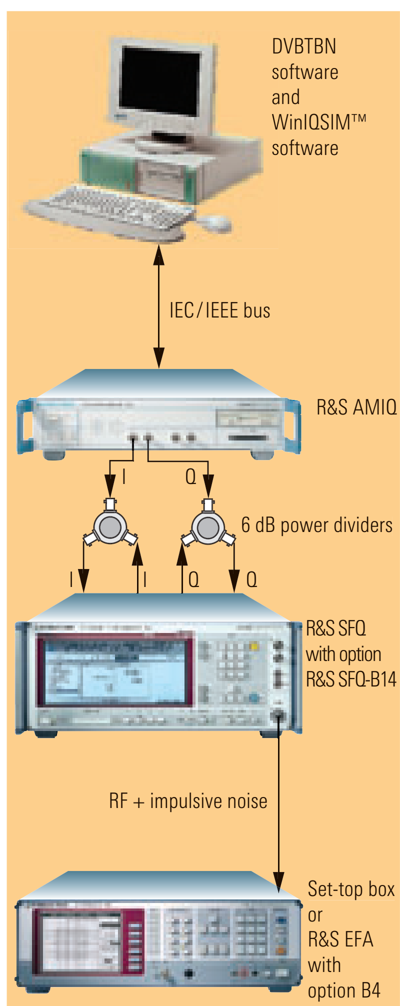
**Modern digital set-top boxes usually offer optimal picture and sound quality. However, if they have not been subjected to EMC (electromagnetic compatibility) compliance testing, your TV set may emit crackling noises and picture interference can be pronounced. This may be triggered, for example, by sparks on the collector of an electric motor (impulsive noise). To remedy this problem, Rohde & Schwarz has developed a simple solution enabling set-top box manufacturers to test their products for compliance with relevant EMC regulations.**

## Test setup

The simulation of impulsive noise for tests on set-top boxes (STBs) for digital TV (DTV) has so far been a highly complex task regarding the reproducibility of test signals. Using state-of-the-art technology from Rohde & Schwarz, this task can be accomplished with a simple test setup (FIG 1).

How to generate impulsive noise with a PC is described in Application Note "DVB-T Bursted Noise Signal Generation" [*]. Using the I/Q Modulation Generator R&S AMIQ and the software described in the application note, any waveforms can be calculated and generated, including pulsed noise with variable amplitudes for the I and Q channels. The signal files generated on the PC are transferred to the R&S AMIQ, where the impulsive noise is available in the form of baseband signals at the I/Q outputs.

**FIG 1 Test setup.**




The TV Test Transmitter R&S SFQ supplies I/Q baseband signals conforming to the specific DTV system as well as modulated RF signals in accordance with DVB-C, DVB-S, DVB-T, ITU-T J.83/B and ATSC 8VSB. The I/Q baseband signals from the R&S SFQ and the R&S AMIQ are combined via 6 dB power dividers and reapplied to the R&S SFQ via the rear I/Q output/input connectors (option R&S SFQ-B14), which must be fitted for this measurement.

The R&S SFQ produces Gaussian white noise in the frequency range of interest (with Noise Generator SFQ-B5). This noise is added to the combined impulsive noise and I/Q baseband signals before the cumulative signal is applied to the I/Q modulator (FIG 1). Passive addition by means of the power dividers reduces the I/Q signal level by 6 dB. This is outweighed, however, by the advantages of this approach, i.e. the simple method of interference simulation and the fact that there is no additional DC offset distorting the residual carrier of the DTV RF signal. The 6 dB attenuation introduced by the power dividers is not considered in the result, so 6 dB have to be subtracted from the NOISE value displayed on the R&S SFQ to obtain the correct value.

The bit error ratio (BER) is measured directly on the common interface (CI) (if available) of the set-top box or by means of the DVB-T Test Receiver R&S EFA (model 40 or 43). The point at which non-correctable errors initially occur is found by increasing the interference signal level. This point is equivalent to a BER $>2 \cdot 10^{-4}$ before Reed-Solomon; this is the limit of reliable reception, which is to be determined by the impulsive noise measurement.

Another approach to finding this limit is by monitoring the TV picture and detecting when errors first occur in the decoded signal from the STB. If the STB under test does not include a CI, this is the only – although not reliably reproducible – approach.

## Residual carrier calibration for the above test setup

Residual carrier suppression is one of the main factors governing DVB-T signal quality. Residual carrier suppression is referenced to the signal power of a single carrier in the COFDM symbol; it will therefore scarcely exceed 20 dB. If, by contrast, residual carrier suppression is referenced to the total power in a DVB-T channel, the value obtained will be higher by 38.3 dB for 8k and by 32.3 dB for 2k. Residual carrier suppression is proportional to the DC offsets of the I and Q signals.

If the sum of the offsets of the I/Q outputs of the R&S SFQ and the R&S AMIQ is too large – e.g. if residual carrier suppression referenced to CW is not higher than 55 dB for the specific DTV standard – CARRIER SUPPRESSION on the R&S AMIQ can be aligned by alternately adjusting the I and the Q DC component until the required value is attained. The Test Receiver R&S EFA acts as a probe in this measurement.

Since appropriate residual carrier suppression is of paramount importance – ensuring good BER values before Viterbi in a DVB-T receiver, for example – a simple and effective method of how to accurately align this parameter will be presented here.

The DVB-T Bursted Noise (DVBTBN) software calculates the interference signal. The I/Q Simulation Software WinIQSIM™ checks the corresponding time-domain signal. The bursted noise signal is then transferred to the R&S AMIQ. The DVBTBN and the WinIQSIM™ packages can be downloaded from the Rohde & Schwarz website.

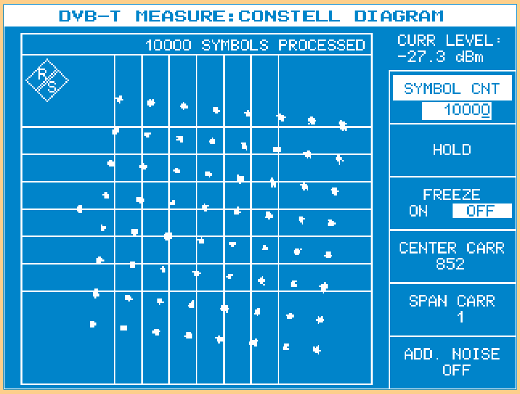
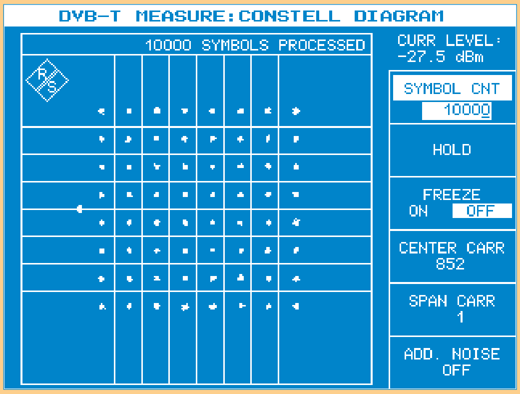



**FIG 2**
**Constellation diagram of central carrier in 2k mode prior to adjustment of residual carrier suppression.**

**FIG 4**
**Nearly correct constellation diagram of central carrier in 2k mode with coarsely adjusted residual carrier suppression.**



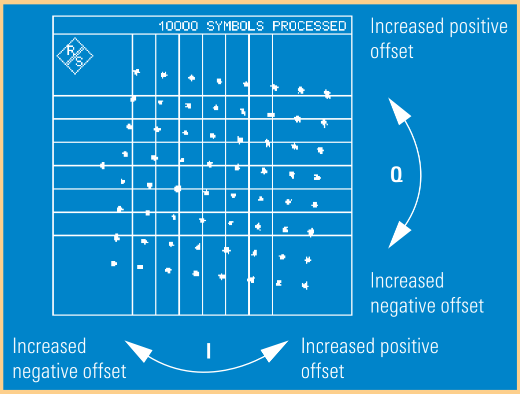
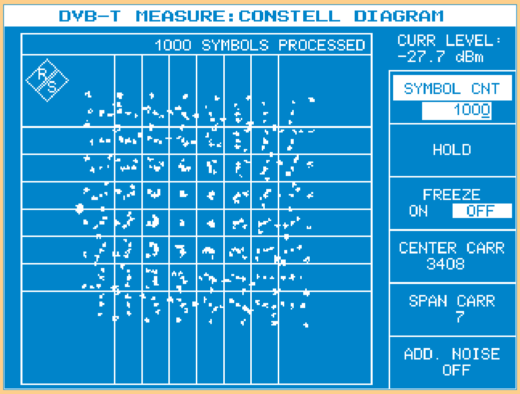




**FIG 3**
**Coarse adjustment is performed by rotating the constellation diagram (by varying the offset of the Q component) and by shifting the I/Q value pairs (by varying the offset of the I component).**

**FIG 5**
**Constellation diagram of 7 innermost carriers and central carrier in 8k mode.**



Prior to adjusting the I/Q DC components, the I/Q amplitudes of the impulsive noise signal are set to zero on the R&S AMIQ by means of WinIQSIM™. A nominal DC voltage of 0 V is now present at the I/Q outputs. This allows the calibration of DC voltage offsets inherent in the test setup by carrying out offset adjustment on the R&S AMIQ by means of WinIQSIM™. This is a precondition for the correct adjustment of carrier suppression in the modulator of the TV Test Transmitter R&S SFQ.

For coarse adjustment of the carrier suppression, the DVB-T 2k mode is selected on the R&S SFQ, and the constellation diagram of the central carrier (No. 856) is displayed on the Test Receiver R&S EFA. If the residual carrier suppression is incorrectly aligned, a constellation diagram similar to that shown in FIG 2 will appear on the R&S EFA.

The constellation diagram is rotated as shown in FIG 3 so that the I/Q value pairs of the central carrier occur on horizontal lines (this is done by varying the offset of the Q component). In addition, the I/Q value pairs are shifted to the centers of the decision fields (by varying the offset of the I component). This yields a nearly correct constellation diagram as shown in FIG 4.

For fine adjustment, seven carriers around the central carrier (No. 3408 with 8k) are selected in the DVB-T 8k mode and mapped into a constellation diagram in addition to the central carrier. After coarse alignment of the residual carrier, a diagram similar to that of FIG 5 is obtained, for example.

In FIG 6, parts of the constellation diagram of FIG 5 are rotated clockwise; this rotation can be compensated for by increasing the offset of the Q component in a positive direction on the R&S AMIQ. Parts rotated to the left would be compensated for by increasing the Q offset in a negative direction. After this, a constellation diagram like that shown in FIG 7 is obtained. If the outer conchoids of I/Q value pairs open to the outside as in this figure, this faulty alignment will be compensated for by increasing the I offset in a negative direction. If, by contrast, the conchoids open to the inside (FIG 8), increasing the I offset in a positive direction would rectify the error.

With optimally aligned I/Q offsets, a constellation diagram like that shown in FIG 9 will appear. This alignment yields CARRIER SUPPRESSION values >25 dB. To verify correct alignment, however, residual carrier suppression has to be checked also in the 8k mode. The test solution offered by Rohde & Schwarz also

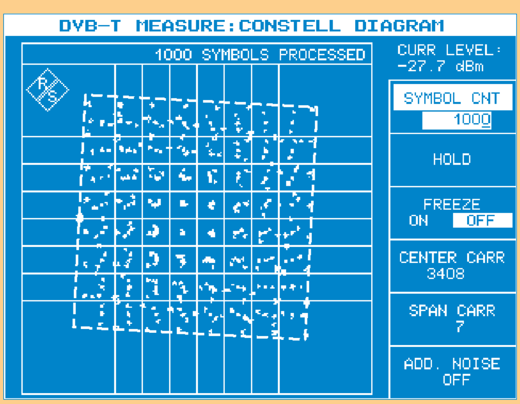



**FIG 6**
**Constellation diagram of FIG 5 rotated clockwise.**

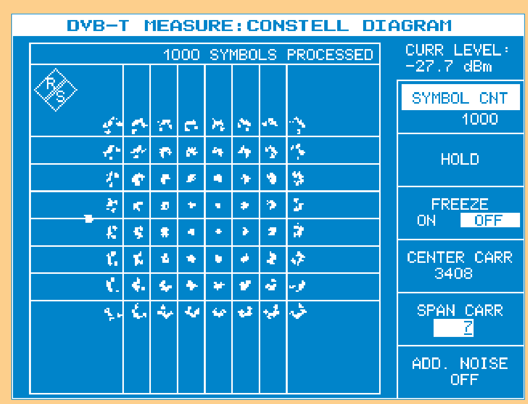



**FIG 8**
**Constellation diagram with corrected Q component offset. I component not yet optimized (conchoids of I/Q value pairs open to the inside).**

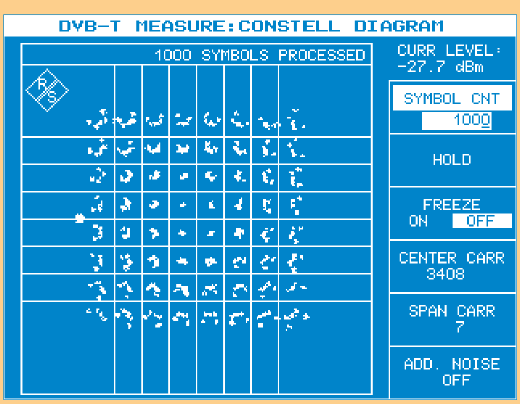



**FIG 7**
**Constellation diagram with corrected Q component offset. I component not yet optimized (conchoids of I/Q value pairs open to the outside).**

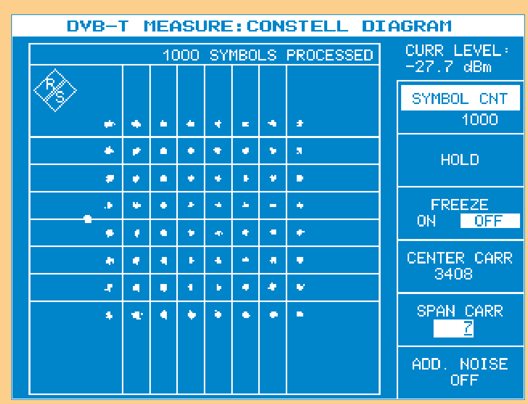



**FIG 9**
**Optimally aligned constellation diagram with residual carrier suppression >25 dB.**

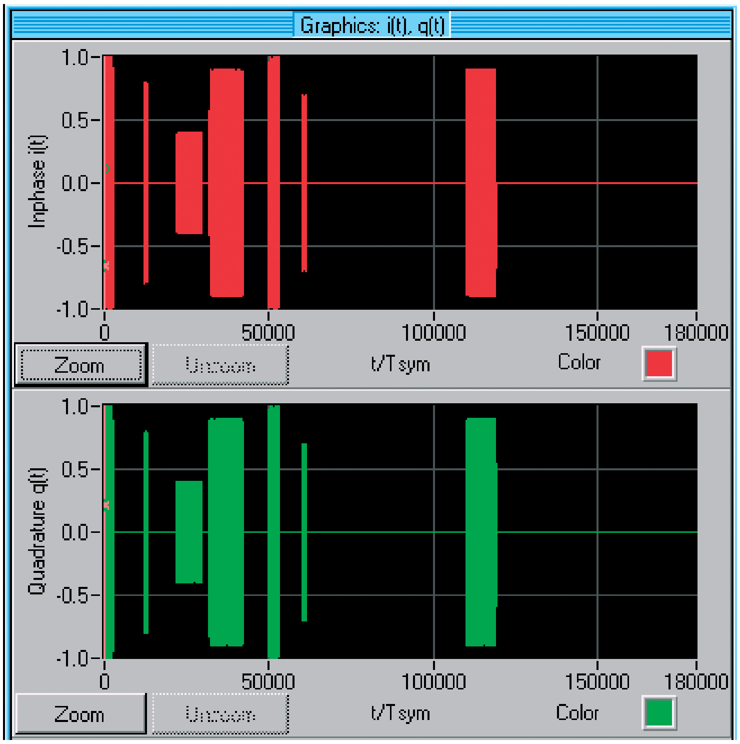



**FIG 10**
**Time-domain signal of impulsive noise.**

provides for automatic alignment of this parameter in a test system, with the Test Receiver R&S EFA measuring the CARRIER SUPPRESSION directly in magnitude and phase. Automatic alignment of this critical parameter is then performed via offset adjustments on the R&S AMIQ.

## Example of an impulsive noise measurement

Trial measurements have shown that test receivers are very sensitive to impulsive noise. The following example demonstrates this by means of a typical measurement on a DVB-T signal.

As already mentioned, the DVBTBN software calculates the interference signal. The corresponding time-domain signal (FIG 10) is checked by WinIQSIM™. The impulsive noise signal is then transferred to the R&S AMIQ, which simulates the interference.

Settings on the R&S SFQ:

| | |
|---|---|
| Modulation | DVB-T |
| Level | +3 dBm (yielding a reading of –3 dBm for the DVB-T signal on the R&S EFA) |
| C/N | OFF |
| Fading | OFF |
| Data | NULL PRBS packet |
| COFDM mode | 474 MHz, 8k, guard interval 1/4, code rate 3/4 |

The maximum possible amplitude of the impulsive noise signal is determined by reading the BER before and after Viterbi: With a peak amplitude of 0.085 V at the I/Q outputs of the R&S AMIQ, the test receiver displays a BER of $2 \cdot 10^{-3}$ before Viterbi and a BER of $2 \cdot 10^{-4}$ after Viterbi. This represents the limit of quasi-error-free (QEF) operation. It corresponds to a ratio of –15.4 dB of the interference signal (peak) to the useful signal referenced to $V_p = 0.5$ V.

The I/Q baseband signal generated by the R&S SFQ has a peak voltage of 0.5 V. The power dividers reduce the amplitude to 0.25 V. The total permissible peak voltage at the I/Q modulator input is 0.5 V, so a peak voltage of max. 0.5 V is also allowed at the I/Q outputs of the R&S AMIQ.

In the above example, the safety margin for the peak amplitude of the impulsive noise signal is 0.500 V – 0.085 V = 0.415 V, which is more than adequate for EMC measurements on set-top boxes.

## Summary

The test setup described in this article for the first time enables the simple, reproducible, highly flexible and favourably priced generation of impulsive noise signals for test and acceptance test applications. The future will show what limit values are required for impulsive noise on DTV equipment.

Sigmar Grunwald

**More information on above test equipment and software at www.rohde-schwarz.com**

REFERENCES

[*] Application Note "DVB-T Bursted Noise Signal Generation" from Rohde & Schwarz (search term: 1MA51)

### Transportable Monitoring and Direction Finding Systems R&S TMS

# Versatile solutions for spectrum monitoring

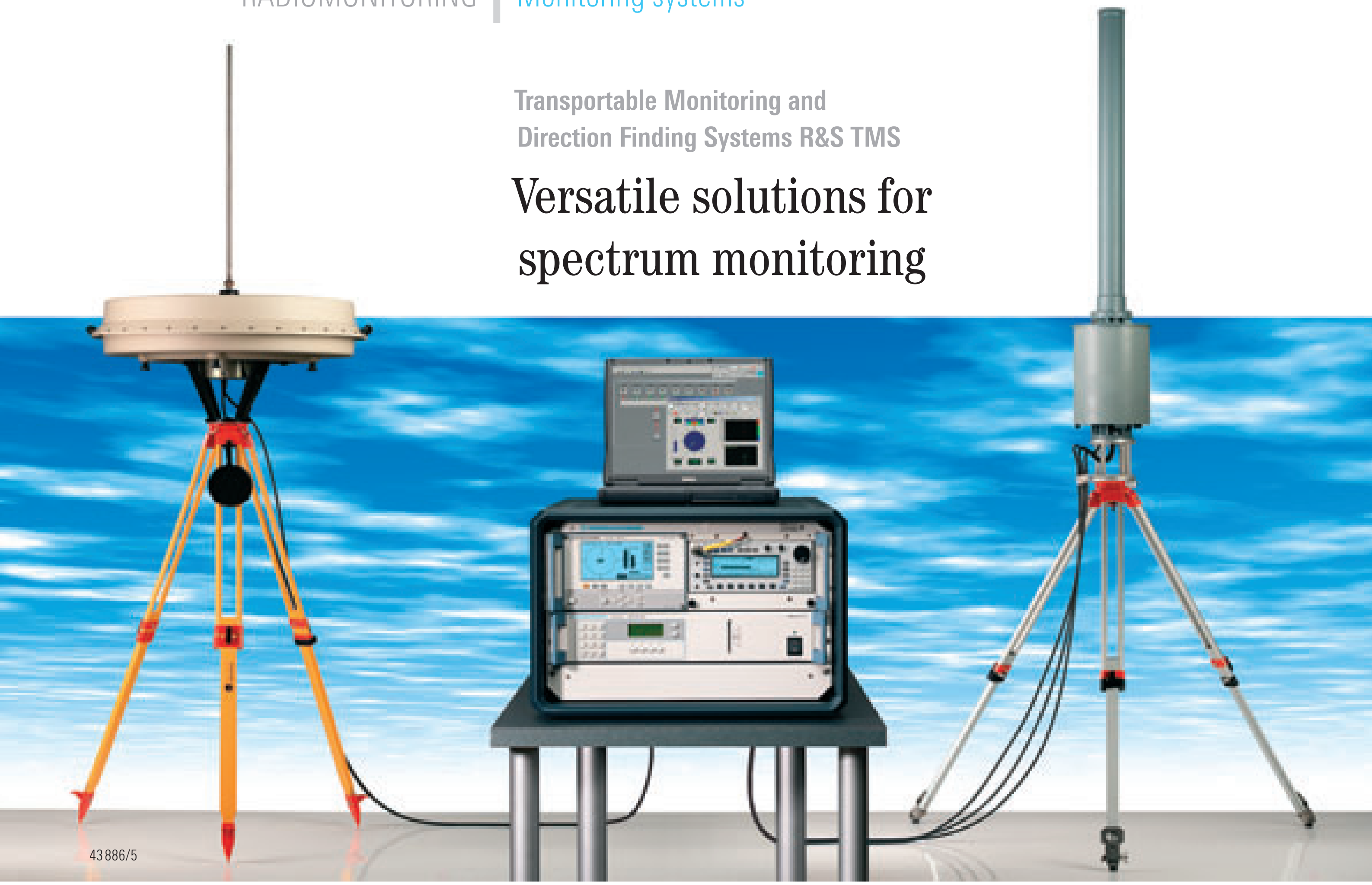



**FIG 1 R&S TMS 200 with options; here used as a fixed monitoring station with Antennas R&S ADD 195 (left) and R&S HE 309 / HF 902.**

**For 15 years, Rohde & Schwarz has enjoyed market success with the Spectrum Monitoring and Management Systems R&S ARGUS-IT [1] and the predecessor R&S TS 9965. The new transportable monitoring and direction finding systems complete the successful equipment and meet a host of additional requirements.**

## Increasingly complex monitoring tasks

Modern monitoring systems include fixed, mobile and portable stations. In many cases, however, this does not serve the purpose or is uneconomical, and new solutions are required (e.g. if interference only occurs only once every few weeks as described in the box on page 48).

## Transportability means flexibility

The new transportable solutions from Rohde & Schwarz are optimized for mobile use at rapidly changing sites with unknown radio scenarios. They are designed for monitoring and direction finding in accordance with ITU recommendations from 20 MHz to 1.3 GHz (with an extendable range from 10 kHz – DF 500 kHz – to 3 GHz). All measurement tasks can be performed either automatically (scheduled) or interactively.

The equipment is accommodated in portable racks for ease of transportation and protection out-of-doors. Not more than two persons are needed to carry the portable rack, which is also true for the antennas.

Hardware and software are ready for use on delivery and ensure fast on-site setup. It is simply a matter of installing the antennas, connecting the cables and switching on. Measurements can be performed for an unlimited period of time, as the stations can be powered not only ▶

from the AC supply (100 V to 240 V AC) but also from external batteries (11 V to 32 V DC). This ensures maximum flexibility and adaptability to all applications and environmental conditions.

The transportable stations are standardized and, thus, a cost-effective solution. However, since they are of modular design, they can also be adapted to different user requirements.

## Transportable systems are an ideal enhancement

The new transportable monitoring systems from Rohde & Schwarz are extremely flexible. They are available in four different versions:

The **R&S TMS 100** (FIG 2) includes the Miniport Receiver R&S EB 200, the Digital Direction Finder R&S DDF195, the compact System Process Controller R&S SPCC and a communication unit in a portable rack. The system can be connected to an antenna and provides network connection via a dialled or leased PSTN line, an ISDN line or a GSM / GPRS 900 / 1800 link.

In contrast to the R&S TMS 100, the **R&S TMS 200** comprises a Switch Unit R&S ZS 129 A1 in the portable rack instead of the system process controller and the communication unit, to which up to 12 antennas can be connected (FIG 1). The equipment is controlled from the System Notebook R&S SPCN outside the rack. This has the advantage that the controller can be taken to the office for data evaluation after measurements have been completed.

The R&S TMS 200 is linked to the network by the **Transportable Communication System TMS-C** which accommodates all facilities required for communication as well as auxiliary equipment (FIG 3).

Additional equipment is available to adapt the systems to different requirements. This includes antennas for different frequency ranges and polarizations, communication equipment for setting up PSTN, ISDN and GSM / GPRS connections, compass, GPS receivers and software packages.

### Example: Special tasks require flexible and mobile solutions

Some interfering emissions occur only very rarely (e.g. once every few weeks). However, the radio service affected may be so important that it is absolutely essential to eliminate the interferer. Pilots, for example, might find that the reception of navigation information is disturbed when they overfly specific areas, which poses a threat to life. In such a case, the affected frequency has to be monitored over a long period of time. The technical parameters of all emissions received must be measured and automatically compared to previous data to filter out known stations (tower or aircraft) as far as possible so that only information on "suspicious" emissions is passed on to the appropriate monitoring station personnel.

If the interferer is not within the receive range of the fixed monitoring stations, these stations cannot be used for signal identification. On the other hand, mobile systems normally cannot be operated unattended for an extended period of time and independently from AC supply. These restrictions affect all monitoring tasks that require long-term measurements beyond the receive range of the fixed or remote-controlled monitoring stations and for which the permanent presence of control staff is too resource-intensive or too costly.

This is where transportable monitoring systems come into their own. They can perform all the measurement tasks usually associated with fixed or remote-controlled monitoring stations and have the extra advantage of being much more cost-effective and capable of being relocated rapidly. This means that the coverage area of a network of fixed and remote-controlled monitoring station can be expanded exactly as needed.

To solve the interference problem described above, a transportable monitoring station could be positioned directly below the air-traffic route concerned, e.g. on the approach track to the runway. All aircraft emissions would then come from the same direction and could be filtered out by the monitoring software. Emissions from the tower can also be filtered out. This ensures that the transportable monitoring station will alert the control station only when a "foreign" signal is detected. If the interference occurs again after a period of time and no alarm is given, the monitoring station is not in the receive range of the interferer and must be relocated. However, if the interfering signal is picked up, the monitoring station can be moved in the direction of the source, and the filter for triggering the alarm can be set to characteristic features such as the frequency offset. The transportable monitoring station can thus be positioned closer and closer to the interferer with a minimum of staff until a vehicle can be used for exact location.

The **R&S TMS 110** and **R&S TMS 210** include the Monitoring Receiver R&S ESMB instead of the R&S EB 200 used in the R&S TMS 100 and R&S TMS 200.

## Host of applications

The versatility of the new transportable systems allows them to be used as attended and unattended fixed stations, mobile stations or even portable monitoring stations.

### Operation as attended fixed monitoring station

The key advantage of transportable systems over fixed monitoring stations is that once the assigned tasks at a site are completed, a transportable system can be moved and quickly set up again. Owing to the system's compact design, it can even be installed on roofs or in difficult terrain. The antennas can be mounted to the tripod by means of special adapters (FIG 1). Depending on the task to be performed and on the frequency range and polarization of the signals to be measured, one or more monitoring or DF antennas are connected to the system.

The main advantage of fixed monitoring stations over transportable systems is that heavy, bulky equipment can be used, e.g. a large antenna array for HF direction finders. If this is not necessary, a transportable system is a cost-effective alternative.

### Operation as unattended fixed monitoring station

Operation of attended and unattended fixed stations is much alike except that routers and modems are integrated in the unattended station for remote control. Analog or digital dialled or leased lines or GMS / GPRS 900 / 1800 links with a data rate of at least 9.6 kbit/s (FIG 4) are used for communication.

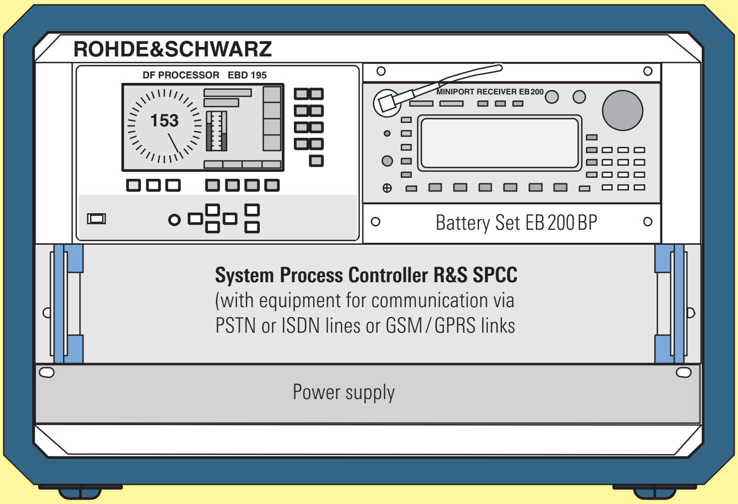



**FIG 2 Equipment of the R&S TMS 100.**

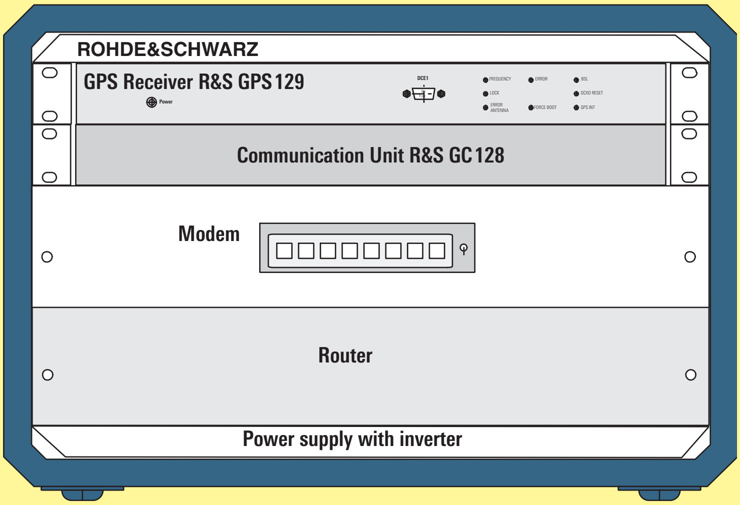



**FIG 3 Additional communication equipment and auxiliary units in the R&S TMS-C.**

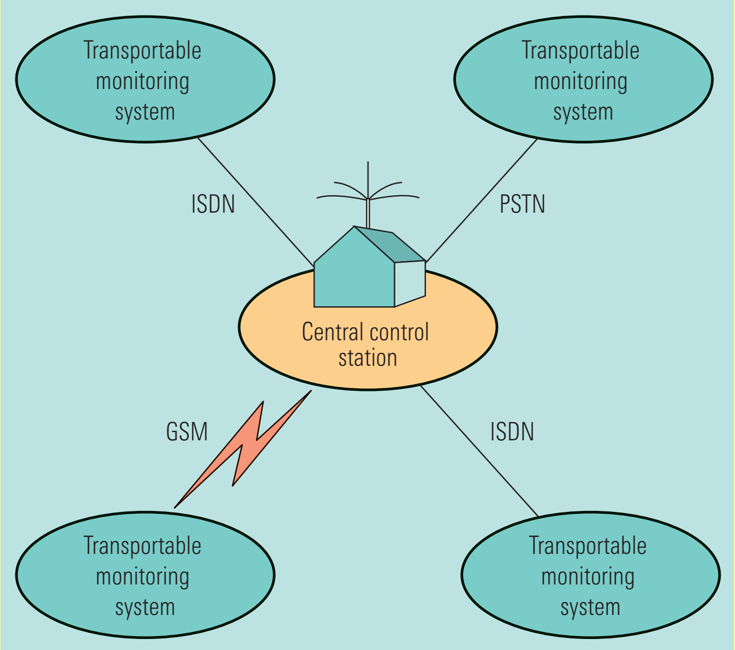



**FIG 4 Four transportable systems operated as remote-controlled, unattended fixed monitoring stations.**

**FIG 5**
**R&S TMS210 with options: sufficiently compact for installation in a vehicle.**

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A central control station can be created from a PC, a router and a modem with appropriate software or even from a transportable system that contains the necessary communication equipment.

## Operation as mobile monitoring station

The transportable system can be installed in all kinds of vehicles (FIG 5). The portable rack containing the equipment can easily be fastened to the vehicle with four screws. Special adapters are used to mount the DF and monitoring antennas to the vehicle roof.

A GPS receiver and compass can be added to the system so that location and direction finding can be performed automatically. The mobile system in a vehicle can, of course, also be remote-controlled, usually via GSM / GPRS 900 / 1800 links.

The system can also be operated while the vehicle is moving. In this case, an antenna capable of withstanding the resulting forces – e.g. the R&S ADD195 – has to be installed on the vehicle roof.

## Operation as portable monitoring system

Due to its modular design, the transportable system can also be used as a portable monitoring station. All that has to be done is to remove the Receiver R&S EB200 from the portable rack and connect it to a hand held directional antenna. The system fits into a convenient carrying bag that also protects the unit against the weather (FIG 6). The receiver is powered by an easily replaceable battery set attached to its base. A spare battery set is integrated in and charged by the transportable system.

**FIG 6 Easy removal of the Miniport Receiver R&S EB200 from the transportable monitoring system, e.g. for manual direction finding.**

## Reliable software

With **Monitoring Software R&S ARGUS** [2], all the equipment can be controlled and operated interactively via virtual front panels (FIG 7), or automatic, program-controlled measurements can be performed. The software records and displays the RF and IF spectra in different graphical representations. A comprehensive statistical evaluation of measurement results can be performed in accordance with the standards and recommendations of ITU-R. Measurement results, their definitions and statistical analyses can be documented in reports.

**Geographic Information Software R&S MapView** shows the site of the direction finder, current DF bearing and the position of the source of interference on a digital map.

**Audio Software R&S AllAudio** [3] is used in the system to record, replay and distribute the audio signals of the receiver. Recorded signals are stored by the controller in an audio database. The operator can set bookmarks during recording and replay in order to quickly find the recording later on. Comments can also be added.

## Summary

Because of their exceptional versatility, the transportable monitoring systems are a cost-effective alternative to fixed and mobile monitoring systems. They ideally complement existing monitoring networks, as they can be easily transported and set up and allow unattended measurements and monitoring to be performed over an unlimited period of time. Another advantage is that countries just starting with frequency monitoring can use the transportable systems as a cost-effective alternative to fixed and mobile monitoring stations.

Jörg Pfitzner

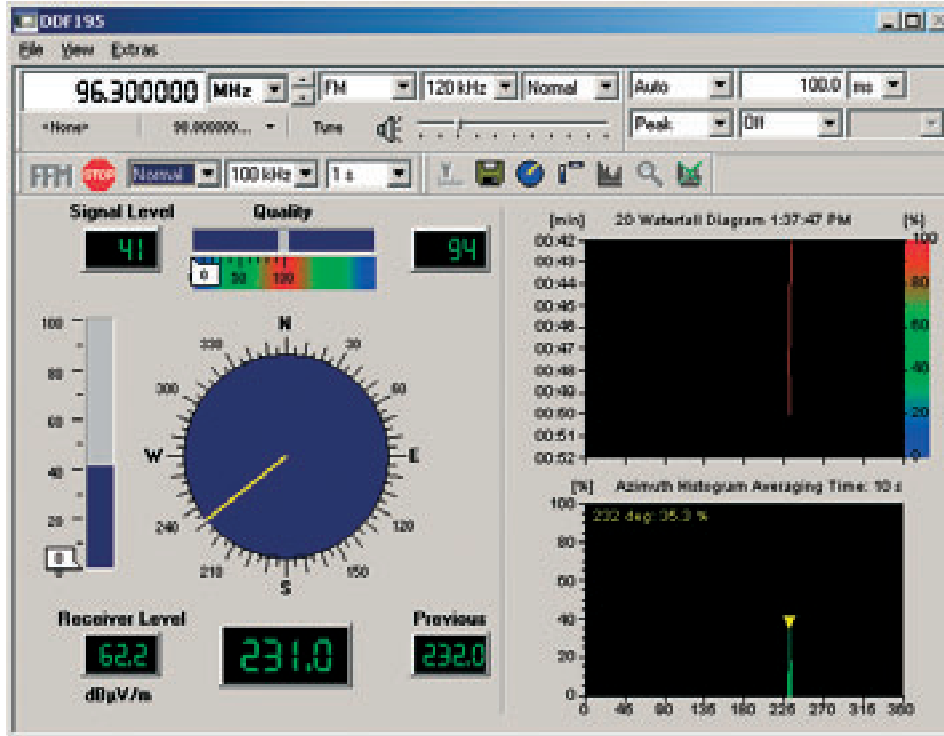
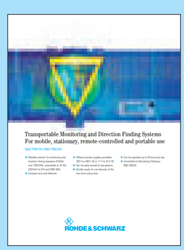



FIG 7 **Optimally adapted to the new systems: Monitoring Software R&S ARGUS.**

**More information and data sheets at www.argus.rohde-schwarz.com**



Data sheet
R&S TMS 100/200

Data sheet
R&S TMS 110/210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[1] Spectrum monitoring and management system for Sri Lanka – Electromagnetic waves do not stop at frontiers. News from Rohde & Schwarz (2000) No. 168, pp 40–42

[2] Spectrum Monitoring Software R&S ARGUS 4.0 – New software generation for spectrum monitoring systems. News from Rohde & Schwarz (2000) No. 167, pp 18–20

[3] R&S GH 127 AllAudio – Digital recording, distribution and management of audio signals in radiomonitoring systems. News from Rohde & Schwarz (2000) No. 167, pp 16–17

Active Broadband Antenna R&S HE500

# Wide frequency range for modern radiomonitoring

**The modern radiomonitoring systems from Rohde & Schwarz are particularly powerful and can simultaneously process and evaluate extremely wide frequency ranges. The Active Broadband Antenna R&S HE500 provides the signal spectrum for these demanding tasks.**

## Use on land vehicles or ships

More and more radio services such as PCN, GSM, UMTS or radionavigation use frequencies above 1 GHz. For this reason, users of radiomonitoring and direction finding systems need a powerful and compact antenna that covers this wide range. With a frequency range of 20 MHz to 3 GHz, the Active Broadband Antenna R&S HE500 meets this requirement. Owing to its small size, it is ideal for use on land vehicles and on ships (FIGs 1 and 2).

FIG 1 Active Broadband Antenna R&S HE500.

## Two antennas at one output

The R&S HE500 stands out for its low weight and small volume. It is protected by a stable fiberglass-reinforced plastic radome against the effects of weathering and high wind speeds.

The antenna consists of two active dipoles arranged one on top of the other for the frequency ranges 20 MHz to 1 GHz and 1 GHz to 3 GHz. The two frequency subranges are combined via a diplexer at one output. The phases of the two antenna voltages in the overlapping range of the diplexer are set such that the signals are cumulative. Thus, the entire receive range is continuously available without any level drop at the antenna output.

The power is supplied by a DC feed section to the coaxial cable at the RF output of the R&S HE500. The power supply ranges from 10 V to 32 V. An integrated voltage regulator provides the correct voltages to the amplifier circuits.

## Accessories

The DC Feed Section R&S IN500 is available for the power supply of the antenna. It has a power connector and feeds the operating voltage into the coaxial cable between the receiver and the broadband antenna (FIG 3). The R&S IN500 is factory-set to an AC supply voltage of 220 V. The unit can also be operated on either an AC voltage of 110 V or a DC voltage of 24 V.

Herbert Steghafner; Werner Dürport

### The R&S HE500 at a glance

- Vertically polarized omnidirectional antenna
- Extremely broadband
- Suitable for stationary and mobile use
- Compensation of cable losses by matched active antenna gain
- High dynamic range
- Voltage supply via the RF line
- Wide voltage supply range (integrated voltage regulation)

FIG 2
Two active dipoles cover the frequency subranges 20 MHz to 1000 MHz and 1 GHz to 3 GHz.

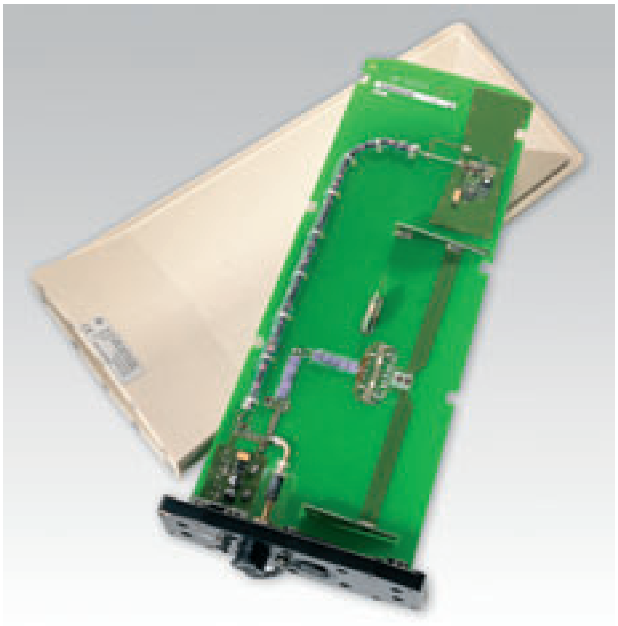

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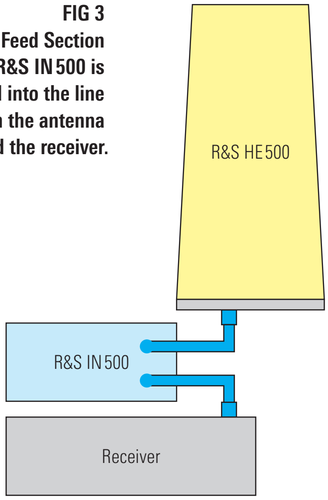
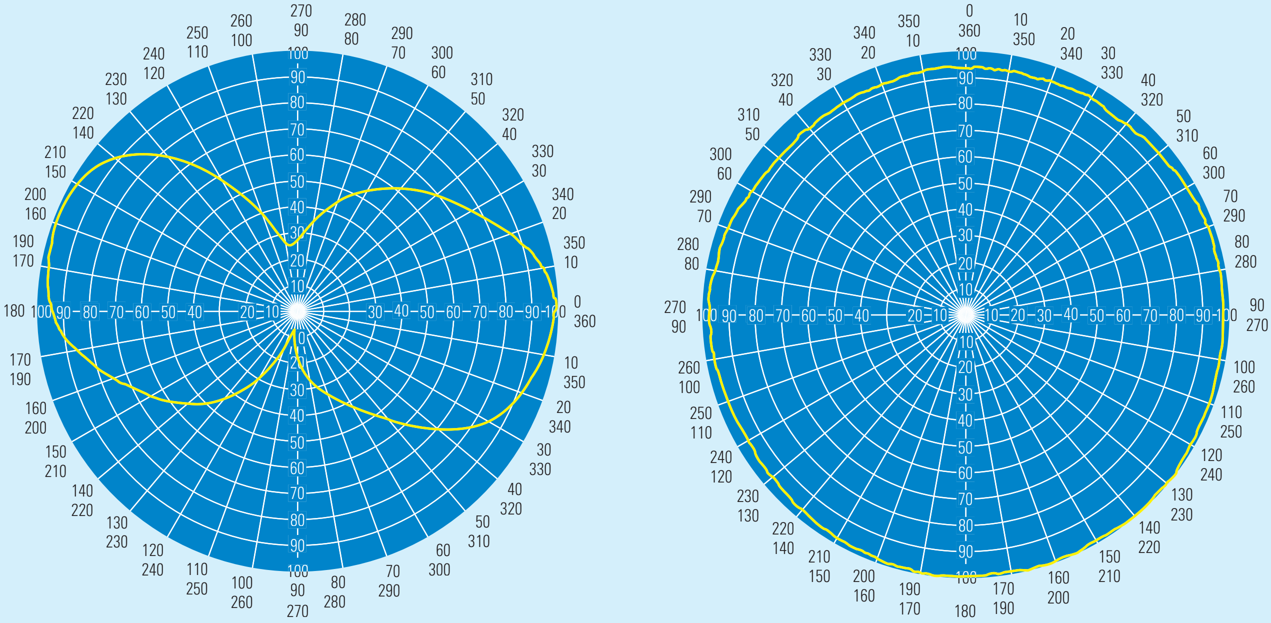
FIG 3
The DC Feed Section R&S IN500 is inserted into the line between the antenna and the receiver.




**More information at www.rohde-schwarz.com (search term: HE500)**



**Antenna diagrams at 1.2 GHz (left E diagram, right H diagram).**

# Rohde & Schwarz expands its leading role in digital broadcasting

## 135 TV transmitters from Rohde & Schwarz put into operation in Spain

**Rohde & Schwarz expands the digital TV network in Spain with six new dual transmitters on the Torrespania, the television tower near Madrid. 135 TV transmitters from Rohde & Schwarz were set up and put into operation in the past two years – 60 of them in a record time of only four months.**

The television tower broadcasts programs to over 5 million viewers. The six new analog dual transmitters had to be accommodated in a very confined space in addition to the six digital transmitters already present. This could be accomplished only because of their liquid cooling and compact design. With a total of 18 high-power TV transmitters from Rohde & Schwarz, the Torrespania is now the world's most effectively used TV tower.

The digital TV transmitters with power ratings from 1 kW to 4 kW broadcast in total 25 programs from different providers. Four channels are transmitted in a single frequency network, two channels in MFN. The transmit power of all transmitters is 73 kW, and they span a length of 12 m. The entire transmitter and cooling system is set up in two corridors at a height of approx. 200 m.

Friedrich Rottensteiner

## New DVB-T project in Taiwan

**It came as quite a surprise when Taiwan, originally tending toward the ATSC TV standard, decided in favour of DVB-T last year.**

Taiwan is the first nation using 6 MHz analog bandwidth to decide in favour of DVB-T in the 6 MHz band. The primary reason the operators in Taiwan changed to DVB-T was the possibility of supplying data to mobile users of TV and data services. As this is a completely new technology, deciding on a suitable supplier was a challenging task. The decisive factor in favour of Rohde & Schwarz was the excellent system concept, outstanding operation and the numerous DVB-T networks already successfully set up.

Network operators in Taiwan are currently in the pre-planning phase for a nationwide single frequency network (SFN). Although the final structure has not yet been defined, options for dividing up the infrastructure are being investigated, particularly as regards antennas. It is not yet clear how to jointly use the multiplexers. The five broadcasters are expected to offer a total of 10 to 15 television programs. A nationwide SFN is to be made available by the end of 2003. The trend toward DVB-T is progressing rapidly in Taiwan. The network operators hope that customers/viewers will embrace the advantages of this innovative technology, thus turning the new project into a technical and commercial success.

Eshwarahally Vikas

## Rohde & Schwarz transmitter on Toronto tower

**A TV transmitter system from Rohde & Schwarz will soon operate on the famous 553 m high CN tower in Toronto.**

The Toronto tower is the highest standalone tower in North America. Last year, CBC Radio Canada decided to replace the existing transmitter by modern, space-saving and low-noise transmitters. With a transmitter concept that best fulfilled all requirements, i.e. failsafe operation, high quality and minimum footprint, Rohde & Schwarz was able to win out against strong competitors.

For the same reasons, Rohde & Schwarz won yet another contract for a transmitter system in Petersborough that will start operation this August.

Reinhard Scheide

## Numerous TV transmitters in the USA

**Numerous new orders for Rohde & Schwarz consolidate the company's position as the worldwide leader in digital broadcasting.**

Central Michigan University, for example, decided in favour of two digital ATSC TV transmitters from Rohde & Schwarz with 14.5 kW and 10.5 kW.

Starting at the end of this year, transmitters from Rohde & Schwarz will also provide Atlanta, Barryton und Kalkasa in Michigan with digital TV signals. Because customer-oriented service and availability of spare parts are key issues, Rohde & Schwarz will complete this order cooperatively with its American partner Acrodyne.

In addition, Nexstar Broadcasting Group, one of the largest transmitter network operators in the USA, has contracted Rohde & Schwarz to supply 16 digital TV medium-power transmitters. Nexstar – like all other transmitter network operators – is required to switch its transmitter network to the digital TV standard ATSC by the 1st quarter of 2003. Because of the network's size, energy consumption and logistics in service are crucial factors. The 16 transmitters will be placed into operation within the next nine months.

Black Hawk College in Illinois also decided in favour of a digital 5 kW UHF transmitter from Rohde & Schwarz.

Eshwarahally Vikas

## Radiocommunications for TIGER and NH 90 helicopters

**Rohde & Schwarz received an order to supply radiocommunications to the German Armed Forces for the TIGER (FIG on right) and NH 90 military helicopters.**

The contract includes the delivery of M3AR VHF / UHF airborne transceivers with the associated control units and several special test systems. This order consolidates Rohde & Schwarz's position as the leading supplier of military radiocommunications of the latest generation, which is already being deployed in the Eurofighter, SAAB Gripen and Embraer SuperTucano / ALX aircraft.

TIGER, a joint project of Germany and France, is the world's most advanced combat helicopter. Owing to its modular design and its lightweight and stable synthetics construction conferring all-weather capability, TIGER can quickly be retrofitted to suit the task at hand. Besides the 80 units each procured by France and Germany, TIGER will also be exported. The NH 90 is a ten-ton transport helicopter and the first of its kind to feature flight-by-wire. It is designed jointly by Germany, France, the Netherlands, Italy and Portugal, which together will also procure approximately 500 units.

The transceivers from Rohde & Schwarz were developed specifically for use in both helicopter types, and they cover the 30 MHz to 400 MHz frequency range. Besides SATURN, the quick frequency hop method used by NATO, and various other functions, they are equipped with an integrated, NATO-compatible encryption module (embedded NATO COMSEC). This unique system, developed by Rohde & Schwarz, ensures tap-proof voice and data transmission.

Photo: Eurocopter

## TETRA mobile radio system to safeguard Siberian oil pipelines

**The Russian crude oil supplier SIBNEFT has contracted Rohde & Schwarz to furnish a turnkey TETRA mobile radio network *ACCESSNET*®-T. Commissioning will take place in Nojabr'sk, Siberia, in August 2002.**

SIBNEFT uses the TETRA mobile radio system for internal communication among service and maintenance staff along the pipelines. It also supports the security authorities in their communication tasks.

Scalability and the capability to connect the infrastructure also via Ethernet lines were the decisive factors in favour of the German solution. The Ethernet connections were implemented in cooperation with Cisco in Russia and the German Cisco representative Com-Store. Network elements such as exchanges and base stations are interconnected with E1 lines and Ethernet connections via routers from Cisco so that all signalling can be performed using IP and all data traffic can be carried out with the advantage of dynamic resources assignment. This leads to optimum utilization of the existing lines, making for increased communication throughput. The network currently consists of two DMX-521 TETRA exchanges and seven TETRA base stations with over 30 RF carriers. Network expansions have already been planned.

## Good attendance at microwave road show in Asia

**The microwave road show held by Rohde & Schwarz in Asia from May through June was highly popular: Approximately 900 participants from over 100 companies seized the opportunity in Taiwan, China and Hong Kong to learn about the latest microwave trends, applications and products.**

The road show which was already successfully held in Europe was aimed at informing interested participants about the latest capabilities and products in microwave measurements. Presentations by experts featured topics such as "MMWave measurements up to 110 GHz" and "Frequency-converting and amplifier measurements by means of the ZVx network analyzers". Further road shows in Spain and the USA are being planned for this year. Your Rohde & Schwarz representative will gladly provide you with the scheduled dates.

Stefan Böttinger

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