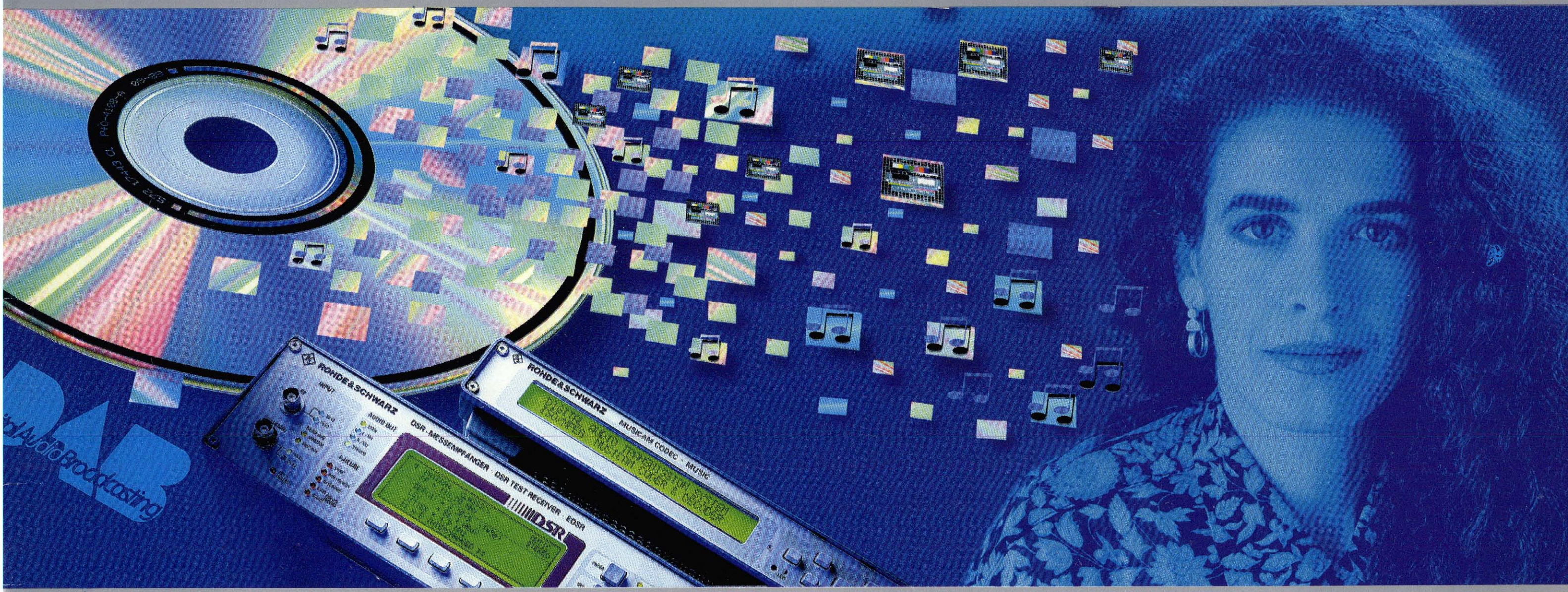
News from Rohde & Schwarz



Focal topic
Digital radio

New test equipment
for digital mobile radio

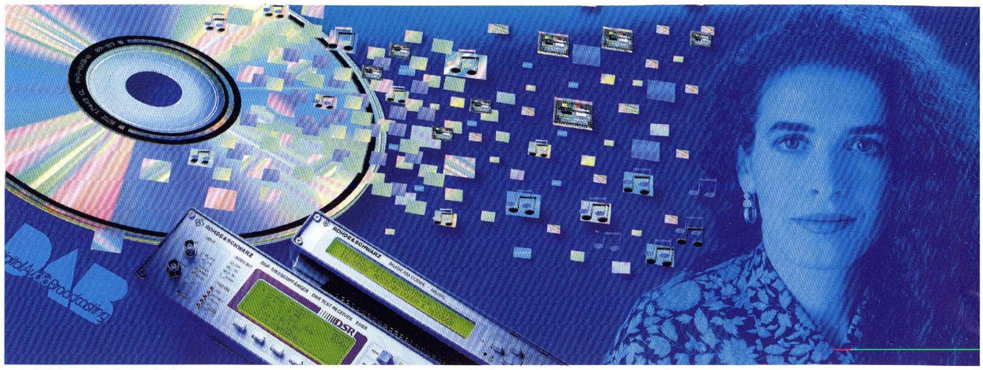
Power sensors
– just plug in and go

145

ROHDE&SCHWARZ

Number 145 1994/II Volume 34

Digital radio – from source to receiver. Rohde & Schwarz is there all the way with system and measuring equipment. For instance with DSR Test Receiver EDSR (page 4) and MUSICAM Codec MUSIC (page 31). All articles dealing with digital radio – this issue's focal topic – are marked by a blue dot.



Articles

Application notes

Refresher topic

Panorama

Regular features

Whether GSM, PCN or DAB – the test vehicle for field-strength coverage measurements allows all digital radio networks to be tested. For more information about its use in digital audio broadcasting see page 24. Photo 41 564/6

Imprint

Published by ROHDE & SCHWARZ GmbH & Co. KG Mühldorfstraße 15 D-81671 Munich Telephone (0 89) 41 29-0 · international *(4989) 41 29-0 · Telex 523703 (rs d) · Editors: H. Wegener and G. Sönnichsen (German); C. B. Newberry, I. Davidson, G. Koranyi (English) · Photos: S. Huber · Circulation 100 000 three times a year · ISSN 0028-9108 · Supplied free of charge · State company or position · Printed in the Federal Republic of Germany by peschke druck, Munich ·

DSR Test Receiver EDSR

Transmission reliability in digital radio

Test Receiver EDSR monitors, analyzes and processes DSR (digital satellite radio) signals broadcast via satellite or cable networks. It detects, assigns and logs faults and interference on transmission links, and is used for fully automatic signal monitoring at cable head-ends and at service providers as well as for on-site troubleshooting.

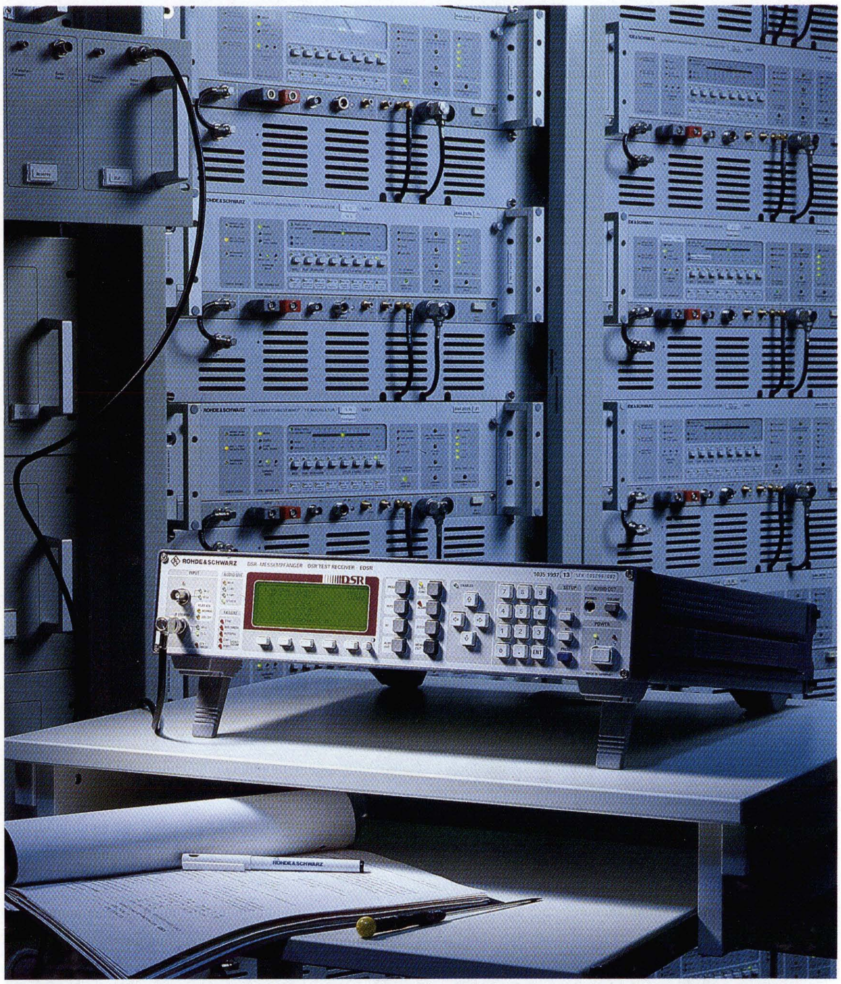


FIG 1 DSR Test Receiver EDSR monitoring a cable head-end

Photo 41 589/1

A test receiver for digital sound-broadcast signals, EDSR (FIG 1) comes equipped with a high-grade AF section. The digital audio signal first passes through an interpolation filter, which markedly improves transmission quality in the event of adverse receiving conditions (ie high BER). The signal is then routed through a digital oversampler and a digital filter, and reconverted into an analog sound signal by two highly linear, extremely low-noise 16-bit D/A converters. An analog filter chain then follows, with extremely low phase distortion even at the limits of the transmission range. A practically stepless, digital level control is provided for volume adjustment of headphones and loudspeaker. The audio signal is output via rear connectors for further processing. A special version of EDSR with additional balanced and floating outputs of highest quality (XLR male connectors) is available, in particular for relay reception and studio applications.

Special **features** of EDSR include:

- tunable input (54 to 854 MHz), impedance switchable between 50 and 75 Ω,
- continuous monitoring of BER without interruption of ongoing program,
- outputs for I/Q signals for visual assessment of transmission quality on oscilloscope (FIG 2),
- digital inputs and outputs for mainframes A and B [1; 2],
- simultaneous acquisition of BER, input level, jitter, synchronization, interpolation and headroom,
- display of input level in dBm, dBpW, dBµV or µV/mV,
- instantaneous display of alarm messages by LEDs on front panel,
- alarm messages when user-selected limit values are exceeded, storage of messages with date and time in alarm register,
- statistical evaluation of alarm messages,
- variety of analog and digital interfaces,
- remote control via IEC/IEEE bus,
- Centronics printer interface and user port,
- decoding of selected sound channel,
- correction of digital audio signal in line with detected bit errors,
- display of program identification and program type,
- automatic program selection according to desired program type,
- digital audio output to standard IEC-958-C, eg for connecting DAT recorder,
- balanced, floating audio outputs (option),
- high reliability due to automatic self-test routines,
- user-friendly, menu-guided operation via LCD display and combined hardkeys and softkeys; direct callup of all important functions.

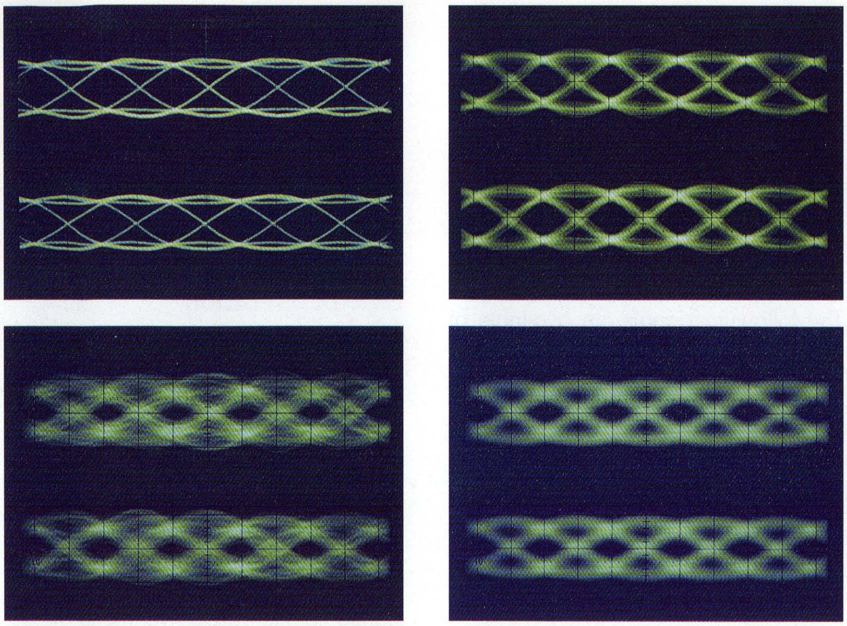


FIG 2 I/Q eye patterns measured with EDSR displayed on oscilloscope. Settings: 500 mV/div, 50 ns/div
a) Ideal test signal, generated by DSR Modulator SFP [3]; measured BER: 0×10^{-9}
b) Real DSR signal, generated by SFP; measured BER: 0×10^{-9}
c) Receive signal disturbed by reflections on transmission path; measured BER: 2×10^{-3}
d) Noise in cable channel amplifier, disturbed reception; measured BER: 2×10^{-3}

Recording faults and interference

Various faults can occur in the transmission of DSR signals. For example, mismatch in the cable network may cause reflections, distorting the original signal to such an extent that unimpaired reception is no longer ensured. Similar degradation is possible when there is noise in channel amplifiers and converters or if there is insufficient headroom. In contrast to analog technology, overloading of digital audio channels is perceived to be unpleasant and simply must be avoided.

In EDSR the user has a tool that reliably detects errors of this kind: input level, synchronization, BER, interpolation and headroom are continuously monitored (FIG 3). The user may define threshold values for level, BER and headroom; an alarm will be generated if a threshold is exceeded. Synchronization loss and interpolation are signalled too. The status is indicated for each parameter by red LEDs on the front panel.

Acquiring bit errors

Beside quality assessment of the transmission characteristics of the DSR signal, quantitative evaluation of the signal, ie determination of bit error rate, is one of the main tasks performed by EDSR. A new test method enables EDSR to evaluate the BER directly, ie without inserting test signals into the program signal. This is necessary because the transmitter, into which a PRBS (pseudorandom bit sequence) signal would have to be fed, is not accessible as a rule. With the method used here, the error-protection data of the DSR signal are evaluated and the BER is determined by bit-by-bit nominal/actual value comparison. The measurement range extends over seven powers of ten from 10^{-2} to 10^{-9}.

A special feature of EDSR in measuring BER is the automatic adaptation of gate time to measured value. This means that the measurement is carried out fully automatically and operator errors are thus avoided. If, with a low BER, the gate time has not yet elapsed, eg shortly after power-up, the elapsed gate time as well as the total gate time will be displayed, providing information on the BER after just a few seconds.

What is DSR?

With digital satellite radio (DSR), which is also offered by Deutsche Bundespost Telekom in cable networks, a sound-broadcast system is available that fulfills all requirements as to sound quality and convenience of use [1; 2]. 16 stereo channels, or 32 mono channels, are transmitted on a digital basis – providing sound quality comparable to that of the compact disk. The sound channels are coded, provided with error protection information, and made into two digital data streams of 10.24 Mbit/s each, which are superimposed on a carrier for phase modulation. As a result of the two data streams, four phase states are possible (quadrature phase-shift keying, QPSK).

The QPSK-modulated carrier, ie the DSR packet, supplies 16 radio programs in digital quality. The receiver decodes the desired program from the data stream. The display reads out the name of the selected broadcasting station (program identification) and the type of program selected, eg news, sport, classical music. Some DSR receivers feature automatic program selection according to the program type desired by the user.

At present a DSR packet with 16 stereo programs is broadcast in Germany nationwide via cable and satellite. Some neighbouring countries, eg Switzerland, use the same system. Negotiations on further DSR packets for use in Germany are in progress.

Alarm messages can be stored with date and time in an internal alarm register that provides the user with a chronological list of fault events (FIG 4). The list can also be output on a printer. The user can configure the program to select what alarm messages are to be stored in the alarm register, eg headroom threshold exceeded (FIG 5). In addition, EDSR forms statistics of the alarm messages collected over the last 24-hour period.

Versatile digital interfaces

To meet very different requirements for program feed, EDSR not only has analog inputs but also digital inputs for mainframes A and B. Data streams A and B contain the entire information of a DSR packet with a data rate of 10.24 Mbit/s each [1; 2]. The data applied require no additional clock as the latter is generated by the unit itself. Both differentially encoded and uncoded signals may be applied.

The following **signals** are available at the outputs for mainframes A and B:

- digitized I/Q signals prior to synchronization,
- digitized I/Q signals after synchronization,
- mainframe signals A and B after differential decoding,
- mainframe signals A and B after differential decoding and descrambling.

In addition, the system clock of 10.24 MHz is available. All outputs are TTL-compatible and can be loaded with 75 Ω.

Ease of operation

Despite the wide variety of functions provided, EDSR affords great ease of operation. The user is able to see at the same time all essential status information and test results on the clear-cut LCD display. Menus are called via hardkeys, whereas menu items are selected via softkeys, which are directly assigned to the respective menu fields. Lateral menus were deliberately not included in the menu structure; submenus exist only for a few special functions. A status line on the display indicates the currently active menu. In the alarm configuration menu (FIG 5), for example, the user can define by means of toggle keys the type of messages that are to be saved in the alarm register (enable) and those that are not (disable). Up to 50 user-definable device setups can be stored in nonvolatile memory in addition to the basic configuration. Upon power-off, the setup last active will be retained.

Christoph Balz

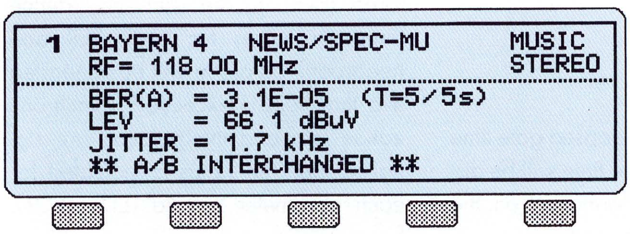


FIG 3 Display of EDSR with test results

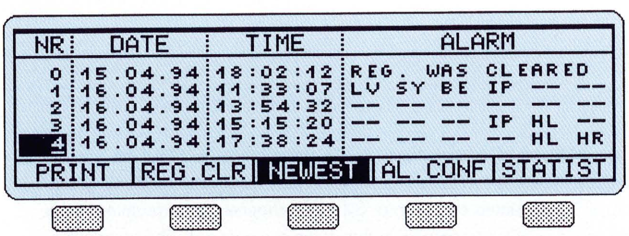


FIG 4 Example of messages enabled for storage in alarm register (LV = level, SY = synchronization, BE = bit error rate, IP = interpolation, HR = headroom right, HL = headroom left)

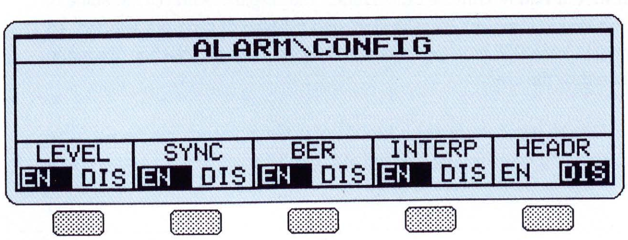


FIG 5 In alarm configuration menu, individual messages can be disabled, ie they will not be stored in alarm register.

REFERENCES

[1] Treytl, P. (ed.): Digitaler Hörfunk über Rundfunksatelliten. 2nd edition, revised. Deutsche Forschungsanstalt für Luft- und Raumfahrt (DLR). Published by Federal German Ministry for Research and Technology

[2] ARD/ZDF: Techn. Richtlinie Nr. 3R1: Digitaler Satelliten-Rundfunk (DSR). Spezifikation des Hörfunk-Übertragungsverfahrens im TV-SAT. Published by Institut für Rundfunktechnik, Munich

[3] Dietl, A.; Kleine, G.: SFP, DSRU and DSRE – the pleasure of digital sound with CD quality. News from Rohde & Schwarz (1991) No. 135, pp 22 – 24

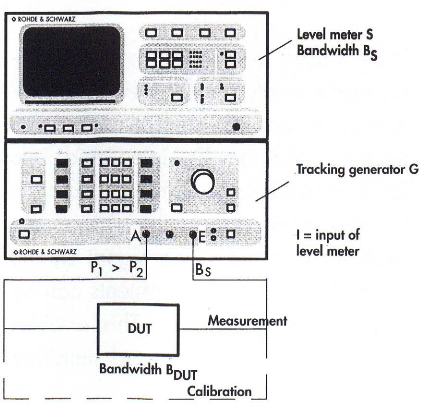
Condensed data of DSR Test Receiver EDSR

Frequency range	
RF input	54 to 854 MHz
IF input	118 MHz
Input impedance (RF/IF)	50/75 Ω, selectable
Input level range	-60 to +10 dBm
Demodulation	QPSK
IF bandwidth	10.5 MHz
Data rate	2 x 10.24 Mbit/s
Audio frequency response (20 Hz to 14.5 kHz)	±0.3 dB
Distortion (40 Hz to 14.5 kHz)	≤0.02 %
Interfaces	IEC 625-1, RS-232-C, Centronics

Reader service card 145/01

Convenient noise-figure measurement on electronic DUTs

The invention makes noise-figure measurements easier and more cost-effective, doing away with the noise source required for conventional procedures while ensuring high measurement accuracy. The invention utilizes the fact that, in the formula for calculating noise figure, the values for high and low noise temperature used with conventional procedures can be replaced by corresponding noise power levels. This is the basis of the patented method, which uses a sinewave generator signal to determine the noise figure instead of the broadband signal from a separate noise source which was used so far. Generating two sinewave signals with different levels with one frequency generator is much less complicated than using a separate, switchable diode noise source. Nevertheless, the measurement is very accurate because the inherent noise of the level meter is determined prior to measurement using the conventional calibration method.



A spectrum/network analyzer or a test receiver (eg ESS, ESN or ESxl from Rohde & Schwarz) with a tracking generator as a sinewave source is ideal for implementing the patented method. With this type of analyzer it is very easy to determine the noise figure of any type of electronic DUT, eg components, amplifiers and the like. For calibration, the output of the tracking generator is connected to the adjacent input of the analyzer. The analyzer is calibrated using two signals with different output levels, then the DUT is connected between the output of the tracking generator and the input of the analyzer (FIG). For the noise-figure measurement the two signals are applied to the DUT. As the noise generated by the DUT is normally very low, a frequency generator which can go down to very low output levels should be used.

The patented method can handle single-frequency measurements as well as automatic, step-by-step frequency measurements over the entire band of the tracking generator. Calibration can be performed in the latter case at each discrete frequency prior to noise-figure measurement, or as part of an initial test run at selected testpoints of the frequency band with the noise-figure measurement being performed in a second test run. It is important to note that only the calibration factors and frequency results that lie within the bandwidth B_S of the level meter are taken into account in the subsequent analysis.

Extract from European patent DE 41 22 189 C2
Application by Rohde & Schwarz on 27 June 1991
Date of publication 7 October 1993
Inventor: Hermann Boss

Implementation of patented method using Test Receiver ESxl

Enter 145/02 for further information on spectrum analyzers

Digital Video Component Analyzer VCA

Waveform monitor and signal analyzer for digital video signals to CCIR 601

Now that the CD has conquered the audio world, it is television which is on its way into a digital future. Although digital signal transmission from a TV transmitter via satellite is still in its definition phase, it is now standard practice to digitize the video signal at its source in the TV studio. Combining the characteristics of a waveform monitor and an analyzer and providing clear displays, VCA is suitable for a great variety of measurements and allows easy handling of digital techniques.

FIG 1 Digital Video Component Analyzer VCA – universal helper in operating and servicing digital TV equipment Photo 41 573

Many units used in a TV studio, such as recorders, mixers, stores and effect generators, are already purely digital. Thanks to the new standard CCIR 601/656 [1] (USA: SMPTE 259M/125M) connection of such equipment may also be digital. To this end, the three components of the video signal (luminance component and two colour-difference components), coded in 10-bit data words in time-division multiplex with 270 Mbit/s, are transmitted without loss in quality via a single coaxial cable up to 300 m long. The number of video units equipped with this interface is increasing from day to day – a good reason for Rohde & Schwarz to provide operating and service personnel with a measuring instrument that meets the above requirements, ie Digital Video Component Analyzer VCA (FIG 1).

Applications

In digital video, as for analog studio applications, appropriate measuring and monitoring equipment is required to ensure reliable operation. The tasks to be performed include level adjustment of camera signals, feed-in of analog signals as well as manipulation and switchover of signals. Moreover, even digital equipment may go faulty and operator's errors cannot be excluded either. Digital transmission presents special problems. Unlike the analog signal, the video signal is not directly affected by interference and so its quality is not deteriorated. Decoding remains largely errorfree up to a certain degree of interference even with the use of long cables and in the presence of additive interfering signals. However, a total breakdown of transmission may occur suddenly without any prior warning.

To prevent such breakdowns, VCA helps all users of new studio technology in the operation, servicing and development of digital TV equipment. This new analyzer combines conventional measurement methods, as known from analog TV waveform monitors, with new functions to check digital coding and monitor digital signal transmission.

The **measurement functions** performed by VCA are as follows:

- detection of weak spots in signal transmission prior to total breakdown of synchronization,
- display of bit errors,
- checking of sync frame (to avoid infringement of standards),
- monitoring of camera signals,
- monitoring of signal distribution in the studio,
- monitoring of signal generation,
- monitoring of signal manipulation.

VCA is used to monitor the digital video signal at all transfer points of a TV studio. An optional remote-control unit enables VCA to be integrated into large measuring systems for comprehensive monitoring in the studio. If a problem with the video signal should arise, the VCA screen contents can be frozen and printed out. This enables documentation of errors and simplifies troubleshooting.

Scope functions

VCA provides a **scope waveform display** for analyzing the waveform of the digital signal. In addition to the possibilities already known from monitoring analog component signals, such as the display of one of the three components (Y, C_B, C_R), display of paraded and overlay waveforms, primary-colour display (green, blue, red), expansion in time and amplitude as well as free line selection, VCA allows direct output of data words using a cursor. Thus the precise digital values of the signal components can be read off for each sample (FIG 2).

VCA provides adjustable averaging to free signals of noise, so also permitting measurement of video signals from the "analog world", which are not usually as constant as digital signals. With test signals it is thus possible to quickly determine the quality of A/D conversion. Thanks to the integration of an ideal, digital D/A converter followed by a standardized filter, VCA can also analyze the quality of D/A conversion by simulating this conversion and displaying the digital video signal exactly like that obtained from D/A conversion.

When it comes to localizing digital-specific errors of the digital video signal and analyzing data words not visible in the picture, it is necessary to display the video signal at bit level. This is possible by means of the **numeric dump** function, permitting digital values to be called up in hexadecimal, decimal or binary numbers together with the associated sample designation and numbering. This combination allows checking of digital sync words and of any sound and ancillary data in the blanking interval (FIG 3).

Measurement functions

With these functions, VCA's capabilities go far beyond a normal signal display. They include three monitoring functions for live signals and two measurement functions for special test signals. The monitoring functions, which are also active in the background of scope mode, are used to test transmission reliability during operation. They check the most sensitive component of the digital video signal, ie the sync frame, which is just as sensitive to interference as picture contents. However, while errors in picture contents may be tolerated, sporadic errors in sync data words may cause complete failure of transmission. The same applies to picture data words that take on the values of sync data words. Since simply observing the picture on the monitor is not much help in this case, it is necessary to assess the three monitoring parameters TRS error, video range error and reserved code error.

TRS error: The timing reference signal (TRS) includes a preamble as well as a protected code word containing all synchronizing data. VCA continuously checks this information to ensure that data remain in compliance with valid standards. Single bit errors are normally corrected and are evaluated as an error rate by VCA or represented on a history display. The error rate is the number of incorrect fields (measured value displayed), while the history display shows the occurrence of errors in time. The frequency of errors can be seen from the points accumulating on the display (FIG 4).

The transmission link is not the only cause of serious faults or failures of the digital video signal, other error sources to be taken into account are signal generation and processing. So VCA also checks data contents. Measuring the **video range error** and thus continuously monitoring the digital video signal ensures that the level is neither too high

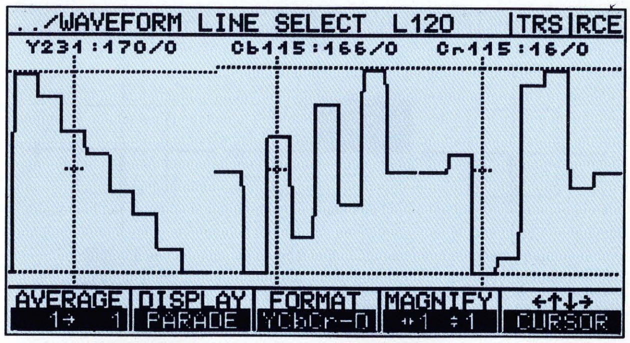


FIG 2
Waveform line select

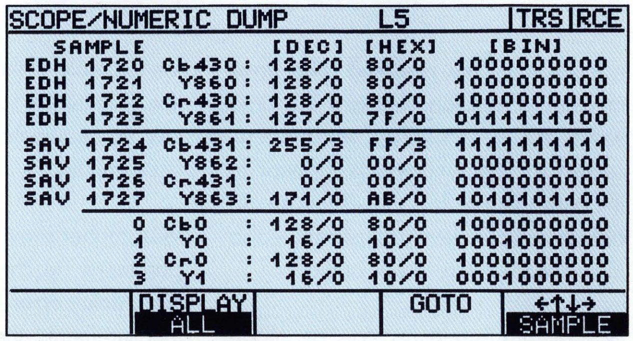


FIG 3
Numeric dump

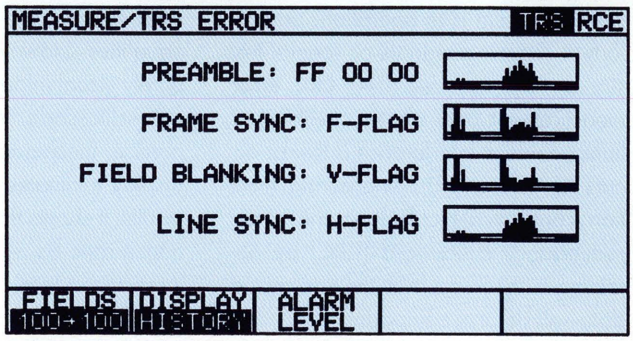


FIG 4
TRS error
displayed
as history

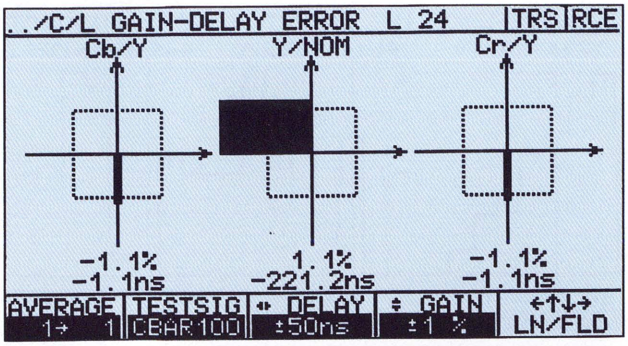


FIG 5 Chrominance/luminance gain/delay error

nor too low. The **reserved code error** measuring function checks if the data words #00/x and #FF/x, which are reserved for the sync words, appear in the active video. This makes it easier to obtain optimum level adjustment – also in confined picture areas of the TV.

Not all measurements can be made while a system is in operation, particularly if repetitive signals or special test signals are required. The **CRC error** measurement only allows checking of lines on which interference is low or occurs very rarely. This measuring function continuously calculates the cyclic redundancy checkword (CRC) by obtaining a checksum from the transmitted data words and comparing it with the value averaged during the previous measurement. With digitally generated test patterns, such as produced by TV Generators SAF and SFF with the CCIR 601 option [2], this checksum is specific for every test pattern. If differences or changes of video data are detected at the end of the cable or any other link, transmission is no longer errorfree. Testing with different signals will indicate whether these irregularities are due to malfunctioning of the unit or whether a complete synchronization and thus signal failure is about to take place. VCA is also able to display these errors as a function of time, so offering the possibility of detecting sporadic errors such as caused by radiotelephones or loose contacts.

One of VCA's special features is the individual monitoring of all ten bits. It is thus possible to detect sporadic errors in the parallel lines of the transmission, for example if there is a faulty signal line or there are faults in the picture processing equipment (recorder, frame store, mixer).

VCA further provides an almost classic parameter, ie **chrominance/luminance gain/delay error** (FIG 5). As in analog measurements, the colour bar signal is used to measure delay and level inequalities. However, compared to the purely visual information obtained from an oscilloscope, VCA is able to furnish precise measured values. A graphic display facilitates evaluation of the test results. It shows the chrominance/ luminance ratio as well as the departure of luminance level from the standard signal. This allows the dynamic range and timing of A/D and D/A converters and of analog modules to be checked as well as clock errors to be detected.

Harald Weigold; Werner Rohde

REFERENCES

[1] CCIR Rec. 602-1 (Encoding Parameters of Digital Television for Studios); CCIR Rec. 656 (Interfaces for Digital Component Video Signals in 525-Line and 625-Line Television Systems)

[2] Zellner, B.: CCVS + Component Generator SAF and CCVS Generator SFF - the allrounders for analog and digital TV measurements. News from Rohde & Schwarz (1994) No. 144, pp 24–25

Condensed data of Digital Video Component Analyzer VCA

Inputs	1 x serial, 1 x parallel
Outputs	actively looped-through inputs
Standards	CCIR Rec. 601/656, SMPTE 125M/259M 8 and 10 bits, 625/525 lines
Oscilloscope	waveform line select waveform numeric dump
Measurements	TRS error reserved code error video range error CRC error C/L gain/delay error
Printer interface	RS-232-C/RS-422-A
Remote control (option)	RS-232-C/RS-422-A

Reader service card 145/03

Power Test Station TSAP

Complete testing of electronic power circuits

Comprehensive testing is a must when producing and servicing power supplies and electronic power circuits, since defective components might pose danger to man and material alike. Power Test Station TSAP ensures proper functioning of the DUT and full compliance with specifications thanks to a combination of in-circuit and special power tests.

In times when power supplies and other electronic power circuits consisted of a few components and were thus relatively easy to test, manufacturers made use of their own selfmade test systems. Nowadays this is quite different, as circuits of this type are highly complex and often comprise a control section with integral microprocessor in addition to the power circuits. Also the demands placed on the testing of these kinds of circuits have become much higher. It is not enough to just connect a load to the DUT and measure output current or voltage with a multimeter, instead all performance data of the circuits have to be checked. And it has to be possible to store test results and call them up when needed. The latter is especially important with a view to ISO 9000 and product-liability legislation.

So electronic power circuits require special functional tests which on the one hand check compliance with specifications, and examine special facilities protecting the circuits against shorts or overvoltages on the other. Plus, the test should take a minimum of time and provide clear and accurate indication of defects. Power Test Station TSAP from Rohde & Schwarz (FIG 1), based on the familiar Test Workstation TSA [1], fully meets these requirements.

In-circuit tests

An in-circuit test is the first step of a comprehensive power circuit test using Power Test Station TSAP. Prior to applying supply voltages to the circuits, it is necessary to ensure that there are no manufacturing defects on the module. Thus the circuit must not have any shorts, opens or incorrectly placed or poled components. This is vital for electronic power circuits, since such defects could destroy modules after switch-on. An in-circuit test is the ideal test for series production. All manufacturing defects or faulty components on the DUT are detected quickly and reliably, allowing easy repair by trained personnel.

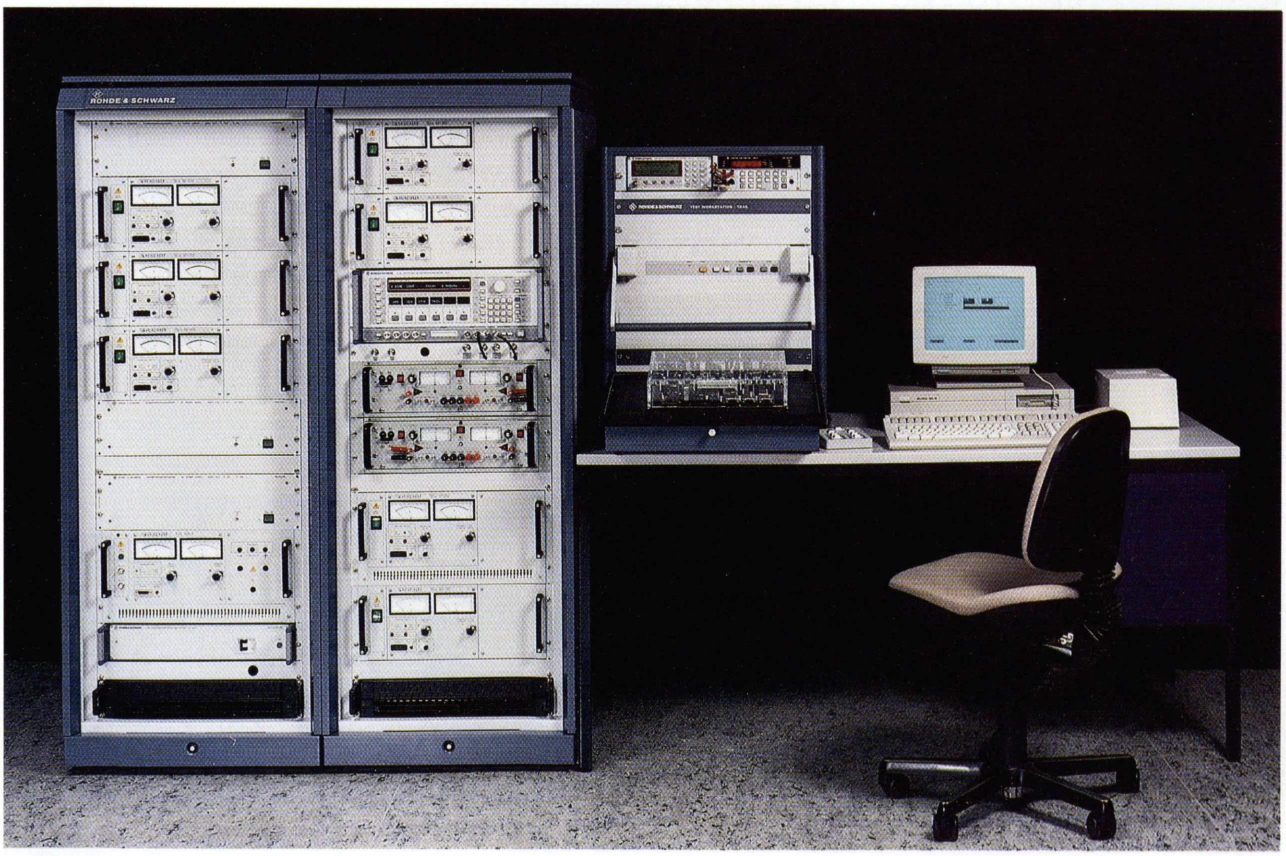


FIG 1 Power Test Station TSAP – new member in TSA family – precisely localizes all defects on power supplies and other power modules.
Photo 40 958

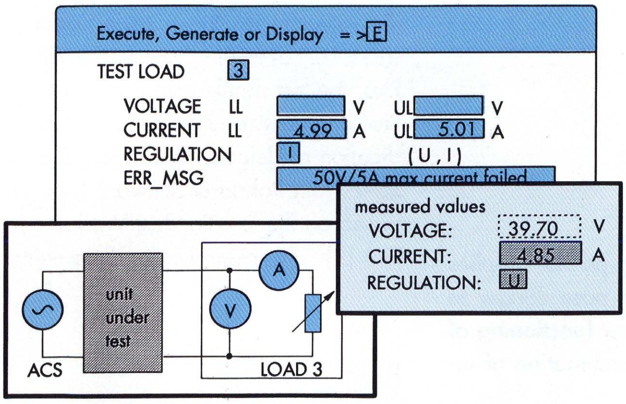


FIG 2 Simple and rapid generation of test program using interactive power-test generator

Another advantage of the in-circuit test is the simple generation of the test program. The test-program generator of TSAP generates the in-circuit test program almost fully automatically on the basis of the module board description and a component library built into the test system. The board description (component list and wiring list) can be transferred entirely from a CAD system. The programmer then only has to make minor changes to the test program for adaptation to series production.

Power tests

The in-circuit test is followed by a functional test. With Power Test Station TSAP this can be done in a single test run. The in-circuit test is aborted after detection of faulty modules, because any defects found first have to be eliminated. During the functional test, the test system checks the performance data of the module and its behaviour in special situations or under loading at the limits. There are fixed test procedures and the individual steps are created via menus using the power-test generator. Only test parameters and permissible limits have to be entered. The complete test step is then generated by hitting a key and can be added anywhere in the program (FIG 2).

Series testing is also practically automatic. The program is automatically loaded by means of a fixture coding. Prior to each test, the type designation and series number of the module are queried; they can either be entered manually or read in via barcode. If required, a report can be provided after each test, or the most important parameters can be stored in the controller and called up any time for proof of the test.

The type and form of individual tests and the hardware configuration of Power Test Station TSAP largely depend on the type of DUT and the intended tests. The most common ones involve measurement of output current and voltage for different loads, the influence of input-voltage changes on output voltage, measurement of hum on output voltage and efficiency measurements.

Power tests

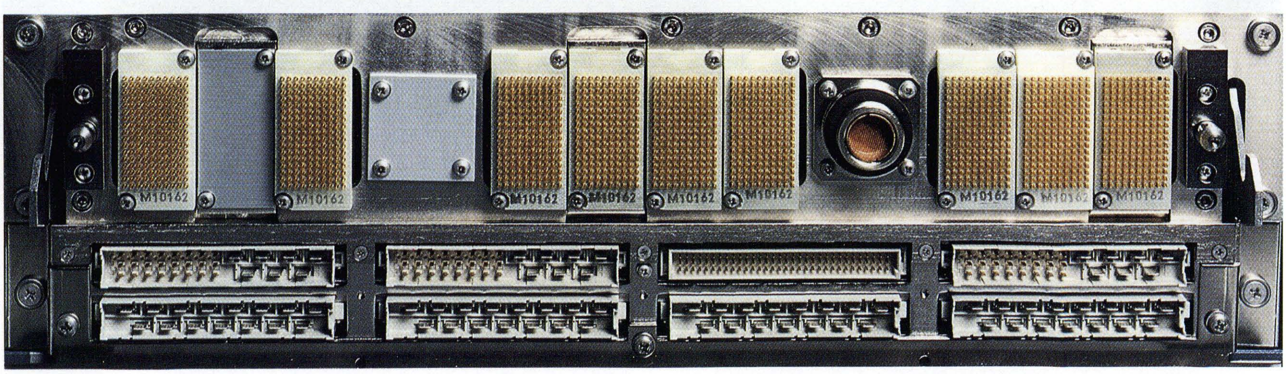
- Output voltage (with and without load)
- Load current
- Current drain
- Input power (active/reactive/apparent power)
- Efficiency
- Load effect
- Source effect
- Cross regulation
- Ripple and noise measurement
- Frequency and pulse width of switching regulators
- Load transient recovery time
- Current limiting
- Shortcircuit behaviour
- Overvoltage protection
- Overvoltage shutdown
- Power-fail function
- Automatic trimming

The behaviour of the circuit in the event of shorts, overload or overvoltage can be tested too (see blue box).

System design

Power Test Station TSAP essentially consists of a TSA base system with additional hardware to carry out power tests. Various accessories such as electronic loads, power supplies for DC and AC voltages, instruments to measure hum voltage and noise as well as instruments for apparent and reactive power are integrated. Connection of

FIG 3 The interface of Power Test Station TSAP is fully compatible with TSA and TSAS system interface, but has additional contacts for high voltages and currents. Photo 40 964



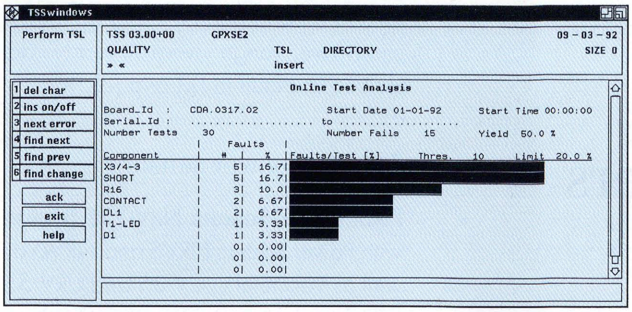


FIG 4 Graphic display of defect statistics for particular module type (ten most common defects)

these extras to the DUT is via special power relays in the test system. By contrast with Test Workstation TSA, the fixture interface was upgraded with contacts for high voltages and currents (FIG 3). However, the TSAP interface is fully compatible with that of TSA and TSAS systems [2], so fixtures of these testers can still be used.

TSAP also includes auxiliary facilities such as discharge circuits, freely assignable relays and test shunts. Especially in the testing of electronic control circuits it might become necessary to simulate signal flows either at the input or at the output of the DUT. Loads, voltage sources and DC/AC amplifiers can then be directly controlled by function generators or even by arbitrary waveform generators, thus allowing simulation of unusual signals. Finally, trimming using motorized screwdrivers and built-in resistor decades is possible during the test run.

ISO 9000

But comprehensive testing is not an end in itself. If a company wishes ISO 9000 certification or if it has already been awarded one, not only has the test procedure to be documented and verifiable but also the test result for every product. Either accurate records of test results are kept or the facilities provided by the TSA tester family are utilized to store all data occurring during a test.

The TSA facilities are also useful for paperless repair. Instead of a printout, data on defects are stored and can be called up onscreen for the purpose of repair. Data from all tests and repairs can be stored, thus providing a complete "curriculum vitae" of the module, which might be useful when a unit is sent back for repair. Moreover, such data can of course be easily used to compile statistics on defects or manufacturing quality (FIG 4). Shortcomings in manufacture and product design can thus be rapidly detected and eliminated. This means for any enterprise that an efficient tool is available for ensuring longterm product quality.

Herbert Hönle

REFERENCES

[1] Tschimpke, L.: Test Workstation TSA for testing in electronics production and service. News from Rohde & Schwarz (1991) No. 132, pp 4–7

[2] Schröder, D.: Test Workstation TSAS tests complex boards in electronics production. News from Rohde & Schwarz (1992) No. 138, pp 4–7

Condensed data of Power Test Station TSAP

Analog in-circuit test	up to 1184 pins, 2- to 6-wire measurement
Digital in-circuit test	up to 1088 pins, 10 MHz
Analog functional test	different signal generators and measuring instruments can be integrated
Digital functional test	up to 512 channels, 10 MHz
Power test	different DC and AC sources, loads, DC/AC amplifiers can be integrated
Computer	PC 486/33 or MicroVAX 3100 or VAXstation 4000
Software	automatic program generator for in-circuit test, CAD data transfer, generation of chip tests based on CAE data, interactive test generator for functional and power tests, paperless repair and quality statistics

Reader service card 145/04

Peak Power Sensors NRV-Z, NAS-Z, NAP-Z

PEP measurements on TDMA radios, TV transmitters and lots more

Modern TDMA radio networks make high demands when it comes to power measurement. Rohde & Schwarz is taking account of this by continuously adding new probes and sensors to its range of voltmeters and power meters. Each family of these instruments is now fully GSM-compatible and provides measurement capabilities for other digital networks as well. Rohde & Schwarz is the only manufacturer offering cost-effective solutions for precise measurement of TV-transmitter sync pulse power.

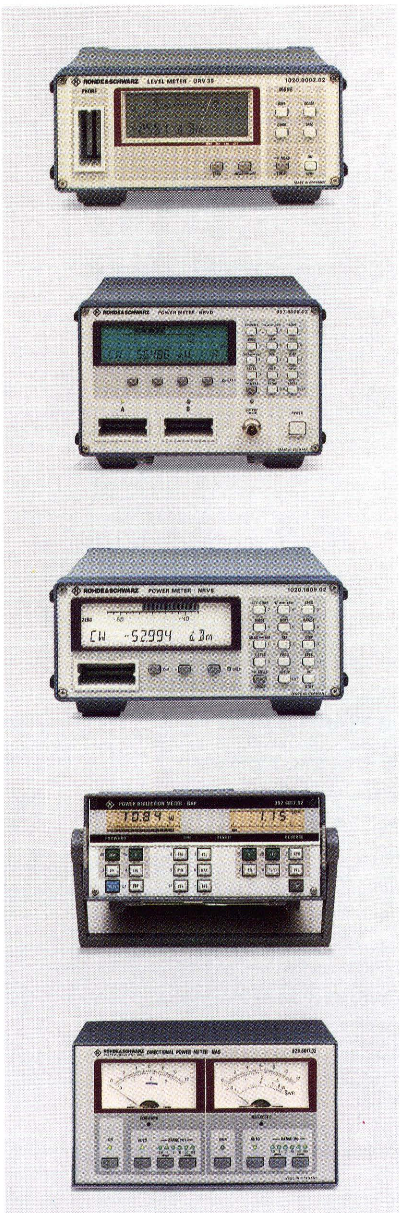


FIG 1 Power meters from Rohde & Schwarz: NAS, NAP, NRVS (identical to Millivoltmeter URV 55), NRVD and Level Meter URV 35 (from bottom)

Precision power measurements are still indispensable in the development and production of radio sets and radiotelephones as well as in the installation of complete transmitter systems. For modulated or pulsed transmitter signals, **measurement of peak envelope power** (PEP) is required to an increasing extent [1] in addition to precise measurement of the average power that can be performed with the aid of thermocouple sensors. Take for instance television, where the sync pulse power radiated at the rate of the line frequency is the test parameter. A similar measurement task is encountered in modern digital radio networks using time-division multiplex. The information for the individual voice and data channels is compressed and sent in narrow time slots. What one wants to measure is the power within the time slot and, possibly, the peak and average power. For the above applications and for many others requiring PEP measurement, Rohde & Schwarz offers a large variety of sensors (see table at end of article). All these sensors are of course able to measure precisely the power of CW signals too. Insertion Units NAS-Z6 for the GSM band and NAP-Z7/Z8 for the shortwave range were already described in detail in [2] and [3].

The new power sensors

Peak Power Sensors NRV-Z31 for use with Power Meters NRVS and NRVD as well as Voltmeters URV 35 and URV 55 (FIG 1) are designed for a variety of applications. They permit direct measurement of low power in the micro- and milliwatt range, as for instance at the IF level of TV transmitters (FIG 2), whereas for measurement of high power right through to the kilowatt range a directional coupler or attenuator has to be connected ahead. NRV-Z31 comes in three models to handle different modulation parameters. Model 02 is designed for general applications with pulse widths from 2 µs and a pulse repetition rate from 10 Hz upwards. So it can be used for power measurements on low-frequency-modulated RF generators (eg diathermic apparatus), TDMA radio equipment (TDMA = time-division multiple access) with $\pi/4$ DQPSK modulation (DQPSK = differential quadrature phase-shift keying) and on many other sources. Even RF bursts with extremely small duty cycles (from 5×10^{-4}) can be measured.

Model 03 can be used for pulse repetition rates from 100 Hz. Having otherwise the same characteristics as model 02, this sensor is distinctly faster. It is mainly intended for system applications and for measuring the sync pulse power of TV transmitters. Model 04, the TDMA version of NRV-Z31, is tailored to the specific requirements of GSM, PCN and DECT networks. For almost a year these power sensors have been successfully used in the production of cordless telephones to the digital DECT standard. All models feature a signal-controlled peak-hold circuit (patent pending), which ensures optimally short measurement times.

Insertion Units **NAS-Z7** and **NAP-Z10/Z11** enable **directional power measurements** in conjunction with the

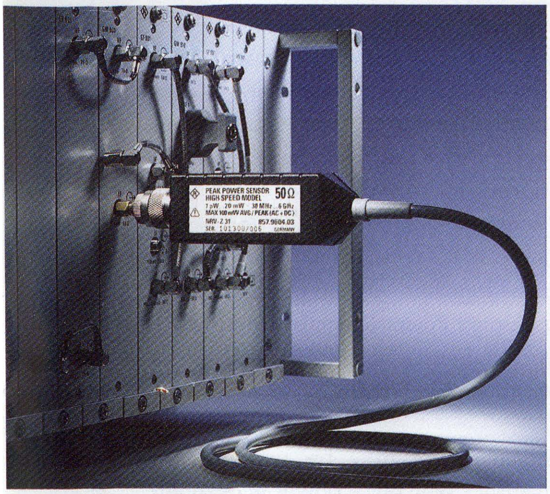


FIG 2 Measurement of TV-transmitter sync pulse power at output of IF stage using NRV-Z31
Photo 41 059/2

basic units NAS and NAP [4; 5]. They are suitable for direct measurement of power and SWR at the output of mobile radios and stationary transmitters. Rugged design and ease of operation make them ideal for in-service measurements on site. Insertion Unit NAS-Z7 can be used for measurements on GSM and PCN base and mobile stations up to 30 W transmitter power (FIG 3). In conjunction with the handy, battery-operated NAS basic unit, it provides a budget-priced yet highly accurate solution for installation and monitoring tasks. And where a measurement uncertainty of a few percent more is no problem, NAS-Z7 can even be used in the entire frequency range from 1 to 2 GHz, for instance for measurements on the mobile stations of the satellite communications system Inmarsat M at 1.6 GHz.

Power Reflection Meter NAP is ideal for all **power and SWR measurements** requiring very high accuracy as well as digital display of the measured value, as for instance in system applications. The two new sensors **NAP-Z10 and NAP-Z11** (FIG 4), which come in two models each, open up several interesting fields of application. Model 02 is the ideal sensor for TV applications, TDMA radio equipment with $\pi/4$ DQPSK modulation and general applications with pulse widths from 4.5 µs. Model 04 was tailored to the requirements of the GSM network and measures the transmitted power of base and mobile stations with high accuracy. For less stringent accuracy requirements, it can already be used at a carrier frequency from 100 MHz and pulse width from 100 µs upwards.

Like all power sensors for NAP, NAP-Z10/Z11 too contain rectifier diodes which are operated exclusively in the square-law region. They behave like a thermal power sensor with short time constant. In addition to peak envelope power, these sensors can also be used to measure the average (AVG) power (by selecting this mode on NAP). Use of Power Sensors NAP-Z10 and NAP-Z11 requires a suitable firmware version of the basic unit. Older instruments will on request be updated by the local Rohde & Schwarz representative.

Power measurement on TDMA radio sets

In the new digital radio networks, voice and data are transmitted in **frequency and time multiplex.** Time multiplex means that the information for a certain number of channels is transmitted in consecutive time slots. Several consecutive time slots form a frame, and after this frame has been sent, the first time slot is normally used again. In addition to the frequency and power of the RF carrier, the duration of the time slot, frame width and modulation method are mainly relevant for power measurements. The modulation mode determines whether the envelope within the time slot is flat (eg with GMSK and GFSK) or whether it varies with the symbol rate as with $\pi/4$ DQPSK (FIG 5).

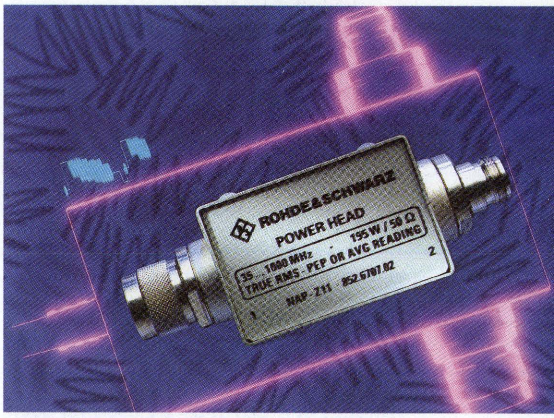


FIG 4 Peak Power Sensor NAP-Z11 (identical to NAP-Z10) for measuring sync pulse power of low-power TV transmitters (model 02) and for GSM applications (model 04)
Photo 41 286/2

GSM specifications (which also apply to PCN/DCS 1800) prescribe GMSK modulation. Eight time slots of 577-µs duration each form a 4.615-ms wide frame. Mobile stations occupy one time slot only and therefore send RF bursts of 577-µs duration and a repetition rate of 216.7 Hz. The specifications allow overshoots at the beginning of the transmission of up to 4 dB above the otherwise flat envelope of the burst. All GSM sensors from Rohde & Schwarz are able to measure the power of the pulse top, ie the transmitted power of the mobile station. Overshoots are suppressed for measurement.

Depending on radio traffic density, GSM base stations occupy up to eight time slots. Since, with a normal power

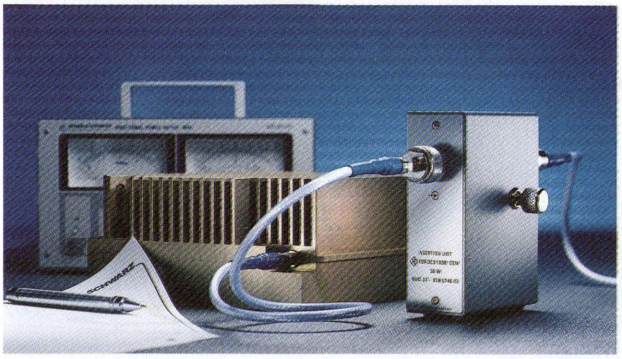


FIG 3 Power measurement at output of 1.8-GHz amplifier using NAS-Z7
Photo 41 528

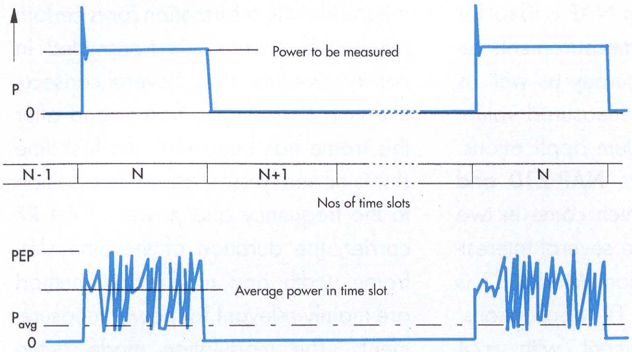


FIG 5 Envelope power of TDMA mobile station using GMSK or GFSK modulation (top) and π/4 DQPSK modulation (bottom)

meter, it is not possible to select a certain time slot, the power of the time slot in which the highest power is transmitted is usually indicated on the meter. If the base station transmits at several frequencies at a time, the RF carriers will be superimposed on one another. In this case it depends on the design of the sensor whether the sum of the individual carrier powers will be indicated as desired, or another value that is usually too high. Power Sensors NAP-Z10 and NAP-Z11 ensure correct power indication throughout the measurement range. NRV-Z31 may be used for such measurements up to a sum power of 10 µW.

TDMA radio sets using π/4 DQPSK modulation (eg to NADC, PDC or TFTS standards) also send the information in the form of RF bursts, but the power transmitted within the burst varies with the symbol rate. The fluctuations amount to +2/-12 dB referred to the average value.

NRV-Z31 (model 02) can be used to determine the PEP of many TDMA signals in line with relevant standards. Power Sensors NAP-Z10 and NAP-Z11 (model 02) additionally allow measurement of the power P_{avg} (averaged over the frame width, see FIG 5). If the average power is to be referred to the time slot, the value measured must be divided by the duty cycle of the RF burst. The maximum symbol rate for PEP measurements with π/4 DQPSK is about 10^5/s for NRV-Z31 and 5×10^4/s for NAP-Z10/Z11.

Measuring sync pulse power

The main standards for terrestrial television as defined by CCIR, FCC and OIRT prescribe **negative amplitude modulation** for the vision signal (C3F negative). This means that the sync pulses are radiated with maximum carrier power (FIG 6). The sync pulse power is therefore used as a reference both at the transmitter and at the receiver end. In the TV transmitter, it is stabilized to the predefined nominal value via a control circuit.

For checking the selected power, thermal power meters with average power reading were previously used almost exclusively. Due to dependence on picture content, measurements could only be performed with test patterns for which the ratio of sync pulse power to average power had to be known. There was no way of monitoring the transmitter during the ongoing program. NRV-Z31 and NAP-Z10/Z11 are the first power sensors for commercial power meters allowing direct measurement of sync pulse power with high accuracy. NRV-Z31 (model 03) is suitable for measurements at the directional-coupler output of high-power transmitters. The measurement uncertainty is comparable to that of thermal power meters. NAP sensors (model 02) are designed for direct power and SWR measurements on antenna feeders of low-power transmitters and transposers. Together with the handy, battery-operated Power Reflection Meter NAP they can easily be taken even to remote transmitter stations.

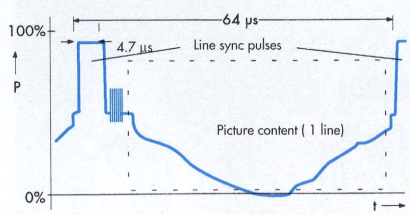


FIG 6 Envelope power of TV vision-carrier signal to CCIR

Sometimes it may be necessary to measure **sync pulse power with superimposed sound carrier**, for instance in small systems which do not have a separate vision and sound transmitter. In this case the reading, which will be too high, can be corrected precisely with the aid of tabulated correction factors. The correction values depend on the vision/sound power ratio, for NRV-Z31 also on the amount of power, so that in this case the maximum power is limited to 1 mW.

The applications described above and many more are possible with the new peak power sensors. In addition to communication measurements, they are also highly suitable for measurements in the field of EMC, medical and scientific research. All these fields use modulated signals which cannot be adequately characterized by average power alone. These measurements, which previously could only be performed with the aid of complex and difficult-to-operate special instruments, can now be performed easily with all new power and level meters from Rohde & Schwarz: just plug them in and go.

Thomas Reichel

REFERENCES

[1] Reichel, T.: RF power measured the right way (I). News from Rohde & Schwarz (1993) No. 142, pp 29–30

[2] Betz, T.: New mobile-radio technology, new test equipment: Directional Power Meter NAS with GSM Insertion Unit NAS-Z6. News from Rohde & Schwarz (1992) No. 139, pp 32–33

[3] Reichel, T.: Shortwave power heads for Power Reflection Meter NAP. News from Rohde & Schwarz (1987) No. 117, pp 39–40

[4] Betz, T.: Directional Power Meter NAS for any radio system. News from Rohde & Schwarz (1991) No. 134, pp 29-30

[5] Löser, A.: Power Reflection Meter NAP for SWR measurements. News from Rohde & Schwarz (1984) No. 106, pp 9–11

Peak power sensors for envelope-modulated RF carrier signals

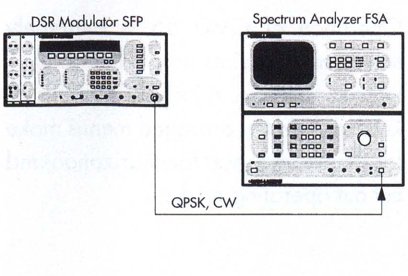
Type	Frequency	Power	Function	Pulse width	Pulse repetition rate	Uses
NRV-Z31						
Model 02	30 MHz to 6 GHz	1 µW to 20 mW	PEP	≥2 µs	≥10 Hz	NADC, PDC, TFTS, TV, general
Model 03	30 MHz to 6 GHz	1 µW to 20 mW	PEP	≥2 µs	≥100 Hz	TV, general
Model 04	30 MHz to 6 GHz	1 µW to 20 mW	PEP	≥200 µs	≥100 Hz	GSM, PCN, DECT
NAS-Z6	890 to 960 MHz	0.01 to 120 W	PEP	577 µs	217 Hz	GSM
NAS-Z7	890 to 960 MHz 1710 to 1880 MHz	0.01 to 30 W	PEP	577 µs	217 Hz	GSM, PCN
NAP-Z7	0.4 to 80 MHz	0.5 to 195 W	AVG, PEP	≥20 µs	≥30 Hz	Shortwave radio, general
NAP-Z8	0.2 to 80 MHz	5 to 1950 W	AVG, PEP	≥20 µs	≥30 Hz	Shortwave radio, general
NAP-Z10						
Model 02	35 to 1000 MHz	0.05 to 19.5 W	AVG, PEP	≥4.5 µs	≥50 Hz	TV, NADC, PDC, general
Model 04	890 to 960 MHz	0.02 to 19.5 W	AVG, PEP	577 µs	217 Hz	GSM
NAP-Z11						
Model 02	35 to 1000 MHz	0.5 to 195 W	AVG, PEP	≥4.5 µs	≥50 Hz	TV, NADC, PDC, general
Model 04	890 to 960 MHz	0.2 to 195 W	AVG, PEP	577 µs	217 Hz	GSM

Reader service card 145/05

Test hint

Measuring level of DSR signals

DSR signals are spread like noise over a bandwidth of 14 MHz, so broadband methods in the absence of other signals (eg VHF FM or TV signals) have to be used for direct level measurement. Measurements are carried out with the aid of voltmeters and power meters (eg URV and NRV from Rohde & Schwarz). To level the DSR QPSK signal, eg in cable-TV networks where the carrier power of adjacent TV and VHF FM signals is added to the QPSK signal level, a **spectrum analyzer** like **FSA or FSB** is required for level measurement.



The analyzer method yields accurate results in all cases and a correction formula is used to obtain the true DSR signal level a_{true}. Level a_{meas}, measured at the center of the 14-MHz DSR signal spectrum with the limited resolution bandwidth f_{res}, has to be converted for a bandwidth of 10.24 MHz. The following formula applies:

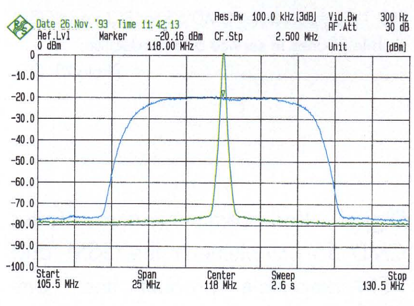
$$a_{true} = a_{meas} + 10 \log (10.24\ \text{MHz}/\Delta f_{res})$$

For resolution bandwidth f_{res} of 100 kHz, for instance, the following correction formula is obtained:

$$a_{true} = a_{meas} + 20.1\ \text{dB}$$

Reading off a_{meas} is simplified considerably when the video bandwidth is reduced.

Gregor Kleine



0-dBm QPSK and CW signals from DSR Modulator SFP measured with Spectrum Analyzer FSB

Enter 145/02 for further information on FSA/FSB

Digital Radiocommunication Tester CMD 55

GSM and PCN tester in one compact unit

Digital Radiocommunication Tester CMD 55 covers the GSM and DCS 1800 bands without any additional equipment being required. In servicing, different types of mobiles (PCN and GSM) can be tested and in production, CMD 55 ensures high flexibility under conditions of varying PCN/GSM throughputs or when the production line is changed from GSM to PCN.

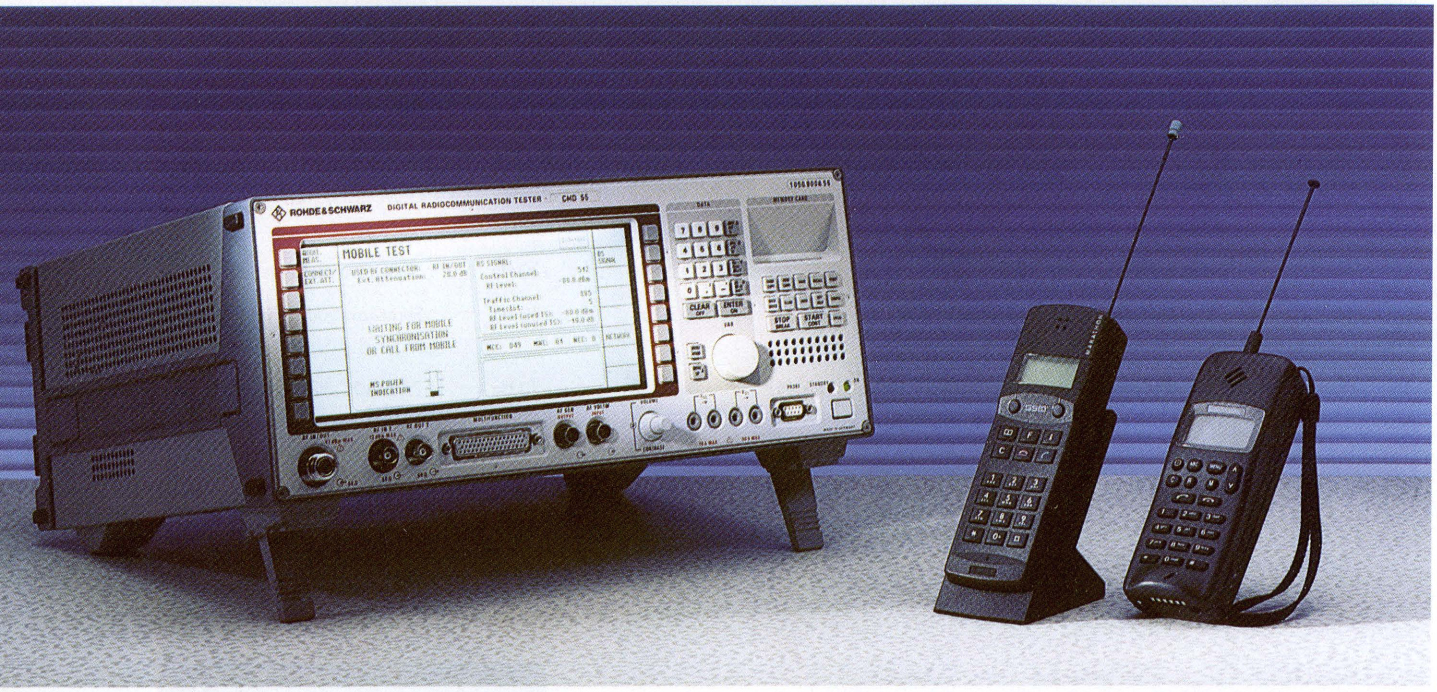


FIG 1 Compact tester CMD 55 for PCN and GSM mobile phones in service and production
Photo 41 501

Digital Radiocommunication Tester CMD 55 complements the GSM- and PCN-compatible product line comprising Frequency Conversion Unit CRTS-Z1 [1], Digital Radiocommunication Test Set CRTP [2] and PCN Simulator TS 8920 [3]. CMD 55, the new member of the CMD family [4-6], is a compact unit for testing PCN and GSM mobiles in service and production environments (FIG 1). It combines low price and small dimensions with high measurement accuracy and speed. For testing mobile telephones CMD 55 simulates a PCN/GSM base station.

The key **test functions** are:
- mobile synchronization,
- location update,
- incoming and outgoing call setup,
- mobile power-level control,
- handover (channel change, time-slot change),
- peak power measurement,
- SACCH measurement (RxLev, RxQual, power level)
- echo test,
- call cleardown by mobile or CMD,
- DC current/voltage measurement,
- phase-error measurement,
- frequency-error measurement,
- measurement of power ramping as a function of time,
- bit-error-rate (BER) measurement,
- AF measurements.

For troubleshooting in mobile radios a number of measurement functions are required which may be used without signalling, such as module testing (FIG 2) and measurements carried out in the service mode of the mobile. For these measurements CMD 55 provides the following functions: RF signal generation, power measurement, measurement of power ramping as a function of time as well as phase- and frequency-error measurements. Option CMD-B41, which includes an AF generator, an AF voltmeter, a distortion meter and a frequency counter, is available for measurements on the audio interface.

Highlights

Operation of CMD 55 is **extremely simple** and requires no detailed GSM/PCN knowledge. A large LCD with softkeys and clearly arranged menus make for simple and short familiarization and cut out operating errors.

The **echo test** allows very rapid go/no-go analysis covering all essential parts of the mobile. A word spoken into the microphone of the mobile is sent to CMD, stored in a buffer memory and sent back to the phone with a delay. In this way it is possible to check the whole signal path from the microphone via RF transmitter section, RF receiver section, modulator, demodulator, signalling section, speech coder/decoder, analog audio components through to the loudspeaker.

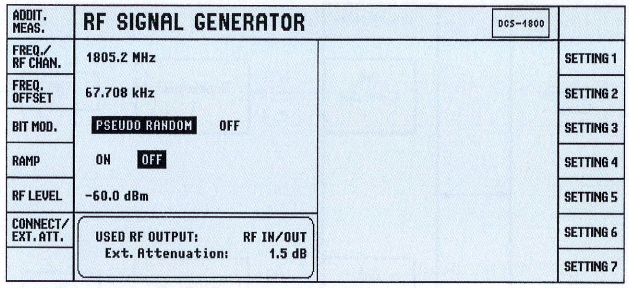


FIG 2 An RF generator is available for module testing. In addition to manual entry of frequency, level, modulation and signal characteristic, complete setups may be called up.

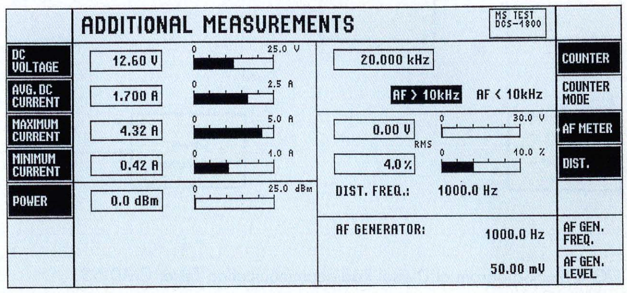


FIG 3 Option CMD-B41 for measurements at audio interface

CMD 55 is equipped with a special logarithmic amplifier for high-dynamic **measurements of power versus time**. To ensure errorfree functioning of the mobile in the PCN/GSM network, a check has to be made of power switch-off (<-72 dB) in the unused time slot.

Special hardware with PCN/GSM-specific time constants is available for **voltage and current measurements.** The peak current in the used and unused time slot and the average value of the pulsed current are measured accurately. From the power consumption it can be ascertained whether the mobile and in particular the transmitter amplifier function properly (FIG 3).

The **universal RF front-end**, provided with a combined RF input/output, an additional high-sensitivity RF input and a high-level output, allows testing of modules or handhelds with built-in antenna via RF couplers.

In the remote-control mode via **RS-232 or IEC/IEEE-bus interfaces**, CMD 55 is designed for fast speed. This yields high throughputs in the production of mobiles. The writing of remote-control programs is facilitated by a command recording routine.

In the **autotest mode**, CMD 55 performs a complete transceiver test at a keystroke. In servicing, for instance, all parameters of a mobile can be measured with the aid of comprehensive routines so that the operator needs no special GSM/PCN knowledge. Test results together with go/nogo information can all be output on a printer.

Advanced, reliable technology

At least one but preferably two GMSK-modulated RF synthesizers are required for simulating a base station. CMD 55 includes two fast-settling (frequency-hopping) synthesizers with independent frequency and level settings for GSM and DCS 1800. This permits simultaneous generation of traffic and control channels. The DCS 1800 frequency range is obtained by adding a 2.7-GHz conversion oscillator signal to the GSM signal (FIG 4).

Various design features make CMD 55 a tester of high quality and reliability. The use of only a few modules with defined interface levels affords simple exchange of modules without any adjustments being necessary. Instead of using relays, RF signals in CMD 55 are switched by means of fast, wear-and-tear-free semiconductor switches (GaAs switches or PIN diodes). The use of SMT components (up to 97%) enables reliable and cost-effective production to the customer's advantage.

The high demands placed on the signal quality and measurement accuracy of CMD 55 – and of the whole CMD family – are met in no small part thanks to the EEPROMs integrated in each module [7]. Module-specific data, characteristics, trimming values, modification status and other information are automatically stored in the EEPROMs during production and testing. The CMD controller gathers the information from all modules, stores it in the main memory (RAM) and makes a copy of it on the hard disk. Thus all information required for level or characteristic corrections is available to the software. On exchanging modules during servicing, the software is informed on the actual status and no hardware adjustments are required.

New: Base Station Testers CMD 54 and CMD 57

The CMD family has been supplemented by testers for GSM and PCN base stations (details will follow in a later issue). CMD 54 carries out measurements on GSM base stations, CMD 57 can also test PCN base stations. Of course, all the benefits of mobile testers CMD 52/55 were retained in the new units. The low volume and weight and sturdy design make CMD 54/57 particularly suitable for rough installation work in addition to use in production

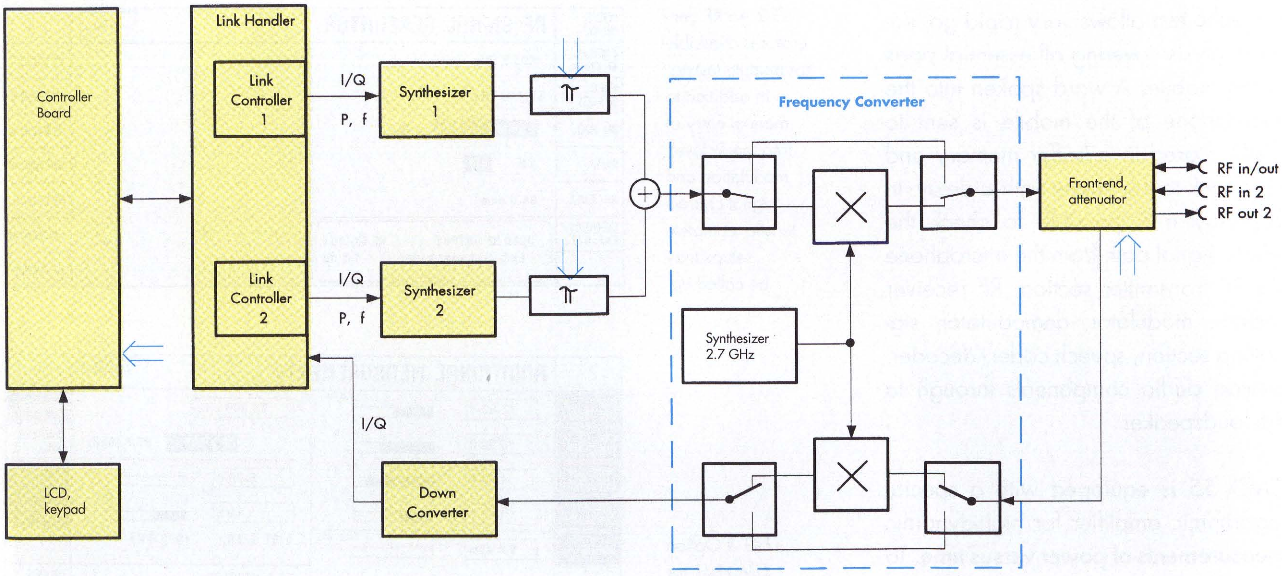


FIG 4 Block diagram of Digital Radiocommunication Tester CMD 55

and service. CMD 54/57 measures all main parameters of base stations: RF output power, power ramping with high dynamic range, spectrum (due to modulation and switching) as well as BER.

Werner Mittermaier; Gottfried Holzman

REFERENCES

[1] Maucksch, T.: PCN Frequency Conversion Unit CRTS-Z1 for GSM test sets CRTS and CMTA 94. News from Rohde & Schwarz (1992) No. 137, pp 39–40

[2] Mittermaier, W.; Holzmann, G.: Digital Radiocommunication Test Set CRTP 02 – The ideal test set for PCN mobile telephones. News from Rohde & Schwarz (1993) No. 140, pp 11–13

[3] Schneider, J.: PCN Simulator TS 8920 – Upward-compatible test system for PCN mobile telephones from development to type approval. News from Rohde & Schwarz (1993) No. 143, pp 4–7

[4] Maucksch, T.: Digital Radiocommunication Tester CMD – Test system for production testing and servicing of mobile GSM telephones. News from Rohde & Schwarz (1993) No. 142, pp 4–6

[5] Maucksch, T.: Measurements on GSM mobiles using Radiocommunication Tester CMD. News from Rohde & Schwarz (1994) No. 144, pp 31–32

[6] Vohrer, M.: Advanced test technology for GSM/PCN mobile phones with CMD 52/55. In this issue, pp 48–49

[7] Rieder, T.: Electronically erasable PROMs – a plus for our customers. In this issue, pp 58–59

Condensed data of Digital Radiocommunication Tester CMD 55

Transmitter	
Frequency range GSM/PCN	935 to 960 MHz/1805 to 1880 MHz
Level	
RF in/out	–35 to –120 dBm
RF out 2	+11 to –77 dBm
Modulation	GMSK, BT = 0.3
Receiver	
Frequency range GSM/PCN	890 to 915 MHz/1710 to 1785 MHz
Input level for full dynamic measurement range	
RF in/out	+10 to +47 dBm (GSM), 0 to +33 dBm (PCN)
RF in 2	–37 to 0 dBm
Signalling	two control channels (one duplex), layers 1 and 2 to GSM/DCS 1800 specification

Reader service card 145/06

VHF FM Transmitter SU 125

Control center for VHF transmitters

In addition to its basic function - that of modulating an MPX signal onto a carrier – the new FM Transmitter SU 125 fulfills a number of other tasks: it drives the power output stages of all transistorized VHF transmitters from Rohde & Schwarz up to 10 kW, gives a comprehensive overview of transmitter operating status and allows data to be exchanged with external units via serial interfaces.

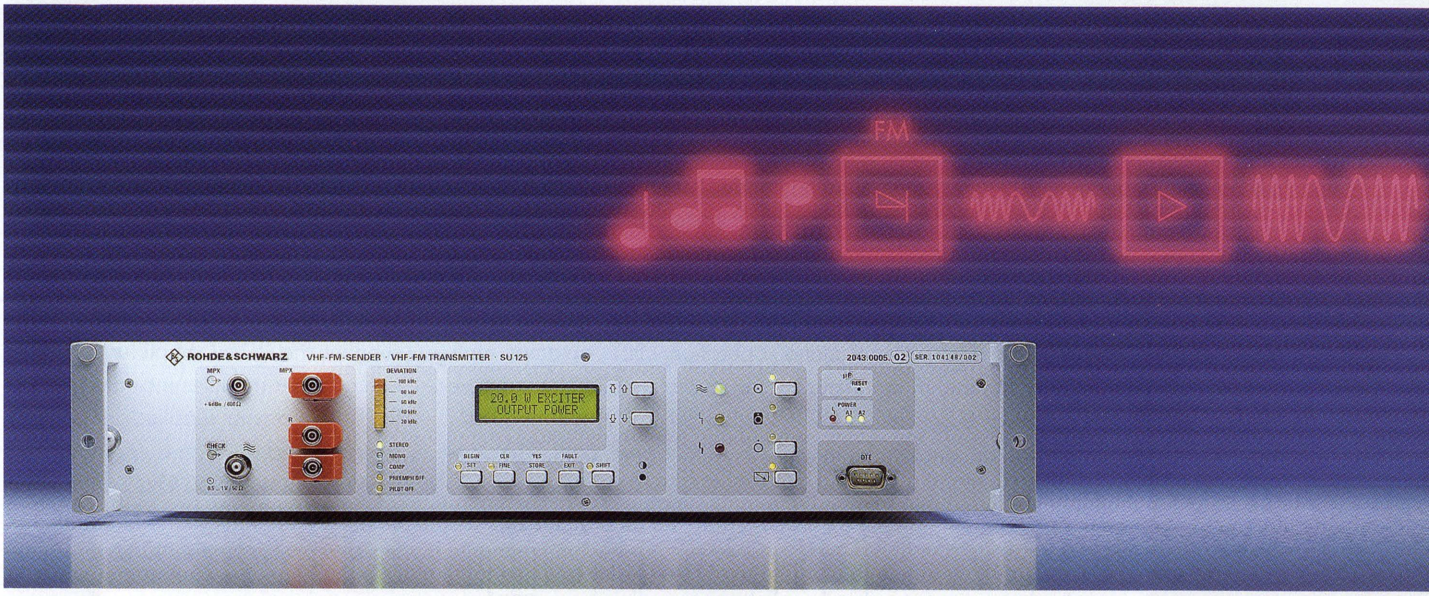


FIG 1 VHF FM Transmitter SU 125, for use as exciter or as low-power transmitter
Photo 41 550

Rohde & Schwarz has developed an exciter for a new, favourably priced series of transistorized VHF transmitters. Compared to its predecessor SU 115 [1], this new exciter has a wider application range and its operation was newly devised. While exciters used to be no more than FM modulators with subsequent power amplifiers, VHF FM Transmitter SU 125 (FIG 1) is a real exciter which queries the amplifier modules in the transmitter rack via a serial bus and a control board, and also operates and monitors the peripherals (eg blower, power supplies, temperature sensor). The transmitter control unit with an internal microprocessor and LC display has thus become redundant.

The exciter is set electronically throughout. All parameter settings of both the exciter and the power output stage are made via keys on the front panel of the exciter. A clear menu together with hardkeys guides the user in carrying out settings. The front-panel LEDs indicate the status of the transmitter and the operating mode selected for the stereocoder. In addition to the digital display, a peak-deviation display with LEDs informs the user about the current deviation.

The most important **extensions compared to the predecessor** are:

- up to four serial RS-232-C interfaces (switchover to RS-485 possible for two interfaces),
- operating-data acquisition interface on front panel (RS-232-C),
- peak-deviation display on front panel,
- MPX input can be switched,
- EEPROM for configuring SU 125,
- remote control for all functions,
- transmitter configuration for standby systems can be stored.

VHF transmitter

Similar to the well-proven, transistorized 10-kW VHF FM Transmitter NR 410 T1 [2] with exciter SU 115, the new FM transmitter with built-in SU 125 offers the following **features**:

- wide power range from 1.3 to 10 kW by using up to eight amplifier modules,
- well-designed, modular rack configuration allowing excellent access to all components,
- lightweight amplifier,
- MOSFET transistors,
- dual power supply without switching regulator,
- very efficient cooling system with low-noise blower.

The control board connected to the serial bus of SU 125 (FIG 2) is the interface with analog and digital transmitter inputs and outputs. Together with the microprocessor it ensures a correct switch-on sequence of the cooling system, supply voltage and exciter power. It also monitors the blower, the inlet and outlet temperature and the operating status of the power modules. A memory chip (EEPROM) on the control board stores all the specific data for the corresponding transmitter rack. In case of an exchange, SU 125 configures itself in line with these stored data and the operator does not need to set any of the parameters. In addition to the named transmitters in 19-inch racks, SU 125 is also the control center in a 19-inch benchtop transmitter with output power of 500 to 1000 W.

Exciter SU 125

SU 125 is available as a 19-inch rackmount of two height units and with self-engaging connectors for use in a 19-inch rack. It also comes as a benchtop. The exciter comprises an analog modulator, a 20-W amplifier, a computer, a remote-control interface and a power supply. An SCA modulator (subsidiary channel authorization) and a modulation monitor are available as option.

The stereocoder [3] incorporated in the **analog modulator** codes the stereo signal by time multiplex with "soft" switchover in 14 steps. Harmonics of the audio signal, which with this technique are first generated above 500 kHz, are rejected by an active lowpass. There are connectors for three SCA signals and an RDS signal to be added to the MPX signals non-interactively. All four inputs can be separately switched on or off. With regard to their sensitivity, they can be set in a wide range. In the operating mode "Composite", the 15-kHz lowpass at the left AF input is bypassed and the preemphasis is switched off so that a broadband modulation input is available, provided the coder is set for mono operation. FET op-amps optimized for audio applications ensure low-distortion driving of the modulator in the AF MPX signal path. The low-noise oscillator is locked to the nominal frequency by a synthesizer with a minimum stepwidth of 10 kHz in conjunction with a highly accurate crystal. A regulated RF amplifier ensures a constant output level of +10 dBm.

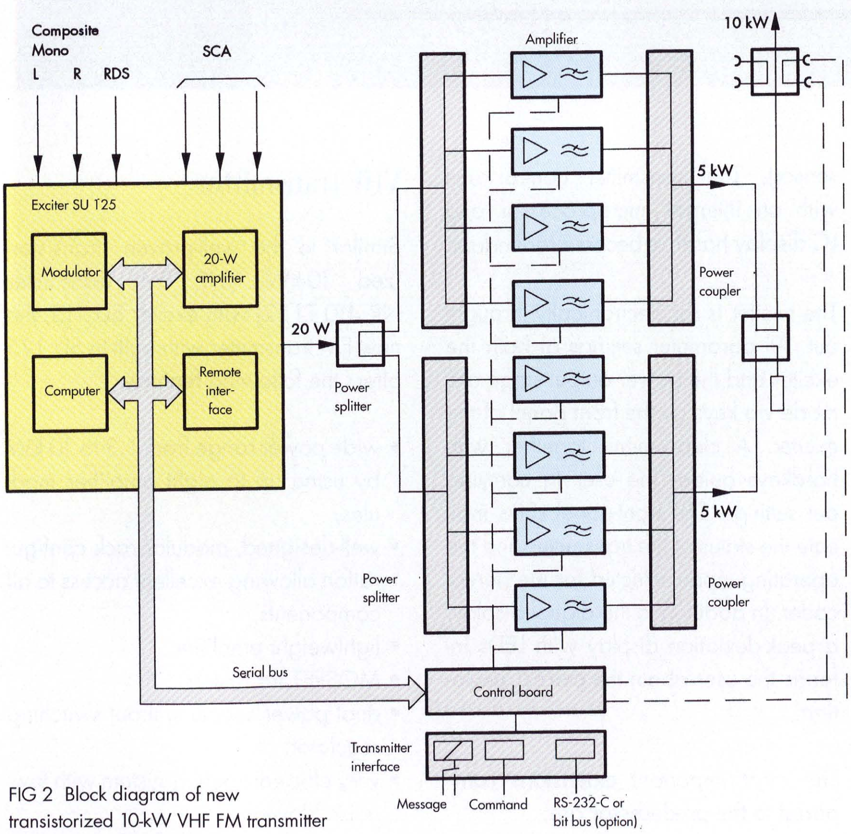


FIG 2 Block diagram of new transistorized 10-kW VHF FM transmitter

The **20-W amplifier**, designed for optimum efficiency, comprises a VHF power MOSFET. The harmonic filter, in microstripline technology, is also integrated in the output network of this transistor. The amplifier maintains the output power up to VSWR ≤ 2. The power is set by changing the operating voltage at the output stage. A directional coupler at the RF output with detector signals incident and reflected power to the amplifier control circuit. Data for the power display are sent to the computer via the A/D converter.

SU 125 is fed from two **power supplies:** one of them with regulated voltage for setting the power of the output stage supplies the 20-W amplifier, the other one all other modules including the options. Both power supplies are primary-switched and have an autorange of 88 to 264 V at 47 to 63 Hz. So this exciter can be used worldwide without having to reconfigure the AC supply inlet.

In line with standard specifications, the **remote-control interface** carries the remote-control commands via floating optocoupler inputs and the remote-control messages via relays. An external interlock loop for switching the carrier on or off is matter of course.

The **optional SCA modulator** can modulate an AF signal onto each of three carrier frequencies from 60 to 100 kHz. The connectors intended as SCA inputs can be used as AF inputs. A crystal-referenced carrier frequency is obtained by coupling it to the 19-kHz pilot frequency.

RF threshold is one of the status indications for the exciter. It confirms that the transmitter outputs enough RF power but does not give any information whether the transmitter modulates the

AF signal provided. This is done by the **modulation monitoring option**, which compares the applied AF signal with the demodulated RF signal and sends a message if there is no modulation.

Microcomputer control

A powerful microprocessor controlling the hardware functions of internal and external modules via a serial bus is the core of the transmitter rack. Each module is protected against hazardous operating states such as breaking of the antenna cable or overtemperature. The computer merely has to recognize such faults and indicate them to the operator on the LC display or send them to a main monitoring center via the remote interface. In addition to this parallel interface there are four serial RS-232-C interfaces, two of which can be switched to RS-485. There is another RS-232-C interface on the front panel which is used for data acquisition with a PC.

The software of SU 125 automatically identifies all connected modules and amplifiers and offers the corresponding menus on the LC display. Moreover, a complete remote control and query can be started via a serial interface and a modem. Data transfer according to the ISO 1745 protocol with RS-232-C drivers and to the bit-bus protocol with RS-485 drivers is also possible. The software is contained in flash memory chips which can be deleted electrically so that a firmware update is carried out via serial interfaces without exchanging EPROMs.

Werner Leimer

REFERENCES

[1] Dietl, A.; Wendl, A.: VHF FM Transmitter SU 115: exciter for VHF sound broadcasting. News from Rohde & Schwarz (1984) No. 107, pp 20–22

[2] Seeberger, H.: Transistorized 10-kW VHF FM Transmitter NR 410 T1. News from Rohde & Schwarz (1992) No. 136, pp 15–17

[3] Kirchner, J.: FM transmitting and receiving units NU 002 for distributing VHF audio broadcast signals. News from Rohde & Schwarz (1990) No. 130, pp 20–23

Condensed data of VHF FM Transmitter SU 125

Frequency range	87.5 to 108 MHz
Modulation	F3E
AF input	L/R; L switchable as broadband input and as mono, balanced R_{in} = 600 Ω/>2 kΩ
AF level	–6 to +10 dBu
SCA inputs	3, can be switched separately
RDS input	1, can be switched
Output power	0 to 20 W for VSWR ≤ 2
Unweighted S/N ratio	≥ 80 dB
Remote-control interface	command inputs with optocouplers, relay messages
Microcomputer	80C186EC/CPU with SRAM, EEPROM, flash memory, watchdog, software can be loaded via interface, nonvolatile data protection
Power supply	88 to 264 V, 47 to 63 Hz
Size	19-inch rackmount, 2 HU (benchtop)

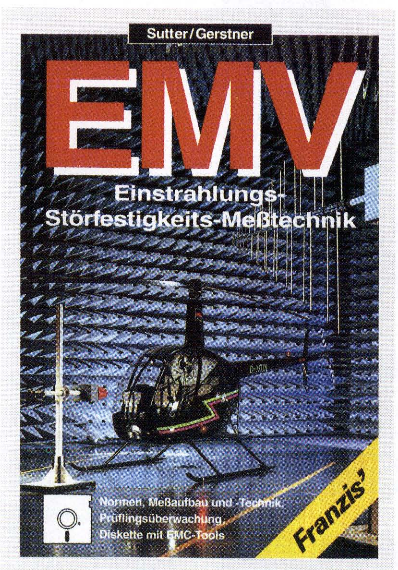
Reader service card 145/07

Booktalk

EMV-Einstrahlungs-Störfestigkeits-Meßtechnik

"EMC Radiation Susceptibility Measurements" by Xaver Sutter and Achim Gerstner focuses on the practicalities of EMC measurements and is based on their work as engineers and product managers at Rohde & Schwarz. Published by Franzis-Verlag Munich, 1994. ISBN 3-7723-5301-0, 256 pages, 50 illustrations. Price DM 78.

New EMC legislation now requires manufacturers of electronic equipment and components to verify immunity to interference. Radiation susceptibility measurements play an important role in this context because of the complexity of the test setups and the enormous investment costs required for a fully equipped anechoic chamber. The book explains in an easy way the new situation and its implications for manufacturers.



The book shows a typical test setup, describes the design of an anechoic chamber, and specifies the components and control software required. Presenting alternative methods of field generation, the authors also demonstrate more cost-effective ways of testing susceptibility.

A diskette with EMC Tools shareware accompanies the book. EMC Tools runs under MS Windows 3.1 and includes auxiliary programs which should be of practical use to everyone involved in this area of testing.

Measuring channel impulse response in DAB network

Digital audio broadcasting (DAB) is a common-frequency radio network in which all transmitters of the network emit the same signal at the same time. In order to minimize interference caused by multipath reception and neighbouring transmitters, a guard interval of 0.25 ms was introduced for the DAB signal. During this interval the receiver ignores all incoming signals. The result is that reflected signals and signals from neighbouring transmitters arriving with a delay shorter than the guard interval will not cause intersymbol interference. It is possible for longer delays to occur, however, which then degrade reception quality.

To gain experience in overcoming these problems and to avoid mistakes in network planning, channel-impulse-response measurements have to be carried out in test networks made up of several transmitters. For measurements in operational DAB networks, Rohde & Schwarz developed a new test mode for Impulse Response Analyzer PCS (FIG 1), which is known for its GSM/PCN and test-transmitter modes [1;2]. With the new test mode special consideration was given to the analysis of propagation delays that are considerably longer than the guard interval. PCS supports all three DAB modes.

The DAB version of Impulse Response Analyzer PCS together with Test Receiver ESVB used as a demodulator provides the following **measurement capabilities:**

- Measurement of channel impulse response (CIR) in the DAB network using the run-in symbol. In mode I propagation delays of up to 500 μs (!) can be analyzed. The maximum dynamic range within a CIR is 35 dB. This dynamic range is automatically matched to the noise and other local receiving conditions so that reflections shown are always real and not simulated by filter noise or similar effects. The measurement repetition rate is 96 ms. Each CIR can be stored in compressed form for subsequent evaluation (depending on the number of paths, 30,000 to 120,000 impulse responses can be stored on the 7.5-Mbyte RAM disk).
- Measurement and display of raw bit error rate (BER) for each CIR also in online mode during measurement.
- Measurement of receive field strength, intersymbol interference and S/N ratio.

FIG 1 Impulse Response Analyzer PCS is an important tool in planning DAB networks thanks to its wide dynamic range, capabilities for analyzing long delays and measuring raw bit error rates, automatic noise suppression and interfering-signal analysis.
Photo 41 564/5

COFDM (coded orthogonal frequency-division multiplex) [3] was chosen as the **modulation method** for DAB. With the aid of frequency- and time-interleaving error protection, COFDM allows demodulation of signals arriving at different times and prevents information losses as may be caused by frequency-selective fading in the receive spectrum. The COFDM-modulated signal is composed of many QPSK-modulated carriers spaced by Δf. For each carrier, phase-shift keying by $\pm 45°$ or $\pm 135°$ is performed at intervals of the symbol duration T_S. A signal segment of the duration $t_s = 1/\Delta f$ is required for spectral separation of the carriers. This signal segment can be taken from a symbol that is longer by the guard interval at any point, but for successive symbols at the same point. It is then converted by means of fast Fourier transform into a complex spectrum which comprises amplitudes and phases of all carriers used during a symbol (FIG 2).

Due to multipath propagation, each carrier undergoes amplitude attenuation and a phase change. Since both parameters in the mobile radio channel are time-dependent, the duration of the symbol has to be selected short enough so that the phase change caused by the radio channel is negligible compared to the superimposed phase-shift keying. In DAB mode I, 1536 carriers (spacing 1 kHz) are subject to phase-shift keying every 1.25 ms.

At a speed of 100 km/h of mobile DAB receivers and a carrier frequency of 250 MHz, the maximum channel-specific phase change is ± 10° per symbol. The uncertainty in the demodulation of the phase difference and the associated BER mainly depend on the interference content of the Fourier-transformed signal segment, the amplitude of the carriers and the time-variant channel change. Determination of these parameters is the basis for proper evaluation of DAB transmission quality.

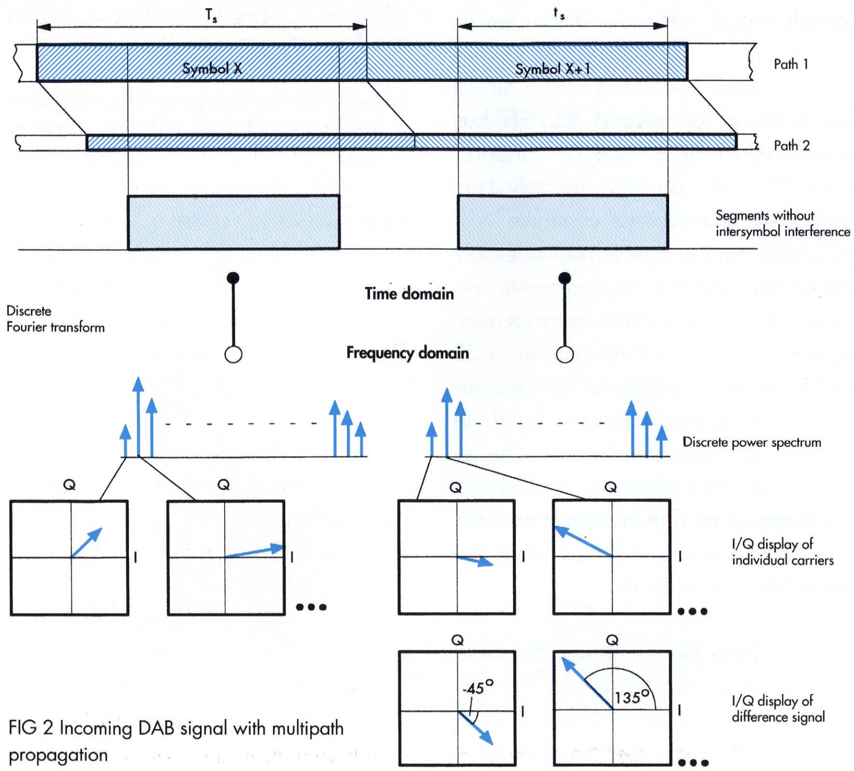


FIG 2 Incoming DAB signal with multipath propagation

The CIR measurement function of PCS supplies the relevant data for this evaluation.

Interfering signals: A low signal/noise ratio is the main reason for errors occurring in transmission. The more precise the findings on the causes of the errors, the sooner measures can be taken for their elimination. PCS is able to provide the following **parameters**:

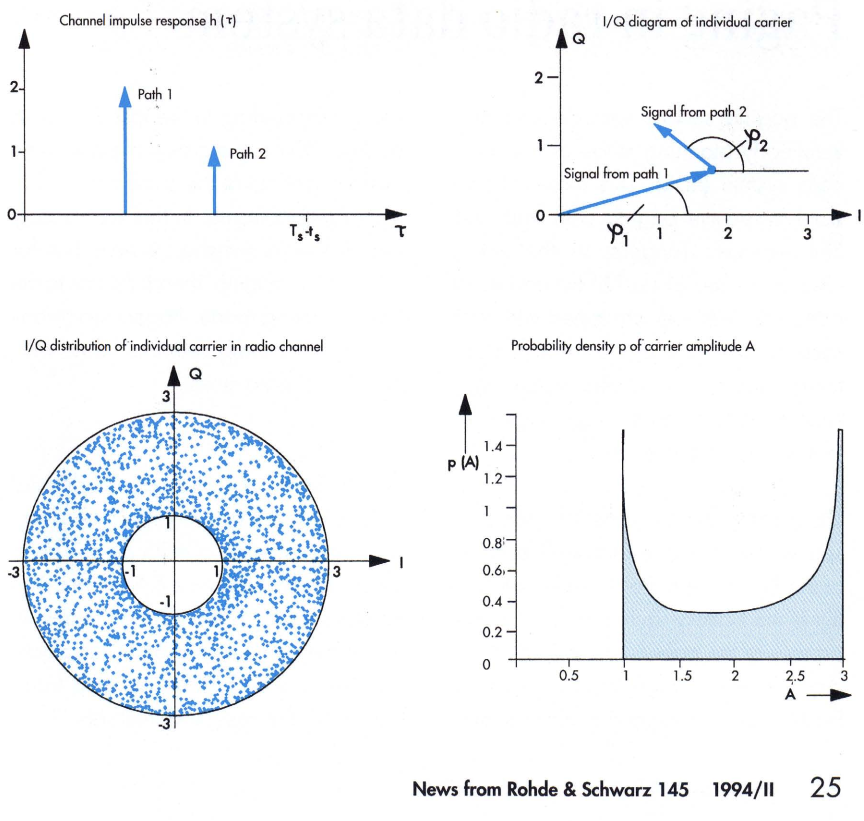
- Receive field strength: can be used to determine device-specific degradation of the signal as a result of basic noise in the radio receiver.
- Integral interference: obtained as a byproduct when calculating the impulse response and comprising all interference that occurs. If the basic noise determined from the receive field-strength measurement is deducted from the integral interference, the extraneous interference (as may be caused by adjacent channels, thunderstorm, ignition sparks, etc) is obtained.
- Intersymbol interference: extraneous interference occurring when the time difference of two propagation paths is longer than the guard interval.

Since PCS is able to measure propagation time differences of up to twice the guard interval in operational networks, intersymbol interference can be determined reliably.

Amplitude distribution of individual carriers: in addition to the interfering signal, which with the exception of certain narrowband interference affects all carriers in the same way, the distribution of the total signal power to the individual carriers also plays an important part in the reconstruction of output data. After phase demodulation, the receiver reconstructs the original information so that this information after COFDM modulation would produce phase changes that agree best with the phase changes measured at the demodulator output. It is not a single but a whole bundle of demodulated phase differences that is used for determining the associated output bit stream. Assuming a constant signal/noise ratio, the total of all phase errors increases with increasing departure from the squarewave shape of the power spectrum measured over the effective symbol duration t_S.

Since the spectrum has to be measured practically point by point and is subject to fast changes in time in mobile reception, the usual type of spectrum analyzers is not suitable for this measurement.

FIG 3 Relationship between channel impulse response and amplitude distribution in radio channel



This is different with PCS, which supplies the desired data by means of Fourier retransform of the impulse response, and, what is more, enables further statistical evaluation of mobile reception. On the basis of the path model, all peaks in the complex channel impulse response change their phase relatively quickly and in many cases independently of each other [4]. With these conditions fulfilled, the same probability density function is obtained for the power of each individual carrier (FIG 3). This is the probability with which a certain carrier assumes some given amplitude, ie the expected phase error with known integral interference. Within the limits of the assumed equal statistical phase fluctuations, it is possible to determine the BER from the interfering signal and the amplitude probability distribution that is the same for all carriers. The BER depends on the degree of coding and is a measure of available transmission/reception quality.

PCS is operated from the front panel, allowing all entries to be made for the graphic user interface. Main menus and functions are directly selected via function keys. New in the PCS model for DAB is the **second IEC/IEEE-bus interface,** which is fitted as standard. Thus PCS can be fully remotely controlled from a process controller with IEC/IEEE-bus card, which considerably facilitates longterm measurements and integration into existing measurement systems, eg with a DAB receiver. PCS still maintains its control of Test Receiver ESVB. This makes programming of the process controller much easier. The user has merely to call up the desired PCS functions as in manual operation. PCS then performs the required ESVB settings fully automatically.

Peter Riedel; Otmar Wanierke

REFERENCES

[1] Riedel, P.: PCS determines channel impulse response. News from Rohde & Schwarz (1992) No. 139, pp 10–12

[2] Riedel, P.: TS 9955 measures channel impulse response in GSM radio networks. News from Rohde & Schwarz (1992) No. 137, pp 12–14

[3] Winter, A.: Simple generation of COFDM signals with Software DAB-K1. In this issue, pp 28–30

[4] Bello, P.A.: Characterization of Randomly Time-Variant Linear Channels. IEEE Trans. Commun. Syst., Vol. CS-11, pp 360–393 (Dec. 1963)

Reader service card 145/08

Paging in radio data system

The paging service was defined at a very early planning stage of the radio data system (RDS). This makes it possible to receive paging calls with special receivers (pagers) in the whole coverage area of an FM transmitter or transmitter network equipped with RDS coders. Calls are in the form of beep tones, numeric or alphanumeric messages, the latter consisting of digits, letters and special characters.

The paging service differs in some respects from other established services of the RDS system. Particularly noteworthy is the battery-saving mode. The addresses of the pagers and thus the paging calls are divided into ten intervals. Each pager is assigned a specific interval corresponding to the last digit of its address. Calls to a group of pagers are always sent out at the same time within a one-minute frame. In this way a paging receiver is switched to reception for only 6 s per minute, then it returns to the battery-saving mode. Pagers synchronize to the coder-defined time frame within the RDS data stream.

The emission of radio calls at defined intervals requires special processing and management of RDS data. This is supported by all Rohde & Schwarz RDS coders by means of paging queues, in which the calls arriving at the interfaces are temporarily stored until their transmission in the assigned intervals.

Paging calls are applied to RDS coders via serial interfaces. Three types of **protocol** are possible:

1. Universal encoder communication protocol (UECP). This is an EBU-defined protocol for the transmission of all RDS data between the server and the coder. For example, there is a command specified for every call category. The protocol supports unidirectional transmission, offers a variety of possibilities for addressing the coder, and incorporates error protection for transmissions to the coder.
2. Telocator network paging protocol (TNPP). This protocol is widely used in the US for routing paging calls. It is network-compatible and ensures optimum

routing of calls between the server and the coder. It also supports unidirectional transmission, providing a variety of facilities for checking the integrity of the data sent.
3. Line protocol. This protocol is based on the protocol defined by the German ARD and Telekom and serves for feeding radio calls to RDS coders.

Programs for generating the command sequences for the above protocols are available.

All paging calls received by a Rohde & Schwarz coder in line with one of the protocols described are checked and decoded and then applied to the basic interface for RDS paging. This interface meets the specifications of European Standard EN 50067. It buffers incoming calls and outputs them in their assigned intervals or, in case the intervals are unequally loaded, in the two intervals following the assigned interval.

Utilization of RDS data-transmission capacity by paging can be divided into two basic categories: high degree of utilization (eg 50% of RDS transmission capacity) for servicing a large number of subscribers to the paging system, and low degree of utilization for a selected group of subscribers (eg the employees of a broadcasting corporation) operating in a large area. The extra infrastructure required for either of the categories is minimal. All that is necessary is to feed the paging information to be transmitted to an RDS coder at the transmitter site, eg via a satellite link or as additional information in the MUSICAM data system [1].

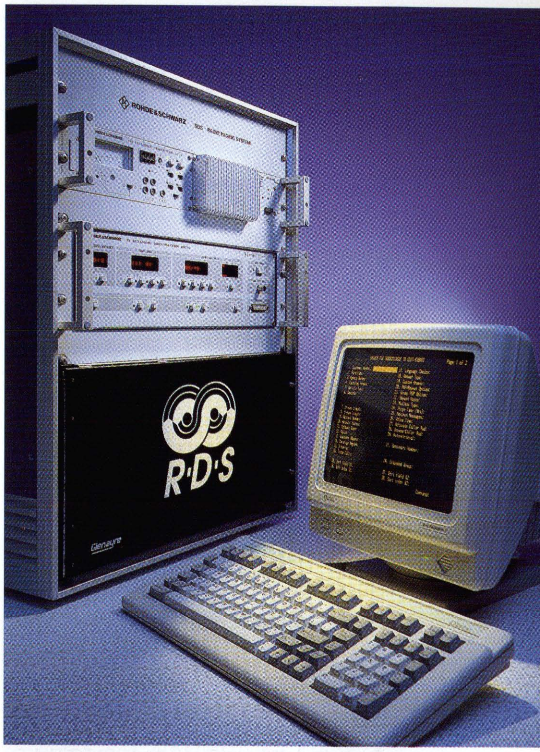
A **fully-fledged paging system** (FIG) incorporates – in addition to RDS Coders DMC 05 [2] or the compact DMC 01 [3] at the transmitter end – a paging center (paging terminal) where calls are accepted automatically or by an operator and the required protocols are generated. Rohde & Schwarz has joined forces with the US company Glenayre in the development and production of paging terminals.

The Glenayre **paging terminal** stands out for a variety of **characteristics:**

- automatic operation with DTMF (tone dialling technique); input of address and message directly on the phone or a pocket dialler;
- paging via operator;
- user-configured voice mailing; a spoken message can be left for a subscriber; the latter will be informed by a radio call that a message has arrived and can listen to the message by calling the terminal;
- user-specific announcements; the user can modify all announcement texts to suit his specific requirements;
- online help; all steps that may be necessary during a call will be explained upon entering a help character displayed in the announcement text, providing easy access to the many capabilities offered by the paging terminal even for infrequent paging users;
- choice of languages; all announcements are available in four user-selectable languages;
- TNPP; the paging calls generated by subscribers are output via user-configurable RS-232-C interfaces. An RDS coder for monitoring channel loading and for conversion into the EBU protocol is available at the terminal.

RDS paging systems using coders from Rohde & Schwarz have been in use worldwide for quite some time. With the introduction of the radio paging service by DeTex (Deutscher Textfunk) in the RDS network of German Telekom, one of the largest RDS paging services was launched at the beginning of this year. The proven RDS Coders DMC 05 were extended by means of a software update to allow data feed using the universal encoder communication protocol of EBU; RDS Coders DMC 01 are factory-set for this protocol.

Günther Zurek-Terhardt



RDS paging system from Rohde & Schwarz with Radio Data Codec DMC 01 Photo 41 544

REFERENCES

[1] Schmidt, P.: Transmission of ancillary data in sound broadcasting to ISO-MPEG standard. In this issue, p 46

[2] Mayr, J.: Radio Data Codec DMC 01 – The all-rounder for new RDS and RBDS applications. News from Rohde & Schwarz (1993) No. 142, pp 16–18

[3] Drews, W.: New RDS software for Radio Data Coder DMC. News from Rohde & Schwarz (1993) No. 140, pp 32–33

Reader service card 145/09

Simple generation of COFDM signals with Software DAB-K1

Digital COFDM modulation (coded orthogonal frequency-division multiplex) is becoming increasingly important in digital audio and video broadcasting (DAB and DVB). Here an RF signal composed of several hundred carriers, spaced one or more kHz from each other, is used to transmit the digitized audio and video signals [1].

Each carrier is modulated separately. DAB, for example, uses 1536 carriers with QPSK modulation (FIG 1). Each carrier can transmit two bits of information. The modulation information remains constant for a specific period of time, ie for the duration of a symbol, which is 1 ms with DAB. The data rate for DAB is thus 1536 carriers x 2 bits = 3072 bit/ms. All data relating to the audio signal are transmitted in the form of symbols in consecutive order. The data rate is somewhat reduced due to the fact that a zero symbol must be inserted periodically for time synchronization of the receivers, and a guard interval inserted between two symbols. A data rate of around 2.4 Mbit/s is nevertheless attainable for a bandwidth of 1.536 MHz.

DVB will probably use 64-level QAM (quadrature amplitude modulation) (final specs are not yet available). It will thus be possible to transmit six bits of information on each carrier, ie three times the above data rate.

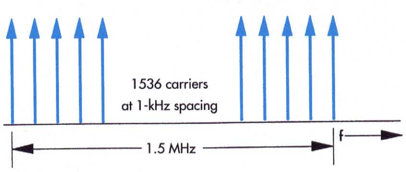


FIG 1 Spectrum of DAB signal

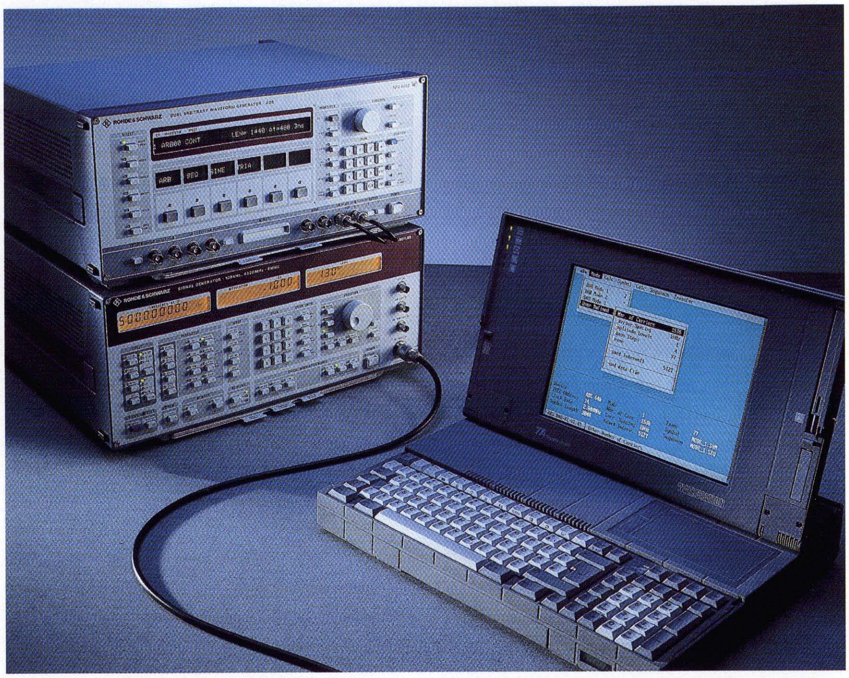


FIG 2 Signal Generator SMHU 58, Dual Arbitrary Waveform Generator ADS and Software DAB-K1 – can be run on industry-standard compatibles – for fast and easy COFDM test-signal generation Photo 41 648

Digital COFDM modulation affords the following **main advantages:**

- Sound and vision signals are transmitted digitally and thus remain undistorted.
- Modulation is not sensitive to multipath reception, which causes fading in FM sound broadcasting and ghost images in TV transmission.
- COFDM is capable of co-channel transmission, ie all transmitters providing the same service to a specific area can be operated on the same frequency.

COFDM transmitters are modulated as follows. Signal processors calculate, from the spectrum obtained from the modulation data, the time characteristic of the I (in-phase) and Q (quadrature-phase) components of the modulation signal. The resulting data are converted into analog signals and applied to the I and Q inputs of a transmitter with an I/Q modulator, which generates the COFDM signal in the desired transmission channel. The center frequency of the transmit signal is determined by the carrier frequency of the transmitter.

The modulation method described above is comparatively new, and special generators for COFDM test signals are not yet available. However, such test signals can easily be produced by Dual Arbitrary Waveform Generator ADS and Signal Generator SMHU 58, which is capable of I/Q modulation (FIG 2) [2]. The advantages of a test signal generated in this way are obvious: the signal is available whenever needed, it is fully reproducible, and can easily be modified, eg for testing a DUT's response to specific signal characteristics. In addition, such a signal allows the user to respond flexibly to changing specifications (especially important for DVB).

However, the arithmetic used for calculating these signals is not so easy to handle. Besides, some knowledge in the programming of ARB generators and experience in data transmission via the IEC/IEEE bus is required. In all these aspects, Software DAB-K1 proves to be very helpful. DAB-K1 was developed for computers compatible with the industry standard. The software calculates COFDM test signals, processes the data and controls their transmission via the IEC/IEEE bus. The software was designed with special emphasis on maximum flexibility with respect to signal generation, to allow for possible modifications of COFDM modulation parameters (the required hardware is listed in the blue box on page 30).

Generation of COFDM test signals

With Software DAB-K1, modulation signals are generated in four steps: 1. definition of the desired modulation parameters, 2. calculation of the time characteristic of each symbol, 3. definition of a sequence of symbols, 4. transmission of the signals via IEC/IEEE bus to ARB Generator ADS.

Definition of the modulation parameters is in the "Mode" menu (FIG 3). When one of the three DAB modes is selected, all parameters will be set automatically, whereas under the "User Defined" menu item the user can enter his own setting for the parameters. The number of carriers of the COFDM signal (up to 8190), the frequency spacing between the carriers, and the duration of the guard interval can be set. The ADS then automatically selects the parameters required for calculation and output of the signal, such as the number of data words and the output clock frequency of ADS. In subsequent signal calculation, random data sequences are modulated on the carriers.

Carriers with specific amplitudes and phases, eg a DVB signal, can be generated with the aid of a carrier data file. This file must contain, for each carrier, an amplitude value and a phase value or, alternatively, a real and an imaginary component in line with the desired spectrum. The structure of this ASCII file is very simple to allow its configuration with any text editor or with simple BASIC programs. FIG 4 shows an extract from such a data file. Software DAB-K1 contains an example of a program for generating such a data file in Microsoft QuickBASIC.

Calculation of the time characteristic of the symbols can be started in the next menu named "Calc. Symbol" (FIG 5). Several parameters can be preset, eg if a phase-reference symbol is to be added to the useful modulation or if spurious phase/amplitude is to be simulated. Two carrier-frequency ranges can be blanked out to simulate fading. To simulate limiting, an upper limit for peak modulation power can be entered. In this way limiting effects can be well demonstrated. The COFDM signal, which looks very uniform in the frequency domain (with DAB, all carriers have the same amplitude), shows an irregular form in the time domain, where pronounced amplitude peaks occur. If these peaks are clipped too much, undesirable widening of the spectrum will result. The maximum peak and the amplitude distribution of the calculated modulation signal are stored in a file and are available for analysis of the signal. The amplitude of the signal is adjusted so that neither the D/A converters of ADS nor the modulator of SMHU 58 will be overloaded.

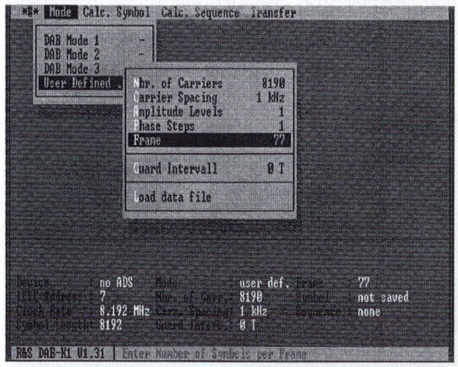


FIG 3 "Mode" menu for setting COFDM parameters

The time characteristic of the symbol with the selected settings is calculated using the inverse fast Fourier transform (IFFT). Here it is possible to calculate the time characteristic of a signal from a given spectrum. A complex time signal

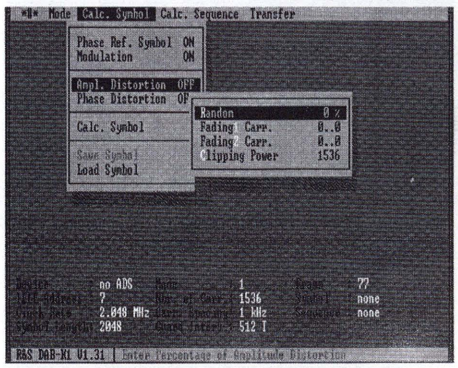


FIG 5 "Calc. Symbol" menu for symbol calculation

will be obtained whose real part contains the data of the I component and whose imaginary part those of the Q component of the modulation signal. The calculated data can be stored in a symbol file. This file, too, uses ASCII format to allow for modifications of the signal in the time domain.

Combination of symbols into a sequence is possible in the "Calc. Sequence" menu (FIG 6). With DAB and probably with DVB too, a number of

USER_FILE:rectangle	*Header für eine Träger-Datei*
**********************	
....	*Daten entsprechend der gewählten Anzahl von Trägern*
86, 0.93264, 0.59231	*Trägernummer, Realteil, Imaginärteil für Träger Nr. 86*
87, 0.14252, 0.32878	*Trägernummer, Realteil, Imaginärteil für Träger Nr. 87*
88, 0.32533, 0.19367	*Trägernummer, Realteil, Imaginärteil für Träger Nr. 88*
89, 0.73482, 0.25278	*Trägernummer, Realteil, Imaginärteil für Träger Nr. 89*
90, 0.54321, 0.12345	*Trägernummer, Realteil, Imaginärteil für Träger Nr. 90*
....	

FIG 4 Extract from data file listing real and imaginary component for each carrier

symbols will be combined into a frame, which is to be initiated by a time-reference and a phase-reference symbol. The reference symbols will, in the case of DAB, be followed by 75 symbols containing the useful modulation. The capability of forming sequences of symbols makes it possible to simulate such a frame.

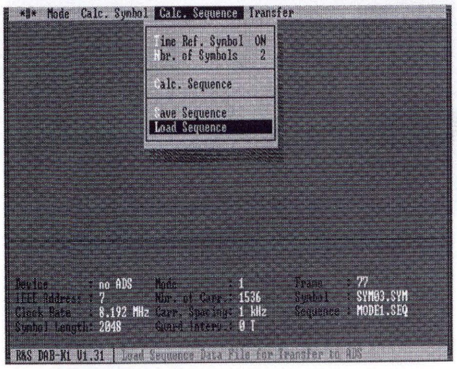


FIG 6 "Calc. Sequence" menu for frame generation

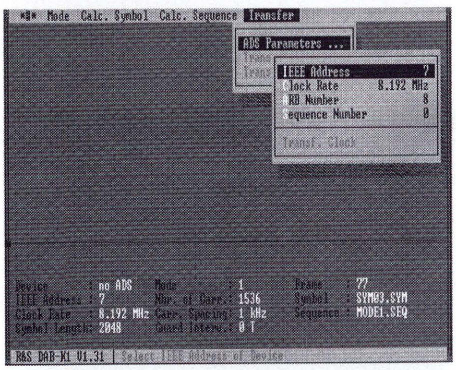


FIG 7 "Transfer" menu for data transmission to ADS

The **time data** of the calculated symbols and sequences are **transmitted to Arbitrary Waveform Generator ADS**. On ADS too, adjustments are possible. For example, the resolution of D/A converters can be reduced to analyze the effects of converter characteristics on the signal (FIG 7). The D/A converters of ADS have resolution of 12 bits, which yields signals of high spectral purity. This resolution can be reduced to 8 bits and thus simulate defects in D/A converters. After data transfer, ADS starts to output the analog signals. The signals are applied to the I/Q modulation input of SMHU 58, which generates the COFDM signal, whose center frequency can be freely selected throughout the frequency range 10 MHz to 2 GHz (FIG 8).

Further applications

With a maximum clock rate of 33 MHz, ADS can output modulation signals with a bandwidth of theoretically up to 16.5 MHz (Nyquist criterion). In practice a bandwidth of about 12.5 MHz is attainable because of the limited steepness of the lowpass filters. The RF bandwidth of the modulated I/Q signal output by Signal Generator SMHU 58 is twice that of the modulation signal, ie maximum 25 MHz. In this band, anything between 2 and 8190 carriers can be accommodated, the number of carriers being limited by the memory space required for the data records used to calculate the signal. The smallest selectable carrier spacing is 10 Hz. Within these limits not only COFDM signals can be generated but also any desired spectra to suit a variety of applications. For example dense frequency-band occupation as encountered with the Japanese PHP (Personal Handy Phone) system can be simulated. This system uses radio channels with a 300-kHz spacing. The combination of ADS, SMHU 58 and Software DAB-K1 makes it possible to generate carriers to simulate a frequency band with 50 channels.

Albert Winter

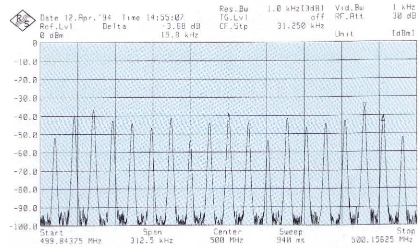


FIG 8 Section of DVB spectrum with 64-QAM-modulated carriers

REFERENCES

[1] Wolf, J.: Field-strength measurements in DAB network with Test Receiver ESVB. News from Rohde & Schwarz (1992) No. 139, pp 22–23

[2] Winter, A.: Test-signal generation for digital audio broadcasting using Generators SMHU 58 and ADS. News from Rohde & Schwarz (1992) No. 139, pp 24–25

Reader service card 145/10

Hardware requirements

Controller: PSA controller family from Rohde & Schwarz or AT compatible with industry standard (operating system MS-DOS 3.3 or higher, main memory: min. 400 Kbytes RAM)

Graphics adapter and monitor: Hercules graphics card and monochrome monitor, or EGA/VGA card with monochrome or colour monitor

IEC-bus card (IEEE 488.1) from Rohde & Schwarz or National Instruments

IEC/IEEE-bus driver from Rohde & Schwarz or National Instruments

Dual Arbitrary Waveform Generator ADS with clock generator

Signal Generator SMHU 58 with I/Q modulator

Transmitting MUSICAM-coded audio signals in telecommunication networks

ISO-MPEG standard 11172-3 defines a new, bit-rate-reduced coding method for high-quality audio signals, based on findings in the field of psychoacoustics and known as **MUSICAM** (masking-pattern-adapted universal subband-integrated coding and multiplexing). The method depends on utilizing the response and imperfection of the human ear in such a manipulative way that the listener is left with a subjective impression of listening to CD quality (transparency) [1;2]. According to the motto "less means more", the essence of the method lies in the fact that the bit rate can be reduced by a factor of 6 to 8 compared to that used in conventional digital coding without any loss in quality. For this reason the ISO-MPEG standard will no doubt play an important role in studios and audio transmissions in the future.

Similar to conventional analog signals, digital MUSICAM data are transmitted via available (public) telecommunication networks. Network operators provide all kinds of leased lines in **terrestrial digital PCM networks** for these transmissions. The networks are hierarchically organized. A typical level for audio transmissions is, for instance, the 2-Mbit/s hierarchy. Normally, the networks use permanent connections, ie lines which are leased for an extended period of time. The presently implemented ISDN network, which uses a basic access channel of 64 kbit/s, fits into the PCM network hierarchy and is used for audio transmissions although, contrary to the PCM network, ISDN is a switched network where connections for transmissions are dialled up, switched and then cleared down again.

In the past few years **signal transmission via satellite** has been gaining more and more importance. Different techniques are being used for point-to-point and point-to-multipoint transmissions and the transponder in space is also an ideal distributor for MUSICAM-coded audio signals. Recently the Astra digital radio system (ADR) was presented to the public by SES Luxembourg, operator of the ASTRA satellite. ADR uses the

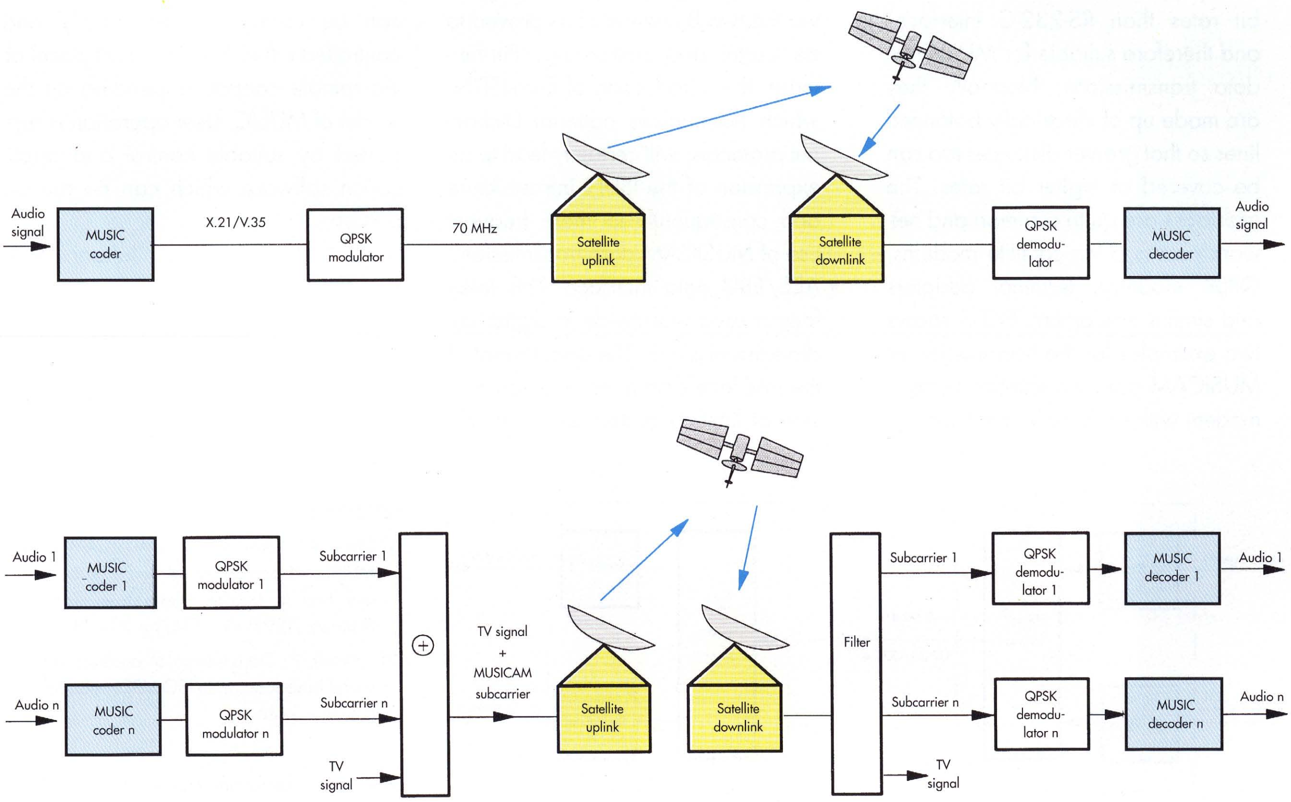


FIG 1 Transmission of MUSICAM signals by satellite according to SCPC (single channel per carrier) technique (top) and subcarrier method (bottom)

subcarrier method on a TV transponder and provides several channels for MUSICAM data.

MUSICAM Codec MUSIC [1] from Rohde & Schwarz is suitable for audio-signal transmission via advanced terrestrial telecommunication networks and satellite links and is equipped with all **interfaces required for network access:**

- X.21,V.35/.36/.37 interfaces. These internationally standardized serial interfaces are able to handle higher bit rates than RS-232-C interfaces and therefore suitable for MUSICAM data transmissions. Normally they are made up of electrically balanced lines so that greater distances too can be covered at higher bit rates. The interfaces are quite common and network access is via satellite modems, QPSK modems, terminal adapters and similar equipment. FIG 1 shows two examples for the transmission of MUSICAM data via satellite using a modem with an X. or V. interface.

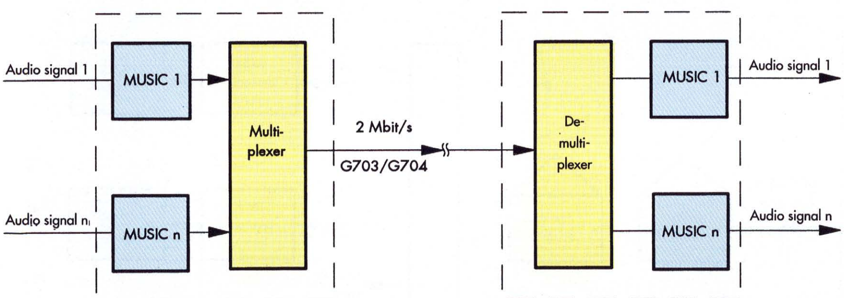


FIG 2 Combination of several MUSICAM signals into 2-Mbit/s TDM signal

- 2-Mbit/s PCM interface. The interface uses the 2048-kbit/s hierarchy G703, G704 standard) and was originally designed for 64-kbit/s TDM transmissions in up to 30 voice or data channels. Of course the time slots can also be filled with MUSICAM data, which means that several MUSICAM stereo channels can be transmitted simultaneously on a 2-Mbit/s line (FIG 2). The 1-Mbit/s DS1 lines (DS1 = 1/2 of 2 Mbit/s) may be used in a similar way for MUSICAM transmissions.
- ISDN interface S_0. The progressing implementation of the switched ISDN network also makes transmission of MUSICAM data via this network attractive. The most common interface for ISDN terminals is S_0, which uses two separate, bidirectional 64-kbit/s data channels (B1 and B2) and one signalling channel (D channel). Especially in outside broadcasting, transmission of high-quality audio signals via the two B channels has proved to be useful and cost-saving. Furthermore, the introduction of Euro-ISDN, which harmonizes national D-channel protocols, will certainly lead to an expansion of the ISDN infrastructure and consequently to more frequent use of MUSICAM data transmission.
- AES/EBU data interface. This interface is used worldwide in digital audio transmissions. The data format of the interface determines the transmission of linearly coded stereo signals particularly in studios and audio systems. At present AES/EBU study groups are preparing a standard specification for modification of the interface, permitting up to four MUSICAM channels to be transmitted without any change of the AES/EBU data frame and the infrastructure.
- DAB interface. In the course of the development of prototypes, the DAB interface WG 1/2 was defined, which permits MUSICAM equipment to be connected to DAB units (eg multiplexer or channel coder). The interface is made up of two balanced lines to RS-422 standard and uses simple clock and data signals for transferring MUSICAM data to DAB units.
- Customized interfaces. Thanks to the flexible interface concept of MUSIC, special interface configurations may be implemented in addition to available standard interfaces. This allows special conditions to be considered, for instance for sync signals or clock and data inputs/outputs.

Parameters of all interface functions can be configured individually and controlled either from the front panel or via remote control, depending on the model of MUSIC. User operation is supported by suitable control and application software which can be run on a PC.

Johann Mayr

REFERENCES

[1] Stark, A.; Krawinkel, C.: MUSICAM Codec MUSIC – Compression of audio data without any loss in quality. News from Rohde & Schwarz (1994) No. 144, pp 20–23

[2] Schmidt, P.: Transmission of ancillary data in sound broadcasting to ISO-MPEG standard. In this issue, p 46

Enter 145/11 for further information on MUSIC

Testing ERMES pagers with Signal Generator SME

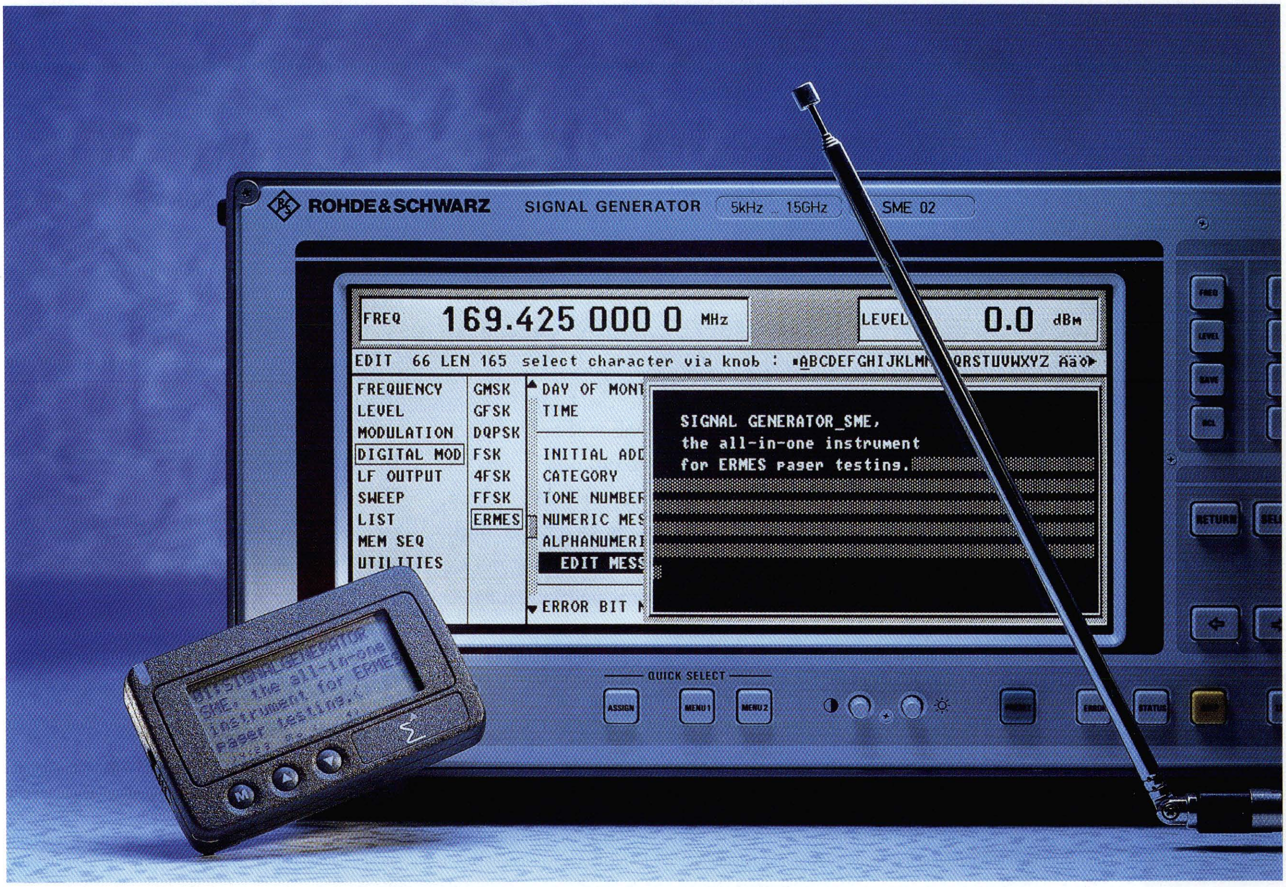


FIG 1 Signal Generator SME for 5 kHz to 1.5 GHz for tests on all types of ERMES pagers
Photo 41 517/2

In 1992/93 ETSI (European Telecommunications Standards Institute) laid down a new Europe-wide standard for radio-paging services: ERMES (European radio message system) [1]. In France and Scandinavia, licences for setting up the new network have already been granted. The first ERMES pagers are available. Well timed for the introduction of the new radio-paging service in Europe, Rohde & Schwarz can now offer a cost-effective, compact instrument for testing ERMES pagers: Signal Generator SME (FIG 1) [2]. SME supplies signals conforming to standard and provides all the required settings, while offering an easy, and straightforward operating concept.

Compared with the British POCSAG standard (POCSAG = Post Office Coded Standardization Advisory Group), which is today's most commonly used service, **ERMES** offers the following **advantages:**

- The decision to operate in a common frequency range makes it possible to use standardized receivers all over Europe.
- The ERMES networks of the individual countries are compatible with each other, allowing subscribers to be called outside their home countries.
- ERMES uses 4FSK modulation. Two bits of the digital input data are modulated onto a carrier at a time, the input data carrying system-specific information in addition to the message to be transmitted. In this way ERMES attains up to twelve times the bit rate of POCSAG without any trade-off of data integrity.
- Messages to ERMES pagers are transmitted in only one of 16 batches (FIG 2), resulting in a reduction of average current consumption.
- ERMES pagers are able to scan up to 16 RF channels. A pager identifies the channels in which messages are sent by comparing the transmitted FSI (frequency subset indicator) with its programmed FSN (frequency subset number). This makes it possible for a network operator to create a network step by step without the need to modify pagers: starting, for example, with one channel and adding further channels as network load increases, assigning the pagers to the channels available.

	ERMES	POCSAG
Frequency band	169.4125 to 169.8125 MHz	146 to 469 MHz (country-specific) 450 to 470 MHz (Cityruf)
Number of channels	16	3 (Cityruf)
Channel spacing	25 kHz	20 kHz (Cityruf)
Modulation	4FSK	FSK or FFSK
Data rate	6250 bit/s	512, 1200, (2400) bit/s

The blue box summarizes the physical parameters of ERMES and POCSAG.

ERMES supports four **types of pager:**

- Tone-only pager; signals the message received by up to eight different tones at two levels of priority.
- Numeric pager; indicates the message received on a display by means of digits and special characters, eg a phone number to be dialled.
- Alphanumeric pager; has full text display capability. The ERMES standard allows very long texts to be transmitted.
- Integrated pager; intended for data applications (eg notebook) and allowing transmission of transparent messages (bit stream).

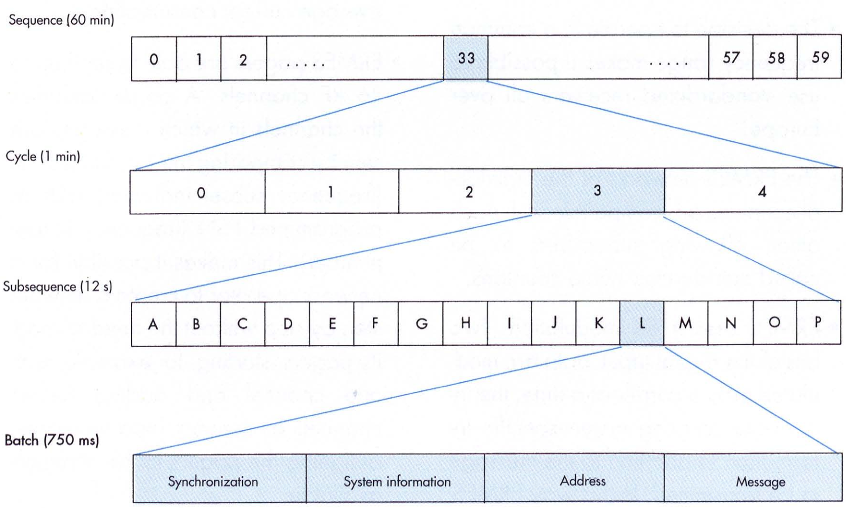
Signal source for pager tests

Seeing as pagers receive but do not acknowledge signals, a signal source modulated in line with standards will suffice to verify proper functioning of a pager. When a signal from such a source is applied to a pager, the transmitted message is indicated optically, acoustically or by vibration, depending on the type of pager used.

Signal Generator SME is ideal for pager tests. Featuring extremely high RF shielding (RF leakage <0.1 μV), which is indispensable because of the high sensitivity of pagers, SME guarantees highly accurate, reproducible results.

A further strong point of SME is its all-in-one concept. Compared with this compact solution, systems made up of several units involve more error sources (eg wrong cabling) and require more space. Fitted with the right options (DM Coder SME-B11, 8-Mbit Memory Extension SME-B12 and, if appropriate, Reference Oscillator SM-B1), SME, supported by its convenient operating menu, will generate all signals required immediately after power-up. This makes it possible to generate ERMES signals errorfree and without a long learning time, even for users working on SME infrequently.

FIG 2 Structure of ERMES telegram



Another feature of SME that plays a crucial role in production and, for example, incoming-goods inspection is its capability for remote control via the IEC/IEEE bus. This allows a maximum number of pagers to be tested per unit of time.

Function tests on ERMES pagers

The most important parameter to be tested on ERMES pagers is sensitivity. The quality criteria are given by the ERMES standard on the one hand and by the manufacturers' quality requirements on the other. A pager fulfills ERMES specifications if eight of ten calls with a field strength of 25 dBμV/m are received correctly. Manufacturers of pagers have to introduce an extra safety margin to meet the standard specifications to compensate for tolerance spread in production batches. The sensitivity test is greatly facilitated by SME's convenient operating concept. The operator enters the pager address, selects the pager type (tone only, numeric, alphanumeric) and defines the message to be transmitted. SME then generates the ERMES signal. In the "Single" mode the generator inserts the message into a subsequence only once, controlled by a trigger signal, and returns to the normal mode while the pager under test remains in sync with the generator. This function is intended primarily for service applications, allowing a call to be sent repeatedly, just by striking a key, without any further settings required on the generator.

Manufacturers' requirements for minimum test times for ERMES pagers are met by the "Always" mode. Here a message is sent in each subsequence. This mode, in conjunction with the special capability of SME to send a message in all batches at the same time (each batch can be selected separately

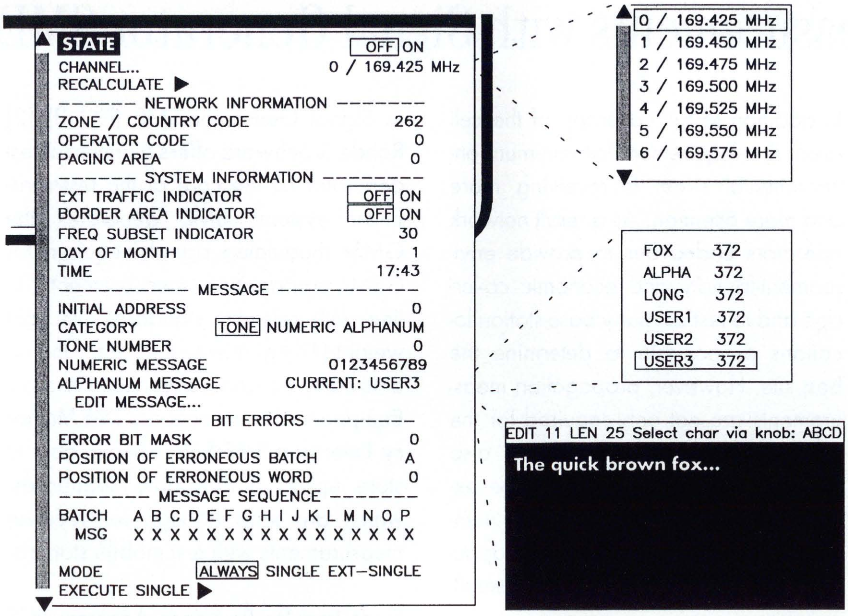


FIG 3 ERMES menu of SME with submenus

to transmit a message), makes it possible to address up to 16 pagers simultaneously. Moreover, this feature allows the generation of 16 calls within a single subsequence (duration 12 s) in manufacturer-specific test modes for ERMES pagers.

To examine a pager's response to bits corrupted during transmission, SME can also generate error bits.

ERMES menu of SME

The operating concept of SME for ERMES tests is such that the whole range of settings required for the complex message structure can be generated by means of a few, easy-to-understand menu commands (FIG 3). SME is capable of generating a complete cycle consisting of five subsequences in line with standard requirements. At the subsequence level, it can be determined for each batch separately if the batch is to transmit a call or filler data. The batches thus defined can be switched to send filler data only either on a keystroke or by an external trigger.

The **ERMES menu** is divided into several **logical sections:**

- General section. Here the channel setting parameters can be selected, ERMES signal generation switched on or off, and output data updated.
- Network information. This section contains the data for the network simulated by SME. These data are sent along with every batch and inform on zone and country codes, network operator code and paging area.
- System information. This provides the following information on the ERMES network: external traffic, border area indication, FSI (frequency subset indicator), day of month, and time.
- Message. All parameters of a call can be set:
  receiver address,
  call category,
  one of 16 call tones for tone-only message,
  generation of numeric message of up to 16 characters,
  selection of alphanumeric message (three predefined messages, three user-definable messages).
- Bit errors. SME allows, for test purposes, individual bits of a subsequence to be corrupted. This is done by selecting a code word of a batch, which is then exclusive-ORed with a user-definable mask of 30 bits. CRC checksums, too, can be made erroneous.
- Message sequence. The transmit mode for call or filler data is defined (send call data continuously, on a keystroke or by an external trigger). In addition, each batch type can be defined separately to contain call or filler data.
- Continuous status display. The subsequence number and the batch type of the data currently output are continuously displayed in the status line of SME while the ERMES signal is being generated. The status line also shows if call or filler data are being sent. The user can thus see at any time if a call is sent and to which type of receiver it is output.

Kurt Lainer; Mathias Leutiger; Daniel Schröder

REFERENCES

[1] ETSI TC-PS: Paging Systems (PS); European Radio Message System (ERMES)

[2] Lüttich, F.; Klier, J.: Signal Generator SME – The specialist for digital communications. News from Rohde & Schwarz (1993) No. 141, pp 4–7

Enter 145/12 for further information on SME

GSM propagation measurements with Signal Generator SME

Propagation measurements are indispensable in the planning of digital, cellular mobile-radio networks. To find optimum sites for base stations, a mobile test-transmitter system simulating the base station is operated from a number of possible locations. The test-receiver system is accommodated in a vehicle, which is then driven along a test route for making measurements. Measured parameters such as level, bit-error rate or channel impulse response (FIG 1) inform on coverage within the cell. The purpose of these measurements is to minimize interference caused by multipath propagation in the reception area.

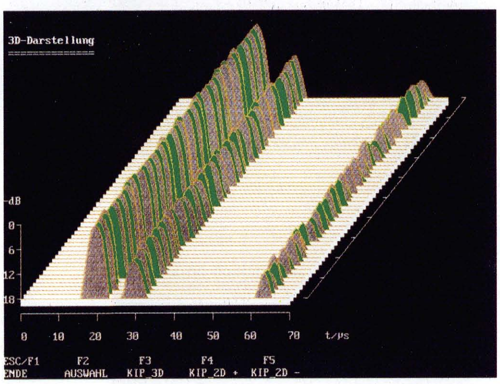
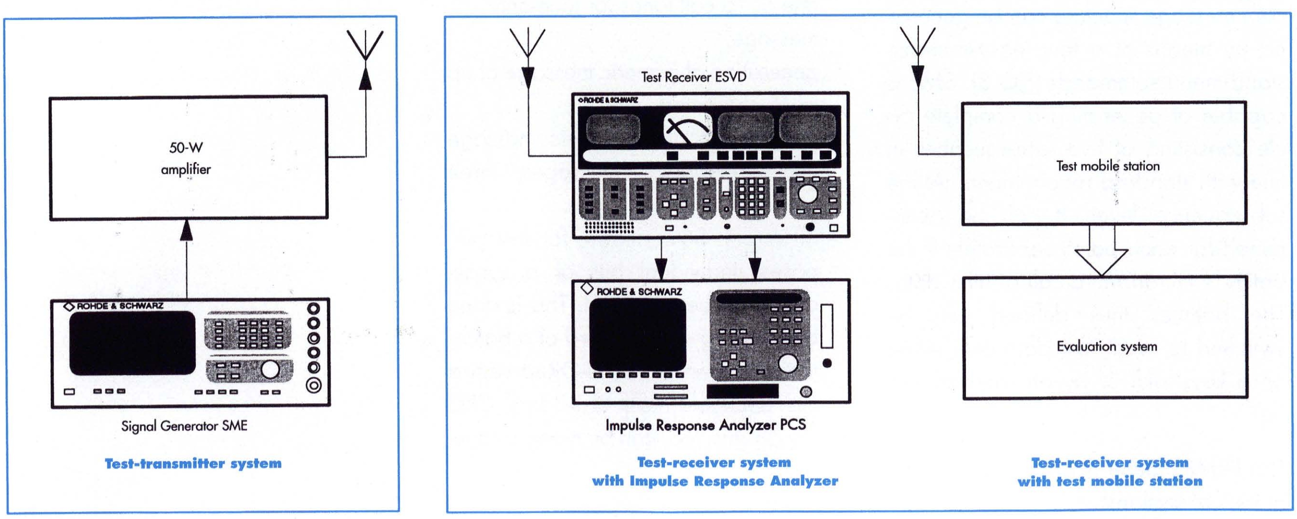


FIG 1 Three-dimensional display of channel impulse response

FIG 2 Test-transmitter and test-receiver systems



In addition to full coverage of the cell area, the requirement for minimum environmental stress is receiving more and more attention. As a result network operators endeavour to provide environment-friendly and economic coverage and to test as many base-station locations as possible to determine the best site. However, propagation measurements are not only required for the planning of new networks but also when existing networks are to be expanded. For instance, when the number of subscribers reaches cell capacity, the cell has to be split up into smaller ones.

GSM test-transmitter system

The GSM test-transmitter system consists of a test-signal generator, a 50-W RF power amplifier and an omnidirectional antenna (FIG 2). The system is required to supply a standard signal, be as light as possible and mobile so that tests may be carried out at sites which are difficult to access. The length of the sent data sequence depends on the test system at the receiver end. If an Impulse Response Analyzer PCS [1] is used for determining channel impulse response, only a short data sequence is required, which is continually repeated. Long data sequences are usually required when a test mobile station is employed at the receiver end.

In Signal Generator SME (FIG 3) [2] Rohde & Schwarz offers a universal test generator as the core of the test-transmitter system. SME generates the GMSK-modulated signals required for GSM propagation measurements in line with relevant standards. Its light weight (17 kg) makes it easy for the user to carry the generator to remote sites. Equipped with an optional **DM Memory Extension SME-B12**, SME is able to store up to 8-Mbit data sequences, which are long enough for receiver measurements with test mobile stations.

Since Impulse Response Analyzer PCS is able to determine channel impulse response also with the aid of a GSM training sequence, the same sequence can be used for measurements with a test mobile station or with an impulse response analyzer at the receiver end. Once the test transmitter is set up, it can be used without any alterations to obtain an overall assessment with the test mobile station or to closely examine critical locations with the impulse response analyzer.

Generating data sequence

Information sent to a test mobile station requires coding in line with GSM specifications. In the eight time slots (0 to 7) of the TDMA frame, BCCH sequences must be sent in time slot 0 and TCH sequences in time slot 3. The remaining time slots are filled with dummy bursts.

For calculating the data sequence, a comprehensive program similar to that implemented in GSM Radiocommunication Test Set CRTP is required [3]. Since Signal Generator SME was designed for propagation measurements in other networks too, a memory is incorporated to replace the sequence calculating function so that data sequences from an external source, eg Radiocommunication Test Set CRTP, can be stored. Even after power-off of SME, stored data are retained in memory until they are overwritten.

Seeing as the data sequence in SME is not calculated but simply stored, it is repeated at a regular interval. The sequence must be long enough for the test mobile station at the receiver end to be able to carry out accurate measurements. Since the test mobile station from Bosch requires data sequences of at least 6.63 Mbits, the optional DM Memory Extension SME-B12 can store data sequences of up to 8 Mbits.

Data sequences available in SME may be stored on a floppy or hard disk with the aid of a PC via an RS-232 interface or IEC/IEEE bus. This allows network operators to hand out floppies with data sequences of different length to subsidiaries, where the data can be read into SME with the aid of a PC or laptop.

Use in other networks

In addition to the described modulation, SME provides a variety of other network-specific modulation modes:

Modulation	**Network**
GMSK	GSM, PCS 1800 (PCN) CDPD, MOBITEX, DSRR
GFSK	DECT, CT2, CT3
4FSK	ERMES, APCO25
$\pi/4$-DQPSK	NADC, PDC, TFTS, TETRA, APCO25

Of course SME will also be able to supply standard modulation signals for future networks which, like GSM, require a test-transmitter system for propagation measurements. This makes SME an ideal signal source for measurements in existing and future networks.

Johann Klier

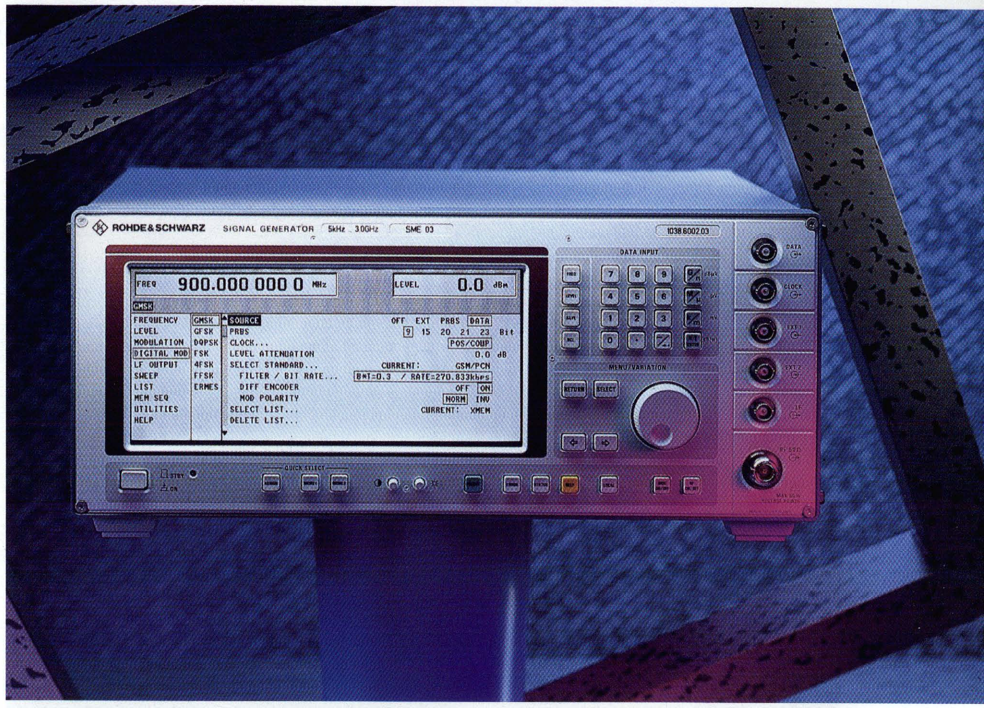


FIG 3 Signal Generator SME, ideal signal source for propagation measurements in digital mobile-radio networks Photo 41 546

REFERENCES

[1] Bues, D.; Riedel, P.: Planning digital radio networks using Impulse Response Analyzer PCS and test transmitter system. News from Rohde & Schwarz (1993) No. 141, pp 26–27

[2] Lüttich, F.; Klier, J.: Signal Generator SME – The specialist for digital communications. News from Rohde & Schwarz (1993) No. 141, pp 4–7

[3] Schubert, W.: Digital Radiocommunication Test Set CRTP 04 – Test set for base stations to new PCN/DCS 1800 mobile-phone standard. News from Rohde & Schwarz (1993) No. 143, pp 8–10

Enter 145/12 for further information on SME

FAMOS monitoring center for video signals

FIG 1 Automatic TV monitoring system FAMOS with Video Analyzer UAF and TV Test Receiver EMFP Photo 40 258

Measurement of a video signal must be objective to ensure optimum signal quality. This can be achieved by inserting test signals into the invisible portion of the video signal and measuring them at several points (studio outputs, TV switching centers, transmit and receive stations). For this purpose Rohde & Schwarz offers excellent analyzers, capable of evaluating more than 20 different parameters of the test signal. Rohde & Schwarz has been supplying fully automatic TV monitoring systems – to permit not only sampling but also continuous measurements – for more than ten years. These systems issue messages if video-signal quality is no longer acceptable.

One of these systems is FAMOS (FIG 1), a favourably priced TV monitoring system first introduced in 1992 [1]. It is suitable for the following **applications:**

- detection of faults in broadband network headends or on satellite transmission links,
- determination of time and location of random errors (eg due to weather),
- checking reception quality in relay receiver stations,
- measurements on distribution networks and video routing switchers for a variety of TV standards,
- comparative measurements on two video signals to localize loss in quality,
- monitoring transmit and receive systems,
- monitoring unattended TV transposer stations.

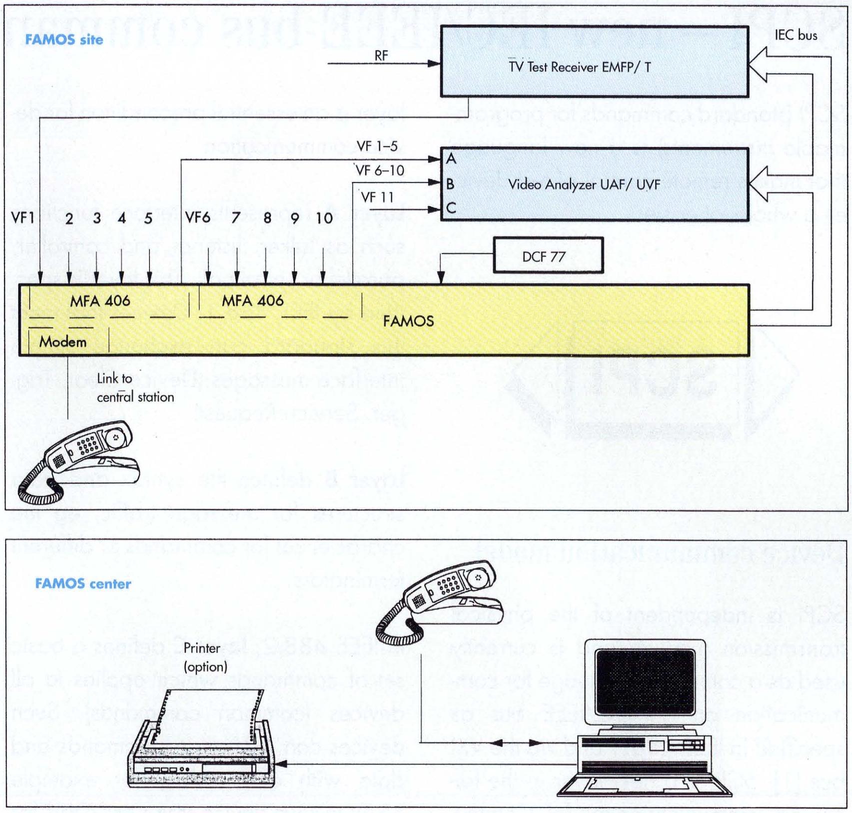
FAMOS incorporates Video Analyzer UVF or UAF [2; 3] to measure the video signal. Test Receiver EMFT or EMFP [4; 5] converts the RF signal to obtain the video signal. FAMOS monitors up to 100 channels, offset channels, special channels and video testpoints. Despite the large number of commands which can be entered on a terminal, a complete TV network can be monitored using a central control and evaluation system, which is particularly useful in applications involving several FAMOS stations. Rohde & Schwarz thus created the FAMOS monitoring center, with the use of a program based on the widespread Microsoft Windows user interface, enabling large systems made up of many FAMOS stations to be operated cost-effectively (FIG 2).

Station status is displayed by LEDs in a window of the computer in the **FAMOS center** (FIG 3). Green means that the status is correct, while yellow indicates that the inner tolerance is exceeded. And red signals that the outer tolerance is exceeded or another serious fault has occurred. LEDs flash when messages are received. If the name of a station is clicked, all associated testpoints and channels appear in the main window of the program. After selection of a channel, all messages received so far on this channel are displayed. Messages can be acknowledged by means of a dialog box indicating the date, time, name and executed activity. LEDs then stop flashing. This complete documentation furnishes proof of the quality and availability of the TV transmission system.

In the FAMOS center, stations can be configured individually. The program permits different settings of the measuring equipment for every channel. Inner and outer tolerances (with hysteresis) can be set individually for every parameter. The parameters of a particular channel can be disabled independently of one another. Any testpoint (channel) not available at present can be disabled and so removed from the monitoring cycle.

Statistics are also generated from the transferred measured values. Average

FIG 2 FAMOS station and center



statistics are displayed, stating for each day of a month, the minimum, maximum and average measured values of parameters, channels and stations (FIG 4). There are also event statistics, indicating how often the inner or outer tolerance is exceeded on each day of the month. Such statistical evaluations allow trends to be analyzed as well as possible sources of faults to be recognized and eliminated. The signal quality of a TV system is thus tested continuously and in turn operational reliability improved considerably. Documents generated by means of this program can, of course, be processed with other Windows programs, eg for records and presentation.

Christian Christiansen

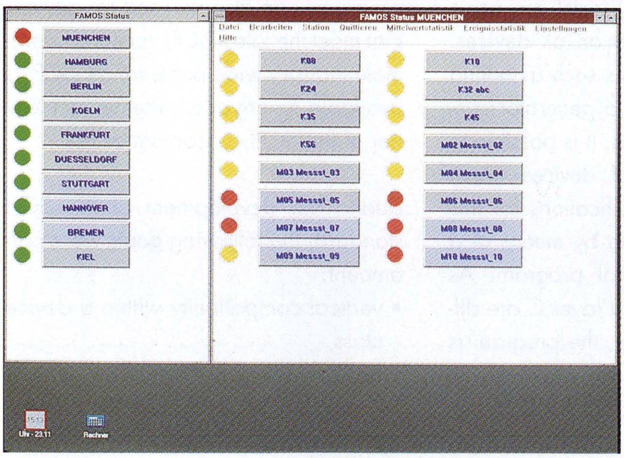


FIG 3
Window indicating status of sites

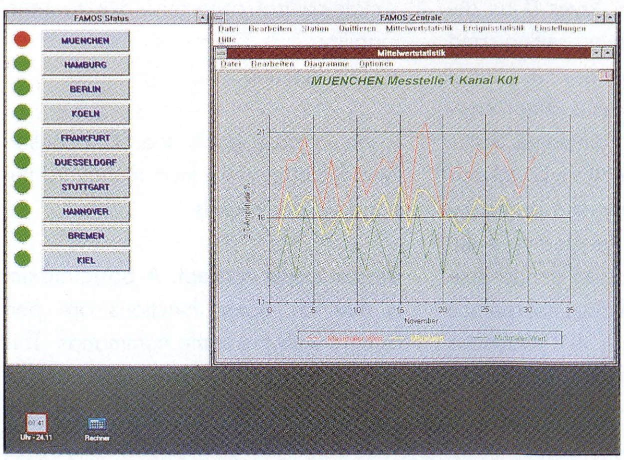


FIG 4
Average statistics

REFERENCES

[1] Haff, A.; Klotzsche, W.: FAMOS: automatic TV monitoring – small, handy, favourably priced. News from Rohde & Schwarz (1992) No. 137, pp 23–25

[2] Henschke, W.; Ibl, H.: Video Analyzer UVF. News from Rohde & Schwarz (1984) No. 106, pp 28–30

[3] Ibl, H. ; Hanssen, W.; Krohne, M.: Insertion-test-signal measurements with Video Analyzer UAF. News from Rohde & Schwarz (1990) No. 128, pp 12–15

[4] Hermsdörfer, O.: New EMF generation of TV test receivers. News from Rohde & Schwarz (1987) No. 118, pp 13–15

[5] Hermsdörfer, O.: TV Test Receiver EMFP for flexible channel selection. News from Rohde & Schwarz (1991) No. 132, pp 36–37

Reader service card 145/13

SCPI – new IEC/IEEE-bus command language

SCPI (standard commands for programmable instruments) is a new language that makes remote control of test devices a whole lot easier.

Device communication model

SCPI is independent of the physical transmission medium and is currently used as a command language for communication on an IEC/IEEE bus as specified in IEEE 488.1 and via the VXI bus [1]. SCPI is a new layer in the following communication model. Communication between two devices can be split up into independent functional layers, each being set up on the other. FIG 1 shows these layers, the IEC/IEEE

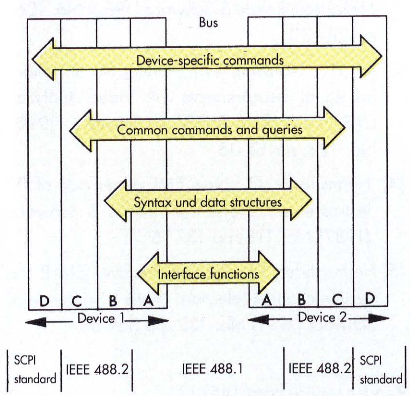


FIG 1 Device-communication layer model

bus to IEEE 488.1 and IEEE 488.2 [2;3] being used as an example.

The hardware, defined electrically and mechanically (connectors, signal levels to be used, etc), is the bottom layer. Standardization of the devices on this layer is an essential precondition for device communication.

Layer A represents interface functions such as talker, listener and controller, parallel or serial poll. This layer is specified by IEEE 488.1. Devices that meet this standard can exchange simple interface messages (Device Clear, Trigger, Service Request).

Layer B defines the syntax and data structures for message traffic, eg the character set for commands or different terminators.

In IEEE 488.2, **layer C** defines a basic set of commands which applies to all devices (common commands). Such devices can exchange commands and data with each other, for example *SAV to save device status or *IDN? for device identification. However, common commands only exist for basic functions implemented on all devices. Special device features such as setting level or frequency on a generator cannot as yet be provided. It is possible to integrate a variety of devices which comply with the specifications for this layer and control them by means of a common remote-control program. As the commands beyond layer C are different for each device, the program is device-dependent, and also voluminous, because commands for all devices have to be stored.

IEEE 488.2 describes **layer D** as device-specific. It contains setting and query commands for device control which are not defined as common commands. Previously the commands at this layer were, if at all, uniformly defined within a product family of a particular manufacturer. This is the starting point of SCPI, which attempts to standardize this layer too. So SCPI does not replace IEEE 488.2, it expands it. This means that even complex device functions can easily be carried out by a standard remote-control program.

Definition of SCPI

The SCPI standard is being developed by a consortium of leading manufacturers of measuring instruments. Rohde & Schwarz became a member in 1990. Other major members are Hewlett Packard, Philips, Fluke, Tektronix, Keithley, Wavetek and National Instruments. Currently the SCPI consortium has more than 30 members.

SCPI language definition is not an official standard. This was intentional, as a drawn-out standardization process would make SCPI too inflexible. SCPI is a "living" standard, continually being expanded to meet the needs of new technological developments. Integrating new device functions into the standard is made as simple as possible. So upward compatibility is of vital importance, ie all earlier SCPI remote-control programs can also be used for devices that meet the latest SCPI version. To promote industry-wide acceptance, SCPI is available to anyone, whether a member of the SCPI consortium or not.

During the development of the SCPI standard, the following **goals** were paramount:

- vertical compatibility within a device class,
- horizontal compatibility between the same functions across the device classes,
- reduction in development costs for remote-control programs due to reusability,
- easy learning.

To attain these goals, the SCPI consortium did a lot more than merely list the standard commands.

Device model concept. A basic maxim is that the same functions are performed with the same commands. This is a break from the usual approach of making minimal changes to manual control facilities when manual and remote control are combined. As manual control is implemented in a number of radically different ways, remote control cannot be standardized in this way. Instead, SCPI structures the commands using a common signal-flow model based on functional blocks. The model in FIG 2 is used as a basis. Depending on the device class, this model can be refined considerably in certain areas (eg for multi-channel instruments), but functional blocks might also be dropped. The model defines the remote-control commands by assigning a specific subsystem in the command tree to each functional block. This guarantees that the same device functions can be performed with the same commands without exception.

Syntax specification. SCPI defines a syntax that goes far beyond IEEE 488.2. A characteristic feature is the organization of commands in a tree structure. A keyword at the first tree node levels is allocated to each functional block of the device model. Then the keyword at the second level is appended and separated by a colon. The second level further subdivides the functional block. This procedure can be used for other levels. Commands typically have three to four levels. Example: SOURce: AM:EXTernal: COUPling AC switches the input of an external AM modulation source to AC coupling.

Another syntactic characteristic is the use of numeric suffixes to distinguish between several identical functional blocks within a single device. The two channels of a two-channel signal generator, for example, are addressed in all commands as SOURce1 and SOURce2.

In some cases SCPI allows the omission of nodes to simplify frequently used commands. So the complete command SOURce: POWer:LEVel:IMMediate: AMPlitude 3 dBm (which gives the exact path from the root of the tree) can be replaced by POWer 3 dBm. Keywords can be shortened to three or four letters as shown by the uppercase letters in the above examples. The shortest form for setting the level to 3 dBm would then be POW 3.

Minimum command-set requirements. Each SCPI device must be able to comprehend a minimum of commands going beyond IEEE 488.2. This comprises

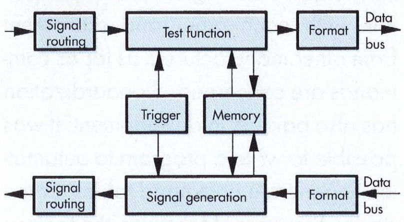


FIG 2 Device model to SCPI

queries for ascertaining device status in detail, so that diagnostic program modules can be used, without modification, for all SCPI devices. A sophisticated status reporting system, which all SCPI devices must contain, also plays a role.

Standardized command words. SCPI also specifies the keywords to be used for those commands going beyond the required command. The greater part of SCPI documentation is devoted to this topic. All device functions for which a keyword already exists must be carried out with this keyword. If there is no SCPI command for a new device function, the developer can define a command himself. He would, however, have to stick to the SCPI device model as well as the syntax rules, and he would have to identify the command as a NON-SCPI command in the manual. Moreover, this command should be submitted to the SCPI consortium for inclusion in the standard. The goal is to add commands for as many device functions as possible to the "command reference". The keywords are defined so that they can easily be read and understood; they can take over physical terms directly.

Specified query format. SCPI specifies a fixed format for sending data (measured values, setting values) from a device to the controller. The response only consists of data – without units or repetition of the query eliciting the response –, thus allowing further automatic data processing by the control program.

Specified *RST conditions. A rule going beyond pure remote control is the specification of the reset status as generated by the *RST command. SCPI provides a detailed specification for the setting value of many device parameters (eg modulation states, sweep mode). Generation of a defined initial status recognized by the control program can thus be simplified for specific devices.

Regulations for remote-control section of manual. To provide clear information on SCPI devices, SCPI lays down certain requirements for the remote-control section of a manual. All commands implemented have to be listed with their complete syntax and a note indicating whether they are defined in SCPI or whether they are device-specific.

SCPI documents

SCPI is a set of three volumes, a fourth currently being written. The first volume defines the syntax and style of the language, including a list of the required commands, defining tree structure, data formats and status reporting system.

Volume 2 is the "command reference". In addition to a description of the functional block device model, it comprises a list of all SCPI-defined commands and their functions in the device. An attempt was made to cover as many device functions as possible by simple but comprehensive commands. Keywords are based on widely used, industry-standard terms. They were chosen to guarantee easy programming for frequently used functions. The frequency of a generator, for example, can be set to 100 kHz with the command

FREQuency 100 kHz. A short BASIC program showing how a frequency sweep is programmed (FIG 3) is given as an example. It was originally written for Rohde & Schwarz Signal Generator SME [4], but can be used for any SCPI-compatible sweeper.

Volume 3 deals exclusively with a format – the data interchange format (DIF) – for sending large volumes of data. This extension to SCPI makes it possible to process large quantities of measurement data which could not be handled with standard syntax.

Volume 4 defines "device classes", which specify a simple device with a certain minimum functional scope and optional functions. DC voltmeter or AC voltmeter are typical classes. More complex device classes can be obtained by combining simpler device classes. A multimeter can thus be defined as the combination of a DC voltmeter, AC voltmeter and ohmmeter. The concept is based on the definition of interface functions as described in IEEE 488.1. By categorizing real devices in terms of these classes, minimum requirements for the command set can be obtained, thus increasing vertical compatibility among devices.

SCPI at Rohde & Schwarz

Many SCPI commands originate from detailed proposals made by Rohde & Schwarz. Rohde & Schwarz is a leader in various fields of application, eg signal generators, and so has made a major contribution to volume 4. All new measuring instruments from Rohde & Schwarz use SCPI, and thus all Rohde & Schwarz devices have a common language, meaning they are compatible with each other and equipment from other manufacturers as far as commands are concerned. Standardization has also paid off in development: it was possible to write a program to automatically generate command tables for the device firmware. Moreover, the tedious work involved in compiling the remote-control section of the manual can be cut considerably by producing a standard SCPI-compatible description.

Daniel Schröder

REFERENCES

[1] SCPI Consortium: Standard Commands for Programmable Instruments, Version 1993.0

[2] IEEE Standard 488.1–1987, IEEE Standard Digital Interface for Programmable Instrumentation

[3] IEEE Standard 488.2–1987, IEEE Standard Codes, Formats, Protocols, and Common Commands for Use with IEEE Std 488.1–1987

[4] Rohde & Schwarz: Manual for Signal Generator SME, 1993

FIG 3 Example of SCPI remote-control program in BASIC: generation of frequency sweep with set markers

```
rem channel open, reset device
CALL IBFIND ("DEV1", sme%)
CALL IBWRT (sme%, "*RST")

rem sweep mode; sweep starts at 100kHz and stops at 800kHz,
step dwell time is 20 ms
CALL IBWRT (sme%, "FREQ:MODE SWEEP; START 100kHz; STOP 800kHz;:SWEEP:DWELL 20ms")

rem set frequencies for marker and activate marker
CALL IBWRT (sme%, "MARKER1:FREQ 200kHz; STATE ON; MARKER2: FREQ 400kHz; STATE ON")

rem start repetitive sweep
CALL IBWRT (sme%, "INIT:CONT ON;:TRIGGER:SOURCE IMMEDIATE")
```

RF power measured the right way (IV)

3.1.1.1 Thermocouple sensors

Thermocouple power sensors are offered nowadays for the entire microwave range. Although thermocouples were used in the past for temperature measurements, it was only through the combination of semiconductor and thin-film technology that fast, sensitive and yet rugged sensors could be produced (FIG 20). The measurement cell is based on a silicon substrate (FIG 21). The termination is a thin layer of tantalum nitride or chromium nickel, and a metal semiconductor contact in the immediate vicinity generates the thermoelectric voltage proportional to the converted RF power (approx. 200 µV/mW). The rated power is 100 mW.

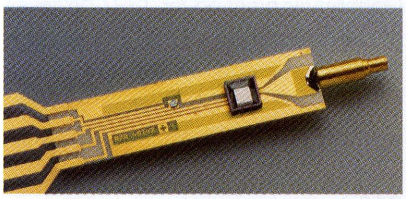


FIG 20 Thermocouple of Power Sensors NRV-Z51 to -Z54 Photo 39 268/1

To keep the manufacturing technique simple, termination and thermocouple are usually DC-coupled. A coupling capacitor is used for DC isolation from the measuring circuit. Large capacitors (high capacitance) needed for low-frequency operation not only degrade matching but also reduce the upper frequency limit. Wide frequency bands can therefore be covered only with several sensors.

In the measurement cell developed for Rohde & Schwarz Power Sensors NRV-Z51 to -Z54, the termination and the thermocouple are DC-isolated. This eliminates the need for a coupling capacitor and a single sensor can be used to cover the entire frequency range from 0 to 18 GHz (N connector) or 26.5 GHz (PC 3.5 connector).

The smallest measurable power is about 1 µW and at least ten times lower than with other thermal methods. This was made possible through special design of the measurement cell, which in conjunction with the poor heat conductivity of silicon makes for good thermal insulation of the termination. The high thermal EMF of the metal semiconductor contact (approx. 700 µV/K) and the relative insensitivity of the thermoelectric effect to fluctuations of the ambient temperature are also important factors. However, slight degradation resulting from holding the sensor in the hand for some time or screwing it to a hot RF junction cannot be avoided altogether. Because heat is supplied at one end, there will be a temperature gradient across the measurement cell, which produces additional thermoelectric voltages. The magnitude of these voltages depends on the power, resulting in a zero shift of the transfer characteristic.

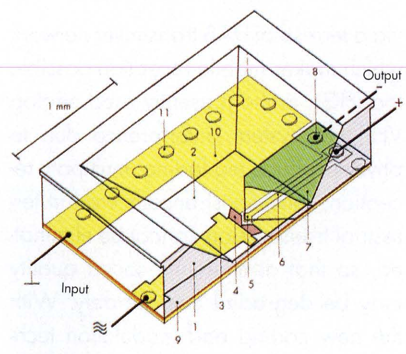


FIG 21 Sectional view of measurement cell of thermocouple sensor shown in FIG 20

1 Silicon substrate
2 Membrane
3 RF feed
4 Termination
5 Thermocouple (hot junction)
6 Metal contact
7 Highly doped silicon layer
8 Cold junction
9 Insulating layer (SiO_2)
10 Metallized ground
11 Bump

The ratio of thermoelectric voltage to RF power is also determined by the magnitude of the input power. From about 10 mW, the transfer characteristic therefore becomes pronouncedly nonlinear (FIG 22). With the sensors previously available on the market, this effect was compensated by analog means, resulting in residual errors up to about ±5% at the high end of the measurement range. Through individual calibration and numerical correction, the linearity error of NRV-Z thermocouple sensors can be kept below 0.5%.

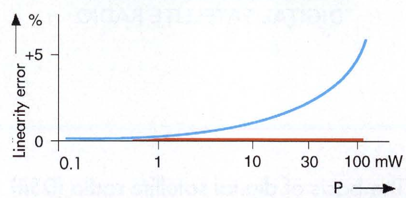


FIG 22 Typical linearity error of thermoelectric cell (red: after numerical correction). Nonlinearity is mainly caused by temperature-dependent heat conductivity of silicon.

The small mass of the sensor makes for small thermal capacity and hence for fast response (thermal time constant is of the order of ms or less). The temperature coefficient of the output voltage is either compensated by analog means or corrected numerically. To minimize microphonic effects and effects of thermoelectric voltages at the connectors of the connecting cable, the output signal of the sensor is boosted before it is taken to the power meter. Thermoelectric cells have excellent longterm stability if they are used within their rated power range. A calibration generator is thus no longer required; it is only needed for sensors which do not have the numerical correction facility.

To be continued. Thomas Reichel

DSR and DAB – digital sound broadcasting today and tomorrow

For several decades VHF FM seemed to be the only suitable method for high-quality transmission of stereo sound programs. The introduction of the digital compact disk (CD) ten years ago set new and considerably higher quality standards for audio transmissions. The advance of digital technology also had consequences for sound broadcasting and led to the development of digital audio broadcasting systems in the 80s.

DSR
DIGITAL SATELLITE RADIO

The basis of **digital satellite radio (DSR)** is a direct broadcast satellite (DBS) of the type Kopernikus or TV-SAT with sufficient output power to allow stationary reception with the aid of small dish antennas. The programs of the various broadcasters are digitally coded and sent to the uplink transmitter, where they are combined into a program multiplex with a data rate of approx. 2 x 10 Mbit/s. This data frame is QPSK-modulated and sent on the satellite uplink. Via a transponder the satellite directly broadcasts up to 16 (digital) stereo programs with a bandwidth of approx. 14 MHz and almost CD quality. At the receiver end the DSR packet is either fed to the individual satellite receiver or converted to 118 MHz and fed into cable networks for distribution to domestic receivers.

While the concept of satellite to cable network has mainly been adopted by DBP Telekom in Germany for instance, Switzerland uses direct generation of DSR packets for its networks. Programs arriving at the network headend are selected, processed and then fed into the cable network as a (local) DSR packet.

In the definition of DSR system specifications, it was decided to use the DS1 standard (digital sound 1 Mbit/s) for coding stereo signals with an audio bandwidth of 15 kHz plus program-related auxiliary information [1]. The DS1 standard can be integrated without any problems into existing networks and PCM hierarchies.

After a few teething troubles in the beginning, DSR has gained ground in the past few years and is now used in most of the cable networks. There are numerous domestic DSR receivers on the market, ranging from low-cost to high-end units with facilities for evaluating auxiliary information.

The existing DSR should not be confused with **digital audio broadcasting (DAB)**, the broadcasting system of the future where, unlike with DSR, digitally coded sound programs are broadcast

DAB
Digital Audio Broadcasting

via a terrestrial DAB transmitter network which makes mobile reception possible too (FIG). In the presently used analog VHF FM system, interference due to physical effects (eg fading, multipath reception, reflections) encountered in terrestrial transmission cannot be eliminated, so that at times the sound quality may be degraded considerably. With the new coding and modulation techniques of DAB, interfering signals are effectively suppressed so that undisturbed (mobile) reception in CD quality is obtained. In addition to CD-quality sound, DAB provides data channels for services such as digital traffic information, alarm services, electronic mailbox and electronic newspapers.

DAB is a European development project partly sponsored by the EU. In the middle of the 80s and as part of the EUREKA 147 project, renowned research institutes, broadcasting corporations and industrial companies in France, England and Germany started to develop and specify basic system functions and to test them with the aid of prototype equipment. New partners from other European countries joined the project and, since 1992, work has been progressing on refining the specifications, international standardization and setting up field trials. In large-scale pilot tests starting in Bavaria in summer 1995, real DAB programs will be broadcast to gain practical experience and to test the acceptance of the new system by the general public. Countrywide implementation of the system in Germany is planned for 1997. In several countries – and equally in Germany – DAB platforms have been created for promoting and coordinating national activities and trials.

DAB is the first system to use the bit-rate-reducing **MUSICAM coding method** (masking-pattern-adapted universal subband-integrated coding and multiplexing) [2 and articles on pp 31 and 46 in this issue] for coding program signals (eg music from CD players), which allows for the psychoacoustic response of the human ear. MUSICAM uses irrelevance and redundancy reduction so that a multiplex signal consisting of several coded audio signals can be sent in a limited bandwidth via a terrestrial transmission channel. Undisturbed mobile reception is ensured by the digital modulation method **COFDM** (coded orthogonal frequency-division multiplex). The multiplex data stream is spread over about 1500 QPSK-modulated carriers so that, in spite of the interference and drops in field strength normally encountered, the COFDM demodulator in the receiver picks up an adequate number of signal components for evaluation. With the aid of error-correction methods and concealment strategies, the receiver eliminates all remaining disturbance or reduces it below the audible threshold. With this modulation method even the delayed signal components of multipath reception (reflections), which are so disturbing in VHF FM transmissions, can be utilized for the directly received signal.

Unlike with VHF FM, COFDM-modulated program signals are transmitted in a frequency-economic way via a common-frequency network, ie all transmitters of the network use the same transmission frequency and operate synchronously. Transmissions in the field and pilot tests are mostly in band III (channel 11/12), but even for pilot tests use of the L band (1.5 GHz) for the transmission of DAB signals will be of growing importance. Real DAB transmissions after 1997 will be in band III and the L band.

Since 1992 Rohde & Schwarz has been involved in the EUREKA 147 project and participated in various working groups of the German DAB platform. Support was provided for the field and pilot tests for example with the following: a DAB coverage test system using Field-strength Test Receiver ESVB [3], a system for generating DAB test signals, MUSICAM codecs and DAB prototype transmitters. Highly linear DAB transmitters required for countrywide coverage and equipment for COFDM modulation are at present under development.

Just in time for pilot tests in 1995, first-generation DAB radios will come onto the market in sufficient numbers so that experience can be acquired and favourably priced DAB radios be produced for the general market when the system is finally introduced in 1997. Chances are good for DAB to make its way worldwide and become the broadcasting system of the next decades, providing the listener at home or on the road with CD-quality music and with lots of extra information.

Johann Mayr

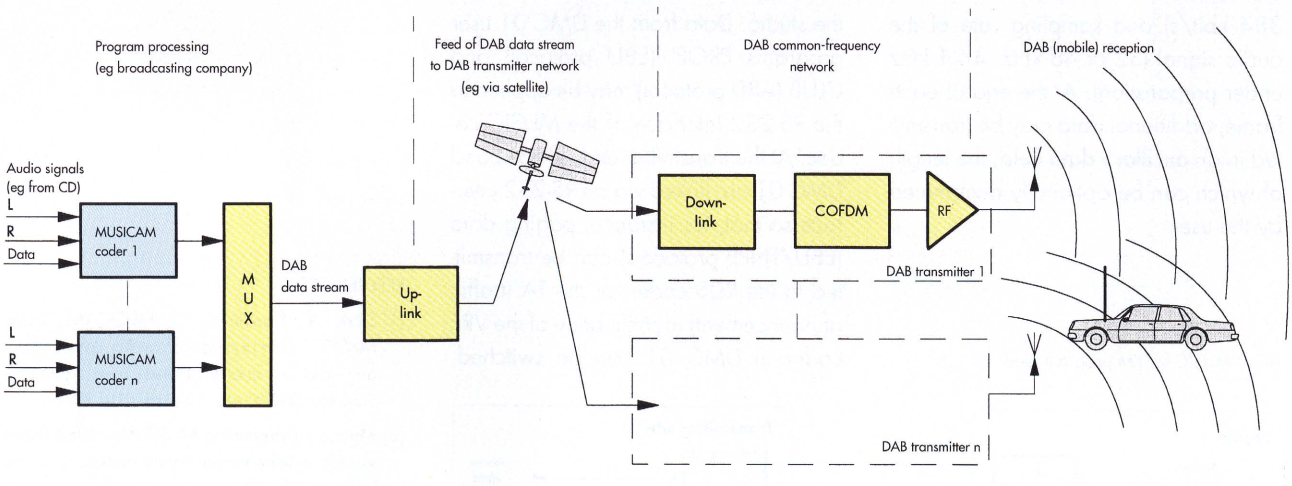
REFERENCES

[1] Dietl, A.; Kleine, G.: SFP, DSRU and DSRE – the pleasure of digital sound with CD quality. News from Rohde & Schwarz (1991) No. 135, pp 22–24

[2] Stark, A,: Krawinkel, C.: MUSICAM Codec MUSIC – Compression of audio data without any loss in quality. News from Rohde & Schwarz (1994) No. 144, pp 20–23

[3] Wolf, J.: Field-strength measurements in DAB network with Test Receiver ESVB. News from Rohde & Schwarz (1992) No. 139, pp 22–23

Principle of digital audio broadcasting (DAB)



Transmission of ancillary data in sound broadcasting to ISO-MPEG standard

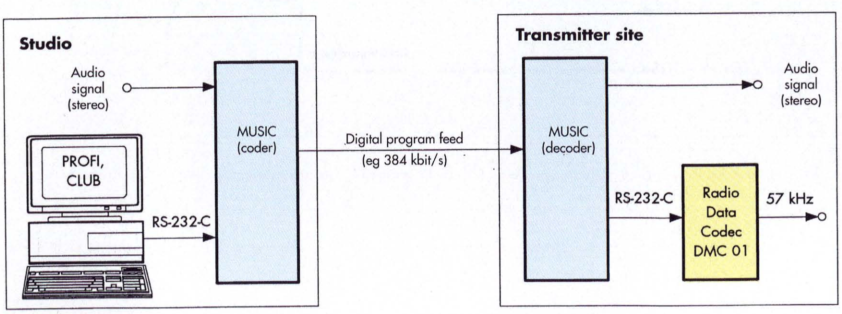
FIG 1 MUSICAM Codec MUSIC for coding and decoding digital audio signals
Photo 41 669

MUSICAM Codec MUSIC (FIG 1) is used for coding and decoding audio data signals [1; 2]. With the aid of the algorithm of the ISO-MPEG 11172-3 standard, the bit stream of a stereo signal can be reduced from about 1.4 Mbit/s to 384 kbit/s or even less. Numerous audibility tests have proved that there is no difference in the subjective perception of bit-reduced and original signals.

The bit stream generated in the coder is divided into frames. A frame contains 1152 samples of the original signal. The number of bits/frame depends on the selected bit transfer rate (64 to 384 kbit/s) and sampling rate of the audio signal (32 or 48 kHz, 44.1 kHz under preparation). At the end of each frame, additional data may be transmitted in an **ancillary data field**, the length of which can be optionally determined by the user.

When the MUSIC codec is used for **FM program feed**, ie for transmitting audio signals from the studio to the transmitter (FIG 2), information can be sent in the data channel to the RDS coder at the transmitter site. The codec provides a transparent RS-232 channel using RDS or paging protocols to EBU, ARD or TNPP (telocator network paging protocol) standards. Consequently any RDS coder capable of handling one of these protocols can be used at the transmitter site. Radio Data Codec DMC 01 [3] can thus be remotely controlled from the studio. Data from the DMC 01 user programs PROFI (EBU protocol) and CLUB (ARD protocol) may be applied to the RS-232 interface of the MUSIC codec. At the transmitter end, MUSIC and DMC 01 are linked via an RS-232 interface so that, for instance, paging data (EBU/TNPP protocols) can be transmitted to the RDS coder, or the TA (traffic announcement) identification of the VRF coder in DMC 01 can be switched.

FIG 2 MUSIC for FM program feed



Data of the TMC (traffic message channel) can also be transmitted in the ancillary data field.

The data channel is equally suitable for user-specific **inhouse applications**. Given a DMC 01, complex remote-control tasks such as those of an FM transmitter can be carried out cost-effectively. Transmitter status is signalled back via an RDS inhouse channel. Channels for such applications are available to the user practically free of charge.

In the **studio** a lot of memory can be saved, for example in digital recording when a MUSIC codec is connected ahead of the tape unit. Ancillary information, eg recording place and time, title and duration, is saved in the data channel and can be played back together with the stored signal.

No doubt, many interesting applications will follow for the MUSIC data channel.

Peter Schmidt

REFERENCES

[1] Stark, A.; Krawinkel, C.: MUSICAM Codec MUSIC – Compression of audio data without any loss in quality. News from Rohde & Schwarz (1994) No. 144, pp 20–23

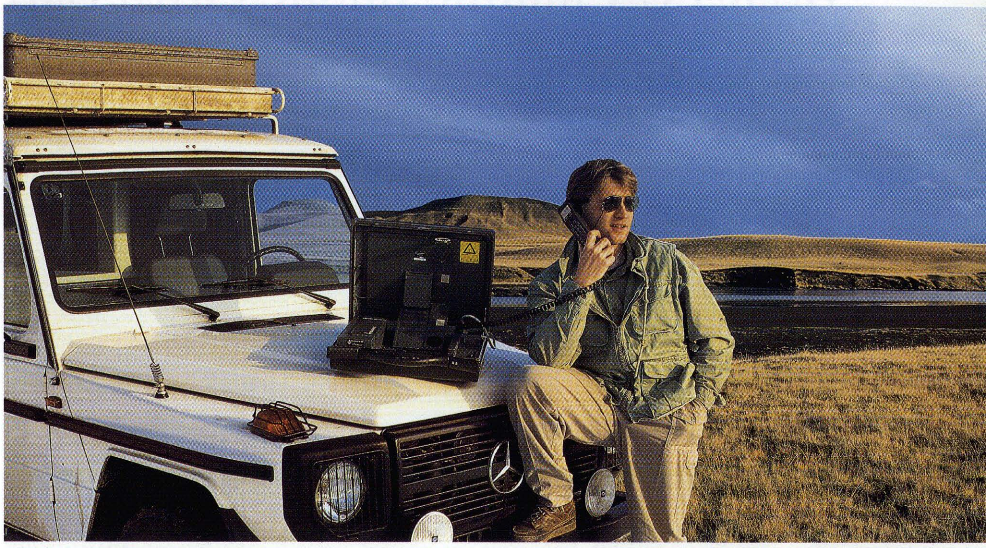
[2] Mayr, J.: Transmitting MUSICAM-coded audio signals in telecommunication networks. In this issue, pp 31–32

[3] Mayr, J.: Radio Data Codec DMC 01 – The all-rounder for new RDS and RBDS applications. News from Rohde & Schwarz (1993) No. 142, pp 16–18

Enter 145/11 for further information on MUSIC

Satellite communication by Inmarsat M

Satphone SP 1600 (FIG) is a new addition to the Rohde & Schwarz product range, designed for use in areas lacking infrastructure. Four geostationary satellites based on the digital standard Inmarsat M provide extremely mobile, worldwide communication. From anywhere in the world, Inmarsat M allows voice, data, fax and pictures to be transmitted to any subscriber of a public telephone network by using automatic dialling. Voice is digitized by a special vocoder and is also transmitted digitally, thus providing excellent voice recognition. A fax machine or a 2400-bps data source can be connected to Satphone. For subscribers making a lot of calls it should be mentioned that a satellite can handle approx. 10,000 calls at the same time.



Mobile communication anywhere and anytime from Satphone SP 1600 Photo 41 471

Registration with the appropriate organization is all that is required to use the phone. The organization assigns a phone number and grants access to the international Inmarsat network. When the caller enters his coordinates on the Satphone (to within 5°), the integral processor calculates the best orientation of the antenna to the satellite and informs the user, who then lines up the antenna in the case with the satellite by means of a compass and the elevation angle. The subscriber is called directly from the Inmarsat M terminal. As each terminal has its own phone number, it is like a normal telephone and can be used for full-duplex communication. The connection is set up via the satellite and a nearby ground station (dialled up). Accounts are settled by the designated organization. In Germany this would be done by Telekom. A charge is made for the satellite and the land lines.

Satphone SP 1600 comes in three different versions:

The **briefcase version** has a transceiver, handset and flat antenna (total weight approx. 12 kg). The briefcase measures 46 cm x 37 cm x 14 cm and can accommodate a small fax machine or a laptop – or even both if the units are very small and very flat. An interface for a cordless phone is available as an option. The briefcase version is designed for international business travellers, radio and TV reporters, relief and rescue organizations operating internationally, expeditions or installation teams.

The **maritime version**, with remotely controlled handset and seawater-proof, automatically tracking antenna, was developed for any type of vessels – from yachts through fishing boats to cruise liners.

The **landmobile version** with an azimuth-controlled antenna is especially tailored to the needs of trucks operated by international haulage companies, touring coaches, service vehicles, vehicles on expeditions and transport of aid supplies.

Satphone is extremely flexible with regard to power supply; it can operate on AC voltages between 110 and 240 V or with DC voltages between 10.5 and 32 V. Power consumption on standby is approx. 40 W and 120 W during transmission. SP 1600 is rugged, can handle temperatures between -25 and +55°C as well as humidity up to 95% (at 40°C) and thus guarantees worldwide calls irrespective of whether you are in the desert, at the North or South Pole or in the deepest jungle.

The most important specifications of Satphone are: frequency band 1530 to 1660.5 MHz, PSK modulation, 10-kHz channel spacing, error-corrected and encrypted duplex mode as well as transmitting power of approx. 16 W. Satphone can of course be integrated automatically into the Rohde & Schwarz message-handling system.

Udo Böhler

Reader service card 145/14

Advanced test technology for GSM/PCN mobile phones with CMD 52/55

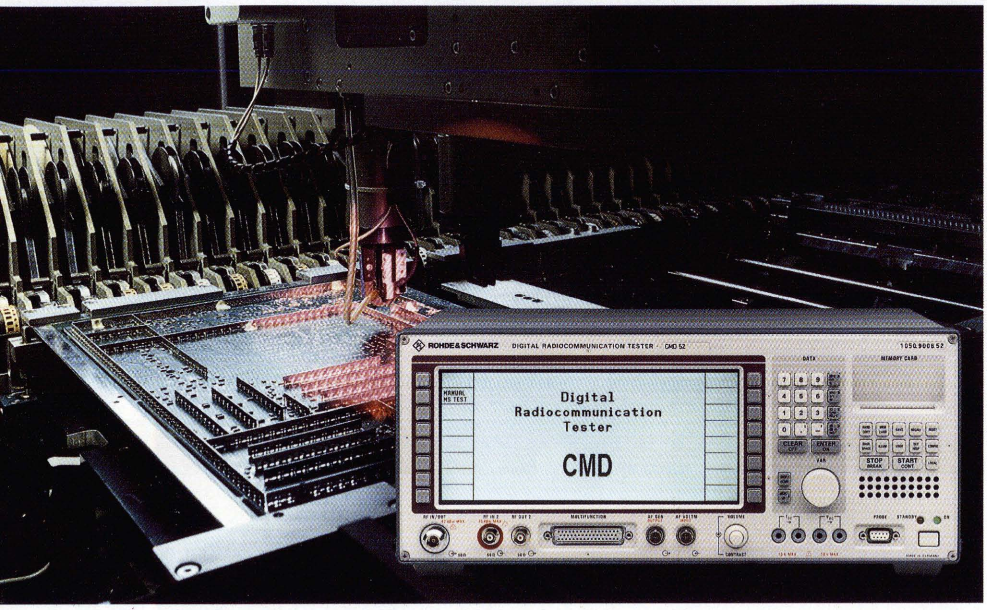


FIG 1 Digital Radiocommunication Tester CMD 52 for use in production of mobiles
Photo 40 882/1

Whether the predicted tens of millions of subscribers to GSM and PCN networks materialize on the future digital mobile-radio market not only depends on the expected reduction of call charges but also on the price of mobile receivers. Low-price telephones imply low production costs, which can only be achieved through high component integration, fully automatic in-line production and test equipment which does not significantly impact on costs. In addition to low investment costs for test equipment and tests in line with network specifications, great importance attaches to future-oriented design (GSM expansions), simple integration into the production environment, high built-in intelligence for keeping preparation costs in the test department low, and high measurement speed. Digital Radiocommunication Testers CMD 52 for GSM (FIG 1) and CMD 55 for GSM and PCN (DCS 1800) [1;2] meet all these requirements.

Because DUTs are all digital, the purpose of digital mobile-radio measurements is not to check the proper functioning of DUTs, as is the case in analog measurements, but to ensure zero-defect production and to confirm this with a final test. For this reason it is mainly those parameters which are affected by the production process that are measured. Particular importance is attached to RF measurements at the air interface (antenna) of the radiotelephone, because non-conformity with network specifications may lead to incompatibility with base stations, underutilization of network capacity or may even cause interference in the radio network. The two CMD models have all the facilities for these measurements, with quality that more than meets production requirements: high level-setting and measurement accuracy, phase and frequency measurements with low inherent error, sensitivity tests in the form of special and customized BER test routines as well as measurements of RF output power versus time with a dynamic range of up to 80 dB. FIG 2 shows three examples of the great variety of measurement and setting capabilities offered by Digital Radiocommunication Tester CMD.

As the large volume of measurements involved are basically the same and might only require a change in a single parameter (different time slots, RF power, RF channels, supply voltages), measurement speed is crucial. This too is no problem for CMD 52/55. Considering the enormous number of DUTs to be tested, not only a great number of test systems will be required when slow ones are used, it may even be necessary to install parallel production lines, and this would mean additional space requirements, more personnel and considerably higher costs.

While in final testing the requirements of different manufacturers are quite comparable, they may vary considerably in module testing and when carrying out repairs as, in this case, all kinds of different units and design concepts are to be handled. The situation is the same when different types and generations of mobiles from the same manufacturer are to be tested. CMD 52 and 55 are, of course, a solution to all these problems. In addition to a universal and powerful basic version, expansions in the form of retrofittable options, eg for more detailed RF analysis, extra AF test equipment or module-specific software test routines are available.

As well as high-speed remote control for automatic module testing or for final tests, manual control is also needed for repairs. All this is provided by CMD, which has a high measurement rate and an easy-to-operate user interface that does not presume any special knowledge of GSM or PCN. Automatic test and analysis routines as well as complete automatic test sequences implemented in CMD (do not need controller support), with and without test reports, allow fast troubleshooting and fault elimination.

CMD 52 and 55 are provided with several RF inputs and outputs and with a universal multifunction connector for a variety of different modules and subscriber mobiles. An additional high-sensitivity RF input makes CMD suitable for measurements on future handhelds without an antenna connector. An essential feature of CMD is that measurement functions can be used even when the modules or mobiles under test are defective or when signalling is errorred, incomplete or missing – a capability which makes CMD ideal for rapid troubleshooting.

The operating principle using two independent transmission channels and one receive channel including signalling capabilities enables the tester to function like a base station and makes it obsolescence-proof as far as the further development of network synchronization is concerned. A sophisticated internal processor concept, which includes digital signal processing for results, ensures fast response to all events. In the remote-control mode, setup functions and measurements can be started without any further intervention by the operator. These capabilities, in connection with an optimized hardware and software structure, allow measurements to be carried out at extremely high speed.

In the case of mobiles used for digital networks, service measurements are becoming more like measurements for module testing, repair and final testing in production. This fact was taken into account when designing CMD, and so the two testers are also excellent solutions to all measurement problems encountered in maintenance and service. CMD helps the manufacturer to set up a comprehensive test and measurement concept in all fields, with the advantage that a consistent measurement philosophy and comparable test results are obtained with the aid of ready-made test programs. Leading international mobile manufacturers have recognized these advantages and the excellent instrument characteristics by officially recommending CMD for their service and repair activities.

Michael Vohrer

REFERENCES

[1] Maucksch, T.: Digital Radiocommunication Tester CMD – Test system for production testing and servicing of mobile GSM telephones. News from Rohde & Schwarz (1993) No. 142, pp 4–6

[2] Mittermaier, W.; Holzmann, G.: Digital Radiocommunication Tester CMD 55 – GSM and PCN tester in one compact unit. In this issue, pp 18–20

Reader service card 145/06

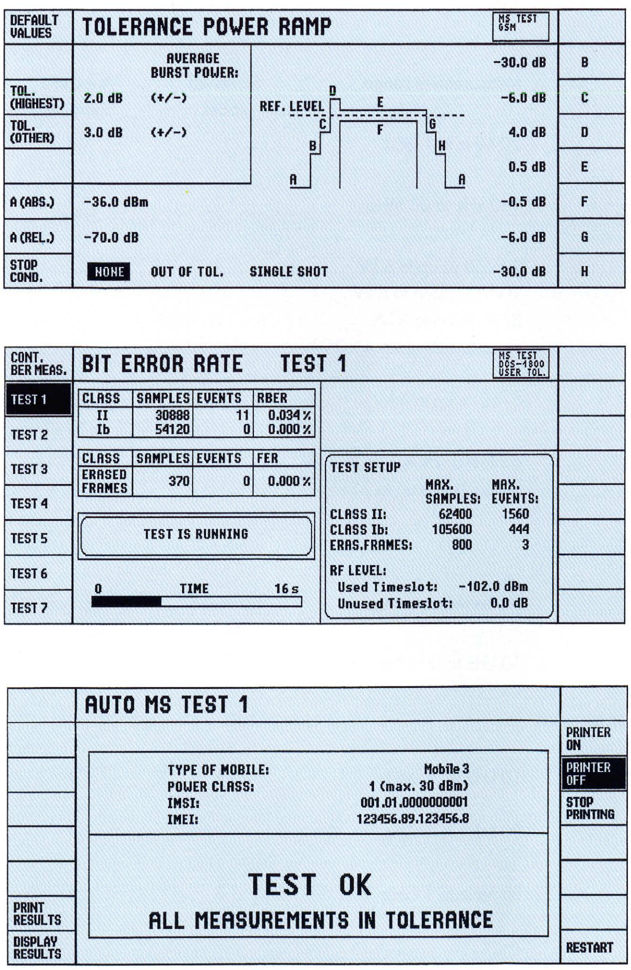
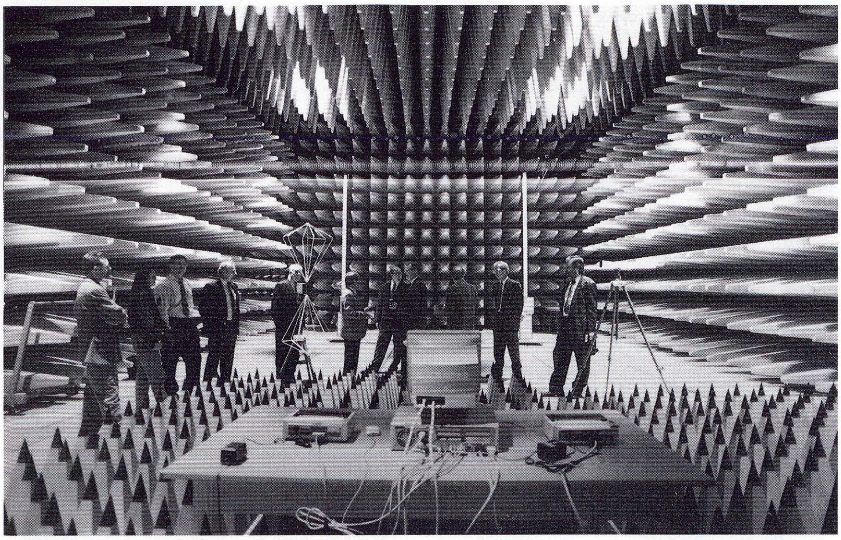


FIG 2 Examples of additional setting and measurement capabilities for simple adaptation of CMD to requirements. Top: definable tolerance mask for power ramp, center: BER measurements, bottom: easy-to-read overall result of automatic test

New EMC center of Siemens Nixdorf in Augsburg



Anechoic chamber of EMC center of Siemens Nixdorf in Augsburg Photo: Marcus Merk

The new EMC center of Siemens Nixdorf Informationssysteme AG (SNI) in Augsburg recently went into operation. SNI thus has one of the most modern EMC centers in Europe at its disposal. Nothing was left to chance as regards test equipment, a turnkey solution from Rohde & Schwarz, the European market leader in the EMC sector, being chosen. SNI attaches great importance to EMC, and not only since new European standards came into force. For many years SNI has been applying stringent rules in development and testing to make sure that its products comply with all relevant decrees of the German PTT and with European regulations.

The extended requirements of new EMC legislation made it necessary to consider whether at least parts of the future EMC tests should be carried out by test houses or whether the company's inhouse activities should be expanded. It was decided to build an EMC center at SNI, the core of which is one of the most modern anechoic chambers in Europe (FIG). To ensure a good return on the investment, SNI decided to offer the services of the EMC center to outside customers.

In addition to experienced personnel and elaborate test equipment, the right test site is essential for EMC measurements. For example, up to now most interference measurements were carried out at open-area test sites. But conditions in this environment are deteriorating because of increasing EM pollution from sound and TV broadcasting, radio services, and other sources. Consequently the evaluation of results is getting more and more difficult and expensive.

In the anechoic chamber of SNI, one of the few in Europe to comply with the stringent requirements of CISPR/A/100 and ANSI C63.4-1992, this kind of interference can be shut out and reproducible results obtained in largely automatic tests. In addition, it is possible to perform EMS measurements (immunity to radiated interference), which are not expedient outside anechoic chambers. Beside complying with all relevant Euro-

EMS measurements

Measurement	Measurement range	Screened cabin	Anechoic chamber
Radiated immunity (IEC 801-3)	20 MHz to 1 GHz		❍
Conducted immunity (IEC 801-6)	150 kHz to 80 MHz		❍
Surge immunity (IEC 801-5)	1.2/50 μs up to 6 kV 10/700 μs up to 6 kV 8/20 μs up to 3 kA max. current drain 4 x 25 A	❍	❍
Fast transient burst (IEC 801-4)	5/50 ns up to 4 kV	❍	❍
Electrostatic discharge (IEC 801–2)	contact discharge up to 8 kV air discharge up to 25 kV	❍	❍

EMI measurements

Measurement	Measurement range	Screened cabin	Anechoic chamber
RFI voltage (conducted emission to VDE, EN, CISPR, FCC)	10 kHz to 30 MHz	❍	❍
EMI field strength (radiated emission to VDE, EN, CISPR, FCC)	10 kHz to 30 MHz	❍	❍
	30 MHz to 1 GHz		❍
RFI power (VDE, EN, CISPR, FCC)	30 MHz to 1 GHz	❍	❍

pean standards, the anechoic chamber (17.6 m x 9.6 m x 6.2 m), the screened test cabins (5.5 m x 3.5 m) and the available test equipment permit measurements in line with FCC regulations, which is a prerequisite for exporting products to the USA or Canada. (The blue box gives an overview of measurements carried out).

The anechoic chamber was designed and installed by Siemens Matsushita Components of Heidenheim. Rohde & Schwarz supplied the complete line of test equipment (hardware and software), with Test Receivers ESH 3, ESAI and ESVP, Signal Generators SMG, amplifiers, controllers and test antennas [1] as the main components, and installed everything as a turnkey solution. Cooperation with the suppliers of the shielding material was as good as ever, considering that Siemens Matsushita and Rohde & Schwarz have for a long time been collaborating in the field of EMC [2] and supplied numerous turnkey EMC centers.

Achim Gerstner

REFERENCES

[1] Rohde & Schwarz Measuring Equipment Catalog 93/94

[2] Gerstner, A.; Greiner. T.: Compact diagnostic chamber: Affordable testing to new EMC standards. Siemens magazine "Components" XXIX (1994), No. 2, pp 12–15

Reader service card 145/15

Thermal power measurement up to 30 W

Despite technical progress in measuring pulsed power [1], thermal measurement continues to be attractive. The new 18-GHz Power Sensors NRV-Z53 and NRV-Z54 with 10 and 30 W rated power (FIG) meet the requirements of many users for precise, handy references in the watt range. Being compatible with Power Meters NRVS and NRVD, with Level Meter URV 35 and Millivoltmeter URV 55, these power sensors are the ideal choice where higher powers have to be measured precisely. The thermal measurement principle ensures reproducible results even for signals with high harmonic content or modulated signals. Power Sensors NRV-Z53/Z54 are therefore ideal for accurate measurements at the output of broadband amplifiers or at the antenna output of transceivers. Their small front end facilitates adaptation to front panels and junction panels with many connections.

Several methods can be used for measuring high power. The most frequent one is indirect measurement via a directional coupler or a power attenuator. The power to be measured is attenuated to such a degree that it can be measured with a commercial sensor. But only precisely measured and stable components will yield useful results. Due to their self-heating, power attenuators turned out to be very critical components. For Power Sensors NRV-Z53/Z54, Rohde & Schwarz therefore chose attenuators featuring high longterm stability and showing only little dependence on power. The specified power rating is not fully utilized. A line section with poor heat conductivity additionally ensures good thermal insulation of the sensor. The sensor itself is based on the thermoelectric measurement cell [2] developed by Rohde & Schwarz and successfully used in Power Sensors NRV-Z51 and NRV-Z52.

It almost goes without saying that NRV-Z53/Z54 are absolutely calibrated. There is no need to calibrate the sensor prior to starting the measurement, nor is it necessary to screw the attenuator on and off: just plug in and go.

Thomas Reichel

REFERENCES

[1] Reichel, T.: Peak Power Sensors NRV-Z, NAS-Z, NAP-Z – PEP measurements on TDMA radios, TV transmitters and lots more. In this issue, pp 14–17

[2] Löser, A.: New thermocouple Power Sensors NRV-Z51 and NRV-Z52 based on semiconductor technology. News from Rohde & Schwarz (1992) No. 139, p 34.

Reader service card 145/16

Checking output power of UHF transceiver using Power Sensor NRV-Z53 and Level Meter URV 35
Photo 50 057

Communications equipment for DSR

While terrestrial digital audio broadcasting (DAB) is still in the introductory phase [1], favourably priced domestic receivers for digital satellite radio DSR [2] have been on the market for quite some time. Germany and Switzerland are broadcasting DSR programs countrywide. Numerous European neighbours broadcast complete German DSR programming on their cable networks or are converting some of the programs into VHF FM stereo signals.

Rohde & Schwarz's **DSR Modulator SFP** generates DSR signals to relevant standards [3]. The modulator may be used either as a broadcast transmitter for a packet of 16 digital stereo audio programs, or as a lab signal generator for developing DSR tuners. A variety of audio plug-ins provide inputs for analog and DS1 signals.

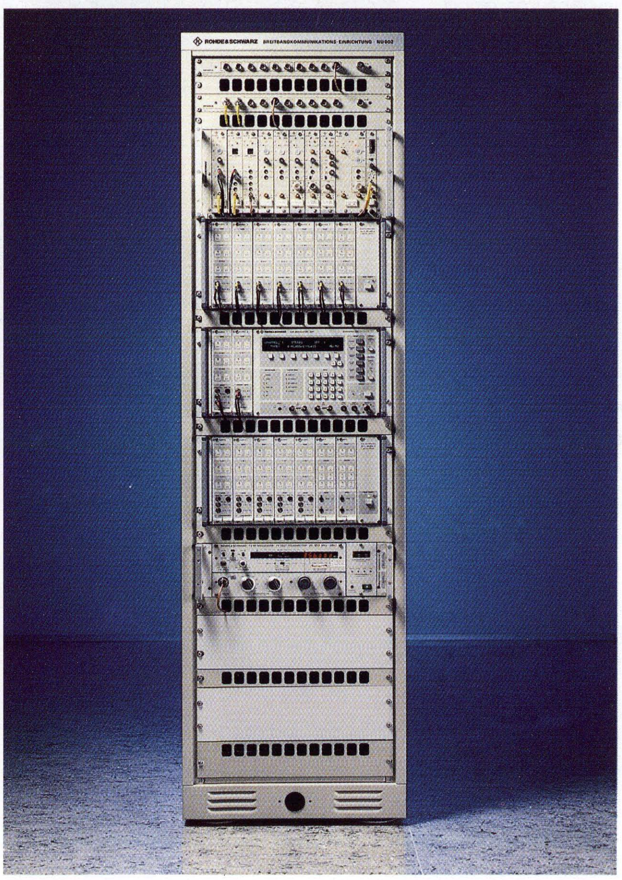
The brand-new **DSR Test Receiver EDSR** presented in this issue (see p 4) is the first instrument that can perform all relevant digital broadcast measurements.

For the reception of DSR signals Rohde & Schwarz developed **Digital Sound Converter DSRU** and **Digital Sound Receiver DSRE** as part of the modular sound receiving/transmitting system NU 002 [4]. DSRU and DSRE are used to forward the signal program via DSR to VHF transmitter sites, for instance, and for feeding individual DSR programs as VHF signals into cable networks. DSRU is directly connected to a satellite antenna and converts the satellite signal to 118 MHz after eliminating all previously accumulated center-frequency variations. The DSR signal can be fed into cable networks either directly or after passing through **Frequency Converter CT 200 UP** (output frequency range 40 to 860 MHz). To convert it to a VHF signal, the DSR signal from Digital Sound Converter DSRU is fed to Digital Sound Receivers DSRE, where one of the 16 stereo programs can be selected. The analog L/R signals from DSRE are applied to **VHF Stereocoder Transmitter CM**. With the aid of **Digital Sound Interface DSRI** and **RDS Codec DMC 01**, the additional DSR data can be fed directly into the radio data system. Also **VHF low-power transmitters** with output power of 20, 100 and 200 W are available [4] as part of the NU 002 system.

The FIG shows a broadband communication system comprising components of the NU 002 plug-in system and DSR Modulator SFP with two DSR extensions to make sure that all 16 channels can be used.

DSR Modulator SFP and Digital Sound Receivers DSRE may also be used to set up digital sound-transmission links for 16 stereo or up to 32 mono channels [3]. Radio-relay or satellite links as well as fiber-optic or coaxial cables are used as transmission media.

Gregor Kleine



Broadband communication system for transmitting digital sound-broadcast signals
Photo 40 966

REFERENCES

[1] Mayr, J.: DSR and DAB – digital sound broadcasting today and tomorrow. In this issue, pp 44–45

[2] Kleine, G.: DSR – Hörfunk in CD-Qualität. ELEKTOR-Satellit 2 (1993) No. 10, pp 52–62

[3] Dietl, A.; Kleine, G.: SFP, DSRU and DSRE – the pleasure of digital sound with CD quality. News from Rohde & Schwarz (1991) No. 135, pp 22–24

[4] Kirchner, J.: Low-power VHF Transmitting Systems NU 002 - All cued up for VHF broadcasting. News from Rohde & Schwarz (1993) No. 143, pp 20–22

Reader service card 145/17

Record attendance at CeBIT 94

The 675,000 visitors to CeBIT 94 in Hanover not only exceeded last year's number by far but also vindicated the optimistic forecast of the show management. It is already being called a "Super CeBIT", with results that satisfy the expectations of both the show management and the exhibitors, who numbered about 5850. More visitors than last year also came to the Rohde & Schwarz stand. This year's CeBIT seems to mark the beginning of the expected economic upswing – at least in the ICT sector.

FIG 1 Dr. Wolfgang Bötsch, Federal Minister of PTT, talking to Hans Wagner, Chief Operating Officer of Rohde & Schwarz (right)
Photo: Rockrohr

FIG 2 Hans Wagner explaining DECT Type-approval Test System TS 8930 to Dr. Otto Wiesheu, Economics Minister in Bavaria
Photo: city press

One day before the show opened, Rohde & Schwarz organized a well-attended press conference. Before a large number of journalists from Germany and abroad Hans Wagner, Chief Operating Officer, reviewed the 92/93 business year, a year in which Rohde & Schwarz was more than breaking even. In his speech Wagner referred to the objectives of Rohde & Schwarz International (RUSIS), a subsidiary founded at the beginning of 1994, and commented on the alliances Rohde & Schwarz entered into with Advantest and Tektronix a short time ago. Afterwards, Heinz Bick, managing director of R&S BICK Mobilfunk, talked about the new trunked-radio applications presented at the show.

The two-level Rohde & Schwarz stand, set up in hall 17 as usual, had an enlarged top level so that more room was available for meetings. This fitted in well with Rohde & Schwarz's leitmotif "More communication" for this year's CeBIT. The theme was also reflected by the exhibits, most of which had to do with mobile radio. The complete range of test instruments and trunked-radio equipment on show further underlined the Rohde & Schwarz competence. Specialists from sales offices and headquarters were on hand to give expert advice. The systems department presented a test vehicle for GSM and PCN coverage measurements and, for the duration of the show, two representatives from the Federal Approval Office for Telecommunications Equipment (BZT) were on hand to demonstrate a type-approval test system for DECT terminals.

On the very first day of the show, Dr. Wolfgang Bötsch, Federal Minister for PTT, paid an information-gathering visit to the Rohde & Schwarz stand (FIG 1). Hans Wagner was the ideal person to explain and demonstrate the equipment and systems for GSM coverage measurements and trunked radio to the Minister. The Minister of Economics of Bavaria, Dr. Otto Wiesheu (FIG 2), also came to the Rohde & Schwarz stand, and was very satisfied to see that a Bavarian manufacturer of measuring instruments and telecommunications equipment is an international front-runner in the field of radio testing.

As far as the exhibits of the Communications Division were concerned, the interest of visitors focussed mainly on the GPS system, Satphone SP 1600, HF Transceiver XK 2100 and the new Compact Receiver ESMC. Instrument Systems demonstrated its complete range of optical measuring equipment, the subsidiary SIT had three exhibits for PC-network data encryption on show. R&S BICK Mobilfunk presented interesting new applications for data acquisition via trunked radio, eg for finding out whether automatic beverage dispensers need topping up.

Christian Rockrohr

Accessnet and Tunnel-Lite at British railway show

At the Railtex exhibition in London, Rohde & Schwarz demonstrated its mobile-radio system specially developed for railway operators (photo top). Based on its Accessnet® trunked-radio system, R&S BICK Mobilfunk has devised a highly sophisticated despatcher system using touch screens. These also control the many communication facilities used by railways, like CCTV, public address, passenger help points and telephones, as well as the radios themselves.

Seeing as railways often run underground, particularly in city centers where there are also subterranean stations, it is of vital importance to have efficient coverage below ground. Traditional systems, set up on leaky feeders with multiple base stations and amplifiers, are prone to serious problems due to intermodulation and mush areas. To overcome this, Rohde & Schwarz in the UK developed Tunnel-Lite®, which uses interference-immune fiber optics to distribute radio signals, while offering valuable spare capacity for CCTV at the same time.

Rohde & Schwarz has just finished installing such a system in Newcastle/UK, where the Tyne & Wear Metro runs an urban railway with 90 trains and two ferries carrying some 44 million passengers a year. These new communication facilities enable the Metro to run driver-only-operated trains and work with unstaffed stations, while still maintaining the highest levels of safety and supervision.

J. Packman

New FM relay stations for BBC

Over the last few years, Rohde & Schwarz has completed contracts with the British Broadcasting Corporation for 10-kW tubed and 5-kW solid-state FM broadcast transmitters. As the BBC's re-engineering program progressed, power requirements became smaller but the number of stations increased. To date 42 stations have been equipped with UR 050 receiver/transmitters and 100 with the newer, modular NU 002, enabling the BBC to serve 99 % of the UK population with FM radio.

The contracts for relay stations were handled by Rohde & Schwarz UK, which purchased standard modules from Rohde & Schwarz in Germany and then built them into complete systems to integrate with the automatic transmitter network of the BBC. Every station has a low-power transposer, driving a power amplifier from the NU 002 range and monitored by an RMU module (photo below). Output power of 500 W and more is achieved by using amplifiers of BBC design and built in the UK. The larger stations required an automatic changeover system to reserve equipment, and this was designed and built by Rohde & Schwarz UK. All stations also needed an interface with the BBC's own automatic monitoring system.

The relay stations are scattered throughout the UK with widely varying population coverage, some being in remote areas while one serves the London area. A third of the UK now receives the pop-music channel, Radio 1, from a Rohde & Schwarz transmitter.

J. Packman

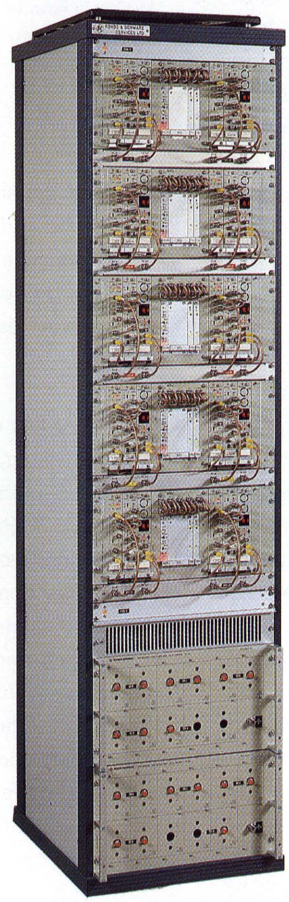
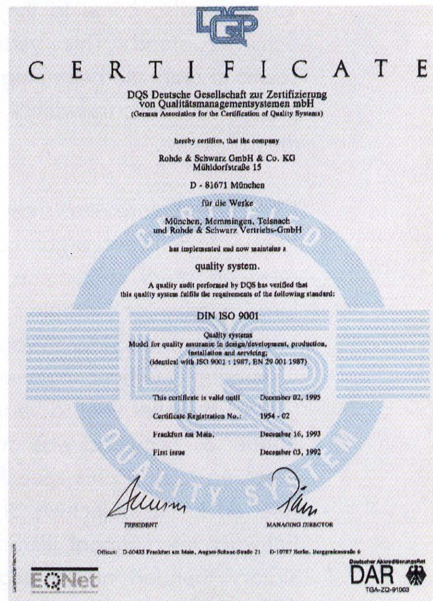


Foto: Astonleigh Studio

ISO 9001 certification for Rohde & Schwarz-Vertriebs-GmbH too

One year after the award of ISO 9001 certification for the quality-management systems of the Rohde & Schwarz plants in Munich, Memmingen and Teisnach by the DQS (German association for certification of quality-management systems) in December 1992, Rohde & Schwarz-Vertriebs-GmbH was also integrated into the system.



CERTIFICATE

DQS Deutsche Gesellschaft zur Zertifizierung von Qualitätsmanagementsystemen mbH
(German Association for the Certification of Quality Systems)

hereby certifies, that the company

Rohde & Schwarz GmbH & Co. KG
Mühldorfstraße 15
D - 81671 München

für die Werke

München, Memmingen, Teisnach und Rohde & Schwarz Vertriebs-GmbH

has implemented and now maintains a

quality system.

A quality audit performed by DQS has verified that this quality system fulfils the requirements of the following standard:

DIN ISO 9001

Quality systems
Model for quality assurance in design/development, production, installation and servicing;
(identical with ISO 9001 : 1987, EN 29 001 1987)

This certificate is valid until	December 02, 1995
Certificate Registration No.:	1954 - 02
Frankfurt am Main,	December 16, 1993
First issue	December 03, 1992

PRESIDENT — MANAGING DIRECTOR

Offices: D-60433 Frankfurt am Main, August-Schanz-Straße 21 D-10787 Berlin, Burggrafenstraße 6

EQNet

Deutscher Akkreditierungsrat DAR TGA-ZQ-91003

Success in obtaining extended ISO 9001 certification is not only confirmation of the high quality standards of Rohde & Schwarz products, it also evidences integration of quality assurance as a management method into all corporate procedures and processes. ISO 9001 quality management covers all activities from development through production and materials management to sales and service.

Major activities of Rohde & Schwarz-Vertriebs-GmbH that were assessed were procedures for reviewing contracts and their coordination, procedures for calibrating test aids in service and repair, plus methods for implementing corrective measures, including fault detection, analysis and reporting to development, production, service and the customer. Special attention also focussed on the training and further education of sales and service staff.

K. Polland

ITU conferences in Geneva

The Radiocommunication Bureau (formerly CCIR), an organ of the ITU (International Telecommunication Union), which in turn is a suborganization of UNO, is responsible for policing the ether to make sure that worldwide radiocommunication can work properly. So negotiations between the different national authorities are the order of the day. The end of 1993 saw two such events in Geneva, the Radiocommunication Assembly (RA) and the World Radiocommunication Conference (WRC 93), attended by representatives from more than 100 nations.

Rohde & Schwarz was present in both cases, with an exhibition of the latest equipment for radiomonitoring and shortwave communication, and with a cocktail reception attended by some 600 guests, including the secretary general of the ITU, Dr Pekka Tarjanne, and Richard Kirby, director of the Radiocommunication Bureau. After a welcoming address by engineer Karl-Otto Müller from Rohde & Schwarz Munich, Dr Tarjanne stepped up to the microphone (photo below) to congratulate Rohde & Schwarz on its 60th jubilee, spontaneously intoning "Happy Birthday Rohde & Schwarz" and accompanied by all present.

1ES-A

▽

Nationwide commercial FM in Norway

The first commercial FM sound-broadcast network has started up in Norway. Since autumn last year, station P4 can be received all over the country.

In March 1993, faced with tough international competition, Rohde & Schwarz won the contract to supply a total of 79 solid-state FM transmitters (43 of 1.3 kW and 36 of 2.5 kW). The accompanying negotiations with the customer produced an optimum solution for the FM transmitters in terms of servicing simplicity, menu-prompted remote control and maximum program availability – plus a very tight time schedule which saw the first transmitters shipped by Rohde & Schwarz by the end of April 1993.

W. Kalthoff

Rohde & Schwarz environmental test engineering for Hamburg's Elbtunnel

Together with its intended extension of the Elbtunnel, Hamburg's building administration is planning the construction of an exhaust-air purification plant. For this purpose a research & development project is being conducted, aimed at biological purification. For continuous monitoring of the trial installation, Rohde & Schwarz, under contract to NITRA of Hamburg, is supplying the entire test engineering, including computerized data recording, evaluation and software integration, as well as implementing the routing and distribution of gas for sampling.

The emission analyzers, housed in a container, detect the toxic gas components SO_2, NO, NO_2, CO and C_nH_m at a total of 13 checkpoints. Dust concentration, temperature, humidity, pressure and pressure difference are also measured in raw-gas and pure-gas channels. The project, which has already started, is scheduled to run for about one year. All measurements will be performed by NITRA. The Rohde & Schwarz plant in Cologne, the center for corporate activities in the field of ecology, is responsible for planning and implementing the test engineering.

Pl

Photo: K. Schillinger

△

Munich's commemorative medal in gold

In recognition of his contribution to the local economy, Dr Dr (hon.) Hermann Schwarz was awarded the commemorative medal in gold of the city of Munich. Christian Ude, the lord mayor, presented the co-founder and senior partner of Rohde & Schwarz, accompanied by his wife Leoni (photo top), with the medal in his official chambers in Munich's city hall. In the last 60 years this medal has only been awarded to 30 persons.

Ba

Reinforcement of extra-European sales activities

Rohde & Schwarz has newly structured its activities outside Europe. Since the beginning of this year ROHDE & SCHWARZ International GmbH (RUSIS) has been responsible for sales in the regions Asia/Pacific, Middle East/Africa and North/Latin America. The new affiliate is headed by Dr Herbert Spiegel, who is responsible for worldwide Rohde & Schwarz sales.

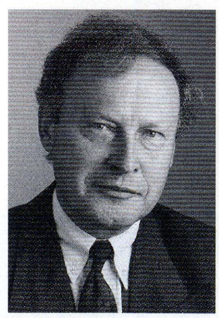
The aim of this measure is to accurately focus the infrastructure that already exists outside of Europe. RUSIS coordinates the foreign representatives, cooperation and other contacts in the regions named, thus ensuring speedier and more efficient service to the customer.

As a result of this new organization, Rohde & Schwarz expects to expand its market shares and improve its penetration of extra-European markets. Rohde & Schwarz already has affiliates and representatives in more than 70 countries.

Pl

New personnel manager at Rohde & Schwarz

Dr Hubert Amend (50) was appointed new personnel manager of Rohde & Schwarz as of 1 January 1994. From 1977 until this date he was responsible for corporate legal and contract matters. Lawyer Amend took



over from Franz Reinhold Huber upon his retirement. Huber joined the company as a design engineer in 1954, became head of the radiolocation and satellite engineering division in 1972 and director of the radiomonitoring and radiolocation group in 1986. He was appointed personnel manager in 1990.

Pl

VHF-UHF Compact Receiver ESMC (20 to 650/1300 MHz) is a multi-purpose receiver for radiomonitoring applications operated via LC display. It is suited for all common signals (basic model: AM/FM/LOG/PULSE, optional SSB/A1A); frequency resolution 1 Hz, max. five IF bandwiths (2.5 kHz to 8 MHz), master/slave operation, search routines, spectrum display (option); several interfaces, AC/DC supply inputs, $^1/_2$ 19-inch, model 02 without front panel.

Data sheet PD 757.1090.21 Enter 145/18

Microwave Signal Generator SMP (2 to 20 GHz, lower-frequency limit option: 10 MHz) supplies signals for all kinds of measurements (AM: DC up to 250 kHz, FM: DC up to 1 MHz, φM: DC up to 100 kHz, pulse modulation: I/O >80 dB, any combination possible; FSK, digital RF/AF/level sweep), output level SMP 02: -20 to >+10 dBm, SMP 22: >+20 dBm, with option from -130 dBm; menu operation, wide range of options.

Data sheet PD 757.0935.21 Enter 145/19

Signal Generator SMY (9 kHz to 1040/2080 MHz, depending on model) for high-precision AM, FM, φM and pulse (only external) modulation; resolution 1 Hz, level range -140 to +13 dBm (overranging up to +19 dBm), internal modulation generator 1 Hz to 500 kHz (resolution 0.1 Hz), RF overload protection 30/50 W.

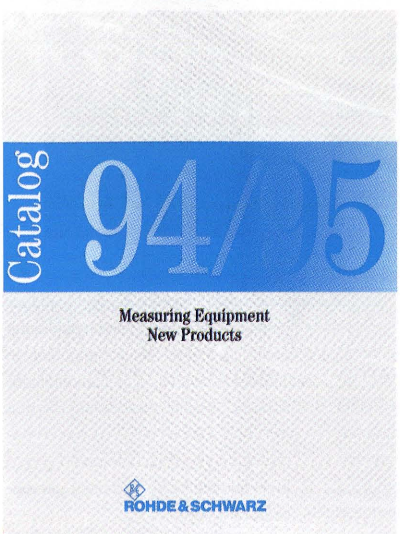
Data sheet PD 757.1119.21 Enter 145/20

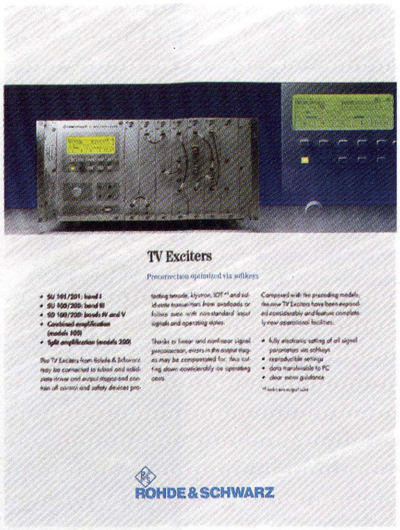
Test System Software TSSwindows for Test Workstation TSA allows a variety of test modes under Windows NT™.

Data sheet PD 757.0958.21 Enter 145/21

New products supplement to Measuring Equipment Catalog 93/94 The supplementary catalog has just come out, with 144 pages presenting the latest developments from Rohde & Schwarz in the field of test and measurement. Focal topics are mobile-radio and EMC measurements. K

Enter 145/22





Industrial Controller PSM (33 MHz) with MS Windows is characterized by high EMC, an all-purpose factory user port, colour display (PSA 7), monochrome display (PSA 5) or without display (PSA 2); seven free slots, can be operated without external keyboard, numerous interfaces (eg PCMCIA).

Data sheet PD 757.1048 21 Enter 145/23

The Rohde & Schwarz line of **RF Step Attenuators** (DC up to 26.5 GHz; 50 Ω) is now contained in one data sheet; new in the program are **RSN** (18 GHz, 11 dB) and **RSH** (5.2 GHz, 139 dB); 1 W.

Data sheet PD 756.4889.23 Enter 145/24

RF/IF Selection FMA-B9 (5 to 400 MHz), model 57, extends Modulation Analyzer FMAV to a calibrated VOR/ILS receiver of high sensitivity, RF level -87 to +30 dBm; allows in addition remote frequency and field-strength measurements.

Data sheet PD 757.1077.21 Enter 145/25

Power Reflection Meter NAP has been extended by Peak Power Sensors NAP-Z10 (0.01 to 19.5 W) and NAP-Z11 (0.1 to 195 W) for models 02 (35 MHz to 1 GHz) and 04 (890 to 960 MHz).

Data sheet PD 756.5533.23 Enter 145/26

DC Power Supply NGSM 32/10 (0 to 18/32 V, 0 to 20/10 A) for automotive electronics and mobile phones produces constant current/voltage and is remote sensing; storage of device setups, options: RS-232-C interface and IEC/IEEE bus.

Data sheet PD 757.1148.21 Enter 145/27

1-kW HF Dipole HX 002 with integrated tuning unit (2 to 30 MHz) guarantees optimum radiocommunication even up to 1000 km, silent tuning, option: frequency-range extension (up to 1.6 MHz), fully automatic operation, no control signals required, 50 Ω, SWR typ. 1.3.

Data sheet PD 757.1102.21 Enter 145/28

TV Exciters SU 101/SU 201 (band I), **SU 100/SU 200** (band III) and **SD 100/SD 200** (bands IV/V) allow fully electronic setting of all signal parameters via softkeys, models 100 for combined amplification and models 200 for split amplification; small exciters can be fitted with switch-on control (with automatic handover); precision offset, all standards, integrated dual-sound coder, NICAM modulator (option).

Data sheet PD 757.0887.21 Enter 145/29

HF Transceiver XK 2100 (transmission: 1.5 to 30 MHz/150 W PEP into 50 Ω; reception: 10 kHz to 30 MHz) from the digital shortwave communications family XK 2000 is a high-quality SSB/AME/FM radiotelephone and teletype/data-transmission set; new areas of application by a variety of options, eg shortwave telephone links (APP) via PABX and PSTN, ALE to FED 1045 and data transmission up to 2700 bit/s (eg fax, colour video); ATU FK 2100 and Power Supply IN 2100 are part of the system.

Data sheet PD 757.0941.21 Enter 145/30

Series 9800 is the new family of immission testers/test sets from **Rohde & Schwarz Cologne**. It comprises Ozone Analyzer ML 9810, CO Analyzer ML 9830, NO/NO_2/NO_x Analyzer ML 9841 and SO_2 Analyzer ML 9850

Data sheet		
ML 9810	PD 757.0993.21	Enter 145/31
ML 9830	PD 757.1019.21	Enter 145/32
ML 9841	PD 757.0987.21	Enter 145/33
ML 9850	PD 757.1002.21	Enter 145/34

An info brochure contains **Universal Test Antennas** (5 Hz to 2 GHz) corresponding to all standards/specifications. They are listed in tabular form.

Info PD 757.0929.21 Enter 145/35

Modulation analysis This 84-page information brochure describes methods of modulation analysis in theory and in practice. It is based on the Rohde & Schwarz family of Modulation Analyzers FMA.

Info PD 757.0793.11 Enter 145/36

With three modular models **Differential GPS System Scout** promises a new era in navigation and location with high accuracy (error between 100 m and 1 or 2 m).

Info PD 757.1025.21 Enter 145/37

MTN – Mobile Telecommunications News This brochure gives an overview of measurement requirements and solutions (including test equipment) for GSM.

Info PD 757.0970.21 Enter 145/38

Radiomonitoring and frequency management solutions This brochure describes solutions offered by Rohde & Schwarz from stand-alone units through to completely automated national networks.

Info PD 757.1054.21 Enter 145/39

Schz

Electronics edge from Bavaria

Appreciation of front-ranking electronics in the »outback« away from the big industrial centers was expressed by »Oberbayerisches Volksblatt« in its issue of 11 Nov 1993:

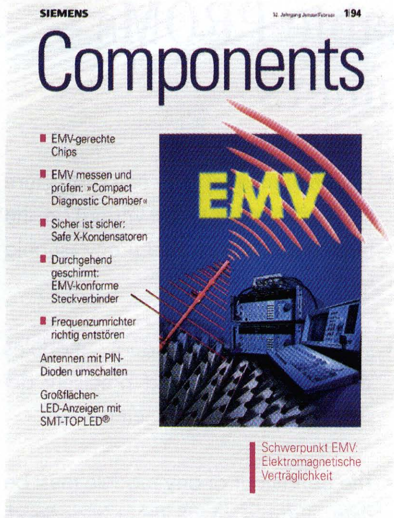
The electronics manufacturing market has long been a domain of the Japanese and Americans, as was plain at 1993's Productronica show in Munich. But Germany is capable of producing intelligent electronics too, as demonstrated by Rohde & Schwarz of Munich with its equipment for communications and testing in quality assurance.

Desert sand and trunked radio

Edition 2/94 of »MobilCom« reported on the supply of a trunked-radio network to the United Arab Emirates:

Rohde & Schwarz is sending its engineers and technicians into the wilderness. The United Arab Emirates want to set up a nationwide trunked-radio network and have contracted Rohde & Schwarz to deliver the hardware for the job. The first phase will see coverage of the major cities with a total of 20 radio cells...by means of Accessnet. This turnkey system includes terminals plus operation centers and despatcher stations.

»Design & Elektronik« presented EMI software ES-K1 with text and illustrations in its 4/94 issue. The cover spread of the specialist magazine for hardware and software designers showed EMI Test System TS 9975, which is driven by the software, and an article inside spotlighted the features of the software, which works under Windows.



In tune with technology

Rudolf Auer, editor in chief and publisher of »AV-Invest«, a specialist magazine for audiovisual communication, attended a seminar at the Rohde & Schwarz training center on the subject of video test technology and enthused in his subsequent report in edition 1/94:

The many connections that the training group of Rohde & Schwarz has established over the years are made use of to bring in competent and skilled speakers on special-interest topics...Theory and practice on the equipment are accompanied by excellently prepared course material.

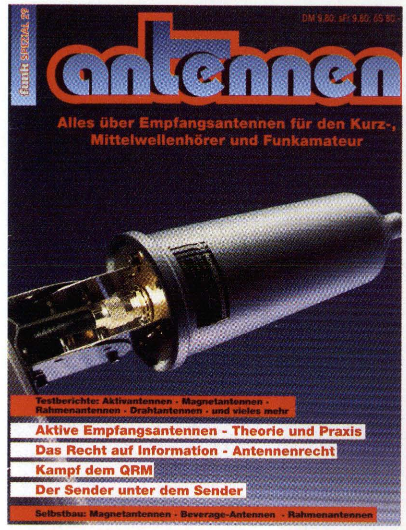
GSM-rádiókészülékek – GSM in Hungarian

Hungary's monthly electronics magazine »Magyar Elektronika« took a look at Radiocommunication Tester CMD 52 from Rohde & Schwarz in its 11/93 issue and came to the conclusion:

The transition to digital methods of transmission posed entirely new problems for test engineering. New kinds of measurement had to be defined for the digital GSM network recently launched in Europe... Other demands on a test set, especially for use in production, are high speed, high precision, remote control by IEC bus and auto-test. Rohde & Schwarz devised its digital Radiocommunication Tester CMD 52 especially to match these requirements.

A new European standard means stricter demands for electromagnetic compatibility throughout Europe in all electronic equipment. The cover of issue 1/94 of the Siemens magazine »Components« showed elements of an EMC test system from Rohde & Schwarz, followed by a four-page article inside.

Active Antenna HE 001 revealed some of its workings in the title motif of a special antennas issue of the magazine »Funk«. This active rod antenna from Rohde & Schwarz satisfies extremely demanding requirements, being primarily intended for the reception of vertically polarized waves in LW, MW, SW and VHF bands.

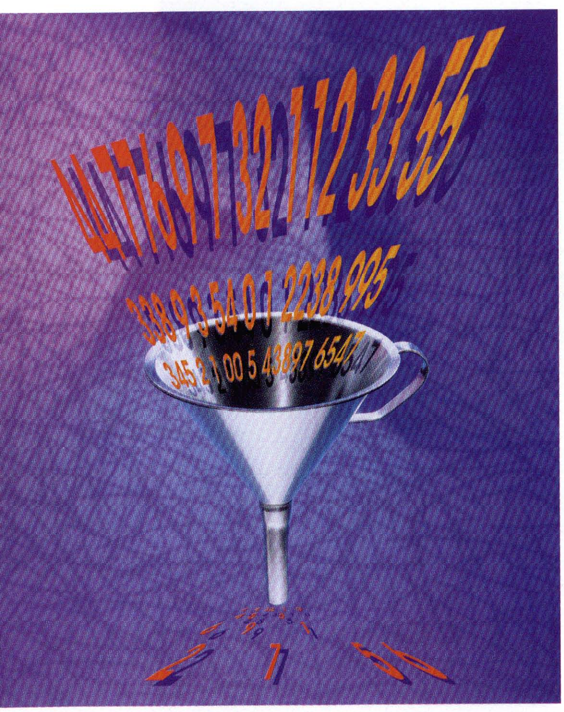


Number 2/94 of the British magazine »Mobile Europe« included a photo of a test system for type acceptance of handies, containing a number of instruments from Rohde & Schwarz. The system was used for the first-time type acceptance of handheld mobiles by the British Approvals Board for Telecommunications (BABT).

Electronically erasable PROMs – a plus for our customers

A dream of all users is to have instruments that do not need to be sent in to a service center whenever a new option is fitted or calibration is carried out or if problems, unavoidable as they are, occur. Costly equipment downtimes could thus be minimized. Instead of forgoing use of the unit for several days – a total failure is relatively seldom – the unit would be up again in a matter of hours. Customer-oriented service of this type would mean that all modules could be exchanged on site without affecting the guaranteed data of the complete unit. Realizing such a concept is not simple, especially for RF modules – a fact that is evident to all engaged in the development of such circuits.

There are some essential **conditions** to be considered as early as the **design stage** of a product, when you already have to start looking ahead to production and service:



- The influence of the unit's structure (motherboard, internal wiring) on the attainable overall accuracy should be known precisely.
- Interfaces of individual modules should be clearly and precisely described by their parameters.
- The behaviour of any module must be determinable at all times independently of the status of the other modules of the unit.
- The device status should be known to the service engineer on site in all details and at any time.
- Complete alignment for obtaining ultimate accuracy should be performed at the manufacturer's, since the required outlay in material and personnel is considerable and is as a rule not available at the customer's.

These considerations give rise to a large number of module-specific data which form an integral part of the hardware. For this reason, it is expedient to store such fixed data on the modules themselves. Use of an **electronically erasable PROM** (EEPROM) for storing data has **advantages** over other types of storage media (RAM, ROM, EPROM, disk):

- no dependence on a durable and failure-proof power supply,
- virtually unlimited number of programming cycles without prior erasure of memory contents,
- updating of data without having to open up the unit and shielded modules for the purpose of exchanging memory chips,
- the latest modification status is incorporated on the module itself.

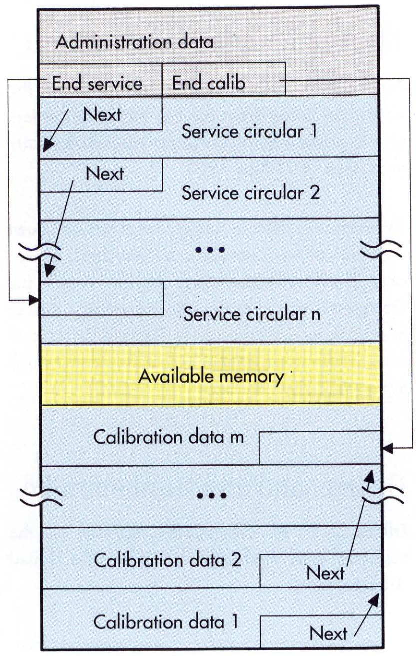


FIG 1 Schematic representation of contents of electronically erasable PROM (EEPROM)

EEPROM contents

In addition to calibration data, the EEPROM is used to hold various administration data such as module number, date of delivery and last repair, version of EEPROM contents as well as number of modifications carried out by a service engineer. A brief description of the service work carried out is contained in the EEPROM in the form of a service circular (FIG 1).

For the storage of data in the EEPROM, it should be noted that the memory is of limited size and data are read at some specific rate. The aim should therefore be to save relevant information with minimum redundance and, regarding parameters describing the hardware, to find the right balance between the volume of stored EEPROM data and the number of calculations performed during the actual measurement.

A good example to illustrate this is measurement of RF power at the termination of a radio tester. If the whole dynamic range of the measurement hardware were to be determined in 0.1-dB steps, the byte requirement would be enormous. In this case, however, time is saved during measurement (look-up table) and software development is simplified. For a range of voltage values from practically DC right through to several GHz at very high accuracy, this method would rapidly lead ad absurdum, considering the large number of measurement points involved as a function of frequency.

An optimal byte-saving technique is obtained through the use of mathematical methods that transform the characteristic of the measurement hardware into a functional relationship between the parameter to be determined (power) and the measured parameter (eg voltage) from a sufficient number of measurement points. It is perfectly adequate merely to store the function coefficients for the determination of the applied power from the measured voltage. The higher outlay on software development and the longer measurement time involved in comparison with the first technique is evident. Thus the practical approach for the user lies somewhere between these two extremes.

Multi-dimensional tables are especially suitable for processing parameters as a function of discrete factors. For the first technique as applied to the power measurement mentioned above, a table made up of several hundreds of lines and a maximum of one thousand columns would be required. It is thus clearly necessary to devise an appropriate method of representing the large volume of data in the EEPROM. In order to repeatedly use parts of the software that access the various tables in the EEPROM, it would be useful to define a variable model table. All requirements of the different modules of the unit can then be fulfilled by configuring such a table.

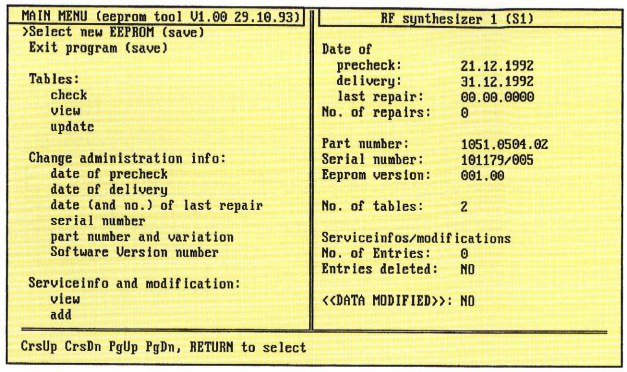


FIG 3 Main menu of service software allowing manipulation of EEPROM contents

Significance of EEPROM data within overall device concept

Assuming a single EEPROM per module, the set aim of being able to exchange any module of the unit without complete recalibration can only be attained if there is a **concept for handling the stored data** for the particular product (FIG 2). Essential points in this respect are:

- The user software must be developed at an early stage and in close association with the hardware so that suitable parameters for detailed description of module behaviour may be specified.
- For each module, extensive measurement routines are to be defined that collect all the parameters to be stored and automatically save them in the EEPROM.
- Service personnel must have a tool at their disposal in the form of service software to fully utilize the benefits of the new technique (FIG 3).
- Any alteration to the EEPROM contents that may be done automatically must be performed by the service software itself, because only this approach allows uniform management of the service data existing at different locations and excludes sporadic errors.

This approach was implemented systematically in Digital Radiocommunication Tester CMD (see articles on pages 18 and 48). Extensive software developed for the use of the EEPROM incorporates hardware-specific functions such as memory chip access and makes application-oriented functionality available. Before the very eyes of the user, the equipment supplier can therefore make the dream of extending the measurement capabilities of an instrument within a few minutes come true, through the use of EEPROMs and by exchanging modules.

Thomas Rieder

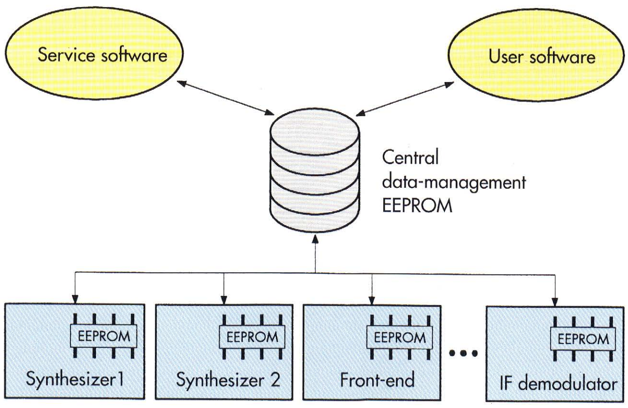


FIG 2 Location of module-specific data within overall unit

News from Rohde & Schwarz 145 · PD 757.0570.21

ROHDE & SCHWARZ

ROHDE & SCHWARZ GmbH & Co. KG · Mühldorfstraße 15 · D-81671 München

P. O. B. 80 14 69 · D-81614 München · Tel. (+4989) 41 29-0 · Fax (+4989) 41 29-21 64