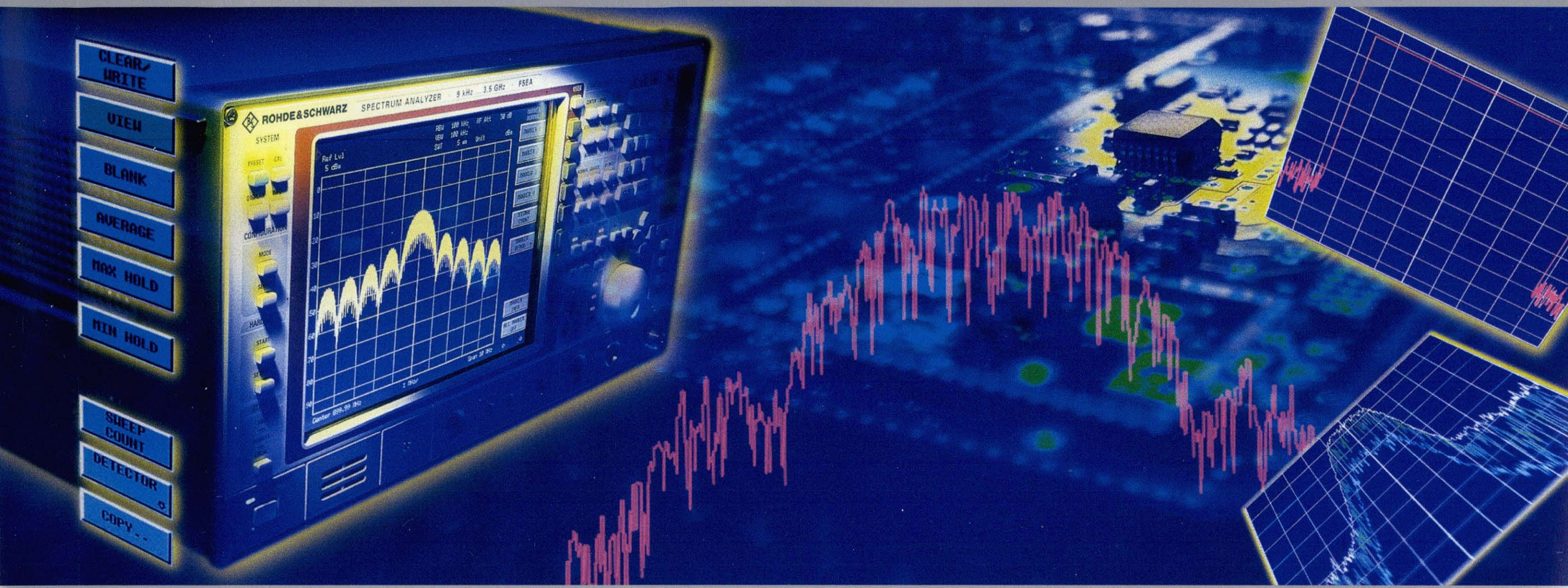
News from Rohde & Schwarz



Spectral analysis
indispensable in development and production

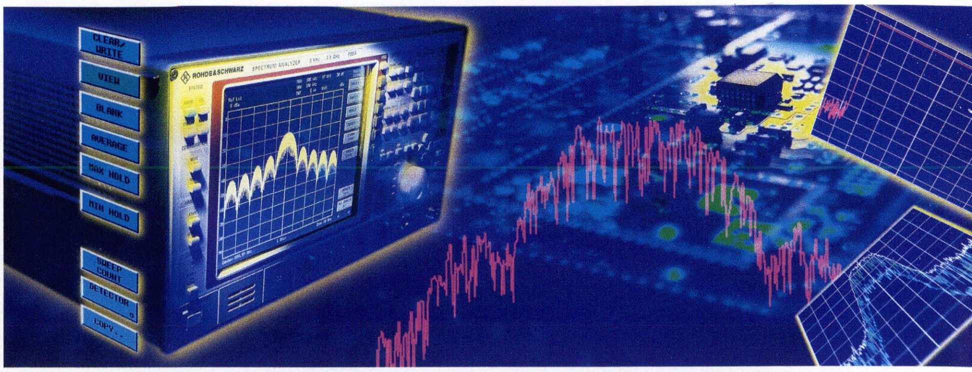
New hardware and software
for EMC measurements

Transmitter and modulator
for digital audio broadcasting

148

ROHDE&SCHWARZ

Number 148 1995/II Volume 35



Rohde & Schwarz expands the spectrum: new Spectrum Analyzers FSEA and FSEB are the first instruments worldwide to combine a real spectrum analyzer with a high-grade analyzer for modulated analog and digital signals. Read all about them from page 4 onwards.

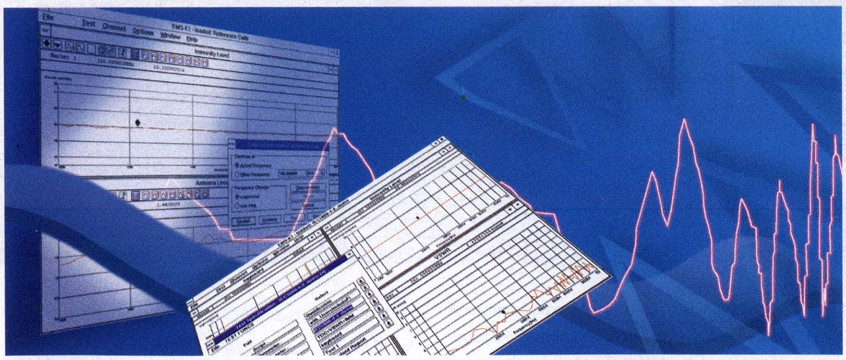
Articles

Application notes

Refresher topic

Panorama

Regular features



To ensure electromagnetic compatibility, EMC aspects must already be taken into account during the development of electric and electronic products. Rohde & Schwarz offers a wide variety of equipment for EMC measurements. The most recent product is System Software EMS-K1 under Windows for the efficient and economical use of test systems. For more details see the article beginning on page 12.

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 · Supply free of charge · State company or position · Printed in the Federal Republic of Germany by peschke druck, Munich · Reproduction of extracts permitted if source is stated and copy sent to R & S Munich

Spectrum Analyzer FSEA/FSEB

New dimensions in spectral analysis

With the FSE family of spectrum analyzers like with the successful FSA family in the past, Rohde & Schwarz is setting new standards in measurement speed, precision, dynamic range and spectral purity – at a price usually expected of products in the medium range. As a completely new feature, the high-grade FSE spectrum analyzers provide analysis of both analog and digital modulation parameters.

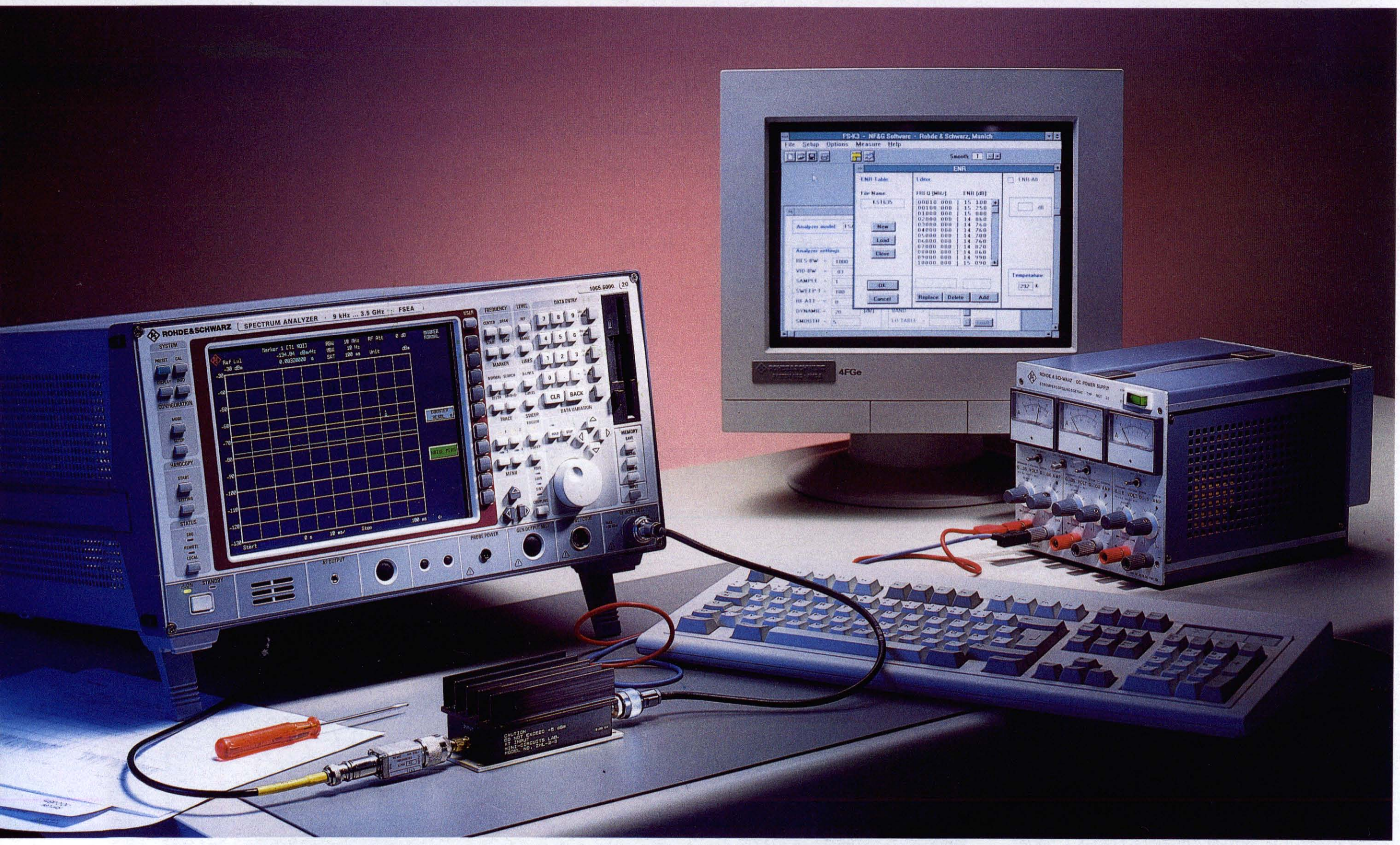


FIG 1 Spectrum analyzers of FSE family provide maximum flexibility and dynamic range. Application programs run on internal computer turn analyzers into complete test systems – example above shows noise-measurement system with noise-measurement software. Photo 41 932/2

The FSE family continues the tradition of the FSA spectrum analyzers [1; 2], which have made a name for themselves worldwide. It consists of four models featuring different frequency ranges and technical characteristics (FIG 1). The upper frequency limit of the FSEA models is 3.5 GHz, that of the FSEB models 7 GHz (FIG 2). The performance of models 20 is that of the high-end of the medium class, whereas models 30 are absolute top-class instruments. Models 20 can be upgraded to give the performance of models 30 in nearly every respect. With its internal 486 PC and modular concept, the FSE family features extremely high flexibility.

Frequency and time are finite resources. Added value and thus economic success will be achieved only by making more effective use of these parameters. Their significance is demonstrated by the fact that in the US private network operators offer millions of dollars even for relatively small frequency bands. Communication via cables would be far more expensive – this goes for copper and fiber-optic cables alike. The growing demand for communication leads to increasingly denser occupation and more and more intensive use of available frequency bands. TDMA and CDMA techniques serve to optimize channel transmission capacity and quality by means of digital modulation enabling denser spectrum occupancy by reducing signal bandwidths. The demands made on wired or wireless communication equipment and systems are growing at the same time and, consequently, the demands on the associated measuring equipment.

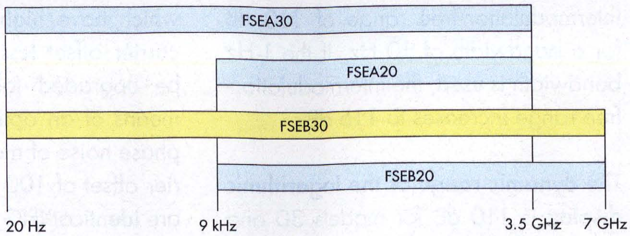


FIG 2
Frequency ranges of FSEA/FSEB models

With competition becoming stiffer worldwide, only the fastest and thus the most cost-effective supplier will be successful. Faster development and faster – and thus more cost-effective – production are mandatory for the market success of a product. And the measuring equipment too plays an important role in this, especially in production. The FSE spectrum analyzer family takes fully into account the trends in both speed and price.

Measurement speed

FSE is one of the fastest spectrum analyzers available on the market. This is attributable to four factors:

High internal computing power
FSE incorporates a 486 PC for the user interface and remote control. The required test settings as well as the calculation and display of results are performed by a network of four transputers and two digital signal processors, which are integrated in the basic unit. The resulting high computing power yields a measurement rate of 25 pictures per second even for full-span sweeps. This is three times the rate of conventional spectrum analyzers. The fast picture refresh rate of FSE is ideal for adjustments, for example, as the display directly follows the adjustment. By splitting up tasks between the internal PC and the transputer network, DOS or Windows application programs can be run on the PC and measurements carried out simultaneously without any reduction in speed. The DOS or Windows user interface can be displayed on an external monitor while the test results (eg the spectrum) are displayed on the FSE monitor (FIG 1).

Fast synthesizer
The synthesizer is capable of sweeping the entire frequency range in 5 ms. In conventional analyzers, the first LO is tuned by means of an analog sawtooth signal and synchronized to the reference frequency only at one or two points over the entire span. This is different with FSE: the first LO is synchronized to the reference frequency at every point of the span. The accuracy with which the marker can be placed on a signal thus only depends on the resolution (number of pixels) of the display. This is a major advantage especially in automatic operation, as it allows the marker to be placed accurately on a known signal also with maximum span.

Fast analog/digital converter
FSE uses a 20-MHz converter with a resolution of 50 ns for digitizing the video signal. This enables a minimum deflection time of 1 µs over the whole screen area, and fast-varying signals can be detected with high resolution. This high resolution also allows fine structures to be detected along the ramps of burst signals, which would not be possible with coarser resolution. Even TV signals can be analyzed, especially well when using the TV demodulator option, which provides the trigger facilities common in TV measurements (FIG 3).

High resolution bandwidths
High time resolution can be put to use effectively only if the resolution bandwidth is wide enough not to limit signal rise or fall times. FSE features resolution bandwidths between 10 Hz and 10 MHz adjustable in steps of 1, 2, 3 and 5, thus providing a sufficient choice of bandwidths. Bandwidths 1 kHz to 10 MHz are implemented by means of analog filters. For 10 Hz to 1 kHz, digital filters are used whose transient response corresponds to that of analog filters so that no difference is apparent to the user. For test signals with a suitable characteristic, FFT filtering with its clear speed advantage can be used alternatively with models 30 and optionally with models 20. FFT bandwidths from 1 Hz to 1 kHz are available.

Dynamic range

Dynamic range plays a crucial role in spectrum analysis, for example in order to develop, produce and maintain transmission systems that make effective use of the frequency spectrum. The following characteristics increase the dynamic range of spectrum analyzers, and FSE is tops in each of them:

- sensitivity, ie the minimum measurable level for a given bandwidth,
- wide dynamic range,
- distortion or intermodulation products generated by the spectrum analyzer itself,
- dynamic range of logarithmic video detector,
- phase noise of internal oscillators.

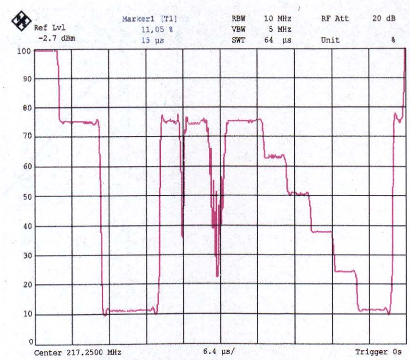


FIG 3 Display of insertion test line CCIR 17 of TV signal in time domain. Vestigial-sideband measurement with colour subcarrier of 20T pulse lowered by 6 dB relative to luminance bar

FIG 4 Edge of GSM burst with limit lines

FSE has a **noise figure** of 15 dB, which is 10 to 15 dB better than that of comparable spectrum analyzers. The minimum measurable level is thus lower by the same amount. On the other hand, bandwidths ten to 30 times wider can be used given the same sensitivity. This too increases measurement speed: bandwidth increased by a factor of 10 results in speed increased by a factor of 100.

With 1-dB compression of more than 10 dBm at a maximum mixer level of 10 dBm, the **dynamic range** of the frontend is sufficient to handle even high signal levels outside the displayed frequency range.

The **third-order intercept point** (IP_3) is +15 dBm for the overall spectrum analyzer, that of the frontend even greater than 20 dBm. This feature, in conjunction with the low noise figure, yields an intermodulation-free range of 110 dB for a bandwidth of 10 Hz. If the 1-Hz bandwidth is used, the intermodulation-free range increases to 116 dB.

The **dynamic range of the logarithmic display** is 110 dB for models 30 and 95 dB for models 20. The importance of dynamic range becomes obvious, for example, when measuring the time characteristic of TDMA bursts in a GSM system. This system defines a mask that ensures that the level of the transmit signal is lowered by at least 70 dB during the transmit intervals, at a resolution bandwidth of 300 kHz and a video bandwidth of 1 MHz. This places great demands on the dynamic range of the spectrum analyzer, bearing in mind that the instrument should have an extra range of about 10 dB to reduce the EUT tolerance margin. FSE offers a dynamic range of 85 dB, a value that is not attained by any other spectrum analyzer (FIG 4).

The **phase noise** of the internal oscillators is another parameter that determines dynamic range. High phase noise will conceal small signals in the vicinity of large signals. For adjacent-channel power measurements, the dynamic range is again largely determined by the phase noise of the internal oscillators. In this respect too, models 30 feature values in the vicinity of the carrier that are not attained by any other spectrum analyzer. Models 20, which have higher phase noise at a carrier offset less than 100 kHz, can be upgraded (also subsequently) by means of an option to give the lower phase noise of models 30. From a carrier offset of 100 kHz, the two models are identical (FIG 5).

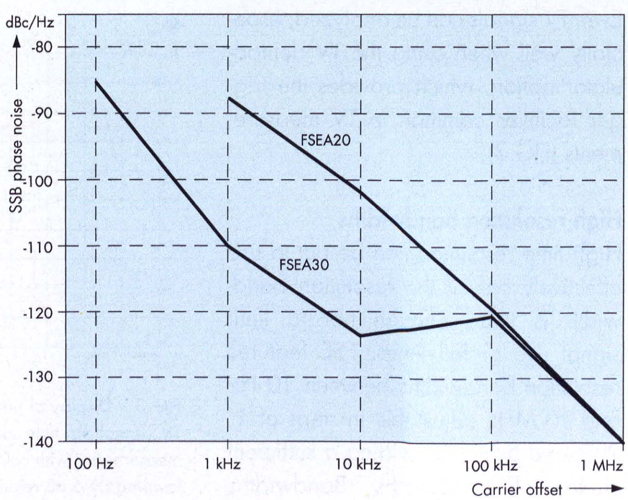


FIG 5 SSB phase noise of FSEA

Multicarrier systems put the intermodulation and phase-noise characteristics of a spectrum analyzer to a hard test. An example of this is the COFDM signal used in digital audio broadcasting (DAB). The signal consists of 1536 carriers spaced 1 kHz from one another in a 1.5-MHz band. Each carrier intermodulates with every other carrier. The intermodulation products formed outside the transmission band must be kept to a minimum to avoid interference with radio services operating in adjacent bands. For the COFDM signal, the dynamic range of FSE is greater than 80 dB at 200 kHz from the useful band (FIG 6).

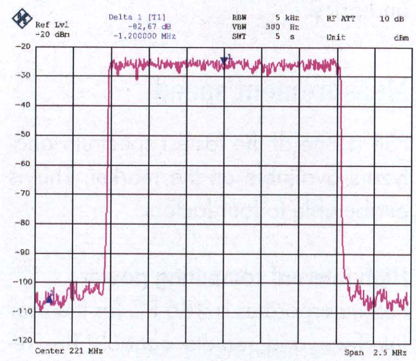


FIG 6 DAB spectrum measured with FSE

Accuracy

High measurement accuracy is another factor that contributes towards lowering costs. Tolerance margins need not be reserved for the test equipment but can be fully utilized for the EUT. In terms of accuracy too, FSE sets a new milestone for spectrum analyzers, featuring a guaranteed total measurement error of less than 1 dB up to 1 GHz and less than 1.5 dB above that. This does away with complicated calculations of the error budget. The **low total error** is obtained as a result of the following features:

- Each module has calibration data stored in an EEPROM. The data are read when FSE is powered on and used in the measurements. The frequency response of the RF frontend and of the attenuator at all settings are corrected. This not only offers the advantage of a low measurement error but also allows each module to be replaced without realignment in the event of a defect.
- FSE features comprehensive built-in calibration routines that can be started by the user as required. Calibration covers the total gain as well as the center frequency, bandwidth and gain for each individual bandwidth. As a completely new feature in a spectrum analyzer, FSE provides online correction of the characteristic of the logarithmic and the linear detector for each measured value. FSE is capable of performing this correction because the video signal is digitized directly without previous video filtering and the video voltage is thus linearized online in a correction EPROM. The characteristic ripple otherwise known of logarithmic amplifiers is no longer a problem either.
- FSE uses digital peak detectors for errorfree, direct detection of video signals over any bandwidth, doing away with the problems of analog detectors such as rise, hold and discharge time as well as temperature drift and aging.

The high linearity of the logarithmic display of FSE is a particularly vital advantage in relative measurements. This is the case, for example, in burst measurements in TDMA systems such as GSM, where 1 dB level tolerance must be maintained during the burst. The error of FSE is negligible for all intents and purposes, so that the entire tolerance margin can be allowed for the EUT. Reducing EUT tolerance margin results in cutting cost and time.

Tailor-made, complete solutions

With its wide variety of options, FSE can be tailored to suit the requirements of a given application. The customer only buys what he really needs and can be sure to meet future requirements by retrofitting FSE with the corresponding option. The following **extensions** are available:

- 7-GHz frequency extension for FSEA models,
- TV demodulator with video output and TV trigger for fields and lines,
- reduction of phase noise up to 100 kHz and OCXO for models 20,
- FFT bandwidths 1 Hz to 1 kHz for models 20,
- vector signal analysis for both analog and digital modulation measurements,
- tracking generator up to 3.5 or 7 GHz, modulation via I/Q inputs,
- computer function with DOS and Windows for application programs,
- Ethernet interface for network applications,
- second IEC/IEEE-bus interface for simultaneous controller function in system applications.

The most important option for complete measurements on modulated signals – both in analog and digital transmission systems – is certainly vector signal analysis, which for the first time combines spectrum and modulation analysis in a high-grade spectrum analyzer. In addition to analog demodulators for AM, FM and PM, FSE incorporates universal demodulators for FSK, BPSK, QPSK, QAM, MSK and GMSK. Modulation parameters such as symbol rate, type of transmit and receive filter, rolloff factor or BT (product of bandwidth and symbol duration), and number of test points per symbol are freely selectable up to a rate of 1.6 megasymbols per second, which covers all usual types of mobile-radio systems. Of course, the settings for the most common transmission systems can be called up directly.

FSE provides internal synchronization to the frequency and the symbol rate of the test signal, so no external reference clock is needed. In addition to the video and external trigger functions mostly used, FSE is capable of triggering on defined bit sequences, thus enabling a time reference to be established to preambles or midambles. This is necessary, for example, in power ramp measurements on TDMA systems such as GSM, which defines the transition from bit 13 to bit 14 of the midamble as time reference. FSE furnishes results for all the key **parameters of digitally modulated signals** (FIG 7):

- magnitude or phase versus time,
- real or imaginary part versus time,
- eye or trellis diagram,
- vector or constellation diagram in polar coordinates,
- modulation errors, eg frequency, phase, amplitude, vector (magnitude), I/Q offset,
- demodulated bits in the form of a table.

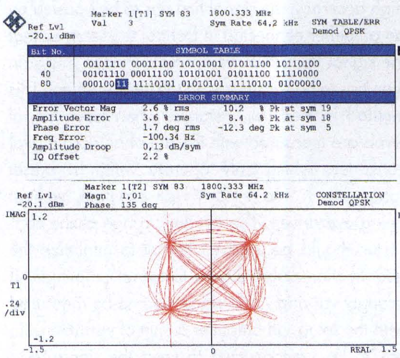


FIG 7 Display of demodulated bits, modulation errors and vector diagram of QPSK-modulated signal

Following digitization of the IF, the demodulators are of a purely digital design, yielding highly accurate results as there is no distortion caused by analog components. With Spectrum Analyzer FSE in conjunction with its vector signal analyzer option, the user for the first time has a high-grade spectrum analyzer which, due to its RF characteristics, is capable of measuring without limitations all parameters in the frequency and time domain, as well as modulation parameters, satisfying even the extremely stringent demands of measurements on mobile radio base stations.

Josef Wolf

REFERENCES

[1] Danzeisen, K.: Spectrum Analyzer FSA for 100 Hz to 1.8 GHz. News from Rohde & Schwarz (1987) No. 116, pp 4–8

[2] Evers, C.: Spectrum analysis up to 5 GHz with FSB. News from Rohde & Schwarz (1989) No. 125, pp 4–7

Condensed data of Spectrum Analyzer FSEA/FSEB

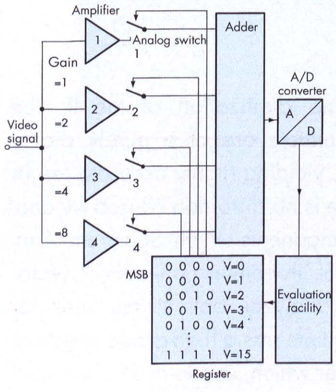
Frequency range	20 Hz/9 kHz to 3.5/7 GHz
Amplitude measurement range	−155/−145 to 30 dBm
Amplitude display range	10 to 200 dB in 10-dB steps, linear
Amplitude measurement error	<1 dB up to 1 GHz, <1.5 dB above 1 GHz
Resolution bandwidths	1 Hz/10 Hz to 10 MHz, in steps of 1/2/3/5
Calibration	amplitude, bandwidth, demodulator characteristic
Display	24 cm (9.5"), colour or monochrome TFT LC display, VGA resolution
Remote control	IEC 625-2 (SCPI 1994.0) or RS-232-C
Dimensions (W x H x D)	427 mm x 236 mm x 460 mm
Weight	21.5 kg (FSEA 20), 23 kg (FSEB 30)

Reader service card 148/01

Patent

Simple and cost-effective measurement of video signal levels

For measuring the amplitude of AC signals with high accuracy, the signal first has to be boosted by an amplifier connected in front of the setup so that the signal lies within its dynamic range. This gain then has to be considered in the measurement. This method is used, for instance, when video signal levels are measured with the aid of analog/digital converters which only operate within a preset range of −1.5 to +1.5 V, for example, without being overdriven. The dynamic range of the converter should be used to the full to minimize the quantization error relative to signal amplitude. If strongly varying video signals are to be measured with the setup, an amplifier circuit of variable gain has to be preconnected to keep the signal level constant, allowing the dynamic range of the A/D converter to be fully utilized without the converter being overdriven. Normally, three special amplifiers of different gain are used for this purpose, one of them being selected depending on the size of the input signal. However, this well-known method is too elaborate and expensive for test setups with a wide input dynamic range. Amplifiers controlled by analog multipliers are not suitable either because of their poor temperature stability.

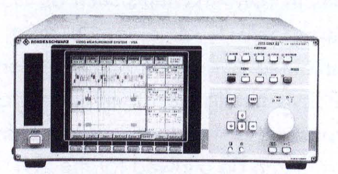


So the purpose of the invention is to provide a test setup similar to the one described above that meets the requirements with minimum circuitry and cost. The patented test setup uses a small number of amplifiers. With n single amplifiers, 2^n-1 gain levels can be obtained. This means that four amplifiers permit 15 gain levels to be set. That makes the test setup very simple and cost-effective although a wide dynamic range can still be covered in fine steps. High demands are set on the amplifier quality. The amplifiers should have sufficient negative feedback so that no gain-dependent phase errors are produced. Another condition is extremely short delays so that tolerances in this respect can be neglected. These requirements are met by modern amplifiers with negative current feedback.

With the patented setup the amplitude of basically any AC voltage signal can be measured with great accuracy. For instance, the setup of the invention permits sinewave, sawtooth or squarewave signals to be accurately measured, the maximum and minimum level being exactly matched to the dynamic range of the test setup. The patented setup has proved to be particularly useful when video signals are measured with the aid of an A/D converter. In this case the luminance bar and black level of the video signal can be adjusted to exactly match the upper and lower limit of the dynamic range of the A/D converter. Thus the resolution of the A/D converter can be fully utilized in the measurement of video signal levels. The FIG illustrates an example of the patented setup.

Extract from patent specification
DE 42 06 195 CI
Applied for by Rohde & Schwarz on 28 February 92
Issue of patent published on 15 April 1993
Inventor: Wolfgang Hanssen

Used in Video Measurement System VSA



Reader service card 148/02

DECT Protocol Tester TS1220

Type-approval measurements on DECT fixed parts (FP) and portable parts (PP) to TBR22

New standards for DECT phones require new test systems. Protocol Tester TS1220 from Rohde & Schwarz is an ideal match for the latest GAP requirements. With its flexible hardware and software, ease of operation and variety of facilities, TS1220 is an indispensable and future-proof test system for the development and type approval of DECT phones.

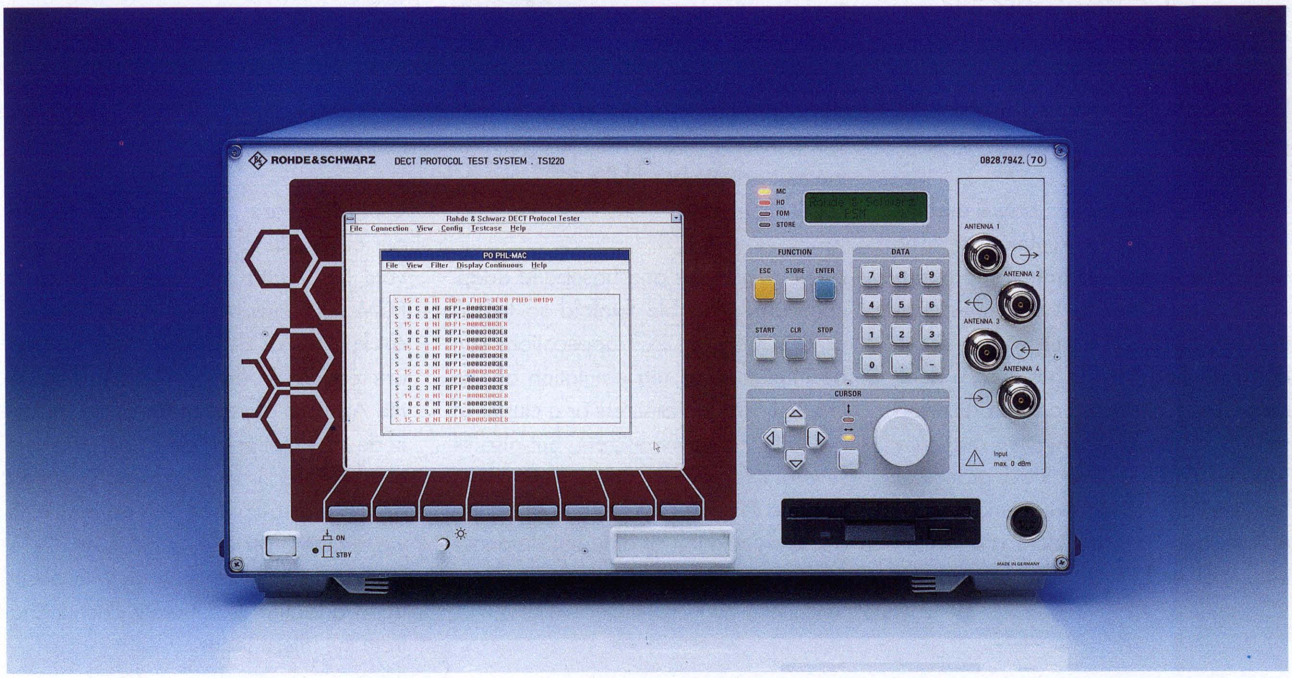


FIG 1 DECT Protocol Tester TS1220 for new DECT regulation GAP – compact and lightweight for mobile use too Photo 42 044

Classic, domestic telephone systems connecting PPs with each other or with the public telephone network via one or several FPs operate increasingly in line with DECT, the European standard for digital, cordless information transmission. Moreover, there are also PABX systems using the DECT standard. The fact that the systems of different manufacturers operate in line with the same standard, however, does not mean that the PPs of one manufacturer can operate with the FP of another. The new DECT regulation ETS 300 444, named the generic access profile (GAP), is meant to overcome the existing class incompatibilities. GAP is limited to the voice service of DECT, ie to the sections of the standard relevant for voice transmission. Thus only one section of the standard, defining a general transit system (also LAN, pager applications, etc), is obligatory for telephone applications. The new section is more transparent and so it can be implemented more easily and faster than the old one.

With the completion of the first GAP versions, manufacturers and test houses of DECT phones now require protocol testers to test their units. The test cases stipulated for type-approval measurements to GAP are currently being defined in TBR22.

Since – due to high bit rates and short response times – signalling at baseband level for DECT places high demands on the test system, most of the current DECT protocol tester functions were hardware-implemented using burst-mode controllers as also employed in DECT terminals. These controllers are processors optimized for the timing and control of different functional groups of a DECT phone. With the aim of short response times and low production costs for DECT phones, it was necessary to integrate many functions on a single chip. The drawbacks of such a test concept based on burst-mode controllers are obvious: the test is not objective as the DUT in fact tests itself. Moreover, the test is not at all flexible as the tester can only provide and test functions that are implemented on available chips.

With DECT Protocol Tester TS1220 (FIG 1) however, Rohde & Schwarz now offers an objective, flexible and future-proof test system to manufacturers of DECT phones and test houses which performs all data interpretations or timing exclusively by means of software. The hardware is simply used to convert RF signals to baseband transparently at the lowest layer and vice versa. This ensures that the test system can easily be adapted to any amendments and new requirements through simple software updates.

System description

The core of the protocol tester is a fast **i860 RISC processor** (FIG 2). It permits implementation of all time-critical processes at the different DECT layers. Since the time requirements on the lowest layers are the highest, these layers were implemented in the RISC processor.

The baseband adaption board and the RF section form the RF interface. The **baseband adaption board** represents in a transparent way the smallest time unit – for DECT a frame with a length of 10 ms and 11520 bits – on a dual-port RAM (DPRAM). So, data received serially at the RF are written cyclically into the DPRAM. The RISC processor has direct access to this memory via a private bus. Transmit data are written into another DPRAM and are passed on to the RF section in serial form. What is important is that all formatting processes in the transmit direction as well as all data-recognition and -interpretation mechanisms are run via the software provided in the RISC processor. Data are thus merely decoupled by the baseband adaption board and converted to a serial format.

The **RF section** performs data processing for the GFSK modulation used with DECT as well as the data retrieval required in the receive direction. The synthesizer of the RF section allows hopping times of approx. 30 μs as well as any frequency or level settings. Other RF parameters (eg frequency deviation) can also be set via the software control. The control is again via the fast private bus of the RISC processor.

All RF subgroups and baseband adaptions are available twofold so that a great variety of DECT applications can be implemented, eg emulation of two FPs with fast synthesizers or a cluster of FPs with slow synthesizers, but also of several PPs as well as mixed systems of FPs and PPs. The dynamic level setting allows simulation of different distances and movements of the phone.

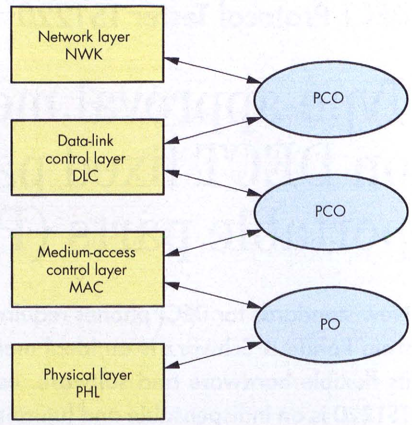


FIG 3 Layer model of TS1220 (PO = point of observation, PCO = point of control and observation)

User data are also coupled in and out of the RISC processor via the private bus. Data are transmitted via a PCM-V.11 interface at a fixed rate of 64 kbit/s – as defined for GAP – and are coded or decoded according to the ADPCM algorithm (adaptive pulse-code modulation). The PCM signal is also provided in analog form. Data can be input or output at any transfer rate via another interface. In this case, there is no data interpretation as with baseband adaption but merely decoupling from the internal bus.

The complete hardware of the DECT protocol tester is embedded in an i486 processor system which, in addition to the usual storage media and some serial and parallel interfaces, also comprises a colour LC display. The processor system provides the interface with the operator and, thanks to the graphics user interface of Windows, affords extremely easy operation. Realtime requirements not covered under Windows are fulfilled by a 32-bit kernel developed for this purpose and allowing priority control of the different layers.

In addition to standard AC voltages, Protocol Tester TS1220 also accepts DC voltages between 10 and 30 V and so it is also ideal for mobile use.

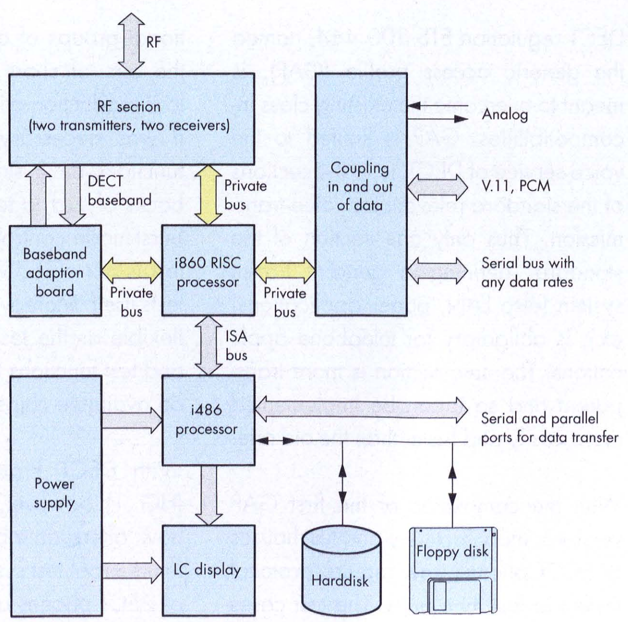


FIG 2
Block diagram of
DECT Protocol Tester
TS1220

Operation

The user interface of the protocol tester is a true **representation of the DECT layer model** (FIG 3). A separate window, in which the uplink and downlink service primitives are displayed, can be opened for each PCO (point of control and observation) between the layers. It is thus possible, using predefined filters, to display elements of interest which violate the protocol for example or correspond to a triggered event. In other menus the basic configurations and other settings can be altered.

The DECT protocol tester not only tests whether the DUT complies with the standard protocol. It also tests the DUT's response in case of a fault or deviation. It is only by means of such tests that the proper functioning of the DUT operating in an environment of different models and implementations of DECT terminals can be ensured. The protocol tester supports such tests by predefined types of faults at all protocol layers, which can be switched on as required by the user. Major examples are faults at the lower layers PHL and MAC, such as CRC or MUX faults, which occur with defined probabilities. Such tests have also been added to GAP test regulations.

The user can also integrate individual processes via the PCOs and thus perform user-defined tests and test cases as described in GAP. The incoming service primitives are handled by the user-defined processes via an uplink and downlink message queue and the resulting elements are transferred to the corresponding layers. In this case the processes are dynamically integrated and started via the graphics user interface. The processor running under Windows calls up the processes with the corresponding priority and supplies them with the required primitive queues so the user can influence the protocol to a great extent seeing that manipulation of the primitives as well as simulation of entirely user-defined layers are possible.

This mechanism is also used for the implementation of a large number of **GAP-TBR22 test cases** formulated in TTCN (tree and tabular case notation). These test cases are first translated into the high-level language C using a TTCN compiler (FIG 4), whereby protocol- and implementation-specific elements are not interpreted but translated into C code in a further run by means of a target-code generator. A C compiler then generates a dynamically linkable and executable code. If the user does not wish to use TTCN formulations, test cases can also be formulated direct in C. Naturally Rohde & Schwarz also supplies test cases to TBR22 as ready implemented and installed turnkey solutions.

Marcus Gloger; Peter Riedel

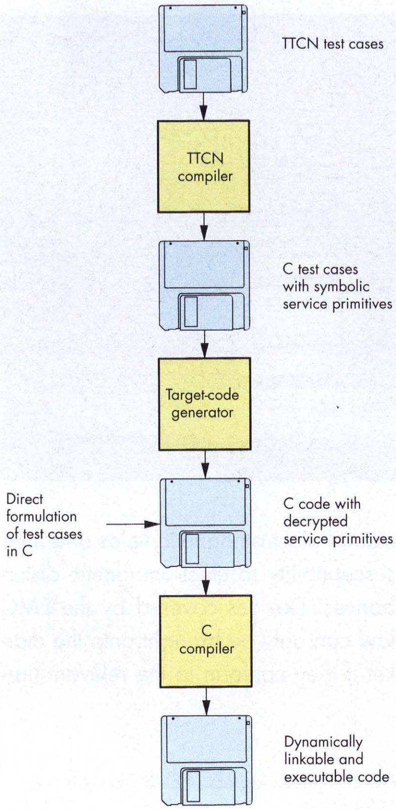


FIG 4 Test cases developed from TTCN

Main features of DECT Protocol Tester TS1220

- Graphics user interface
- Complete DECT GAP implementation
- TTCN test cases executable to TBR22
- Any implementation for the DECT transit system through open concept
- Any user data rates
- All DECT protocol layers are software-implemented (incl. MAC-PHL)
- Protocol layers as individual processes in realtime environment
- User-defined DECT protocol layers can be easily implemented
- Predefined fault simulation
- Two fast synthesizers with RF reference characteristics

Reader service card 148/03

System Software EMS-K1 under Windows™

Automatic measurement of electromagnetic susceptibility

Rohde & Schwarz program package EMS-K1 under Windows is a modern tool that makes it possible to carry out automatic electromagnetic-susceptibility measurements on EMS test systems. This easy-to-operate system software can be used to considerably speed up measurements in development environments, acceptance measurements in test houses and EMC quality tests in production.

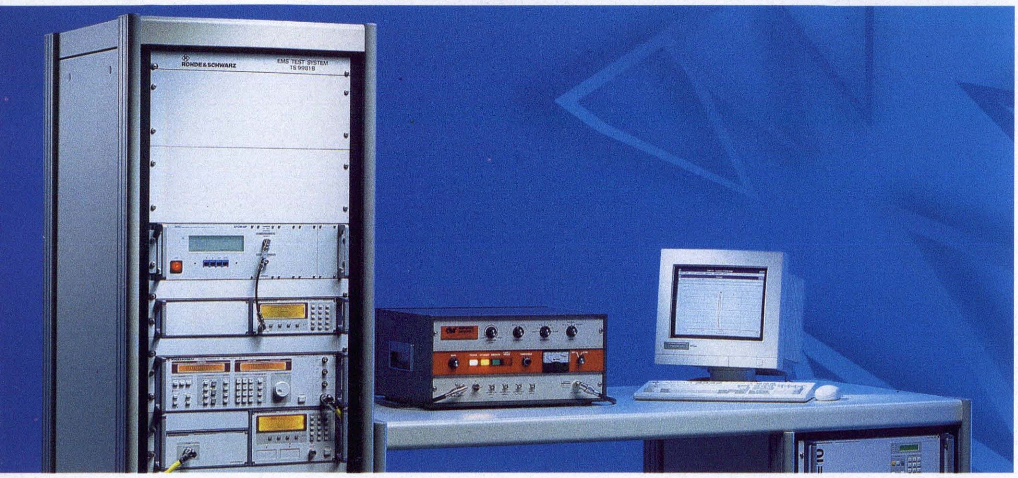
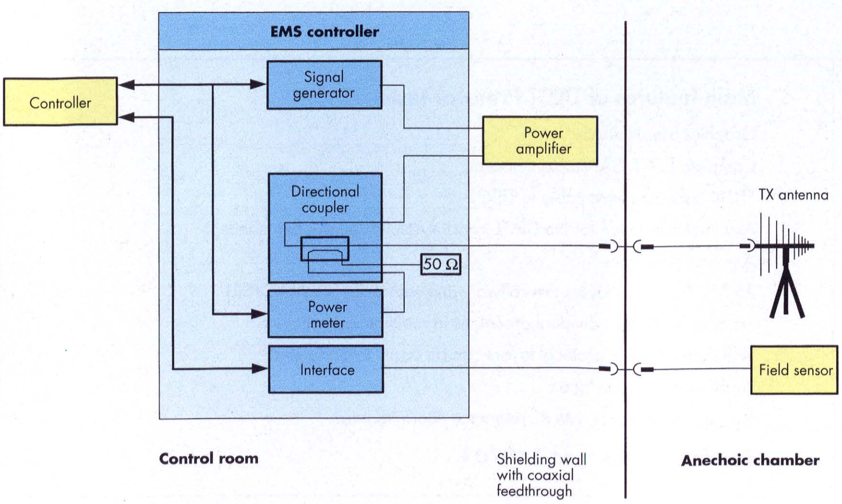


FIG 1 EMS Test System TS9981 for measuring immunity to radiated fields to IEC 1000-4-3
Photo 41 568/1

In accordance with the EMC law of 13 November 1992, all electrical and electronic products have to meet certain specified limits relating to the emission of electromagnetic fields and their susceptibility to electromagnetic disturbances. Devices covered by the EMC law can only be brought onto the market if they conform to the relevant harmonized European standards. Conformity can be declared by the manufacturer or by the agent marketing the goods. The devices must be labelled with the EU conformity mark.

FIG 2 Block diagram of EMS Test System TS9981



If the electromagnetic compatibility of a final product is to be ensured, a suitable EMC strategy has to be adopted early at the development stage. Electromagnetic compatibility can only be proven through electromagnetic-interference (EMI) and electromagnetic-susceptibility (EMS) measurements. Rohde & Schwarz supplies a wide range of measurement equipment and systems for checking electromagnetic compatibility to all relevant standards [1]. The classic test receiver, LISNs and test antennas are the main components of an EMI test system.

The essential **components of an EMS test system** for measuring immunity to electromagnetic fields are an RF generator, a power amplifier and the antenna to generate the field. A field-strength meter is used to measure the generated field strength. Other system components are devices for switching signal paths, as well as power meters and directional couplers for checking the output power of the amplifier and the VSWR of the antenna system. FIGs 1 and 2 by way of illustration show the latest Rohde & Schwarz EMS test system – TS9981 for measuring electromagnetic immunity to international EMC standards IEC 1000-4-3. In the case of test systems for measuring immunity to conducted interference, for example TS9986 [2], the antenna is replaced by a coupling/decoupling network or a current clamp.

System software functions

The powerful software package EMS-K1 forms the basis for the automatic control and monitoring of EMC test systems and also for the acquisition and analysis of the measurement data. It is through automation that measurement systems can be effectively and economically utilized.

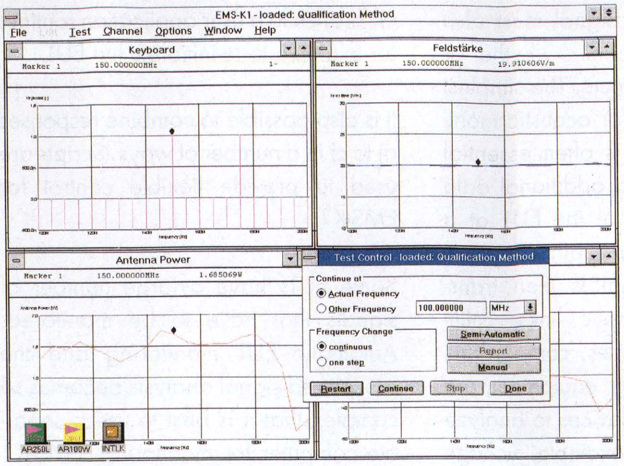


FIG 3 When predefined measurement has been loaded, Test Control menu and EUT and System Monitoring diagrams are displayed. There are icons for interlock loop and power amplifier at bottom left of screen. They indicate current state.

The other **advantages of automation** are:

- reproducibility and high accuracy of test results,
- automatic generation of comprehensive test reports,
- permanent system control,
- automatic calibration and correction of frequency-dependent parameters.

System Software EMS-K1 is easy to operate and has been optimized for both investigations in a development environment and acceptance measurements. The other main features of the software package are predefined, automatic measurement sequences and procedures and a high degree of flexibility to comply with new EMC standards and measurement procedures. The three **basic EMS-K1 functions** are:

- automatic generation of test signals (field strength, current, voltage),
- automatic monitoring of the EUT for malfunctions,
- determination of the immunity threshold if there is an EUT malfunction.

The complete software package can be run on a PC or a PC-compatible industrial controller, for example Process Controller PSM [3]. The measurement devices are controlled via an IEC/IEEE bus using an integral interface card.

Operation

Following the start of EMS-K1 and logging on, the main menu is displayed. By selecting the menu items New Test… or Load Test… a predefined test sequence can be started. The Test Control menu (FIG 3) can be used to interrupt a measurement at any time in order to switch to a semiautomatic measurement mode and repeat a measurement at a single frequency point. Afterwards the automatic measurement can be continued. When the whole frequency range has been covered, a test report is generated and the measurement is terminated.

A special feature of EMS-K1 is the way measurement data are stored. Each test result is stored together with the **test specification** (FIG 4), which contains all definitions for the measurement configuration. It comprises the following **components:**

- script and script parameters,
- immunity parameter setting,
- system and EUT monitoring,
- test-result definition and report configuration.

The measurement sequence, and so the measurement method, is defined in the script. If necessary, individual sequence parameters can be changed at the start of measurement by means of the script parameters. The parameter setting contains all the definitions required to generate the immunity parameter. These include, for example, the frequency ranges, the test level and the modulation of the test signal. As a rule these settings are stipulated in the EMC standard that forms the basis for the measurement. The menu items System Monitoring and EUT Monitoring (EUT = equipment under test) are used, as their names imply, to specify the system and EUT monitoring. The test-result definition and the report configuration determine the layout of the test report.

As the complete test specification and the measurement result data are both stored, it is possible to call and repeat a measurement using exactly the same settings – after any length of time. So it is very easy to repeat a measurement with the same parameters after the EUT has been modified and compare the new results with the earlier ones.

As well as fully automatic system operation, it is also possible to control each device in the EMS test system using the virtual controls displayed by EMS-K1 onscreen. This means that individual measurements and tests that are not part of the usual EMC sequences can be performed manually from the computer.

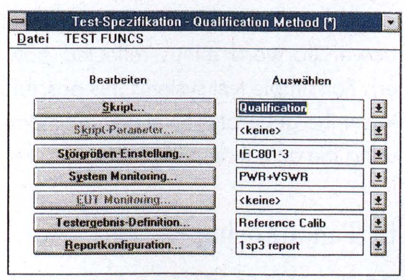


FIG 4 Test specification containing all components required for complete measurement definition

Automatic generation of immunity test signals

EMS-K1 is a universal software package and suitable for just about any **measurement method and test systems:**

- measurement of immunity to radiated interference using an antenna, stripline and TEM or GTEM cell,
- measurement of immunity to conducted interference using CDNs or current clamps,
- measurement of immunity to magnetic fields,

Depending on the test system, immunity level can be defined and displayed in various units as field strength, voltage, current or power. The transducer converts the RF energy from the amplifier into the required immunity parameter.

Three operating modes are available for setting the **disturbance level:**
1. Transducer: the immunity test level is set by means of a specified transducer conversion factor (constant or frequency-dependent) for the amplifier or generator output power.
2. Reference calibration: using the calibration data from a reference measurement, the immunity parameter level is set using the frequency-dependent amplifier power values derived from the calibration measurement.
3. Sensor: the test level is set to the required value using the actual level measured with a sensor (closed loop).

Normally, the level is set in all operating modes by using the actual, measured amplifier output power: depending on the system configuration, it is possible to select forward power or net power (forward minus reflected power). For simple test systems it is possible to set the generator level without measuring the actual amplifier output power.

EUT monitoring

When susceptibility measurements are performed, not only must the test signal be generated but the reaction of the EUT to this test signal must also be monitored to determine whether or not a malfunction occurs. The simplest approach is optical or acoustic monitoring. However, it is often essential to obtain and record additional data about the response of the EUT at a number of internal testpoints or at its interfaces. The signal is then transferred using fiber-optic links. Millivoltmeters, oscilloscopes, comparators and other measuring equipment are used as monitoring devices to analyze the data. Thus, for example, voltage curves can be recorded, bit error rates determined or binary states monitored while the EMS test is being performed.

Only when EUT monitoring is an integral part of the EMS software can fully automatic EMS measurements be implemented. This requires a high degree of flexibility, as the software must be able to handle a variety of EUT interfaces and signals to cover all types of EUT. When the disturbance level is applied, it is often necessary to monitor and analyze several analog and digital signals (monitor channels).

EMS-K1 provides logical monitor channels which can handle analog or digital data. There is almost no practical limit to the number of these channels that can be defined; the crucial limiting factor is processor power and the time required for monitoring. Depending on the graphics resolution, any number of channels can be displayed as diagrams onscreen during a measurement. The operator can change the selection of displayed channels while the measurement is running.

If there is a **nogo** condition, ie malfunction of the EUT, a variety of **responses** can be adopted:

a) store the frequency and the EUT measurement value and automatically continue the measurement,
b) stop the program to enter an operator message, or
c) branch to a user application routine, for example to re-initialize the EUT.

It is also possible to combine responses a) to c) in a number of ways. Scripts are used to provide flexible control for EMS-K1.

Some EUTs have a large number of signals that have to be monitored. Automatic EUT monitoring and the associated signal analysis becomes so complex that it is best to use a separate computer for monitoring. EMS-K1 has a simple hardware and software interface to synchronize the two computers when this approach is adopted.

Measurement sequence control

The measurement sequence control in EMS-K1 software is encoded in scripts. The scripts are accessible to the user, who can adapt them to his requirements. Scripts provide a high level of flexibility and are easy to modify. The scripts form a structured programming language (FSL, flexible script language) which has certain elements in common with Pascal. There are also a number of reserved words and functions that have been specially provided for EMC measurement applications.

The EMS measurement sequence is implemented by two standard scripts – the qualification mode and the susceptibility mode.

In the **qualification mode** the selected parameter profile (limits as a function of frequency) is run automatically and the responses of the EUT are recorded. If there is no EUT malfunction, the EUT passes the test and fulfills the specified immunity limits. The measurement is thus completed. Only if there is a malfunction is the frequency in question noted automatically. The operator can enter comments of his own and the measurement is continued. The EUT, therefore, does not meet the specified limits. The test report lists the frequencies at which malfunctions have occurred.

In the **susceptibility mode** the immunity threshold is automatically determined when a malfunction occurs. The immunity parameter level is reduced by a defined amount (say 10 dB, but any value can be selected by the operator) and then increased in predetermined steps until the malfunction occurs again. The level and frequency are noted in the test report. The susceptibility profile of the EUT can then be displayed in the form of graphs or tables.

System monitoring

EMS systems often generate high RF power (100 W to 10 kW) or field strength which could be a hazard to equipment or personnel. Apart from the usual hardware safety mechanisms such as interlock loops and cutouts, a lot can be done on the software side to **improve safety,** for example:

- device status checks before the measurement is started,
- interlock loop monitoring,
- VSWR monitoring,
- limit maximum amplifier input and output power.

The required range of functions in EMS-K1 is provided by the System Monitoring menu. Like the EUT monitoring mode, internal test system parameters are monitored in various channels, certain channels being selected for display onscreen. This makes early detection of changes in the system possible. They can be listed and the program can react to them by stopping the measurement sequence, for example.

Other functions

Another important feature of EMS-K1 is its ability to simulate all software functions in the virtual mode without any devices being connected. In this operating mode, test specifications and reports can be created on a second computer independently of the test system or test sequences can be checked. Evaluation functions, like the function for determining the uniform area to IEC, round off the extensive range of EMS-K1 functions.

Rohde & Schwarz EMC test systems are in use all over the world. System Software EMS-K1 is highly flexible and adaptable so that it can satisfy the wide range of requirements and customer specifications. An example of this is the use of DDE (dynamic data exchange) software interfaces defined under Windows to link standard software packages like spreadsheets or word-processing programs and DLL (dynamic link library).

Dr Klaus-Dieter Göpel

REFERENCES

[1] Rohde & Schwarz Measuring Equipment Catalog 93/94, pp 55–111

[2] Benthues, M.; Göpel, K.-D.: Automatic EMS measurements to IEC 1000-4-6. News from Rohde & Schwarz (1995) No. 147, pp 42–43

[3] Bues, D.; Stegmaier, J.; Valhdiek, D.: Industrial Controller PSM – Automated testing and control in production and lab. News from Rohde & Schwarz (1994) No. 146, pp 19–21

Modules for System Software EMS-K1 under Windows

EMS-K1	System Software for EMS test systems, EMS-K2 or EMS-K8 are additionally required
EMS-K2	Standard device driver package for EMS-K1
EMS-K3	Extension for EMS-K1: script development kit
EMS-K4	Extension for EMS-K1: remote control of power amplifiers and high-power switches
EMS-K8	Device driver package for EMS-K1, for EMS test system 1 to 18 GHz
EMS-K9	Complete software package, consisting of EMS-K1, EMS-K2, EMS-K3, EMS-K4 and EMS-K20
EMS-K20	Extension for EMS-K1: basic device driver package for EUT monitoring
EMS-K21	Driver for EMS-K1: additional PC for EUT monitoring

Reader service card 148/04

RF Current Probe EZ-17 and Calibration Jig EZ-18

Defined EMC measurements

RF currents carried on supply and control lines of equipment and systems can be measured by means of current probes. Commercial and military standards stipulate limit values of RFI current for diverse fields of application. Rohde & Schwarz offers three models of RF Current Probe EZ-17, providing the user with the right tool whatever the application.

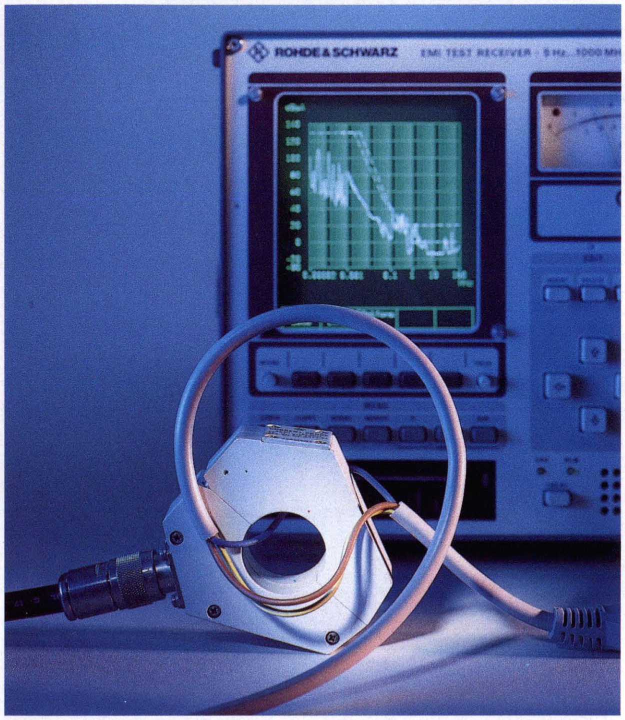


FIG 1 RF Current Probe EZ-17 for emission and bulk-current injection measurements in frequency range 5 Hz to 100 (200) MHz
Photo 42 021/1

Coupling networks and transducers are links between an EUT and the measuring equipment. In the field of EMC measurements, the interface between an EUT and the measuring equipment is not a connector with defined impedance and dimensions as in general RF measurements. Depending on the EUT type and configuration as well as on the frequency of the test signal, emission and immunity tests involve the measurement or injection of either voltages and currents on connecting lines or of field strengths from or to the enclosure including the connecting lines. Coupling networks and transducers serve for converting the test signal for the measuring equipment (receiver or generator). Such equipment includes line-impedance stabilization networks, coupling/decoupling networks, probes (impedance converters), clamp-on current probes and injection probes, field probes and antennas.

EMC standards generally define the parameters to be measured on connecting lines in different ways. While commercial standards on RFI and immunity measurements mainly stipulate line-impedance stabilization networks or coupling/decoupling networks for conducted interference – voltage measured across a stabilized impedance – and only accept current probes or injection probes in exceptional cases, military EMC standards as a rule prefer the latter. In other words, RF currents are mostly measured and immunity against conducted interference is tested by means of current injection probes (bulk-current injection (BCI) test).

Standards on use of current probes

RF current probes measure the current on conductors enclosed by them and for multiple-wire systems – especially for systems consisting of balanced signal and control lines – the resulting common-mode current.

Some commercial but most military **standards and drafts stipulate limits for the RFI current:**

- A planned amendment to CISPR 22 defines RF current limits in the frequency range 0.15 to 30 MHz for those cases in which T line-impedance stabilization networks are not available or applicable.
- The future version of CISPR 25 contains several limit classes with voltage and current limits for vehicle components in the frequency range 0.15 to 108 MHz.
- Standard IEC 1000-3-2 stipulates limits for AC supply harmonics up to the 40th harmonic (2 kHz to 50 Hz line frequency).
- MIL-STD-461A, B and C comprise a number of limits for conducted emissions in the range 30 Hz to 15/20 kHz (CE 01) and in the range 15/20 kHz to 50 MHz (CE 03/04); MIL-STD-461D reduces RFI current measurement to a range 30 Hz to 10 kHz (CE 101).
- The British standard DEF-STAN 59-41 stipulates RFI current measurements in a wide frequency range from 20 Hz to 150 MHz.
- The French standard GAM-EG 13 confines itself to a range from 30 Hz to 50 MHz.
- The most stringent requirements on sensitivity are made by the German regulation VG 95373, part 20 with limit values down to –48 dBµA.

There are also other type specifications for civil and military aircraft with similar requirements on frequency ranges that differ from the standards mentioned above.

For the sake of completeness, there are also **standards for EMS measurements** using current probes:

- The future version of IEC 1000-4-6 stipulates that bulk-current injection probes are to be used in those cases where coupling/decoupling networks cannot be applied. The frequency range is from 0.15 to 80 (230) MHz.
- ISO standards recommend the BCI test for complete vehicles (ISO 11451-4 from 1 to 400 MHz) and for vehicle components (ISO 11452-4 from 0.01 to 200 MHz).
- The latest MIL-STD-461D standard includes the BCI test with currents of up to 5 A in the frequency range 0.01 to 400 MHz, placing stringent requirements on the overload capacity of BCI probes.
- DCE 02 of DEF-STAN 59-41 stipulates currents of up to 115 dBμA in the range from 0.05 to 400 MHz.
- GAM-EG 13 also defines the frequency range 0.05 to 400 MHz for the BCI test.
- The BCI test is under discussion for regulation VG 95373.

The three models of RF Current Probe EZ-17 from Rohde & Schwarz (FIG 1) are suitable for the applications mentioned: model 02 serves for emission measurements in the frequency range 20 to 100 (200) MHz, model 03 for emission and susceptibility measurements in the same range and model 04 with balanced output for emission measurements in the range 5 Hz to 2 MHz.

RFI current measurement with RF Current Probe EZ-17

A current probe can be regarded as a transformer. It transforms current I_1 in the test circuit to a voltage V_2 into 50 Ω. The most important parameter of the RF current probe is the transfer admittance Y_t. If V_2 is the RFI voltage displayed by the test receiver and I_1 the RFI current to be measured, the following applies:

$Y_t = I_1 / V_2$

Y_t has the unit A/V = S

The transfer admittance is the reciprocal value of the transfer impedance Z_t and the transducer factor k is the logarithmic transfer admittance. If v_2 is the RFI voltage level in dBμV displayed by the test receiver and i_1 the measured RFI current level in dBμA, the following applies:

$k = i_1 - v_2 = 20 \log (Y_t / 1\ S)$

k has the unit dB (S)

So, the transducer factor k has to be added to the RFI voltage level to obtain the RFI current level. A low transducer factor increases the measurement sensitivity of the system consisting of test receiver and current probe. FIG 2 shows the transducer factors of the three models of RF Current Probe EZ-17.

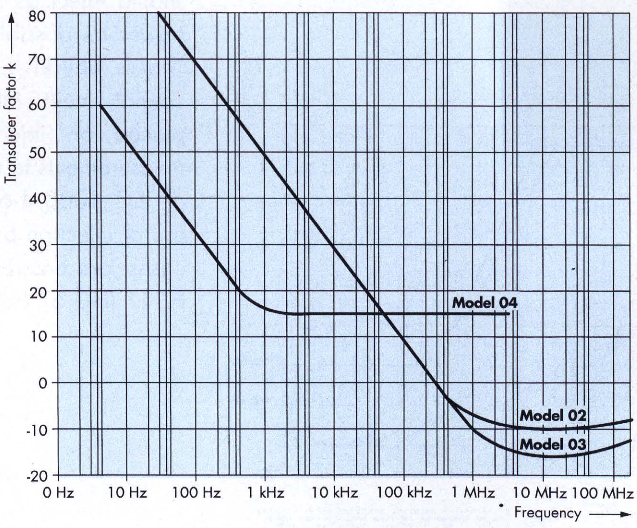
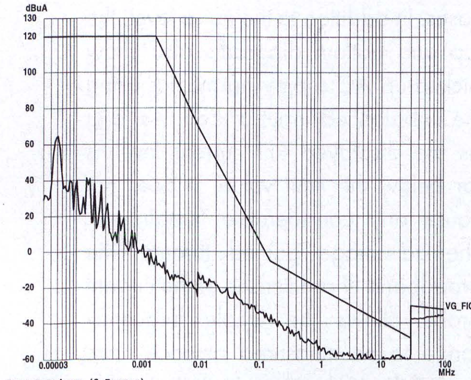


FIG 2
Transducer factors of three models of Current Probe EZ-17

As it is usually difficult for the user to calculate the sensitivity of a system consisting of test receiver and transducer from data sheets, FIG 3 indicates the sensitivity curve for the system of EMI Test Receiver ESS and RF Current Probe EZ-17 in particularly critical cases. In addition to the noise level, the top and bottom diagrams also show picked-up AC supply harmonics using the unbalanced input of ESS. As long as the displayed RFI current level is far below the limit value, it does not cause any considerable impairment. The advantage gained through the broadband characteristic of the current probe allows the whole frequency range to be measured at once however. If the highest sensitivity in the frequency range below 10 kHz is to be made use of, model 04, whose coil is ungrounded and provides a balanced output, together with the balanced input of ESS is recommended. Model 04 provides the required system sensitivity especially in conjunction with spectrum analyzers whose first IF is very high and where the LO rejection of the first mixer stage is therefore not as high as in the frequency range 1 of ESS (5 Hz to 50 kHz).

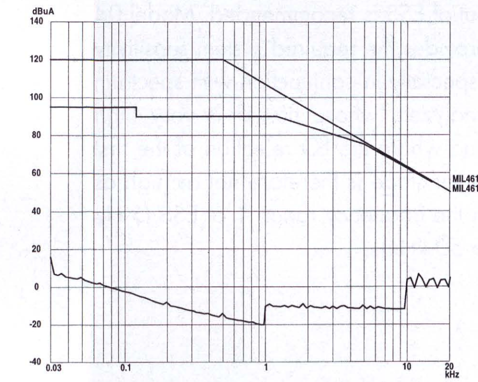
Measuring line harmonics with ESS and EZ-17

Part 3-2 of EN 61000 (part 2 of VDE 0838) stipulates limits for harmonic currents. The standard has special requirements on time-domain instru-



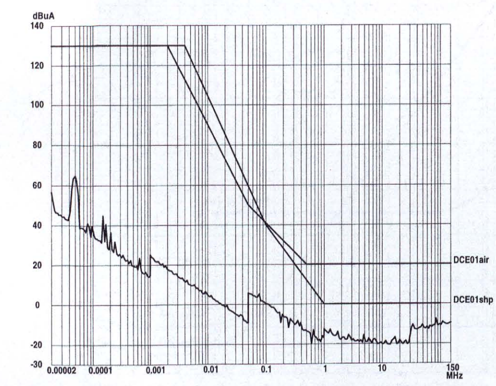
Scan Settings (3 Ranges)

Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp	OpRge
30Hz	10k	6.3%	10Hz	AV	1s	0dBLN	ON	60dB
10k	30M	6.3%	200Hz	AV	50ms	0dBLN	ON	60dB
30M	100M	6.3%	10k	AV	50ms	0dBLN	ON	60dB



Scan Settings (3 Ranges)

Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp	OpRge
30Hz	1k	6.3%	10Hz	PK	200ms	0dBLN	OFF	60dB
1k	10k	6.3%	100Hz	PK	50ms	0dBLN	OFF	60dB
10k	20k	6.3%	1k	PK	50ms	0dBLN	OFF	60dB



Scan Settings (5 Ranges)

Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp	OpRge
20Hz	1k	6.3%	10Hz	PK	200ms	0dBLN	OFF	60dB
1k	50k	6.3%	100Hz	PK	50ms	0dBLN	OFF	60dB
50k	1M	6.3%	1k	PK	50ms	0dBLN	OFF	60dB
1M	30M	6.3%	10k	PK	20ms	0dBLN	OFF	60dB
30M	150M	6.3%	100k	PK	20ms	0dBLN	OFF	60dB

FIG 3 Noise indication of EMI Test Receiver ESS with RF Current Probe EZ-17. Top: measurement to DEF-STAN 59-41 DCE 01 (aircraft/ship) with model 03; scan settings show settings of ESS. Middle: measurement to MIL-STD-461D (limit line is lowest envelope of all limits) with model 04. Bottom: measurement of narrowband interference to regulation VG 95373, part 20, limit class 1, with model 03.

mentation with discrete Fourier transform for the measurement of fluctuating and rapidly changing harmonics. In these cases – especially in case of doubt – the use of DFT analyzers with a defined time window is prescribed. For constant harmonics, which are produced by many electrical and electronic devices, a combination of test receiver or spectrum analyzer (such as ESS, ESAI, ESBI and ESMI from Rohde & Schwarz) and an RF Current Probe EZ-17 provides absolutely correct results (FIG 4). To obtain a total error of less than 5%, additional calibration of the system with the aid of an AF generator is recommended.

EMS measurement with RF Current Probe EZ-17

There is a fundamental difference between RF current probes for emission measurements and current probes for EMS measurements (BCI probes). Current probes for emission measurements must not influence the circuit to be measured (insertion impedance in test circuit max. 1 Ω according to CISPR 16-1), whereas BCI probes should inject as much of the offered power as possible to the test circuit. That is why RF Current Probes EZ-17 cannot meet all the requirements placed on injection probes. EMS measurements to the lowest limit class of IEC 1000-4-6, which allows the use of injection probes in exceptional cases, are possible with model 03 of EZ-17 (FIG 5), however.

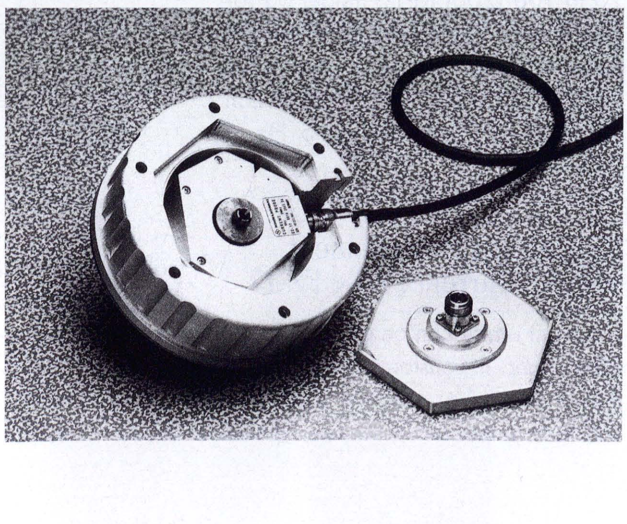
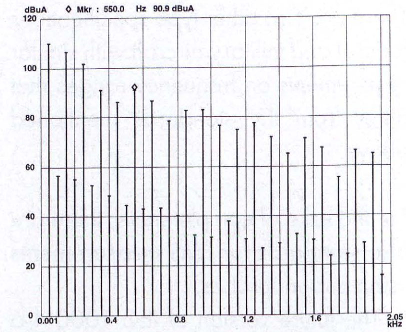


FIG 6
Calibration Jig
EZ-18
Photo 41 663



Special Scan Settings

Start	Stop	IF BW	Detector	M-Time	Atten	Preamp	OpRge
50Hz	2k	10Hz	AV	1s	AUTO LN	OFF	60dB

FIG 4 Line harmonics spectrum measured with special scan of ESS. With its bandwidth of 10 Hz, EMI Test Receiver ESS offers enough selectivity for measuring harmonics of line supply currents.

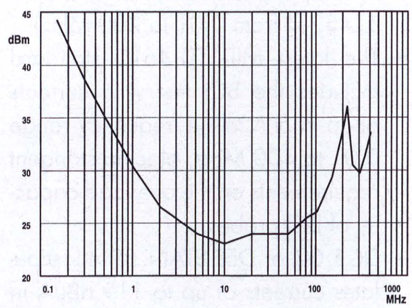


FIG 5 Power on EZ-17, model 03 required to generate secondary voltage corresponding to 1 V EMF in line with limit class 1 of IEC 1000-4-6. At additional amplitude modulation of 80%, required peak power on current probe is nearly 50 dBm (100 W).

Calibration Jig EZ-18

Calibration Jig EZ-18 (FIG 6) is used to calibrate all models of EZ-17. It is therefore ideal for use in labs wherever the RF current probe has to be recalibrated. For this purpose a defined RF current is injected into EZ-17. The return loss of EZ-18 with Current Probe EZ-17 is better than 23 dB up to 100 MHz (FIG 7). Thus, the uncertainty of the transducer factor can be kept below 1 dB up to 100 MHz.

As the calibration jig meets the requirements for all common test jigs, it can also be used to calibrate EMS measuring equipment. If the RF current probe is used to measure the screening effectiveness of RF cables*, EZ-18 serves for calibration of the test setup – best by using the normalizing function of the measuring instrument.

Werner Held; Manfred Stecher

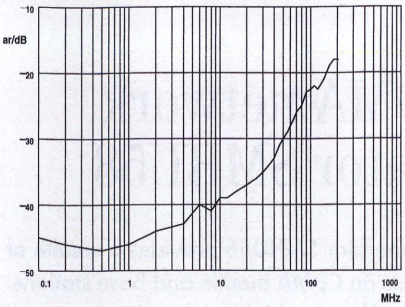


FIG 7 Return loss curve of Calibration Jig EZ-18

* Stecher, M.: Measuring cable shielding in frequency range 9 kHz to 300 MHz. News from Rohde & Schwarz (1983) No. 100, p 21

Condensed data of RF Current Probe EZ-17

	Models 02/03	Model 04
Frequency range	20 Hz to 100 (200) MHz	5 Hz to 2 MHz
RF connector	N female	Twinax female
Insertion impedance	≤0.8 Ω/≤1 Ω	≤0.1 Ω
Transducer factor in range with flat frequency response	−10 dB/−17 dB	+15 dB
Max. DC current or peak AC current	300 A (f <1 kHz)	300 A (f <100 Hz)
Inner diameter	30 mm	30 mm

Reader service card 148/05

Digital technology for sound and TV broadcasting

by Paul Dambacher, head of the sound and TV broadcasting subdivision at Rohde & Schwarz. German edition published in 1994 by R. v. Decker's Verlag, G. Schenk GmbH, Heidelberg; ISBN 3-7685-2894-4, 350 pages, 194 illustrations, hardcover, available in bookshops at a price of DM 78.

Sound and television broadcasting are undergoing a revolutionary development from the classical analog to digital technologies, especially to digital signal processing. This change became evident over the past ten years taking shape in many individual steps and will largely be completed within the next decade, including the audio and video baseband signal.

The book describes digitization which covers every field of sound and TV broadcasting from recording in the studio and transmission via terrestrial transmitters, satellites or cable to receiving and recording at the consumer's. In this context, data compression based on the findings of psychoacoustics and psychooptics without any loss in quality and the assignment of hierarchical quality levels play a dominant role. Block and convolutional error protection methods as well as digital modulation modes ensure optimal adaptation to the transmission media. The evolution in this field is illustrated by way of pragmatic models.

This book is a reference not only for technicians and engineers working with TV and sound broadcasters, the PTT and in industry, but also for students of communications engineering as well as technically inclined viewers/listeners who wish to get a closer look into the subject matter.

CDMA Coder SMHU-B6

Test signals for CDMA network with Signal Generator SMHU58

The new CDMA coder option for Signal Generator SMHU58 provides a wealth of new signals and functions for measurements on CDMA mobile and base stations. It turns SMHU58 into an extremely cost-effective, high-quality CDMA signal source.

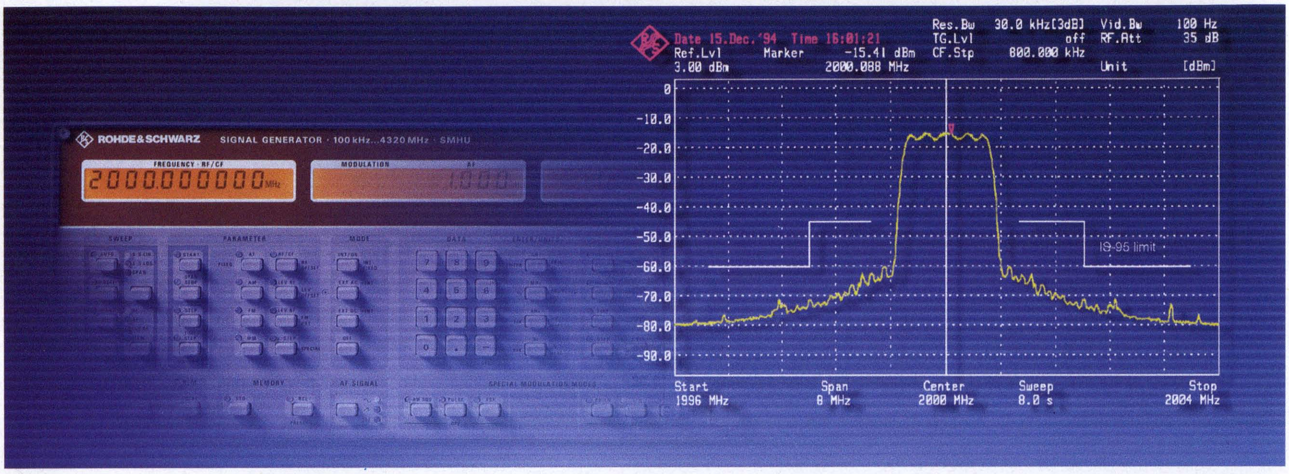


FIG 1 Signal Generator SMHU58 now also performs measurements on CDMA networks

SMHU58 – this admittedly unexciting designation stands for a Rohde & Schwarz signal generator of the absolute top class. SMHU58 with I/Q modulator is simply the combination to choose when complex modulation signals need to be measured [1]. Rohde & Schwarz has developed a number of options for SMHU58 to handle mobile-radio measurements. These options make it easy to generate test signals for mobile-radio networks (eg PDC, NADC, DECT and PHS). As a completely new extension, Coder SMHU-B6 for the US standard CDMA network (IS-95 [2]) has now been added to the SMHU range of options (see the blue box for a short introduction to CDMA).

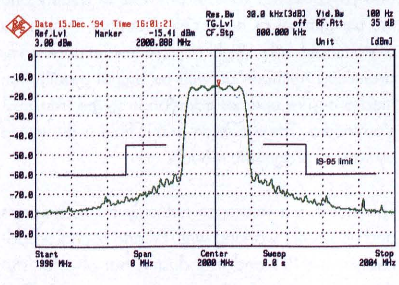


FIG 2 CDMA spectrum generated with Signal Generator SMHU58 and Coder SMHU-B6

The coder can be retrofitted as easily as the other options. The main function of the coder options is to generate I and Q signals for the I/Q modulator of SMHU58 (FIG 1). All coders can generate the test signals with network-specific modulation without requiring any auxiliary equipment. For this purpose, they are fitted with pseudo-random data generators. An external data source can be connected alternatively. The CDMA coder in addition offers a 768-bit freely programmable RAM for encoder data.

A new feature in the CDMA coder is the **integrated microprocessor,** which markedly increases the number of setting functions. It also provides the option with a serial RS-232-C interface for feeding in external modulation data. This interface is very useful as it is integrated as standard in every PC. A connecting cable for the interface comes with the CDMA option of course.

The CDMA coder is ideal for mobile-station measurements. It can emulate two channels of a CDMA base station (forward channel). **QPSK modulation** is used. One channel is the pilot channel, the second channel can be configured as a sync, paging or traffic channel, or as a second, orthogonal traffic channel. FIG 2 shows the quality of the generated CDMA spectrum. Adjacent-channel interference is far below the limit prescribed by IS-95.

The CDMA coder carries out complete **channel coding to standard IS-95.** The modulation data are thus the input data for the convolutional encoder with data rates of 1.2, 2.4, 4.8 or 9.6 kbit/s. SMHU-B6 also provides setting facilities that go beyond CDMA channel configuration and data-rate selection, so there is a whole variety of special test functions which are especially valuable when testing mobile receivers. For example, the CDMA signal can be blanked during a selectable number of

Code-Division Multiple Access (CDMA)

CDMA is a multiple-access method. This means that the limited capacity of a radio channel is allocated to subscribers currently needing transmission capacity. The multiple-access method most commonly used in digital mobile-radio systems is TDMA (time division multiple access). TDMA is used, for example, in GSM networks, where every subscriber is allocated a defined period of time for the transmission and reception of messages. In a CDMA network, by contrast, all subscribers are transmitting at the same time at the same frequency. The receiver at the CDMA base station is nevertheless able to separate the individual messages by using the direct-sequence spread-spectrum technique, where modulation data are chopped by a code sequence at a high data rate (FIG A).

For CDMA to IS-95, the transmission rate for modulation data is 19,200 symbols per second, whereas the chip rate of the code sequence is 1.2288 MHz. As a consequence, the modulation spectrum is spread by a factor of 64 – hence the designation spread spectrum. Filtered QPSK is the modulation used. The modulation data sent can be retrieved by a spread-spectrum receiver using the same code sequence as the transmitter. If the receive signal is correctly correlated to the code sequence, the maximum level will be obtained at the receiver. If, on the other hand, the receive signal is correlated to another than the received code sequence, the level at the correlator output will be low or, in the ideal case, zero.

CDMA uses special code sequences. The most important characteristic of the codes is their orthogonality relative to each other. This orthogonality enables separation of the CDMA channels. IS-95 defines a set of 64 orthogonal code sequences based on Walsh functions. Besides this, pseudo-random sequences are used, for example the long code for subscriber identification and pilot PN sequences for base-station identification. The proper functioning of a CDMA system essentially depends on correct synchronization of the mobile-station receiver both in terms of frequency and time. For this reason a pilot signal is sent by each CDMA base station (FIG B).

Walsh function 0 is used for the pilot channel. The remaining 63 Walsh codes are used for the sync, paging and traffic channels. Before the modulation data are spread by means of a Walsh code, channel coding is performed with encoder, interleaver and long-code scrambling. The data rates at the input of the encoder are between 1200 bits/s (eighth rate) and 9600 bits/s (full rate). The channels of a CDMA base station together form the forward link, which is the transmit signal of the base station (FIG C).

The transmit signal of the mobile station differs from that of the base station. Channel coding is different, and offset QPSK is used for modulation. The pilot PN sequences that are synchronized to the base-station pilot signal by the mobile-station receiver are used again for spreading the modulation data. The mobile station does not send a pilot signal however. Reception at the base station is critical as mobile stations operate at different distances. For this reason, an elaborate closed-loop level-control system covering the base station and mobile stations is provided, ensuring that the signals from all active mobile stations arrive at the base station with approximately the same level. The interfering noise decisive for each link is formed by the sum of the signals from all other mobile stations. It is this noise that determines the quality of the transmission link.

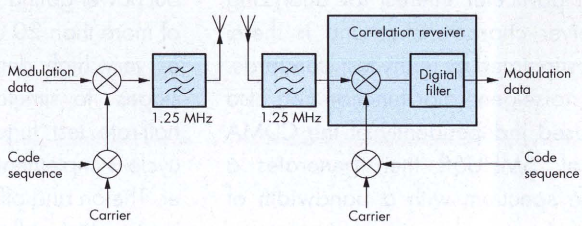


FIG A Principle of spread-spectrum transmission

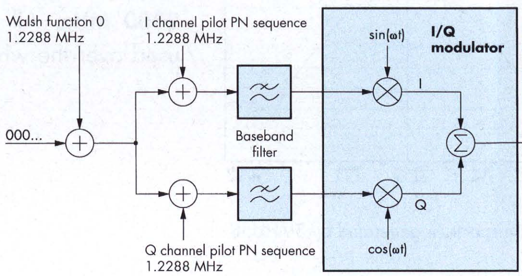


FIG B Generation of pilot signal of base station

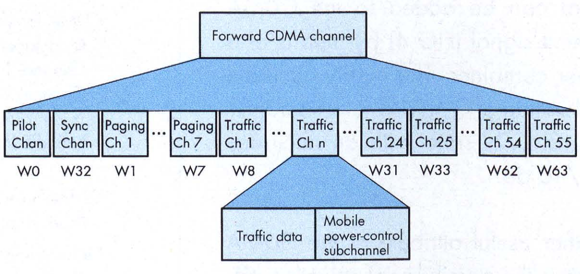


FIG C Forward-link channel allocation, transmit signal of CDMA base station

80-ms frames in order to test the level supervision of mobile stations. In addition, uninterrupted level reduction by 20 dB (no mechanical switching) can be set. The mobile station should respond to this by increasing its transmit level (open-loop control), the step response being precisely defined by IS-98 [3].

The most important extra function provided by the CMDA coder is its **built-in noise generator.** After switch-on, a noise signal with a white spectrum of 2 MHz is added to the CDMA signal. The amplitude distribution of the noise signal is Gaussian, and the signal is therefore referred to as additive white Gaussian noise (AWGN). This signal is of particular interest for analyzing receiver characteristics and is therefore stipulated by many test standards. The noise-generator function can also be used independently of the CDMA signal. SMHU58 then generates a noise spectrum with a bandwidth of more than 2 MHz and a freely selectable center frequency (FIG 3). This signal can be added to the CDMA transmit signal (FIG 4) by means of a power combiner. The highly accurate level setting of SMHU58 allows adjustment of S/N ratio with an accuracy of 1/10 dB.

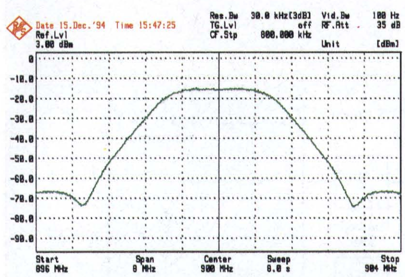


FIG 3 Noise spectrum generated by SMHU58

Another useful attribute of the CDMA coder is the possibility of selecting **offset QPSK modulation.** This allows the generation of a mobile-station signal modulated with all zeroes (CDMA reverse channel). This signal is used, for example, for tests on output stages of mobile stations. When transmitting at a reduced data rate (eg half rate with 4800 bits/s), the mobile station carries out power gating with a dynamic range of more than 20 dB. This process places very high demands on the output stages. To simulate power gating, a half-rate test function with 50% duty cycle is implemented in the CDMA coder. The on and off periods are 1.25 ms each, which reflects the conditions encountered in a real mobile station.

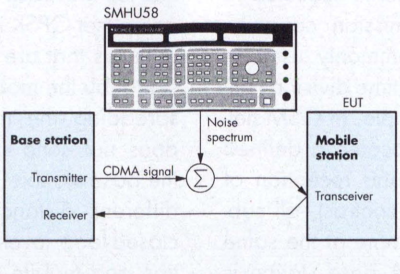


FIG 4 Noise spectrum added to CDMA transmit signal

SMHU58 with CDMA coder has an **output frequency range of 4 to 2000 MHz.** All test signals can be used over the whole frequency range without any restriction. This fully covers the PCS bands around 1900 MHz defined by the US FCC (Federal Communications Commission). IF measurements, too, can be carried out with SMHU58. The option SMHU-B6 includes DOS Software CDMA-K1. This enables a variety of additional settings, for example variation of CDMA channel levels relative to each other. With the AWGN function, S/N ratio can be adjusted over a wide range.

Klaus-Dieter Tiepermann

REFERENCES

[1] Lüttich, F.; Hecht, A.: Signal Generator SMHU58 with I/Q modulator. News from Rohde & Schwarz (1990) No. 132, pp 8–11

[2] TIA/EIA/IS-95, Mobile Station – Base Station Compatibility Standard for Dual-Mode Wideband Spread Spectrum Cellular System, US Telecommunications Industry Association

[3] IS-98, Recommended Minimum Performance Standards for Dual-Mode Wideband Spread Spectrum Cellular Mobile Stations

Condensed data of SMHU58 with CDMA Coder SMHU-B6

Frequency range	4 to 2000 MHz
Level range	140 to +3 dBm
CDMA forward channel	max. 2 channels, channel coding to IS-95
Modulation	QPSK, baseband filtering to IS-95
Channel 1	pilot channel
Channel 2	can be configured as pilot, sync, paging or traffic channel
Encoder input data	internal from RAM, internal pseudo-random or external, data rates 1.2/2.4/4.8/9.6 kbit/s
CDMA reverse channel	1 channel without channel coding
Modulation	offset QPSK, baseband filtering to IS-95
Noise generator (AWGN)	
Amplitude distribution	Gaussian
RF bandwidth (3 dB)	>2 MHz

Reader service card 148/06

CATV Headend System CT200

CATV signal processing intelligent, compact, versatile

CATV Headend System CT200 from Rohde & Schwarz is an extremely versatile and modular system for processing vision and sound signals so that they can be fed into cable networks. Petra Schönberger, Dipl.-Ing. (FH) from the German Telekom in Munich and Peter Sturm, Dipl.-Ing. from the Research and Technology Center of Telekom in Darmstadt report on the first CATV system that was put into operation at the end of last year.

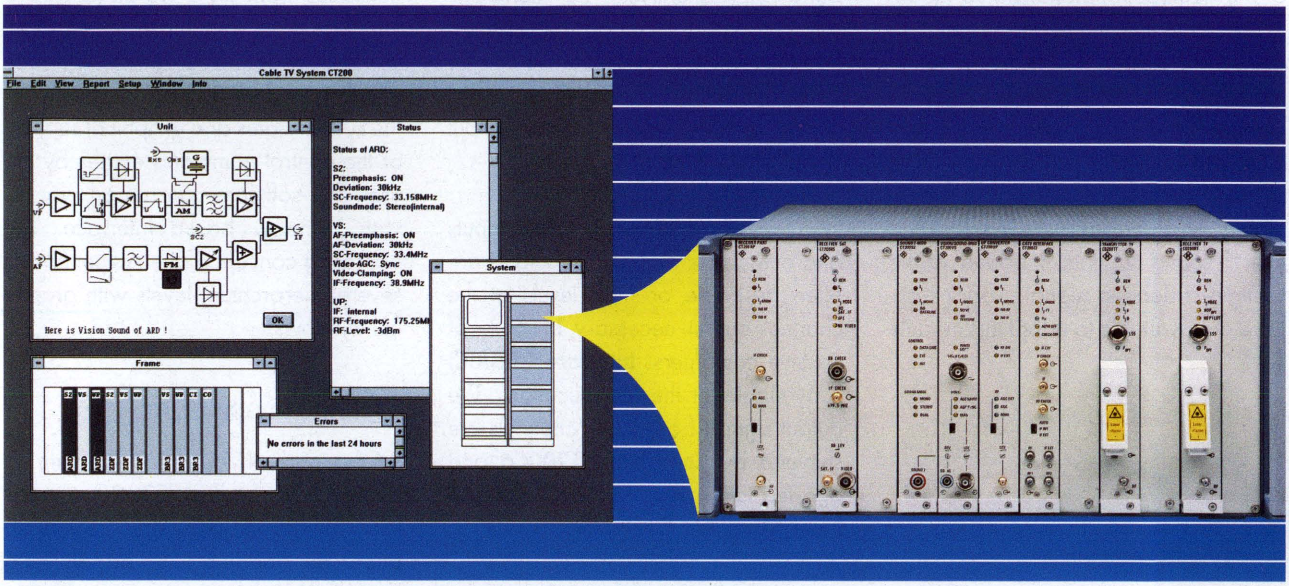


FIG 1 CATV Headend System CT200 featuring versatile modular design is able to handle all signal-processing tasks in broadband distribution networks Photo 41 454

The main task of cable network operators is to condition the broadcast signal – no matter whether it is received via terrestrial, fiber-optic or satellite links – and feed it into a broadband cable network. To suit these applications, Rohde & Schwarz has developed CATV Headend System CT200 (FIG 1). It consists of a number of individual components (see overview in blue box) which cover the entire range of cable signal processing from the RF signal and optical signals through to digital broadcast signals. Depending on the specific application, customized systems can be configured. All modules have their own microprocessor and can be accessed by the controller via a serial bus (SERBUS). The system software supported by the controller can easily be adapted to a large variety of applications. Operational reliability has a high priority in the CT200 system concept and is ensured by a decentralized power supply which allows independent operation of each individual channel.

Mechanical design

Frame CT200F5 with a height of five units (216 mm) provides accommodation for twelve CT200 modules. The necessary connections to the other CT200 components assigned to the same channel are established by the rear-panel connectors via the motherboard of the associated power supply. Each CT200 module is assigned a certain slot in the power supplies to ensure smooth internal communication. The frame can be individually fitted for a specific channel, with all CT200 modules being suitable for use.

Data and commands from **Controller CT200CO** are transferred on a serial bus via the main motherboard to the relevant components. Since all modules have the same dimensions, any application can be implemented with the same basic mechanical configuration. This straightforward concept allows up to 36 channels to be accommodated in a 19-inch rack, thus providing an economical solution to the serious space problems often encountered in cable headends.

Components of CT200 system

Frame	CT200F5
Controller	CT200CO
Vision-Sound Modulator	CT200VS
Sound-2 Coder-Modulator	CT200S2
QAM Modulator	CT200QM
Upconverter	CT200UP
Interface	CT200CI
Combiner	CT200C6
Combiner / Amplifier	CT200A4
Tuner	CT200RP
Analog Demodulator	CT200AD
Satellite Receiver	CT200RS

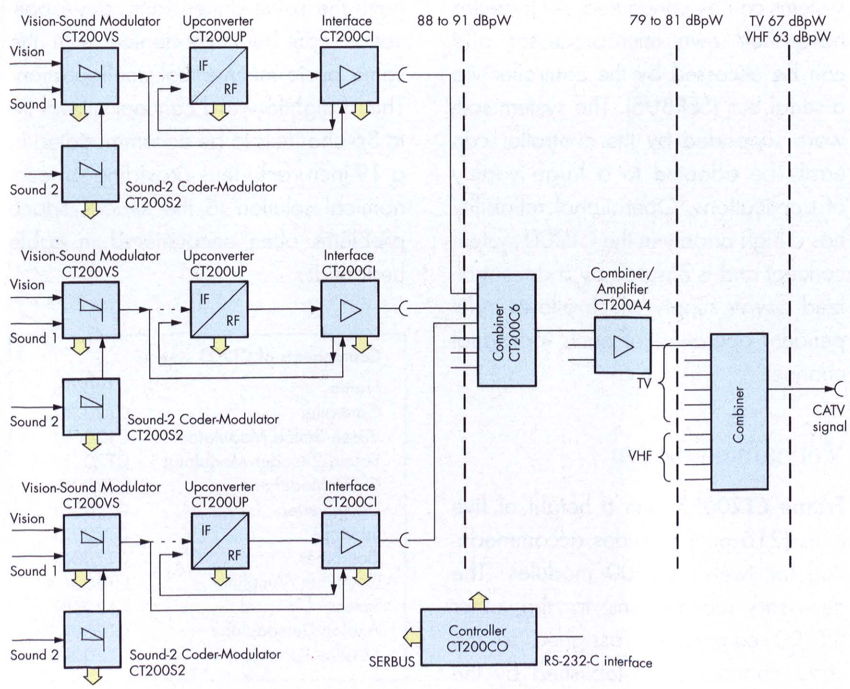
Electrical design

For conversion of received signals to RF, the vision and sound signals are taken via an audio/video patch panel to **Vision-Sound Modulator CT200VS** (FIG 2). For dual-sound transmission **Sound-2 Coder-Modulator CT200S2** is inserted as a separate module, which generates the frequency-modulated second sound subcarrier, provides matrixing of the AF signals from the left and right channel and generates the modulated pilot signal for identification of the dual-sound/mono/stereo mode. A special feature is the free selection of the sound carrier. In the vision-sound modulator the CCVS is level-controlled, clamped and – depending on the specific requirements – precorrected. The IF vision carrier is then amplitude-modulated and the frequency-modulated first IF sound subcarrier added to the vestigial sideband signal. Various options are available to adapt this module to different TV standards. For the transmission of digitally modulated signals, **QAM Modulator CT200QM** is used instead of the vision and sound modulators. It allows QAM signals of high-order modulation (16/64/256QAM) to be fed into broadband distribution networks.

Upconverter CT200UP converts the IF signal to a freely selectable RF channel between 47 and 862 MHz. With the aid of plug-in filters (bandpass, lowpass) both narrowband and broadband applications can be implemented. Through locking to an external frequency all output converters can be synchronized. A special level control circuit provides a stabilized output signal at any time.

In a system, additional signal inputs and outputs as well as test outputs are often desirable or high levels at the channel output necessary because of passive combiners. **Interface CT200CI** is available for these applications. The output signals from all RF channels are summed by **Combiner CT200C6** and boosted to the required level by **Combiner/Amplifier CT200A4.**

FIG 2 Block diagram of signal processing



Controller and software

The controller device is the brains of the system and can handle up to 36 channels per rack. In conjunction with the microprocessors of the modules it provides comprehensive monitoring, control and self-diagnostics of each system component. The controller also permits an (n+1) standby configuration to be implemented to enhance the operational reliability of the system.

CT200 modules are monitored and controlled from a PC via an RS-232-C interface. The available system software provides a graphics interface allowing visual graphical display of the system status and graphical support of the control command entries by the user. The software can run on any PC with Windows-based interface. The operating concept of the system covers several hierarchical levels with graphical windows.

Systems in operation

At the end of last year Telekom in Munich put the first CT200 systems from Rohde & Schwarz into operation for feeding TV signals into broadband distribution networks in line with relevant standards (FIG 3). TV signals received from the satellites DFS 2, ASTRA and ECS are processed for about 500,000 subscribers of Telekom in Munich and surrounding areas.

The previous processing units had to be replaced since the technical standard at the site of the satellite receiving equipment no longer satisfied the future-oriented concept of Telekom. Modernization was based on the condition that at least twice the number of processing units had to be accommodated on the same premises and with the same air conditioning system. The CT200 system concept from Rohde & Schwarz appeared to be the ideal solution since it allows up to 18 processing units to be accommodated in a 19-inch rack in line with the requirements of Telekom. The clear, software-supported modular design of the CT200 system and the level-matched testpoints and interfaces make system planning and operational monitoring particularly easy.

Each processing unit in the Munich headend consists of Sound-2 Coder-Modulator CT200S2, Vision-Sound Modulator CT200VS, Upconverter CT200UP and Interface CT200CI for level and interface matching to satisfy the conditions of Telekom. One frame of 19-inch width and 216 mm height accommodates three processing units. If required, a Passive Combiner CT200C6 can be integrated in the frame at a later date.

The modern, intelligent CATV Headend System CT200 has all the technical **features** required by today's large headends, such as:

- powerful system management for control and monitoring,
- troubleshooting through self-diagnostics,
- individual system software for specific applications
- operational reliability through decentralized power supply,
- switchover to standby processing unit – (n+1) standby – in case of failure.

Following the successful type-approval test in line with TL 5820-3076 of German Telekom, the new system was put into operation in late 1994 in Munich. To ensure easy implementation of an (n+1) standby configuration in the future, a separate modulation rack was installed for each satellite receiving equipment. In the CT200 system, tuning and alignment is so easy that it is no problem to change the frequency of the TV modulators if required.

In the case of program intervals or breakdowns, the processing units concerned are modulated by a PAL Substitution Signal IF Modulator SBKP from Rohde & Schwarz that is installed centrally at the site and generates an FuBK test pattern as the IF substitution signal. For digital transmission of TV signals, the sound-2 modulator and the vision-sound modulator can be replaced by a QAM Modulator CT200QM.

Petra Schönberger; Peter Sturm; Reinhard Scheide

FIG 3 CATV Headend Systems CT200 (right-hand rack) operated by German Telekom in Munich Photo 42 033/1+3

Condensed data of CATV Headend System CT200

Input signals	analog, digital
Transmit frequency range	47 to 862 MHz
Output level	0 to 9 dBm, SMA, 50 Ω
Receive frequency range	terrestrial 45 to 862 MHz, satellite frequency 950 to 2050 MHz
Number of channels per rack	<36
Interfaces	SERBUS, RS-232-C, modem
RF outputs per channel	2
Video interface	BNC, front panel, 50 Ω
Audio interface	Lemo Triax, front panel, 12 kΩ/600 Ω, balanced
Digital interfaces	ECL 10K, BNC, submin-D
Digital modulation	16QAM, 32QAM, 64QAM, 128QAM, 256QAM
Power consumption per channel	approx. 59 W

Reader service card 148/07

COFDM Modulator MCM01

Channel coding and modulation for digital audio broadcasting

The COFDM Modulator MCM01 is part of the DAB equipment developed by Rohde & Schwarz. It uses the digital modulation method COFDM, which guarantees errorfree, terrestrial audio-signal transmission to stationary, portable and mobile receivers.

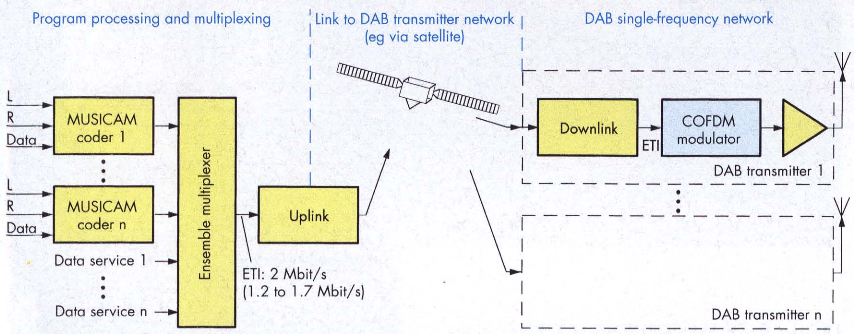


FIG 1 Configuration of DAB system

The new digital audio broadcasting (DAB) system permits transmission of audio signals in CD quality even to mobile listeners. DAB is a European development sponsored as part of the EUREKA 147 project. Since the middle of the 80s, research institutes, broadcasting corporations and industrial companies in France, England and Germany have been involved in the development. The system was tested in regional field trials with the aid of first equipment generations, and in 1994 an internationally standardized system specification was published (draft ETS 300 401). Pilot projects for broadcasting DAB programs will be started in the middle of this year. Country-wide implementation of the system in Germany is planned for 1997 [1].

The DAB system

Terrestrial transmission of digital audio signals became economically viable with the availability of efficient data-reduction methods. DAB uses the MUSICAM coding method, which reduces the data volume to about one seventh without degrading the perceptible signal quality [2]. For instance, after reduction a stereo signal is transmitted at a rate of 192 kbit/s. Since a DAB signal is able to transport 1.2 Mbit/s of information, several MUSICAM signals are combined in a multiplexer (FIG 1). The remaining transmission capacity may also be used for data services like road user information or warnings. The resulting program packet is called a DAB ensemble. The multiplexer is connected to the COFDM modulator via the ensemble transport interface (ETI). The ETI is a 2-Mbit interface defined independently from the network links to the individual transmitters.

Fundamentals of COFDM modulation

The signal arriving at the receiver in the multipath channel is impaired by several physical effects. Delay differences caused by multipath propagation produce interference between consecutively transmitted symbols, and reflections in the vicinity of the receiver cause frequency-selective fading. The movement of the receiver produces phase and frequency shifts (Doppler effect). Moreover, the receiver surroundings and consequently the multipath pattern continuously change.

To compensate for these effects, the French research institute CCETT (Centre Commun d'Etudes de Télédiffusion et Télécommunications) developed COFDM (coded orthogonal frequency division multiplex) [3]. The multiplex data stream is distributed to 1536 carriers (in transmission mode I), which are then QPSK-modulated at a correspondingly lower data rate. The carriers are arranged so as not to influence each other. As a result a symbol period considerably longer than any relevant signal delay is obtained. A guard interval is introduced to avoid adjacent symbols disturbing each other. The receiver thus always finds an interference-free signal section. Furthermore, when the information is distributed to many carriers, only parts of the information will be destroyed by frequency-selective fading whereas in the case of the single-carrier method the whole information would be lost. Any information missing can be retrieved from the undisturbed data received with the aid of an error-correction method.

The COFDM signal can be broadcast in **single-frequency networks** (SFNs), ie all transmitters of a supply area use the same frequency. This is possible provided that the maximum signal delay resulting from the transmitter distance is shorter than the guard interval. For instance, with transmission mode I the maximum transmitter distance is 90 km. The receiver picks up the signals from other transmitters as useful echoes so that no disturbing interference is caused.

Error-protection coding includes convolution coding with a rate of 1/4 and subsequent puncturing. In this case

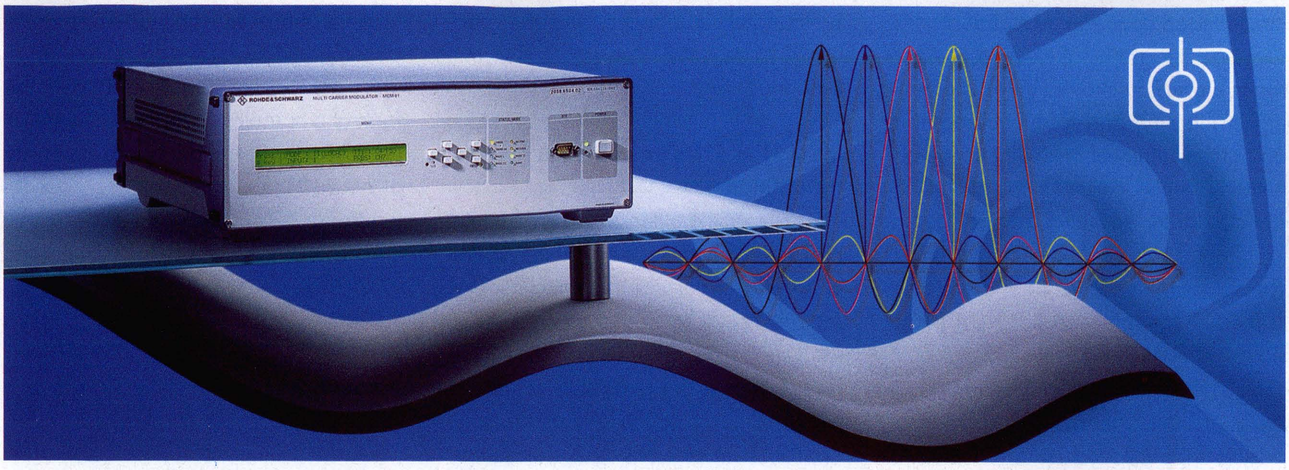


FIG 2 COFDM Modulator MCM01 for digital audio broadcasting

individual bits are removed from the data stream according to a fixed pattern. With the aid of a convolution coder, different codes providing different degrees of protection can be produced (24 in the case of DAB). The individual bits of a data-reduced audio signal can thus be protected as required according to their susceptibility to errors (unequal error protection). This mechanism allows the coded data stream to be adapted to requirements and channel capacity to be optimally utilized.

The Viterby decoder associated with the convolution coder is particularly suitable for correcting even frequently occurring errors in a poor transmission channel. Since long error sequences (block errors), as may be caused by a vehicle stopping at traffic lights, put the coder out of function, block errors are split up into single errors by interleaving the bits in the **time and frequency domain** (time frequency interleaving).

After assigning the data to the individual subcarriers, a **fast Fourier transform** (FFT) is performed to convert the spectrum into the time domain. Thus the DAB baseband is obtained, which is available as an inphase and quadrature signal.

Design of COFDM modulator

COFDM Modulator MCM01 comes as a menu-controlled bench model (three height units) of low seated depth with LC display (FIG 2). A kit is available for mounting MCM01 into a 19-inch rack. The COFDM modulator comprises four modules (FIG 3):

The **channel coder** processes the HDB3-coded input signals (to G.703) and generates the required sync and clock signals from them. Synchronization to a local reference frequency is also possible. The modulator can choose between two input interfaces and outputs the selected input signal (eg for monitoring). The modulator configures itself with the aid of the input data stream (transmission mode, number of programs, error protection, etc), which is checked for transmission errors upon reception. If errors are detected, the coder interrupts data conversion in order not to disturb an SFN. If required, the transmission mode can be set locally. To ensure unimpaired operation of an SFN, a digital delay line (up to 0.5 s) compensates for the signal delays occurring on the transmission links. To measure bit error rate, a channel can be replaced by random data which are either generated internally or applied from the outside. A complex

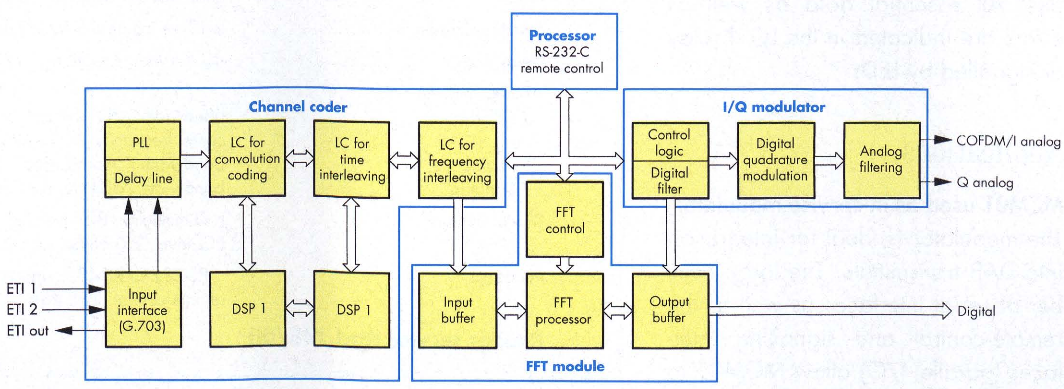


FIG 3 Block diagram of COFDM Modulator MCM01

circuit made up of digital signal processors and programmable logic ICs performs error-protection coding, interleaving in the time and frequency domain and offers sufficient flexibility to comply with possible changes of the DAB standard later on.

The computed spectral data are routed to the **FFT module** where the DAB time signal is calculated with the aid of a special processor. After generation of the guard interval, an MPX signal comprising inphase and quadrature data is formed. Signal peaks as may occur with the DAB signal are limited to a specific value. The MPX signal is output with ECL level at two digital output interfaces. This makes MCM01 compatible with the quadrature modulators used in the field trials.

The third plug-in, the **I/Q modulator,** limits the DAB spectrum with the aid of a digital filter and multiplies the sampling rate by four (oversampling). After digital quadrature modulation the DAB signal is output at a center frequency of 2.048 MHz via a precision 12-bit D/A converter and an analog aliasing filter. Alternatively, the analog quadrature signals can be output.

A **processor** handles communication with external devices and serves for remote control of MCM01. MCM01 is provided with four serial, one remote-control and one signalling interface. Another serial interface on the back panel allows the control software to be replaced without exchanging EPROMs. The other modules are menu-controlled via an internal serial bus. All essential data as well as errors are indicated in the LC display or signalled by LEDs.

Applications

MCM01 used as in-service modulator
The modulator is ideal for integration into DAB transmitters. The large number of serial interfaces as well as the remote-control and signalling interfaces (parallel I/O) allow MCM01 to be remotely controlled and the modulator to be integrated into a transmitter control loop.

MCM01 in SFNs or local DAB transmitters
Thanks to the built-in delay-compensation line, which is adjustable via the keyboard, operation of the COFDM modulator in a single-frequency network is particularly simple. Considering that the transmission mode of MCM01 can also be selected locally, operation in a local DAB transmitter, for instance with an MPX signal of modified program content, is also possible.

MCM01 as COFDM test generator
MCM01 may be operated with or without input signal (in the latter case in a fixed configuration, third-generation DAB). Here a freely selectable subchannel may be filled with random data. This makes MCM01 also suitable for use in laboratories or in receiver development and production. The capability to output the COFDM signal as a digital or analog baseband signal or in the form of a complete quadrature-modulated DAB signal enhances the flexibility of MCM01 for test-generator applications.

Cornelius Heinemann

Condensed data of COFDM Modulator MCM01

Modulation	COFDM to ETS 300 401
Number of carriers	1536 (mode I) 384 (mode II) 192 (mode III)
Input	ensemble transport interface, BNC, 75 Ω
Synchronization	to ETI or external 5-MHz reference frequency
Delay line	<0.5 s with resolution of 1/2.048 MHz
Analog outputs	
COFDM	bandwidth 1.537 MHz, center frequency 2.048 MHz, BNC, 50 Ω
I analog	bandwidth 768 kHz, BNC, 50 Ω
Q analog	bandwidth 768 kHz, BNC, 50 Ω
Digital outputs	I/Q multiplex, 8-bit parallel, 4.096 Msps/s, ECL level, 25-contact submin D
Interfaces	5 RS-232-C/RS-485, signalling, remote control, IEEE 488 (in preparation)

Reader service card 148/08

REFERENCES

[1] Mayr, J.: DSR and DAB – digital sound broadcasting today and tomorrow. News from Rohde & Schwarz (1994) No. 145, pp 44–45

[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] Le Floch, B.; Halber-Lasalle, R.; Castelain, D.: Digital sound broadcasting to mobile receivers. IEEE Transactions on Consumer Electronics, Vol. 35, No. 3, 8/89

250-W Solid-State DAB Transmitter SM225D1

Terrestrial sound transmitter for digital audio broadcasting

With the development of the Solid-State DAB Transmitter SM225D1 Rohde & Schwarz has stepped into a new era of terrestrial broadcasting. While previous sound broadcast transmitters used analog modulation modes AM and FM, the new transmitter generation transmits a multicarrier signal according to the digital COFDM modulation method.

The transmission quality of an analog FM transmission link AF → frequency modulation → transmitter → receiver → AF cannot be significantly improved because of the technical principle involved. Mobile reception in particular often falls short of expectations. Along with the enormous advance of digital technology, the digital modulation method COFDM (coded orthogonal frequency division multiplex) was developed as part of the EUREKA project 147 for digital audio broadcasting (DAB). The new modulation method allows undisturbed stationary and mobile reception of audio programs in CD quality. Signals from several audio sources are coded individually with the aid of the MUSICAM Codec MUSIC [1], compressed and applied to a multiplexer, where they are converted into a serial data stream with a maximum data rate of 2 Mbit/s. COFDM Modulator MCM01 [2] distributes the QPSK-modulated data stream to multiple carriers which are broadcast by a transmitter after mixing to the RF. Transmission of data on multiple carriers and the added error-correction code make the signal extremely insensitive to interference in terrestrial transmission channels. Contrary to FM, where the carrier has to be present on reception, with DAB the carrier may be incomplete or disturbed without any loss in broadcast quality.

DAB transmitter network

In the case of FM-modulated signals, a separate transmitter operating on a specific frequency has to be installed for each audio source to make sure that programs are broadcast to all listeners in a specific coverage area. This may lead to overcrowded frequency bands in densely populated urban areas. The problem can be overcome by using a DAB system where several programs can be broadcast with the aid of a single DAB transmitter. This advantage may be utilized for the whole coverage area if, in addition to using the same transmission frequency, all transmitters are modulated with the same data stream from one multiplexer (single-frequency network). In a DAB network the data stream is transmitted from the multiplexer to each transmitter site via satellite or cable. Different signal delays on these links are compensated for by the COFDM coder of the transmitter.

Considerably less energy is required for operating a DAB transmitter network than for present FM networks. On the one hand this is due to the fact that only one transmitter is required for broadcasting several programs, and on the other to the reduced output power required to broadcast COFDM-modulated signals. With this modulation method the DAB transmitter can be operated with a considerably lower S/N ratio than a comparable FM transmitter.

Requirements of DAB signal on transmitter amplifier

The DAB signal at the output of the COFDM coder in transmission mode I consists of 1536 carriers spaced by 1 kHz, which are all QPSK-modulated (FIG 1). Viewed on an oscilloscope, the DAB signal is similar to a noise signal and has very high amplitude peaks formed by addition of the individual carriers. The ratio of peak to thermal power of the DAB signal (crest factor) is 8 to 10 dB. The transmit amplifier must be able to transmit this peak power and feature high linearity in the entire modulation range, otherwise intermodulation products may occur within and outside the DAB signal. Within the signal, such products degrade S/N ratio and outside the signal they cause interference to other services. To meet all requirements, Rohde & Schwarz uses a fully transistorized power amplifier, like the ones used in high-power TV transmitters, which features high sync peak power and excellent linearity.

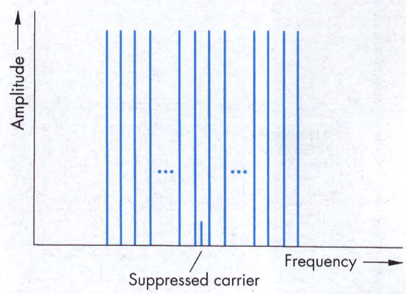


FIG 1 DAB signal: 1536 carriers at interval of 1 kHz

DAB transmitters

In some countries DAB pilot projects are already under way. The responsible institutions chose the TV channel 12 at 223 to 230 MHz (235 MHz) and the L band at 1452 to 1492 MHz for these projects. Rohde & Schwarz offers the necessary transmitters. The

250-W DAB Transmitter SM225D1 (FIG 2) was designed for operation in channel 12. Its **main features** are:

- broadband, highly linear and redundant, transistorized power amplifier,
- exciter with built-in linearity correction,
- testpoints and loopthroughs on front panel,
- built-in fan,
- cooling-air intake from transmitter room and directed air cooling possible,
- primary switched power supply without power transformer,
- COFDM coder and satellite receiving units can be integrated,
- input for synchronization to external frequency,
- GPS frequency standard (optional),
- remote-control interface.

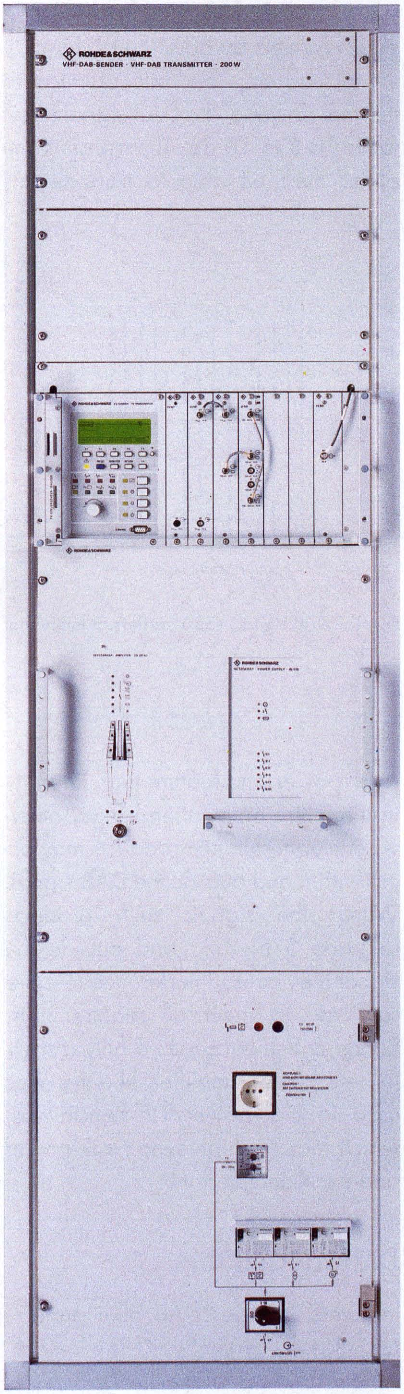


FIG 2 250-W DAB Transmitter SM225D1 generates multicarrier signal for broadcasting COFDM-modulated program signal
Photo 41 844

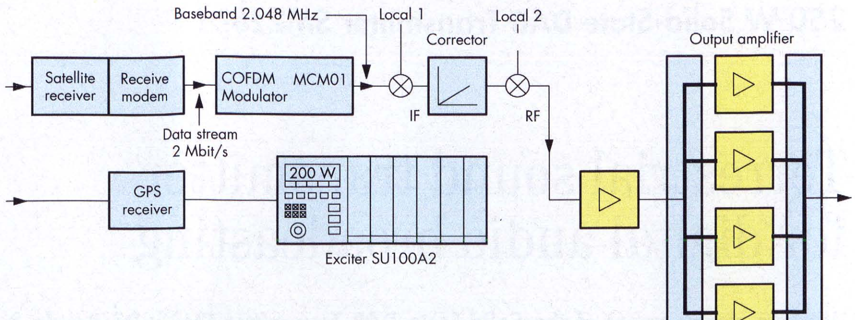


FIG 3 Block diagram of DAB Transmitter SM225D1

Configuration and operation of Transmitter SM225D1

DAB Transmitter SM225D1 consists of the cabinet rack with fan, power distribution panel, power supply, amplifier, exciter and the optional units COFDM coder, satellite receiver and GPS frequency standard (FIG 3). Power supply and amplifier are fitted with self-engaging connectors, while the exciter can be withdrawn on telescopic rails. The remote-control interface is incorporated in the top cover. The fan cools both the power supply and the amplifier and can take in air from the room or from an air duct. A small-size coarse filter is sufficient for air filtering. With the given transmitter concept there is space provided for a further amplifier to double output power. With the exception of the output power, the RF signal paths are looped through on the front panel. Testpoints are provided at the main interfaces. For compliance with the spectrum mask of the radiated signal, a bandpass filter is installed outside the transmitter rack.

When the transmitter is fitted with all plug-ins, the modulation signal from the satellite antenna is routed to the satellite receiving unit in the transmitter, where a modem demodulates the received signal into a data stream comprising the digital data from the audio sources. The data stream is QPSK-modulated onto 1536 carriers with the aid of COFDM Modulator MCM01. Exciter SU100A2 converts the signal to RF and is virtually identical with the input stage of Rohde & Schwarz TV transmitters. The two mixers convert the signal to the 38.9-MHz IF and then to an RF of 223 to 230 MHz. The frequency of the local oscillators can be adjusted from the front panel to obtain a 25-Hz step variation for the output frequency. Via the reference-frequency input (10 MHz) the oscillators are locked to the frequency of the GPS receiving unit. In addition to the control stages for matching to subsequent amplifiers, the IF section contains a corrector for further improving output-amplifier linearity in amplitude and phase. All settings can be made from the front panel with the aid of menus. The output power of the exciter is controlled via a directional coupler.

The fully transistorized output amplifier consists of four power stages connected in parallel and combined via a coupler. The amplifier has a protection facility consisting of a reflection, input power and temperature circuit. A special feature is the patented power level control which prevents the other stages from being overdriven if one of the four stages fails. A new type of fine-finned aluminium heatsink produced by Rohde & Schwarz is provided for cooling. The operating voltages come from a primary switched power supply.

All relevant operating parameters are displayed on the transmitter control unit integrated in the exciter. The built-in microprocessor and all settings such as on/off, frequency, output power, linearity correction, etc are controlled by means of softkeys. The remote-control interface provides floating status signals.

Rainer Steen

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] Heinemann, C.: COFDM Modulator MCM01 – Channel coding and modulation for digital audio broadcasting. In this issue, pp 26–28

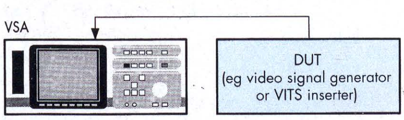
Condensed data of 250-W Solid-State DAB Transmitter SM225D1

Frequency range	223 to 230 (235) MHz
Frequency accuracy with GPS unit	1×10^{-9}
Output power	250 W (SM225D1)/500 W (SM525D1)
Intermodulation products $f_0 > \pm 977$ kHz	35 dB (with output bandpass filter compliance with spectrum mask)
Power supply	3 x 400 V ±15%
Power consumption	approx. 2.5/5 kW
Cooling-air flow	approx. 7/13 m^3/min
Dimensions (W x H x D)	583 mm x 1000 mm x 2026 mm
Weight	approx. 250 kg

Reader service card 148/09

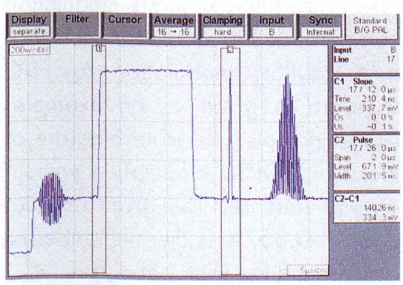
Simple video measurements through cursor functions

A special feature of the versatile **Video Measurement System VSA** is cursor measurements in the scope mode. The three-channel oscilloscope of VSA puts an end to the widespread belief that a cursor is a vertical line in a display just good enough for simple level measurements. With each



of the two cursors, VSA also permits peak values, pulses and video signal edges to be analyzed in any channel automatically in addition to level measurements. This is possible because the cursor line has been expanded to a general-purpose cursor window of variable width (up to 10 µs) and measurement functions (level, peak, pulse, slope) can be selected. For instance, the peak cursor automatically computes the peak values (positive, negative and peak-to-peak) of any signal section within the cursor window.

As an example from the great variety of possible measurements, here is explanation of how to determine the timing of a 2T pulse relative to the rising edge of the luminance bar in testline CCIR 17. With a conventional oscilloscope accurate results can be obtained only after elaborate settings. On VSA the video testline CCIR 17 is displayed in the waveform window (see FIG below). The 2T pulse in the right half of the window is covered by the 2-µs wide cursor window 2, for which the pulse function is selected. In addition to the pulse parameters level and width, the timing of the pulse center (average of the two pulse edges) is determined and



displayed as the time difference to the measured value of cursor 1. The 1-µs wide cursor 1 serves as a slope cursor and is centered on the rising edge of the luminance bar. The slope cursor calculates the 50% level, the rise time as well as over- and undershoots of the luminance bar edge, and in addition determines the exact time of the 50% level of the edge as a reference for the time difference C2 – C1. The measured time difference (14026 ns) shows the exact position of the 2T pulse referred to the rising edge of the luminance bar.

Thanks to the clear and simple control capabilities of VSA, even elaborate settings as required for the measurement of interchannel delay arising from the time shift of analog component signals can be carried out quickly and easily.

Thomas Bichlmaier

Reader service card 148/02 for further information on VSA

Simulating vector errors with Signal Generator SME

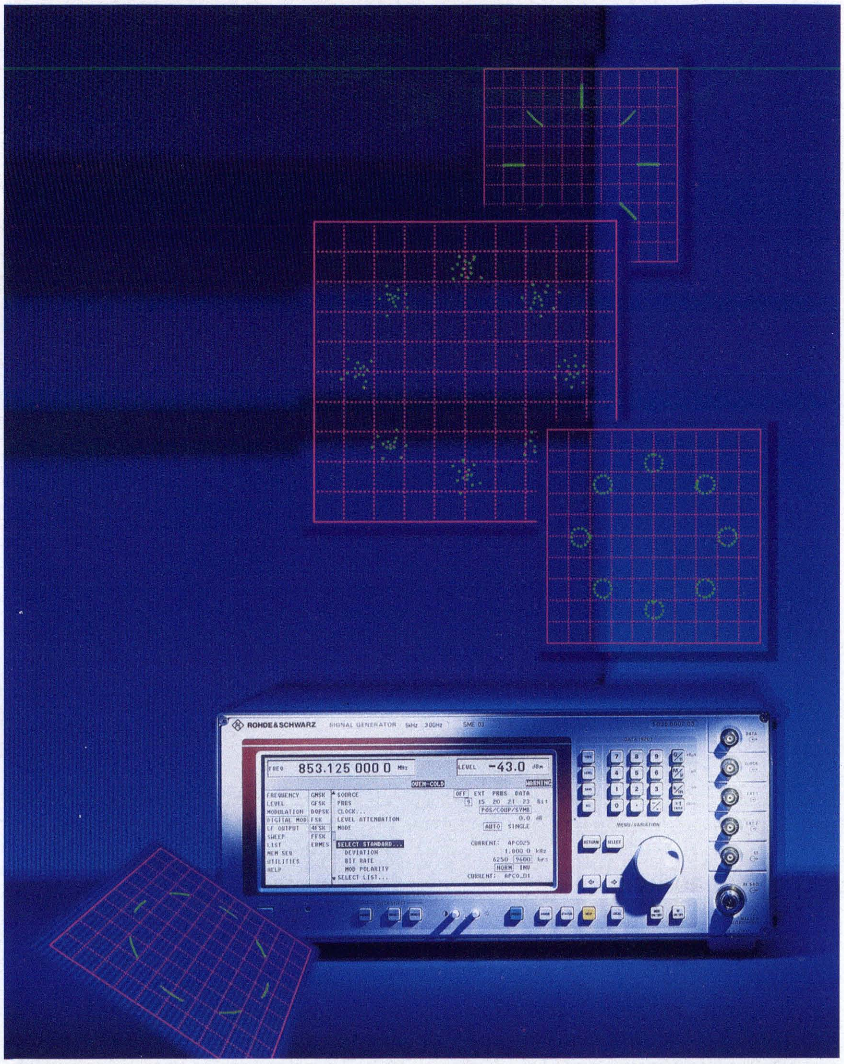


FIG 1 Signal Generator SME supplies all signals for testing digital mobile-radio receivers

To ensure proper operation of transmitters and receivers of different modes in a communication network, there are prescribed limit values for the permissible modulation error. Manufacturers can take this into consideration and test their receivers accordingly. In contrast to analog systems, the change from good to poor reception is quite abrupt for digital systems.

Measuring instruments fulfill these error limit requirements with a large margin. To be able to test receivers for the permissible error limits, the modulation error has to be simulated. Signal Generator SME (FIG 1) is the ideal measuring instrument for this task [1;2] since spurious modulation can be added to wanted modulation. $\pi/4$ DQPSK modulation to PDC standard is given as an example: FIG 2 indicates the state diagram of the $\pi/4$ DQPSK modulation without any interference. The given residual error of 0.857% is the inherent error of SME and the vector analyzer.

FIG 3 illustrates the different types of error simulation. The top left state diagram shows the effect of a spurious carrier. SME can simulate this carrier by simultaneous AM and FM. In the example, SME is at the same time amplitude- and frequency-modulated with a 3.4-kHz tone. The modulation index is set to 0.125 for the two types of modulation, resulting in a vector error of 12.5%. This type of spurious modulation produces a constant and reproducible vector error. The error has the same magnitude at each sampling point as shown by the circles in the figure. In the top right diagram, noise rather than a sinewave tone is modulated. The vector error is now randomly distributed at the sampling points. The bottom diagrams show the effect of spurious modulation that has been produced either with AM or FM. The spurious simulation with only AM or FM is useful if the susceptibility to interference of a receiver or demodulator has to be accurately determined or if, in case of GSM, phase error alone has to be simulated.

The simulation of a spurious carrier is also used to reduce the time for BER (bit error rate) measurements. With

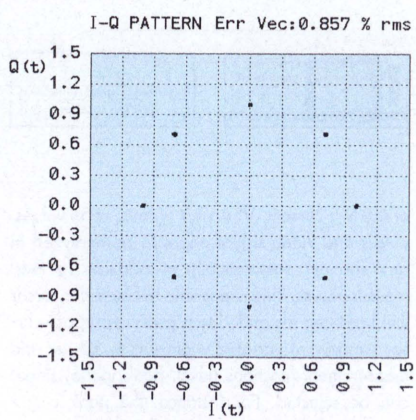


FIG 2 $\pi/4$ DQPSK state diagram without spurious modulation

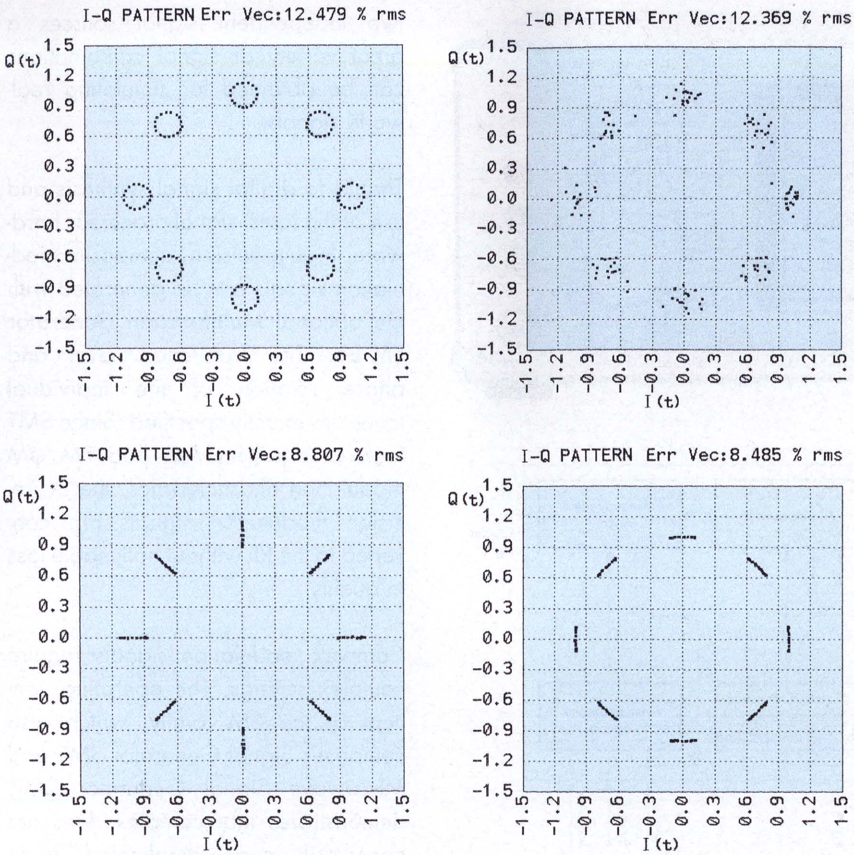


FIG 3 π/4 DQPSK state diagrams with spurious modulation. Top left: simultaneous AM and FM with 3.4-kHz tone; top right: simultaneous AM and FM with noise; bottom: only AM or FM spurious modulation

good BER values (10^{-12}) as required for data transmission, the measurement normally takes a very long time. In the presence of an interfering source, the decision margin is reduced by a known value, as can be seen in the top left diagram. The increased BER value can thus be measured easily and the true BER value calculated. This saves an enormous amount of time: BER measurements which normally last days can be performed within minutes.

These are just a few examples from the wide range of applications offered by SME. Nonetheless they again prove that SME is able to perform complex measuring tasks without additional measuring instruments thanks to the free combination of modulation types and the large number of available options. Until now, a second signal generator and a noise generator were necessary for the measurements mentioned above. SME requires simply the following options: FM/φM Modulator SM-B5, LF Generator SM-B2 or Multifunction Generator SM-B6 and DM Coder SME-B11.

Johann Klier

REFERENCES

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

[2] Klier; J.: Extensions to Signal Generator SME for testing new digital networks. News from Rohde & Schwarz (1994) No. 146, pp 40–41

Reader service card 148/10

Stereo, VOR, ILS – generating complex modulation signals with Signal Generator SMT

Up to a few years ago the performance of signal generators was limited to one main task, generating RF signals of clearly defined level and frequency suitable for modulation. Normally, only fixed frequencies (400 Hz and 1 kHz) were available as internal modulation signals or the modulation signal was derived from tunable – in most cases optional – internal LF sources. Special modulation signals for testing complex DUTs had to be provided by the user, the signal generator only produced the RF signal to be modulated. In the meantime the situation has changed considerably. Modern signal generators are also able to generate complex modulation signals. They offer the functions of several signal sources at an extremely attractive price. Signal Generator SMT is a typical example of this new class of instrument. The basic unit is the platform that can be upgraded as required by means of a wide range of options [1]. The user only pays for the function he really needs for his application and his budget is not burdened with characteristics that are of no use to him. In the SMT three optional modulation-signal sources (FIG 1) are

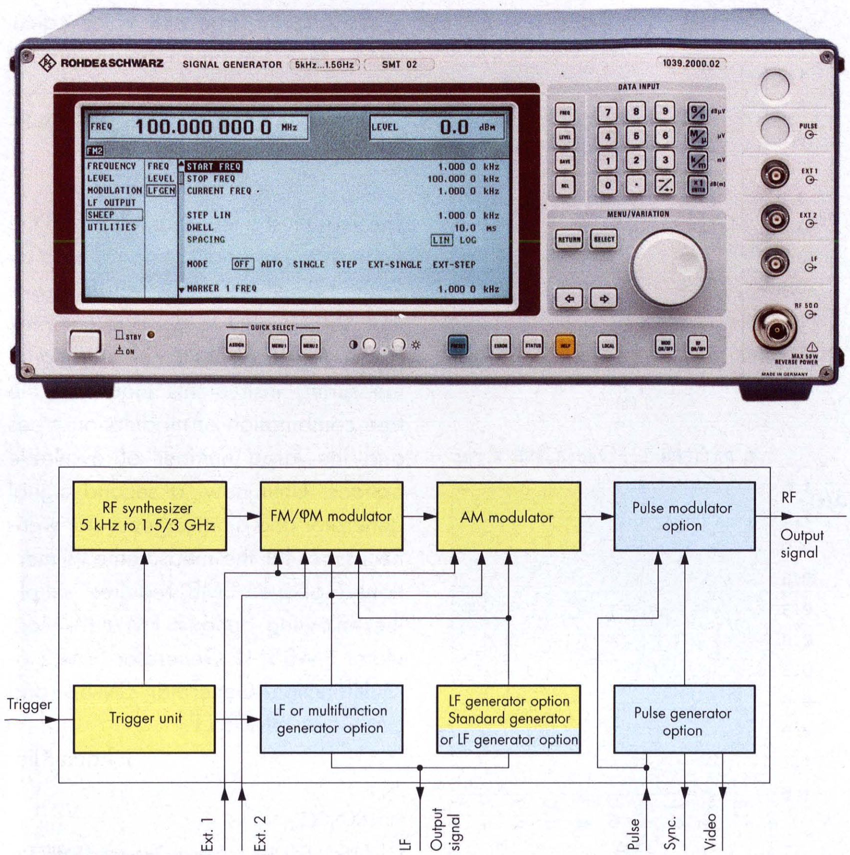


FIG 1 Signal Generator SMT for 5 kHz to 1.5 GHz (model 02) or 3 GHz (model 03) is of modular design (options are blue)
Photo 41 118/2

available in addition to the four fixed frequencies provided as standard: a pulse generator (SM-B4), an LF generator (SM-B2) and a multifunction generator (SM-B6).

The adjustable pulse width, delay and repetition frequency of **Pulse Generator SM-B4,** and the single and double pulses of variable spacing make SMT independent of external pulse sources. Together with the excellent characteristics of the pulse modulator option, SMT becomes the ideal signal source for testing radar receivers.

With the **LF Generator SM-B2,** which can be fitted in addition to the fixed-frequency LF generator, a second favourably priced, internal signal source is available for AM, FM or φM. Besides crystal-accurate sinewave signals up to 500 kHz, the digital signal synthesis of the LF generator permits accurately defined squarewave, triangular and noise signals to be generated. Option SM-B2 may be used twice or in parallel with the multifunction generator option so that two independent, tunable modulation-signal sources are available. Through the simultaneous generation of AM, FM/φM and pulse-modulation signals with the aid of two independent signal sources a great variety of signal combinations can be obtained for simulating real-world signals.

Thanks to digital signal synthesis and use of the latest signal-processor hardware, high-precision, composite modulation signals can be generated with the optional **Multifunction Generator SM-B6.** The frequency, level and phase relation of the individual tones are exactly specified. Since SMT features excellent AM and FM/φM modulation characteristics, these precision modulation signals are converted to the RF without noticeable loss in quality.

Complex modulation signals require complex settings. The operating concept of the SM family, which also comprises Signal Generator SME and Microwave Signal Generator SMP, demonstrates that complex does not necessarily mean complicated [2]. In spite of the great variety of parameters used, SMT features a clear display and a user-friendly operating concept, so working with it is no problem even for untrained users.

Generating stereo signals

Excellent modulation characteristics and the accurate digital synthesis of the multifunction generator make SMT an ideal instrument for generating high-quality stereo signals in the range from 88 to 108 MHz. The flat amplitude-frequency response and high phase linearity of modulation-signal

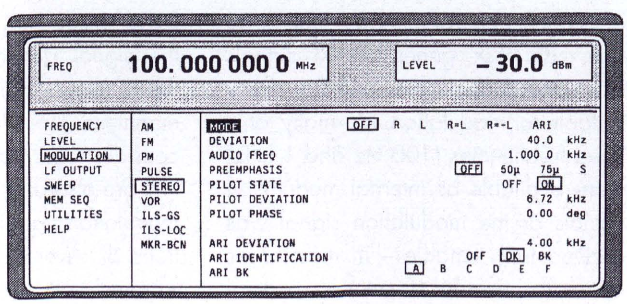


FIG 2 Stereo menu of Signal Generator SMT with multifunction generator option

source and frequency modulator provide a stereo-channel separation of >60 dB for the modulation signal and of >50 dB for the RF signal. Excellent spurious suppression of >76 dB and distortion below 0.1% make SMT a high-quality signal source.

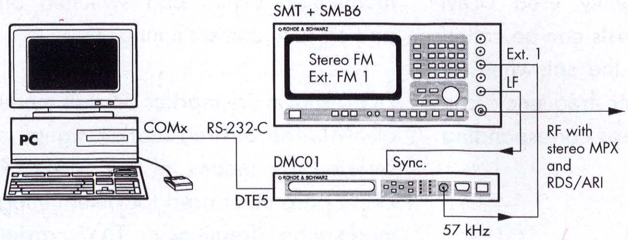


FIG 3 Generating RDS test signals with Signal Generator SMT and Radio Data Codec DMC01

With the aid of the multifunction generator option a complete test of stereo receivers can be performed (FIG 2). For measuring channel separation, an audio signal is sent to the receiver in one of the two channels (L or R mode), while in the other the crosstalk is measured as a function of the audio frequency. The frequency response or distortion of the receiver can be determined in the L=R mode, where identical sinewave signals are transmitted in the two stereo channels. With the aid of the LF sweep function of SMT, the audio signal can be swept in all the above-mentioned modes in the specified range 0.1 Hz to 15 kHz with any step width and sweep time so that measurements can be carried out fully automatically and in a minimum of time. In the ARI mode (automatic road-user information) the function of the traffic announcement decoder of a car radio can be tested. Area and traffic announcement identification can be switched over or on and off. The stereo MPX signal or the 19-kHz pilot tone for baseband applications is available at the LF output.

For testing receivers with RDS by means of SMT, the output signal of the Radio Data Codec DMC01 [3] is integrated in the internally generated stereo MPX signal (FIG 3). The 19-kHz pilot tone from SMT synchronizes the RDS signal. Programming and control of DMC01 are carried out in a PC program.

Generating air-navigation signals

The low amplitude and phase response of the AM modulator in SMT is the basis for the accuracy of the generated VOR and ILS signals (VOR = VHF omnidirectional radio range, ILS = instrument landing system). The excellent quality and longterm stability of the modulation signals generated by means of the multifunction generator option ensure the high reliability required for testing VOR/ILS receivers. Function tests are in line with ARINC 578 and 579 and extremely easy thanks to the internally stored, standard VOR/ILS settings. All major VOR and ILS parameters are clearly displayed on the large LCD.

VOR parameters can be varied accurately and with high resolution in the VOR menu of SMT (FIG 4). The bearing angle can be set continuously between 0 and 360° with resolution of 0.01°. For checking the alarm function of a VOR receiver, individual VOR signal components can be suppressed in the VAR, SUBCARRIER and SUBC+FM modes, which are available in addition to the standard NORM mode setting. With the aid of the „VOR default setting" function, the standard setup can be called up by a keystroke.

The VOR transmission frequency can be varied either according to the standardized VOR channel pattern or with programmable step width. For generating a VOR station identification code, an LF signal of variable frequency can be superimposed on the VOR modulation signal and switched on and off with correct timing with the aid of the memory sequence function using Morse code. A noise signal may be superimposed in addition to the VOR signal for simulating receiver faults. The VOR modulation signal is available at the LF output of SMT as a test signal for the receiver modules.

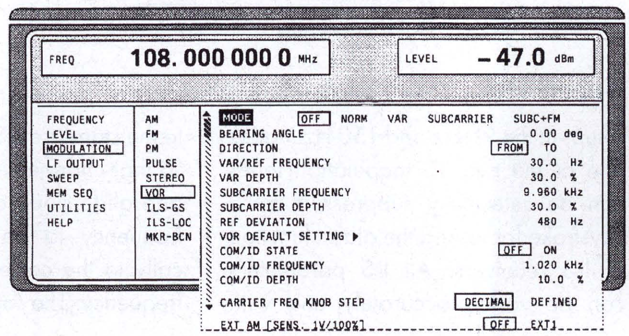


FIG 4 VOR menu (standard setting)

Information on the deviation of an aircraft from its ideal landing course is obtained in the **ILS receiver** by evaluating the difference in modulation depth of the 90-Hz and the 150-Hz modulation signals of the localizer or glide-slope signal. Thanks to the highly accurate digital signal synthesis of the SMT multifunction generator, the difference in modulation depth of the two modulation signals can be determined with resolution of 0.01%.

ILS localizer and glide-slope signals differ in their RF transmission frequency range and the nominal modulation depth of the two modulation tones. For this reason two ILS menus are provided in SMT: ILS-GS for simulating the glide-slope signal and ILS-LOC simulating the localizer course (FIG 5). The main difference between the two menus are the modulation-depth default values. Each menu offers three ILS modes: NORM, 90 Hz and 150 Hz. NORM corresponds to the standard setup; in the 90-Hz and 150-Hz modes one of the two ILS modulation tones can be selectively suppressed by a keystroke for testing the alarm function of ILS receivers. All ILS parameters can be varied accurately and with high resolution. The DDM value (difference in depth of modulation) can be entered as a decimal number, as a (standardized) value of the current of the ILS receiver's indicator or as a logarithmic modulation-depth ratio of the 90-Hz and 150-Hz signals in dB. The DDM value is calculated as follows:

DDM = [AM(90 Hz) – AM(150 Hz)] / 100%

In addition to varying the numerical DDM value, frequently used DDM values for receiver tests can be called up with the aid of the spinwheel of SMT. The RF carrier frequency can also be varied in steps corresponding to the standard ILS carrier frequencies, so that changeover between localizer and glide-slope operation causes the frequency to be adapted automatically to the corresponding RF carrier frequency. The "sum of depth" parameter allows the arithmetic sum of the modulation depths of the two modulation tones to be varied without the DDM value being affected. For more detailed tests an external noise signal may be superimposed onto the ILS modulation signal. The "default setting" function permits standard ILS values to be set by a keystroke. Just as in VOR mode, the RF signal and modulation signal are available in parallel. For simulation of a runway identification, an LF signal of variable frequency may be superimposed onto the ILS modulation signal and switched on and off with correct timing.

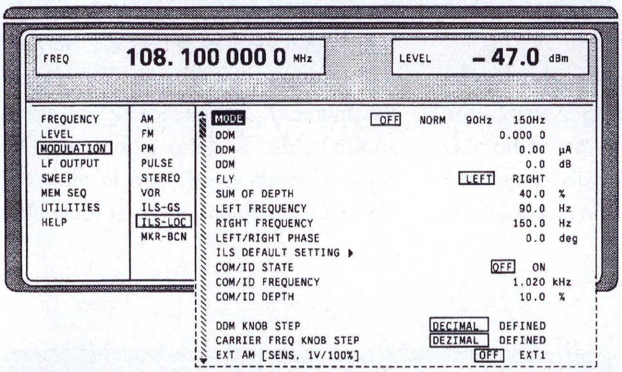


FIG 5
ILS glide-slope menu

FIG 6 shows the **marker beacon menu** of SMT. The desired marker signal is selected by means of the MARKER FREQ parameter used for determining modulation frequency. The carrier frequency of the marker beacon can be varied in accordance with the standard frequency spacing with the aid of the spinwheel in the same simple way as in the ILS menu.

Hans-Günter Titze

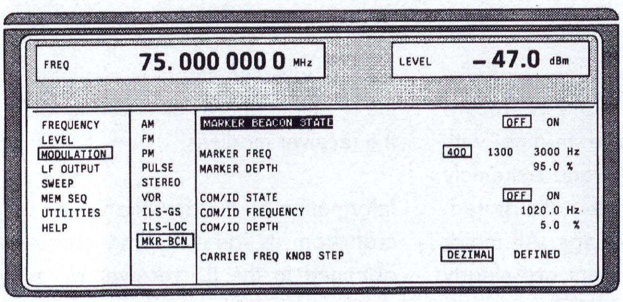


FIG 6
Marker beacon menu

REFERENCES

[1] Lüttich, F.; Klier, J.: Signal Generator SMT – The signal source for receiver and EMS measurements up to 3 GHz. News from Rohde & Schwarz (1993) No. 142, pp 13–15

[2] Lainer, K.; Rieger, A.: Operating concept of new Rohde & Schwarz signal generators. News from Rohde & Schwarz (1993) No. 142, pp 32–33

[3] Mayr, J.: Radio Data Codec DMC01 – The allrounder for new RDS and RDBS applications. News from Rohde & Schwarz (1993) No. 142, pp 16–18

Reader service card 148/11

New test receiver models for present-day and future transmission methods

With Test Receivers ESVB12 and ESVN40 (FIG 1), Rohde & Schwarz has extended the existing range of models [1 to 3] by two new versions that are specially tailored to the requirements of modern digital transmission.

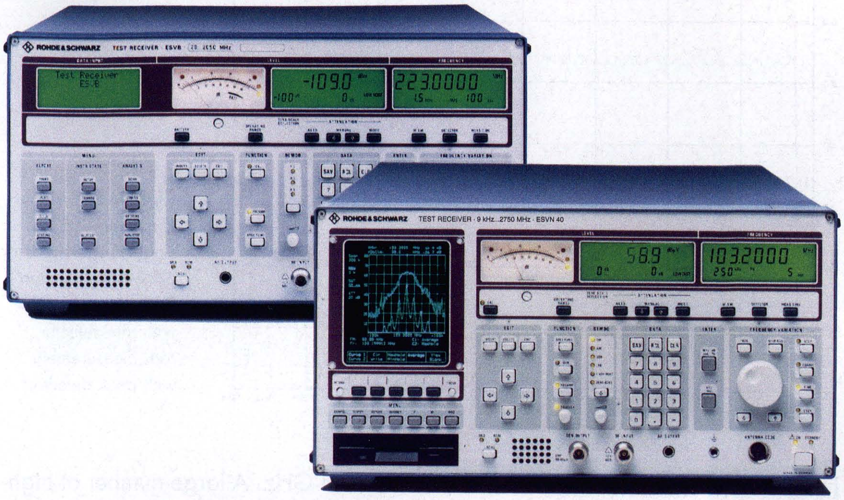


FIG 1 Test Receivers ESVB12 and ESVN40 - specialists for digital radio transmission

Measurements in DVB network

An important aspect of drawing up DVB (digital video broadcast) specifications is compatibility with existing systems. In satellite transmissions the available channel bandwidth is between 26 and 54 MHz, whereas in terrestrial or cable transmissions it is no more than 8 MHz, which calls for modulation methods affording high spectrum efficiency. Using a data-compression factor that was not thought possible some years ago (the MPEG-2 standard devised by ISO and IEC has been accepted as a standard worldwide for source coding), it is now possible to transmit one HDTV or two to four SDTV programs (standard definition television, corresponding to today's PAL quality) within this narrow band.

Consequently there are stringent demands on the amplitude and phase linearity of the system components. This is contrasted by the requirement of effectively utilizing the available channels through adjacent-channel occupancy. **Test Receiver ESVB12** meets the high measuring requirements, incorporating a special 8-MHz IF filter with an excellent shape factor (typ. 1:1.8). The latter allows even the guard bands between the digital and the analog TV signal to be measured when taboo channels are occupied.

When the system parameters for analog FM radio and conventional vestigial-sideband AM TV broadcasting were defined, stationary reception only was considered. Modern transmission methods must however take into account mobile (portable) reception as well. The problem of multipath propagation in terrestrial transmission systems can be alleviated by using COFDM (coded orthogonal frequency-division multiplex). COFDM also affords higher frequency economy through common-frequency operation. The COFDM signal behaves like white noise, resulting from the addition of many single carriers randomly distributed in the transmission channel. Therefore an rms meter is required for **power measurement** on a DVB signal. ESVB12 has a fast rms detector that weights the 8-MHz DVB signal correctly with a crest factor of 10 dB. FIG 2 shows the result of a measurement.

Despite the extensive topographic databases available today, **coverage measurements** have not lost in significance when it comes to assessing reception quality. As the boundary of a coverage area is approached, digital transmission methods show a certain disadvantage compared with analog systems. In an analog system, the transition from good to bad signal quality is smooth, whereas in a digital system the signal may be lost suddenly. To compensate for this, hierarchical transmission can be introduced, eg using multi-resolution QAM, where the complex values of the modulation symbols are non-uniformly distributed in the complex plane. This results in a step-by-step reduction of picture quality with deterioration of the signal quality, the process being referred to as graceful degradation. ESVB12 is ideal even for the **detection of short-term field-strength minima** in mobile applications, as it affords extremely fast level measurements and a wide dynamic range [1], characteristics that have proved their value in DAB test systems.

Apart from the **receive field strength** as the most important test parameter, **channel-impulse-response measurements** provide conclusive information on interference caused by multipath propagation. ESVB12 is ideally equipped for this type of measurement, featuring an I/Q demodulator with the I and Q outputs having a bandwidth of 4 MHz each.

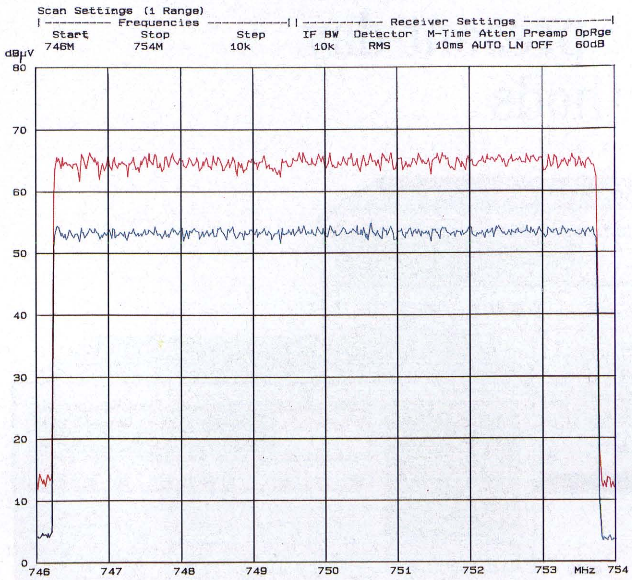


FIG 2 Spectrum of COFDM DVB signal consisting of 6785 single carriers, each 64QAM-modulated (blue: measurement with rms detector, red: measurement with peak detector)

Useful and interference signal measurements from 9 kHz to 2.75 GHz

The upward trend in wireless telecommunication observed since the mid-80s has led to the creation of numerous radio services using purely digital transmission methods. One of the resolutions passed by the World Administrative Radio Conference (WARC) in 1992 was the allocation of several subbands between 1 and 2.7 GHz in order to meet the growing frequency demands. For example, numerous bands between 1.7 and 2.7 GHz are now available for FPLMTS (future public land mobile telecommunication systems), voice and data communication via LEO (low earth orbit) satellites, and broadband data transmission via RLANs (radio local area networks).

Field-strength measurements are indispensable both at the network planning and operational stage. **Test Receiver ESVN40** comes with several options for flexible adaptation to the frequency range under examination. The range 20 to 2050 MHz, which is mostly used by state-of-the-art communication services, is already covered by the basic version of ESVN40. Option ESVN-B1 extends this range down to 9 kHz, option ESVN-B2 up to 2.75 GHz. A large number of high-grade preselection filters (13 fixed-frequency filters and five tracking filters), low-noise preamplifiers and four high-level mixers guarantee a dynamic range that satisfies even the most discerning requirements. Versatile analysis functions including frequency measurement via the air interface with a built-in high-precision reference, as well as modulation-depth, frequency- and phase-deviation measurements are specially tailored to the requirements of radiomonitoring (FIG 3).

For **radiomonitoring in computer-based systems,** up to 10,000 frequencies can be stored in the test receiver [3]. This allows measurements in various bands with different test parameters (level, modulation, frequency) to be carried out with a minimum measurement time of 400 μs per measurement (level). The results are output to the controller blockwise, continuously or upon exceeding a limit value (alert mode), which is detected by the receiver automatically.

With its two signal processors, ESVN40 is capable of performing even comprehensive **signal analysis.** Two FFT algorithms are implemented in the test receiver for measuring the occupied bandwidth and for tone decoding, for example according to the CTCSS (continuous tone-controlled squelch system) method. The latter considerably extends the range of applications offered by Radiomonitoring Software TS9965/Win [4].

Dietmar Weber

FM Broadcast Spectrum
at Munich/Germany
Antenna: 3-element Yagi
Operator: D. Weber

Modulation Meas Time: 0.500 s
Hold Time: 1.000 s

Threshold Scan result list (* = threshold exceeded):

Date: 23. Mar 95 10:40

Frequency MHz	Level dBuV/m	AM %	FM kHz	Freq offset kHz
Threshold:	40.0	10.0	40.000	0.000
89.50000	71.2*	15.7*	16.019	0.015*
90.00000	72.9*	30.0*	47.645*	0.528*
91.30000	70.5*	35.9*	31.708	0.024*
92.40000	66.9*	10.2*	26.231	-0.034*
93.70000	59.5*	98.5*	66.896*	0.027*
95.50000	62.2*	34.0*	60.452*	-0.042*
97.30000	68.4*	27.8*	54.110*	-0.176*
98.50000	70.7*	32.3*	53.492*	-0.008*
100.40000	45.5*	33.5*	32.861	0.145*
102.30000	73.8*	4.8	22.690	-0.012*
102.70000	45.0*	68.8*	71.323*	-0.038*
103.20000	65.8*	20.0*	33.726*	-0.108*
105.70000	67.6*	45.9*	51.392*	0.038*
107.70000	63.4*	52.1*	70.129*	-0.009*

Date: 23. Mar 95 10:50

Frequency MHz	Level dBuV/m	AM %	FM kHz	Freq offset kHz
Threshold:	40.0	10.0	40.000	0.000
89.50000	70.7*	9.1	48.345*	0.007*
90.00000	72.2*	21.2*	54.110*	0.515*
91.30000	70.7*	33.5*	43.774*	0.038*
92.40000	66.7*	46.4*	78.777*	-0.032*
93.70000	58.6*	35.3*	37.515	0.001*
95.50000	62.7*	36.7*	58.805*	-0.024*
97.30000	68.2*	41.3*	66.135*	-0.184*
98.50000	71.2*	48.5*	56.128*	-0.003*
99.00000	42.0*	85.6*	21.192*	0.032*
100.40000	45.6*	60.0*	26.396	0.140*
102.30000	74.9*	3.8	16.307	-0.031*
102.70000	41.3*	72.9*	62.428*	-0.053*
103.20000	65.8*	10.9*	21.249	-0.109*
105.70000	66.6*	41.7*	42.168*	0.029*
107.70000	64.5*	43.1*	58.969*	0.040*

Date: 23. Mar 95 11:00

Frequency MHz	Level dBuV/m	AM %	FM kHz	Freq offset kHz
Threshold:	40.0	10.0	40.000	0.000
89.50000	71.1*	18.0*	17.131	0.018*
90.00000	72.5*	29.1*	43.197*	0.516*
91.30000	69.8*	33.2*	49.869*	0.017*
92.40000	66.1*	11.3*	18.696	-0.049*
93.70000	56.6*	85.1*	64.995*	-0.009*
95.50000	63.0*	46.9*	60.616*	0.027*
97.30000	68.8*	47.5*	60.699*	-0.143*

FIG 3 Typical printout of automatic monitoring of level, frequency and deviation in VHF band at intervals of 10 min

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] Wolf, J.: Test Receiver ESN and ESVN – Top all-rounders for signal and EMI measurements up to 2 GHz. News from Rohde & Schwarz (1993) No. 141, pp 11–13

[3] Keller, M.: Radiomonitoring with Test Receivers ESN and ESVN. News from Rohde & Schwarz (1995) No. 147, pp 39–40

[4] Pfitzner, J.: Radiomonitoring System TS9965 – complete coverage up to 18 GHz. News from Rohde & Schwarz (1994) No. 146, pp 22–25

Reader service card 148/12

New power sensors enter booming radiocom market

The range of power sensors for Power Reflection Meter NAP, Power Meters NRVS and NRVD and Level Meter URV35 is continuously growing. Rohde & Schwarz has brought out two new power sensors (FIG 1) to meet the requirements of digital radiocommunications: NAP-Z42 for power and SWR measurements up to 2 GHz, and NRV-Z33 for measurements on mobile phones with up to 20 W transmit power and on low-power TV transmitters (for main technical data see blue box).

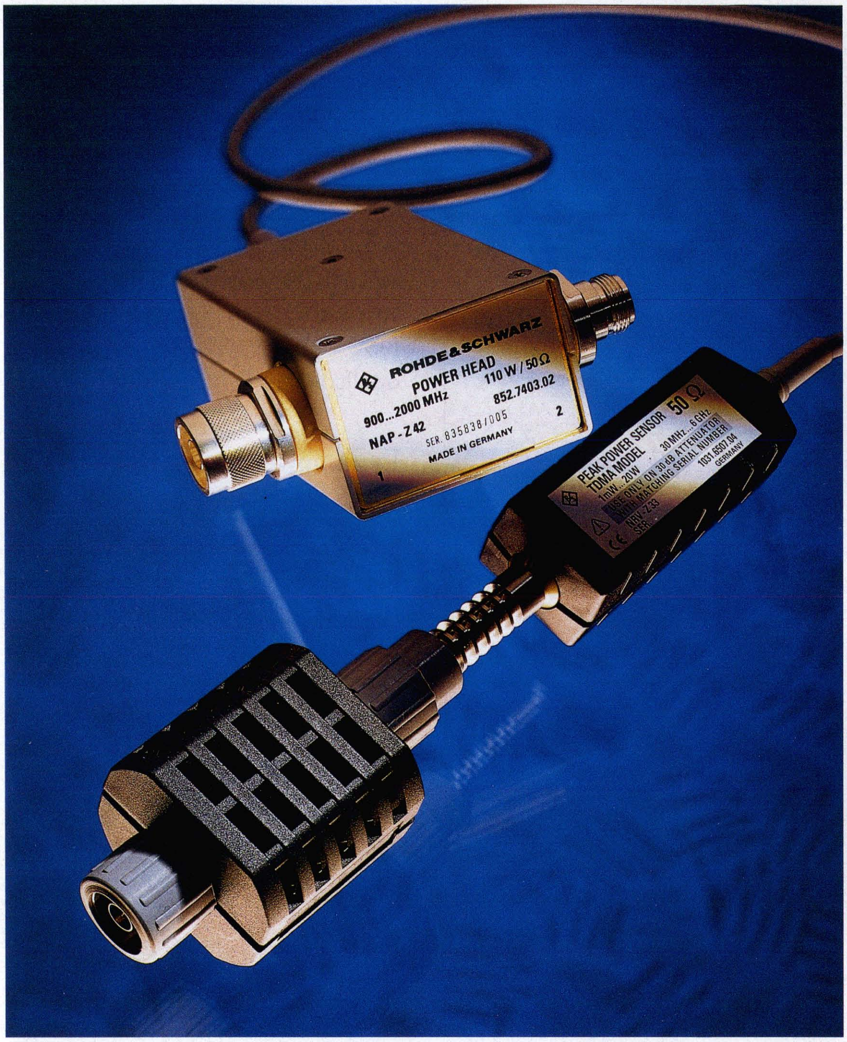


FIG 1 110-W Directional Power Sensor NAP-Z42 covering 0.9 to 2 GHz for transmitter power and SWR measurements in base stations, and 20-W Power Sensor NRV-Z33 for burst power measurements in GSM mobile radio networks and general applications up to 6 GHz. Photo 42 027

Power and reflection measurements up to 2 GHz

Power Reflection Meter NAP for in-service measurements on all types of radio and transmitting equipment has been a market success for over ten years [1]. NAP not only features high directivity for accurate SWR measurements but is outstanding for high-accuracy average power measurements on modulated signals. NAP is the only directional power meter to offer this feature and in this respect behaves like a thermocouple sensor. Power Sensor NAP-Z42 for the frequency range 0.9 to 2 GHz with nominal power of 110 W is ideal for measurements on mobile and base stations of GSM, DCS 1800/1900, PDC, PHP, MIRS (MCA) mobile radio networks, on the TFTS in-flight radio system and the Inmarsat M satellite communication system.

Many of these standards use a modulation method (eg $\pi/4$ DQPSK) that produces an envelope varying at the symbol rate, which places great demands on the test equipment [2]. NAP-Z42 is an ideal choice for such measurements, bearing in mind that other directional power meters provide accurate results only for CW signals and are thus less suitable for applications of this type.

	NRV-Z33	NAP-Z42
Measurement principle	terminating power sensor	directional power sensor
Measured quantity	PEP	average forward/ reflected power
Frequency range	30 MHz to 6 GHz	0.9 to 2.0 GHz
Power measurement range	1 mW to 20 W	50 mW to 110 W
Directivity	–	>24 dB (typ. 30 dB)
Min. pulse width	2 µs (mod. 03), 200 µs (mod. 04)	–
Min. pulse repetition rate	100 Hz/s	–
Basic units	NRVS, NRVD, URV35, URV55	NAP

The NAP measurement method also proves advantageous for modulation modes with a flat envelope (eg GMSK, FSK or analog FM). Problems similar to those encountered with modulated signals may occur in all applications in which signals from several transmitters are to be measured in a common antenna line. The envelope of the resulting sum signal is not flat but characterized by beats between the different frequencies (FIG 2). However, in this case too the user expects

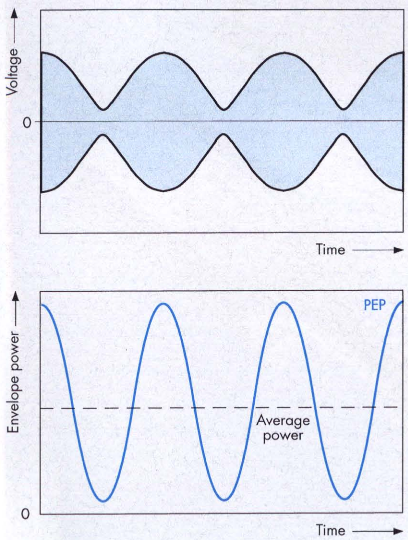


FIG 2 Superposition of two unmodulated RF carriers (power ratio 2:1); top: voltage, bottom: power

a correct indication of the result, ie of the sum of the various transmitter powers. This is guaranteed only with an instrument like NAP, which measures the average power. Using unsuitable instruments, serious errors may occur. This may be quite baffling to the user, in view of the fact that the individual powers are exactly known.

The measurement principle of NAP is implemented by means of additional circuitry for the purpose of amplifying the extremely small output voltages from rectifiers which are driven exclusively in the square-law section of their characteristic. Although the circuit design of the rectifiers does not impose any limitation on the modulation mode, Power Sensor NAP-Z42 should only be used for measuring transmitter signals of high spectral purity.

The first NAP-Z42 power sensors are already working successfully in Japan for measuring the transmit power of MCA network base stations at 1500 MHz, and they are planned for applications in the PDC network too. The development of the new power sensor was encouraged strongly by the Rohde & Schwarz partner Advantest, who can look back on very good experience with NAP-Z5 (350 W, 25 MHz to 1 GHz) in similar applications.

Peak power measurement up to 20 W

Power Sensors NRV-Z31 have been in use for two years for peak power measurements from 30 MHz to 6 GHz [2]. NRV-Z33, which comes in two models, now enables measurements at even higher power. The decisive advantage for the user is that he can measure high-power sources directly, without any attenuators or directional couplers switched in for power reduction.

The two models of NRV-Z33 differ with respect to their range of applications. Model 03 can measure the peak envelope power of signals using any type of modulation or of pulsed signals from a pulse width of 2 µs, and is therefore suitable for many applications, eg direct measurement of the sync pulse power of low-power TV transmitters. Model 04 is tailored to the requirements of GSM networks, so it is suitable for both DCS 1800 and DCS 1900. Model 04 can directly measure the burst transmit power of mobile stations in the range 1 mW to 20 W. The overshoot at the leading edge of the burst, which is allowed according to the standard (up to 4 dB), is blanked effectively. With up to seven measurements per second, NRV-Z33 is unrivalled in speed and thus superior to thermocouple sensors as regards this type of application. Thermocouple sensors do provide high measurements speeds, but not for low-frequency-modulated signals as used in GSM (217 Hz) and not over such a wide level range.

The advantages outlined above were decisive for the Finnish company Nokia, one of the world's largest manufacturers of radiocommunication equipment, in purchasing NRV-Z33. Power sensors of this type together with Power Meter NRVS are now in use on several of Nokia's production lines, ensuring fast testing of cordless telephones. The decision in favour of NRV-Z33 is remarkable not the least for the fact that these power sensors were subsequently integrated into the finished test systems of another supplier.

Further power sensors for new applications are to follow along the plug in and play principle.

Thomas Reichel

REFERENCES

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

[2] Reichel, T.: Peak Power Sensors NRV-Z, NAS-Z, NAP-Z – PEP measurements on TDMA radios, TV transmitters and lots more. News from Rohde & Schwarz (1994) No. 145, pp 14–17

Reader service card 148/13

Automatic measurements on CD players using Audio Analyzer UPD

The successful Audio Analyzer UPD is able to carry out practically all required audio measurements both on analog and digital interfaces [1]. In addition to single measurements, whole test sequences can be performed automatically with the aid of Universal Sequence Controller UPD-K1, which is available as an option, and results may be processed and printed as required by the user [2].

Specifically for testing CD players, Rohde & Schwarz offers an **application program** (application note with program floppy), which makes use of the sequence control. The program permits fully automatic measurements on all commonly used CD player interfaces of consumer sets as well as professional studio equipment (FIG). The basic model of UPD will be sufficient to carry out all measurements on analog interfaces. Normally these will cover all requirements. Although the data stream at the digital interfaces can be analyzed, it only provides information on the signal recorded on the CD which, however, is not changed by the CD player. At the digital interfaces, merely a protocol analysis of the auxiliary data transmitted in the digital data stream could prove to be of interest. This analysis can be carried out with the aid of option UPD-B2, which includes the standard interfaces AES/EBU, S/P DIF and the optical interface.

A **test CD** is used to generate test signals. Basically any test CD could be used, but in this case the CD player would be required to select the correct tracks for the measurement in question. In most cases this cannot be done automatically, as only the more expensive CD players can be remotely controlled. This disadvantage can be avoided by using Audio Test Disc UPA-CD from Rohde & Schwarz: it holds all required signals in a sequence permitting automatic measurements to be carried out. Apart from starting the CD player, no other action is required during the play of the CD. In addition to test signals for CD players, the CD from Rohde & Schwarz supplies signals and signal sequences for testing other audio components, for instance tape recorders.

The application program is **very easy to operate.** After installation on Audio Analyzer UPD – child's play with the aid of the supplied installation program – the user is prompted through the sequence by means of a few menus. He may enter the type of CD player to be tested, which will be printed later on the detailed test report. Date and time are taken automatically from the UPD system clock. Selection of an automatic test sequence or single measurements is possible.

The following **measurements** can be performed on a CD player:

- reference output voltage and channel asymmetry,
- pitch error,

Audio Analyzer UPD testing CD players (loaned by Lindberg, Munich) Photo 41 958

- signal/noise ratio,
- dynamic range,
- converter linearity,
- frequency response,
- distortion,
- phase difference,
- crosstalk,
- intermodulation distortion.

Measurements are in line with the international **standard** IEC 1096:1992 (Methods of measuring the characteristics of reproducing equipment for digital-audio compact discs) or with the European standard EN 61096:1993. This standard replaces a number of preliminary directives. Some of the measurements are now carried out in a slightly modified way. For instance, before IEC 1096 came into force, the dynamic range was weighted with an A filter, which yielded better results than the measurements to standard. To enable comparison of current measurement results with previous ones, the Rohde & Schwarz application program also includes measurement with A-weighting.

A test method for determining the behaviour of CD players in the case of defective discs is under discussion at present by the standardization committees. The effectiveness of error correction is however an essential criterion for the practical value of a CD player in everyday use, particularly when damaged or dirty CDs are played. For this reason the application program also offers a way of measuring the tracking error. In this case special test CDs are used which simulate surface defects and defects of the information layer.

During the measurement, results are continually displayed on the monitor. Afterwards the results can be documented in various ways, from storing values for subsequent processing to printing complete test reports with numeric or graphic representation of results.

All measurements are described in detail in the extensive application note where, in addition to theory on CD technology, typical results obtained in practice can be found.

Klaus Schiffner

REFERENCES

[1] Kernchen, W.: Audio Analyzer UPD generates and measures analog and digital audio signals. News from Rohde & Schwarz (1992) No. 139, pp 13–15

[2] Hempel, J.: Automatic audio measurements with user-friendly control system of Audio Analyzer UPD. News from Rohde & Schwarz (1993) No. 143, pp 29–30

Reader service card 148/14

Video Generators SAF/SFF always up to date with new software

Video Generators SAF and SFF (FIG 1) have been on the market for about three years and have meanwhile become well-known and valued as general-purpose signal sources for TV measurements [1]. They provide all the test signals and functions for analog video measurement in composite and component form. Thanks to the optional Digital Video Interface to CCIR 601/656, they are also suitable for digital component signals [2]. A new software version (V3.02) is now provided to make operation easier, beside offering new functions and signals.

Operation is now possible in either German or English. And for all those who do not want to make use of the full range of signals provided, unnecessary test signals can be deleted from the list. Thus a clear display is obtained which shows only signals required for testing. Switching back from the short menu to the complete menu is of course possible any time. Functions that are often needed can be assigned to four hotkeys. From the status menu it is possible to go back to the required function by hitting a single key. These aids are listed in the menu options of the setup menu (FIG 2).

New functions in the phase/time menu allow new applications: to test the lock-in range of colour-subcarrier PLLs, the colour-subcarrier frequency can now be changed. The error from the relevant standard frequency is displayed. Thanks to the extended phase/time menu the user can now vary sync and burst parameters like position, width and risetime in the permissible ranges. Variations of position and width are essential for testing

FIG 1 Video Generators SAF and SFF for use in TV labs and studios as well as for transmission operations Photo 40 326

clamping circuits; by altering the risetime a variation of sync and burst pulses can be simulated (FIG 3).

The **sweep-burst signal group** has been **extended** by sine signal and V-sweep signals (marker var.) as well as by the sweep + burst parameter submenu (FIG 4).

The sine signal is a full-field signal with selectable frequency in the range 0 to 6 MHz which is used for intercarrier measurements on TV transmitters for example. The V-sweep signal, a vertical sweep signal in the frequency range 0 to 6 MHz, contains fixed frequency markers at 1, 2, 4 and 6 MHz. Frequency-response errors on transmission links can be localized accurately by means of a vertically shifted marker.

The operating mode automatic (program monitoring) has been extended by the menu item program output/auto. If the sync signal is too small in this operating mode, switchover to a substitution signal is performed after a preselected time. Moreover, video monitoring can be activated, which is switched over to a substitution signal after a selectable time if the sync signal is present but there are no testlines and picture contents. This video monitoring is ideal for use on transmission links which provide a sync frame despite a program failure.

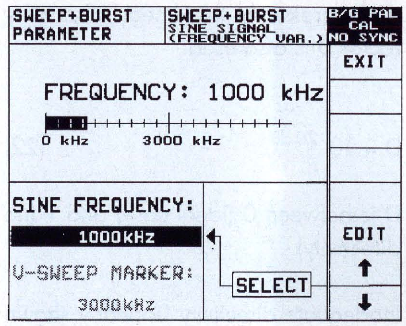


FIG 4 Menu sweep + burst parameters

A new teletext test page complying with the international standard CISPR 13 helps to immediately detect transmission errors in teletext.

Linus Obermayer

REFERENCES

[1] Mahnken, D.: SAF and SFF, the new video generators for TV measurements. News from Rohde & Schwarz (1992) No. 138, pp 14–17

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

Reader service card 148/15 for further information on SAF/SFF

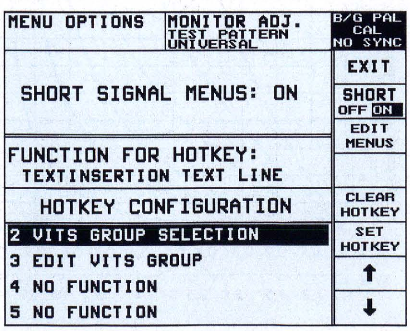


FIG 2 Menu options in setup menu

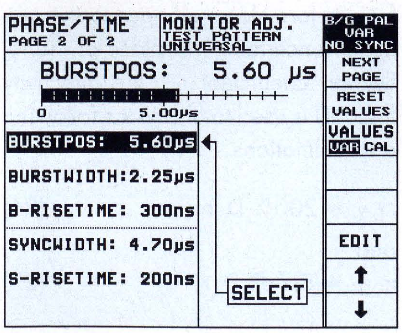


FIG 3 Menu phase/time, page 2

RF power measured the right way (VII)

3.1.3.2 Directivity

The directivity of a coupler, ie its ability to separate incident and reflected power, has a decisive influence on measurement accuracy. **Directivity a_D** is the term used to describe the level difference between indicated incident power P_i' and indicated reflected power P_r' for a reflection-free matched load (FIG 38):

$$a_D = 10\,\text{dB}\,\log\,(P_i'/P_r') \quad \text{for } r_L = 0 \qquad (21)$$

The greater the difference, the better the directivity. Standard values for directional sensors lie between 25 and 35 dB.

In addition to the logarithmic directivity expression, the linear **directivity factor D** is also used:

$$D = 10^{\frac{-a_D}{20\,\text{dB}}} \qquad (22)$$

D is between 0 (ideal case) and 1 (no directivity).

Inadequate directivity is clearly shown in the indicated reflected power P_r', but it also influences the measured incident power P_i'. Due to the unknown phase relationship between the forward and reflected wave, neither magnitude nor sign of the resulting measurement errors are predictable. There are measurement uncertainties which the manufacturer is not able to specify and which the user has to estimate.

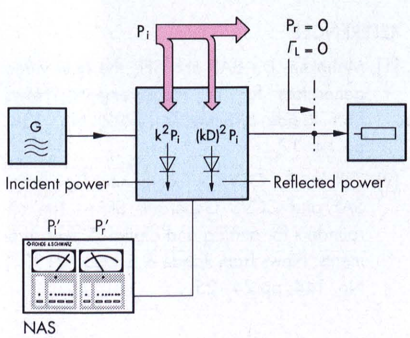


FIG 38 Measurement of directivity (k = coupling coefficient; D = directivity factor)

The measurement uncertainty for the reflection coefficient is very easy to determine. Based on the measured values P_r' and P_i', the reflection coefficient of the load is derived from the following relationship or read out directly:

$$r_L' = \sqrt{P_r'/P_i'} \qquad (23)$$

The true value may be greater or smaller by the directivity factor D:

$$r_L' - D \le r_L \le r_L' + D \quad \text{for } D \le r_L' \qquad (24)$$

$$0 \le r_L \le r_L' + D \quad \text{for } D > r_L' \qquad (25)$$

From this it follows that the matching of loads whose reflection coefficient is smaller than the directivity factor cannot be measured properly. To put it another way, the directivity should at least be as high as the expected return loss. Equations 24 and 25 only take into account the effect of the directivity on the indicated reflected power and this is sufficient in the case of a well-matched load. Generally, the effect on the indicated incident power (see further below) must also be considered. The corresponding error limits for the measured return loss are given in FIG 39.

The measurement uncertainty for the incident power (ε_D) can be derived from a formula analogous to the mismatch uncertainty. In place of the reflection coefficient r_G, the directivity factor D is used to obtain the following approximations

$$\varepsilon_{D\%} \approx 200\%\ D \cdot r_L \qquad (26)$$

and

$$\varepsilon_{D\,dB} \approx 8.7\,\text{dB}\ D \cdot r_L \qquad (27)$$

with a validity range of about 20% or 1 dB (FIG 40).

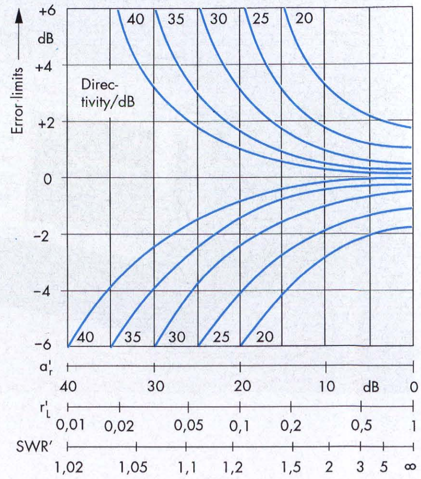


FIG 39 Error limits for return loss due to insufficient directivity; a_r', r_L', SWR' = measured return loss, reflection coefficient and SWR

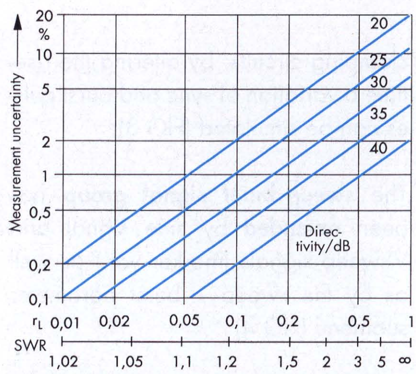


FIG 40 Maximum measurement uncertainty for incident power due to insufficient directivity

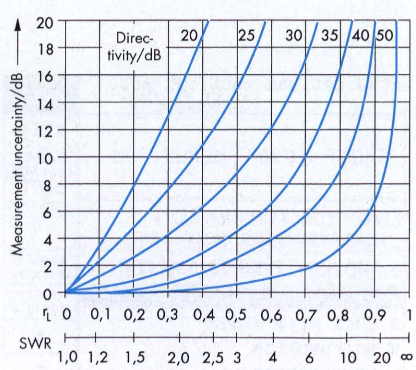


FIG 41 Maximum measurement uncertainty for absorbed power due to insufficient directivity

The relative measurement uncertainty for the absorbed power, which is calculated from the difference between indicated incident and reflected power, can be found in FIG 41.

3.1.4 Coaxial voltage probes

Coaxial voltage probes with diode rectifiers (FIG 42) may also be used for power measurements. They are available for frequencies up to about 2 GHz and a very favourably priced alternative for measuring incident power with well-matched loads or when requirements on measurement accuracy are not high. Modern probes provide all facilities of intelligent error correction. The rectifier is connected to the inner conductor either directly or via a capacitive 10 : 1 attenuator. The attenuator allows almost complete decoupling of the rectifier. Therefore, such probes exhibit excellent matching and low insertion loss over the entire useful frequency range.

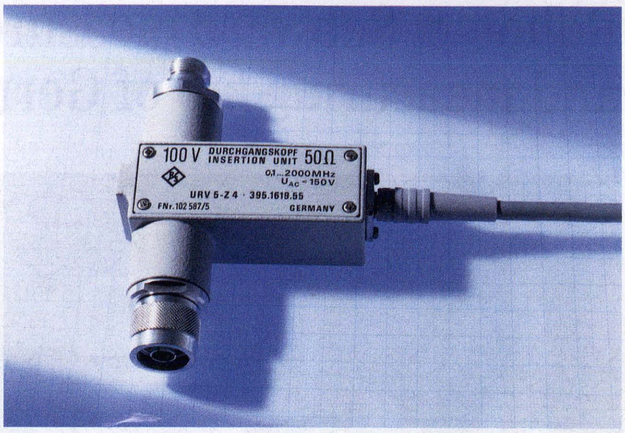


FIG 42
100-V Insertion Unit URV5-Z4 with attenuator for voltage measurements in coaxial circuits in frequency range 0.1 to 2000 MHz
Photo 40 621/1

3.2 Basic units

The basic units have the task of processing the output signal from the sensor (FIG 43). With the exception of envelope sensors, the sensor signals are usually low DC voltages with superimposed, residual low-frequency modulation. They are boosted in a low-noise and low-drift chopper amplifier to a level where they can be digitized. The AC component is suppressed by lowpass filters or the A/D converter itself. Modern instruments feature extensive numerical correction of the measured values based on sensor-specific data. The frequency has to be entered by the user. The corrected results can be output on the display or via a remote-control interface.

3.2.1 Zeroing

With all power meters, there are additional errors at the lower measurement limit due to superimposed interference. Thermoelectric sensors and diode sensors are mainly affected by thermal voltages and offset voltages in the chopper amplifier. Thermal voltages are produced by exposing the junctions of different materials to temperature gradients. The offset and thermal voltages shift the transfer characteristic of the sensor from the origin by an amount independent of the measured power (FIG 44). The resulting relative error is the greater, the smaller the measured power.

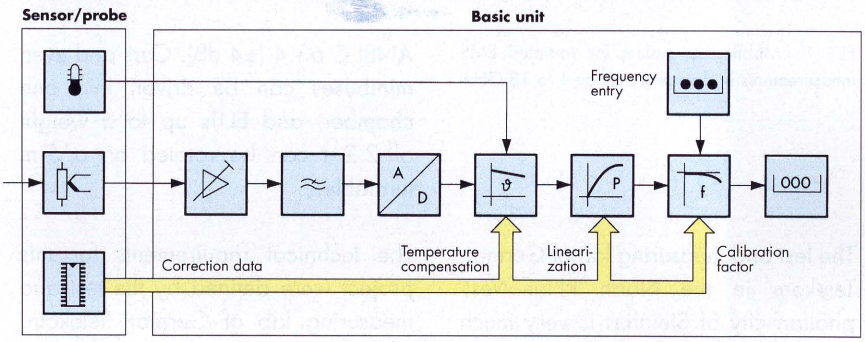


FIG 43 Power meter with numerical correction of sensor-specific parameters (Power Meters NRVS and NRVD)

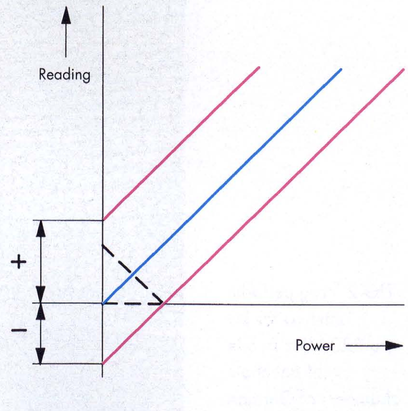


FIG 44 Zero error

This effect can be corrected for all power meters by zeroing. For this purpose, the power to be measured must be disconnected first. You should also avoid touching the sensor so that no additional thermal voltages are produced. The residual error after zeroing and the display noise determine the sensitivity of the power meter.

To be concluded.

Thomas Reichel

Rohde & Schwarz measurement technology in test and measuring lab of German Telekom in Steinfurt

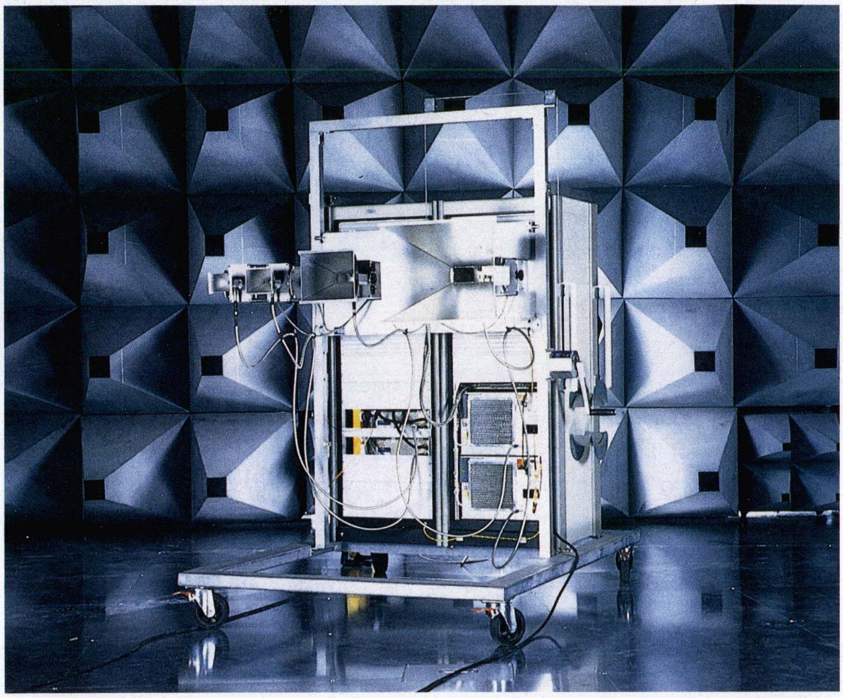


FIG 1 Mobile test system for radiated EMS measurements in frequency range 1 to 18 GHz

The test and measuring lab of German Telekom in the North Rhine-Westphalian city of Steinfurt is very much involved in the field of EMC for telecommunication and information equipment. Other fields of application are analog and digital transmission in the AF and RF range, electroacoustics as well as analog and digital interface measurements.

Two screened anechoic chambers of 24 m x 18 m x 9 m (L x W x H) including a test track of 10 m as well as four test chambers are available for the services offered to all manufacturers of electrical and electronic equipment. One of the anechoic chambers complies with the requirements for standardized site attenuation to DIN VDE 0877 part 2. The second chamber is in full compliance with ANSI C 63.4 (±4 dB). Cars and even minibuses can be driven into one chamber, and EUTs up to a weight of 2.2 t can be rotated on a 5-m turntable.

The technical requirements for this project were defined by the test and measuring lab of German Telekom. The turnkey project was carried out by Frankonia, which was responsible for the anechoic chambers and associated infrastructure, and by Rohde & Schwarz, which supplied the complete measuring equipment. Special requirements for the equipment were compliance with the latest standards as well as all common standards, flexibility and ease of expansion.

Emission and electromagnetic susceptibility tests

Measurements of **radiated emission** depend on the size and weight of the EUT and are performed in one of the two anechoic chambers. Two EMI test systems (20 Hz to 1.8 GHz and 20 Hz to 26.5 GHz) can be operated at the same time. The core of these test systems is EMI Test Receiver ESAI. In addition, a test system for 1 to 26.5 GHz with Spectrum Analyzer FSM is available, which can also be used in one of the anechoic chambers. The antennas required for measurements are attached to automatic antenna masts. A variety of probes, sets of probes for E and H nearfield measurements, current probes and

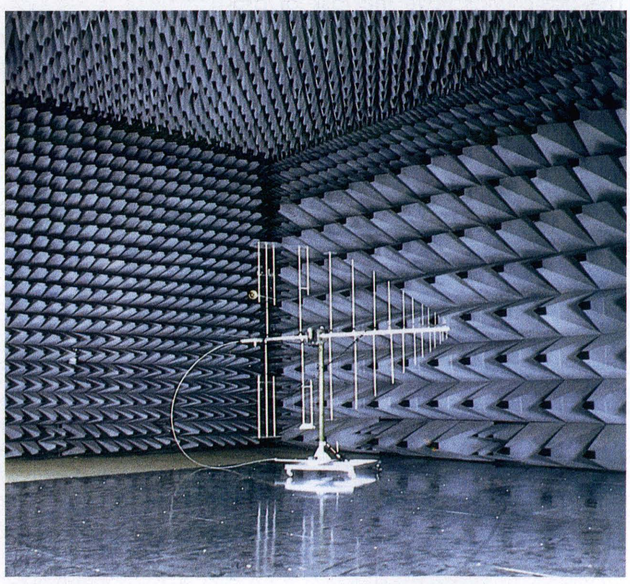


FIG 2 Log-periodic antenna for 20 to 220 MHz in one of anechoic chambers of German Telekom in Steinfurt

line-impedance stabilization networks are available for measuring conducted emissions.

Two EMS test systems are available in the anechoic chambers to measure **radiated susceptibility.** They can be operated in parallel and cover the frequency range from 10 kHz to 1 GHz. The core of such a system is a signal generator and three amplifiers. The amplifiers are accommodated in a separate amplifier room and are remotely controlled by the test system. A mobile test system for 1 to 18 GHz can be used alternatively in one of the two anechoic chambers (FIG 1).

Log-periodic antennas for 20 to 220 MHz (FIG 2) and 220 MHz to 1 GHz are also used in the anechoic chambers. The frequency range from 10 kHz to 20 MHz is covered by a small E/H field generator.

The test systems for EMS measurements are each supplemented by an EUT monitoring system with two audio analyzers, which are used to analyze an EUT during EMS measurement. It is simple to decide whether an EUT is operational under the influence of EM fields of a certain field strength. A camera and interphone system allows monitoring of an EUT from the test chamber.

The test systems (EMI, EMS and EUT) allocated to an anechoic chamber are each controlled from a workstation. A high degree of flexibility, efficiency, reproducibility and operating convenience of the test systems comes with the **system software** developed by Rohde & Schwarz. This makes the work of the test engineer a lot easier, as he can concentrate fully on monitoring the measurement.

System measurements for DECT

The European-wide introduction of DECT (digital European cordless telecommunication) for cordless phones and the publication of CTR6 (common technical regulation) in the official journal of the EU meant that measurements of radio-frequency system parameters became part of the approval procedure. The test and measuring lab of German Telekom in Steinfurt was one of the first independent test labs on the market authorized to carry out such measurements. Years before this authorization, the lab had already developed and trialed test methods and instructions for DECT systems.

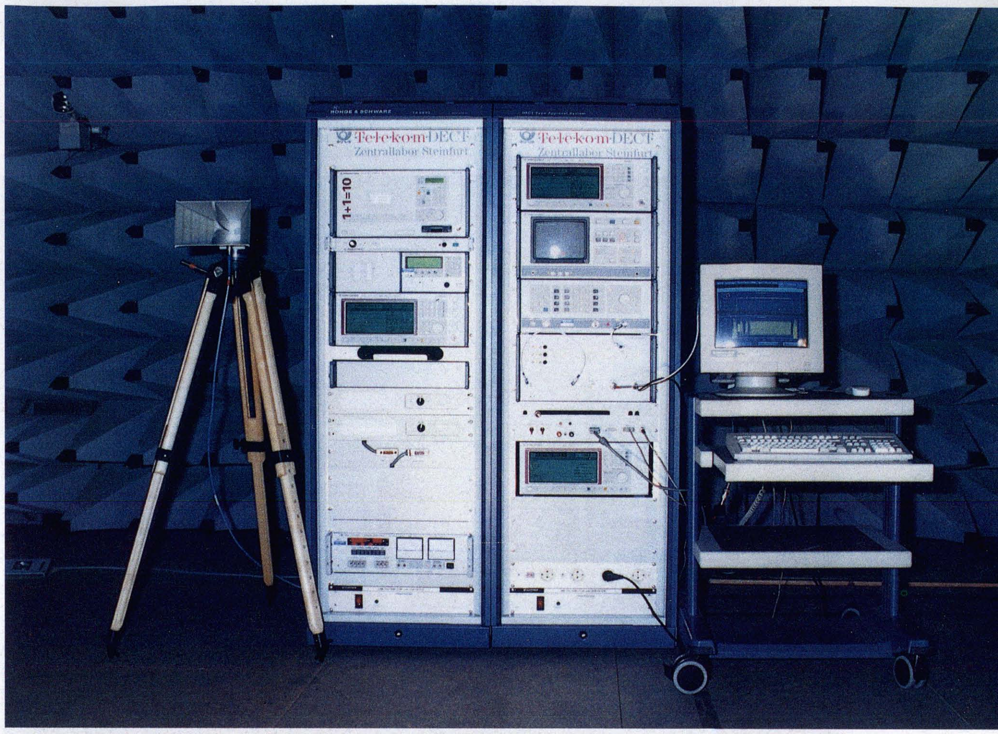


FIG 3 DECT test system in test and measuring lab of German Telekom

Photos: German Telekom

The DECT Type-Approval System TS8930*, supplied to German Telekom in Steinfurt, represents a landmark in DECT measurements.

In conjunction with the measurement technology already available as well as the anechoic chambers, this test system from Rohde & Schwarz (FIG 3) plus the associated software allow all CTR6/TBR6 measurements as well as the required climatic tests. Analysis down to bit level is also possible. Beside many other manufacturers, German Telekom, which itself offers DECT terminals and systems, is one of the users of this flexible measurement technology.

Measurement of telephony parameters according to CTR10 and specifications according to PAP (public access profile) and GAP (generic access profile) will also soon be possible in the Steinfurt test lab. An accreditation test for CTR6 and CTR10 was successfully conducted by DEKITZ (Deutsche Koordinierungsstelle für IT-Normenkonformitätsprüfung und Zertifizierung), the German coordinating office for IT standard conformity.

Hubertus Brunstering (German Telekom);
Achim Gerstner

*Tiwald, W.: DECT Type-Approval Test System TS8930 – Type-approval measurements on cordless telephones to TBR 06/10/11. News from Rohde & Schwarz (1995) No. 147, pp 14–17

Reader service card 148/16 for further information on EMC and DECT test systems

EMS test lab at Test and Certification Institute of VDE in Offenbach

FIG 1 Operator position of EMS test lab at Test and Certification Institute of VDE in Offenbach
Photo 41 568/2

Since the opening of its new EMS test lab about a year ago, the Test and Certification Institute of VDE (Association of German Electrical Engineers) in Offenbach has been offering a complete range of EMC services to its customers. The test lab was a turnkey solution from Rohde & Schwarz. The shielded cabins including all the fittings were provided by Siemens-Matsushita.

The shielded test cabin is designed to perform measurements in line with IEC 1000-4-3 and is thus fitted all round with absorbers. There is also a shielded, air-conditioned cabin containing the amplifiers. The operator position (FIG 1) is located in an unshielded laboratory.

The computer-controlled **EMS test system** from Rohde & Schwarz allows type-approval measurements to IEC 1000-4-3 and IEC 1000-4-6 in the frequency range 10 kHz to 1 GHz (FIG 2). It contains a Signal Generator SMG, a relay matrix, two power amplifiers, a Millivoltmeter URV 5, a field-strength measurement system, a transmitting antenna as well as coupling networks. The amplifiers provide output powers of 300 W (up to 100 MHz) and 100 W. With the higher power in the lower frequency range, the test system is ideally equipped for future standard requirements. Measurements from 26 MHz upwards in line with the currently valid regulation IEC 801-3 are also possible with a biconical antenna. The amplifiers can be controlled manually or remotely by the system controller (PC).

An **EUT monitoring system** transmits the electrical signals picked up from the EUT to the operator position via fiber-optic cables. The signal parameters can then be directly read off on RMS/Peak Voltmeter URE3 or registered and logged by the computer. A video and audio system operating also via fiber-optic cables allows visual and acoustic monitoring of the EUT functions.

System Software EMS-K1 (see also article on page 12) supports the substitution method stipulated in standard IEC 1000-4-3/6. It is also an extremely useful tool to perform and evaluate field calibration according to standard. The number of points that can be defined in the reference plane is between four and 36. The evaluation algorithm determines the reference point and the forward power associated with the nominal field strength at every test frequency.

Reinhard Göster

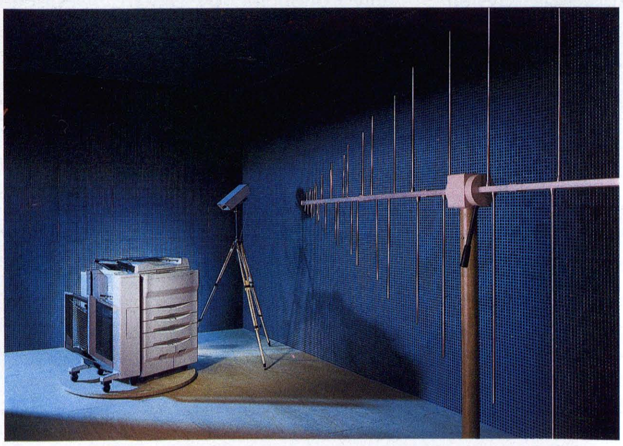


FIG 2
Measuring electromagnetic susceptibility of photocopier to IEC 1000-4-3
Photo 41 566/1

Reader service card 148/17 for further information on EMC measurements

New, ultra broadband mobile antenna for VHF-UHF Direction Finder PA1555

Mobile VHF-UHF Direction Finder PA1555 from Rohde & Schwarz was designed with all those customers in mind who wish to transport equipment from one site to another rapidly and easily and to operate it at a site for a short period of time. The DF antennas for the frequency ranges from 20 to 200 MHz and from 200 to 1000 MHz are thus of lightweight construction. A tradeoff had to be made, however, with regard to the stability of the antenna (max. 100 km/h wind velocity).

FIG 1 Handy DF Unit PP1555 of mobile VHF-UHF Direction Finder PA1555 weighs only 7.5 kg. Display Unit GB1555 (front) allows remote control of direction finder. Photo 41 949

As a result of the compactness of DF Unit PP1555 (FIG 1) and the possibility of operating it from a DC power supply, the demand arose for a fully mobile antenna working in a continuous frequency range from 20 to 1000 MHz. This requirement can now be satisfied with VHF-UHF DF Antenna AP1555M (FIG 2). The electronics of the antenna are accommodated in a weatherproof, round plastic housing of 1.1 m in diameter, which also makes the antenna suitable for use onboard ships. The scanning and switching signals of the DF process are superimposed upon the audio signal at the AF output of direction finders with a common receive and evaluation channel, so Antenna AP1555M contains two additional RF outputs (20 to 200 MHz, 200 to 1000 MHz) for connecting a monitoring or search receiver (eg EB100 or ESMC), where the AF signal is then provided in unimpaired form.

FIG 2 New antenna for mobile VHF-UHF Direction Finder PA1555 is accommodated in plastic housing with diameter of 1.1 m and height of 25 cm and covers whole frequency range from 20 to 1000 MHz. Photo 41 951/1

Mounting the antenna is very easy, using the well-proven and practical quick-release fasteners employed with other DF antennas from Rohde & Schwarz. If the DF antenna is to be mounted on the roof of a vehicle, the use of Adapter for Vehicle Mounting AP502Z1 is recommended. For this type of installation a shortened antenna cable of 5 m can be supplied. Moreover, Adapter for Mobile DF Antennas AP502Z5 (mounting the DF antenna on a mast) as well as Tripod with Adapter AP502Z5 are available.

If DF Unit PP1555 is to be installed in the boot of a vehicle, the use of Display Unit GB1555 (option) is recommended, allowing convenient and inconspicuous operation of the direction finder from the passenger seat (see FIG 1). Menu keys are available with which almost all PA1555 functions can be called up. To cut out the risk of operator errors in demanding applications, the control keys were reduced to a minimum of three. That is why individual frequencies cannot be entered but, instead, one of up to 100 channels stored in the DF unit may be called up. For GB1555, which comes with a 7-m connecting cable, Holder for Display Unit PP007DH can be supplied as an accessory. The holder is mounted on a swan-neck, allowing Display Unit GB1555 to be positioned for an optimum viewing angle and leaving the operator free use of his hands for other settings or adjustments.

Ulrich Unselt

Reader service card 148/18

Trunked-radio systems for emergency services in Syria

Two modern trunked-radio networks were recently put into operation for two of the most important emergency services in Syria, the Damascus fire brigade and civil defence. Both networks are based on proven ACCESSNET® infrastructure technology from Rohde & Schwarz and user radio sets from Bosch. R&S BICK Mobilfunk, acting as the main supplier, received the order for turnkey handover of both radio networks.

Syria is currently undergoing a modernization phase, covering the entire, national copper-based PSTN. In the course of this, one million subscriber lines will be installed together with a fiber-optic network. The Syrian government intends to upgrade the country's communications systems, including those of public emergency services, to meet the requirements of the 21st century.

The installation of the new ACCESSNET® trunked-radio system enables the Damascus **fire brigade** to carry out all current and future missions with much greater efficiency than before, and for the benefit of all. The involvement of other authorities responsible for public safety or companies offering related services ensures rapid communication throughout. Fire brigade, ambulances and other emergency or municipal services and utilities can now be coordinated centrally on one communications network and thus optimally deployed. ACCESSNET® also permits the PSTN and other communications systems to be linked to a trunked-radio switching center via suitable interfaces so that mobile and copper-based telephone subscribers can communicate with each other.

The stationary trunked-radio system of the Damascus fire brigade comprises an operation & maintenance computer, a medium-power trunked-radio switching center and a radio base station using five radio channels. Thanks to the flat terrain and low-profile architecture, coverage extends to more than 60 km. Later on more radio cells will be added so that neighbouring towns can also be included in the service.

The great variety of ACCESSNET® trunked-radio switching centers of various power classes guarantees that the right system can be supplied for every requirement (FIG 1), from a mini system for stationary or mobile use in vehicles through to a country-wide network that can handle any number of subscribers.

A country-wide trunked-radio network is planned for **civil defence** so that all Syrian towns can be covered. In the four largest cities, Damascus, Aleppo, Oms and Lathakia, the trunked-radio systems are already in operation and use star or triangular networks based on a central switching center in Damascus (FIG 2).

Both trunked systems are based on the MPT 1327/1343 signalling standard. They have identical hardware and differ only in the number of cells within their areas of coverage. This compatibility simplifies maintenance, servicing and spare-part logistics. In addition to the standard MPT functions, individual channels of the radio base stations can be remotely connected from the switching center so that, as in a conventional radio system, specific groups of subscribers are able to communicate during operations on site via radio base stations independently of subscriber numbers, call setup time, calltime limits, etc.

This special function makes the use of MPT trunked-radio systems feasible for fire services and civil defence forces. This and ACCESSNET® 's data transmission capability helped clinch the deal for Rohde & Schwarz.

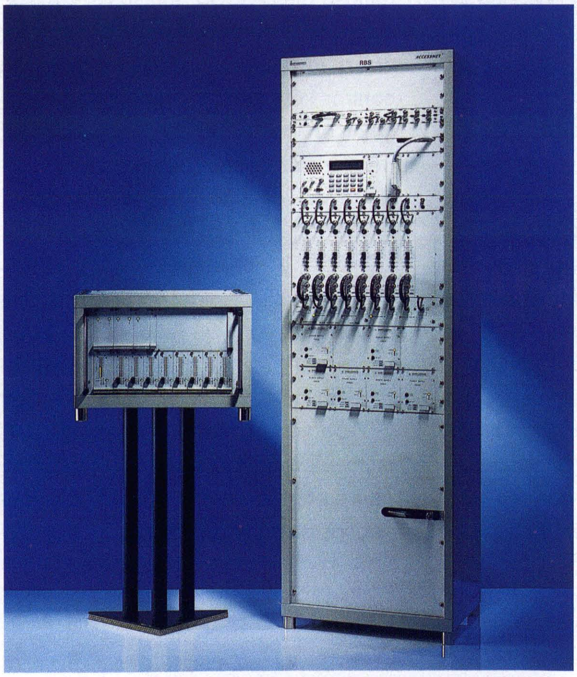


FIG 1 Trunked-radio system ACCESSNET® with switching center (left) and base station for up to eight channels
Photo 41 906

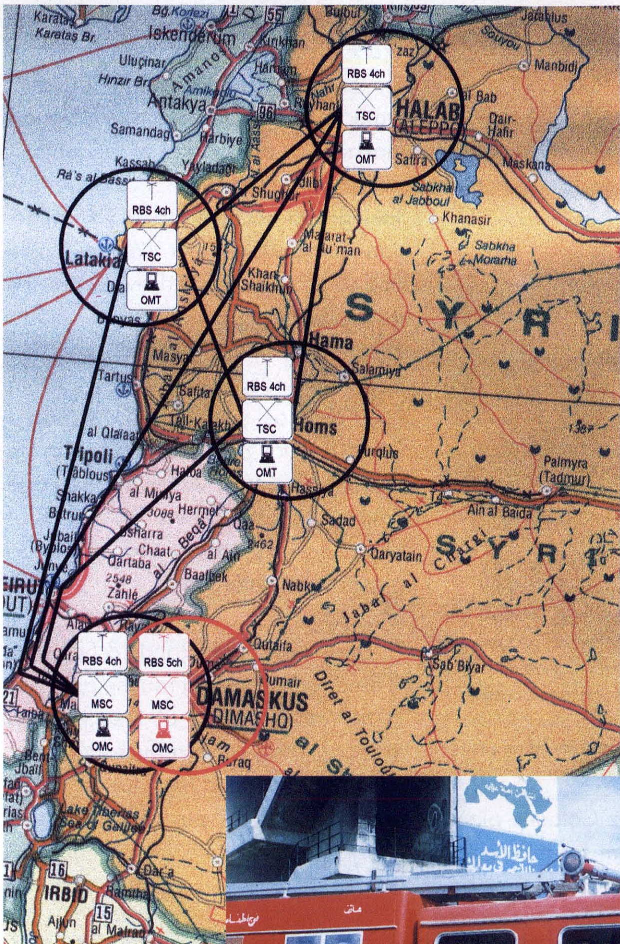


FIG 2 Networking of trunked-radio systems in Syria (fire brigade red, civil defence black); RBS = radio base station, MSC = master system controller, OMC = operation & maintenance center, TSC = trunked system controller, OMT = operation & maintenance terminal

ACCESSNET® has set standards for mobile communication in Syria. The trunked-radio network of the civil defence forces, in particular, is a basis for country-wide coverage. In the near future it will provide sufficient capacity and all the necessary features to other authorities and service suppliers (eg gas and power utilities, municipal government, public transport, motorway services, forestry commissions, broadcasting companies, news agencies, harbour authorities, railways and airports), so that all the special requirements of these closed user groups can be met. The trunked-radio systems in Syria will provide an attractive service until GSM is implemented, and most likely long after.

Karl-Heinz Wagner

Reader service card 148/19 for further information on trunked radio

Monitoring waste-water quality by fully automatic trace analysis

In industrial production surface water is generally used for processing, cooling or as a universal solvent. As a result water may become polluted with a great number of dangerous substances such as nitrate or ammonium, which lead to the eutrophication of the water, or with elements like mercury which are toxic for human beings and animals.

Domestic waste water is drained into municipal waste-water treatment plants, large industrial plants are obliged to purify sewage water by their own means. Since industry has to monitor and prove the quantity of contaminants in its waste waters, the concentration of these substances has to be determined by means of chemical analyses. Up to now such tests were carried out on random samples only, which did not reflect the actual pollution of water in production. For this reason it has become more and more important for industry to carry out routine water tests online, that is fully automatically and continuously. The results obtained may then be directly considered for controlling production systems so that procedures can be

FIG 1 Automatic water analysis system from Rohde & Schwarz Cologne accommodated in an easily transportable, bright blue container to be set up on site

optimized. Deviations can thus be detected in time and eliminated by modification of processing procedures.

There are legally prescribed limits for water contamination caused by industrial plants. For instance, in Germany fees are charged for polluted water, which are proportional to the degree of contamination. Reducing the amount of pollutants will result in a reduction of fees. This is an incentive for industry to measure the concentration of pollutants in its sewage.

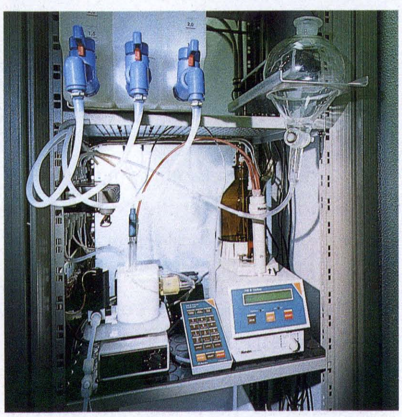


FIG 2 Water sampling module
Photo 42 052

The Rohde & Schwarz Cologne plant offers a turnkey system for fully automatic water analysis, which may be set up at any place on a company's premises (FIG 1). The system comprises a container acting as a workstation and test room accommodating the multi-element analysis system used as a sensor, and the water sampling module (FIG 2). Probe sampling is carried out in several reproducible steps. Various software modules are provided for controlling the automatic test procedure (FIG 3). In addition to automatic measurements, the online system also performs function checks and calibration within minutes and handles bidirectional communication with the process control center. It also controls the timing of switchover to different water samples and detects and signals leakages or a shortage of reagents.

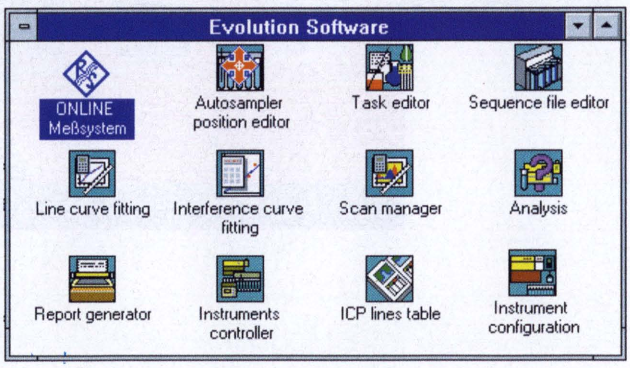


FIG 3 Software modules for controlling waste-water analysis system

Taking into account industry's obligation to monitor water contamination and to provide related evidence, the test system uses a well-known analytical method, optical emission spectroscopy with inductively coupled plasma (ICP-OES) as specified by standard DIN 38 406, part 22, for tracing up to 33 elements in water and sewage waters. ICP-OES allows 70 to 80% of all naturally occurring elements to be proved and determined.

The test system from Rohde & Schwarz is used for optimizing routine analyses in numerous sectors of the chemical industry. The system reduces costs for online analysis and fees due for water pollution, so it will pay off after only a few years.

Norbert Schuster

Reader service card 148/20

Spectrum Analyzers FSEA and FSEB (20 Hz/9 kHz to 3.5/7 GHz) are of modular design and can be used for digital or analog mobile radio, TV, CATV, AM/FM sound broadcasting, DAB or general-purpose measurements; frequency resolution 0.01 Hz, resolution bandwidths 1 Hz to 10 MHz depending on model, noise figure 15 dB, IP3 15 dBm, phase noise (at 10 kHz from carrier) −123 dBc (Hz), intermodulation-free range 105 or 116 dB, full-span sweep in 5 ms, measurement error up to 1 GHz <1 dB, >25 sweeps/s; 24-cm display, PC-compatible, loudspeaker and headphones connector, numerous interfaces and options.

Data sheet PD 757.1519.21 enter 148/01

Video Measurement System VSA (0 to 9 MHz) is an analyzer (video, FFT), 3-channel oscilloscope, vectorscope, monitor and system controller (486) with four loopthrough inputs (1 V ±6 dB, return loss up to 6 MHz >40 dB), DC input (1 MΩ), colour or monochrome graphics screen (640 x 480 pixels); standard B/G, I, D/K, PAL; several interfaces.

Data sheet PD 757.0464.21 enter 148/02

GSM Go/NoGo Tester CTD52 automatically provides go/nogo messages and (as an option) comprehensive analyses of mobile phones; LCD display with softkeys, reference oscillator; small and lightweight.

Data sheet PD 757.1502.21 enter 148/21

Software WinLoc supported by R&S direction finders automatically locates and monitors HF/VHF/UHF signals, whereas MapEdit generates (pixel and vector) maps; Windows 3.1, network-compatible.

Data sheet PD 757.1483.21 enter 148/22

CDMA Coder SMHU-B6 is fitted with clock generator, data generators and noise generator for test-signal generation to US specifications IS-95, -96 and -98 as well as with DOS Software CDMA-K1 for settings; level range with SMHU58: −140 to 0 dBm.

Data sheet PD 757.1577.21 enter 148/06

EMS Test System TS9980 is used for automatic EMS testing of TV and sound broadcast receivers to VDE 0872/EN 55020/CISPR 20; models for audio/audio + 1 TV standard/audio + 4 TV standards.

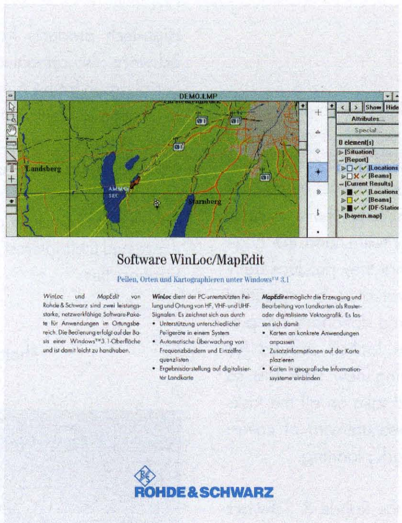
Data sheet PD 757.1525.21 enter 148/23

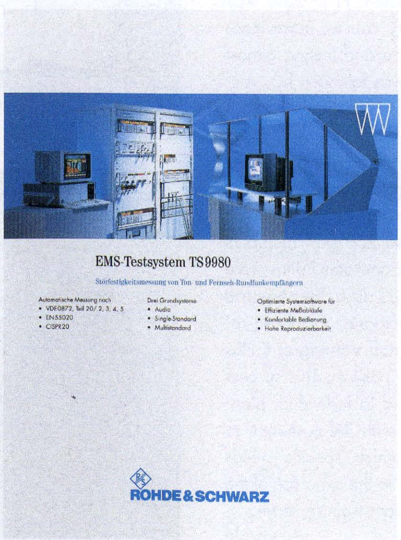
CCVS + Component Generator SAF and CCVS Generator SFF – the optional digital interface to CCIR 601 with parallel/serial/analog video signals and test signals to CCIR 801 has been included in the data sheet.

Data sheet PD 756.9845.22 enter 148/15

VHF-UHF-SHF Direction Finder DDF190 (20 MHz to 1.3 or 3 GHz) is used for taking bearings of signals with various modulation modes; sensitivity (VHF/UHF) 2 to 10 µV/m, three-digit display and arrow indicating direction, error 1 to 2° rms; interfaces RS-232-C and IEC 625; AC supply or battery operation.

Data sheet PD 757.1460.21 enter 148/24





Digital IF Spectrum Display EP090 (DC to 5 MHz) with AF and IF input (optional converter for 10.7 and 21.4 MHz); resolution 0.125 Hz, dynamic range ≥80 dB, display refresh rate 30/s; waterfall display; optional output 4.5 MHz.

Data sheet PD 757.1554.21 enter 148/25

Ahead in cable Distribution of sound and TV broadcast signals from satellite, terrestrial or microwave reception and from metal or optical waveguides. CATV Headend System CT 200 is state-of-the-art and future-proof.

Info PD 757.1477.21 enter 148/26

25th anniversary of Teisnach works The Rohde & Schwarz works presents itself, its range of services, its achievements and the milestones in its history.

Info PD 757.1490.11 enter 148/27

New application notes

Baseband signalling with digital inputs and outputs

Appl. 1CPAN02E enter 148/28

Baseband signalling with analog I/Q inputs and outputs

Appl. 1CPAN03E enter 148/29

SME-K1 software for generation and transfer of modulation data to Signal Generator SME, including associated program

Appl. 1GPAN17E enter 148/30

Time delay measurement in the digital studio

Appl. 7BM11-10-1094-E enter 148/31

Reduction of the number of the vertical blanking intervals assigned with test signals

App. 7BM11-12-1294-E enter 148/32

Signals of the PALplus test pattern generated by Video Generators SAF and SFF

Appl. 7BM11-13-0195-E enter 148/33

Measurement of the power bandwidth at defined distortion with Audio Analyzer UPD, including associated program

Appl. 1GPAN18E enter 148/34

Measurements on professional tape machines using Audio Analyzer UPD, including associated program

Appl. 1GPAN19E enter 148/35

Data sequences for various digital communication networks for Signal Generator SME, including associated program

Appl. 1GPAN20E enter 148/36

Measurements on CD players using Audio Analyzer UPD, including associated program

Appl. 1GPAN21E enter 148/14

Schz

Photos: Uhl

Rohde & Schwarz on the air in Vietnam ▷

Since 1992 Vietnamese television has been broadcasting in PAL from Hanoi, the nation's capital, with a dual transmitter system from Rohde & Schwarz. This marks a move away from SECAM, the TV standard used before. Voice of Vietnam, the state broadcaster, now plans to expand its FM network nationwide over the next five years. Faced with tough competition from France, Japan and the USA, Rohde & Schwarz succeeded in winning the contract for the first of the planned stations. A 10-kW dual FM transmitter system with passive backup has been on the air in Ho Chi Minh City since mid-November of last year (the photo shows the broadcasting station and the dual transmitter). Voice of Vietnam can now be received within a radius of about 100 km from the city, meaning that there is coverage of the entire Mekong delta, a region where 13 million Vietnamese live plus some 500,000 foreign citizens. Further Rohde & Schwarz stations with lower output (3.7 and 1.3 kW) are due to follow soon: first in Thai Binh province close to Hanoi in north Vietnam, and then in La Dong province in the south.

K. Thomé

E-Plus and the training center

Following on from D1 and D2, a third digital mobile-radio network – E-Plus – was set up and working in next to no time. Rohde & Schwarz made a sizeable contribution to this by providing systems for measuring coverage. 29 vehicles, fitted with modern test receivers in automatic systems for measuring field strength and channel impulse response, are now in daily use, ensuring sufficient field strength and good radio-channel characteristics in the areas covered. Operation of these systems calls for a big team, and the huge flow of data that they produce daily has to be evaluated by qualified technicians using stationary computers. So E-Plus looked around for ways of training new staff fast so that they could take on all the tasks involved in measurement of coverage and network planning.

This is where the Rohde & Schwarz training center came in. The subject matter was elaborated together with the network operator, and then the customized training was carried out in several phases. First there was an introductory course, more theoretical in nature and lasting almost a week. This was followed by practical instruction on the customer's own systems once they had been shipped. Everything was rounded off by in-depth training and instruction on special software for network planners. Some 250 staff members of the network operator E-Plus were trained within 52 days. The response from the participants and those responsible for staff training at E-Plus was extremely positive. This success can be credited to individual planning together with the customer, to the way in which specific needs were met, and to the expertise of the Rohde & Schwarz training team.

P. Hatzold

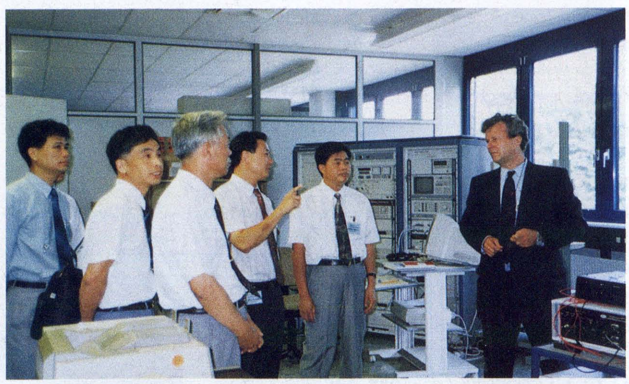
Visitors from China at Rohde & Schwarz in Munich

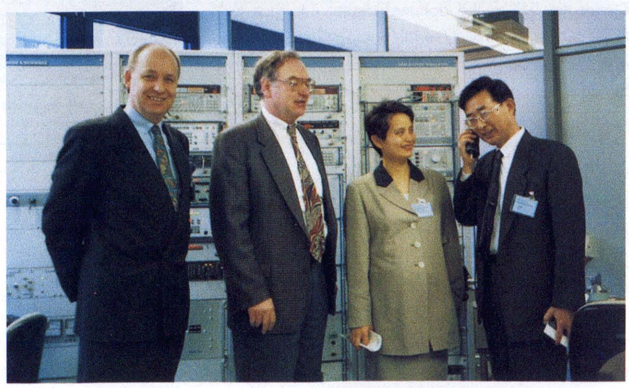
By way of the Chinese embassy in Bonn, a visit to Rohde & Schwarz in Munich was arranged for a delegation from the Center of Technology Exchange in Guangdong province. This province, situated in the south of China close to Hong Kong, is one of the country's financially strongest and most industrialized regions. During this part of their trip to Gemany the guests were able to obtain an impression of what private enterprise is capable of. Following a tour of the various divisions, the guests showed special interest in a presentation of systems for GSM, PCN and DECT type approval (top photo). GSM trials are currently in progress in southern China, with the aim of creating an extensive mobile-radio network for the region.

High-tech products from Rohde & Schwarz also appealed to a managerial group from China International Economic Consultants in Beijing (bottom photo). The guests from the Chinese capital were very impressed by the high standard of the technology that the company produces and expressed their interest in expanding business ties.

J. Beckmann

▽ Photos: Beckmann





TV transmitters for Russia

Words of praise and admiration came from the director of New Channel in St. Petersburg at the recent handover and startup of a 20-kW Dual TV Transmitter System NT425D1 from Rohde & Schwarz. In the presence of the numerous guests attending the event, he drew special attention to the microprocessorized front-end of this new generation of TV transmitters. He said that he and his staff were very impressed by the clear menu guidance for operating the transmitter as well as the convincing style of the maintenance and service concept. Prior to this the system had undergone critical examination during a test phase lasting several days. K standard is used in Russia, so there was special focus on those parameters that differ from German specifications. The technicians and engineers in St. Petersburg stated afterwards that they were extremely satisfied with the results. In Moscow too there are plans for setting up an NT425D1 dual transmitter system in the course of this year.

R. Tappert

Photo: Rockrohr

Successful press conference on mobile radio

The Rohde & Schwarz division for mobile-radio T&M products recently staged a press conference for 14 journalists representing technical and business publications. After a welcoming address by division head Michael Vohrer, Manfred Grossmann, head of product management, explained the current market for mobile-radio testers in facts, figures and diagrams (photo). In the product presentations that followed, the journalists got a close look at the technology, with the chance of checking out a mobile phone or handy that they had brought along on the brand-new CTD52 Go/NoGo Tester, complete with a printed report of course. Dr Hans-Jürgen Schneider, project manager for mobile-radio type-approval systems, was on the spot to answer technical questions. A lot of material was put across and discussed within a relatively short time and there was extensive literature laid out ready for the journalists, so a little refreshment was scheduled after all this. The buffet lunch arranged in the cafeteria of the training center was greatly appreciated, and offered an opportunity of finding out more about various points of interest. C. Rockrohr

11th international EMC symposium in Zurich

"Test it! It's a question of confidence" was the motto sported by Rohde & Schwarz – combined with the CE conformity symbol – at the 11th EMC symposium plus exhibition early in March. Some 1000 EMC specialists met under the roof of the ETH in Zurich to report on their work or see what new aids industry had to offer. Rohde & Schwarz took along two new products for a world première: electromagnetic susceptibility software EMS-K1 (see article on page 12) and the precertification EMI Test Receiver ESPC. The latter, a small and compact solution, is a low-cost addition to the ESHS/ESVS/ESS family of test receivers and covers the entire frequency range from 9 kHz through 2 GHz.

A gala dinner accompanied by the sound of original Swiss music and the magic artistry of a nimble-fingered conjurer was much enjoyed by key customers and participants in the symposium, as was the traditional Weisswurst breakfast with beer and Brezen staged by Rohde & Schwarz. Many, faced with the unfamiliar fare, will have been encouraged when they read the words "Test it! It's a question of confidence".

V. Janssen

Photo: Flad

Rohde & Schwarz at CeBIT 95

From 8 through 15 March 1995 everything again revolved around information and communication technology at the world's biggest showgrounds in Hanover. A total of 6167 companies (up from 5845 the year before) from 59 countries pitched their tents on an exhibition area of 318,344 sqm, again a big increase from the previous year. There were some 14% more visitors too, the busiest day being the Saturday with 129,000. According to Hubert H. Lange, CeBIT chairman, this is breaking-point. The visitors were especially interested in mobile phones, private telecommunication networks and multimedia applications. Rohde & Schwarz staged its appearance – as usual in hall 17 – at this, the tenth CeBIT, under the motto "Rohde & Schwarz – Communicative". The focus among the exhibits was on systems for measuring mobile-radio coverage, the new digital Accessnet-D system for trunked radio, shortwave and long-haul radiocommunication plus all the related lab instrumentation. The number of visitors to the Rohde & Schwarz stand with a major interest in GSM test engineering and trunked radio was about the same as one year earlier.

On the third day of the show, undersecretary Hans Spitzner from the Bavarian department of commerce (2nd from right in photo) visited the stand and, accompanied by Wolf-Rüdiger Lange (right), head of corporate development, learnt about the exhibits. Michael Vohrer (left), division manager for mobile-radio T&M products, personally demonstrated the new CTD52 Go/NoGo Tester for GSM. On Sunday the federal minister for post and telecommunications, Dr Wolfgang Bötsch, called by. Heinz Bick, managing director of R&S Bick Mobilfunk, was the right person to explain to him the equipment for trunked radio that was on show. And to round off his 15-minute visit, the minister also saw a demonstration of the handy CTD52 tester. C. Rockrohr

Photo: Müller

Spectrum analyzer as multiuser unit

Wolf-E. Schreyer, head of product marketing for EMC T&M products and signal analysis at Rohde & Schwarz, talking to "Markt & Technik" in the issue of 13 January 1995 on the subject of spectrum analyzer versus oscilloscope:

The user wants to see solutions at the push of a button, save time and detect a general trend without specialist knowledge. Because of the wide spread in areas of application it's obvious that not every user can be a specialist. Spectrum analyzers that are low-cost and easy to work with are especially in demand for EMC. ...By selling the customer application-specific units, we're offering him a service at the same time.

What radio standard does Europe need?

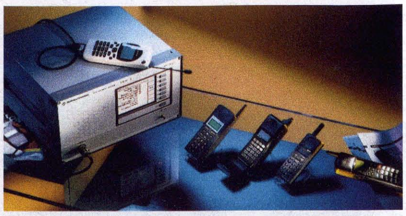
"Funkschau" tried to find an answer to this in its 25/94 issue and asked various experts what they thought:

Gregor Kleine of Rohde & Schwarz puts in a plea for DSR. The difference between the new digital sound-broadcast techniques ADR, SARA, DSR and DAB is that DSR is the only one that works without data reduction. So hifi freaks who know their way about prefer DSR to the other techniques. ...Rohde & Schwarz is currently the sole producer of the DSR coder. The Munich company is also supporting DSR with a new kind of bit-error meter that allows precise measurement of bit-error rate during ongoing broadcasts as well as offering numerous means of checking and monitoring.

Mobile-radio testing for everyone

One day after the press conference on mobile radio that Rohde & Schwarz staged in Munich, the 17 February 1995 issue of "Münchner Merkur" found words of praise:

Rohde & Schwarz makes complicated technology simple. In the rapidly growing market of test engineering for mobile radio, Rohde & Schwarz, already at the forefront of the world market, intends to put even more effort into it. This sector already accounts for about one tenth of company turnover of 800 million DM. New from Rohde & Schwarz is the GSM Go/NoGo Tester CTD52, the smallest (simulated) base station in the world and easy to operate even for sales personnel (photo right).



Sights on the digital future

In a report on test engineering for digital audio and video, edition 2/95 of "AV-Invest", which focuses on audiovisual communication, had something to say about the new Analyzer System VCA from Rohde & Schwarz:

With its VCA Rohde & Schwarz, the leading German producer in transmitter technology and various special areas of test engineering, intends to play a part in the newly emerging market for test engineering for digital video. In the VCA the team around Dr Harm has created a special test system for digital component signals to CCIR 601 and SMPTE 259 N and 125 N standards. In other words an instrument that is not designed for digital components alone.

Ice-cold test

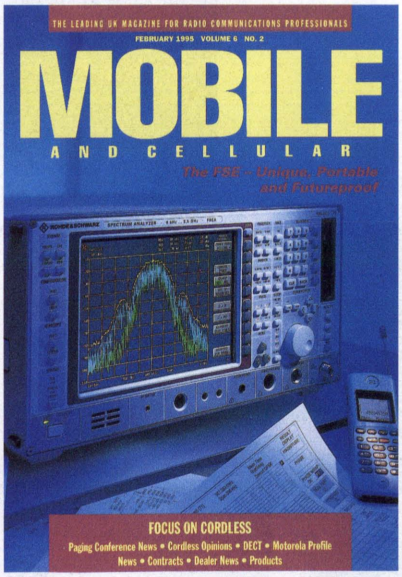
"Mobiltelefone und Pager", published in Ulm, made a first performance comparison of new E Net handies in its 2/95 edition, using the Compact Tester CMD55 for GSM and PCN:

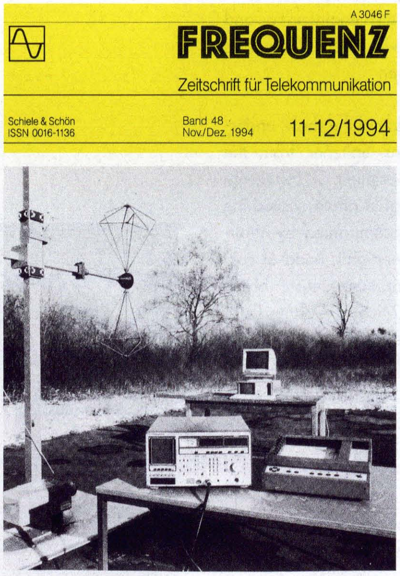
This digital radiocommunication tester simulates a base station for the connected phone and, besides allowing registration, call setup and cleardown, control of transmit power, change of channel and forced termination, also permits analysis of error rates, receiver sensitivity and speech quality on mobile radios.

Strong bond

Würzburg's "Elektronik-Praxis" of 17 February 1995 reported on Rohde & Schwarz/Advantest cooperation:

Rohde & Schwarz and Advantest have been cooperating for three years on joint marketing of their products. Now the two companies have come up with a new family of spectrum analyzers that complement one another. According to Reinhard Bruckner, head of test and measurement division at Rohde & Schwarz: Together with Advantest we're the market leader in Germany and Europe for spectrum analyzers, with a share of between 40 and 50%.





Modern technology from Rohde & Schwarz as the cover star of edition 2/95 of England's leading mobile-radio magazine "Mobile and Cellular", of number 11-12/94 of Berlin's "Frequenz" and of the book "Elementi di propagazione elettromagnetica", published in Rome in the series Radio & Data Communication: spectral analysis of the very best at midrange price from the new FSE family, EMI Test Receivers ESHS and ESVS to satisfy all the tough demands of professional EMI measurements, and the display of Spectrum Analyzer FSA showing an intermodulation measurement.

The motto at Rohde & Schwarz: half time to market

Product life cycles becoming shorter throughout industry, quality requirements getting stiffer and profit margins ever shrinking – these are the conditions industrial product development is facing today. To meet the challenges and maintain a competitive position, thus securing economic growth and employment, companies must develop new strategies, find new approaches to problem-solving, and adopt new organizational concepts.

Seeing that the objectives, including reduction of costs and throughput times, quality improvement and higher flexibility, are the same worldwide, the competitive advantage will lie with those who achieve objectives before the competition and respond faster to customers' needs. It is no longer individual processes that are the focus, but the optimization of a multitude of interlinked processes. Rohde & Schwarz is solving these tasks applying half-time-to-market (HTTM) methods.

This does not mean that HTTM is ushering in a new age at Rohde & Schwarz. Instead it is a continuation of activities aimed at improving the marketability of R&S products. The current process differs from previous rationalization measures, among other things, in that organizational structures and processes are being systemized, integrating all those participating in a process.

Assisted by an external consultant, Rohde & Schwarz in early 1991 carried out a **five-stage project-management analysis:**

Stage 1 Actual status assessment of project management from the definition phase to serial production of a development project

Stage 2 Evaluation and analysis of results of assessment and identification of potential trouble spots

Stage 3 Reconciliation of actual status and presentation of actual status analysis

Stage 4 Development of target concept for introduction of simultaneous engineering

Stage 5 Presentation of target concept

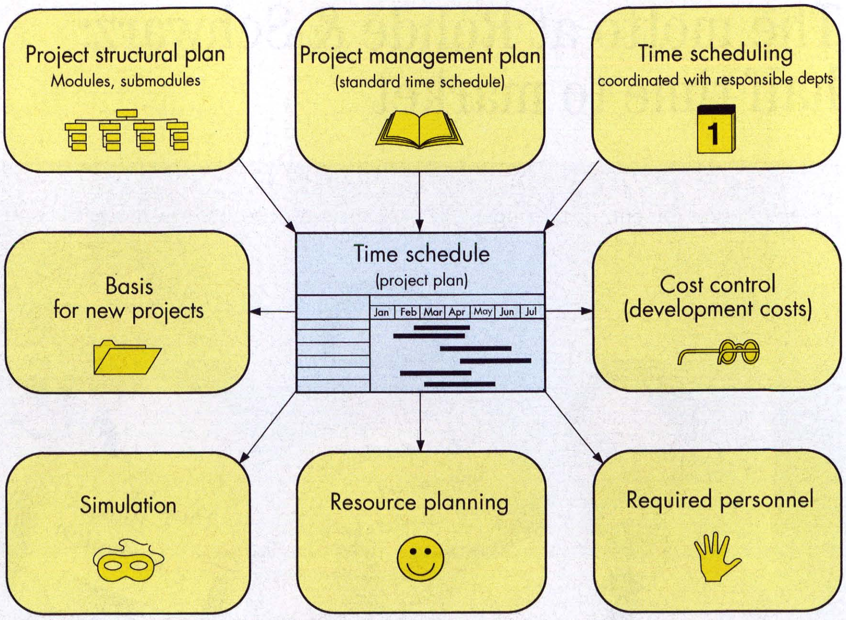


FIG 1 Project management in HTTM process

Simultaneously with the execution of the project stages, two pilot projects were started with the aim of finding time-saving measures and testing them systematically. Teams were formed for both pilot projects including, right from the start, design and development, marketing, production, purchasing and quality management. The trouble spots identified during the implementation phase of the pilot projects and their analysis led to the development of HTTM methods. These can essentially be divided into **six categories of measures:**

Concentration on key projects

This category is mainly characterized by the introduction of a program and product planning phase. For the program planning phase, typical questions to be answered are: What markets are we going to supply in the future? With what products? What business units should be selected to cover these markets? This is followed by project limitation, taking into account available resources, the definition of product descriptions as well as applications, turnover targets and time of market introduction, as well as ascertainment of the price situation. In the product planning phase, the preliminary standard specifications, technical and marketing concepts as well as the preliminary project plan are drawn up jointly by the responsible subdivision, strategic marketing, product marketing, field sales and development.

Intensification of definition phase

The definition phase is divided into a predefinition and a main definition phase. The object of the predefinition phase is to generate a feasibility study, that of the main definition phase to develop the overall product concept. At the end of the predefinition phase is the request for a design order, at the end of the main definition phase specifications are frozen, ie the standard specifications, system design, test plan and project plan are set down definitely. The motto is better (ie more detailed) definition, and faster (ie intensified) implementation.

Parallelization of processes in product development and production

In addition to the parallelization of processes, job packages are formed which must be limited to prevent them from running for an excessive period of time. Further measures taken at the same time include early integration of production with start workshops, differentiated release of subassemblies with type testing, generation of development samples under series production conditions, early release of items to be purchased, and organization of the time schedule according to milestones (continuous time schedule covering all project stages). One of the most important points is generation of a continuous time schedule (project plan) which ensures that all employees participating in a project have the same information on project status (FIG 1). The continuous time schedule is generated with the aid of a software tool and is accessible to each participating employee via the PC network. The time schedule allows control of development costs, defines who is to do what at what time, and enables resource planning. It also allows the situation resulting from possible delays as well as their consequences to be simulated. Last but not least, analysis of the time schedule can be used as a basis for new projects.

Installation of project management and project organization

Another important measure is setting up an interdisciplinary project team with a project manager, subproject manager and project coordinator

(FIG 2). This interdisciplinary team ensures that all organizational units are integrated into the project on time and kept up to date at regular project meetings. The time schedule jointly worked out by the project team and project management, covering all phases from product planning to market introduction, forms the basis for project handling and is updated in project team meetings. Project management constantly reviews resource planning as well as development and manufacturing cost plans, calls project team meetings and works out new HTTM methods. Further, upon completion of a project, the project team carries out a project analysis, and results are put to use in follow-up projects.

Synchronization of hardware and software development

One of the most frequent trouble spots is insufficient synchronization of software and hardware development. This is due in no small part to inadequate estimation of the software development work involved. The problem can be alleviated by project-specific software planning with clear-cut division into subsystems, modules and submodules. This method allows the amount of project-specific software work to be defined and coordinated with the hardware on schedule. Structural software plans not only define the project-specific software work to be done, but also serve as a database for time and cost calculation in new projects. Expenditure can be cut by standardizing modules and module groups.

Parallelization and shortening of organizational processes

Optimally structured and transparent processes simplify networked thinking and action. Predefined methods and procedures as well as the parallelization of activities lead to reduced development times. Examples of this are the parallelization of subassembly development, generation of documentation and market introduction measures with the current development.

The methods and measures described are aimed at bringing together man, technology and organization with the objective of developing high-quality products at competitive prices within a reasonable time. They are the building blocks for a company to maintain its market position and achieve lasting customer satisfaction. To put these measures and methods into practice, each R&D company relies on highly motivated, highly qualified employees. Rohde & Schwarz therefore motivates its employees to a high degree and offers seminars for vocational training. The challenge for all employees at Rohde & Schwarz is definitely not only to recognize changing conditions but to master and even shape them. All employees are requested to support the new principles, to set by their behaviour a positive example in the face of changing conditions, and to prepare the ground for gaining further knowledge by way of innovative action. An employee committed to a project is characterized by three conditions: qualification (ability), motivation (willingness), and implementation of objectives (authorization).

To meet customer expectations with respect to quality, time and price, Rohde & Schwarz applies not only the HTTM principle but also the target-costing principle. While HTTM is primarily aimed at reducing process times, the purpose of target costing is to keep costs to a level accepted by the market. HTTM and target costing are mutually complementary principles and are implemented by means of already existing organizational structures and project teams.

Dieter Roßkothen

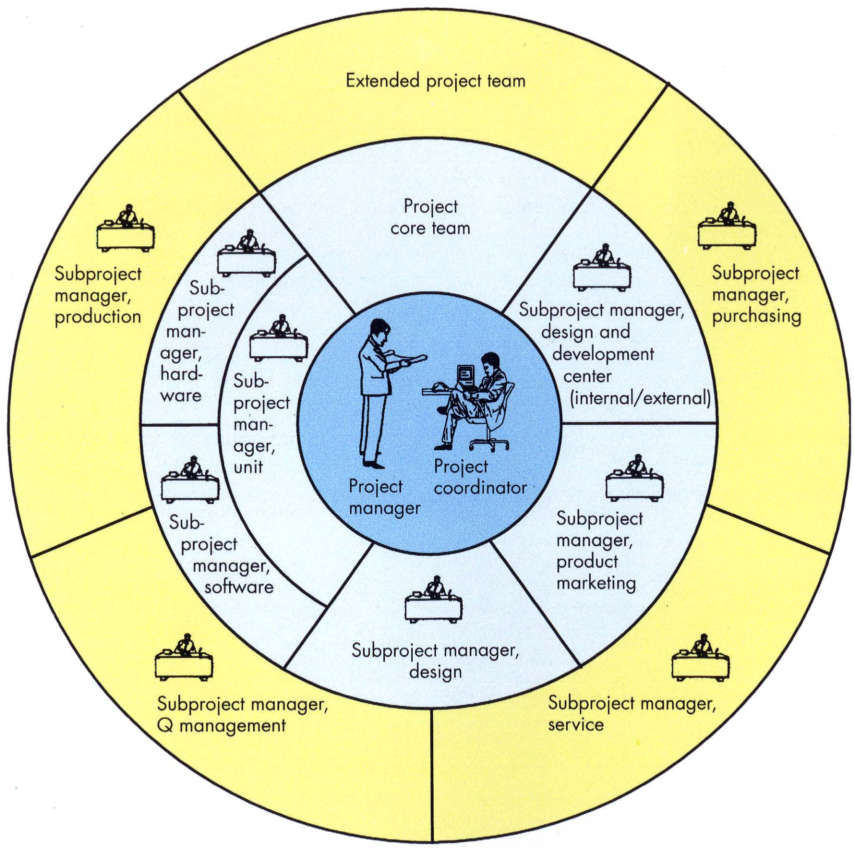


FIG 2 Structure of project team

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

News from Rohde & Schwarz 148 · PD 757.1402.21