News from Rohde & Schwarz

Multimedia
Rohde & Schwarz right there from the start

Radio test and measurement
Innovation in mobile phone testing

ATC radiocommunications
Now with RCMS and 8.33-kHz channel spacing

152

ROHDE & SCHWARZ

Number 152 1996/III Volume 36

Digital broadcasting and multimedia communication are the topics of our final article (page 57) which breaches the gap between the world of analog sound and TV broadcasting and that of digital audio and video broadcasting with its interactive communication facilities. The photo on the cover is to give an impression of this multimedia world. For more information about digital TV see our articles on pages 17 and 20.

Articles

Application notes

Refresher topic

Software

Panorama

Regular features

The future of sound broadcasting is digital – and Rohde & Schwarz is the perfect partner. The most recent member in our family of DAB transmitters is 100/200-W Solid-State Transmitter NL5010/5020 for the L band (page 24).

Imprint

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Digital Radio Tester CTS55

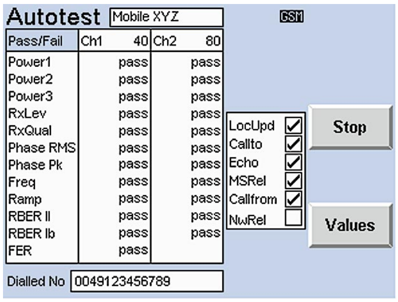
All-in-one service tester for GSM, PCN and PCS mobile telephones

Digital Radio Tester CTS55 from Rohde & Schwarz is a cost-effective, compact tester for all servicing, maintenance and repair work on GSM, PCN and PCS mobile radiotelephones in a single unit. It therefore bridges the gap between pure go/nogo tests and sophisticated GSM measurement technology.

FIG 1 Digital Radio Tester CTS55 provides fast function testing combined with in-depth mobile phone tests to GSM, PCN and PCS.
Photo 42 434

Digital Radio Tester CTS55 (FIG 1) is a synthesis of fast function testing and classic measurement technology for GSM 900, DCS 1800 (PCN) and DCS 1900 (PCS) mobile radio systems. It is an optimum combination of the GSM/DCS features of Go/NoGo Testers CTD [1] and the in-depth testing of Digital Radiocommunication Tester CMD [2; 3] for joint coverage of all aspects of servicing from simple function tests through to repairs. Its brilliant, high-resolution colour display makes using CTS55 a joy and allows it to show off its strong points, in particular the result graphics.

CTS55's quick function test can be called at the press of a button and produces all the important features of a mobile telephone on different RF channels. As well as a go or nogo



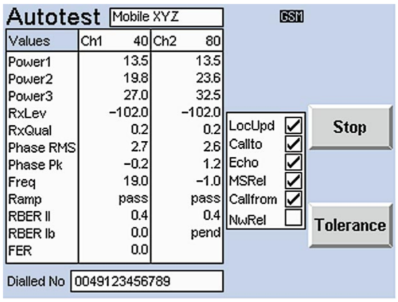


FIG 2 CTS55 autotest automatically checks all mobile phone characteristics on various RF channels and displays result as go/nogo or numerically with out-of-tolerance warnings.

display for the particular parameter and an overall evaluation, test results can also be shown in very simple numerical form with out-of-range displays too (FIG 2). A digital signal processor allows you to determine power ramping, phase and frequency error and bit error rate in a form like that used by Digital Radiocommunication Tester CMD. Not only can these functions be called during automatic test sequences, in conjunction with other test facilities they are also available in the classic manual mode. This second mode of operation enables CTS55 to fulfil all the requirements of a high-flexibility repair tester. In addition to the wide range of digital result displays in a highly practical format (FIG 3), graphics for test parameters such as power ramping or phase error can be selected with a single keystroke. For in-depth analysis there are zoom functions which simplify the interpretation of anomalies and so make servicing easier.

CTS55 has the following **test and measurement facilities** for fast testing and in-depth analysis of mobile phones:

- synchronization of mobile phones with base stations (simulated by CTS55),
- registration (location update),
- incoming and outgoing call setup,
- incoming and outgoing call clear-down,
- control and measurement of transmitting power,
- handover (channel change),
- measurement of peak power,
- sensitivity measurement (RxQual, RxLev),
- function test on dialling pad by displaying the called number,
- display of IMSI (international mobile subscriber identity) and IMEI (international mobile equipment identity),
- echo test,
- bit error rate and frame error rate measurements,
- phase error measurement,
- frequency error measurement,
- power ramping measurement.

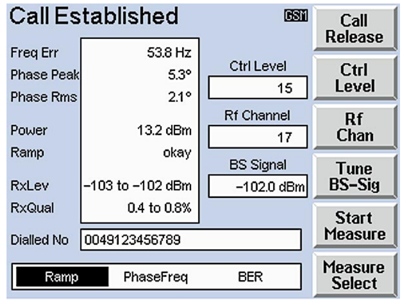


FIG 3 In manual mode CTS55 simultaneously indicates all relevant test values and parameters on its display.

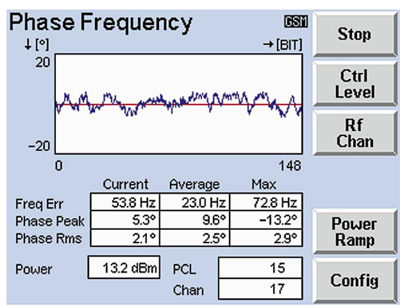


FIG 4 Phase/frequency curve and numerical display of current, average and maximum value provide information about modulation characteristics of mobile phone.

During the fast function test or go/nogo test CTS55 measures all the parameters of the mobile phone on any selectable RF channel and clearly displays the function in the form of individual evaluations and of an overall evaluation. If required, a test report can be output on a printer to show whether repairs are necessary or only as backup documentation. When the classic manual mode is used, all measurements can be called up with a continuous result display. This makes alignments and troubleshooting easy if repairs have to be made. In particular, the graphic displays showing phase error, frequency error (FIG 4) and power ramp (FIG 5) give an exhaustive description of the transmitter and make it easy to determine the causes of faults. The simultaneous display of the various bit error rates and frame error rates with a user-selectable measurement interval gives you a relatively deep understanding of receiver characteristics (FIG 6).

Operation of Digital Radio Tester CTS55 is especially simple, with just six softkeys and easy-to-understand screen prompts. A sophisticated menu structure navigates almost automatically through the measurement, and the multilingual user interface (English, German, French, Italian, Dutch, Spanish) prevents misinterpretations and incorrect operation. Direct access softkeys are used to control the tester. This also includes calling tests and selecting parameters; an ASCII keyboard can also be connected. If an automatic test sequence is being run, it is possible to change over to graphic mode to carry out additional detailed analysis if an out-of-tolerance condition is encountered for example.

Digital Radio Tester CTS55 is designed as a **mini base station** with independent transmit and receive channels and realtime signalling for the broadcast control channel (BCCH) and traffic channel (TCH). Several processors generate and analyze test signals or are used to return the words spoken into the microphone to the mobile telephone receiver with a defined delay.

Digital Radio Tester CTS55 measures all parameters that could influence correct phone operation. Besides power

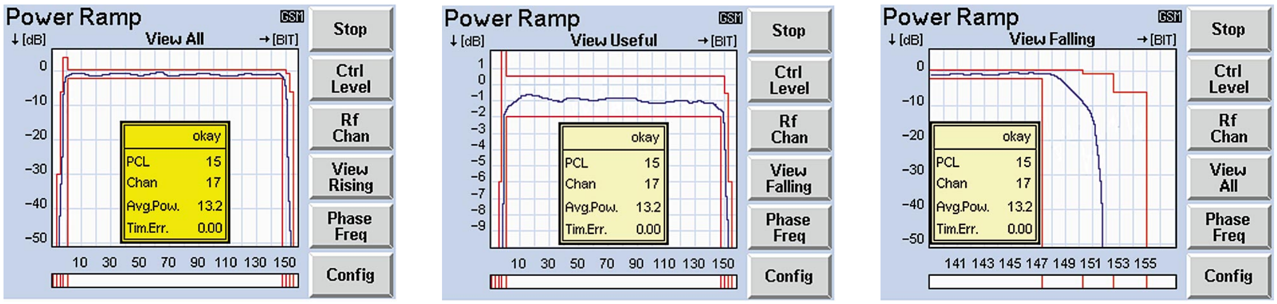


FIG 5 Power ramp with inserted tolerance window makes it easy to detect deviations from nominal curve.

level it determines phase and frequency error and power ramping as well as the various bit error rates and frame error rate. **Options and accessories** are available to increase the ease of operation and test accuracy of CTS55:

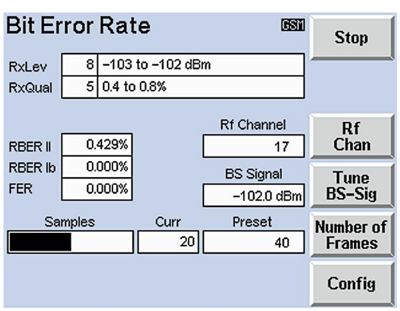


FIG 6 During receiver test, CTS55 simultaneously indicates relevant bit error rates (RBER II and RBER IIb) and frame error rate (FER) as well as RxQual and RxLev values sent back by mobile phone for monitoring.

- OCXO reference oscillator for enhanced accuracy of all frequency-related test parameters (CTS-B1),
- small RF-shielded case (CTD-Z10) for DUTs to prevent spurious test results caused by local GSM, PCN or PCS networks, especially in the case of bit error rate measurements,
- test SIM (subscriber identity module) to put a mobile telephone into service – even without a customer card (CRT-Z2).

Due to its great variety of functions, low weight of less than 8 kg as well as small dimensions and ease of operation, the applications of CTS55 range from use as sales support for mobile phones to a repair tester in service departments or in production. Last but not least, the exceptional price/performance ratio of Digital Radio Tester CTS55 now makes it the most interesting solution for servicing tasks in the GSM/PCN/PCS mobile phone sector.

Michael Vohrer

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[2] Mittermaier, W.: Module test with Digital Radiocommunication Tester CMD52/55. News from Rohde & Schwarz (1995) No. 149, pp 36 – 37

[3] Vohrer, M.: Low-cost Service Radiocommunication Testers CMD50/53 for GSM/PCN/PCS mobiles. News from Rohde & Schwarz (1996) No. 150, pp 54 – 55

Condensed data of Digital Radio Tester CTS55

DUTs	GSM, PCN (DCS 1800), PCS (DCS 1900) mobile phones
Operating modes	manual and fully automatic test sequence with printer report
Functions	synchronization, registration, call setup, call clear-down, channel change, power change, echo test
Test facilities	sensitivity (RxLev, RxQual), power, power ramping, frequency error, phase error, BER (RBER II, RBER IIb), FER, IMSI, IMEI

Reader service card 152/01

Spectrum Analyzer FSEM/FSEK

Fast spectrum analysis now through to 40 GHz

There are new additions to the FSE spectrum analyzer family: in Spectrum Analyzer FSEM Rohde & Schwarz has now moved into the microwave range through to 26.5 GHz and, with FSEK, for the first time through to 40 GHz. New on the world market is a vector signal analyzer option which allows modulation analysis of digitally modulated signals at these frequencies. Standards of measurement speed, precision, dynamic range and spectral purity, set by FSE in the RF range, are of course maintained by the latest members of the family in the microwave range.

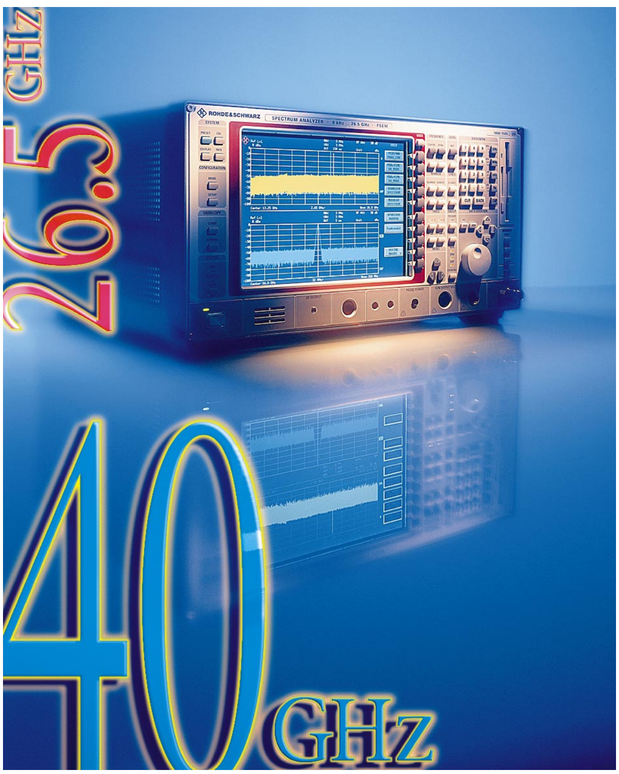

FIG 1 Spectrum Analyzer FSEM up to 26.5 GHz and FSEK up to 40 GHz
Photo 42 573

Increasing communication traffic and a densely occupied frequency spectrum in the lower frequency range are the reasons for resorting to higher and higher frequencies. The transition from voice or data transmission to digital picture transmission requires wider bandwidth per channel and denser spectrum occupancy. For T&M these trends call for higher frequency limits for characteristics that up to now were only necessary for the lower frequency range. Rohde & Schwarz takes these trends fully into account by offering two new members of the FSE spectrum analyzer family [1; 2]: FSEM and FSEK (FIG 1). The FSE family consists of eight models that differ in performance and frequency range (FIG 2). The upper frequency limit of the FSEM models is 26.5 GHz (overrange up to 27 GHz), that of the FSEK models 40 GHz. The performance of models 20 is that of the high-end of the medium class, whereas models 30 are absolute top-class models.

Dense spectrum occupancy places high demands on the transmitters and receivers of a communication system. Interference of adjacent channels and other radio services has to be avoided. Adjacent channels may be impaired in particular by the modulation spectrum and by intermodulation at the transmitter, other radio services by spurious emissions or especially harmonics of the transmitter. For all communication systems these spectral characteristics are subject to very stringent specifications. A suitable spectrum analyzer is therefore required to verify the characteristics in development, production or service. Inadequate characteristics of a measuring instrument, for example too low a dynamic range, can be compensated by external units such as preamplifiers and switchable filters but will always involve extra costs (additional hardware and longer test times) and at the same time the risk of erroneous measurements.

Dynamic range

Dynamic range is one of the key parameters of a spectrum analyzer. Dynamic range covers different characteristics such as sensitivity, overdrive

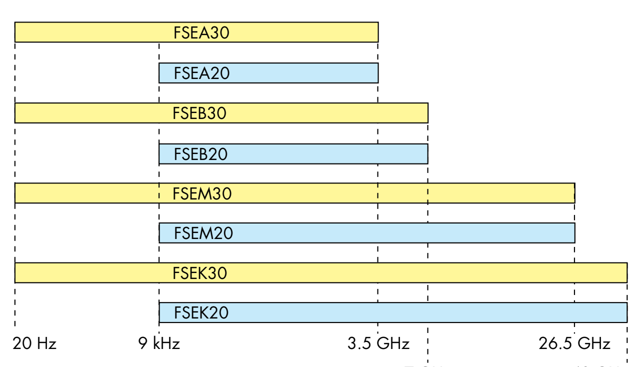

FIG 2 Frequency range of eight FSE models

(1-dB compression), intermodulation, phase noise and display range. Microwave analyzers FSEM and FSEK of the FSE family offer excellent figures for all the above-mentioned parameters.

A precondition for high dynamic range is high **sensitivity** to analyze weak signals. To achieve high sensitivity, FSEM and FSEK operate with fundamental mixing up to an input frequency of 26.5 GHz, ie the input mixer uses the fundamental of the first LO to convert the input signal to the first IF. Thus the mixer yields low conversion loss, which in turn is reflected in the noise figure (FIG 3). Above 26.5 GHz, FSEK mixes with the fourth harmonic of the LO. Most spectrum analyzers use harmonic mixing at frequencies well below 10 GHz (6 to 8 GHz). So harmonics of signals might no longer be detected due to the reduced sensitivity of the analyzer. In this case an external preamplifier and a highpass filter for attenuating the fundamental are required. The low noise floor also brings an advantage in speed: a wider resolution

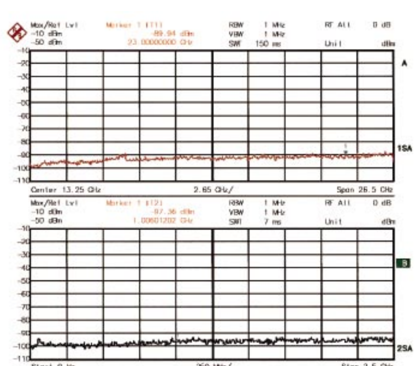

FIG 3 Noise display of FSEM over whole frequency range measured with bandwidth of 1 MHz (top) and in range important for radio transmission to 2.5 GHz

filter can be used to attain the same displayed noise floor as with less sensitive spectrum analyzers. The double bandwidth results in a displayed noise floor that is 3 dB higher but allows fourfold sweep speeds – a considerable gain in time and thus a cost reduction in production for example.

In addition to sensitivity, **large-signal behaviour** is important for dynamic range, ie 1-dB compression, intermodulation-free range or harmonics suppression. For all three parameters microwave analyzers FSEM and FSEK yield the same excellent characteristics as low-frequency analyzers FSEA and FSEB. The 1-dB compression of the RF input of +10 dB allows measurement of very weak signals in the presence of high signal levels without impairing the weak signal. The signal path to the IF filters can be overdriven by 15 dB above reference level. Overdrive indications warn the user if the input signal is too high – also in the case of automatic operation from a controller. This saves the use of notch filters at the transmit frequency in the measurement of nonharmonics, for example, and makes for a simplified test setup. Together with resolution bandwidth of 10 Hz, the third-order intercept point of +15 dBm yields an intermodulation-free range of more than 100 dB. The result of this is as follows: if several large RF signals are present at the antenna connector of a mobile radio base station, for example, signals with a difference in level of up to 100 dB can still be measured without requiring notch filters to suppress the high levels.

Especially if nonharmonics in adjacent channels have to be measured, the phase noise of the internal oscillators is a decisive factor for dynamic range. Too much phase noise suppresses weak signals or spectral components in the adjacent channel, but the spectrum analyzers of the FSE family are exemplary in this respect too (FIG 4). It is noteworthy that the low phase noise in the vicinity of the carrier drops to 140 dBc per 1-Hz test bandwidth at 10 MHz. Even the phase noise of oscillators for transmitters or receivers can be measured with sufficient dynamic range – a major advantage in speed and handling compared to the

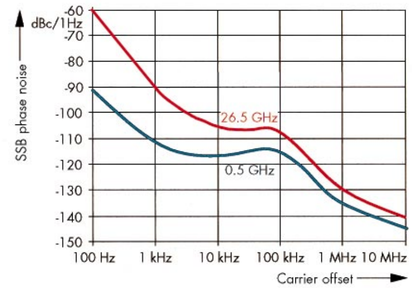

FIG 4 Single-sideband phase noise of FSEM and FSEK at 500-MHz and 26.5-GHz input frequencies

usual test setups for phase-noise measurement.

Precision

As far as precision is concerned, microwave analyzers FSEM and FSEK show, like the other members of the family in the RF range, characteristics that have not been matched so far, ie frequency accuracy, level measurement accuracy and reproducibility of results.

Even at large frequency spans, **frequency accuracy** is attained by a sweep with the first conversion oscillator locked to the internal or external reference at each frequency. At relatively small spans from about 5 MHz most spectrum analyzers use a free-running YIG oscillator tuned by an analog sawtooth voltage. The nonlinearity of the YIG tuning characteristic has a direct effect on frequency accuracy. Things are quite different with the FSE family. Even for the maximum span of 27 or 40 GHz the tuning oscillator is crystal-accurate at any frequency – and at that even for the minimum sweep time of 5 ms. Frequency lines indicated with a marker can be displayed direct with high resolution and without intermediate steps – in the split-screen display simultaneously in a second measurement window.

Like with FSEA and FSEB **level measurement accuracy** is also very high on the agenda for microwave analyzers

(FIG 5). For these analyzers too, Rohde & Schwarz gives the guarantee that a maximum total level error will not be exceeded – a claim unique amongst spectrum analyzers. The total error is as low as 1 dB (up to 1 GHz) and 3.5 dB (at 40 GHz) in the whole temperature range. This is made possible for the first time by very stringent production tolerances and internal calibration routines for absolute gain, the resolution filters (bandwidth and gain) and for the log amplifier characteristic together with correction data stored on each module for the frequency response of for example the attenuator, the YIG preselector and the front-end. The guaranteed level measurement accuracy often spares the user an elaborate correction, eg with an additional power meter, provides measurement reliability and tolerances

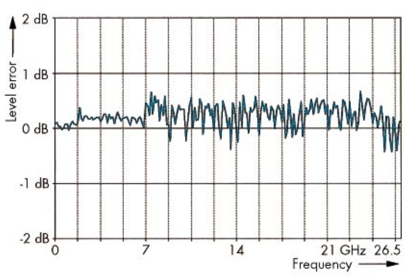

FIG 5 Frequency response of FSEM up to 26.5 GHz (without correction by peaking function)

can be fully utilized for the DUT instead of reserving them for the measuring instrument.

The largely digital signal processing encompassing the resolution filters from 1 Hz to 1 kHz, detectors and the fully synchronous sweep ensures good measurement **reproducibility.** Temperature and aging no longer have an effect. It is also noteworthy that measurement errors are not eliminated by background calibration during operation but only at the request of the user. So there will be no unpleasant surprises caused by an automatically triggered calibration routine.

Speed

Time is one of the most important cost factors, in development where products have to be launched fast, or in production where products have to be manufactured at high throughput and thus cost-effectively. Here too FSEM and FSEK set standards in many ways and help the user reduce costs by saving time and thus become more competitive: the fast synthesizer allows a minimum sweep time of 5 ms up to 7 GHz and 150 ms over the whole frequency range at full level measurement accuracy. With 25 pictures per second, procedures can be analyzed practically in realtime. Manual alignments can be performed with an "analog feeling". The 20-MHz A/D converter also allows display of short signals with high resolution (100 ns/div) thanks to the maximum bandwidth of 10 MHz. The high computing power (586 PC with 133-MHz clock frequency, transputer network and DSPs) yields very fast response times and data outputs on the IEC/IEEE bus even in the case of complex functions such as phase noise measurement, power or adjacent-power measurement and optionally for several channels at the same time.

Microwave analyzers FSEM and FSEK can of course be extended to application-specific solutions with the same options as the RF analyzers. Vector Signal Analyzer Option FSE-B7 [2] deserves special mention since for the first time modulation analysis of digitally or analog-modulated signals is now possible also in the microwave range in a single unit.

Josef Wolf

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[2] Wolf, J.: Spectrum Analyzer FSE with Option FSE-B7 – Vector signal analysis – indispensable in digital mobile radio. News from Rohde & Schwarz (1996) No. 150, pp 19–21

Condensed data of Spectrum Analyzers FSEM/FSEK

Frequency range	20 Hz/9 kHz to 26.5/40 GHz
Amplitude measurement range	–152/–142 to 30 dBm
Amplitude display range	10 to 200 dB in 10-dB steps, linear
Amplitude measurement error	<1 dB (up to 1 GHz), <1.5 dB (1 to 7 GHz), <2 dB (7 to 18 GHz), <2.5 dB (18 to 26.5 GHz), <3.5 dB (26.5 to 40 GHz)
Resolution bandwidths	1 Hz/10 Hz to 10 MHz, in steps of 1/2/3/5
Calibration	amplitude, bandwidths, demodulator characteristic
Display	24 cm (9.5") colour or B/W TFT LCD, VGA resolution
Remote control	IEEE 488 (SCPI 1994.0) or RS-232-C

Reader service card 152/02

Calibration System TS9099

Automatic test equipment calibration to ISO 9000

Rohde & Schwarz has developed the powerful Universal Calibration System TS9099 to enable fast calibration of a whole variety of RF measuring instruments in line with ISO 9000. This system was specially designed for signal generators, test receivers and radiotelephone test assemblies for frequencies up to 2 GHz. The frequency range can be extended at any time.

FIG 1 Calibration System TS9099 for signal generators, test receivers, radiotelephone test assemblies and similar equipment
Photo 42 188

System architecture

Calibration System TS9099 (FIG 1) is modular and upward-compatible, so systems can easily be adapted to different user test requirements. Compared to manual measurement, automatic calibration produces considerable savings in time and additionally read and write errors are avoided. The user can easily add new standard units to the basic equipment and connect new DUTs to the system.

The **basic units of the calibration system** (FIG 2) are:

- signal generator,
- spectrum analyzer,
- modulation analyzer,
- power meter,
- precision attenuator,
- system panel,
- controller with printer,
- software.

An uninterruptible power supply, peripherals and small units as well as racks, table and antistatic facilities complete the system.

System accuracy can be increased considerably by means of a rubidium frequency standard regulated by a standard-frequency receiver. Of course, TS9099 can be connected to any frequency standard already used by the customer. All measuring units of the calibration system were selected so that the DUT parameters to be calibrated can be determined at the prescribed accuracy in the required ranges.

The system panel belongs to the basic equipment of the automatic system; it serves on the one hand for mechanical interfacing of a DUT and on the other for switching electrical signals from a DUT to the measuring instruments and vice versa. Automatic and coordinated interconnection of the DUT with the various instruments within a calibration routine is also established via the system panel.

The test assembly is equipped with a selftest routine for checking and documenting the status of the system on power-up. The reference standards used can be varied or exchanged. The characteristic impedance used for RF measurements is 50 Ω. All RF connections are BNC or N.

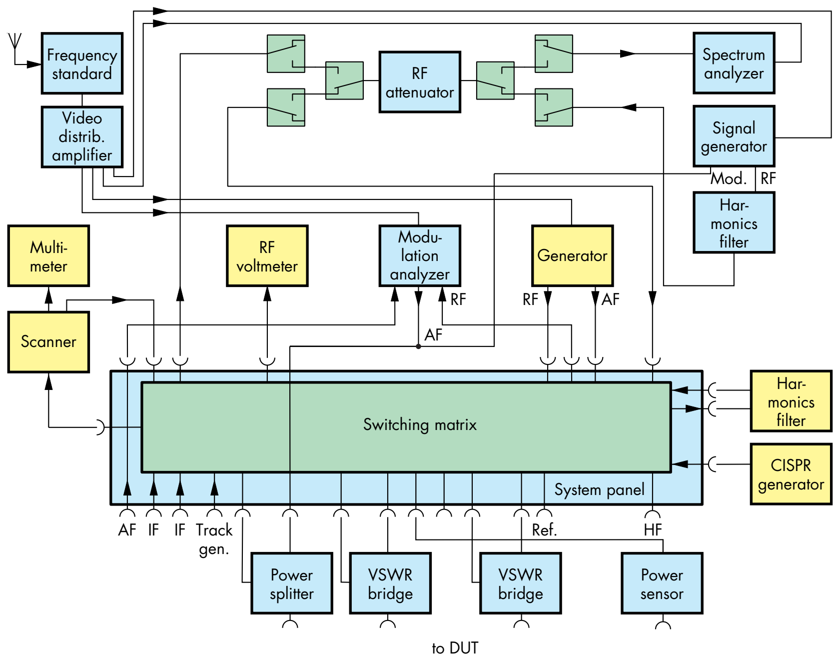

FIG 2 Block diagram of Calibration System TS9099 (options in yellow)

System software

The state-of-the-art system software is interactive (FIG 3), messages indicate incorrect operation. Menu guidance can be selected in German or English. The software is divided into two parts: basic software and user-definable library containing test routines. After system training, the user himself can write such routines. This library can be extended for any equipment with a remote-control interface by the user or Rohde & Schwarz. The DUT permitting, test sequences can be automated using the software and the system panel.

Process control is effected by a user-programmable controller with IEC/IEEE-bus interface. This networkable controller can be equipped with storage media such as a streamer or exchangeable harddisk. The measuring instruments, the DUT (if remotely controllable) and the computer are linked via the IEC/IEEE bus or serial interfaces. The controller steers the complete test sequence and stores and processes test data. The customer can also order yearly recalibration of the whole system by an authorized center (eg Rohde & Schwarz Cologne Plant). In addition, it is possible to conclude a maintenance contract for regular inspection of the system at defined intervals.

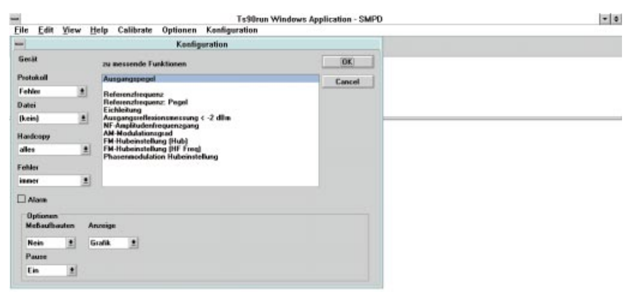

FIG 3 Software interface

Application

The TS9099 test system serves for **calibration of the following measuring instruments:**

- signal generators,
- test receivers,
- RF millivoltmeters,
- power meters,
- radiotelephone test assemblies,
- spectrum analyzers,
- frequency counters,
- attenuators,
- cables,
- probes.

Measurements are made of all required DUT parameters such as carrier frequency, S/N ratio, RF level and power, attenuation, reflection coefficient, amplitude, frequency and phase modulation, modulation frequency, AF level and AF total harmonic distortion as part of the guaranteed specifications. After calibration, the results are displayed on the screen of the system controller or output on a printer.

Jon Pedersen

Condensed data of Calibration System TS9099

Frequency range	10 kHz to 2160 MHz (can be extended)
Level range	–140 to 13 dBm (can be extended)
Types of modulation	AM, FM, φM
Modulation frequency	1 Hz to 100 kHz
Power measurement	
Power range	1 μW to 100 mW
Frequency	0 to 18 GHz
Test modes	automatic, interactive
Interfaces	IEC/IEEE bus, RS-232-C, TTL

Reader service card 152/03

System Processor MERLIN GR2000

Powerful processor stands toughest conditions

System Processor MERLIN GR2000 is now replacing MERLIN GR856, which has been used for many special applications all over the world. MERLIN GR2000 meets the same stringent environmental conditions but with more performance, a more advanced bus system and better expandability than GR856. The enhanced price/performance ratio will make GR2000 an attractive proposition for new applications, whether stationary or mobile.

High computing power is a feature of many PCs, but applications outside the comfortable office enviornment soon separate the men from the boys. System Processor MERLIN GR2000 (FIG 1), which is of course compatible with the industry standard, not only offers high computing power but is also suitable for use under extreme environmental conditions. It is of sturdy construction, has low RF emission and low susceptibility to EMI, is rackmountable and operates reliably at temperatures from 0 to 50 °C.

The basic model of GR2000 offers the usual performance characteristics of a standard PC: plug-in Pentium CPU card (currently 133 MHz), 16-Mbyte RAM (expandable to 256 Mbytes), PCI VGA graphics card, CD-ROM drive, 3 $^{1}/_{2}$-inch disk drive, 1-Gbyte exchangeable harddisk and a PCI Ethernet card. Thanks to the **modular design** and versatile expansion capabilities, the system processor can be tailored to customer's specific application needs. A wide variety of special, intelligent interface cards – eg fax, video frame grabber cards and encryption cards – are available. The passive backplane can accommodate up to eight plug-in cards. This design allows, among other things, various CPU upgrades, and so guarantees that the equipment is future-proof. The basic configuration provides five additional slots with PCI or ISA bus for further expansion.

MERLIN version GR2000X is equipped with EMC filters at its inputs and outputs (FIG 2) and has special shielding. This means low emission and low EMI susceptibility. **RF shielding** is effective both for radiated and conducted interference and ensures interference-free operation in two respects. On the one hand, the system processor is not affected by strong EMI, and on the other, the unit itself does not affect equipment sensitive to EMI (eg receivers). The

FIG 1 Rugged System Processor MERLIN GR2000 can work effortlessly even in toughest conditions of vibration, impact and shock.
Photo 42 561

filters at the serial and parallel interfaces make MERLIN ideal for use in applications that encounter extraordinarily high levels of spurious emissions.

The **enclosure** is of an extremely sturdy construction. MERLIN can even be used in environments exposed to water spray and – thanks to a pressure cooling system with the air sucked in via filters – in dust-laden atmospheres too. The frame is reinforced and designed to withstand extremely high mechanical stress. This ensures problem-free operation under extreme vibration, impact and shock loads, which occur in vehicles and onboard ships. MERLIN will also operate smoothly in rough terrain or on the open sea. The 19-inch rack model, an alternative to the bench model, is particularly suited for use in vehicles. MERLIN is compatible with all conventional keyboards and monitors. Rohde & Schwarz also supplies special keyboard and monitor versions for more sophisticated requirements.

A choice of **power supplies** is available for System Processor MERLIN. As an alternative to the standard version, a power supply that satisfies the stringent requirements for use onboard ships in line with STANAG 1008 is available. This version is immune to large voltage fluctuations and AC-line spikes of up to 2.5 kV. Moreover, the user can choose between AC and DC power supplies.

The **exchangeable harddisk** affords maximum flexibility and data security. As a boot medium, it enables fast and convenient loading of another operating system or of programs for various applications and requirements. Sensitive information can be conveniently stored in a safe place. Special storage media are available for applications subject to extremely high levels of vibration.

With the **CD-ROM drive,** which is included as standard, Rohde & Schwarz is taking a forward-looking approach to industrial PCs. This feature provides access to the world of multimedia and simplifies the installation of modern operating systems [1].

FIG 2 EMC filters in serial and parallel interfaces of System Processor MERLIN GR2000X
Photo 42 568/1

Its EMC compatibility means that System Processor MERLIN can be used in the immediate vicinity of radio transmitters and their antennas. In conjunction with message-handling programs and special, intelligent interface modules, **data transmission** can be implemented and combined [2] using a wide variety of media such as HF, VHF and UHF radio links, telephone lines and satellite links. The message-handling programs support the transmission of fax files and vido stills [3] and optimize the use of e-mail networks. The familiar office environment can thus be connected to various communication networks.

MERLIN has proven itself as a system processor and data terminal in a large variety of applications implemented by a great number of customers. **Functioning as a data terminal,** MERLIN is operated with an ICOM-8 card. This provides eight serial channels, eases the workload of the CPU as it has its own processor, and also supports 5-bit teletype mode (Baudot code). It allows more instruments to be simultaneously controlled than is the case with a conventional PC. MERLIN can thus utilize several media at a time and avoid delays in data transmission. An encryption card can be fitted to make the transmission of sensitive data more secure.

Thomas Kneidel

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Condensed data of System Processor MERLIN GR2000

Processor	
CPU	plug-in Intel Pentium processor board, 133 MHz, 16 Mbytes
Graphics card	PCI VGA, 2-Mbyte RAM
Exchangeable harddisk	1 Gbyte
Drives	3.5-inch disk, 1.44 Mbytes; CD-ROM
Interfaces	
Standard I/O	2 x COM, 1 x LPT, filtered I/O interfaces (GR2000X)
Free slots	1 x PCI, 3 x ISA, 1 x PCI/ISA
Network card	PCI Ethernet

Reader service card 152/04

Series 200 and 400U radio equipment

Innovations in ATC radio-communications: RCMS and 8.33-kHz channel spacing

Reliability has top priority in ATC radiocommunications as human lives are at stake. Central and flexible remote control and monitoring systems (RCMS) as well as the 8.33-kHz channel spacing planned for 1998 contribute to safety. For this reason Rohde & Schwarz has logistically upgraded its ATC radio equipment: Series 200 now comes with RCMS and 8.33-kHz channel spacing. Series 400U is also available with 8.33 kHz. Thus the customer is already provided with ultramodern and future-proof solutions.

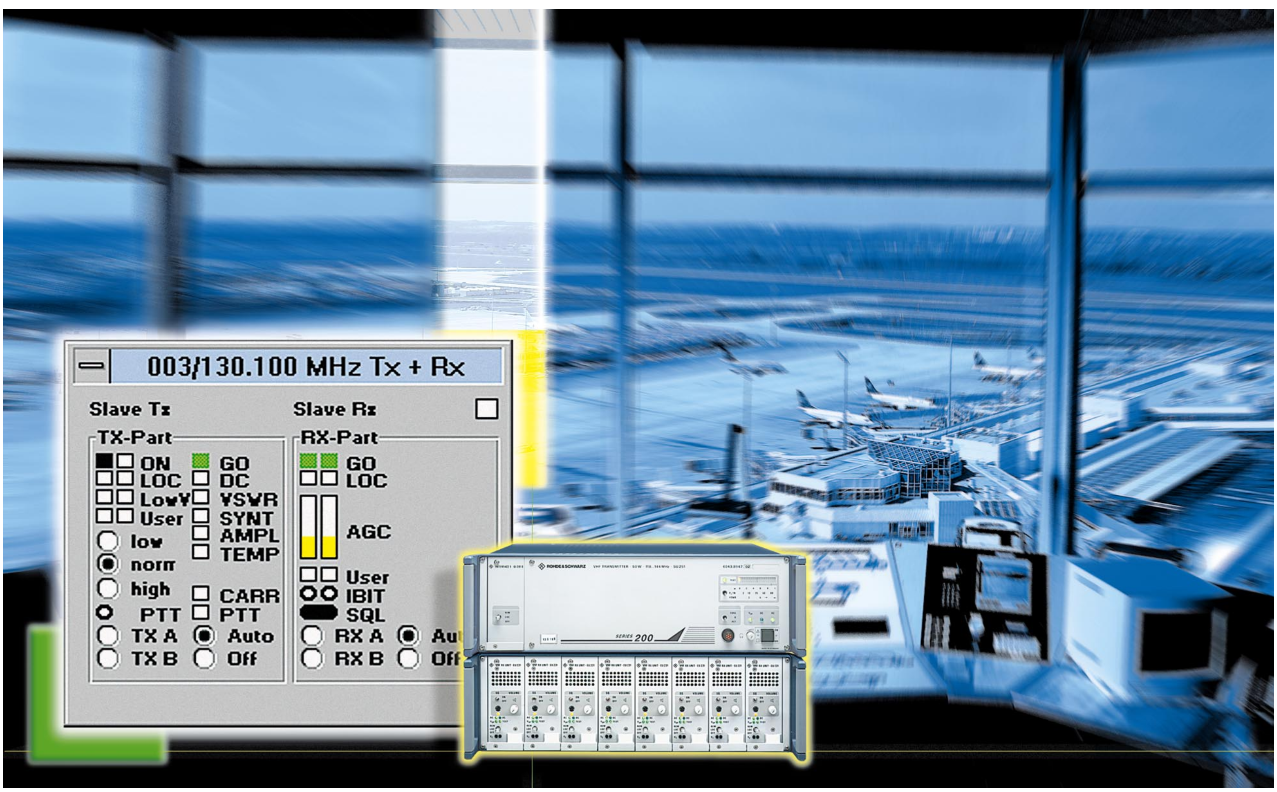

FIG 1 VHF system with eight single-channel Receivers EU231A and single-channel Transmitter SU251 as well as channel-specific RCMS window (example: channel 003/130.1 MHz, separate transmitters and receivers each in automatic 100% standby mode) Photo 42 570

The technical safety of an ATC radio system depends on a variety of features and measures at the device and system level. They include low unit downtimes, equipment redundancy, frequency planning and solutions to collocation problems. Modern systems also call for central control and monitoring with special functions to ensure link reliability, convenience and cost efficiency calculated over the system's lifetime.

Remote Control and Monitoring System RCMS

The RCMS especially developed by Rohde & Schwarz for **Series 200 radio equipment** [1] offers the user different ways of remote control (interfaces, transmission techniques) as well as integration of auxiliary tools (options, add-on units) and user-friendly software (FIG 1). Any ATC radiocommunications system is subject to customer-defined specifications and constraints for all its subsystems such as radio, operation and control or voice switching. RCMS meets these requirements thanks to its flexibility and offers the system planner different techniques and special features.

Parallel technique. This allows normal operation of the radio equipment via conventional interfaces.

Digital REM BUS technique. The new model (.03) of REM BUS Drive Unit

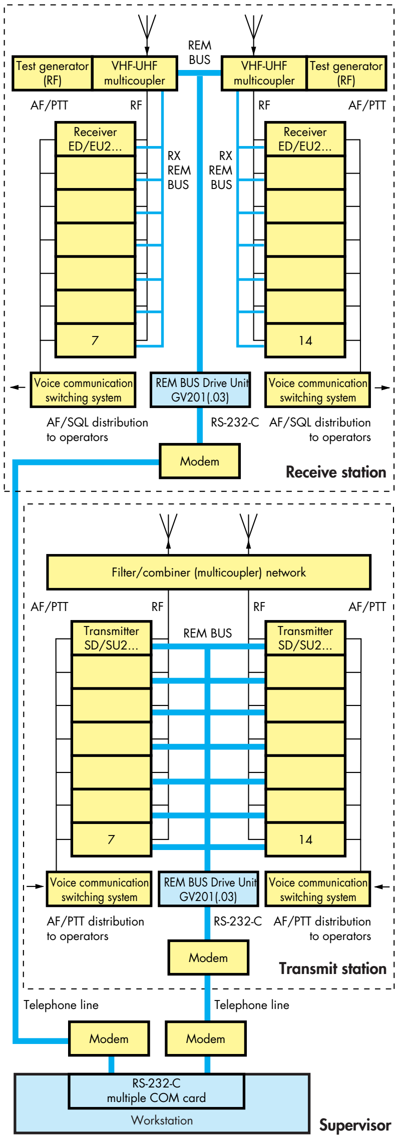

FIG 2 Digital control and monitoring system (RCMS) for separate VHF/UHF transmit and receive stations with 14 radio channels

GV201 allows control at PC COM interfaces via RS-232-C (FIG 2). The corresponding RCMS software can be used for single-channel and multi-channel Series 200 radio equipment and is downward compatible with single-channel systems installed so far. Altogether 30 control and monitoring functions can be transmitted per transceiver channel.

Audio inband technique via four-wire telephone lines. With this option the leasing fees for point-to-point telephone lines, especially for transceivers, can be reduced considerably. A carrier frequency (2040 or 2440 Hz) is nested into the two bidirectional audio spectra (FIG 3). The combination of 4FSK and AM modulation as well as the use of a digital 24-bit signal processor with high computing power of 20 MIPS allows around 20 remote control and monitoring functions including the time-critical functions PTT and AGC/squelch to be modulated and demodulated.

Hybrid technique. The above-mentioned techniques can also be combined for special system requirements.

Thanks to these remote control and monitoring system features, **technical supervisors benefit from the following:**

- central configuration of the radio system,
- continuous tests,
- display of station and channel status,
- manual and automatic radio redundancy,
- RF tests at any operating frequency of receiving systems,
- remote error analysis partly down to the functional unit,
- permanent result logging,
- efficient deployment of personnel.

All this is not limited to the airport but can be used country-wide: thanks to modems or the inband technique the technical supervisor can be contacted practically anywhere and at any time. Rohde & Schwarz is offering special support for the supervisor with **Maintenance and Service Package X-LINK** (Express Link). With this extremely economical product, software updates and functional checks (error analysis) of a radio system are performed at Rohde & Schwarz headquarters in Munich via telephone lines after receiving the customer's request and permission to access the equipment – no matter whether the airport is in the South Pacific or in Siberia.

Reorganization of frequency management

Increasing air-traffic volume and the predicted frequency demand for voice and radio data transmission in the VHF range from 118 to 137 MHz create the need for fast and radical reorganization of frequency management. The operational requirement for undisturbed channels would not be met by merely halving the present channel spacing from 25 kHz to 12.5 kHz, so the **International Civil Aviation Organization ICAO** has come to the following decisions after tests conducted by the British ATC authority (CAA/NATS) as well as feasibility studies and specifications by different committees (eg EUROCAE, ETSI) with active participation by Rohde & Schwarz:

- A VHF channel spacing of 8.33 kHz (voice) and 25 kHz (voice and data) will be introduced.
- Operation in Europe will be launched on 1 January 1998 in selected air corridors.
- Modulation will be AM A3E (double-sideband modulation, DSM).
- Ground single-channel radio equipment will be for 8.33 or 25 kHz.

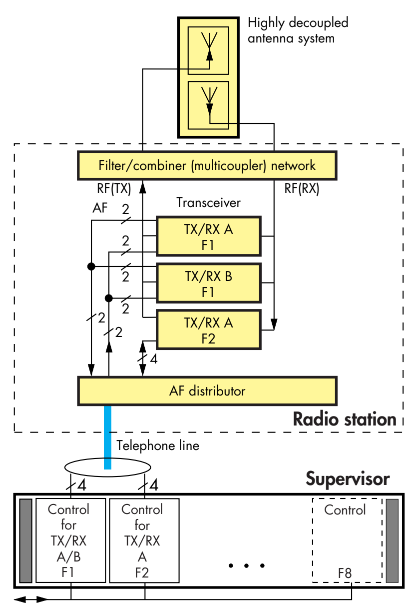

FIG 3 Analog (AF) inband RCMS for VHF-UHF radio station with transceivers with one redundant (F1) and one normal channel (F2)

- Airborne transceivers will have switchover capability between 8.33 and 25 kHz.

Switchover between 8.33 and 25 kHz also has to be possible for ground VHF multichannel radio equipment such as for emergency standby or special tasks (SAR, defence).

ATC operators in key European areas (southern part of Great Britain, the Benelux, France, Germany, Switzerland, Austria and northern Italy) are now asked to invest on the basis of the decisions taken with a view to implementing the new frequency channels in ground radio control centers. Airlines will have to retrofit part of their fleets.

The 8.33-kHz requirement has in particular implications for the following **components:**

- synthesizers for transmission, reception and test (channel setting and higher frequency stability),
- receivers (higher selectivity through IF crystal filters),
- transmitters (lower modulation upper cutoff frequency),
- operation and display (adaptation of hardware, device-specific firmware and system software).

Innovations in Rohde & Schwarz radio equipment

The new units of **Series 200/single-channel** comprise a new, universal synthesizer. Models of VHF Receiver EU231A/D and VHF Transceiver XU221/XU251 are now available for 8.33 or 25 kHz with corresponding IF filters. For the transceivers, a modulator extension is additionally provided for the 8.33-kHz specific frequency response. This modulator extension for 8.33 kHz is available as an option for VHF Transmitters SU221/SU251. To guarantee retrofitting from 25 to 8.33 kHz (or vice versa) with minimum logistics and service, the IF filters as well as the modulator extension are equipped with connectors. A test generator for receiving systems using 8.33-kHz channel spacing is another new option.

Series 200/multichannel VHF and UHF radio equipment that can be switched to any frequency within the 25- or 8.33-kHz channel spacing is currently being developed (first digital ATC receiver) and will be available in time before 8.33-kHz operation is started.

New in **Series 200/RCMS** too: REM BUS Drive Unit GV201 and RCMS software are of course tailored to the new techniques. Thus they comprise important components and performance features for PC-controlled RCMS. One of the most attractive innovations of RCMS is Service and Maintenance Package X-LINK mentioned already.

As part of **Series 400U,** which is based on the successful Series 400 [2], Rohde & Schwarz offers the following new 25- and 8.33-kHz-compatible unit types for civil and military multichannel applications: Transceivers XU452U8 (VHF) and XT452U8 (VHF/UHF), Transmitters SU452U8 (VHF) and ST452U8 (VHF/UHF) as well as Receivers EU458U (VHF) and ET458U (VHF/UHF). An AF/telephone Interface is available as an option for 8.33-kHz transmitters and transceivers. The operating software for the radio equipment is of course also designed for 8.33-kHz operation.

Optimum coordination between all persons involved in introduction of the 8.33-kHz channel spacing (ATC operators, airlines, service, supply industry, etc) guarantees in these times of reorganization that restrictions of air traffic or impairment of flight operations in the parallel 25-kHz ATC sectors are reduced to a minimum. Rohde & Schwarz contributed to this by committing itself early to the definition phase and by developing, producing and supplying new radio equipment in good time. After just one year of development, the 8.33-kHz technique could be launched in June 1996 with 100 units from each of the Series 200 and 400U radio equipment.

Hans-Günther Klarl; Martin Kessler

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Innovations in Series 200 and 400U radio equipment

Series 200	
VHF single-channel receiver and transceiver	8.33- or 25-kHz spacing, depending on version
VHF single-channel transmitter	8.33 kHz (with Modulator Extension GM201C8) or 25 kHz
Multichannel units	currently being developed
REM BUS Drive Unit GV201 (.03)	RS-232-C interface for PC-COM cards, conversion to REM BUS
Operating Software GC201-S (.03)	combined version for 8.33 kHz and 25 kHz
Test Generator GT231T1 (.22)	8.33-kHz and 25-kHz compatible, for single-channel and multichannel units
4-carrier offset according to ICAO	with standard synthesizer
Series 400U	
VHF + VHF/UHF multichannel receiver	8.33 kHz/25 kHz switchover
VHF + VHF/UHF multichannel transmitter and transceiver	8.33 kHz/25 kHz switchover (with GI419U)
AF/Telephone Interface GI419U	module for 8.33-kHz compatible transmitters and transceivers
Operating Software GB406-S	combined version for 8.33 kHz and 25 kHz

Reader service card 152/05

TV Test Receiver Family EFA

Top fit for digital television

Small-size, compact, future-oriented, upgradable – this is how TV Test Receiver Family EFA shows its true self. With this family Rohde & Schwarz has created a test platform that can easily keep pace with rapid developments in television. Before the official start of digital video broadcasting, Rohde & Schwarz can already offer the world's first demodulator for QAM signals which is able to perform all the measurements required on cable digital channels. An analog TV test receiver – either broadband or selective – is available for monitoring the previous TV channels. Digital and analog functions can also be combined in a single unit, which can be expanded by adding options.

With its modular design the compact 12-kg TV Test Receiver EFA (FIG 1) is extremely versatile and made for easy upgrading. In addition to the microprocessor module fitted as standard and the modules of the respective basic EFA model, another five functional modules can be accommodated (FIG 2). Every user can thus configure a model to suit his specific requirements or upgrade the basic model at a later date.

Basic models

The first member of the EFA family is **the analog TV test receiver with selective receiver section.** It receives amplitude-modulated TV signals to all common standards, selects the TV channel and converts it to IF. Picture and sound signals are then demodulated by the analog demodulator. Sound is demodulated according to the intercarrier method, where the vision carrier is multiplied by the sound carrier and the intercarrier thus obtained is selected and frequency-demodulated. The advantage of this is that incidental phase modulation from local oscillators as provided in every TV receiver does not appear in the demodulated audio signal, whereas that from the vision modulator is reflected in the demodulated audio signal. TV Test Receiver EFA detects this interference and is therefore suitable for measuring and monitoring the sound quality of received signals. The frequency-demodulated audio signals are brought out at balanced outputs. For measuring incidental carrier

FIG 1
TV Test Receiver EFA, allround specialist for measurements on analog and digital TV signals – seen here in headend station
Photo 42 575

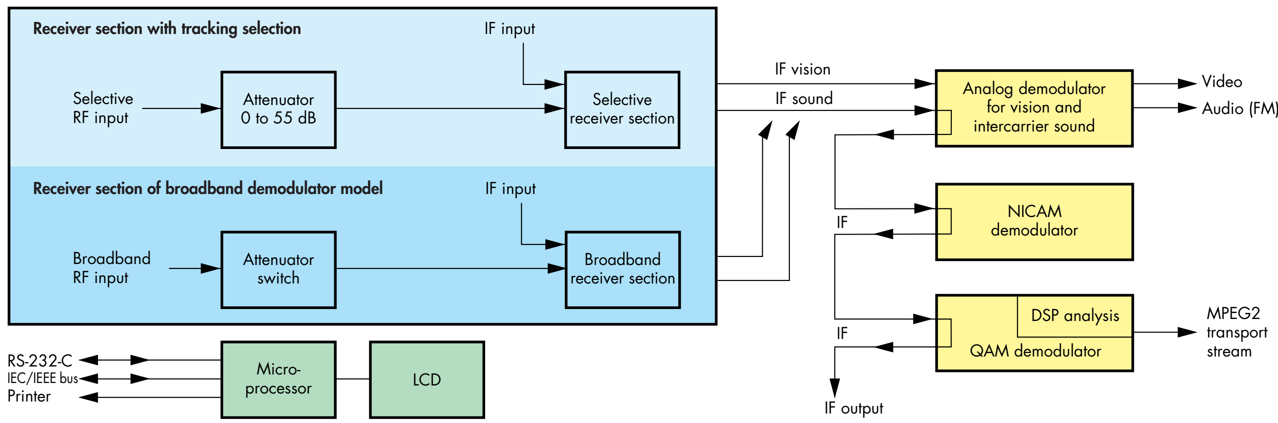

FIG 2 Block diagram of TV Test Receiver EFA (basic models shown in blue, functional modules in yellow). Receivers can be configured to suit specific application.

phase modulation (ICPM), TV Test Receiver EFA provides a quadrature-demodulated vision carrier signal. In conjunction with an internal or external zero reference pulse and an oscilloscope or video analyzer, it allows quantitative determination of ICPM.

The **analog TV Test Receiver** EFA measures all important **RF transmission parameters** and displays them on an LCD (FIG 3):

- power and voltage of vision carrier in dBm, dBpW or µV/mV, dBµV,
- vision carrier frequency,
- vision/sound carrier level ratio,
- vision/sound carrier frequency spacing,
- FM sound carrier deviation,
- FM pilot deviation,
- pilot frequency.

Depending on the model, Test Receiver EFA demodulates TV signals of standards B/G, D/K, K1, I or M/N. In addition to a constant video group delay, implemented in each receiver model, TV Test Receiver EFA features group-delay correction that depends on the respective standard and is available for all worldwide TV standards.

An optional **NICAM demodulator** is available for decoding the digital QPSK-modulated sound carrier to NICAM 728 standard. Further options (functional modules) are in development.

In addition to the model with selective receiver section, the **analog TV test receiver is also available with a broadband receiver section.** In single-channel applications it is used for measurements directly on the source. Typical examples are measurement of the quality data of TV transmitters and transposers in single-channel mode as well as monitoring radiated RF signals. A Nyquist demodulator ensuring system-compatible demodulation of the generated signals is used for these applications.

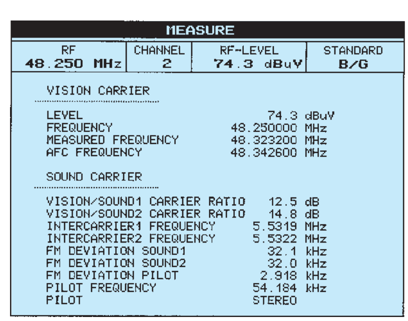

FIG 3 Screen display for analog TV test receiver mode

Further functional modules can be added to the broadband TV test receiver just as to the selective one.

Another member of the EFA family is the **DVB test receiver with QAM demodulator.** It is used for measurements on digital channels in cable-TV networks. Instead of an analog demodulator, a demodulator for quadrature amplitude-modulated (QAM) signals – fully compatible with the DVB standards [1] – is used in this case for processing the DVB-C channel converted to IF. The output signal is then in the form of a serial or parallel MPEG2 transport stream [2].

The **QAM demodulator** measures the following **parameters** separately, performs calculations [3] and outputs the results on its display in line with requirements of the DVB Measurement Group [4]:

- constellation diagram,
- RF level,
- signal/noise ratio,
- bit error rate,
- amplitude imbalance,
- carrier suppression,
- phase error and phase jitter,
- modulation error ratio (MER).

The constellation diagram (FIG 4), which is graphically displayed and mathematically evaluated by a signal processor, supplies the most important information on QAM signals. To ensure the required statistical reliability for the evaluated parameters, about 1,000,000 I/Q values are considered.

The QAM demodulator can be fitted with up to three SAW filters so that not only 8-MHz QAM packets can be processed with 64QAM which is almost standard today, but also packets of 4 or 2 MHz. Thanks to the versatile configuration possibilities of the QAM demodulator, 4QAM to 256QAM can be selected for all current methods. Among many other features, error protection can be switched off and the roll-off factor selected. A built-in noise generator is available for determining the noise margin.

It is of course possible to equip the test receivers for the measurement of both analog and digital TV signals. The modular design allows optimum customization and the configurations described above are only a few among many.

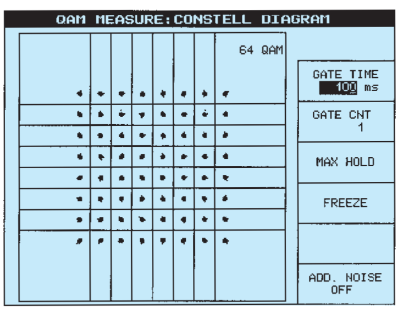

FIG 4 Constellation diagram in QAM demodulator mode; result hold time adjustable from 2 ms to infinite

Interfaces

EFA features a large LCD for display of user information, measured values and graphs. Hardkeys and softkeys ensure great ease of operation. The microprocessor module provides a variety of interfaces; the receivers can be remotely controlled via IEEE bus or RS-232-C interface and come with a printer connector. The demodulated sound can be monitored via a built-in loudspeaker or headphones.

Uses

The broadband TV test demodulator is ideal for the precise measurement and monitoring of the quality data of TV transmitters and transposers. The selective receiver model is required for measurements in cable-TV networks. For this application the combinational unit with analog and QAM demodulator is recommended. The powerful test receiver family is of course also suitable for applications in development labs, quality management and production monitoring.

With TV Test Receiver Family EFA from Rohde & Schwarz an enormous step has been made towards digital video broadcasting, whilst taking full account of previous TV standards. The program will be continuously expanded by new functional modules to open up further sectors of digital television.

Christoph Balz; Ernst Polz; Walter Fischer

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Condensed data of TV Test Receiver Family EFA

Frequency range	47 to 862 MHz
Inputs	RF, IF
Input impedance, RF	50 or 75 Ω
Input voltage range	
Selective analog TV test receiver	30 µV to 1000 mV
Selective QAM receiver	100 µV to 700 mV
Broadband analog TV demodulator	10 to 2500 mV
Outputs	IF, controlled
Loudspeaker, headphones	adjustable volume, can be switched off
Interfaces	IEEE 488, RS-232-C, Centronics
Nyquist test receiver	
Inputs	external zero reference pulse
Outputs	video, Q signal, audio balanced, audio unbalanced, headphones
QAM demodulator	
Specifications	compatible with DVB guidelines
Order of QAM	4, 16, 32, 64, 128 or 256
Rolloff factor	0.15 to 0.30, selectable
Internal noise generator	12 to 62 dB C/N, adjustable
Outputs	parallel or serial MPEG2 transport stream, serial data/clock before error correction

Reader service card 152/06

MPEG2 Generator DVG and MPEG2 Measurement Decoder DVMD

Test equipment for digital TV in line with MPEG2

A new TV standard is about to be launched worldwide. Thanks to digital technology many more programs can now be broadcast and flexible scrambling offered without the need for more bandwidth. Rohde & Schwarz supplies the test equipment that guarantees the quality of these digital TV transmissions received via a set-top box: MPEG2 Generator DVG and MPEG2 Measurement Decoder DVMD.

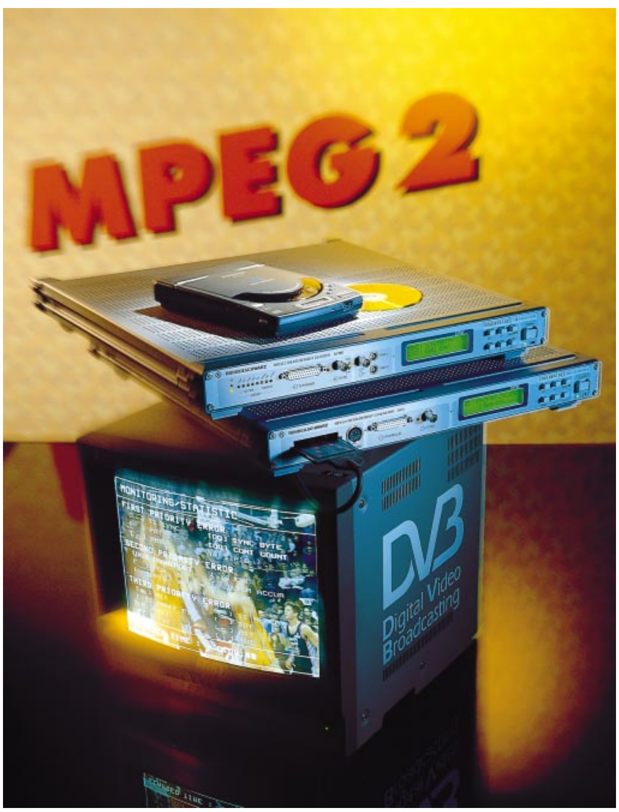

FIG 1
MPEG2 Generator DVG and Measurement Decoder DVMD with TV monitor showing decoded picture and menu display
Photo 42 498/1

MPEG2 Generator DVG

MPEG2 Generator DVG (FIG 1) is a signal source for MPEG2 transport streams. The structure of these streams and the data reduction methods employed were developed and standardized by MPEG (Moving Picture Experts Group) and the DVB (Digital Video Broadcasting) project. A main feature of the transport stream is that it contains several programs, each consisting of several substreams (video, audio and data signals). Programs are no longer combined at RF frequencies after the modulator, as is the case with conventional TV techniques, but produced at the baseband in the form of a program and signal multiplex.

DVG generates these multiplex signals and is a favourably priced and compact alternative to expensive MPEG2 encoders with multiplexer and external standard generators. It is ideal for testing and commissioning MPEG2 transmission links and may be used as a substitution signal source in the case of program failures or for adjusting and testing decoders and TV sets. Since DVG takes its signals from RAM and they can be played back time and time again without any "wear and tear", the generator is predestined for applications where continuous operation is required. These features make DVG a practical, high-availability signal source wherever MPEG2 signals are to be found.

MPEG2 signal structure

MPEG2 signals are digitized video and audio signals that have undergone considerable data reduction. The MPEG2 standard permits several data reduction methods to be used [1]. A main feature of video data compression is that in most cases only data variations (differential video) are transmitted. To meet this requirement, the signals generated by DVG consist of continuously repeated moving picture sequences. To avoid discontinuities at the end of each sequence, the following should be borne in mind: the programs in the transport stream are assigned different presentation time stamps (PTS) and decoding time stamps (DTS), enabling the decoder to determine the sequence of the pictures to be transmitted and to synchronize them with the accompanying audio signals. Another time marker, the program clock reference (PCR), is used as a reference. If the same unchanged sequence were permanently repeated without time stamps, there would be "time jumps" and all down-stream equipment would have to be resynchronized. The time stamps for each program are therefore continually updated in DVG and a continuous signal like that produced by an encoder is generated, although the scene is repeated over and over again (FIG 2). Only the use of continuous transport streams such as these ensures

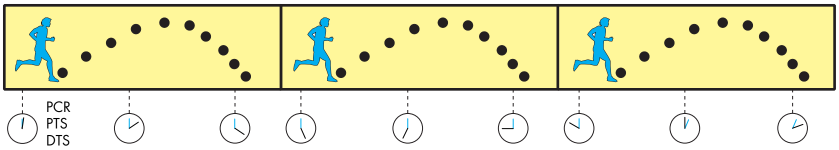

FIG 2 Continuous PCR, PTS and DTS time stamps in repeated sequences

smooth and reliable tests on MPEG2 terminal equipment and transmission links.

Signals generated by DVG

As FIG 2 suggests, some of the DVG transport streams also contain live sequences, ie video and audio signals, whose quality cannot be determined by measuring equipment but only by eye. As data-reduced signals have little or no redundancy, even a small number of bit errors may impair transmission quality, particularly in areas where the picture is changing. Therefore live sequences are essential for checking that transmitters and decoders are operating correctly.

In addition to transport stream transmission, analog signal processing in the terminal equipment also has to be checked. D/A conversion in the decoders and adjustments of the picture geometry in TV sets are normally tested with video stills and the analog sound-signal path has to be adjusted or tested as well. DVG provides all essential test patterns and analog sound signals required for these tests. The Rohde & Schwarz codec test pattern (FIG 3) and the standard sound sequence CCITT 0.33 are ideal for fast, automatic tests with video and audio analyzers.

This test pattern created by Rohde & Schwarz not only covers all analog measurements but simultaneously checks whether the MPEG2 transmission is OK or whether only the last decoded picture is displayed by the decoder. This check uses four white areas rotating in each field and a white spot moving backward and forward across 24 frames displayed on the screen. The loss of frames during transmission is indicated by irregular flicker of the rotating areas and by a halting movement of the white spot. The moving spot may also be used for delay measurements.

The transmission of data in the MPEG2 multiplex is still an open question – even among broadcasters. Many data services could certainly be envisaged, but viewers will still, first and foremost, want teletext facilities in the future. So the transmission of teletext data has to be checked as well. In this case DVG inserts teletext pages in the form of data packets into the transport stream multiplex.

Even all these signals do not exhaust the capabilities of DVG. When a keyboard, a mouse and a VGA monitor are connected, DVG becomes a PC with additional signal generation features. For instance, with the aid of the Stream Combiner® program packet, the MPEG2 specialist is able to generate his own signals and make special settings in the system information data. Even errors may be included in the transport stream.

Simple operation and multifunction interfaces

All the main configuration data of the transport streams are shown on the integral LCD. Normally the data shown by the LCD will be sufficient, but if more detailed information is required a printer or VGA monitor can be connected. In this case all the information in the transport stream is available at the press of a button. In addition to the RS-232-C interface, DVG also has a PCMCIA adapter. This adapter, the same as that provided on every laptop, may be used for connecting SCS interfaces, network cards, exchangeable harddisks or a CD-ROM drive for storing signals.

The selected transport stream is available at three DVG outputs. The TS parallel output on the front panel is a synchronous, parallel LVDS interface. The level at this output was set to the upper limit of the DVB standard A010 [2] so that at least two devices can be connected. Two devices may also be connected to the two serial, asynchronous outputs (TS ASI), one on the front, the other on the rear of DVG. These two types of interface have now become the de-facto standards.

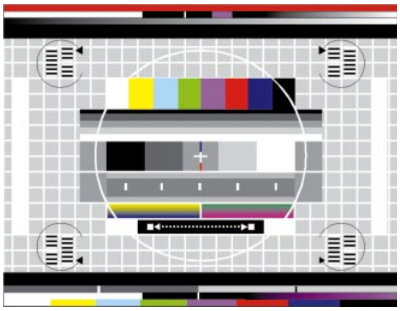

FIG 3 Rohde & Schwarz codec test pattern

All these signals, interfaces and configuration capabilities make DVG not only a compact but also a universal MPEG2 signal source and thus an essential tool for measurements to MPEG2 and DVB.

MPEG2 Measurement Decoder DVMD

By monitoring and analyzing the MPEG2 transport stream, DVMD (FIG 1) performs a completely new kind of measurement task that has arisen because of the introduction of digital TV. The measurements are intended to ensure smooth interworking of all components in a DVB transmission network. DVMD also provides information about the contents of the transport stream and decodes the programs contained in them. Results of the protocol analysis can then be compared to the decodability of video and audio signals. The measurement decoder not only provides comprehensive information about the quality of the transport stream but makes the new technology transparent so that reliable use is ensured.

No way out for errors: protocol monitoring online

Comprehensive, highly integrated hardware combined with a powerful signal processor system is the basis for continuous and comprehensive monitoring and analysis of a transport stream. Analysis is always performed in realtime. Not only are substreams or individual programs monitored, the integrity of the whole transport stream is checked. This makes it possible to demonstrate that timing is correct and contents of protocols and parameter values are complied with during transmission as well as with lab measurements.

Monitoring and analysis of the transport stream are based on the guidelines laid down by the Measurement Group of the Technical Module of the European DVB project [3]. The tests defined in the guidelines are classified in terms of three priority groups according to their importance. First-priority tests check synchronization of the transport stream and program access. Tests in the second priority group identify transmission errors and check time references in the elementary streams, while tests of the third group monitor service information for compliance with DVB guidelines.

All three groups are taken into account by DVMD when the transport stream is monitored. If an error occurs, detailed information that depends on the type of error is output so that the error source can be pinpointed. The ability to trigger on a specific or any type of error (trigger on error) is also based on this monitoring system. In this case the transport stream before and after the trigger event is recorded and can be output via a serial interface for further analysis.

This online measurement capability allows the network operator in particular to determine the data rates of the transport stream, programs and elementary streams, which is a significant form of analysis. Data rates indicate the network load and determine transmission costs. They are not derived from service information in the transport stream but computed online.

Decoder unit: essential enhancement plus second test set

DVMD combines a test set and decoder in one unit and uses decoding as an additional test method. As a result you can directly "hear and see" what results mean. **Video and audio signals** are available in analog and digital form:

- analog video in PAL, NTSC or SECAM (two outputs),
- analog video in Y and C,
- digital serial video (ITU-R 601/270 Mbit/s),
- analog audio L/R (two outputs each),
- digital audio AES/EBU.

The audio-visual content of a transport stream is laid bare and can be passed on in decoded form.

No restrictions for scrambled programs

DVMD may also be used for scrambled programs. These have no effect on protocol monitoring since the relevant data are not scrambled. A common interface defined by the DVB project [4] is available for decoding scrambled programs. With the aid of a key card, obtainable from the broadcaster, even scrambled programs can be analyzed.

```
MONITORING/STATISTIC

FIRST PRIORITY ERROR
  [00] TS SYNC          [08] SYNC BYTE
  [00] PAT              [05] CONT COUNT
  [00] PMT              [00] PID
SECOND PRIORITY ERROR
  [05] TRANSPORT        [02] CRC
  [00] PCR              [  ] PCR ACCUR
  [  ] PTS              [00] CAT
THIRD PRIORITY ERROR
  [01] NIT              [02] SI REPEAT
  [  ] UNREF PID        [00] SDT
  [00] EIT              [00] RST
  [  ] TDT

ELAPSED TIME : 00:21:17
```

FIG 4 Error statistics from MPEG2 Measurement Decoder DVMD

MONITORING/REPORT

NO	TIME	EVENT		PID
000	--------	14.May 96	------------	
001	12:15:00	START		
001	12:43:21	CRC	PMT	0132
002	14:30:06	TS SYNC	LOSS	
003	14:35:00	TS SYNC	OK	
004	17:40:13	CONT_COUNT	LOST_P	1226
005	18:32:20	TRANSPORT		0064
007	--------	15-MAY-96	------------	
008	07:32:57	TRANSPORT		0068
009	07:32:59	TRANSPORT		0068
010	08:14:07	PMT	REP	0132
---	10:25:36			

ELAPSED TIME 22:10:36

FIG 5 DVMD test report

DECODER/SELECT PROGRAM

NO	NAME	ELEMENT	CA	Mbit/s
ALL	6 PROGRAMS			38.132
1020	ARD	VAaD		6.001
1080	ZDF	VAD		5.996
1102	ORF2	VAaD		6.000
1440	SRG1	VaaAD		6.194
1690	MTV	VAaD	*	5.127
1830	PREMIERE	VAaaD	*	8.385

15 MAY 96 11:43:23

FIG 6 Data rate of all programs in transport stream determined by DVMD

Menu-guided operation and display

The LCD of DVMD is used to operate it and display information. A TV monitor can also be used for this purpose via the OSD function (onscreen display). The OSD function displays the coloured menus with the desired transparency in the decoded picture (FIG 1). This gives a clear display of detailed measurement results. The following **test menus** are available:

- joint display of error counters for all monitored parameters (FIG 4),
- preparation of a detailed test report (FIG 5),
- display of all programs in the transport stream with information on program structure, data rates and scrambling (FIG 6),
- list of all elementary streams in a program plus associated data rates.

LEDs on the front panel of DVMD directly display each of the first-priority tests (TS_sync, Sync_byte, PAT, Continuity_count, PMT [3]) and the main tests in the second priority group (Transport_error, CRC). All other tests in the second and the third priority groups are indicated by a single LED.

User-friendly remote control

DVMD offers full remote control. All settings and queries can be made via a serial interface. In addition, data contained in the transport stream may be read and analyzed further. This applies to data sections with syntax errors (trigger on error) as well as to filtered data components (eg packets of a substream or packets with adaptation field).

DVMD offers more than just access to a new TV measurement technique. It provides comprehensive information on structure and syntax and allows detailed monitoring and analysis of the protocols used for any MPEG2 multiplex data stream.

Michael Fischbacher; Harald Weigold

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[3] DVB-TM 1601: Measurement Guidelines for DVB Systems

[4] DVB-TM 1341: Common Interface Specifications for Conditional Access and other Digital Video Broadcasting Decoder Applications

Condensed data of MPEG2 Generator DVG and MPEG2 Measurement Decoder DVMD

DVG

Output signals	transport stream to ISO/IEC 13818-1
Length of transport stream packets	188/204 bytes (settable)
Data rate of transport stream	0.6 to 54 Mbit/s (settable)
Total data rate of elementary streams	up to 15 Mbit/s
Total data quantity of elementary streams	100 Mbits
Stored signals	approx. 20 transport streams (MP@ML), moving picture sequences, test patterns, test tones, teletext
Signal outputs	1 x TS parallel (to DVB-A010), 2 x TS ASI (to DBV-A010)
Interfaces	ports for PC peripherals

DVMD

Input signals	transport stream to ISO/IEC 13818-1
Length of transport stream packets	188/204 bytes
Data rates of transport stream	0.6 to 54 Mbit/s
Signal inputs	1 x TS parallel (to DVB-A010), 2 x TS ASI (to DVB-A010)
Tests to DVB-TM 1601	1st priority (Ts_sync, Sync_byte, PAT, Continuity_count, PMT, PID) 2nd priority (Transport_error, CRC, PCR, PCR_accuracy, PTS, CAT) 3rd priority (NIT, SI_repetition, unreferenced_PID, SDT, EIT, RST, TDT)
Other tests	trigger on error, data rates of transport stream or substreams
Decoder outputs	
Video	2 x CCVS, 1 x Y/C, 1 x ITU-R 601
Audio	2 x analog audio L/R (LEMO), 1 x AES/EBU
Interfaces	RS-232-C

Reader service card 152/07

100/200-W Solid-State DAB Transmitter NL5010/5020

Terrestrial broadcasting of digital audio in L band

The 100/200-W Solid-State L-Band DAB Transmitter NL5010/5020 completes the range of Rohde & Schwarz DAB transmitters which cover all DAB frequencies. The new audio broadcast transmitter operates in the frequency range 1452 to 1492 MHz and fully complies with the requirements made on a modern DAB transmitter.

The international specification for the DAB (digital audio broadcasting) system (ETS300401), which was published in 1994, was prepared by renowned research institutes, sound broadcasting corporations and industrial companies as part of the European project EUREKA 147. From the very beginning Rohde & Schwarz played a decisive role in this work [1].

The L-band Transmitters NL5010 (100 W) and NL5020 (200 W) were developed on this basis and now complete the line of Rohde & Schwarz DAB transmitters. Thanks to their design, quality, and operating philosophy they fit perfectly into the range of well-proven Rohde & Schwarz transmitters [2]. The main components of the transmitters are COFDM Modulator MCM01 [3], Exciter SD100A2, Amplifier VL5010, primary-switched Power Supply IN916, power distribution and a high-pressure fan, which are all designed as plug-in units and accommodated in a transmitter rack (FIG 1).

Since a new type of amplifier is used in the transmitters, the output bandpass filter for limiting out-of-band transmissions may also be integrated in the rack. This was not possible with previous transmitter models. There is also ample space to accommodate a GPS frequency standard (option).

Function

Depending on the type of ETI (ensemble transport interface) to the transmitter site, the signal from the satellite demodulator or from another source is fed to COFDM Modulator MCM01 (FIG 2), which $\pi/4$ DQPSK-modulates the data onto carriers, the number of which is determined by the selected DAB mode. This baseband DAB signal with spectrum width of approx. 1.5 MHz and center frequency of 2.048 MHz is applied to Exciter SD100A2. After mixing to a fixed IF (38.902 MHz) the signal is amplitude- and phase-equalized and then finally converted to an L-band frequency in the range 1452 to 1492 MHz (setting increment 25 Hz). The RF signal is then amplified in the exciter and routed to the transmitter output stage, directly in the 100-W

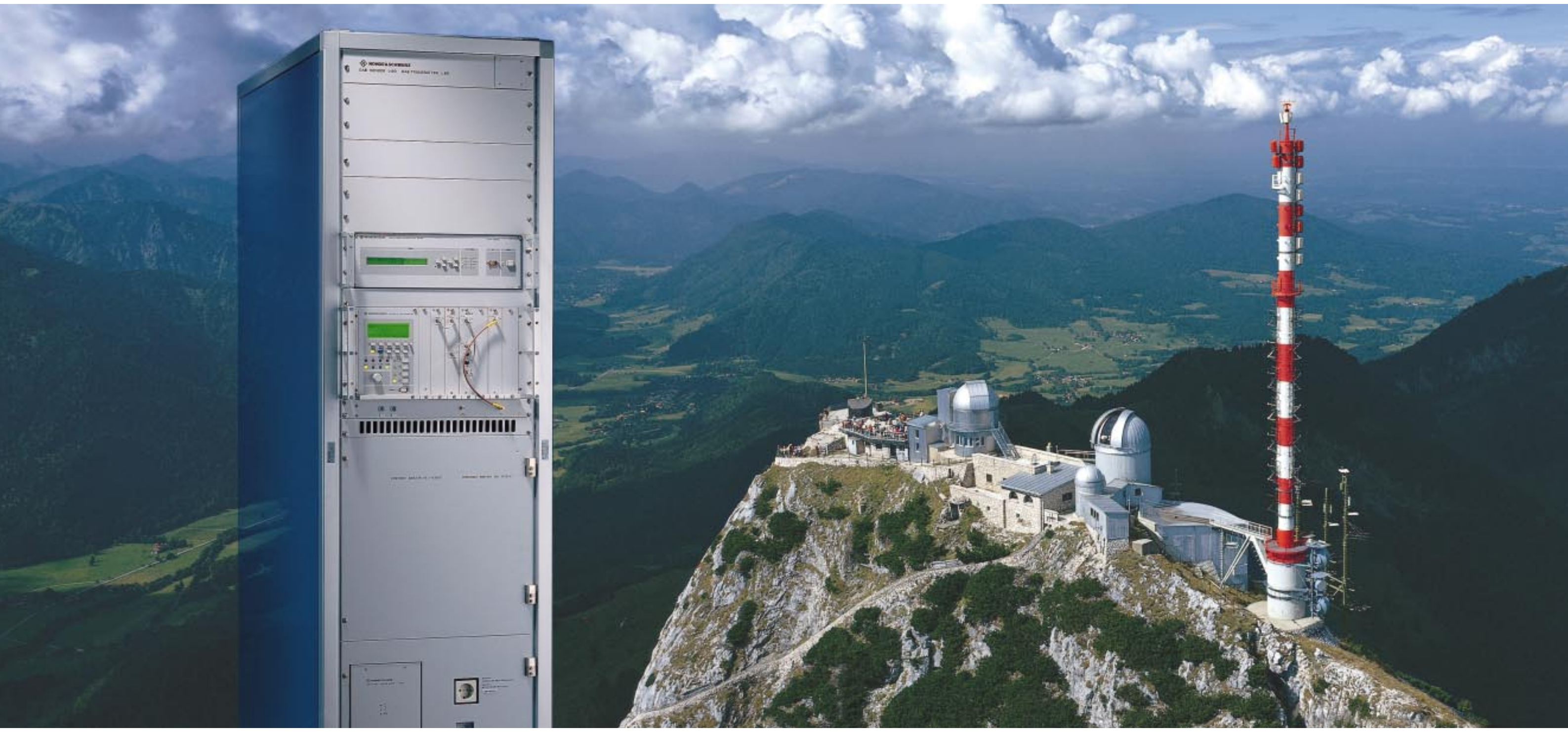


FIG 1 100-W Solid-State DAB Transmitter NL5010. 200-W model contains second amplifier module in transmitter rack. This type of transmitter has already been in use for more than one year at Wendelstein as part of world's largest DAB network. Photo 42 530

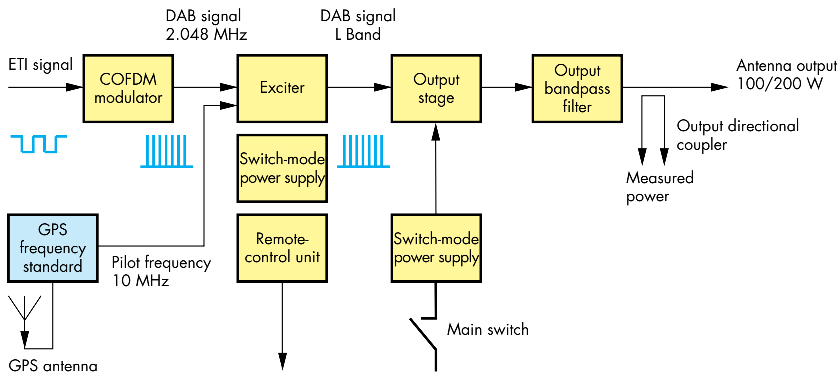


FIG 2 Block diagram of 100/200-W L-band transmitter

transmitter or via a power splitter in the 200-W transmitter.

Transmitter operation (eg on/off, power and frequency setting, deemphasis) is menu-guided and performed from the exciter using a backlit LCD and the keypad. The exciter also displays the status of all relevant transmitter functions and is used to monitor and control the transmitter. A remote-control unit includes floating contacts for transmitter switch-on and switch-off as well as for monitoring the operating status of the whole transmitter.

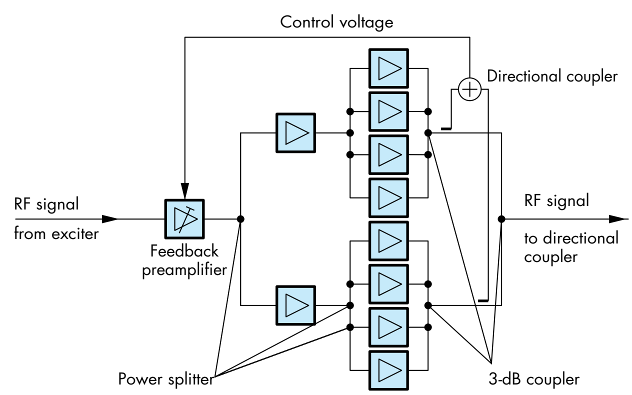
If the DAB transmitter is to be part of a single-frequency network (SFN), the required frequency stability of each transmitter ($\Delta f/f = \pm 1 \times 10^{-9}$) must be obtained from a highly accurate GPS frequency standard. This standard supplies a 10-MHz pilot frequency and makes the reference frequency available to any site within the network. A directional coupler at the antenna output feeds the RF test output and the forward and reflected power that is coupled out and displayed on the exciter.

The primary-switched power supply with self-engaging connectors provides all the voltages needed by the DAB transmitter. The power distributor contains a contactor for switching on the high-pressure fan and a phase monitor which sends the "power supply present" message for the transmitter's three-phase power supply. The high-pressure fan provides adequate cooling for the power supply and amplifier. All components are designed so that a fairly small, coarse air filter is sufficient.

DAB transmitter amplifier

The DAB signal is a multicarrier signal with its information in the relative phase of the $\pi/4$ DQPSK-modulated carriers. With certain information it is possible for many carriers to have the same phase. Carrier amplitude reinforcement occurs and, in critical cases, an exceptionally high input signal is applied to the output amplifier for a short period. The output amplifier must, therefore, be highly linear over the entire voltage swing so that intermodulation products inside and outside the useful frequency range are minimized.

FIG 3
Amplifier of Solid-State DAB Transmitter NL5010



To meet these requirements Rohde & Schwarz developed the solid-state L-band DAB Transmitter Amplifier VL5010. Even without an output bandpass filter, the compensated amplifier has intermodulation suppression of 30 dB. The RF signal from the exciter is routed via a preamplifier, a power splitter and two further amplifier stages each with four parallel push-pull amplifiers (FIG 3). At the output of these parallel circuits, a proportion of the power is coupled out by a directional coupler and fed to the gain control in the preamplifier. If a transistor in a particular module fails, protection circuits in the module prevent a power increase in the

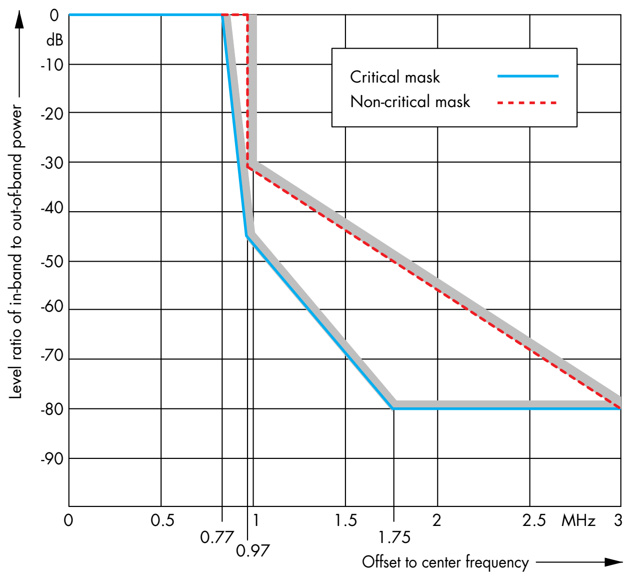


FIG 4 Specification for DAB emissions in L band (measurement bandwidth 4 kHz)

other modules. This ensures high reliability and a long service life for the whole amplifier. If the temperature at the specially designed aluminium heatsink is too high, a temperature sensor in each of the two parallel amplifier modules can switch off the carrier. A circulator at the output of each 100-W module protects the transistors in the transmitter amplifier if there is excessive mismatch.

Practical applications

In July 1995 the participants in the T-DAB planning meeting in Wiesbaden finalized frequency and band allocations for terrestrial DAB. All DAB transmitters from Rohde & Schwarz operate in the approved frequency ranges of 174 to 240 MHz and 1452 to 1492 MHz. However, transmitters are also available for the ranges 47 to 68 MHz and 87.5 to 108 MHz to cover the whole frequency range used by DAB transmitters. Thanks to a four-section output bandpass filter, the new DAB solid-state transmitter has no problems with the tolerance mask specified for its frequency range (FIG 4). This mask stipulates the maximum level for emissions outside the frequency band occupied by the carriers.

In autumn 1995, the first European DAB pilot project was launched in Bavaria [4]. Since then Rohde & Schwarz transmitters have been demonstrating their excellent quality and flexibility as stand-alones or as part of single-frequency networks far beyond the borders of Bavaria and Germany. Thanks to the company's high level of expertise in the field of DAB, Rohde & Schwarz has participated as a system and component supplier in all DAB projects to date (ARD pilot project, Deutsche Telekom, Australia, Switzerland, Sweden, etc) and so has made a major contribution to their success.

Rainer Steen; Johannes Steffens

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Condensed data of 100/200-W Solid-State DAB Transmitter NL5010/5020

Frequency range	L band, 1452 to 1492 MHz
Input signal	ETI version 4.0
Output signal	to ETS300401
RF output power	100 W (NL5010)/200 W (NL5020)
Intermodulation suppression (f_o > ±977 kHz)	>30 dB
Max. frequency error without/with GPS unit	$1 \times 10^{-7}/1 \times 10^{-9}$
Line voltage	3 x 400 V ±15%
Power consumption	1.3/2.3 kW
Cooling air intake	approx. 7/13 m^3/min
Dimensions (W x H x D)	583 mm x 2026 mm x 1000 mm
Weight	approx. 275/310 kg

Reader service card 152/08

TV Transmitter Test System TS6140

Guarantee of high signal quality in TV transmitter networks

Does a TV transmitter comply with standard specifications? Is it possible to measure individual parameters during servicing? Can operating errors be avoided during servicing? These are questions which a TV network operator may ask. Rohde & Schwarz answers: no problem with TV Transmitter Test System TS6140, the fourth generation of R&S test systems for television.

High-grade test equipment is indispensable for putting TV transmitters into service and maintaining them to ensure that the highest transmission quality can always be obtained. In addition to ITS systems for on-air monitoring of TV transmitters, Rohde & Schwarz now offers TV Transmitter Test System TS6140 (FIG 1), based on Test System UCMF [1], for extensive, full-field transmission characteristic measurements off air. It is a reliable and easy to operate test system that has full-featured manual operation but also computer-aided test programs to simplify operation and prevent incorrect measurements.

Method of operation and design

TV Transmitter Test System TS6140 has all the features required for measuring the transmission characteristics of a TV transmitter to German standard specifications [2; 3] (FIG 2). In Signal Selector MFA703 the connections for the video and audio signals to and from the TV transmitter are made, the measuring instruments are configured and the RF and IF links between the test system and the transmitter are set up, depending on the measurement task. It also compensates for frequency response of the test cables. The TV transmitter is connected by means of cabling which can also be used for alternative DUTs (eg test demodulator or relay receiver). Inputs and outputs provided for video and audio signals on the front panel are used for testing individual units or PC boards, eg for repairs. These connections can also be reconfigured with the signal selector. All units are connected to Process Controller PSM7 via interfaces

FIG 1 Mobile version of TV Transmitter Test System TS6140 for comprehensive off-air vision and sound measurements
Photo 42 486

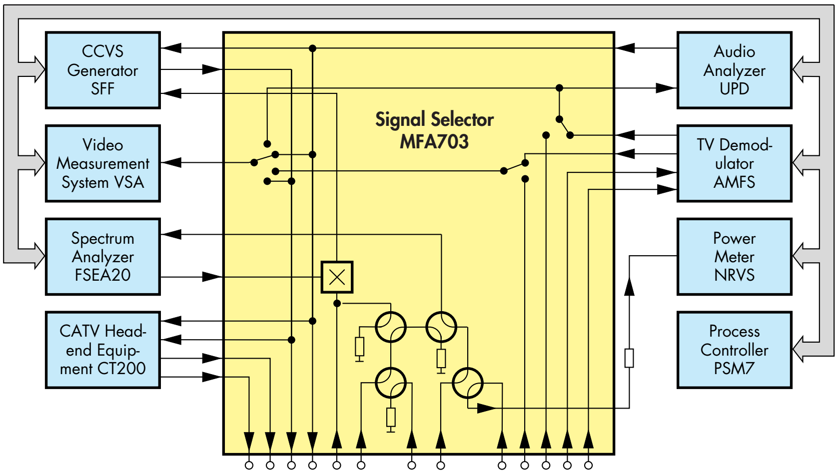

FIG 2 Block diagram of TV Transmitter Test System TS6140

(IEC/IEEE bus, serial interfaces) to control the test and output the results. The flexible system concept means that customer-specific tasks can be accommodated.

Characteristics and applications

TV Transmitter Test System TS6140 is menu-controlled via the process controller. The **operating program** was developed as an application under Microsoft Windows; its graphics user interface provides a powerful user-friendly operating environment. TS6140 can, of course, be manually operated to perform one-shot measurements. Signal-path switching is carried out from Operating Panel MFA801 or via the process controller's graphics user interface. The signal paths are displayed clearly as symbols and block diagrams. Connection is made immediately when the path is clicked with a mouse. The measuring instruments are set from the front panel and test results are evaluated via the front-panel display of each instrument.

The operator can also use **computer-aided measurement** for service procedures. He selects the measurement item from a menu of ready-to-run measurements and performs it interactively helped by the computer. The appropriate parameters are set via the graphics user interface (FIG 3). Depending on the task, the computer can handle device settings, signal path switching and choose a display mode for the test results.

The results of each measurement are stored in a database on harddisk and can be exported to a floppy disk. Comments can be added to each measurement and printed out at a later date.

TV Transmitter Test System TS6140 can also support acceptance tests or be used to document the condition of equipment before and after repair work performed with **automatic measurements.** The operator selects the measurements to be carried out from a table and specifies how the data are to be handled (storage, printing). After confirmation of the settings, the measurements are run automatically in the selected order. The parameters (testpoint, vision signal, etc) can also be configured separately. The automatic measurements handle all aspects of acceptance testing for TV transmitters covered in standard specifications. The comprehensive help function, specially designed for TS6140, can be called from any mode and so, in effect, is an online operating manual.

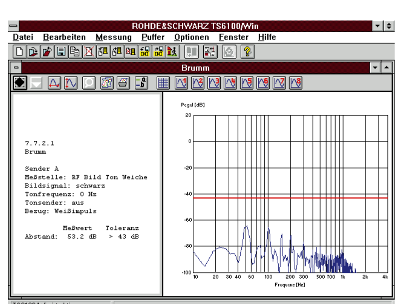

FIG 3 Operating program for one-shot measurement

Special test facilities

TS6140 provides a **number of new features** that earlier generations of TV transmitter test systems did not have:

- Measurements can be made not only on the TV transmitter but also on the test demodulator, relay receiver, transposer and VF amplifier.
- Vision-Sound Modulator CT200-VS together with Sound-2 Coder-Modulator CT200-S2 and Upconverter CT200-UP generates the required IF and RF test signals.
- Power Meter NRVS and Peak Power Sensor NRVS-Z31 accurately and rapidly measure the maximum available envelope power of periodically pulsed RF signals into 50 Ω and are used for direct measurement of peak envelope power. Coupling and line losses are taken into account and corrected.
- Spectrum Analyzer FSEA20 [4] with its tracking generator provides the analyzer mode and can also perform frequency measurements. The frequency counter can be synchronized to an external reference and resolution set down to 0.1 Hz. The analyzer resolution bandwidth can be selected in 1, 2, 3, 5 steps from 10 Hz to 10 MHz, the dynamic range is 95 dB. The RF and VF amplitude-frequency responses can be measured with FSEA20 and the mixer in MFA703.

- Audio Analyzer UPD [5] measures dual-sound operating data. The switchable weighting filters allow measurement of weighted and unweighted S/N ratios to DIN/CCIR, the tracking bandpass is used for measuring stereo and channel crosstalk and the distortion meter for determining total harmonic distortion and the distortion for single harmonics.
- Video Measurement System VSA [6] is used to measure signals in the time domain and to determine group delay. The video and FFT analyzer of VSA simultaneously computes up to 150 parameters from the input signal. Analysis of the sin x/x signal frequency spectrum calculated with FFT gives the group delay curve.

Westdeutscher Rundfunk was the first transmitter network operator to use the modern TV Transmitter Test System TS6140. It has been in operation for several months at three sites and this system will soon be installed in six other transmitter stations and a test laboratory.

Walter Deschler; Gerhard Strauss

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Test parameters covered by TV Transmitter Test System TS6140

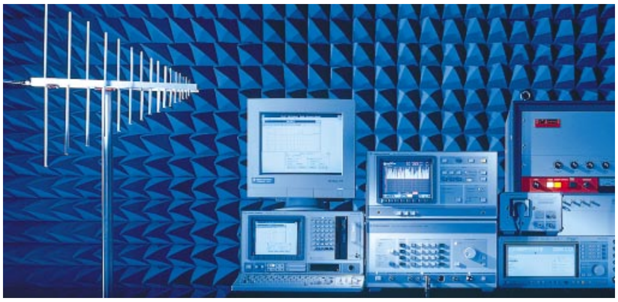
Measurements on vision transmitters	transmitting power, vision-sound ratio, frequency, spurious emissions, level, amplitude-frequency response, VF group delay, tilt, settling time, luminance nonlinearity, chrominance nonlinearity, difference-frequency distortion, phase deviation of vision carrier, intermodulation, unwanted modulation, intercarrier interference ratio
Measurements on sound transmitters	frequency deviation (levelling), differential deviation, amplitude-frequency response, preemphasis, stereo and channel crosstalk, THD and difference-frequency distortion, unwanted FM modulation, polarity

Reader service card 152/09

EMC system solutions: We watch the rule

This was the motto of a comprehensive PR campaign Siemens Matsushita Components started in the leadup to 1 January 1996, the date as of which electronic products irrevocably had to comply with German EMC legislation. The range of EMC test equipment, accessories and software packages has become larger, and small- and medium-sized companies now have the possibility of performing at least some EMC measurements using their own personnel and equipment. The focus in one of the ads by which Siemens Matsushita Components presented its EMC product line is an EMC test assembly from Rohde & Schwarz (photo). This assembly comprises a test antenna, a PC with test software (left), a test receiver (center) as well as a signal generator, an artificial mains network and a power amplifier (right, from bottom).

Rohde & Schwarz is the pacemaker and world-market leader in EMC compliance test engineering. Participation in international standardization bodies ensures that hardware and software are always in conformance with the relevant standards. The company's competence and efficiency is also underscored by the fact that Europe's largest EMC test center in Greding was designed, equipped and handed over turnkey by Rohde & Schwarz and that practically all renowned firms in the automobile and electronics industry rely upon support and products from Rohde & Schwarz. Rohde & Schwarz offers test receivers, spectrum analyzers, signal generators, amplifiers and antennas for measuring interference and electromagnetic susceptibility of machines, vehicles and the like. Sö



VHF-UHF Direction Finder DDF190

Digital direction finding from 20 to 3000 MHz to ITU guidelines

DDF190, the youngest member of the new digital DF family, has now been launched on the market. This compact DF add-on for VHF-UHF receivers is available at an extremely favourable price. It operates on the correlation principle and is mainly used for locating sources of interference and unauthorized emitters.

FIG 1 DF and monitoring vehicle with VHF-UHF Direction Finder DDF190. With its upper frequency of 3 GHz, DDF190 can also detect sources of interference affecting new radio services (eg GSM, PCN, PCS, WLL and GPS).
Photo 42 572

Digital signal processing coupled with innovative RF technology has set new standards in many fields and direction finding is one of them. DDF190, a fully remote-controlled **DF add-on for commercial receivers** with an unregulated 10.7-Hz or 21.4-MHz IF output follows on from the fast Scanning Direction Finder DDF0xS [1] and Monitoring Direction Finder DDF0xM [2]. ESMC and ESN from the Rohde & Schwarz receiver program are ideal for use with DDF190, which is a very cost-effective way of adding an extremely broadband direction finder to high-quality measuring and monitoring systems.

DDF190's design meets the recommendations in the ITU Spectrum Monitoring Handbook [3]. The wide frequency range from 20 to 3000 MHz and high system accuracy make DDF190 ideal for civil radiomonitoring tasks. Thanks to its compact design it can be used for **mobile** as well as **stationary** applications (FIG 1). Since DDF190 is also system-compatible, it can be used as a **stand-alone unit** or be **networked** for a variety of system applications. The whole frequency range is covered with just two antennas. Since only one coaxial cable and control cable are required to connect up DF Unit EBD190, installation is simple and low-cost. The direction finder can, of course, be powered from a battery or the AC supply. In both cases the DF unit provides the supply voltage for the active antennas. When used for stationary applications, the antennas can be located up to 95 m from the DF unit using the standard cable sets. For cables longer than 40 m an additional power supply unit is provided.

Direction Finder DDF190 operates as a **correlative interferometer** and can handle all types of modulation. The direction finding procedure makes use of digital signal processing. The phase differences between the antenna voltages generated by the signal received by the antennas are compared with reference values and then checked for maximum correlation. The advantage of this DF method is that, because antenna elements do not need to be grouped into subarrays, wide-aperture DF antennas can be used covering large frequency ranges with a minimum number of antenna elements.

Operation

DF Unit EBD 190 is operated using a clearly laid-out front panel keypad and a large LCD (FIG 3). All functions required during operation are under direct key control. The receiver is operated separately, but the interfaces for antenna range selection are supported. Since direction finding is performed by sequential scanning of the DF elements, and only one receiver is used, switching noise is produced in the AF signal of the receiver. To eliminate this noise when aural monitoring is being performed, scanning and so direction finding may be switched off. Selectable averaging times (0.1 to 5 s) and matched filtering in DDF 190 (1 to 100 kHz) considerably improve bearing accuracy – particularly in the case of noisy signals or signals with interference.

Three operating modes and two display modes optimize direction finding for various applications.

In **normal mode** the DF process is controlled by a selectable squelch threshold which is compared with the currently received, relative IF level. It is best to

FIG 2 DDF190 upgrades VHF-UHF receivers to top-end DF system – with accuracy and sensitivity above 1 GHz unrivalled by any other compact unit. Photo 42 571/1

use this mode for monitoring radio networks or simplex communication. Bearings of short-duration signals (minimum 50 ms) can also be taken. As the selected averaging is cancelled at the end of a signal, the bearing display follows the changing directions of incidence without any delay.

In **continuous mode** direction finding is performed continuously. With sliding averaging, the display is updated every 0.5 s. This means that direction finding can be performed on weak signals or signals with a very large bandwidth.

The **gate mode** is used for bearings on keyed transmitters as the squelch threshold is also activated but the averaging memory is not cleared if the signal is below the threshold. Integration over many pulses is therefore possible.

The **DF display** comprises a three-digit number and a radius for indicating direction. The DF quality, derived from the correlation function, is displayed with each DF value. For stationary applications, a compass with north adjustment is used as a reference and the vehicle axis for mobile applications. The latter is crucial when the vehicle is being used for homing. In this case a compass is also used to continuously indicate where north is with respect to the vehicle. Vector direction finding with QDM as used in air traffic control can also be selected.

In each of these modes DF values can also be displayed as a **histogram** in addition to the display mode already referred to. This is very useful for analyzing communication networks: all DF values obtained since this display mode was activated are displayed as rays, the length of each ray being a measure of the frequency of occurrence of the bearing angle it represents. Results can also be displayed and printed out as lists. Postprocessing functions like smoothing, determination of local maxima and sorting support histogram analysis.

On power up of the direction finder, the **system environment** (antennas, class of receiver, compass) is automatically determined. A realtime clock outputs a time marker for each bearing taken. This facilitates bearing/emitter assignment in networked DF and radiolocation systems.

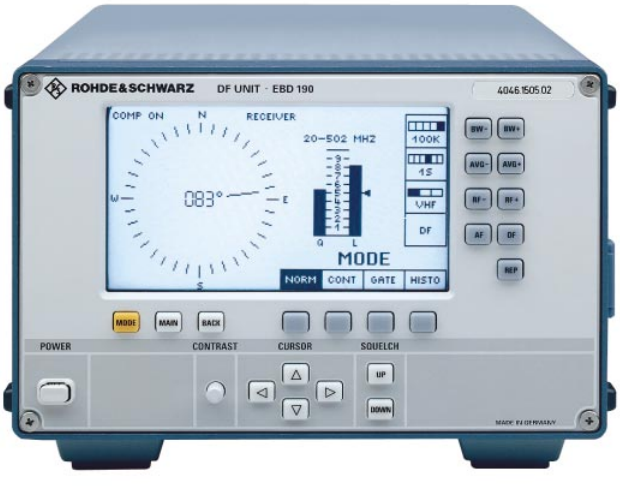


FIG 3 Front view of DF Unit EBD190 Photo 42 473

FIG 4
Antennas ADD190 (top) and ADD071 on common mast
Photo 42 477/1

Antennas

The range **20 to 1300 MHz** is covered by **Antenna ADD190.** Its small diameter of only 1 m and the uncriticality of polarization make the antenna ideal for mobile applications although it also has considerable advantages in stationary use. Thanks to its small size, it is unobtrusive, protected as standard against direct lightning strikes and can withstand wind speeds of 200 km/h.

Antenna ADD071 is provided for the UHF range **1.3 to 3 GHz.** Designed as a circular array of dipoles in front of a reflector, ADD071 may be fitted on the same mast as ADD190 (FIG 4). This combination is already available as standard.

An electronic compass add-on may be fixed to the antennas for automatic direction finding referred to north.

System compatibility

DF Unit EBD190 provides remote control via a serial RS-232-C interface. Remote control (virtual control panel) is identical to front-panel operation. The DF unit also provides an RS-422/ RS-485 and a TTL parallel interface for the connected receiver. Character sequences for receiver control are passed on by the DF unit. Compact commands and configurable message formats reduce the required communication capacity to a minimum. Two modes using a minimum number of messages are provided in addition to the three operating modes: timed single and repetitive DF. An external control input is provided for a radio modem; this does not affect direction finding in any way (internal transmitter suppression).

To create larger systems with DF stations at any location, Rohde & Schwarz offers comprehensive solutions into which DDF190 can be directly integrated. Radiomonitoring System TS9965 [4] provides fully automatic monitoring, measurements and analysis to CCIR and ITU recommendations. In the DF measurement mode, results from several DF stations can be handled and marked on a digitized map. Within this system, DDF190 may be connected to receivers with IEC/IEEE-bus control in unmanned stations. Channel and frequency scans are also supported. The Radiolocation System RAMON-locate [5] was designed to accommodate the DDF190/ESMC combination.

Franz Demmel; Raimund Wille

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Condensed data of VHF-UHF Direction Finder DDF190

Frequency range (depending on receiver and DF antenna)	VHF/UHF (20 to 1300 MHz) UHF (1.3 to 3 GHz)
DF error	2° rms (30 to 80 MHz) 1° rms (80 to 1300 MHz) 2° rms (1.3 to 2.7 GHz)
DF sensitivity VHF/UHF UHF	frequency-dependent 1.5 to 10 μV/m 3 to 10 μV/m
Minimum signal duration	approx. 50 ms
Bandwidths	1/2.5/8/25/100 kHz

Reader service card 152/10

EMC measurements up to 40 GHz with Microwave Signal Generator SMP

Apart from an RF signal of high spectral purity and precisely adjustable output power, signal generators for EMC measurements require top-quality AM and pulse modulation, spike-free frequency and level sweeps and last but not least a mature operating concept permitting automatic measurement sequences to be performed with or without an external controller. The microwave generators from the SMP family set the standards – as do all other signal generators from Rohde & Schwarz. Four models and a comprehensive range of options are available from which the user may choose the equipment he needs – tailored to his specific requirements – at an excellent and unrivalled price/performance ratio [1 to 3].

FIG 1 Signal Generator SMP and GTEM (gigahertz transverse electromagnetic) cell – an up-to-date combination for susceptibility measurements Photo 42 574

The term **electromagnetic compatibility** (EMC) is very apt: if people are compatible they can work together easily and effectively without anyone disturbing anyone else, and the same applies to electrical devices. Certain ground rules must be observed in any partnership and this is why EMC standards and suitable measuring instruments were developed at a very early stage. However, the frequency range did not go beyond 1 GHz as this was all that was required for all the main activities of modern radiocommunication. The range beyond 1 GHz was generally reserved for military and scientific applications.

The need for EMC testing has always been appreciated by forward-looking manufacturers of top-quality electronic devices and systems. The end of the transition period for the CE mark at the beginning of this year would not have been a reason to implement any major changes as EMC awareness was already considered good practice. The **EMC test equipment** used today derives from equipment for military applications, where sensitive receivers, powerful transmitters and noisy engines have always had to operate in close proximity without interfering with one another. Compatibility principles were, therefore, defined and appropriate test equipment developed. Adapted to present-day requirements, these principles are now the basis of current national and international EMC regulations.

As said already, mature **standards and test specifications** are currently available for civil and military applications in the range up to 1 GHz. Military standards still apply to higher frequencies, although lately more and more civil applications are transferring to this range. Examples can be found in satellite communications as well as in automobile and aeronautical engineering. It can be assumed, therefore, that standards for EMC tests will be extended to 40 GHz in the near future. New top-class technology at an affordable price will obviously be required

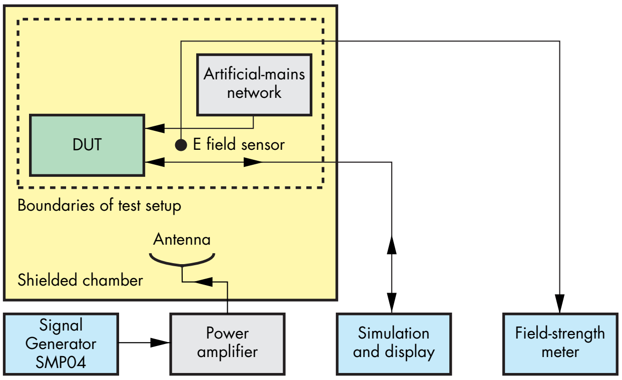

FIG 2 Measurement of immunity to radiated interference from 1 to 40 GHz using Signal Generator SMP (to MIL-STD-462D). Signal Generator SMP04 (10 MHz to 40 GHz) is used as stimulator, EMI Test Receiver ESMI with Harmonic Mixer FS-Z40 for display purposes and field-strength measurements.

Selection of currently valid military and civil EMC standards for the microwave range

Standard	Designation	Description	Microwave range	Application
MIL-STD-461D/462D RES103	Radiated Emissions, Antenna Spurious and Harmonic Outputs	Measurement of harmonics and spurious emissions from antennas	1 to 40 GHz	Military (USA)
MIL-STD-461D/462D RES103	Radiated Susceptibility, Electric Fields	Measurement of immunity to radiated RFI (electric field)	1 to 40 GHz	Military (USA)
DEF STAN 59-41 (PART 3), DRS03	Radiated Susceptibility	Measurement of immunity to radiated RFI	0.79 to 18 GHz	Military (UK)
VG 95 370/VG 95 373, Teil 13, Messverfahren SF 04 G	Messverfahren für Störsicherheitsabstände gegenüber systemeigenen Feldstärken	Measurement of immunity to radiated RFI	1 to 40 GHz	Military (Germany)
SAEJ1113 Part 21	Semi-anechoic Chamber	Measurement of immunity to radiated RFI	0.03 to 18 GHz	Vehicle test (USA)
ISO 11451-2/ ISO 11452-2	Road vehicles – Electrical disturbances by narrowband radiated electromagnetic energy – vehicle test methods – Part 2: Off-vehicle radiation sources	Measurement of immunity to radiated RFI	0.2 to 18 GHz	Vehicle test (international)
EN 50083-2	Cabled distribution systems for television and sound signals – Part 2: Electromagnetic compatibility for equipment	Measurement of radiated interference (substitution method)	1 to 25 GHz	Telecommunications, TV and sound broadcasting (Europe)

and is already available in the form of generator family SMP (FIG 1) from Rohde & Schwarz with models from 10 MHz/2 GHz to 20, 27 and 40 GHz. The table in the blue box gives a selection of current military and civil EMC standards covering 1 to 40 GHz.

A glance at the standards shows the main fields of application for microwave signal generators. First, there are **measurements of immunity to radiated interference** – also known as susceptibility measurements. In this case the signal generator usually drives a power amplifier with an appropriate bandwidth connected to an antenna emitting the signals for irradiating the DUT (FIG 2). Depending on the requirements, the DUT's functions should not be impaired at all or only within certain defined limits. In particular, there may be DUT resonances at the high-frequency end of the microwave band: small slits in the housing or short line structures in circuits or on PCBs may act as high-Q resonators and cause total failure in an extremely narrow frequency range. Thanks to SMP's digital sweep such resonance points can be rapidly and reliably detected, the smallest settable increment being 0.1 Hz. The excellent frequency stability also ensures that measurements can be reproduced. Any DUT malfunction can be found and demonstrated at a later date. Another important advantage of the SMP sweep is that there are no level spikes. Level spikes may destroy any power amplifier down-stream or even the DUT and will certainly cause measurement errors.

Another main application of microwave signal generators is the **calibration of test setups,** as shown in FIG 3. Prior to the actual measurement, the signal generator is used to calibrate the level display of the test receiver. Obviously, the accuracy and stability of the generator level have to meet stringent requirements. Thanks to an overdesigned ALC system and careful instrument calibration in the factory, this is no problem for generators from the SMP family. The test receiver used in test setups like that shown in FIG 3 can also be calibrated by applying the generator signal to the receiver via an antenna and not via a cable [2]. This means that the transfer characteristics of the receiving antenna are also taken into account.

Normally, frequency drifts in RF cables, power amplifiers and the antenna of the test setup cause considerable level errors. This cannot be avoided in spite of the excellent level accuracy of SMP (typical error 0.1 dB). Fortunately, SMP does have a number of **functions for frequency response correction:**

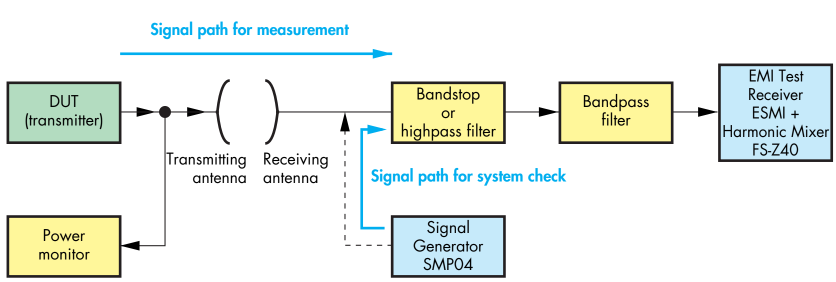

FIG 3 Measurement of radiated harmonics and spurious from 1 to 40 GHz to MIL-STD-462D using Signal Generator SMP and EMI Test Receiver ESMI

- user correction for a user-defined RF frequency response,
- memory sequence, a programmable sequence of complete front-panel setups,
- list mode, a programmable sequence of up to 2003 frequency/level pairs,
- and, last but not least, external level control using an external power meter [4].

When SMP is operated manually, ie without an external controller, it is best to use the user correction function to correct the overall frequency response. If a Power Meter NRVS or NRVD is available, the required correction values can be determined automatically by means of a keystroke. Programmers of automatic test systems prefer direct frequency response correction via IEC/IEEE bus using the controller. In this case, level control is performed by SMP's ALC, giving resolution of 0.01 dB. The actual value is determined by means of a power meter with directional coupler at the antenna input or via a field-strength sensor near the DUT.

The above examples clearly show that SMP, a powerful, future-oriented and favourably priced instrument from a manufacturer with decades of experience in all fields of EMC measurements, is the right solution to any EMC measurement problem between 10 MHz and 40 GHz.

Wilhelm Kraemer

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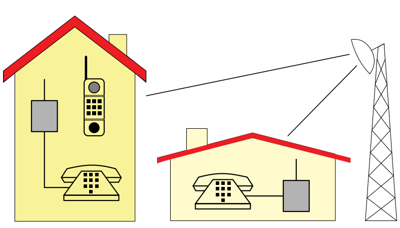
Reader service card 152/11

Test hint

Optimizing wireless local loop systems

DECT is not only used for classic applications such as domestic cordless phones, but is also considered a solution for making the last step in the implementation of new telecommunications networks. This application called WLL (wireless local loop) is at present being tested in various field trials. Other than with GSM, DECT frequencies are not allocated to a specific operator but can be used by every type-approved DECT application. Consequently, the DECT frequency band has to be shared with DECT units working in an uncoordinated manner. The DECT standard allows for this by defining dynamic channel selection (DCS) and associated handover procedures that switch over to other channels in case of interference or sliding collisions to ensure interruption-free communication.

The algorithm for dynamic channel selection has not been defined exactly. The solutions are manufacturer-specific and not disclosed to the public. The traffic capacity specified for DECT, which is high in comparison with GSM, is based on theoretical considerations assuming an optimum DCS algorithm. To attain the specified value under real-world conditions, not only well-proven DCS algorithms but also geographical conditions have to be utilized optimally (eg by means of directional antennas at the transmitter and receiver end).



DECT Protocol Tester TS1220 (see News from Rohde & Schwarz No. 148) supports the operators of DECT WLL networks both in the assessment of DCS algorithms and the optimal positioning of antennas. In the monitoring mode the system synchronizes itself to a user-defined DECT fixed part and logs all data packets exchanged with portable parts via the air interface without intervening with the DECT network. On the basis of the data collected, failed or successful handover and communication attempts as well as occupied channels can be detected. Thus the operator can draw conclusions about the strong and weak points of channel selection algorithms.

In addition, the optional channel occupancy software informs the user about the receive levels measured on all DECT channels (RSSI value) and about the origin of the signals received. The signals might originate from coordinated or uncoordinated DECT units and non-identifiable interference sources (FIG). The physical parameters of the DECT signals and the identities exchanged are also indicated, so the signals can very easily be allocated to sources inside or outside the network. Moreover, the option allows antenna positions to be optimized using the RSSI values which are referred to the identities displayed. TS1220 can either be installed in a vehicle for mobile use and operated with its own height-adjustable antenna. Or it can be connected direct to the antennas used in the network.

Marcus Gloger; Peter Riedel

Reader service card 152/12 for further information on TS1220

Measurements on hearing aids with Audio Analyzers UPD and UPL

FIG 1 Audio Analyzer UPD – ideal for standard tests on hearing aids Photo 41 956

The ear is an extremely sensitive organ. If healthy, it is capable of processing sounds with an extremely wide dynamic range. Nevertheless, it can easily be damaged by longterm exposure to, say, industrial noise or excessive noise levels in discos or from walkmen. As the effect on hearing is often only noticed later on, there is an increasing number of young people with hearing defects that have to be corrected with a hearing aid.

Hearing defects are caused by a wide range of impairments of the hearing capacity, for example by frequency-dependent sensitivity losses in specific frequency ranges or by a shifting of the complete sensitivity curve. Modern hearing aids must, therefore, be capable of compensating for a variety of defects, and a precise determination of their electroacoustic characteristics is essential.

There are several national and international **standards** (eg IEC 118 Parts 0 to 12 and ANSI S3.22) that define measurements on hearing aids using sinusoidal tones. Further standards (eg ANSI S3.42) defining measurements on hearing aids using a broadband noise signal are in preparation. For the latter type of measurements, a signal with precisely defined frequency distribution and crest factor will be generated and the correlation between the output signal of the hearing aid and the input signal determined. Manufacturers of hearing aids, especially those supplying the US market, will shortly be obliged to test their products to these standards. With its Audio Analyzer UPD [1] and High-Speed Option UPD-B3, Rohde & Schwarz can already provide the test and measuring equipment required.

Special application programs for Audio Analyzers UPD and UPL [2] make it possible to perform measurements on hearing aids to IEC 118 and ANSI S3.22. Measurements are performed in an acoustic test chamber, which may be an anechoic room or a small test chamber with appropriate damping. Commercial test microphones can be used, and the loudspeaker of the test chamber can be driven directly by UPD (FIG 1) or UPL if efficiency is sufficiently high. A coupler to IEC 126 or an ear simulator to IEC 711 can be used for connecting the microphone to the hearing aid. No further equipment is required except for a printer if the user wishes to log results.

The **application program** runs under the UPD or UPL universal sequence controller and is operated via softkeys or function keys on a keyboard. After starting the program, the user can select the standard according to which measurements are to be performed, ie ANSI S3.22 or IEC 118. Test settings are stored separately for each standard and are recalled each time the program is started.

The **measurement menu** of the application program offers the following **choice of settings and test functions:** CONFIG, DUT, FRQ-RESP, IN-OUT, DIST, NOISE, ATTACK, CALIB.

Prior to initial measurement, the microphones and test chamber must be calibrated using the **CALIB** menu item. The calibration data of the microphones and the frequency response of the test chamber are stored and taken into account automatically each time the program is restarted. After each calibration, the microphone data are added to a file named MICRO.HST. This file can be analyzed to verify the stability of the microphone data.

The parameters for the test steps are defined using the **CONFIG** menu item, for instance scaling for frequency response measurements, broadband or selective measurements, etc. The data are permanently stored and used in all subsequent measurements.

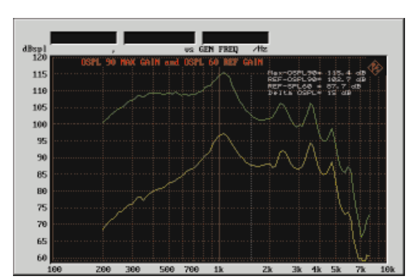


FIG 2 Frequency response of sound pressure saturation level of hearing aid at maximum gain, and output sound level with input sound level of 60 dB as reference

The DUT data are entered using the **DUT** menu item. These data are printed out with the result graphics.

One of the most important characteristics of a hearing aid is its frequency response: **FRQ-RESP** menu item. To measure the response, the hearing aid is first of all set to maximum gain and the output sound level measured at 90 dB sound pressure. This gives the sound pressure saturation curve. Next, the reference gain of the hearing aid is set and the frequency response measured at 60 dB or 50 dB sound pressure level, depending on the type of hearing aid. The resulting curve is displayed in the same diagram as the sound pressure saturation curve (FIG 2). On completion of the measurement, the user can rescale the Y axis as desired, display the frequency response curve as the acoustic gain curve and, in this display mode, generate further curves, for instance to determine the effect of frequency response controls by means of a set of curves. Results can be output using a HPGL printer, so providing documentation that meets the standards for official product approval.

The acoustic transfer characteristic – **IN-OUT** menu item – of a hearing aid is needed to correct sensitivity losses of the ear as a function of volume. How the transfer characteristic varies with frequency can be determined by performing measurements to obtain up to five traces (sound pressure level, gain or compression ratio) at selectable frequencies (FIG 3).

A hearing aid should output the amplified signal with as little distortion as possible if the original sound is to be reproduced as faithfully as possible. Using the **DIST** menu item, distortion of the acoustic signal is measured at 70 dB sound pressure level over the whole frequency range. The D2 and D3 distortion products are determined and displayed as curves in a diagram.

The gain of the hearing aid is needed to restore the original sensitivity of the ear as far as possible. Only the acoustic signal should be amplified, the inherent noise of the hearing aid being kept as low as possible. The **NOISE** measurement is made to determine the acoustic noise pressure output level of the hearing aid with no input. From these data and the gain of the hearing aid, the equivalent input noise pressure level can be calculated. Naturally, external noise must be sufficiently attenuated by the test chamber if this measurement is to produce useful results.

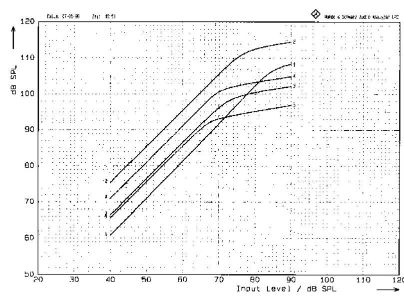


FIG 3 Output sound level vs input sound level of hearing aid at 500, 1000, 1600, 2500 and 4000 Hz

A characteristic of hearing aids that is particularly difficult to describe is the AGC response time. State-of-the-art hearing aids often have multistage control circuits with different time constants. For example, individual gain control or compression is applied to syllables, so the response time must be milliseconds. The **ATTACK** menu item is used to perform automatic measurements on the attack and release times of hearing aids with AGC. The test conditions can be user-defined. Attack and release curves are displayed and evaluated by the program, and the results output as numerical values. For the first time ever, a function has been implemented that provides an easy way of making measurements on and documenting the complex control response of hearing aids from fractions of milliseconds up to several seconds in one go.

Precise measurement of the electroacoustic characteristics of a hearing aid is essential if the development, production and quality management of the product are to be improved. This information is also vital for the case notes of patients whose hearing aids have been adapted to compensate for a specific hearing problem. Like other electromedical equipment, hearing aids must undergo type testing before they can be sold. In Germany, such tests are performed by the Physikalisch-Technische Bundesanstalt (Federal German Bureau of Standards) in Brunswick. This federal test agency uses Audio Analyzer UPD and the special application program to carry out type-approval tests on hearing aids. Every hearing aid manufacturer that uses Audio Analyzer UPD or UPL can be sure that he will meet all relevant technical requirements for type-approval tests.

Tilman Betz

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Reader service card 152/13

Quality testing of mobile phones using multitone audio analysis of Digital Radiocommunication Tester CMD

FIG 1 To handle more stringent quality requirements for GSM and DECT mobile stations, Digital Radiocommunication Tester CMD from Rohde & Schwarz was upgraded with powerful AF measurement functions. Photo 40 944/1

Europe is not the only place where digital GSM and DECT networks have flourished. Variations of these networks are taking hold all over the world, but the market is by no means saturated. Manufacturers of mobile phones still have to woo the customer to win orders. All manufacturers are able to supply the basic functions required for mobile operation and so customers now tend to go for features that can be assessed directly rather than the provision of basic features. Design and quality are features that can clinch a purchase. Using the right measurement technology has a positive effect on quality. From the outset, Rohde & Schwarz has designed its GSM and DECT production testers to guarantee quality at the RF interface [1; 2]. In the meantime, this has come to be thought of as a standard basic function. The situation is different as far as the AF interface of the mobile is concerned. Within the acceptable quality range, quality differences in the audio signal can be clearly discerned by the user and this may influence his decision to buy.

For this reason, Rohde & Schwarz has considerably upgraded the AF measurement capabilities of its GSM/DCS 1800/DCS 1900 and DECT radiocommunication testers. Multitone audio analysis has been added to functions such as AF generator, AF meter with rms and peak value meter, distortion meter and frequency counter. In the new measurement mode, CMD (FIG 1) generates up to 14 user-selectable frequencies in the range 50 Hz to 8 kHz with individually adjustable levels (can also be switched off). After the multifrequency signal has passed through the DUT, CMD performs narrowband voltage measurements at these frequencies.

Measurements

Fast frequency response measurement (FIG 2): the user selects 14 points on the frequency response curve and sets each frequency to the same level. Measuring the output levels of the DUT at these points gives the frequency response of the DUT. If there are frequencies which have passed through the DUT and are far below the possible measurement limits, the measurement range for these particular frequencies can be extended by increasing the level on the generator side. Since all frequencies are measured simultaneously, the frequency response measurement is fast in spite of the narrow measurement bandwidth (approx. 2 s at 1 Hz). This measurement is a good choice for noisy production environments as most of the external noise is excluded thanks to the narrow measurement bandwidth.

True harmonic distortion measurement: the distortion measurement performed up to now was in fact a SINAD measurement, ie the total signal is referenced to a signal from which the fundamental has been removed. With multitone audio analysis individual harmonics can be singled out. The fundamental frequency at a certain level is set on the signal generator. Then up to 13 harmonics are chosen with the signal generator switched off. On the output side, narrowband measurements on all the frequencies provide information about the whole harmonic spectrum.

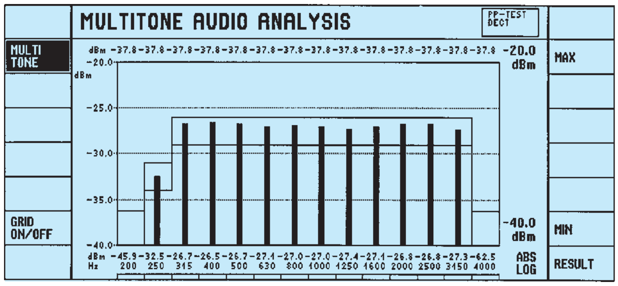

FIG 2 AF frequency response. Results from multitone audio analysis are always displayed as bargraphs. Bars represent points selected on DUT's AF frequency response.

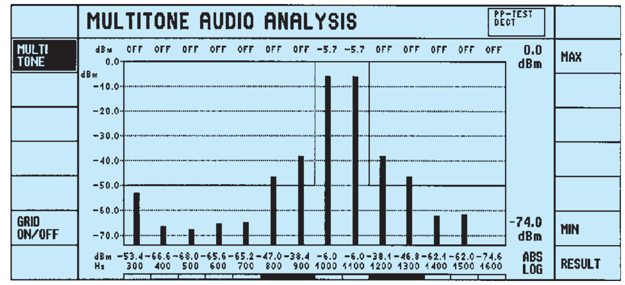

FIG 3 AF intermodulation measurement. Two larger bars represent test tones, smaller ones at right and left unwanted intermodulation products measured by CMD at high speed over wide dynamic range.

Intermodulation measurement (FIG 3): like distortion measurement, this measurement too is used to check the linearity of the DUT. Two test tones instead of one are used in this case, however. The intermodulation products occur at precisely predictable frequencies which are a function of the two test tones. Consequently, a level is assigned to two of the frequencies and the others are set to the expected intermodulation frequencies with no generator signal present.

Aliasing products: prior to transmitting analog voice signals in a range from 300 Hz to 3.3 kHz on the digital network, the signals are sampled at a rate of 8 kHz. Frequency components above 4 kHz must not reach the sampler as otherwise unwanted aliasing products would be produced. Knowing the test frequency and the sampling frequency, the aliasing frequency can be determined precisely. The level is then measured at these points.

Control and operation

Signal paths (FIG 4): CMD's AF interface with its new multitone analysis facilities and the "old" AF test functions with generator and analyzer can be connected to the front-panel connectors or to CMD's ADPCM interface for DECT applications. If CMD is equipped with a Speech Encoder/Decoder CMD-B5 for GSM, the AF interface may be internally switched to this option.

Operating modes: in the single-shot mode, the generator can be started before the analyzer to allow the DUT to settle completely before the measurement is started. Normally the continuous measurement mode is chosen for manual operation, results being updated every second. If the operator suspects that there is an out-of-tolerance condition, continuous measurement can be stopped to examine the outlier more closely.

Analysis using tolerances: as with any other CMD result, tolerances may be set for the results obtained from multitone audio analysis on a go/nogo basis. With the aid of this function, a single go/nogo outcome can be obtained from every group of 14 results – in other words, a single, accurate conclusive result can be obtained from a complex measurement.

Result display: the great variety of display and scaling modes – tailored to specific measurement tasks – makes reading of results easy and simplifies their interpretation. Any signal generator level may be used as a reference for the measurements or an independent reference value can be defined. As appropriate, log or linear scales may be chosen on CMD.

Thomas Maucksch

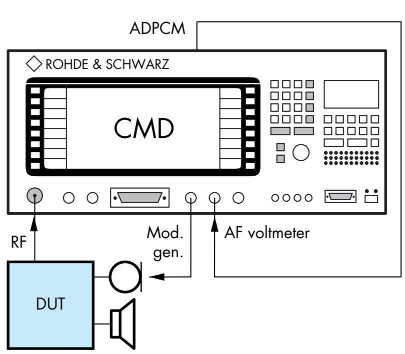

FIG 4 Setup for measuring frequency response, distortion, intermodulation and aliasing in microphone path of DUT (here DECT portable part). Similar setup is used for measurements in loudspeaker path.

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Reader service card 152/14

Tailor-made applications in industrial automation with factory user port for Controller PSM

FIG 1 Industrial Controller PSM is ideal for automatic test facilities. Photo 41 488/1

Automatic testing often requires only relatively simple functions for setting and evaluating a DUT, eg a mobile phone. For these purposes Industrial Controller PSM (FIG 1) [1; 2] is equipped to standard with the factory user port (FUP), a universal interface. This means that a multitude of applications can be implemented without any additional hardware. The supplied software library considerably reduces the time required to become familiar with the FUP and its operation.

Function blocks

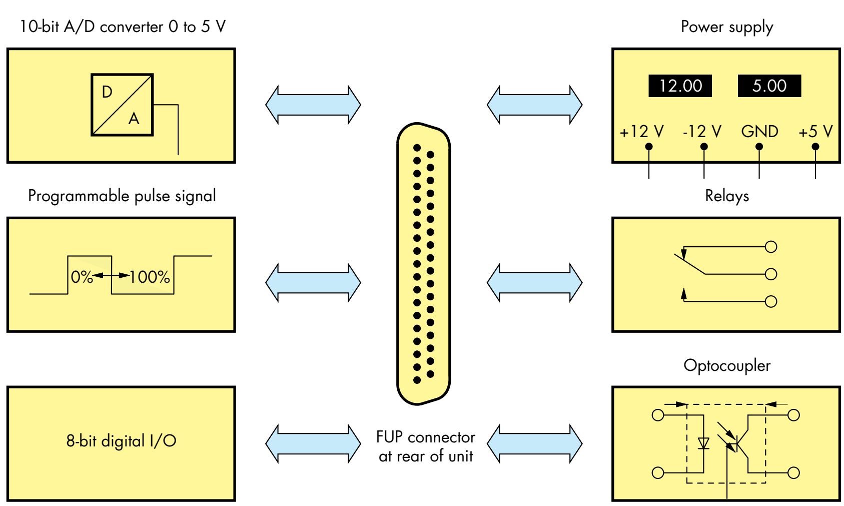
The factory user port provides the following **functions** for use with external equipment (FIG 2):

- 10-bit A/D converter, four channels, 0 to 5 V,
- eight digital inputs and outputs,
- pulse width modulator which can also be used as an analog output,
- optocoupler input,
- optocoupler output,
- two relays, each with a changeover switch,
- supply voltages for external circuits.

A microcontroller controls all these functions. It is connected to the ISA bus in PSM, from where it can be conveniently operated via the FUP software interface using the following **languages:**

- R&S BASIC,
- Microsoft VisualBASIC for DOS,
- Microsoft VisualBASIC for Windows,
- Microsoft BASIC PDS 7.0,
- Microsoft QuickBASIC,
- Microsoft C for DOS,
- Microsoft C for Windows,
- Borland Pascal 7.0,
- Microsoft Pascal 4.0.

FIG 2 Functions of factory user port for Industrial Controller PSM



Applications

Since Industrial Controller PSM was launched on the market approximately two years ago, Rohde & Schwarz has published more than ten application notes, which can be obtained by all users from their R&S representative. Relevant applications for the FUP are DC measurements (V, I, R), AC line monitoring, battery testing and remote control of satellite antennas. The first three applications demonstrate the powerful language interface of the FUP, whereas the fourth makes use of its complete range of functions and involves writing firmware.

DC current and voltage measurements
In many cases this simple application (Application Notes 1CMAN19 and AN20) makes an external IEC/IEEE-bus multimeter superfluous; it demonstrates DC voltage or DC current measurements. Sampling every 100 ms (in the VisualBASIC example) means that slowly varying quantities can also be measured. There are four measurement ranges: 10 V, 100 V, 1 A and 10 A. Each measurement range is assigned to one of the four A/D converter inputs via a matching circuit. The minus pole of the signal to be measured is connected to PSM's ground. Application Note AN19 describes control under VisualBASIC, whereas AN20 deals with control under Rohde & Schwarz BASIC. R&S BASIC has a steep learning curve, as the interpreter immediately executes any command that is entered.

AC line monitoring
This application example (Application Note 1CMAN22) describes how to monitor the AC line. The optional DC Supply (PSM-B3) must be fitted to PSM if you want to measure power supply drops or failures. This option can also be modified to give an uninterruptible power supply. AC line monitoring is performed under VisualBASIC. The rectified AC voltage which has been tapped via a transformer is measured periodically. Supply failures and their durations are recorded. The AC voltage is also monitored so that small fluctuations can also be detected.

Battery tests
This example (Application Note 1CMAN25), which is somewhat more complex than the applications mentioned above, demonstrates the monitoring of various characteristics related to rechargeable batteries. The following **tests** can be performed with this application:
- determination of battery capacitance,
- absolute and differential temperature measurement,
- monitoring of charging,
- discharge monitoring.

This application also provides an introduction to programming the FUP using VisualBASIC and shows you how to write a Windows program too. The battery under test is first discharged until a preset minimum voltage is reached. It is then recharged until either a maximum voltage or a maximum temperature is exceeded. The battery is now fully charged and its capacitance can be checked in another discharge cycle. The VisualBASIC program supplied shows two graphic windows with curves describing the battery voltage and temperature as they change during the charge or discharge cycle, the battery capacitance is indicated as a function of the charge or discharge cycle (FIG 3).

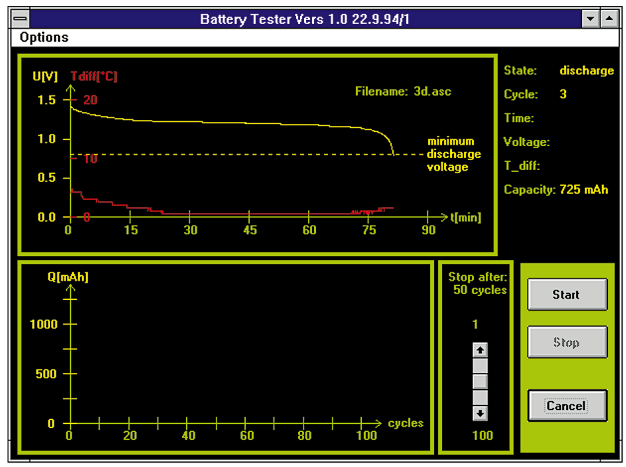


FIG 3 Screen display for battery testing application

Remote control of satellite antennas
This example (Application Note 1CMAN10) demonstrates the FUP's full range of functions in combination with PSM. The built-in microcontroller, which has software that can be loaded for particular applications, uses data preprocessing to solve very complex measurement tasks. If a satellite antenna is controlled by a built-in controller, the data signal is a sequence of pulses, different pulse widths representing a 1 or a 0. As these pulses have to be very short (64 or 86 µs), an independent microcontroller such as the one provided in the FUP is an ideal pulse source. In this case, software which has been specially designed for this task is loaded into the FUP microcontroller and started. A software library has been supplied to make it easy to send data to the microcontroller and so position the antenna.

Joachim Stegmaier

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Reader service card 152/15

Fast adaptive data transmission on shortwave at up to 5400 bit/s with HF Modem GM2100

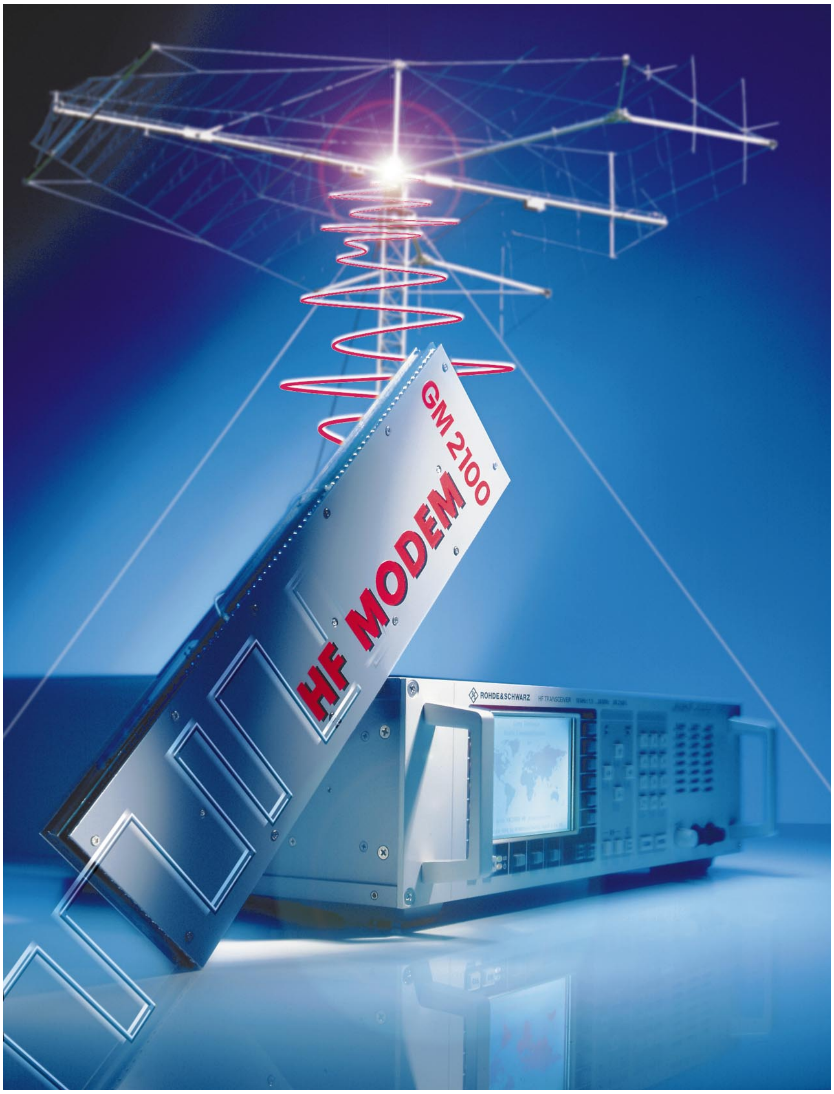

FIG 1 HF Modem GM2100 for shortwave data transmission at up to 5400 bit/s
Photo 42 569

When it was first introduced, shortwave data transmission was limited to 200 bit/s. This was because of the problem of multipath propagation in shortwave communications. Error control methods such as FEC (forward error correction) and ARQ (automatic repeat request) ensure minimal bit error rates. Methods of compensating for multipath effects could however not be developed cost-effectively until powerful signal processors came along. They made it possible to increase the data rate to over 2400 bit/s, which became the standard for most shortwave modems for a period of several years.

In HF Modem GM2100 (FIG 1), Rohde & Schwarz has now pushed the speed limits for data transmission even further. This modem from the XK2000 family of shortwave radio equipment [1] makes data transmission rates up to 5400 bit/s possible. Adaptive methods are used for matching the data transmission rate to the quality of the path: under favourable propagation conditions, transmission is at maximum speed, under less favourable conditions, the number of error control bits is increased. This results in a considerable increase in the effective data throughput for a typical shortwave link.

Data modem GM2100 has **three signal formats for data transmission:**

- a Rohde & Schwarz signal format,
- a signal format to MIL-STD-188-110A (single-tone method),
- a signal format to STANAG 4285.

The **R&S signal format** is compatible with those of data modems GM857C4 [2] and GM2000. For GM2100 it was optimized to give data rates between 900 and 5400 bit/s. FIG 2 shows the structure of a frame with this signal format transmitted by GM2100. If GM2100 is used in conjunction with an ALIS processor [3], the transmission rate is automatically matched to the radio-link quality and to the requirements of the transmission protocol, and optimum utilization of the transmission channel is also ensured. During link setup, the ALIS processor automatically calculates the maximum possible link

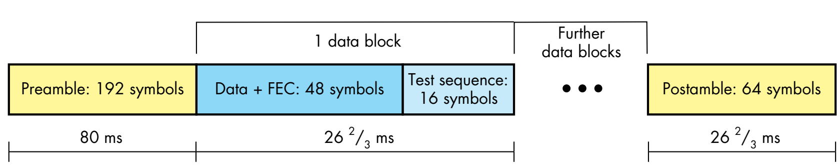

FIG 2 Frame structure of Rohde & Schwarz signal format for HF Modem GM2100

Modulation method	Info bits	Redundancy bits	Code rate	FEC [%]	Net data rate [bit/s]
8PSK	144	0	No FEC	0	5400
8PSK	120	24	5/6	17	4500
8PSK	96	48	2/3	33	3600
8PSK	72	72	1/2	50	2700
4PSK	36	36	1/2	50	1800
2PSK	18	18	1/2	50	900

TABLE 1: Possible data rates for Rohde & Schwarz signal format for HF Modem GM2100

	Typical data volume non-compressed	Typical data volume compressed	Data reduction	Transmission time with GM2100
Text	2.5 Kbyte/page	0.9 Kbyte/page	64%	2.5 s
Fax	30 Kbyte/page	24 Kbyte/page	20%	63 s
Video	490 Kbyte/page	15 Kbyte/page	97%	44 s

TABLE 2: Data transmission times for typical shortwave applications

data rate. This gives full compatibility with the Rohde & Schwarz series HF850 and XK2000 HF systems.

The HF modem phase-modulates the HF carrier, using 2PSK, 4PSK and 8PSK. 2PSK is used for a data rate of 900 bit/s and 4PSK for 1800 bit/s. As fewer phase states are used for transmission, 2PSK and 4PSK increase the reliability of data transmission for links of lower quality. 8PSK is used for high-quality HF paths. To further increase the data rate in the latter case, the redundancy of the FEC of a transmitted block can be adjusted. In this way, transmission rates up to 5400 bit/s can be achieved (TABLE 1).

A great advantage of the transmission method employed by GM2100 is automatic detection of the received signal data rate by means of a code received at the start of reception. This means that the receiving data modem need not be told the data rate of the transmitting modem. The ALIS processor makes use of this feature and transmits RSX.25 protocol data at a lower rate. Even though the quantity of these data in relation to the user data is vanishingly small, the protocol data are extremely important for the transmission protocol. This intelligent control function therefore greatly enhances data transmission reliability.

The high transmission speeds achievable, in conjunction with the RSX.25 protocol, give a synchronous data rate of 3600 bit/s at the data terminal interface for high-quality radio links. This corresponds to an asynchronous data rate of 4480 bit/s for an interface setting with eight data bits, one stop bit and no check bit, ie to a practically continuous data stream of 4500 baud. TABLE 2 shows the data transmission times for an HF system with System Processor MERLIN [4], HF Transceiver XK2100, the ALIS processor and HF Modem GM2100.

For transmissions using standardized **signal formats to MIL-STD-188-110A,** 8PSK at a rate of 2400 symbols per second is employed. Asynchronous data rates between 75 and 4800 baud and synchronous data rates between 75 and 4800 bit/s are possible. FEC for error control can be set according to the selected transmission speed. Interleaving of the transmitted data with an interleaver length between 0.6 and 4.8 s can also be selected.

For transmissions using **STANAG 4285 signal format,** similar data rates as with MIL-STD-188-110A can be achieved by means of various modulation methods. Here too, a long or short interleaving time can be selected.

Although MIL-STD and STANAG signal formats do not allow as high a data throughput as the R&S signal format, their availability on GM2100 ensures interoperability with stations using these standards. GM2100 gives maximum transmission rates at low BERs, making shortwave data transmission technically comparable with worldwide satellite transmission or PTT lines.

Günter Wicker; Gerhard Greubel

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[3] Greiner, G.: Reliable shortwave with ALIS. News from Rohde & Schwarz (1987) No. 116, pp 47–50

[4] Kneidel, T.: System Processor MERLIN GR2000 – Powerful processor stands toughest conditions. In this issue, pp 12–13

Reader service card 152/16

Digital modulation and mobile radio (III)

2 Basic modulation techniques

2.4 Frequency-shift keying

All the types of modulation described so far have been linear. The (double sideband) baseband spectrum is shifted linearly in the RF range. The modulators used are memoryless as neither the instantaneous phase φ(m) nor the instantaneous amplitude a(m) are functions of previous values φ(m-p) or a(m-p).

Another way of transmitting digital signals is mapping the M-ary baseband signals onto RF signals with M different frequencies. This type of modulation is referred to as M-ary frequency-shift keying (FSK). FSK is not linear and the RF spectrum is a Bessel spectrum which has frequency components that are not present in the original signal.

A simple form of frequency-shift keying with no memory can be implemented by switching between M oscillators each with a different frequency. When this is done, the phase of the RF signal is random. The disadvantage of this type of FSK is that the RF spectrum has large sidelobes. Frequency-shift keying with continuous phase shifts (continuous phase frequency-shift keying, CPFSK) does not have this drawback. A CPFSK modulator can be implemented with a voltage-controlled oscillator (VCO) or an I/Q modulator.

Binary FSK is the simplest form of FSK and is described in terms of the two signals

$$s_1(t) = A \cdot \cos[2\pi(f_c + \Delta f)t]$$

and (12)

$$s_2(t) = A \cdot \cos[2\pi(f_c - \Delta f)t]$$

2.5 Correlation and distance between signals

The parameters used to represent information are not the only differences between the various types of modulation. There are also differences in their sensitivity to external interference and, as mentioned previously, efficient use of the available RF bandwidth. A number of parameters that indicate how well a modulation method can transmit information on a particular radio channel have to be considered. In chapter 1, modulation was defined as the assignment of one of the M possible signals that could be transmitted to a block of k bits. The signal is distorted during transmission. The purpose of demodulation in the receiver is to detect the signal in the presence of the noise which has been introduced during transmission and to distinguish it from the other M-1 signals that could have been sent. It is obvious that a modulation technique based on a set of M signals can best fulfil its task if these M signals are as different from each other as possible. Mathematically, the degree of similarity between two signals is expressed in terms of their correlation factor

$$\rho = \frac{\int_T s_1(t) \cdot s_2(t)\,dt}{\int_T s_1^2(t)\,dt} \qquad (13)$$

or in terms of their Euclidean distance

$$D^2 = \int_T [s_1(t) - s_2(t)]^2\,dt$$
$$= E_1 + E_2 - 2\sqrt{E_1 \cdot E_2} \cdot \rho \qquad (14)$$

where E is the mean energy over the duration of the symbol.

When $E_1 = E_2$, as is the case with PSK and FSK, this equation simplifies to
$D^2 = 2 \cdot E_{bit} \cdot (1 - \rho)$. (15)

For binary ASK ($s_2 = 0$) this formula gives a distance $D_{ASK} = \sqrt{E}$ and $D_{BPSK} = 2\sqrt{E}$ for BPSK ($s_2 = -s_1$). There are two distance values for QPSK, $D_{max} = 2\sqrt{E}$ and $D_{min} = \sqrt{2}\sqrt{E}$.

The Euclidean distance for FSK depends on the modulation index; in the case of CPFSK with a modulation index of 0.5 $D_{CPFSK} = \sqrt{2}\sqrt{E}$. This is the basis for the modulation technique used for GSM radio networks.

2.6 Coherent demodulation

When RF signals are phase-modulated, the resulting spectrum does not have a component at the carrier frequency. This means that the relationship between the current phase which carries the information and the phase of the unmodulated carrier is not directly available. Therefore, a complex method is used to regenerate the carrier so that it has its original frequency and phase. There are several frequency synchronization techniques that can be used, for example squaring the modulated signal once or twice and then dividing the doubled frequency by two (BPSK) or the quadrupled frequency by four (QPSK). Another approach is to periodically transmit an unmodulated frequency which the local oscillators in the receiver can lock onto. Usually the exact phase is obtained by means of special sequences (training sequences) contained in the datagrams. The cross-correlation of the received sequences with identical sequences stored in the receiver provides phase corrections for the local oscillators.

A signal of the form $\cos(2\pi ft)$ and an orthogonal signal of the form
$-\sin(2\pi ft) = \cos(2\pi ft + \pi/2)$
are recovered from the regenerated carrier.

Both components are multiplied by the received signal $A(t) \cdot \cos(2\pi ft + \varphi(t))$ and the following are obtained:

$$A(t) \cdot \cos(2\pi ft + \varphi(t)) \cdot \cos(2\pi ft)$$
$$= \frac{1}{2} A(t)[\cos(\varphi(t)) + \cos(4\pi ft + \varphi(t))],$$

$$A(t) \cdot \cos(2\pi ft + \varphi(t)) \cdot \cos\left(2\pi ft + \frac{\pi}{2}\right)$$
$$= \frac{1}{2} A(t)\left[\cos\left(\varphi(t) + \frac{\pi}{2}\right)\right.$$
$$\left.+ \cos\left(4\pi ft + \varphi(t) + \frac{\pi}{2}\right)\right]. \qquad (16)$$

The following terms remain when RF components are filtered out (FIG 7):

$$\frac{1}{2} A(t)[\cos(\varphi(t))]$$

and (17)

$$\frac{1}{2} A(t)\left[\cos\left(\varphi(t) + \frac{\pi}{2}\right)\right] = \frac{1}{2} A(t)[-\sin(\varphi(t))]$$

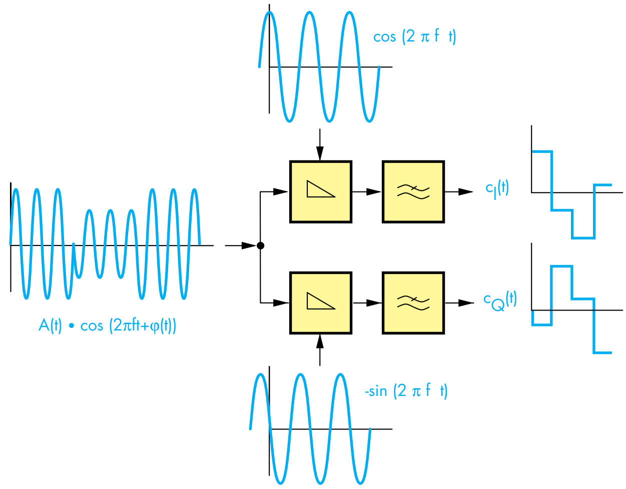


FIG 7
Coherent demodulation

However, as equation (3) shows, these are the modulating signals of the I and Q carrier components to within a constant factor and, as equation (6) shows, they are the components of the complex envelope of the modulated signal to within the same constant and the sign of the imaginary part. If the original data are to be recovered, the inverse of the mapping onto the signals $c_I(t)$ and $c_Q(t)$ or onto the complex envelope $\underline{u}(t)$ must be found.

Coherent demodulation must be used for systems using true phase modulation, provided that differential coding is not used for the data. When phase shifts and not absolute phases are used to encode information, this is referred to as differential coding. Coherent demodulation can, however, be used for all other types of modulation. In general, it performs better than non-coherent methods, ie lower bit error rate for the same ratio of bit energy to noise power density.

3 Modulation methods for mobile-radio networks

The last chapter would lead one to conclude that BPSK has the greatest immunity to noise introduced by the transmission channel. Indeed, after transmission through a channel that only adds white noise to the wanted signal, referred to as an AWGN channel (added white Gaussian noise), BPSK is optimal with respect to the bit error rate as a function of the bit energy to noise power density ratio E_{bit}/N_0. This type of modulation is, therefore, used as a benchmark for other types of modulation. The bandwidth efficiency is inadequate however. Although M-ary PSK and QAM have considerably better bandwidth efficiencies, they exhibit small Euclidean distances, which means that their susceptibility to noise on the transmission path increases as the number of signal states increases. The implementation of modulators and demodulators also becomes more and more involved as the complexity of the modulation technique increases.

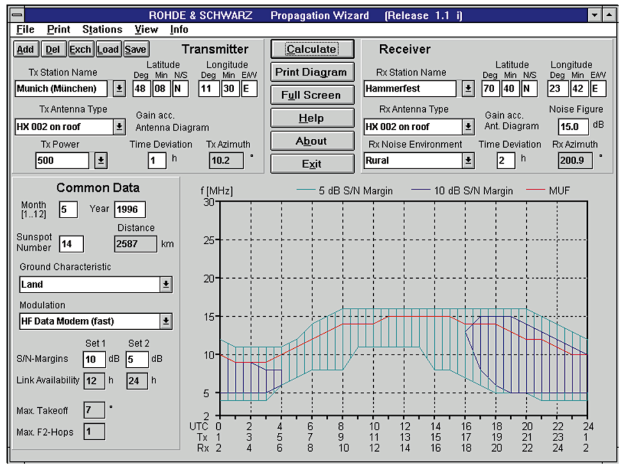
Ostensibly, when compared with BPSK, QPSK seems to be a good trade-off between efficient use of bandwidth, immunity to noise and technical complexity because of its mean minimal difference in Euclidean distance and its bandwidth efficiency, which is twice as good. By contrast, CPFSK as implemented in GSM networks requires far more complex hardware and so on the face of it does not appear to be the optimum choice.

However, a more careful analysis of the band-limited RF signals and their suitability for radio transmission gives an entirely different perspective. Band-limited M-ary PSK exhibits spurious incident AM modulation of the RF carrier. The reason for this is that the magnitude of the RF signal vector changes during phase transitions which are slower than those that occur with modulation without band-limiting. This effect is particularly marked when the phase changes by 180° (transition from 00 to 11 for BPSK and 10 to 01 for QPSK), the carrier being reduced to zero for a time. The carrier is reduced to 0.7 of its maximum value when the phase changes by 90° and to 0.38 of its maximum value when the phase changes by 135° (possible phase shift for 8-PSK) – this is equivalent to attenuation of 8.4 dB. This precludes the use of effective but nonlinear C-class amplifiers in mobile radios and means that linear A-class amplifiers are required for the output stage. It also makes it more difficult to recover the carrier from the modulated signal, which is essential for coherent demodulation.

To be continued Peter Hatzold

PropWiz – Windows program for shortwave radio link prediction

Propagation Wizard, or PropWiz, is a new program which allows the quality of a shortwave link between any two points in the world to be predicted in an extremely easy way. Propagation Wizard calculates the reliability of a link, ie the available time for a desired S/N ratio and the appropriate frequency range. Results are displayed as well laid-out graphics on a monitor (FIG). Colour printouts can be produced on any colour printer. The available time for a link is indicated in hours per day.



Result printout of shortwave link calculation made with Propagation Wizard

A **free demo version** of this program is now available for the first time from the Rohde & Schwarz Web site and can be downloaded by anyone wanting to try it out (address: http://www.rsd.de).

With its simple, self-explanatory user interface (Windows 3.x or 95) and the high forecast quality, Propagation Wizard is unique on the market. It takes into account the characteristics of Rohde & Schwarz transceivers of all power classes (HF850/XK2000), modulation methods (eg Data Modem GM2000) and, most importantly, the characteristics of transmitting and receiving antennas (eg HX002, AK471). The vertical radiation patterns (ie gain as a function of elevation angle and frequency) are used in calculation. Customer-specific requirements and parameters can easily be implemented.

To determine S/N ratio, not only the received field strength but also atmospheric, galactic and man-made noise at the site of reception are taken into account in accordance with the relevant CCIR recommendations. Thanks to Propagation Wizard, the complex chain of link-quality calculations can now be performed by just pressing a key or clicking a mouse. Propagation Wizard is, therefore, also ideal for the exhaustive, high-reliability analysis of large and complex radio networks, including all interconnections, at a relatively high speed. Previously, calculations of this kind had to be performed using the following sequence of steps:

1. Calculation of the field strength at the reception site using a program.
2. Determination of all noise and interference at the reception site by means of CCIR tables (depending on place, time of day and season).
3. Calculation of S/N ratio taking into account inherent receiver noise, bandwidth and the receiving antenna.
4. Comparison of calculated S/N ratio with minimum nominal ratio for modulation method used.
5. 24-fold repetition of steps 1 to 4 for all hours of the day.
6. If input parameters were changed, (eg to correct antenna gain for the calculated frequency range), all previous steps had to be repeated.
7. All calculations and evaluations had to be repeated for new transmission or reception sites.
8. Results had to be presented as graphics for a full assessment.

Propagation Wizard spares the user all this work and gives the result in no time. Calculations can be performed with slightly altered parameters any number of times, allowing the effect of specific parameters to be determined (eg minimum required transmitting power).

Here are the **special features of Propagation Wizard** again at a glance:

- extremely easy operation through self-explanatory Windows user interface,
- Windows help function (context-sensitive) always available in the background,
- based on proven algorithms,
- includes all relevant shortwave link parameters in the calculation,
- takes into account the characteristics of Rohde & Schwarz shortwave system components,
- takes into account the vertical patterns of Rohde & Schwarz antennas,
- calculates the available time and optimum frequency range for a shortwave link,
- displays results as graphics on the monitor,

Software

- outputs colour hardcopies on a printer,
- performs all calculations very rapidly.

Propagation Wizard is available in **two versions:**

- standard version for normal PC (min. 800 x 600 pixels),
- laptop/notebook version (640 x 480 pixels).

Both versions are available as free demos with Munich as the reception station. All features of the program including the printing function are available, allowing prospective users to make a complete assessment of Propagation Wizard.

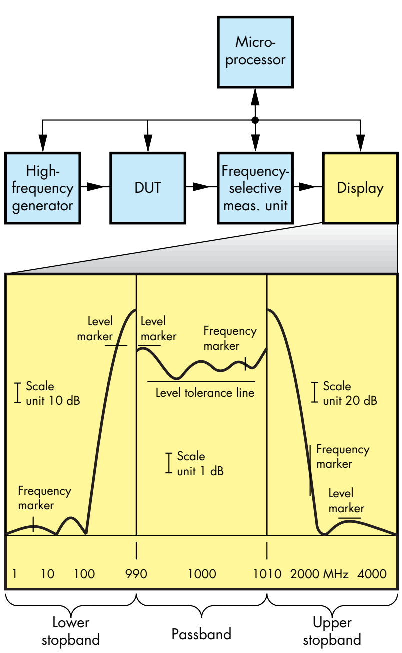
Dr. Hans Waibel; Peter Maurer

Reader service card 152/17

Patent

Frequency-selective measurement and display of frequency-dependent test parameters

In the field of RF measurements, there are an increasing number of analyzers for frequency-selective analysis of frequency-dependent test parameters over a frequency range of interest. For example, there are spectrum analyzers that display the amplitude of a test signal as a function of frequency over a wide frequency range in nearly realtime on a CRT (eg Spectrum Analyzer FSA from Rohde & Schwarz). There are also network analyzers which have a tracking generator as well as the frequency-selective analyzer (eg Scalar Spectrum and Network Analyzer FSAS). Network analyzers of this kind can be used for measuring the amplitude versus frequency characteristics of a four-terminal network. There are also vector network analyzers that can measure both magnitude and phase. From the magnitude and phase, the impedance of a device under test (DUT) can be calculated, for example, and from the phase/frequency curve the group delay. Network analyzers of this kind can, therefore, be used for measuring a wide variety of DUT parameters. The main problem with all the analyzers that have been referred to is, however, that they cannot be adjusted to obtain optimum accuracy and measurement speed for a specific measurement task or DUT.



The purpose of the invention is to provide an analyzer similar to the one initially described that can be optimally tailored to the measurement task to be performed. This problem is solved for an analyzer as described in the preamble of the main claim through the characteristic features of the analyzer. Useful further developments, in particular for the design of a network analyzer, result from the subclaims. The invention provides for optimum adjustment of frequency scaling (number and distribution of the frequency steps) and the scaling of the test parameters (eg amplitude, phase, impedance and group-delay scaling) to a specific task in various subranges of the overall frequency range. For example, when measuring the transfer characteristics of a lowpass or highpass filter, the overall frequency range of the network analyzer is divided into two subranges (passband and stopband), and measurements are performed in the two subranges using different frequency scales and different test parameter scales (FIG). To perform measurements on a bandpass or a bandstop filter, it is expedient to divide the total frequency range into three adjacent subranges, with the scaling of each range adapted to the filter passband and stopband ranges, the middle range having higher frequency and level resolution than the neighbouring stopband ranges. Since the patented analyzer allows the user to select the number of frequency steps per subrange, the analyzer's measurement speed can be optimized, which is very useful for aligning DUTs. The display of frequency or test parameter markers, eg level markers, or of test parameter tolerance lines, eg nominal level lines, during the measurement makes the patented analyzer a highly versatile instrument suitable for a wide variety of measurement tasks, eg for measuring the selectivity characteristics of highpass, lowpass, bandpass or bandstop filters. The patented analyzer can also be used for displaying various selectivity characteristics of a multiport DUT, for example a diplexer consisting of a lowpass and a highpass filter, in which case a multichannel instrument would have to be used.

Extract from patent specification EP 473 949 B1
Applied for by Rohde & Schwarz on 11 March 1992
Issue of patent published on 21 June 1995
Inventor: Klaus Danzeisen

Used in Vector Network Analyzers ZVR

Reader service card 152/18 for further information on ZVR

Digital Radiocommunication Tester CMD55 with new measurement functions

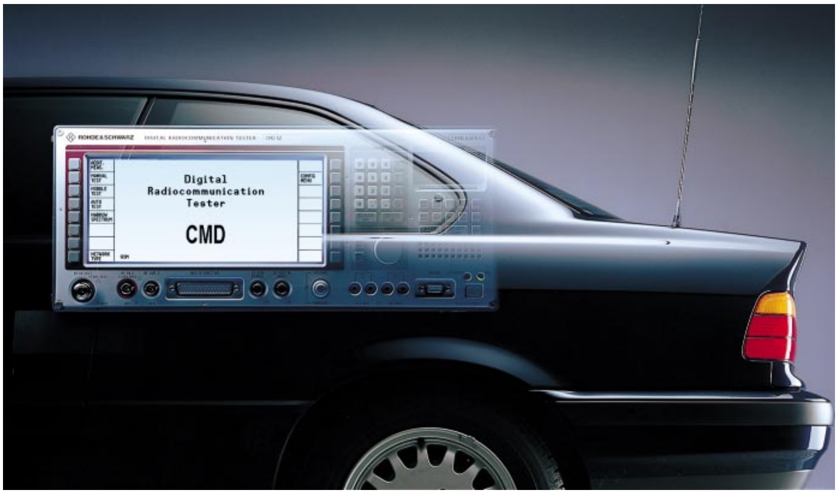


FIG 1 Digital Radiocommunication Tester CMD55 Photo 40 946

CMD55 (FIG 1) is a compact unit for testing GSM, PCN and PCS mobile phones in advanced service and production environments [1; 2]. The tester has been upgraded with a variety of new measurement functions to comply with the latest requirements for these application areas.

The following new characteristics make CMD55 ideal for use in **mobile-phone production:**

To measure the RF parameters of mobiles, the tester has to simulate a base station so that a call can be set up. The complete signalling procedure for a **location update** requires up to 10 s, but this may be too long for a production environment. CMD has two ways of saving valuable processing time. As well as the complete signalling procedure, there is also an abbreviated signalling mode where all signalling messages not required for testing are eliminated. Testing can be speeded up even further if the IMSI (international mobile subscriber identity) is known, as a direct call can be made from the mobile to CMD (direct paging). Production departments generally use a test SIM card with a known IMSI.

Production tests on mobile phones have to be performed at different **TX powers.** The signalling procedure required for a power change is also very elaborate. Here too, test duration can be cut by changing channel in CMD to change TX power, ie by choosing the same channel but with different power. The signalling procedure is much shorter in this case.

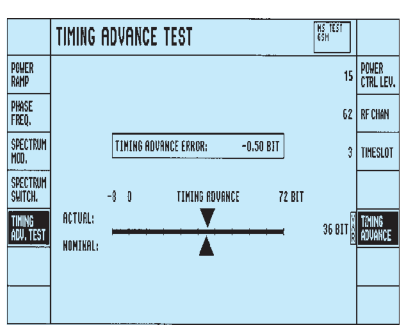


FIG 2 Timing advance test menu

To speed up the **remote-control mode,** the outgoing and incoming remote-control commands are displayed on the CMD screen, but not the menus required for manual control. This command display function is extremely useful for writing and testing remote-control programs in the test phase. In normal operation the command display function can be disabled, giving a further increase in speed. When used in automatic repair test setups, CMD can be directly switched over from remote to manual. The menu level and the signalling status are retained however. This means that immediately after fault detection by the automatic test program, the fault can be analyzed in more detail using the graphics menus in the manual mode.

The processing speed of the hardware components in CMD55 has also been increased thanks to a faster **microprocessor system.** The modular design of CMD means that the new controller module can also be retrofitted to test systems that have already been supplied.

The following new features enable CMD55 to be used in **development and quality assurance** of mobile phones.

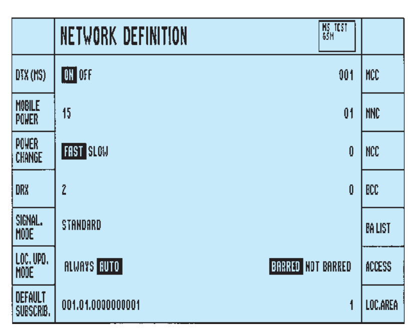


FIG 3 Network definition menu

A GSM phone has to have the correct frequency and time slot synchronization with respect to the test setup which is acting as the base station. CMD can measure how early or late the mobile is transmitting, ie it performs a **timing error measurement.** A **timing advance test** can also be performed. In this case CMD tells the mobile by how much it should send too early or late so that it can make a correction and then measure the time offset (FIG 2). This function is required for delay correction when base stations are a large distance away.

To check the **dynamic RF characteristics** of mobile phones, one of CMD's four different frequency hopping sequences can be activated by a simple keystroke. A realtime speech coder/decoder (option CMD-B5) is available for measuring **AF parameters.** It is operated in conjunction with the AF measurement unit comprising a voltmeter, distortion meter, bandpass filter and AF generator (option CMD-B41). After making a connection to the AF interface of the mobile's hands-free facility or attaching an acoustic coupler, the AF characteristics of the mobile can be measured precisely.

The user of CMD55 may specify a number of signalling parameters (FIG 3) to **simulate** different **networks** for example. This means that the roaming behaviour of mobiles can be tested in the home network, or in others, by using special network SIM cards. If there are a large number of neighbouring cells, the mobile's hardware and software have to handle the increased load. To assess the effects of the extra workload, the type of neighbouring cell and their number can be selected on CMD.

Prior to measurements, discontinuous reception or discontinuous transmission can be set on the mobile phone. Capabilities like setting the mobile output power or choosing "registration barred / not barred" mean that CMD can handle very specialized applications.

Werner Mittermaier

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Reader service card 152/19

ACCESSNET® – a solution for communications in Russia

Following market liberalization there is large demand for telecommunications in Russia which cannot be met by the existing telephone network. Telecommunication facilities in Russia have not reached the same level as those in highly developed industrialized nations. There are many places where the copper-based PSTNs are obsolete, overloaded and unable to cope with the growing demand.

In the wake of the free-enterprise economy, private network operators are investing in mobile communication networks. Most of these systems are patched together from conventional radio components, offering a limited range of functions and in most cases only limited availability to the user. In industrial centers, mobile telephone networks to NMT and GSM standards are being implemented, but this means enormous investment and operating costs for the network operators and subscribers.

The ACCESSNET® trunked-radio system from Rohde & Schwarz, based on the European MPT 1327 signalling standard, is the ideal solution for the requirement profile of potential network operators and users in Russia. Thanks to modular design, communication systems from compact local systems to regional and supraregional trunked radio networks can be implemented at comparatively low investment cost


МИНИСТЕРСТВО СВЯЗИ
РОССИЙСКОЙ ФЕДЕРАЦИИ
ССЭ Система сертификации "Электросвязь"
СЕРТИФИКАТ СООТВЕТСТВИЯ
№ ОС/1 – РС – 418
Выдан – 13 февраля 1996 г.
Срок действия – до 1 февраля 1999 г.
ССЭ, регистрационный номер РОСС RU.0001.013С00
Сертификат № ОС/1–РС–418
Выдан Министерством связи Российской Федерации
№ 2125

FIG 1 Russian type-approval certificate for Rohde & Schwarz base station ND950 for private trunked-radio networks

FIG 2 Presentation of ACCESSNET® trunked-radio system at SIBCOM telecommunications show in Novosibirsk Photo: author

[1 to 3]. The multitude of supplementary call types and data transmission facilities of these systems offers a much wider range of services to the subscriber than any cellular phone system.

Supraregional frequency assignment for trunked-radio systems by the appropriate authorities is much easier than it is for a great number of conventional systems. If licences are granted to selected network operators who make their network infrastructure available to various user groups, more efficient use can be made of the available frequency resources.

Rohde & Schwarz anticipated the demand for communications in Russia early on, and since 1994 has been seeking closer cooperation with Russian partners to consolidate a basis for future business relationships. Since type approval of the ACCESSNET® trunked-radio system is a precondition for supplying and commissioning, it was given top priority. Rohde & Schwarz is now one of the first manufacturers to be granted a Russian certificate for a trunked-radio system – ACCESSNET® (FIG 1).

The multi-faceted marketing activities have begun to bear fruit. Joint projects were implemented with local system integrators in Moscow and Novosibirsk (FIG 2). Two systems are already in operation, four others are to be installed shortly. Operators of the trunked-radio networks make useof the whole application spectrum of ACCESSNET® as a public mobile radio system and for security services, harbour authorities and railway companies. The flexibility of ACCESSNET® and its network architecture which is unique on the market, as well as Rohde & Schwarz's expertise with high-performance systems, are powerful arguments for Russia to choose ACCESSNET® as a solution to its communication problems.

Andreas Schneider

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[1] Wagner, K.-H.: Trunked-radio systems successful all along the line. News from Rohde & Schwarz (1994) No. 146, p 55

[2] Schinke, U.; Klier, W.: Radiocommunication System ACCESSNET®-D – Trunked radio goes digital. News from Rohde & Schwarz (1995) No. 149, pp 28 – 31

[3] Wagner, K.-H.: A vision comes true – trunked radio for United Arab Emirates. News from Rohde & Schwarz (1995) No. 151, pp 50 – 51

Reader service card 152/20

Rohde & Schwarz test equipment in EMC test center of safety standards authority of Hesse

FIG 1 EMC test system of safety standards authority of Hesse

The EMC laboratory of the safety standards authority of Hesse (TÜH) offers the whole range of measuring and testing facilities for electronic equipment of any kind. The test equipment is designed for measurements of electromagnetic susceptibility (EMS) in the frequency range 10 kHz to 2 GHz and electromagnetic interference (EMI) in the range 5 Hz to 18 GHz. The measuring and test equipment supplied by Rohde & Schwarz (FIG 1) allows fast testing and flexible adaptation to different DUTs; the associated software ensures optimum utilization of the anechoic and shielded chambers installed by Siemens (FIG 2).

In the Kassel branch of the Hesse technical authority, new buildings for laboratories and offices as well as an open-area test site occupy more than 2000 m^2; large rooms allow testing to directives on EMC, machinery and low-voltage equipment. Thanks to its central and easily accessible location as well as its powerful technical outfit, the laboratory is an interesting partner for manufacturers and importers of electronic instruments and systems of up to approx. 2500 kg.

The computer-controlled EMS test system from Rohde & Schwarz, for example, allows measurements for acceptance tests to IEC 1000-4-3 and IEC 1000-4-6 in the frequency range above 10 kHz. It includes a Signal Generator SME, a relay matrix, three power amplifiers, a Millivoltmeter URV5, a field-strength test system, a transmitting antenna as well as coupling networks. The test system, which features higher power in the lower frequency range, is suitable for the future development of standards. If required, measurements with different antennas are possible from 1 MHz upwards. The amplifiers can be manually or remotely controlled by means of the computer.

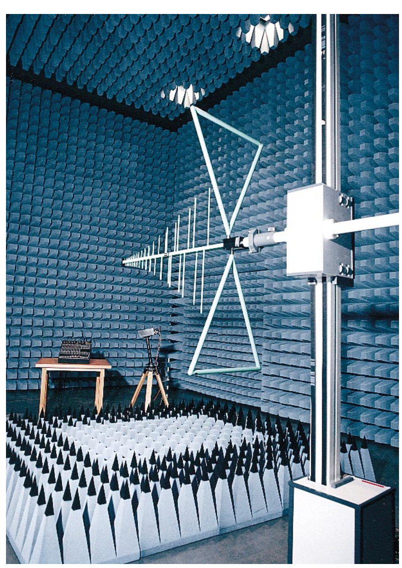


FIG 2 Anechoic chamber in Kassel
Photos: Eberth

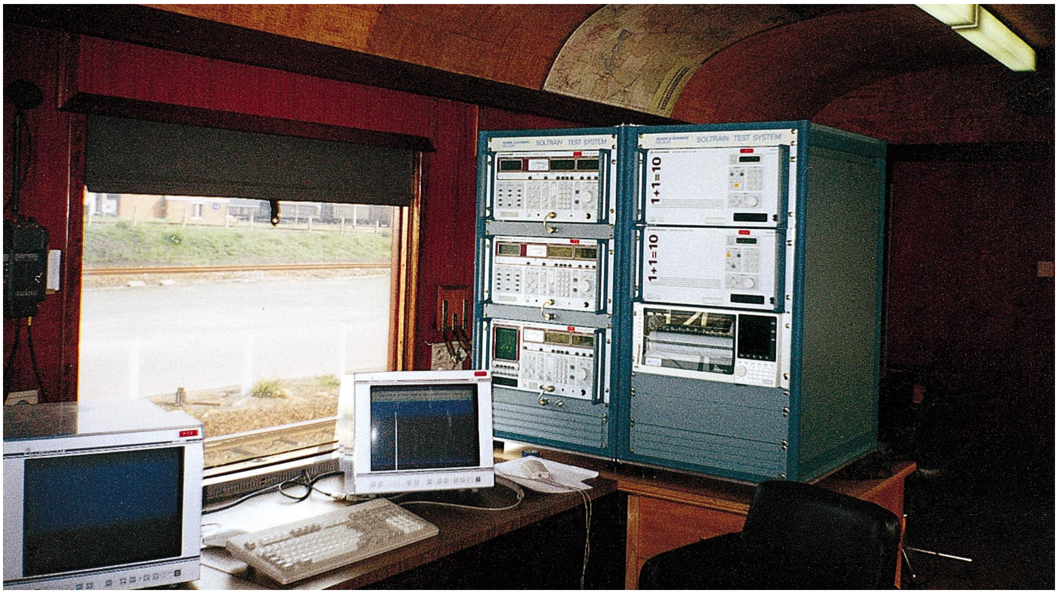
An EUT monitoring system transmits electrical signals from the equipment under test to the operator's position via fiber-optic cables. There the signal parameters can be read off the voltmeter or collected and logged by the computer. A video and audio system also operating via fiber cables is used for the visual and acoustic check of the EUT function. The computer-controlled EMI test system offers application-oriented facilities for measuring EUTs of up to 2500 kg on 3-m turntables in the anechoic chamber and at the open-area test site. A sheltered building made of special plastics is designed for open-area testing at distances of 3 and 10 m independent of the vagaries of the weather.

All measurement rooms have a 3 x 32 A power supply, a large number of power supply units for ancillary facilities as well as compressed-air, water, sewage and waste gas connections. Regular servicing and calibration of the measurement and test systems guarantee high quality and reliability of the results.

Klaus Wunderlich (TÜH); Peter Busch

Reader service card 152/21 for further information on EMC test equipment

SNCB uses R&S test system for planning and quality assurance in Belgian railway communications



Railway communications test system of SNCB with two Test Receivers ESVS10, one ESN and three PCs
Photo: SNCB

The red carriage that can be seen on the lines between Louvain and Aarschot or Gembloux and Namur in Belgium looks a bit bizarre. Its job is to measure the field strength of transmissions in the radio network linking trains and base stations. Several years ago SNCB (Societé nationale des chemins de fer belges) decided to set up a radio network linking trains and the railway control center and ordered the test system they needed from Rohde & Schwarz (FIG). The system is not just for the national rail network but will also be used for Eurostar, Thalis and the planned Paris – Brussels – Cologne – Amsterdam rail link.

"If the radio network is to work properly, call setup must be reliable and there must be no lost call, in other words the received field strength must be adequate at all times", explains the engineer responsible at the radiocommunications department in the SNCB's infrastructure laboratories. The test carriage has two functions. Firstly, it is used to determine the number and positions of the base stations. Secondly, it is used to check the field strength once the network has gone into operation. To do this, the carriage has to travel the entire Belgium rail network in both directions twice a year.

The test system is controlled by pulses from a tachometer attached to one of the carriage's axles. Spurious results due to superposition are eliminated by performing three measurements (as three radio frequencies are used) every three centimeters – at speeds of up to 200 km/h. The results are analyzed statistically to determine whether there is a 95% probability of the 6 dB threshold being exceeded on the national network (95% of the time and 95% of the coverage area); for high-speed lines 98% is the requirement.

Only 540 ms are available for measuring and processing the measurement results, displaying them in realtime and generating graphs and tables. Of course, this can only be achieved by a really fast system. Rohde & Schwarz uses three test receivers operating at a fixed frequency around 460 MHz: one ESN and two ESVS10s. The equipment used also includes three Process Controllers PSM, one for data acquisition, one for statistical analysis of the data and one for printing out, protocolling and presenting the data as graphics on a laser printer. The field strength values are also output on a YT plotter at the same time, but without statistical analysis. The software used was specially designed for railway applications by Larisys, a French company.

Finally it should be mentioned that the carriage is also equipped with an office for field work, a workshop, a kitchen and a small room with a boiler and a generator. "They could send us to the middle of Siberia", quipped the crew. "If we had an oil supply, we'd be totally self-sufficient."

Jacques Stellamans (SNCB Brussels)

Reader service card 152/22 for further information on railway communications test systems

Audio Analyzer UPL has evolved out of UPD (but has fewer functions and slightly restricted specifications), is compatible with UPD and suitable for mobile use; various options, eg digital audio interfaces.

Data sheet PD 757.2238.21 enter 152/23

GSM Go/NoGo Tester CTD52 and GSM/DCS Go/NoGo Tester CTD55 The data sheet has been revised to include the new CTD55.

Data sheet PD 757.1502.22 enter 152/24

Digital Radiocommunication Testers CMD54, CMD57 The data sheet has been completely revised and expanded especially with regard to applications and options.

Data sheet PD 757.1231.23 enter 152/25

Type Approval Systems for Mobile Radio This brochure gives an overview of all systems available.

Info PD 757.2321.21 enter 152/26

Software TS51K1 and TS55K1 ensures fast, efficient and economical measurements when used with GSM Coverage Measurement Systems TS9951 or TS9955 from Rohde & Schwarz.

Data sheet PD 757.2415.21 enter 152/27

Shielded TEM Line S-LINE (150 kHz to 1 GHz) for EMS measurements with Rohde & Schwarz equipment is of compact design and available in two sizes; 50 Ω, VSWR <3, max. 100 W.

Data sheet PD 757.2338.21 enter 152/28

EMI Software ES-K1 The range of drivers has been expanded, the screen pictures have been updated.

Data sheet PD 757.0406.22 enter 152/29

EMI Test Receivers ESHS (9 kHz to 30 MHz) **and ESVS** (20 to 1000 MHz) Receiver models 10 and 30, which are still available, are now presented in a single revised data sheet.

Data sheet
ESHS PD 756.3260.22 enter 152/30
ESVS PD 756.9422.22 enter 152/31

Peak Power Sensor NRV-Z33 (30 MHz to 6 GHz; 1 mW to 20 W; 50 Ω) Model 03 for TV transmitters and general-purpose measurements, model 04 for TDMA radio technology.

Data sheet PD 757.2344.21 enter 152/32

Industrial Controller PSM Retrofit to Pentium (90 MHz) and 1-Gbyte harddisk as well as update of range of options.

Data sheet PD 757.1048.23 enter 152/33

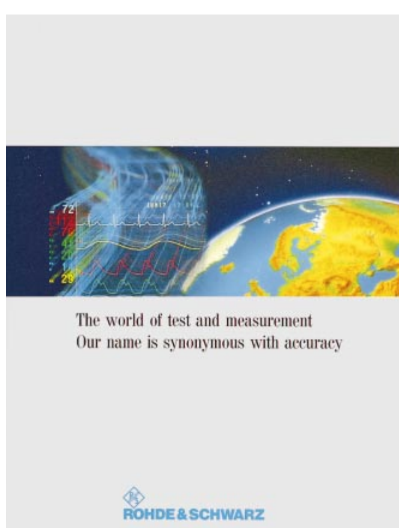
Signal Generators SME and SMT (5 kHz to 6 GHz) Models 06 (6 GHz) are new in the product range.

Data sheet
SME PD 757.0358.23 enter 152/34
SMT PD 757.0364.22 enter 152/35

Receiver Part CT200RP (45 to 862 MHz; IF conversion), **TV Receiver CT200RA** (45 to 862 MHz; baseband conversion), **Satellite Receiver CT200RS** (950 to 2050 MHz; baseband conversion, option: ADR decoder) and **QAM Modulator CT200QM** (31 to 41 MHz; modulation of MPEG-coded video/audio signals onto IF) are extensions to the modular TV system CT200. The data sheets for **Controller CT200CO, Upconverter CT200UP and Vision/Sound Modulator CT200VS** have been revised.

Data sheet CT200-

CO	PD 757.0735.22	enter 152/36
QM	PD 757.1890.21	enter 152/37
RA	PD 757.1877.21	enter 152/38
RP	PD 757.1860.21	enter 152/39
RS	PD 757.1883.21	enter 152/40
UP	PD 757.0729.22	enter 152/41
VS	PD 757.0712.22	enter 152/42



Terrestrial Flight Telecommunication System JETCALL (1670 to 1675/1800 to 1805 MHz) The data sheet presents airborne equipment (to ETS and ARINC) for public radiocommunications.

Data sheet PD 757.2296.21 enter 152/44

Radiolocation System NetTrap consisting of up to four Direction Finders PA1555 (20 to 1000 MHz), Software WinLoc and a laptop enables full-duplex voice and data transmission.

Data sheet PD 757.2315.21 enter 152/45

VHF/UHF Direction Finder DDF190 (20 MHz to 3 GHz) The revised data sheet furnishes detailed information about bearing accuracy as well as general features.

Data sheet PD 757.1460.22 enter 152/10

Radio Paging Systems with Multi-Protocol Capability This brochure from **R&S BICK Mobilfunk** describes the infrastructures of national and local systems for public paging operators.

Info PD 757.2367.21 enter 152/46

TETRA – Trans European Trunked Radio for Professional Mobile Radio This brochure from **R&S BICK Mobilfunk** informs about features, basic and extra services of the new transeuropean standard.

Info PD 757.2373.21 enter 152/47

The world of test and measurement – our name is synonymous with accuracy is the title of a brochure which presents the Test and Measurement Division of Rohde & Schwarz. The four strong pillars of test and measurement are mobile radio, EMC, general-purpose and RF measurements as well as systems.

Info PD 757.2450.21 enter 152/48

New application notes

Network connection to a server via network card with CRTS/P/C
Appl. 1CPAN04E enter 152/49

Measurement of transient responses in AGC circuits using Audio Analyzer UPD or UPL
Appl. 1GPAN32E enter 152/50

Measurement of spurious emissions of GSM, DCS1800 and DCS1900 transmitters with spectrum analyzers of the FSE family
Appl. 1EPAN17E enter 152/51

Measurement of power ramps of GSM, DCS1800 and DCS1900 signals with spectrum analyzers of the FSE family
Appl. 1EPAN18E enter 152/52

Storing and loading complete test receiver data records via IEC/IEEE bus
Appl. 1EPAN20E enter 152/53

Exchanging data records between different test receiver models
Appl. 1EPAN19E enter 152/54

Schz

First DKD qualification for a mobile calibration lab

The Rohde & Schwarz Cologne Plant has received approval from the Physikalisch-Technische Bundesanstalt (PTB, German bureau of standards) to conduct DKD calibration and certification at customers' premises with the MKL04 mobile calibration laboratory. Certificates of the DKD (German calibration service) have a special advantage in that they are recognized internationally, without any further verification, when a firm is quality-audited. So the customer can be sure of traceability to national standards as called for in ISO 9000 ff, EN 45001 and other specifications. This process of qualifying a mobile calibration laboratory in the German calibration service broke new ground, so the requirements for it were set down in discussions between the PTB and Rohde & Schwarz. They went far beyond the demands made on a stationary calibration lab of course, and included

– measures for maintaining the calibration status of the standards and instruments during transport and on-site operation,
– maintenance of the required environmental conditions on site and during transport,
– assurance of calibration of the standards in the superordinate, stationary DKD calibration laboratory at the Rohde & Schwarz Cologne Plant.

In addition, the engineer performing on-site calibration obviously has to be specially qualified. His workplace in the MKL04 is an air-conditioned compartment in a van body mounted on a truck chassis (photo above). There are four workstations for DC, AC and high-frequency measured variables. Calibration on site naturally has its benefits for the customer compared to calibration at a stationary facility. No time is lost for transport, and turnaround time is restricted to the duration of calibration. Calibration of Rohde & Schwarz and other brands of equipment is single source, and visiting a customer in this way helps promote good contacts. H. Bremmekamp

ILA 96 – Rohde & Schwarz demonstrates its competence

The international aerospace show in Berlin from 13 through 19 May 1996 was a real attraction this time round. 216,000 visitors attended, some 44% more than two years ago. The main reasons were the interesting exhibits and flight demonstrations of course, like the world première of Eurofighter 2000 and the NH90 multi-mission helicopter, and the good weather also did its share. The number of major international companies attending was also higher this time, even though there is some way to go before the likes of the Aérosalon in Le Bourget/Paris can be matched. But the signs are very encouraging, and the show's claim to be a gateway to markets in the east for German and international industry seems to be bearing first fruit.

Rohde & Schwarz was present on its own stand in a new design (photo below). The exhibits were presented with application-related background photos and a brief explanatory text. The logo for the show was "Competence in Avionics and ATC Comms". A very professional and expert image was created by products selected from test engineering for ATC, VHF-UHF ATC communication, traffic control with direction finders, military and civil avionics, mobile air traffic control and determination of position in traffic management with GPS/DGPS.

After experiencing all the modern technology, customers and visitors were able to refresh themselves in the "Fliegerstüberl", the centerpiece of the stand and extremely popular. Once again it could be seen that the show is a major event for both customers and exhibitors, and it can only be hoped that the ILA really does fulfil its promise of becoming a success story, especially in its internationalism and as a gateway to the east. J. Frantzen


Photo: Gläser


Photo: Geigl (Siemens AG)

EMI test system at Siemens in Munich

The institute for quality engineering, trial and approval of Siemens in Munich operates a number of anechoic chambers. The "giant anechoic chamber", brought up to the latest technical standards in 1995 at a cost of some three million DM, has a useful inner space of 18 m x 11.3 m x 7.4 m and can take even the biggest EUTs. Thanks to its hybrid absorbers, ie plastic absorbers compounded with carbon on ferrite plates, it now allows tests in line with the stiffer demands for field-strength instrumentation of ANSI-C 63.4, CISPR 16 and CISPR 22. EMI Test System TS9975 from Rohde & Schwarz that is used here (photo left) consists of Test Receivers ESMI and ESVS30 and a controller for the turntable and antenna mast. It works fully automatically in the frequency range 20 Hz through 26.5 GHz (see News from Rohde & Schwarz 142). Operation is possible round the clock, so tests can be conducted faster and are more attractive in terms of cost. Another two Rohde & Schwarz EMI test systems (ESH3/ESVP/EZM) have been in operation for a number of years in three other anechoic chambers of the institute. The customers are divisions of Siemens itself, international industry, state, civil and military bodies.
K. Geigl; D. Poltnigg

Satphone for CARE Canada

The CARE Canada organization, whose headquarters are in Ottawa, carries out emergency humanitarian relief operations around the world. So its workers need to be able to be reached at any time and wherever they are, even in regions with poor infrastructure, as is often the case. For this reason CARE Canada ordered SP1600 Inmarsat M satellite telephones from Rohde & Schwarz. SP1600 provides CARE's staff with interference-free communication, greater security and improved effectiveness. The digital Inmarsat M standard using four geostationary satellites enables highly mobile, global communication. Speech, data, fax and pictures can be transmitted by direct distance dialling from just about anywhere in the world to any subscriber of the public telephone network (see News from Rohde & Schwarz 145 and 149).

The photo shows Christopher Cushing (left), senior program officer of the emergency response unit of CARE Canada, and Peter Foulger, Vice President Sales and Marketing of Rohde & Schwarz Canada, at the handover of an SP1600 satellite telephone in its briefcase version.

D.G. Stephenson

Rohde & Schwarz receivers for British aviation authority

Britain's CAA (civil aviation authority) recently took delivery of 14 Rohde & Schwarz VHF receivers for Stansted Airport (right in the photo below Derek McLauchlan, Chief Executive of NATS, part of the CAA, accepting the first unit from Wolfgang Winter, Sales Director Europe of Rohde & Schwarz). This is part of a contract won five years ago, during which time more than 1200 VHF-UHF transmitters and receivers have already been supplied for the CAA's communications facilities. The high reliability of the equipment enables CAA technicians to carry out their work efficiently and without interruption. As Paul Bolden, project manager of national air-traffic services, put it: "On average the Rohde & Schwarz equipment is exceeding the contracted availability of 33,000 hours MTBF by about 60%. This has allowed us to consolidate our maintenance facilities. The modular construction of the equipment means that site engineers now only replace a faulty unit with the spare. The failed unit is then refurbished as required at our central maintenance unit before being tested and returned as the station spare. Previously many faults at component level were repaired on site by the engineer. This has reduced on-site spares holdings." Bolden added: "A direct benefit of the revised maintenance policy is that training requirements have reduced considerably and training course duration has now been cut by 50%."

T. Stephens

Photo: Astonleigh Studio

In memoriam Dr. Rohde

On 4 October 1996 Dr. phil. nat. Dr.-Ing. E.h. Lothar Rohde would have been 90. He departed from us much too early in 1985. Dr. Rohde was not only one of the founders of the company. Until his death he was its technical and scientific impulse. Dr. Rohde had an infallible understanding of the challenges posed by a customer's requirement and was able to respond with unique solutions. His first principle was speedy implementation of the ready product for key customers.

He challenged design engineers to go to the limits of what was possible, technically and in how fast they achieved it too. His visionary, pace-setting ideas, which he reported on in countless publications all over the world and recorded in numerous patents, made a decisive contribution to Rohde & Schwarz's worldwide reputation.

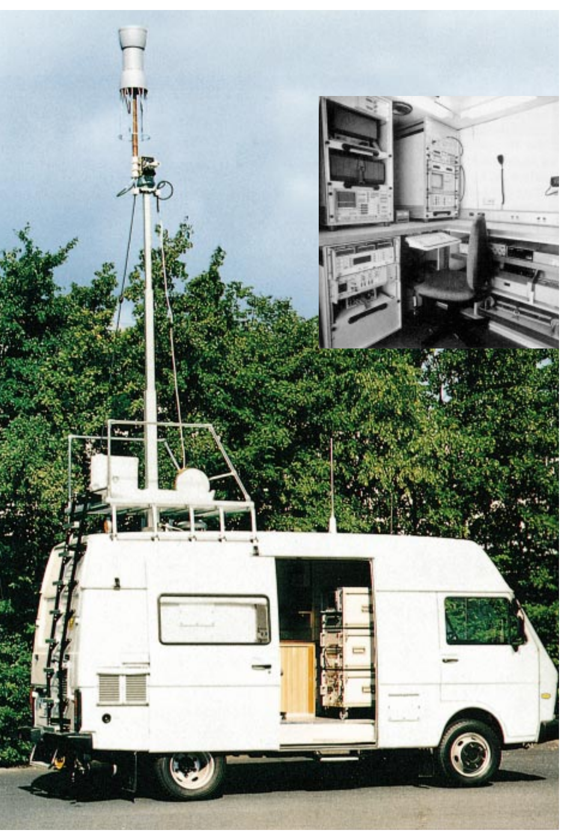
His maxims – intuition and care and concern for the customer – are a model and legacy for us today in moulding the company's future.

F. Schwarz; H. Wagner

Bavaria live in China

The »Wirtschaftswoche« of 25 April 1996 reported about a DAB demonstration, in which the vice-minister of China's ministry for broadcasting, film and technology had an opportunity of gathering information on the status of the DAB project currently under way in Bavaria:

He Dong Cai shook his head in astonishment when the car radio announced: "Slow moving traffic on the circular and arterial roads in and around Munich". Bavaria live in China. The minister had heard a warning to drivers sent over the air as part of Bavaria's DAB (digital audio broadcasting) project. ...The DAB lobby has a further argument for potential customers like China: its know-how lead based on years of experience. The engineers of the Munich-based communications and test engineering specialist Rohde & Schwarz, for instance, have been looking into the possibilities of DAB since 1985 already. The biggest item on the agenda to date is the pilot project in Bavaria, costing 42 million DM.



Constantly on the move, the mobile units of the new radiation test squad of the German army, most of whose equipment came from Rohde & Schwarz. In edition 6/1996 of »Soldat und Technik«, a magazine for defence technology, armaments and logistics, author Harald Konrad spoke of the job of this service: radiation tests on equipment and systems, buildings and rooms, etc.

Superlative of the superlatives? That was the question put by the international magazine for radio »funk« in its June 1996 issue. It not only meant the automatic linear shortwave booster Ehorn Alpha 87 A from the US company ETO but also a spectrum analyzer that is absolutely top in its class, Rohde & Schwarz's FSEA20, which the magazine's engineers used for 122 tests to sound out this power amplifier.

Pinpointing by satellite

Elaborate searching for mislaid containers was a subject for the daily »Blick durch die Wirtschaft« on 23 April 1996:

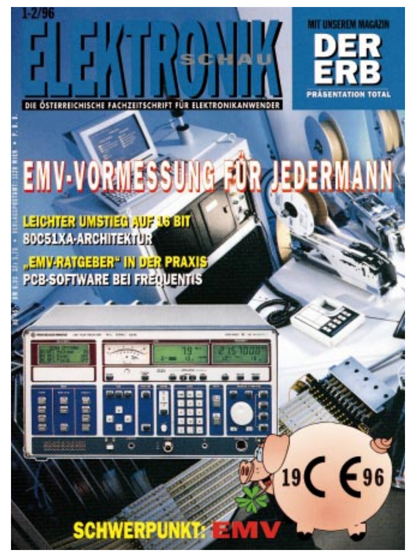
Goods traffic by sea is largely handled with standard containers. Hamburg's Hafen- und Lagerhaus AG (HHLA) moves some 1.5 million of these big boxes every year. ...Mislaid containers can be a nightmare when they are not found where they should be because of a mistake by the driver. Tracking them down can be a long process, and the ship has to wait in the meantime. Just one lay day costs an average of 100,000 DM. So HHLA asked Rohde & Schwarz to devise a means of searching for them. It works by satellite location with GPS (global positioning system) and there are two versions of it. ...But often it is still not accurate enough. So Rohde & Schwarz then came up with differential GPS, increasing accuracy to about one meter.

Digital Video Component Analyzer VCA served as an eye catcher for the cover of the April 1996 edition of the English monthly magazine »TVB Europe«. VCA combines the conventional testing skills of analog TV waveform monitors with whole new functions for monitoring digital coding and signal transmission. It allows in-depth analysis of data content and examination of the data frame.

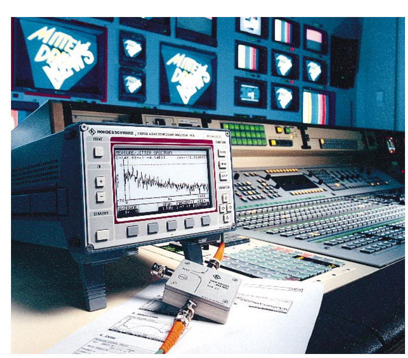
Optical and electrical test

This combination interested number 4/1996 of the English magazine »Test«, which looked at the LV1 test system:

The capabilities of LV1 really show through integration in a Rohde & Schwarz production testing system. The magic word is parallelization. The steps of the electrical test (eg in-circuit test) and the optical test run entirely in parallel without any time loss. But it is also possible to combine optical and electrical tests (eg display test, LEDs), substantially enhancing test depth and without the need for extra tools or test time.



CE labelling has been in force throughout the EU since the beginning of the year, and this was a topic for edition 1–2/1996 of the Austrian magazine »Elektronik-Schau«. Under the title "EMC precertification testing for everyone" it presented EMI Test Receiver ESPC from Rohde & Schwarz as an attractively priced and straightforward test set for EMC measurements parallel to the production process.



Digital broadcasting and multimedia communication

In the past decades, classic broadcasting, namely sound and TV broadcasting, used to be a field of its own with specific developments, largely independent of the world of telecommunications and computers.

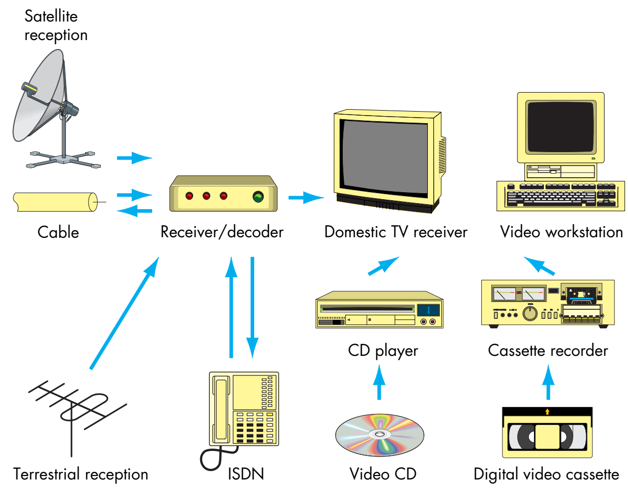


FIG 1 Scenario for utilization of DVB [1]

Sound broadcasting

Analog sound broadcasting, using amplitude modulation for longwave, shortwave and mediumwave and frequency modulation for VHF, more or less retained its principle of sound transmission over the past decades. The only innovation was the radio data system (RDS), which was specified in 1984 and then launched in Europe with differences in the information services provided from country to country. With its introduction in the United States as from 1994 and in many other non-European countries RDS became worldwide standard.

The compact disc, launched by Sony and Philips in 1985, was one of the events triggering off the revolution in sound broadcasting towards digital techniques. The CD created quality very close to that of a concert hall and added a further benefit in terms of simple and robust handling. The CD was of course a challenge to sound broadcasting to provide the same quality and performance features. This is when the demand for terrestrial propagation of digital audio broadcasts for mobile reception came up. From 1988 to 1992 the specification committee EUREKA 147 defined digital sound transmission with DAB (digital audio broadcasting) as a pure audio transmission system for mobile reception up to a vehicle speed of 160 km/h. Further applications covered by keywords such as "value-added service" and "data service" were added. The DAB channel can be considered as transparent point-to-area coverage for mobile reception and with an effective data capacity of about 1.2 Mbit/s. The introduction of DAB in Europe and many countries outside Europe should be completed by the turn of the millennium.

Television

The international TV standards PAL, SECAM and NTSC have practically been untouched up to the present day as far as the picture information is concerned. The developments made mainly had a program-supplementary character. Over the past ten years innovations were achieved on the basis of the given redundancy in the time- and frequency-related representation of the signal. In the mid-70s, for example, the teletext system was launched in different versions throughout Europe. Another digital TV service was added in the early 80s: the video program system (VPS) based on the TV data line ensuring program-synchronous recording by video recorders even in the event of program delays.

The change in TV picture transmission came about in the mid-80s in Europe with the compatible MAC (multiplex analog component) line. D2MAC is a combination of separately transmitted, compressed luminance and chrominance signals and a digital sound and data burst. An intermediate stage in the overall development is the analog PALplus method, which is compatible with PAL but specified for the new aspect ratio 16:9. Digitization in the picture area began in the TV studio with the specification of the 4:2:2 component standard (CCIR Rec. 601). As for transmission from the studio to the viewer, the future lies no doubt in digital video broadcasting (DVB), which is ready to be implemented in the media of satellite, cable and terrestrial transmissions. Toward the end of 1995, the European DVB project concluded the specification of channel coding and modulation for broadband digital TV channels.

With DVB the digital baseband signal is sent in compressed form according to the MPEG2 standard (Moving Picture Experts Group). Depending on the compression factor there are different quality levels and data rates: LDTV (limited definition TV with 1 to 1.5 Mbit/s), SDTV (standard definition with 4 to 6 Mbit/s), EDTV (enhanced definition with 11 Mbit/s), HDTV (high definition with 30 Mbit/s). The net data capacity of one or more video and/or audio sources is transmitted within a multiplex signal (transport stream, TS). DVB thus follows the container principle with

FIG 2
CATV configuration with QAM modulator for intelligent broadband communication systems [2]

transparent transmission channels. Error protection for the transport stream is adapted to the physical medium by means of channel coding. The stipulated modulation modes are QPSK (quadrature phase shift keying) for satellite transmissions, 64QAM (quadrature amplitude modulation) for cable and OFDM (orthogonal frequency division and multiplexing) for terrestrial broadcasting. For the latter, the modulator in the terrestrial transmitter is followed by high-power amplifiers for the OFDM modulation signal. These amplifiers are preferably of solid-state design and feature high linearity.

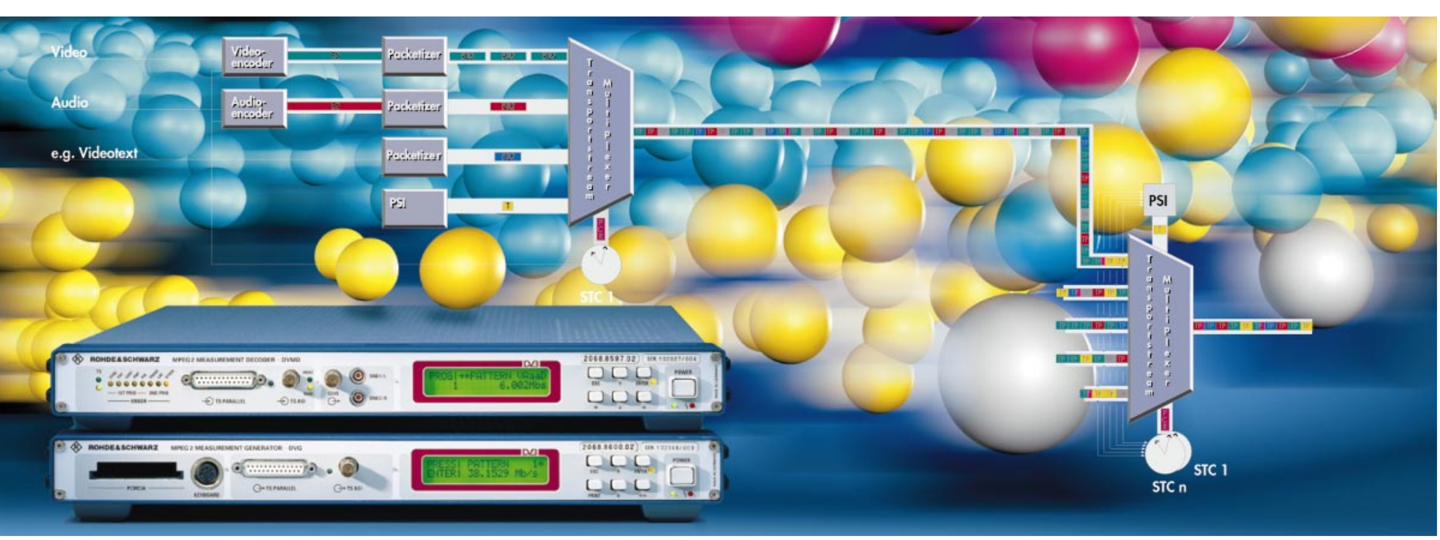
Multimedia

Parallel to the revolutionary developments in the field of broadcasting, a union of the worlds of audio/video, telecommunication and computer was started up last year for the consumer sector (FIG 1). "Multimedia" is synonymous for the convergence of the applications.

In this context the foremost feature is the **combination of devices in the home** such as desktop workstations, CD video, digital video cassettes, CD players and/or video cameras to form a kind of local area network (LAN). The second feature, which is **interactivity via a data channel,** can nowadays already be implemented via digital telecommunication media such as GSM/PCN (global system for mobile communications/personal communication network), ISDN (integrated services digital network) or Internet. Multimedia also implies a third feature, ie the broadband **transmission of moving pictures, sound signals and data services.** The classic broadcasting media using terrestrial, satellite and cable transmissions with SMATV (satellite master antenna TV) are utilized in the introductory phase. Further broadcasting media such as MMDS (multichannel microwave distribution system), BISDN (broadband ISDN) or IBCN (integrated broadband communications network) or ADSL (asymmetrical digital subscriber line) are being developed and made accessible for multimedia transmission. The interactivity potential is taken account of by an initially narrowband back channel in the transmission medium.

The new multimedia world needs acceptance by the consumers of course. Therefore it must be introduced step by step. In the first step compatibility between the existing TV receiver and the new digital transmission technology will be established with the aid of the set-top box or the integrated receiver decoder (IRD). The set-top box has functions similar to a computer to establish the connections between the digital broadcasting medium and the conventional TV receiver, the PC and the telecommunications network, ie it is a multimedia switching center. Broadband transmission channels for multimedia are specified in the form of DAB and DVB-S (satellite), DVB-C (cable) and DVB-T (terrestrial) and their imple-

FIG 3 MPEG2 Generator DVG and Measurement Decoder DVMD for DVB transport data streams [3]



mentation is already in progress in some European countries.

The new **digital transmission technologies** bring decisive **benefits for the consumer:**

- low-cost receivers in a multimedia environment,
- good picture quality (SDTV) to high definition TV,
- large number of programs,
- portable reception of terrestrial TV programs,

as well as for the **network operator:**

- economical utilization of the resource frequency,
- flexible use of the transmission channel,
- reduction of investment, energy and service costs.

Therefore the implementation of the DAB and DVB standards is being strongly pushed ahead as shown by the following examples.

Implementation of DAB began in 1995 with the Bavarian pilot project as the first project worldwide using single-frequency operation on this scale. In addition to the channel-12 transmitters including DAB coder/decoder, Rohde & Schwarz supplied the complete infrastructure with audio baseband coding (MUSIC) and DAB multiplexer as well as program distribution via satellite. German Telekom recently started commissioning 60 DAB L-band transmitters for a national coverage network with Rohde & Schwarz as the main supplier.

Digital video broadcasting was started in mid-1996 via the SES-ASTRA satellite 1F, which was launched to its orbital position 19.2° east from the Baikonur (Kazakhstan) cosmodrome in April 1996. Another two ASTRA digital satellites are planned for 1997. Eutelsat, too, will take up digital television in 1997 via the Hot Bird satellites 4 and 5.

Broadband cable technology is optimally prepared for digital television with interactive communication: the hyperband originally intended for D2MAC transmission is now available. In addition, interactive capability in the form of the back channel is given in the range from 5 to 20 MHz. German Telekom will have equipped its cable headends with modern digital systems for 64QAM modulation, frequency conversion and distribution by the end of 1996 and relies on well-proven Rohde & Schwarz technology (FIG 2). The next step will be the implementation of intelligent interactive headends with servers, billing and network monitoring as well as connection to public data networks.

FIG 4 TV Test Receiver EFA with QAM measurement functions for DVB-C [4]

Terrestrial digital video broadcasting will be started in the UK in 1997 with the programs of NTL and BBC. In Germany, DVB-T pilot projects in Berlin, Cologne and Munich are now in the planning stage. Since 1995, a DVB-T transmitter from Rohde & Schwarz has been tested by the Swiss PTT. This transmitter can be switched over to the emission of PAL signals for coverage comparisons.

The particular strength of Rohde & Schwarz in analog broadcasting will be continued in the new digital technology. We offer solutions in the form of units, systems, turnkey single-frequency networks, broadband communication systems as well as remotely controlled test and monitoring equipment for network operators. With its key products for digital broadcasting system and test equipment (FIG 3 and 4), Rohde & Schwarz is right now best prepared to live up to its reputation as one of the world's leading DAB/DVB suppliers and to master the quantum leap into the digital future of broadcasting and multimedia communication.

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