News from Rohde & Schwarz

TETRA
Trunked radio for professionals

Industrial controller
Favourably priced, portable, EMI-proof

Shortwave
Powerful and sturdy transceivers

1997/I
153

ROHDE & SCHWARZ

Number 153 1997/I Volume 37

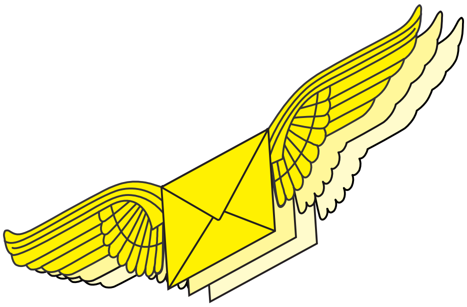
TETRA (trans-European trunked radio), the new standard for professional digital mobile radio, will soon be adopted by the competent European bodies. All manufacturers of TETRA base and mobile stations are required to perform approval measurements on their products. Rohde & Schwarz provides the appropriate test equipment with its TETRA Test Systems TS8940. For more information see article on page 4.

Photo 42 443/1

Articles

Refresher topic

Application notes



Wireless on the Internet: Message Handling Software PostMan from Rohde & Schwarz integrates for the first time radio into international communication networks (page 28).

Software

Panorama

Regular features

Power Sensor NRT-Z44 is a power measurement device of the superlative since it constitutes a measuring instrument of its own including processor. Its operation at the serial interface of a PC is extremely easy (page 7). Photo 42 683

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); G. Koranyi, C. B. Newberry (English) · Photos: S. Huber · Artwork: Nike Hofmann · Circulation 100 000 four 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

TETRA Test Systems TS8940

Type-approval tests of TETRA base and mobile stations to TBR35

The future of professional mobile radio is digital and the European TETRA standard promises the best of transmission quality, ie as long as base and mobile stations pass TBR35 type-approval tests. These can be carried out during development and production with TETRA Test Systems TS8940 comprising a TETRA simulator and a TETRA protocol tester.

FIG 1 TETRA Test System TS8940 Photo 42 709/1

The digital European standard TETRA (trans-European trunked radio), currently being finalized by ETSI (European Telecommunication Standards Institute), promises more flexibility, greater frequency economy and better transmission quality in professional mobile communication. TETRA is intended for authorities and organizations in the security sector and also operators of public trunked-radio systems for haulage, the power industry and passenger transport.

TETRA specifications

TETRA uses time-division multiplex with four communication channels on a 25-kHz carrier. The duplex spacing between transmit and receive frequency is 10 MHz. The first TETRA trunked systems will operate in the 380 to 440 MHz frequency band, and later also between 870 and 890 MHz. TETRA compresses the voice signal to 4.8 kbit/s and after error control the gross data rate is 7.2 kbit/s per time slot. If two or four time slots are used for voice and data transmission, data rates of up to 28.8 kbit/s are feasible. If only data are to be transmitted, it is possible to use a mode called packet data optimized. Another special feature of the TETRA standard is the direct mode, where TETRA mobile stations can call another TETRA mobile direct without going through a base station. A further TETRA feature is multi-address call with dynamic group arrangement.

Type-approval tests for TETRA base and mobile stations are outlined in standard TBR35 (technical basis for regulation), which refers to the following ETS specifications: ETS300394-1 (radio), -2 (protocol testing specification voice plus data) and -3 (protocol testing specification packet data optimized). Rohde & Schwarz devised Test Systems TS8940, including the TETRA simulator and TETRA protocol tester, for verification, quality assurance and type approval of TETRA base and mobile stations (FIG 1).

TETRA simulator

The TETRA simulator comprises a control unit, I/Q modem, spectrum analyzer, two RF generators, a power meter and an RF switching matrix (FIG 2). The

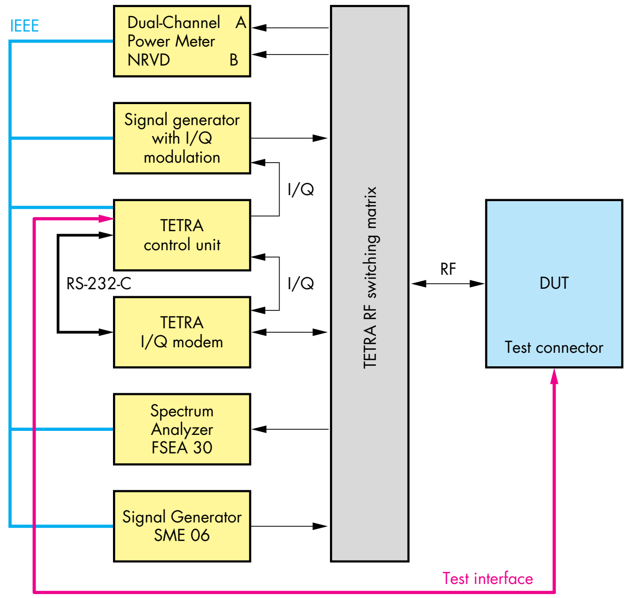


FIG 2
Block diagram
of TETRA simulator

core of the system is the **TETRA control unit,** including the controller for the entire system in addition to the basic signalling and measurement unit. The basic signalling unit consists of a data buffer, a sequence controller, an i860-RISC processor and a digital I/Q interface card. The RISC processor generates all required call control messages and forwards them to the sequence controller, which ensures that correctly timed data are sent to the DUT. The **I/Q modem** modulates the data stream and sends it to the DUT via the switching matrix and, in the reverse direction, demodulates and digitizes the data received from the DUT before forwarding them to the sequence controller. Data are evaluated in the RISC processor and answered as necessary. Special test cases require deliberately distorted test signals (fading). This function is integrated in the TETRA control unit, which distorts the signal in the baseband and transfers it to the I/Q modem.

TBR35 prescribes a second interface in addition to the air interface: the test connector implemented in the TETRA control unit as an RS-232-C interface. With the aid of a respective protocol, bit error rates of different logic channels can be measured to TBR35 on all TETRA mobile and base stations conforming to this protocol.

The system is supported by a **signal generator with I/Q modulation** that produces the faded TETRA interference signal, and **Signal Generator SME 06** to produce the interference signal for testing blocking and immunity to intermodulation. **Spectrum Analyzer FSEA30** is used to measure the power ramp, modulation spectrum and spurious emissions.

All signals are amplified and filtered in the **RF switching matrix** which incorporates relays, mixers, circulators, directional couplers and several customized filters. RF measurement levels have to be highly accurate, so the TETRA simulator uses two high-frequency probes at strategically important testpoints to minimize frequency response. Channel A of **Dual-Channel Power Meter NRVD** is used to monitor simulator transmission level, channel B to monitor received level. Any level errors occurring during measurements are automatically corrected with the aid of previously stored reference values.

RF measurements to TBR35

The TETRA simulator uses some 20 programs to measure the RF parameters of TETRA base and mobile stations to TBR35 specifications. Measurements are grouped in transmitter, receiver and transceiver tests.

Transmitter tests check the power ramp characteristic and the quality of the RF output spectrum plus immunity to intermodulation in the transmitter output stage.

In **receiver tests** the sensitivity of TETRA base and mobile stations is checked as well as their immunity to modulated and unmodulated interference in transmission and adjacent channels.

Transceiver tests check modulation, frequency, synchronization, frame alignment and transmission level matching as a function of received field strength.

Operation

A convenient graphic software interface simplifies operation of the TETRA simulator. Control, Test Cases, Selftest and Path Compensation **menus** can be selected. Control gives the user access to the PICS (protocol implementation conformance statement) and PIXIT (protocol implementation extra information for testing) files of the DUT. One or more test cases can be selected and executed in the Test Cases menu. Test cases can also be generated with parameters other than those specified in TBR35. If Selftest is selected, the operator can start a complete system test or the selftest of individual system instruments. The Path Compensation menu offers a variety of possibilities to increase the measurement accuracy. Internal path compensation considers all losses of the test system through to the antenna connector. External path compensation makes up for losses outside the test system (eg cable loss).

The user may, of course, create his **own test programs.** Generation of custom programs is easy thanks to the realtime operating system and standard C programming language. A fast C compiler and a variety of debugging procedures permit efficient and time-saving development of test software.

TETRA protocol tester

In addition to measurement of RF characteristics, TBR35 prescribes protocol measurements, for which the TETRA protocol tester is intended. Test cases are currently being created by ETSI using the TTCN (tree and tabular combined notation) specifying language and are expected to be ready this year.

The TETRA protocol tester consists of the TETRA signalling unit and the control unit (FIG 3). The signalling unit comprises the RF frontend, A/D and D/A converters, TETRA filter and DSP cards.

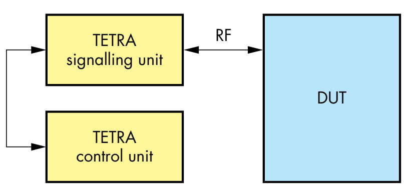


FIG 3 Functional units of TETRA protocol tester

The complete TETRA protocol stack is implemented on the digital signal processors. User interface, TTCN tools (TTCN compiler, target-code generator) and test cases are provided in the control unit. The TETRA signalling unit and the control unit communicate through PCOs (points of control and observation) provided between the individual protocol layers (FIG 4).

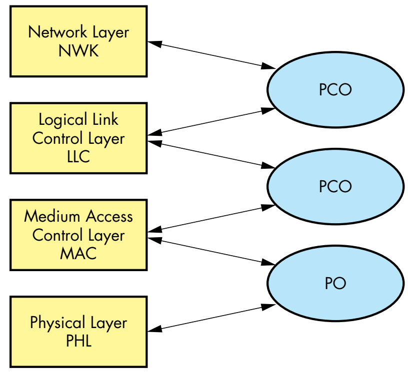


FIG 4 TETRA layer model (PO = point of observation, PCO = point of control and observation)

The protocol tester as the user sees it is a true representation of the TETRA layer model. A separate window can be opened for each PCO between the layers, in which the uplink and downlink messages are displayed. With the aid of predefined filters, information items of particular interest can be selected and displayed, eg elements violating the protocol or corresponding to an event that is to be triggered. Further menus can be selected to change the basic configuration and other settings.

The TETRA protocol tester not only checks the response of a DUT to a standard protocol, it also investigates DUT behaviour in the case of faults and deviations. The tester supports these investigations by using predefined error types in all protocol layers, which can be activated by the user as required.

The user may integrate his own procedures through the PCOs for executing user-defined tests and test cases as described in TBR35. The same method is used to implement the test cases formulated in TTCN. If the user does not wish TTCN formulation for test cases, he can formulate them direct in C instead. Rohde & Schwarz can supply all protocol test cases to TBR35 as ready implemented and installed turnkey solutions.

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Wilfried Tiwald

Features of TETRA Test Systems TS8940

TETRA simulator

Graphic user interface
RF tests executable to TBR35
Comprehensive system selftest
Path compensation for increased measurement accuracy
Simple creation and implementation of user-defined tests

TETRA protocol tester

Graphic user interface
Complete implementation of TETRA protocol stack
TTCN test cases executable to TBR35
All protocol layers software-implemented
Easy implementation of user-defined TETRA protocol layers
Predefined error simulation

Reader service card 153/01

Power Reflection Meter NRT

The next generation in directional power meters

More than ten years ago Rohde & Schwarz set new standards with its Power Meter NRV, featuring intelligent sensors and affording ease of operation not known until then. Power Reflection Meter NRT takes things a step further: its sensors have become self-contained measuring instruments that communicate with the basic unit or another terminal via a standard serial interface.

Directional power meters are used to determine transmit power and matching parameters (FIG 1) and therefore have a long tradition in the installation, maintenance and monitoring of transmitters and antennas. At Rohde & Schwarz this tradition goes back to the 50s and is associated with instruments as familiar as NAN, NAK, NAU, NAD, NAUS, NAP and NAS [1]. The new generation of power reflection meters not only offers self-contained sensors but also an accuracy and a wealth of functions not known before, making them suitable, even more so than their predecessors, for use in development, testing and quality management.

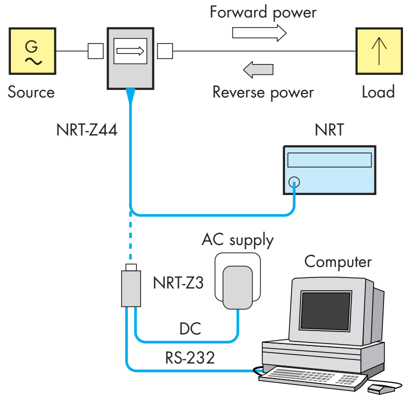

FIG 1 Power reflection meters are connected between source and load and measure power flow in both directions. Directional Power Sensor NRT-Z44 can be operated from basic NRT unit or computer with serial interface.

Market introduction of the NRT family starts with the basic NRT unit and Directional Power Sensor NRT-Z44, which is tailor-made to meet the present and future requirements of radiocommunication (FIG 2): frequency range from 200 MHz to 4 GHz, power measurement range from 0.03 to 120 W (AVG) / 300 W (CW, PEP), and compatibility with all common digital modulation standards. Further sensors for other frequency and power ranges are planned. NRT can be used in conjunction with all NAP power sensors (200 kHz to 2 GHz, 1 mW to 2 kW) [2; 3].

The best in sensors

Power Sensor NRT-Z44 measures fast and with high precision all relevant physical power parameters of transmitters as well as load matching. It is of sturdy design, insensitive to strong electromagnetic interference and remotely controllable from several hundred meters away. Combination of these features in a single power sensor is chiefly due to its design as a self-contained instrument. The power sensor not only includes a directional coupler and an analog section but also a processor kernel for control of the hardware and the remote interface and for processing measured data (temperature compensation, linearization, zeroing and frequency-response correction).

FIG 2 Power Reflection Meter NRT and Directional Power Sensor NRT-Z44 combine excellent technical characteristics with attractive design and great ease of operation. Photo 42 660

To accommodate the power sensor in a small enclosure, a new solution had to be found for the RF coupling circuit, which used to occupy as much as 80% of available space. As a result, a directional coupler of highest precision was designed taking up no more than a quarter of the total volume of the power sensor. Up to a frequency of 3 GHz, directivity, which is the quantity relevant for matching measurements, is greater than 30 dB and insertion loss is maximally 0.09 dB, ie negligible. The two measurement channels are unsymmetrical, the reverse channel being 10 dB more sensitive. This allows matching measurements at very low power. The surfaces of the primary circuit are silver-plated throughout, yielding excellent intermodulation characteristics, with unwanted frequency components kept to a minimum (FIG 3). Digital data streams on the connecting cable go unnoticed by the user of course, and radiated emission from the microprocessor present at the RF connectors is below the limit of detection. All these features make NRT-Z44 suitable not only for testing but also for fixed installation.

The key parameters measured by NRT-Z44 are average **forward power** and **load matching,** both with extremely high accuracy. In measurement of the power of a carrier with an unmodulated envelope (CW, FM, φM, FSK, GMSK, etc), uncertainty is no more than 4%, taking into account the test frequency. This performance is comparable to that of thermal power meters. Likewise, measurements on modulated envelopes (AM, π/4-DQPSK, CDMA, DAB) or superimposed carriers (eg on a common antenna feeder) will not produce any significant errors up to an average power of 120 W.

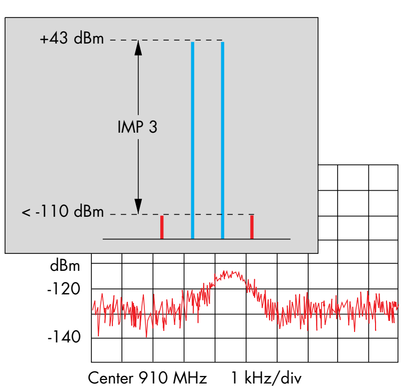

FIG 3 Sensor NRT-Z44 features excellent intermodulation characteristics: 3rd-order intermodulation products are well below –110 dBm. Carrier spacing (IMP3) is better than 155 dBc. Test parameters: 2 x 20 W (+43 dBm) carrier power in GSM band

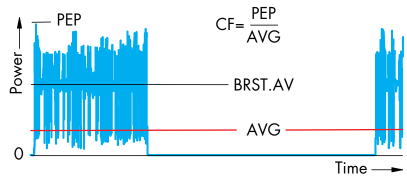

FIG 4 Definition of key power parameters for modulated RF burst (AVG: average power, PEP: peak envelope power, BRST.AV: burst average, CF: crest factor)

Directional Power Sensor NRT-Z44 measures several **parameters of modulated RF** (FIG 4): peak envelope power (PEP) provides information on the periodic peak value of output power and is thus an important quantity for describing the maximum output level of a transmitter. The same applies to the crest factor (CF), which is the ratio of PEP to average power and directly indicates substantial modulation distortion. With a suitable evaluation bandwidth (selectable in steps), both functions can be used for spread-spectrum signals up to a bandwidth of 2 MHz (CDMA, DAB) and yield satisfactory results much faster than expensive envelope analyzers.

The **power of RF bursts** can be measured in two ways: with the PEP function for bursts with an unmodulated envelope from 200 ns pulse width and with the average burst measurement function (BRST.AV). The latter measures the power of modulated bursts from the average power (AVG) and the duty cycle, which may be defined by entering the burst duration and repetition rate or determined automatically by the power sensor. Stochastic modulation signals can be described by means of the complementary cumulative distribution function (CCDF). This function measures the probability of the envelope power exceeding a selectable threshold and thus allows determination of amplitude distribution.

Operation made easy

Operation is easiest using the basic NRT unit. NRT has all the facilities that the user could possibly wish for. Besides a large display and a manageable number of clearly laid out keys, NRT offers **remote control** capability: via an IEC/IEEE bus in accordance with IEEE 488.2 or via an RS-232 interface using the SCPI instruction set, both implemented to standard. In **manual operation** switchover between the main functions is made by a keystroke, eg changing units from W to dBm, switching between average power and a configurable envelope parameter (PEP, CF, BRST.AVG, CCDF) or between SWR and another matching parameter. Further functions selectable at a keystroke include measurement of relative power differences in dB or %, display of maximum and minimum values, scaling of the two bargraphs, acoustic SWR monitoring, switchover between forward power and absorbed power, and many more. Settings are made in three clear-cut menus. Measurement accuracy can be further enhanced by zeroing, frequency-response correction and by selecting a source or load reference plane.

NRT can be extended with three **options.** NRT-B1 allows all NAP sensors to be connected. NRT-B2 provides two additional connectors for type NRT-Z sensors, switchover between the sensors being made in a matter of seconds. Option NRT-B3 turns NRT into a mobile unit: an Ni-MH battery enables up to eight hours continuous operation independent of the AC supply. The battery can be quick-charged within two

FIG 5
Power Reflection Meter NRT and 4-GHz Directional Power Sensor NRT-Z44: competent tools for on-site applications, here during installation of mobile-radio base station
Photo 42 667/1

hours by a built-in charger. Alternatively, a standby battery can be installed in next to no time. NRT together with all its accessories can be accommodated in a sturdy carrier bag – ideal for on-site applications (FIG 5).

What more can be said about NRT? It offers all the features expected of a state-of-the-art measuring instrument: continuous AC supply range without switching, storage of instrument settings, no maintenance as no lithium buffer battery is used, firmware download via the RS-232 interface, elapsed-time meter, etc.

Direct power monitoring on PC

The functionality of Directional Power Sensor NRT-Z44 can also be utilized to the full without the basic NRT unit by operating the sensor on the RS-232 interface of a PC or other computer. For this, Interface Adapter NRT-Z3 (RS-232 to RS-422) is required, which includes a direct plug-in power supply (see FIG 1). Demo software is available that runs under Windows. The above combination affords full functionality of Sensor NRT-Z44 at an unbeatable price. The attractiveness of the new solution becomes particularly evident when it is compared to a conventional test setup consisting of a dual directional coupler, two power sensors and a peak power analyzer. The stand-alone solution is therefore ideal for the following applications: computer-controlled power measurements in research and development, power monitoring of transmitters and EMC test systems, in-production measurements and many more.

All in all, NRT is a truly *plug-and-play* instrument.

Thomas Reichel

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

Condensed data of Power Reflection Meter NRT

Basic unit NRT	
Frequency range	200 kHz to 4 GHz
Power measurement range	1 mW to 2 kW
Measurement functions (sensor-dependent)	
Power	average, peak envelope (PEP), burst average, complementary cumulative distribution function
Matching	SWR, return loss, reflection coefficient, reverse power
Sensors	NRT-Z44 and all NAP sensors
Remote control	IEC/IEEE bus, RS-232
Power supply	AC supply and rechargeable battery
Directional Power Sensor NRT-Z44	
Frequency range	200 MHz to 4 GHz
Power measurement range	0.03 to 120 W (AVG) / 300 W (CW, PEP)
Directivity	30 dB up to 3 GHz
Measurement functions	same as basic unit NRT
Interface with basic unit/computer	full-duplex RS-422, power supply 7 to 28 V DC; connection to RS-232 interfaces with Interface Adapter NRT-Z3

Reader service card 153/02

Portable Industrial Controller PSP

Measurement and control made mobile

Downsizing in three attributes is what makes Industrial Controller PSP different from its predecessors: down in price due to consistent design to cost, down in size making PSP Rohde & Schwarz's first portable controller, and RF emission cut down to a minimum.

FIG 1 Convenient use of Portable Industrial Controller PSP in helicopter Photo 42 681

Hardware

The excellent electromagnetic compatibility of T&M controller PSP has not come out of the blue. EMC criteria were observed throughout development and design of this controller. Extensive filtering on electronic components together with a sealed casing and new style of construction allow this industrial controller to be used side by side even with highly sensitive receivers without impairing results. Two models are available: PSP2 without display and PSP7 with a high-contrast 8.5-inch display (FIG 1).

What goes on inside PSP is just as good, as its **configuration** shows:

- AMD586 processor with 133-MHz clock,
- 8-Mbyte RAM, expandable to 128 Mbytes,
- 500-Mbyte harddisk on local bus,
- fast, flickerfree SVGA graphics with up to 1280 x 1024 pixels resolution on local bus for external monitors,
- simultaneous display on internal (PSP7) and external monitor,
- type-III PCMCIA interface,
- parallel interface to EPP/ECP standard,
- two serial interfaces with FiFo,
- fast 16-bit GPIB interface, compatible with IEEE-488.2 standard,
- 3.5-inch disk drive,
- integrated keyboard with 31 keys and knob.

Despite its compact size, PSP has four extension slots, two of which are full length (330 mm) and two just 18 mm shorter. This enables PSP to be adapted to any special measurement task on hand.

PSP can be operated on batteries or DC sources, so it is not dependent on an AC supply. Its power supply unit accepts the kind of DC voltages available on ships, in aircraft and vehicles. Internal or external batteries ensure several hours of operation totally independent of stationary supplies. High operating dependability and reliability (eg uninterruptible power supply, manufacture to ISO 9000) guarantee problemfree operation, especially in automated production, where the controller can take on central importance as a control and monitoring element.

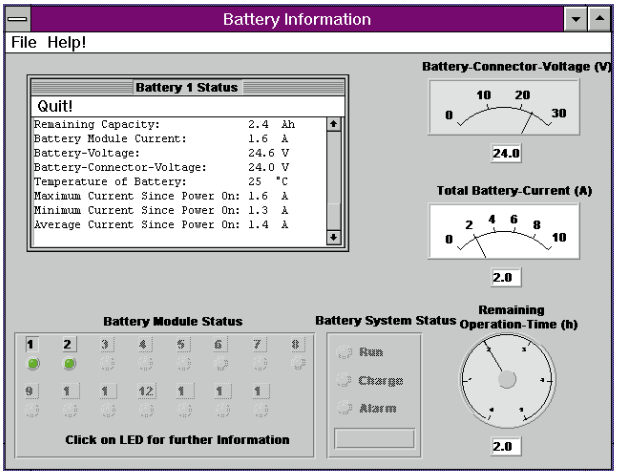

FIG 2 Display of battery status

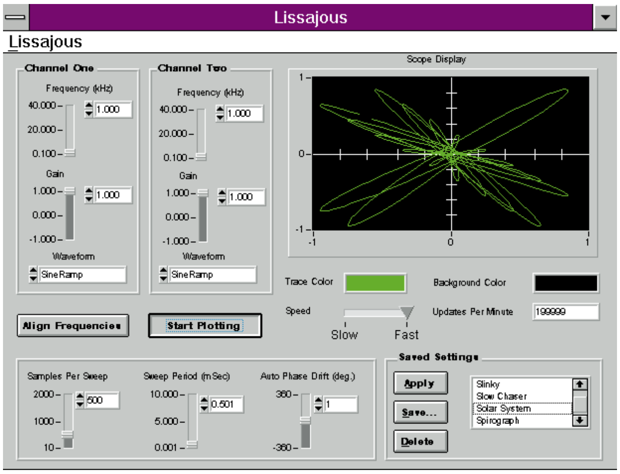

FIG 3 Display of test results using LabWindows/CVI

Software

PSP comes equipped with a complete software package. All required **programs and drivers** are **ready installed** and optimally attuned to one another. There is no need for the user to subsequently configure and optimize the system – just switch on and go.

An integrated **battery management** function tells the user at any time how long PSP can continue to operate on the remaining battery charge, which leads to better utilization and prolonged battery service life. All relevant data can be polled conveniently through the battery control software. This includes not only charge or discharge status but also a whole variety of battery-specific data such as the number of charging cycles of the connected batteries and the useful capacity of individual battery packs (FIG 2).

LabWindows/CVI (C for virtual instrumentation) is PSP's professional development tool for **typical T&M tasks.** This enables professional Windows programs to be generated quickly and easily. LabWindows/CVI offers a development environment for both standardized hardware and software components, making it an ideal solution for data collection, data processing and equipment control. The program supports standard interfaces like GPIB and RS-232 as well as T&M plug-ins for test-data acquisition. Comprehensive analysis functions and graphic display tools allow fast and convenient processing and professional presentation of measured results (FIG 3).

LabWindows/CVI considerably reduces development times for complex test and control programs. The programming aids contained in LabWindows/CVI will be particularly appreciated by beginners. They cover primarily generation and management of graphic user interfaces under Windows, development of ANSI-C programs as well as control of test equipment and T&M plug-ins.

LabWindows/CVI drivers for Rohde & Schwarz measuring equipment greatly simplify device programming. Settings are entered by a mouse click, control commands are executed interactively. Of course, all CVI drivers for Rohde & Schwarz measuring equipment are ready installed on PSP.

Michael Altmann; Joachim Stegmaier

Condensed data of Industrial Controller PSP

CPU	AMD X5, 133 MHz, 8-Mbyte RAM, expandable to 128 Mbytes
Display	8.5-inch colour LCD (PSP7), no display (PSP2)
Harddisk	500 Mbytes or larger
Disk drive	1.44 Mbytes, 3.5-inch
Interfaces	
Internal	ISA bus
External	GPIB, 2 x RS-232-C, PCMCIA, printer, keyboard
Operating system	MS-Windows 3.1 upwards and MS-DOS 6.2 upwards
T&M software	LabWindows/CVI
Programming languages	R&S Basic, software drivers for QuickBasic, MS-Visual Basic, MS-C, TurboPascal

Reader service card 153/03

HF Transceivers XK2500 and XK2900

The new members of HF Transceiver Family XK2000

New transceivers for 500 W and 1 kW output have been added to Rohde & Schwarz's XK2000 family of radio equipment for shortwave communications from 1.5 to 30 MHz. Their range of applications covers land-mobile and shipboard use as well as stationary operation by authorities, national forces, security services and the like.

1-kW HF Transceiver XK2900 consisting of receiver/exciter, 1-kW power amplifier and power supply unit Photo 42 700

Nowadays worldwide shortwave communication means automatic, fast and independent radio links for speech and data transmission which connect two terminals direct over any distance. Prerequisites are reliable call setup, fast and secure data transmission and adaptive response of the system to any link disturbance. Thanks to highly advanced radio processors, perfect data protection and high-speed data modems, Rohde & Schwarz hardware and firmware fully meet these requirements. In addition, a fast serial bus system as well as digital processing of both transmit and receive signals guarantee excellent performance in Rohde & Schwarz transceivers. Operating costs are very low, so the user gets an exceptionally economical solution for worldwide speech, data and image transmission [1].

The new members of the XK2000 family, HF Transceivers XK2500 and XK2900 (FIG), were developed to the most highly advanced standards and are produced using the very latest processes. They may be controlled locally or remotely depending on the version of **Receiver/Exciter GX2900** that is used (L or R). The man/machine or user interface of the 500-W and 1-kW transceivers is the same as that of the smaller XK2100 with output power of 150 W [2]. Power amplifiers and receiver/exciter may be spaced up to 65 m apart. The interface between receiver/exciter and amplifier handles varied chores such as digital controlling and analog regulation of power amplifiers, controlling of antenna tuning units, line matching unit, harmonics filter and antenna. This guarantees full compatibility of XK2500 and XK2900 with ready installed ATUs or antennas of the HF850 family. Furthermore, a plug-in module allows control of an active selective antenna for duplex operation with a separate receive antenna or of a motor-tuned preselector for operation under extreme collocation conditions.

All **options** of Transceiver XK2100 can naturally also be accommodated in Receiver/Exciter GX2900, for example:

- automatic phone patch for telephoning on shortwave,
- communication processor for automatic link setup,

- voice processing unit for high-quality speech,
- digital selection to solve collocation problems,
- data modem for fast and secure data transmission (up to 5400 bit/s [3]),
- Rx/Tx interface for full-duplex operation with remote receiver and GMDSS operation (global maritime distress and safety system) with DSC (digital selective call),
- data link interface for naval communication to MIL-STD.

Supported by this variety of options, the XK2000 family can satisfy even the most stringent customer requirements, and its high system flexibility lends itself to both conventional and highly innovative applications. Software can be updated simply and speedily via the built-in RS-232-C interface. A new feature is that a Transceiver XK2100 or a Receiver/Exciter GX2900 can be configured by softkey for both transmit and receive operation or just one of the modes. This is of particular interest for duplex operation with a remote receiver. The fact that the same equipment and options are used at either end of the link is a great logistic benefit.

HF Power Amplifiers VK2500 and VK2900 of the new transceivers look exactly alike. The amplifier stages are exclusively in TMOS FET technology and produce a signal of particularly low noise and high spectral purity. Their sophisticated cooling concept allows output of CW signals even at maximum permissible ambient temperature with the transistor chips operated far below their temperature limits. The 1000-W version is equipped with two 500-W output stage modules of the kind used in the 500-W amplifier. This means that if one of the modules in the 1-kW version is undergoing maintenance, the amplifier can continue to operate at 500 W. When XK2500 is configured with certain types of ATU and antenna, it is also possible to reduce maximum output power to 400 W (PEP or CW) by softkey.

The amplifiers are modular and easy to service. Excellent operational reliability is guaranteed by a comprehensive test and monitoring system and a dedicated single-chip processor. The continuous monitoring function and built-in tests register normal operating statuses, which are displayed as plain text, while faults are localized down to module level. Depending on the type of fault detected, operating functions are either restricted or the unit is switched off for reasons of safety. Receiver input protection is provided for operation under extreme HF collocation conditions, so input voltages of up to 100 V present no risk.

Power Supply Units IN2500 and IN2900 of the transceivers are designed for one- and three-phase operation. A transformer is available for uncommon supply voltages as may be found on ships for example. Emergency power such as a 24-V battery can be fitted for uninterrupted switchover in case of power failure, thus ensuring continued communication at reduced power. Both power supply units have blowers that are activated automatically in case of overtemperature.

All components of the XK2000 family are **suitable for harsh environments,** so their use in vehicles and onboard vessels will not pose any problems. Shock absorbers are available for extremely high levels of shock and vibration. Nor will varying climatic conditions and critical EMC environments impair operation of the transceivers. Besides qualifying for the EC type-examination certificate (CE label), the transceivers meet the major requirements of MIL-STD-188-141A. They have also received general certification by Germany's Federal Approvals Office for Telecommunications.

Robert Träger

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Condensed data of HF Transceivers XK2500 and XK2900

Transmit/receive frequency range	1.5 to 30 MHz/10 kHz to 30 MHz
Classes of emission	A1A (CW), J3E (SSB), H3E (AME), J7B (A7J, radio data), F1B (FSK/AFSK), B8E (ISB), F3E (FM)
Transmit power XK2500/XK2900	500 W/1000 W (PEP and CW)
Intermodulation suppression	> 36 dB, typ. 40 dB (referred to PEP)
Receiver noise figure	9 dB (8 kT_0) with preamplifier
Intercept points, typical	70 dBm (IP_2), 35 dBm (IP_3)
Remote-control interfaces	RS-232-C, RS-485/RS-422 (bus-compatible)

Reader service card 153/04

TV Test Transmitter SFQ

Digital test signals for the television future

TV Test Transmitter SFQ is a complete solution for testing digital TV receivers. It specializes in the generation of standard DVB signals for satellite and cable transmissions. SFQ also processes analog, frequency-modulated satellite TV and sound signals to PAL, SECAM and NTSC standards. Audio signals are transmitted with analog FM and digital ADR sound subcarriers.

FIG 1 TV Test Transmitter SFQ generates standard DVB signals. Photo 42 592

Timed just right for the beginning of the era of digital TV, Rohde & Schwarz is launching a new TV test transmitter on the market: the SFQ (FIG 1). It is capable of processing source-coded signals to MPEG2 standard for digital transmission via satellite or cable. The main **features** of SFQ are:

- wide output frequency range from 0.3 to 3300 MHz,
- generation of standard DVB-S and DVB-C signals (S = satellite, C = cable) in line with ETS 300 421 and 300 429 specifications [1],
- input data rate selectable between 2 and 60 Mbit/s,
- switch-selected energy dispersal, Reed-Solomon coder and interleaver,
- variable rolloff factor for pulse shaping,
- data, random sequence, null transport stream packet selectable as modulation signal,
- application of external I/Q signals,
- adjustable puncturing rate for QPSK (quadrature phase shift keying),
- selectable QAM (quadrature amplitude modulation) modes (16, 32, 64, 128, 256QAM),
- generation of standardized FM satellite signals,
- selectable standard for FM transmission (PAL, SECAM and NTSC),
- up to six FM sound subcarriers with internal audio generators,
- up to twelve ADR sound subcarriers (Astra digital radio) with internal MUSICAM generators,
- internal noise generator.

These features open up a wide **field of application** for SFQ in development and production as well as in the service of digital TV receivers and their modules. System margins have to be checked at the latest during final testing of receivers to avoid their early failure at the customer. SFQ with built-in noise generator and MPEG2 Generator DVG [2] are the right team for this job. In the laboratory SFQ convinces by its great variety of modulation modes and parameter settings. When it comes to EMC testing, SFQ and DVG form an ideal signal source for checking out TV receivers.

Design and options

The **flexible modular concept** allows SFQ to be equipped to suit the customer's measurement requirements. The TV test transmitter comes in three models (FIG 2). Model 10 is particularly suitable for the requirements of DVB applications. Model 90 comprises all the modules required for analog satellite FM transmission. Model 50 is the complete solution made up of models 10 and 90 for generating digital DVB signals and analog FM satellite signals.

Realistic receiving conditions can be simulated with the aid of a noise generator. For this purpose the digital SFQ model 10 can be equipped with a **broadband FM module** comprising a noise generator in addition to the FM modulator. The noise signal is added to the information signal by way of a coupler to produce a defined C/N (carrier-to-noise) signal. With the broadband FM module included in models 90 and 50, the noise generator is automatically available. The **FM subcarrier module** in models 90 and 50 generates two completely conditioned FM subcarriers. Two additional subcarrier modules may optionally be fitted: FM or

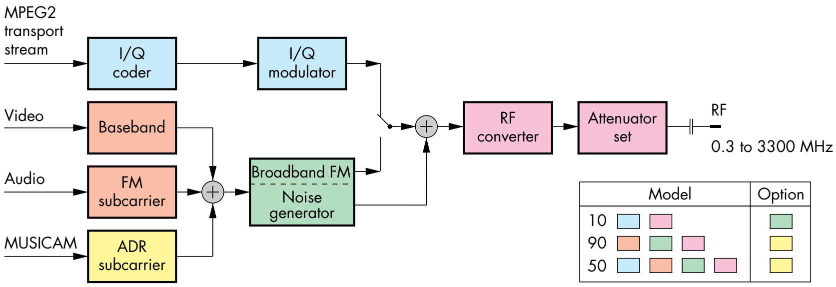

FIG 2 Block diagram of three models of TV Test Transmitter SFQ

ADR subcarrier. A total of six carriers can then be transmitted.

Coding and mapping for satellite and cable

TV Test Transmitter SFQ encodes the applied transport stream for satellite and cable transmissions to standard and conditions it so that I and Q (inphase and quadrature) signals are obtained. SFQ accepts transport streams with a packet length of 188 or 204 bytes. The input interface is synchronously parallel in LVDS (low-voltage differential signalling) format [3]. The input data rate can be set between 2 and 60 Mbit/s. The incoming data rate is measured and adopted in the setting by a simple keystroke.

In addition to the external transport data stream, a random sequence or null transport stream packet as defined in the DVB measurement guidelines [4] can be selected. SFQ warns the user if the input signal fails or the set data rate does not match the incoming one. In this case the data stream is linked to a random sequence, ensuring that signal energy is evenly distributed (energy dispersal). Energy dispersal can of course be disabled.

Following energy dispersal a Reed-Solomon coder (204, 188) is provided as an outer coder for error control. 16 bytes are added to the unchanged 188 data bytes. These 16 bytes represent the redundancy that allows eight errored bytes of a frame to be corrected. A convolutional interleaver with depth of 12 and base delay of 17 transmits the data evenly distributed over a relatively long period of time. If data transmission is impaired for a limited time, the large interference is split into many small interferences that can be corrected by the Reed-Solomon decoder. The interleaver can also be disabled.

Until after the convolutional interleaver, coding is the same for satellite and cable transmission. After the interleaver additional inner error-control coding is performed for the **satellite signal:** convolutional encoding with subsequent puncturing. The convolutional encoder has a rate of 1/2, constraint length of 7 and generator polynomials 171 (octal) and 133 (octal). This procedure doubles the data rate. Puncturing is carried out next, ie bits are left out in the transmission as specified in the standard so that the data rate is reduced again. Mapping into the I and Q path is performed at the same time. All DVB puncturing rates (1/2, 2/3, 3/4, 5/6 and 7/8) are selectable on SFQ. The concatenated error control for satellite transmission ensures that with input error rates of 1×10^{-3} a data signal with a BER of approx. 1×10^{-12} is available at the receiver end. The spectrum is limited by pulse filtering. A square root cosine rolloff factor of 0.35 is prescribed for satellite transmissions. The factor can be adjusted in SFQ between 0.25 and 0.45.

No inner coding is performed for **cable transmissions,** as in this case interference due to noise, nonlinearities and interruptions is less likely than on satellite links. Mapping is carried out first, depending on the QAM order. 64QAM is normally used in cable transmissions. With 64QAM, six bits are combined to a symbol and differentially coded. 16QAM, 32QAM, 128QAM and 256QAM can also be selected in SFQ. For cable transmission too, pulse filtering is used to limit the signal spectrum. The nominal factor is 0.15 and can be varied between 0.1 and 0.2.

I/Q modulation

In the I/Q modulator the two orthogonal I and Q components of the RF signal are controlled in amplitude and phase by the serial I and Q data streams from the coder. The two RF components are added to give an output signal that can be amplitude- and phase-modulated as required.

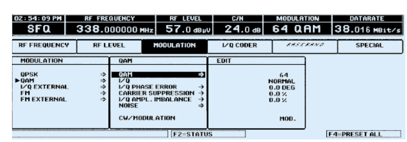

FIG 3 Menu display for QAM modulation

Assignment of I and Q components in SFQ can be interchanged so that an inverted RF signal is obtained. High demands are placed on the I/Q modulator particularly with a view to high-order quadrature amplitude modulation. The internal calibration of SFQ guarantees that I and Q paths show identical gain, the phase is exactly 90° and carrier suppression at least 50 dB. Non-ideal behaviour of the I/Q modulator can be simulated by deliberately detuning amplitude, phase and residual carrier (FIG 3). As a result bit errors are produced allowing quality assessment of receivers or demodulators

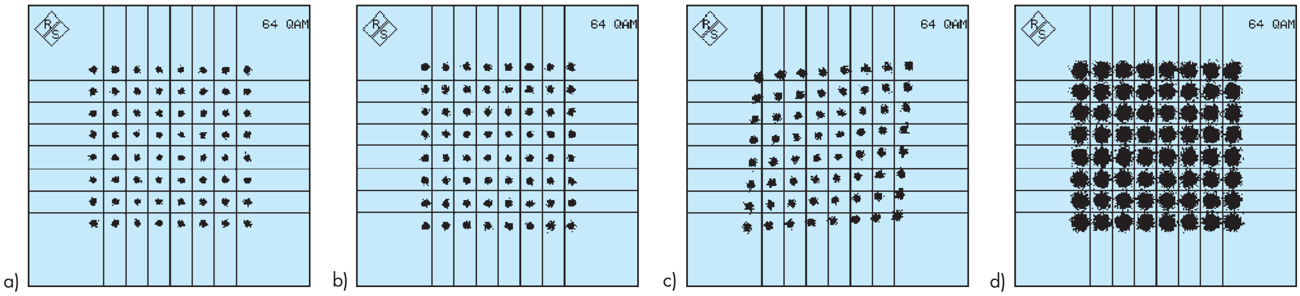

FIG 4 Constellation diagram showing at left ideal 64QAM signal of accurately aligned I/Q modulator a) and deliberately misaligned 64QAM signals with b) 10% amplitude imbalance, c) 10° phase error and d) superimposed noise (C/N = 24 dB)

(FIG 4). DVB Test Receiver EFA [5] is an ideal instrument for detecting and calculating QAM quality parameters.

Analog baseband conditioning and frequency modulation

Analog FM TV transmission via satellite will certainly be used for years alongside digital QPSK modulation. For this reason SFQ is also able to condition analog TV channels with all appropriate characteristics: eg dispersal signal synchronous to video frame, automatic deviation doubling in the case of video signal failure, deviation inversion for video and energy-dispersal signal, deviation adjustment for video signal, dispersal signal and separately for each sound subcarrier. TV standards PAL, SECAM or NTSC are selectable.

In the Astra satellite system it is planned to transmit further audio and data channels in addition to the accompanying stereo (7.02/7.20 MHz) or mono (6.5 MHz) sound channel. The built-in MUSICAM generator can produce up to twelve ADR subcarriers. If more than six subcarriers are required, a second SFQ will have to be used. The modules of this unit are controlled by the master SFQ via the internal SERBUS. SFQ thus meets all requirements for conditioning analog TV channels transmitted via satellite.

Noise generator

The noise generator produces white noise with a Gaussian distribution at the set output frequency over the channel bandwidth. The power density of the noise signal can be set indirectly as a C/N (carrier-to-noise) ratio. This is extremely convenient for the user as the C/N ratio in dB can be entered immediately after the selection of the demodulator receive bandwidth. SFQ can thus simulate different types of interference as they really occur along the satellite or cable transmission path to the receiver.

Erhard Kretschmer;
Franz-Josef Zimmermann

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

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Condensed data of TV Test Transmitter SFQ

Coding and modulation (DVB-S and -C)	to ETS 300 421 and ETS 300 429
For DVB-S	
Puncturing rates	1/2, 2/3, 3/4, 5/6, 7/8
Modulation	QPSK
For DVB-C	
Modulation	16, 32, 64, 128, 256QAM
I/Q modulation	
Detuning of phase error	±10°
Detuning of amplitude imbalance	±10%
Detuning of residual carrier	0 to 50%
Analog baseband and FM	
Video and dispersal signal conditioning	for PAL, SECAM and NTSC
FM sound subcarriers	up to 6, internal
ADR sound subcarriers	up to 12, internal
Output frequency range	0.3 to 3300 MHz
Output level	+4 to –99 dBm (CW: +13 dBm)
Noise generator	C/N = 0 to 60 dB, resolution 0.1 dB

Reader service card 153/05

Digital modulation and mobile radio (IV)

3.1 π/4 differential QPSK

A special form of baseband signal encoding that only uses phase shifts of 45° and 135° is used for networks operating to the Japanese JDC standard and for digital trunked-radio networks in Europe and this is one solution to the problem. The approach at least prevents carrier extinction, momentary loss of the carrier. With π/4 differential QPSK the information is not represented by an absolute phase but rather in terms of a phase difference. So coherent demodulation is unnecessary and there is no need to deal with the difficult problem of reconstructing a carrier with exactly the same frequency and phase of the original from the received signal, strongly distorted by the mobile-radio channel.

The original data sequence a(n) undergoes serial/parallel conversion, thus generating a new symbol sequence $b(m) \in \{00; 01; 10; 11\}$ whose elements are assigned to the phase transitions listed in TABLE 2. This assignment is essentially a type of Gray coding, adjacent symbols and signals differing by just one bit. An approach of this kind reduces bit errors. The π/4 offset gives the modulator a memory function.

Dibit	Phase transition
00	$\Delta\varphi = 0 \cdot \pi/2 + \pi/4 = 45°$
01	$\Delta\varphi = 1 \cdot \pi/2 + \pi/4 = 3\pi/4 = 135°$
11	$\Delta\varphi = 2 \cdot \pi/2 + \pi/4 = 5\pi/4 = 225° = -135°$
10	$\Delta\varphi = 3 \cdot \pi/2 + \pi/4 = 7\pi/4 = 315° = -45°$

TABLE 2 Phase transitions for π/4 DQPSK

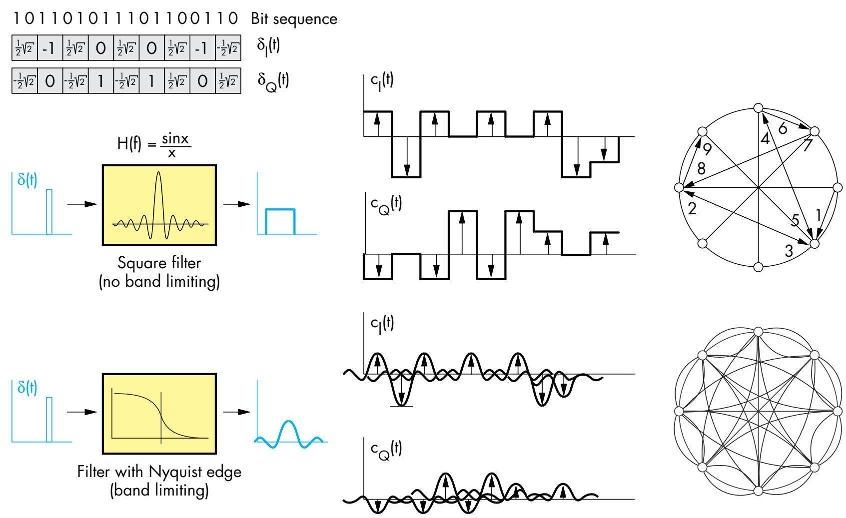

FIG 9 Data sequence, I/Q signals and phase state diagrams for π/4 DQPSK

The phase transitions are modulated onto the carrier by an I/Q modulator (FIG 8). First the current carrier phase is obtained from the sequence of phase differences by means of a feedback loop, then the two modulation signals $c_I(t)$ and $c_Q(t)$ are calculated from the carrier phase. At this stage the modulation signals are in the form of delta functions $\delta(mT) \in \{+1;\ +1/2\sqrt{2};\ -1/2\sqrt{2};\ -1\}$.

They are then band limited by passing them through lowpasses (FIG 9). A raised cosine filter is used. Moreover, filtering is shared between the transmitter and the receiver.

By splitting up the overall filter response into equal parts at the transmitter and receiver end

$$H(f) = \begin{cases} 1 & \text{for } 0 \le f \le \frac{(1-\alpha)}{2T} \\ \sqrt{\frac{1}{2}\left\{1-\sin\left[\frac{\pi(2fT-1)}{2\alpha}\right]\right\}} & \text{for } \frac{(1-\alpha)}{2T} < f \le \frac{(1-\alpha)}{2T} \\ 0 & \text{for } \frac{(1-\alpha)}{2T} < f \end{cases} \qquad (18)$$

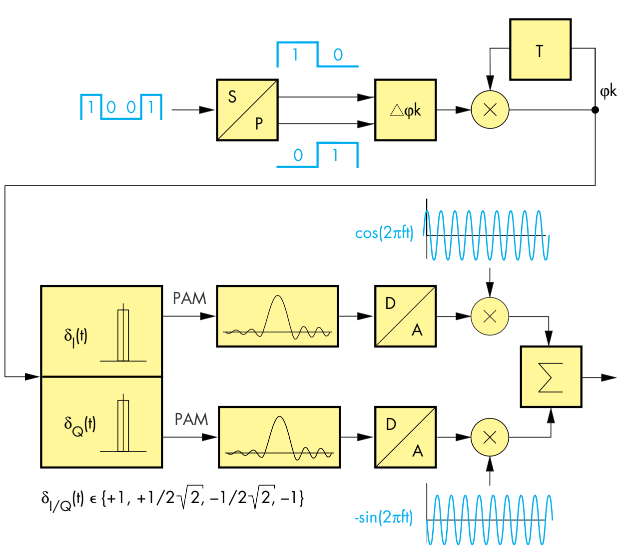

FIG 8 I/Q modulator for π/4 DQPSK

it is possible to obtain an optimal signal/noise ratio when recovering the received symbol sequence b′(m).

To be continued. Peter Hatzold

In-production testing of automotive electronics

The kind of electronic components used in automobiles are frequently subject to extreme conditions like large temperature fluctuations and strong vibrations, besides being exposed to electromagnetic interference, so they have to meet particularly stringent requirements to guarantee operational reliability and safety. This means that, in addition to painstaking development and testing of such circuitry, thorough quality assurance is also called for during production. It is not enough to simply check products for manufacturing defects. A combination of different test procedures is necessary to comply with the high standards imposed. In many cases functional tests and a run-in test are made obligatory by automobile manufacturers anyway. On top of that all test results have to be fully documented and archived for a long period to satisfy product liability and ISO 9000 requirements. On the other hand, competition is particularly fierce among suppliers to the automobile industry, so cost cutting in manufacture is essential. This in turn entails the necessity to employ cost-efficient testing solutions and to optimize test times. An example taken from industry illustrates how Rohde & Schwarz can contribute to producing the right answer.

The **Temic Microelectronic** company in Ingolstadt (Bavaria) produces central controllers for the Daimler-Benz E series and SLK roadster. This module controls various devices such as direction indicators, windshield wipers, window openers and sun-roofs. The module is about the size of a dual Eurocard and consists of numerous analog and digital components, one or two microprocessors, various power drivers and switch-

FIG 1
Test Workstation
TSAC in use at
Temic Microelectronic
in Ingolstadt
Photo 42 627/2

ing relays. The PCB is fitted with SMT components on both sides and the end-product is housed in a plastic casing. To check out these modules Temic uses altogether five test systems from Rohde & Schwarz including programs and test fixtures (FIG 1).

The **test concept** involves two phases: first a combinational test on a Test Workstation TSAC [1] followed by final testing of the complete modules by a Universal Test System TSU [2] (FIG 2). In the combinational test the module is contacted by a vacuum fixture. Thanks to its double-chamber design, the fixture allows increased throughput by testing one module on one side of the fixture while another is being placed for testing on the other. The TSAC system first checks modules for manufacturing defects in an analog in-circuit test, then customer-specific components are examined in a functional test. Here the module's own diagnostic capabilities are utilized, via the CAN bus, which maintains communication between individual control modules in a vehicle, and via the K bus, which is another serial line and serves for fault diagnosis in a vehicle. For such tasks all systems of the TSA and TSU series can be fitted with an application module allowing customer-specific solutions based on a CAN bus and a K bus interface to be mounted on available space free on the module. All functional tests are performed with the aid of load simulation units integrated in the fixture. Once these have been completed the user can be sure that a module is free of manufacturing defects and all its basic functions are in order.

Upon completion of the combinational test, modules are sampled at random for reliability. The samples undergo an active run-in test of several days' duration, performed by a TSU system with a special switching matrix and a climatic rack. During the entire procedure the modules are supplied with operating voltage and cycled through functional tests at changing temperatures.

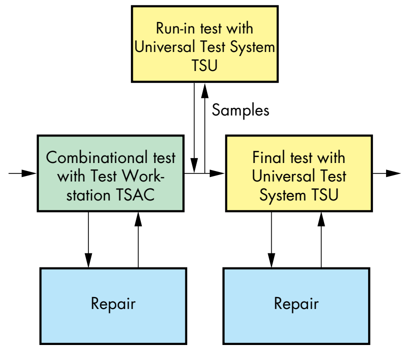

FIG 2 Diagram illustrating test strategy using TSAC and TSU

Once a module has finally been housed in its plastic casing, it undergoes final testing via its interface contacts. Real loads, eg electromotors, are used to make this as realistic as possible. The functions of the modules are fully tested step by step, which also involves use of the CAN bus and the K diagnostic line. Automatic alignment is carried out simultaneously, but despite the large number of individual tests and the alignment procedure, overall time to test is only about 1 min 20 s.

All related test data are saved according to ISO 9000 guidelines and then archived. For this purpose the test systems convert the data to a suitable format and transport them to the quality-management system. Test data are used to draw up quality statistics and facilitate paperless repair. Each test system is supplemented by repair stations. The fault data of a module can be displayed on a repair station's screen by reading the EEPROM-stored serial number specific to the module and appropriate repair actions entered subsequently. This guarantees uninterrupted documentation of module service life right from the beginning.

Both systems – TSAC and TSU – belong to the same test system family, so the user will be able to considerably cut down on times needed to **develop programs,** seeing as large parts of the functional tests contained in the combinational test, final test and active run-in test are very similar and can be transferred from one system to another. Plus, the same modules can be used in both systems, which is another benefit as far as the CAN-bus interface is concerned. Combination of TSAC and TSU proves to be a particularly economical solution for this two-phase test strategy, as an optimal test platform can be selected for each phase without the cost of unnecessary overheads.

Rohde & Schwarz devised a turnkey solution including the complete project development, configuration and supply of the test systems, test programs and fixtures as well as commissioning and the training of Temic staff.

Klaus Kundinger

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Reader service card 153/06

Measuring noise parameters of twoports with Spectrum Analyzer FSM

Determining the noise parameters of twoports requires measurement of spectral noise-power density. Normally such measurements are carried out with highly sensitive receivers by the radiometer principle or with commercial, automatic noise-factor meters. Lately spectrum analyzers too come equipped for this application, although they are mainly intended for observing spectra with discrete frequencies rather than precise measurement of extremely low noise levels. Stability of receiver parameters with time is an important criterion for these measurements so that calibration should not be necessary more than once a day.

Spectrum Analyzers FSM from Rohde & Schwarz [1] are not just analyzers but also highly stable test receivers suitable for noise measurements up to 26.5 GHz, and in fact they offer clear advantages over commonly used noise-factor meters. The advantages are very evident when it comes to determining transistor noise parameters. This is far more complex than measurements on complete amplifiers or mixers in a 50-Ω system for example. Various impedances, which can show a lot of dependence on frequency, have to be applied to a transistor input, so the variable receiver bandwidth of the spectrum analyzer is a great advantage. MESFETs and HEMTs exhibit extreme mismatch in the lower GHz region and have high gain, so they are prone to oscillations. For this reason a spectrum analyzer would be required in the setup anyway to detect the absence of oscillations during noise measurements.

The Ferdinand Braun Institut für Höchstfrequenztechnik (institute of microwave engineering) in Berlin was faced with the need to measure MESFETs in the frequency range 0.2 to 2.7 GHz. But the required accuracy could not be achieved with commercial noise test systems using common receivers. FSM with its selectable receiver bandwidth in conjunction with a special impedance tuner showed itself as a dependable solution for measuring the required parameters.

Complete noise characterization

The noise figure of a twoport depends on the circuitry at the input. The minimum noise figure F_{min} can only be obtained with noise matching, ie when the optimum source reflection coefficient Γ_{opt} is effective at the input. The relationship between noise figure F and source reflection coefficient Γ_S is defined by the following formula:

$$F = F_{min} + \frac{4R_n}{Z_L} \frac{\left|\Gamma_S - \Gamma_{opt}\right|^2}{\left(1-\left|\Gamma_S\right|^2\right)\left|1+\Gamma_{opt}\right|^2}$$

Γ_S is the source reflection coefficient, Z_L the reference impedance and R_n the noise resistance. The latter is a measure of deterioration of device noise parameters as you move away from optimum source reflection coefficient.

The above formula shows that four parameters are needed to determine the complete noise characteristic of a network at a particular frequency: minimum noise figure F_{min}, noise resistance R_n, optimum source reflection coefficient $|\Gamma_{opt}|$ and the phase angle of Γ_{opt}. These four parameters are normally deduced by connecting a circuit to the input that has been determined beforehand in a reflection coefficient measurement and by measuring the noise power at the output. The best known method is that of Lane [2]. It is based on noise-figure measurement for different source reflection coefficients and subsequent matching to the straight part of the characteristic as defined by the formula above. Since four unknown quantities are to be determined, at least four measurements are required. But a greater number of measurements (25 in this case) is normally performed to increase accuracy. The various source reflection coefficients are in most cases obtained with low-loss impedance tuners, preferably under computer control, connected between the noise source and the DUT. In the Y method the noise figure is determined by alternate measurements with the noise source switched on and off. But there are two shortcomings that cause problems particularly in measurement of low-noise transistors (MESFETs, HEMTs) in the lower GHz region. Firstly, the source admittance is different in the on and off state and, secondly, tuner loss (1 to 2 dB) is usually higher than the noise figure of the DUT (0.1 to 0.5 dB), besides being different from setting to setting.

For these reasons other types of test setup are increasingly being used. The cold-source method [3] means measuring for at least five different source reflection coefficients, just one of them with increased noise temperature. The others are formed by the inherent noise of tuner losses at ambient temperature. The cold connections are implemented by mechanical or PIN-diode switches for instance, the hot connection by a noise generator. This method eliminates the two error sources mentioned above. However, it does involve permanent use of a vector network analyzer, because the s-parameters of the DUT, tuner system and receiver have to be known. A simpler way is the standard 8-term model [4]. In addition to the four noise parameters, the input admittance of the DUT is also determined. So once a

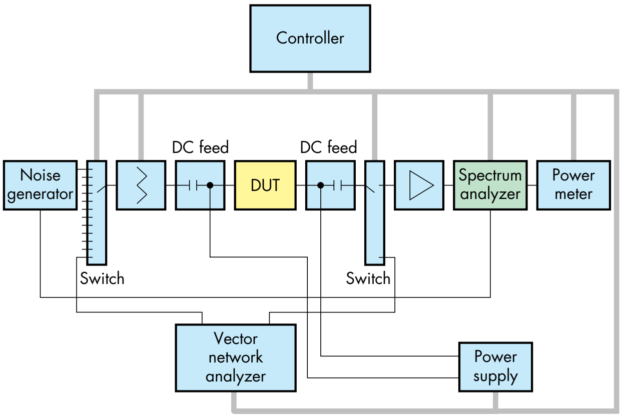

FIG 1
Block diagram of test setup for noise measurements with Spectrum Analyzer FSM

tuner with reproducible settings is characterized, the cold method allows receiver and DUT parameters to be characterized, ie all required parameters to be determined.

Special features of transistor noise measurements

While only one measurement is required for routine measurements on amplifiers or mixers in a 50-Ω system, ie Γ_{opt} and R_n are not determined at all, transistors make much higher demands for the following reasons:

1. The minimum noise figure of MESFETs and HEMTs in the lower GHz region is very small (F_{min} 0.5 dB).
2. The input impedance is almost purely capacitive, so noise matching for the source reflection coefficient $|\Gamma_{opt}|$ occurs at approx. 1. This is difficult to achieve with an impedance tuner.
3. The very high gain resulting from strong transformation at the input may cause a transistor to oscillate (> 20 dB).
4. Strong transformation is of narrow bandwidth, meaning that double-sideband measurements are not possible because Γ_S is different in the two sidebands, even if they are only a few MHz apart. In the lower GHz region the bandwidth has to be limited for single-sideband measurement too. This is not possible with noise-factor meters, which usually have a bandwidth of 4 MHz.

Here, by contrast, the decisive **advantages of FSM as a noise-factor meter:**

- High sensitivity in conjunction with a low-noise preamplifier ensures low noise figure in the receiving system. The wide FSM frequency range (100 Hz to 26.5 GHz) is only limited by this preamplifier.
- Single-sideband reception means that no tunable microwave filters are required.
- The selectable input bandwidth permits measurement with strong narrowband transformation at the transistor input.
- A spectrum analyzer is required in any case to monitor the oscillation status.
- All settings, switching of the 28 V for the noise generator and data readout can be performed on an IEC/IEEE bus.

A practical noise measurement system

FIG 1 shows the test setup with a controller. Spectrum Analyzer FSM is used as a power meter with frequency conversion. The measured level can be read in the display with a marker or indicated on a highly sensitive power meter connected to the IF output (21.4 MHz). The latter solution was used at the Ferdinand Braun institute because the linearity of the marker display is not sufficient for all purposes and measured values would have to be linearized with the aid of a correction function. However, very good results were obtained with the power meter. The broadband amplifier (0.1 to 4 GHz) connected ahead reduces the noise

FIG 2
On-wafer test setup for noise measurements with Spectrum Analyzer FSM at Ferdinand Braun Institut für Höchstfrequenztechnik, Berlin
Photo: Blask

figure of the receiver system to F < 2 dB. The DUT is connected between an impedance transformer and the broadband amplifier. This DUT may be either a single transistor in a test fixture with coaxial connectors or an on-wafer transistor contacted by microwave test probes (FIG 2). The impedance transformer consists of a step attenuator (switchable between 0 and 11 dB) and an electromechanical SP12T switch, the outputs of which are alternately open or shorted. Because the line length varies with the switch position, the phase angle of the reflection coefficient is different at each frequency. The magnitude can be varied in addition using the attenuator, and a 50-Ω system can be implemented in the 11-dB setting. Thus a great variety of source reflection coefficients is obtained. Although these are arbitrary values, they may be employed for evaluation by the Lane method.

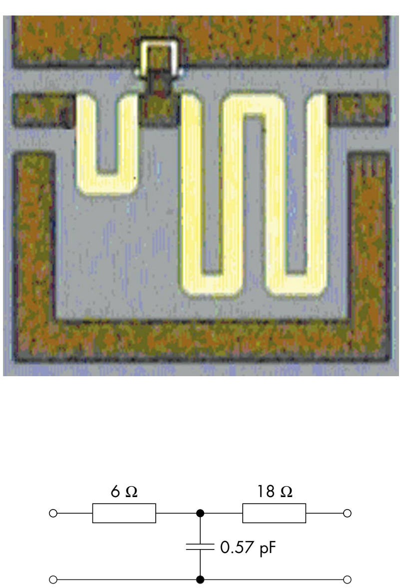

FIG 3 Noise test structure in MMIC technology. Bright meander lines are ohmic resistors. MIM capacitance to ground can be seen in upper left third. Four noise parameters can be calculated accurately from equivalent T circuit.

The following **system parameters** must be known for fully determining the noise parameters of a transistor at different frequencies:

- The four noise parameters of the receiver referred to the input. In this case the microwave probe at the transistor output is used as the reference plane. The test receiver therefore comprises the microwave probe, DC feed, switch, preamplifier and FSM as well as the connecting cables, which should be as short as possible and of low loss. For measuring these parameters the impedance tuner is connected to the input via a thru, all tuner settings are selected and the receiver is measured in the same way as the DUT subsequently. Using these data the contribution of the receiver can be corrected when noise measurements on the transistor are performed.

- The reflection coefficients of the following components:
  a) receiver with respect to the input reference plane,
  b) noise generator at the same reference plane,
  c) impedance tuner at the reference plane of the input microwave probe. The impedance tuner therefore includes a DC feed and the required connecting cables in addition to the SP12T switch and the attenuator. Particular care should again be taken that low-loss components are used so that areas around the outer edges of the Smith chart can be reached for approaching the Γ_{opt} of the field-effect transistors.

- The bandwidth-gain product of the receiving system is measured with the calibrated noise generator connected to the input. For this, the attenuation between the coaxial noise generator and the reference plane at the receiver input has to be known accurately and is determined in a twoport measurement.

For interpretation of noise measurements, the twoport s-parameters of the DUT also have to be known to calculate mismatch at the receiver

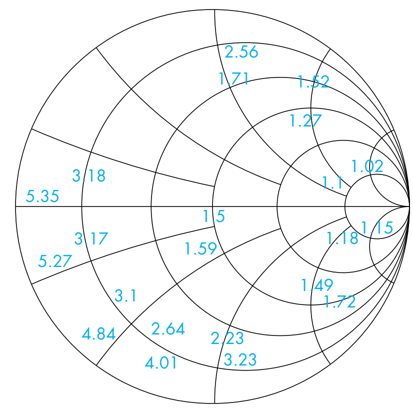

FIG 4 Distribution of reflection coefficients of impedance network at various attenuations (f = 700 MHz). Noise figures measured with test structure in FIG 3 are marked. Distribution of reflection coefficients is different for each frequency and therefore random but exactly reproducible.

input and the noise power delivered from the tuner to the DUT [5]. Noise parameters are determined mostly at discrete frequencies in a specific frequency band. The required s-parameters are previously measured and stored. When measurements are repeated at the same frequencies and the test setup is not changed, calibration of the bandwidth-gain product is seldom required.

Measurement examples

In a trial of the test setup, measurements were carried out on enclosed MESFETs, HEMTs in a coaxial test fixture [6] and on-wafer MESFETs produced at the Ferdinand Braun institute. The following settings were made on FSM for the on-wafer measurements used to demonstrate the test procedure:

Mode	Resol. BW	Video BW	RF attenuation	Ref. level	Span	Sweep	Scale
Analyzer	1 MHz	30 kHz	0 dB	–20 dBm	0 Hz	100 ms	log

A "noise standard" with parameters reproducible by the test setup would be desirable for assessing system accuracy. Ideally a standard of this kind would be a transistor with accurately known s- and noise parameters. This cannot be obtained with an on-wafer device and with conventional test equipment because of the problems described with noise measurements in the frequency range 0.2 to 2.7 GHz. Furthermore, the accuracy of factory calibration of the noise generator (max. inaccuracy 0.3 dB) is not sufficient to measure transistors with F_{min} from 0.1 to 0.5 dB. For this reason a purely passive test structure was produced on the wafer together with the transistors (FIG 3), the four noise parameters of which are similar to those of the MESFET – without gain of course – and which can be extracted from the s-parameters, which can be measured with high accuracy. The measurement should not only confirm these four parameters but also yield the corresponding noise figure for each of the source reflection coefficients. The deviation of each testpoint from the theoretical value according to the equation is an indicator of measurement quality and thus of the performance of the test setup. Calibration of the noise generator can also be checked. The Smith chart in FIG 4 shows the source reflection coefficients obtained at different switch settings of the impedance tuner together with the measured noise figure of the test structure. The theoretical characteristic and measurement results are compared in FIG 5: even at a great distance from the noise minimum, no deviation can be found between the two sets of values. This is a measure of the high accuracy of the test setup based on Spectrum Analyzer FSM.

This high accuracy is also confirmed in transistor measurements. But the evaluation method has to be modified this time because of the extremely low noise figures and high gain. According to the equation the minimum noise figure is obtained by intercepting the ordinate

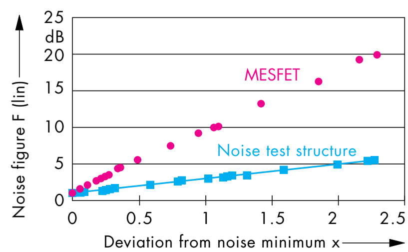

FIG 5 Lane diagram of noise figure versus deviation from noise minimum $x = |\Gamma_S - \Gamma_{opt}|^2 / (1-|\Gamma_S|^2)|1+\Gamma_{opt}|^2$. Intercept on ordinate is given by F_{min}, slope of noise resistance by R_n. Examples for measurement at 700 MHz. Blue straight line represents calculated values of test structure.

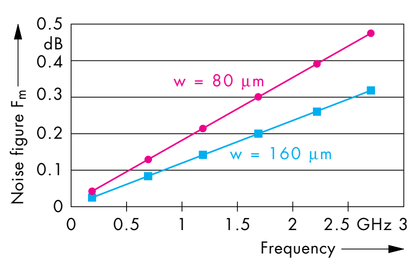

FIG 6 Minimum noise figure versus frequency. Two MESFETs with gate widths of 80 and 160 µm. Operating point: V = 3 V, I = 10 mA. Determination according to [7].

for $\Gamma_S = \Gamma_{opt}$. However, with noise figures around 0.1 dB this value cannot be determined accurately as Γ_{opt} can very seldom be directly set. For this reason the method used in this case is based on evaluation of noise resistance R_n [7]. R_n is determined by the slope of the equation and can therefore be read more exactly than the intercept on the axis. The method uses a theoretical noise model for field-effect transistors and yields simple formulae in the lower GHz region, thus permitting this kind of evaluation. Above about 5 GHz these conditions are not fulfilled, but since the noise figure of transistors is higher and $\Gamma_{opt} < 1$, this method is no longer required. FIG 6 shows a MESFET measurement in the frequency range 0.2 to 2.7 GHz.

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Reader service card 153/07 for further information on FSM

Fit for future radiomonitoring and radiolocation up to 3 GHz

Continuous growth in wireless communication means that the capacity of classic VHF and UHF bands can no longer ensure interference-free radio traffic. So more and more operators all over the world are moving into higher frequency bands through to 3 GHz. Rohde & Schwarz is keeping pace with this trend by introducing frequency-extension options for Compact Receiver ESMC and Digital Monitoring Direction Finders DDF0xM.

Thanks to the variety of tuners available (model 0: 500 kHz to 30 MHz, model 1: 20 to 650 MHz, model 2: 650 to 1300 MHz), the modular **VHF-UHF Compact Receiver ESMC** [1] forms the basis of many monitoring systems. **Frequency Extension ESMC-FE** (FIG 1) offers capability for monitoring the latest radio services in frequency bands up to 3 GHz, eg GSM, PCN, PCS, WLL and GPS. It can be housed in a 19-inch rack together with ESMC or otherwise used as a detached unit (FIG 2). All entries and displays are effected on the ESMC front panel or on its remote-control interface, so all ESMC functions are also available to Frequency Extension ESMC-FE. Options enable coverage of a continuous receive range from 500 kHz through 3 GHz.

FIG 2 Various cable sets permit detached use of frequency-extension unit up to 10 m away.

FIG 1 Frequency Extension ESMC-FE (right) takes range of ESMC monitoring receiver through to 3 GHz. Photo 42 469

Due to the many possible combinations and a future-oriented concept in terms of options (preselection for tuner 0, antenna splitter, OCXO reference) ESMC with ESMC-FE covers the whole spectrum of radiomonitoring tasks. The advantages of the teamed equipment are its compact design for mobile use, the possibility of both manual and remote control in semi-automatic applications, and the variety of interfaces for stationary missions. So the user can choose a solution tailored to his specific requirements and for optimum price/performance.

Of course, Rohde & Schwarz also has suitable antennas to offer for the extended frequency range – for omnidirectional reception of vertically and horizontally polarized waves, plus log-periodic antennas for directional reception.

ESMC and ESMC-FE together with digital VHF-UHF Direction Finder DDF190 [2] form a powerful and attractively priced, compact system that is ideal for mobile radiomonitoring and radiolocation up to 3 GHz (FIG 3).

Depending on the DF converter used, **Digital Monitoring Direction Finders DDF0xM** cover the frequency range 0.3 to 30 MHz, 20 to 1300 MHz or 0.3 to 1300 MHz [3]. **UHF DF Converter ET070** and **UHF DF Antenna ADD070** are available for extension to the frequency range 1300 through 3000 MHz. Control is always handled from VHF-UHF DF Converter ET050 of the basic model, so subsequent extension is simple even when tuners are used in a detached role (FIG 4). The control and signal-processing software required for the frequency extension is already in place in the basic model.

FIG 3 Compact radiomonitoring and radiolocation system in mobile DF unit: VHF-UHF Receiver ESMC with Frequency Extension ESMC-FE, Panoramic Display EPZ513, VHF-UHF Direction Finder DDF190, compass and antenna controller
Photo 42 611/9

Automatic identification of the system configuration means that only a few operations are required to initiate a system. The extremely fast switching times in the DF converters and antennas plus the use of state-of-the-art signal processors in evaluation units ensure detection of signals even as short as 500 µs.

UHF DF Converter ET070 incorporates for the most part modules of the ESMC frequency extension, so its basic characteristics are comparable to those of a high-quality receiver such as ESMC. Together with VHF-UHF DF Converter ET050 it may be set up at a distance of up to 500 m from the digital processing unit and thus close to the antenna at difficult locations. Fiber-optic cables are used for control purposes, DF signals being transmitted at the IF on inexpensive coaxial lines.

UHF DF Antenna ADD070 is a circular array with a central reflector. It can be attached to one mast together with the VHF-UHF antennas. The antenna comes in two versions, one for stationary and another for mobile applications. The use of broadband dipole elements and low-noise preamplifiers is a guarantee of high bearing sensitivity.

Christian Gottlob; Franz Demmel

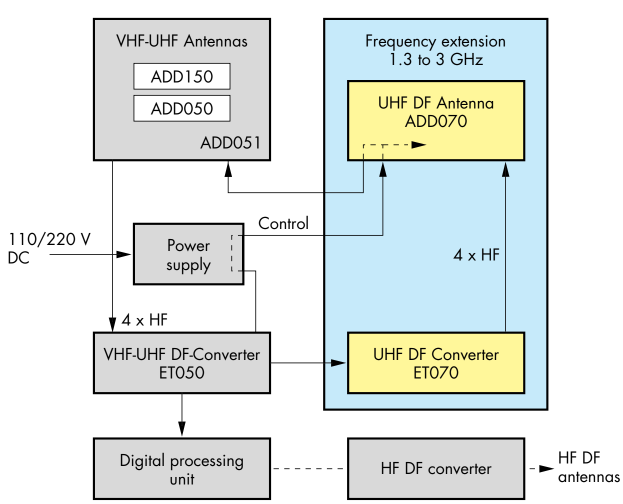

FIG 4 Block diagram of Digital Direction Finder DDF0xM with 1.3 to 3 GHz frequency extension

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Reader service card 153/08

Spectrum monitoring the ITU way

The third edition of the *Handbook on Spectrum Monitoring* of the International Telecommunication Union (ITU) was published in 1995. It is based on the latest findings on all aspects of radiomonitoring and ranks as the standard document for the spectrum-management community. From the very beginning spectrum-monitoring systems from Rohde & Schwarz have been designed to meet the requirements of the ITU Radiocommunication Bureau (ITU-R). And for the first time Rohde & Schwarz participated in preparation of the manual.

Spectrum monitoring yields all the **information** required for spectrum management, for spectrum monitoring itself and for the tasks to be carried out by the personnel involved, eg:

- actual spectrum occupancy versus authorized occupancy,
- deviation from authorized transmission parameters,
- location and transmission parameters of legal and illegal transmitters,
- interference from or among transmitters,
- recommendations on eliminating interference.

In addition to this information, **results of measurements** as described in chapter 3 of the handbook are equally important:

- frequency measurement (ITU-R Rec. 377-2, Rep. 272-5),
- field-strength and power-flux-density measurement (ITU-R Rec. 378-4, Rep. 273-7),
- spectrum-occupancy measurement (ITU-R Rec. 182-3, Rep. 668-3),
- bandwidth measurement (ITU-R Rec. 443-1),
- modulation measurement (ITU-R Rep. 277-3),
- radio direction finding and location (ITU-R Rep. 372-6),
- identification (ITU-R Rec. 978-1).

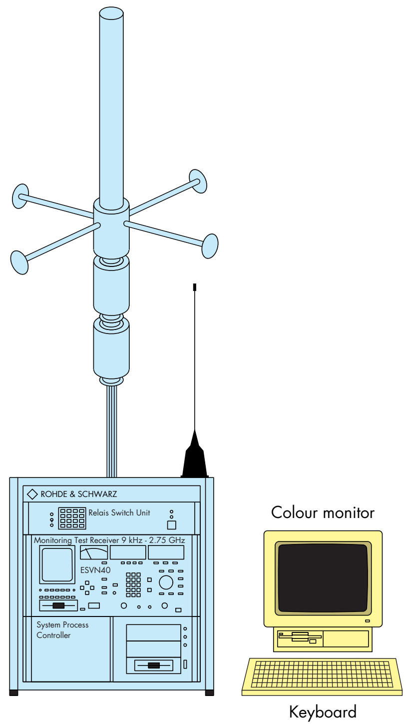


FIG 1 Basic model of spectrum-monitoring system with test receiver, controller and antennas

Chapter 5 of the handbook prescribes the following **special technical procedures:**

- global positioning by satellites (GPS),
- maps,
- intermodulation and harmonic products.

Spectrum Monitoring System SMSI from Rohde & Schwarz offers capability for performing all tasks assigned by the ITU to regulatory authorities worldwide. The system features substantial software for automating measurements, processing and evaluating results as well as analyzing interference. Storage of all monitoring activities and their correlation to a central database improves spectrum-monitoring efficiency to an extent unknown previously. The monitoring system can be implemented in just about any configuration. Its nucleus is Test Receiver ESVN40 (9 kHz to 2.75 GHz). This, together with a controller and antenna system (10 kHz to 3 GHz), forms the most compact model of SMSI suitable for full stand-alone operation (FIG 1).

Upgrades of the system are possible at any time, and will normally involve:

- extra measurement and receiving equipment (directional antennas with rotator, direction finder, analyzer for transmission parameters, digital signal-acquisition and processing devices, audio and video equipment),
- remote control of SMSI servers by SMSI clients via LAN (Ethernet) or WAN (analog or digital, switched or dedicated lines, ISDN),
- connection of several workstations to an LAN,
- connection to a spectrum-management database via LAN or WAN,
- equipment for mobile applications (vehicle integration) with mast, compass, GPS and GSM data link in line with ITU-R Rep. 668-3 (FIG 2).

The integration of ready installed Rohde & Schwarz monitoring equipment into a new SMSI system is a straightforward and cost-efficient procedure. Radiolocation equipment and analyzers may be fitted as system enhancements. Training of user personnel in Munich can complete such upgrades, which are possible in a minimum of time.

The **networking of SMSI systems** is very simple irrespective of different configurations. Countrywide or regional spectrum monitoring networks normally comprise one or more control centers, fixed or transportable test and monitoring stations and mobile units. Test stations will be unmanned or permanently or just occasionally attended. The control center is able to contact stations at any time and assign them a whole variety of tasks. The client/server principle used in this case ensures convenient and reliable operation.

Spectrum Monitoring Software ARGUS supports measurements, monitoring, result evaluation and display. A module for remote control and networking may also be linked. This software runs under the Windows NT operating system and is notable for its ease of use, operational reliability and network capability. Other advantages are the uniform control routines, multitasking and the flexibility offered for integrating extra software (eg MS Office). ARGUS is a client/server application with a measurement part (server) and a control part (client). The software can be remotely controlled over large distances or operated on a stand-alone PC. Each test station can be used simultaneously by up to four control stations and each operator may control up to four test stations at the same time. Data integrity is ensured by code words at various user levels, operational reliability in the network by callback functions.

The software offers **five measurement modes:**

- direct for control of measuring instruments via virtual panels,
- interactive for computer control of measuring instruments including intermodulation analysis,
- automatic for monitoring and acquisition of results for further processing by evaluation software (FIG 3),
- DF for location and triangulation with map display,
- macro for generating custom measurement routines.

On the strength of such systems, Rohde & Schwarz has to date set up three countrywide monitoring networks and dozens of stand-alone installations. The demand for advanced spectrum-monitoring systems is bound to increase in the future – especially as more digital technology appears, which requires a clean and tidy spectrum for disturbance-free operation.

Wolf D. Seid

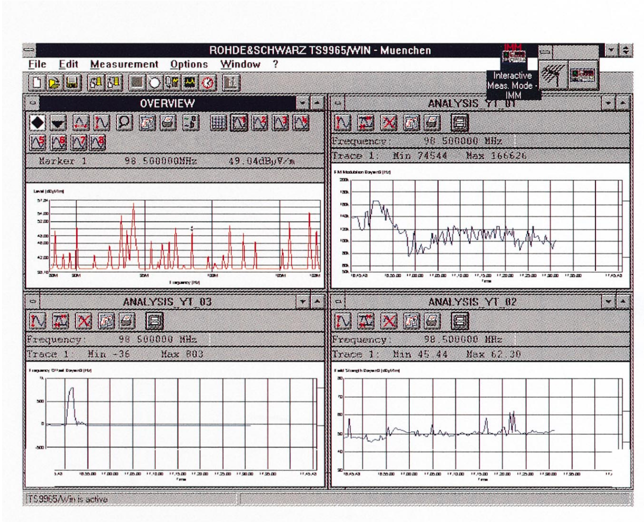


FIG 3 Results measured in automatic mode

FIG 2 Mobile monitoring unit Photo 42 611/3

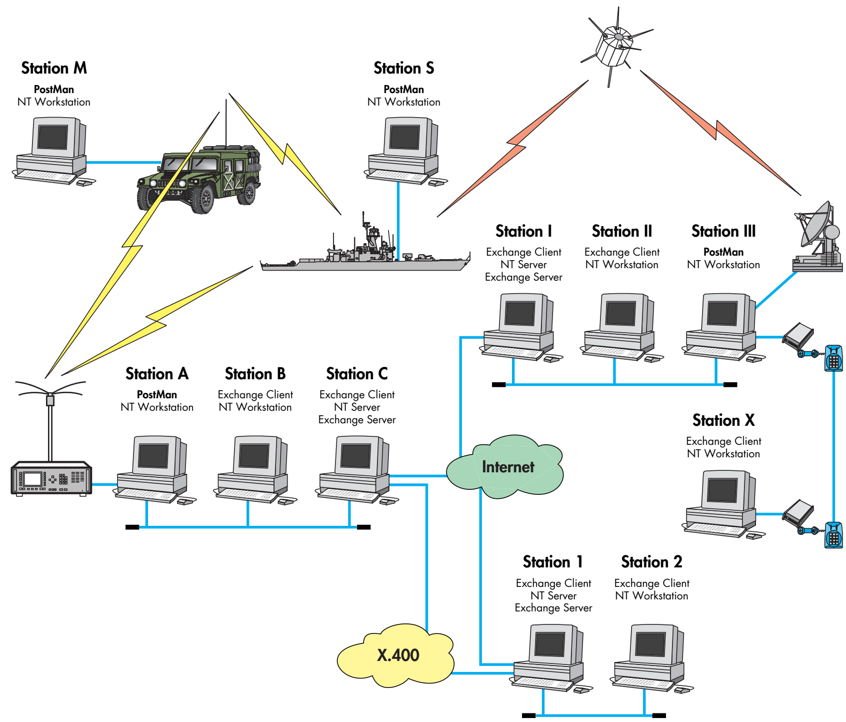
Reader service card 153/09

When the PostMan rings on Internet

There is increasing demand, especially in the US, for integrating shortwave and VHF/UHF radio links into international communication networks. With its **Message-Handling Software PostMan,** Rohde & Schwarz is the first company to come up with a solution for the proven and cost-effective shortwave medium. PostMan provides access to global communication networks, the reserve of wired media until now, and thus opens up the whole world of international communication also on islands and in desert and polar regions.

The new software product is based on the **Microsoft Windows NT operating system,** which is considered the future standard for professional applications. It is a pure 32-bit operating system that will run on an Intel-based or RISC high-end PC. It allows networks to be set up without the need for extra products. Windows NT, in conjunction with the Microsoft Exchange E-mail product, offers as standard the most commonly used protocols and connection of wired media to international communication networks. PostMan sets up on the MAPI interface (messaging application programming interface) of Exchange. Windows NT and Exchange serve as a gateway to communication networks such as X.400, Microsoft Mail and Internet (FIG).

The integration of radio transmission into modern communication systems became possible through a special Windows NT driver developed by Rohde & Schwarz. This driver meets the specific requirements for integrating radio systems and has not been offered so far by any other supplier. The radio driver is based on the **international standard protocol TCP/IP** (transmission control protocol/Internet protocol) and thus provides a multi-vendor interface. Thanks to this additional hardware driver, PostMan enables data transmission via a variety of media including shortwave, VHF/UHF, SatCom, GSM, telephone lines and LAN.



With its Message-Handling Software PostMan, Rohde & Schwarz is first supplier worldwide to add radiocommunication capability to international communication networks.

PostMan optimizes use of available media by **alternative routing.** If the medium intended for transmission is interrupted, PostMan automatically changes to an alternative one (governed by a list of priorities) and continues transmission there. Before the switch to another medium, a check is made to see if transmission can be continued on the same medium but on an alternative path (eg via a relay station).

Conditions for transmission on a given medium may be more or less favourable depending on the time of day (eg times at which telephone charges are low or shortwave transmission quality is high). PostMan allows **optimum transmission times** to be defined for each medium. The time for transmitting a predefined message can be specified precisely up to 30 days in advance.

Use of the Windows NT operating system also allows integration of commercially available programs, like for editing fax messages or video stills with an **OLE server** (object linking and embedding). It will also be possible to integrate into PostMan all future word- and image-processing programs available under Windows NT.

Existing **E-mail networks** are basically of two types: the client/server architecture and the peer-to-peer network.

The **client/server architecture** has a centralized organization. A server performs all administration tasks and controls all activities associated with this type of E-mail system. When a message is sent from station A to B, it is stored in a post office on the server. The post office manages and handles all messages of the network. Station B, which polls the server in cycles, will be informed that a message has been placed in the post office for it and can be accessed.

Peer-to-peer networks, by contrast, consist of users with equality of access and are without any hierarchical structure. There is no user exclusively acting as a server. Resources are made available and controlled by all users. As far as electronic mail is concerned, peer-to-peer networks usually have centralized message management. One of the workstation computers performs the functions of a post office, ie of message management.

In a radio-based E-mail system, message management by a central post office is not economical. The **E-mail addressing** of PostMan therefore manages without a post office. Messages are sent direct to the addressed station and locally stored. This procedure must be adopted in radio networks, as communication links would be unduly loaded through the polling of a post office. What is more, routing messages via a post office means that messages would have to be sent twice, a solution that is impractical in shortwave communication.

PostMan of course enables the integration of **encryption methods.** This is of interest to users who want to protect their messages against unauthorized access by third parties.

To meet the requirements of E-mail systems with integrated radiocommunication, additional **acknowledgments** must be provided. In addition to the familiar Read Receipt received by the sender when the recipient opens a message, PostMan features a Delivery Receipt as well as a Non Delivery Report acknowledgment. Delivery Receipt is received by the sender when transmission of a message to the addressed station is successful, Non Delivery Report if a message cannot be delivered because the addressed station is switched off for example. PostMan thus ensures that the sender is immediately and precisely informed of the transmission status of a message – a feature not afforded by most other E-mail systems.

Thomas Kneidel

Reader service card 153/10

Rohde & Schwarz assists young people in choosing a career

In its supplement *Professional Training in 1997* the Munich daily tz published the opposite photograph, taken during an exhibition on jobs and careers held at the careers advisory service of the Munich employment office. This exhibition is an annual event aimed at helping school-leavers to choose a suitable career. In 1996 almost 13000 young people, teachers and also parents made use of this opportunity for information. Some 120 different careers were presented under the motto *Jobs Live.*

Several trainers and trainees from Rohde & Schwarz were there last time to give visitors an idea of apprenticeships in communication electronics/radio engineering and the kind of employment they lead to. On two workstations they demonstrated what people in such jobs do (the photo shows a test assembly including a Radiocommunication Tester CMT54). In February 1997 the exhibition will celebrate its tenth anniversary. Sö

RAMON basic software for Digital Direction Finders DDF0xM and DDF0xS

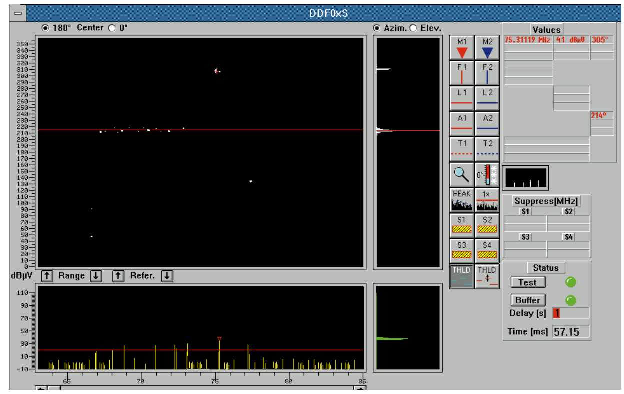


FIG 1 Overview display of Scanning Direction Finder DDF0xS

Radiomonitoring System RAMON® detects and monitors emissions in the frequency range 10 kHz to 18 GHz [1]. Using tried and tested standard components from Rohde & Schwarz, it is possible to compile even the most complex of radiomonitoring systems to customer requirements.

The purpose of detection and surveillance is to provide supervising stations with information enabling them to assess the actual scenario and prepare reports on it. The data obtained provide the answers to a whole series of questions regarding the who, when, where, what and why of a particular radio emission. Direction finding and the location of emitters play a major part in answering these questions. In conventional radiomonitoring systems a DF order is given to the DF base station and in the case of a successful bearing the result is signalled back. This procedure is time-consuming and requires several bearing stations, some of which may be manned. Modern radio transmitters emitting bursts or hopping between frequencies are difficult or not at all possible to detect with conventional methods.

For reliable detection of the signals generated by modern methods of data transmission **Digital Monitoring Direction Finder DDF0xM** [2] or **Digital Scanning Direction Finder DDF0xS** [3] can be used and controlled by Radiomonitoring System RAMON. Rohde & Schwarz has developed two new basic programs – Overview and Fixed Frequency – for the purpose. Scanning and direction finding are performed in the same direction finder, so the operator automatically receives the bearing for every activity revealed by the spectrum. Thus signal detection and direction finding go hand in hand. This applies to both traditional and frequency-agile signals.

The main **features of the radiomonitoring and radiolocation system** include:

- RAMON user interface,
- frequency ranges HF/VHF/UHF,
- radiolocation using several direction finders,
- storage of selected DF and location results in RAMON database,
- optional display of DF and location results on digital map (MapView [4]),
- control of monitoring receivers from direction finder or vice versa.

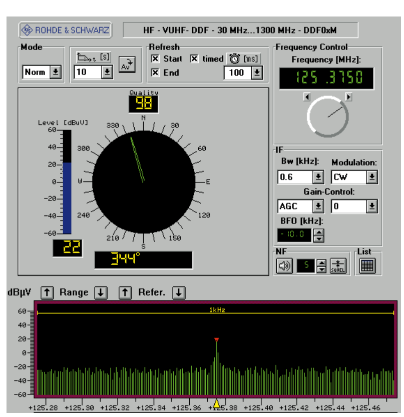


FIG 2 Azimuth display of Monitoring Direction Finder DDF0xM in Fixed Frequency mode

Direction Finders DDF are able to process complex search orders for detecting radio signals. A **search order** may comprise

- up to nine frequency ranges,
- up to 50 suppress ranges.

The order is prepared with the aid of an editor and can be stored, reloaded and modified.

In the **Overview** mode the direction finder continually scans the frequency ranges of the search order and an overview of the scanned spectrum is displayed with direction information. Due to its high scan speed DDF0xS is particularly suitable for this mode. The overview display comprises four windows and a tool bar (FIG 1). The bearings of the detected signals are shown in the top left window, their levels in the window below. The frequency scale at the bottom edge is for both windows. The windows on the right show the frequency of occurrence of individual bearings or levels in the form of a histogram. A waterfall diagram showing activities at individual frequencies over time can optionally be displayed. In the example a frequency-agile signal with 214° bearing is active. The display shows several bearings at different frequencies from the same direction and a cluster in the histogram. The operator may read the bearing angle with the aid of an azimuth line.

For direction finding at a particular frequency, the frequency is selected in the level window with the red triangular marker. A mouse click switches from Overview to **Fixed Frequency** mode. The selected frequency appears as the center frequency in the spectrum. FIG 2 shows the detection of a transmitter on 125.375 MHz at 344°. The display shows the spectrum around the center frequency and allows the direction finder to be tuned.

Using the Overview and Fixed Frequency device control windows, Direction Finders DDF0xM and DDF0xS are fully integrated into Radiomonitoring System RAMON, adding another two powerful modules to its capability.

Claus Holland; Rudolf Reimann

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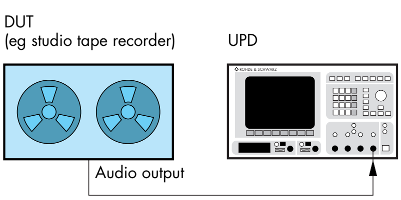
Reader service card 153/11

Measurement of clicking noise

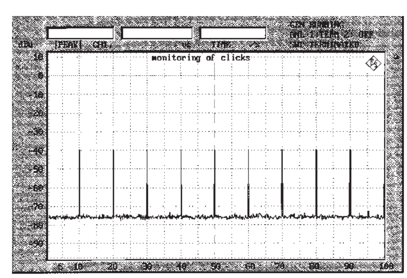


Unlike continuous interference, clicking noise and similar sporadic, usually not reproducible types of interference generally escape measurement. Frequently, such types of interference have to be analyzed by the trained ear of a test engineer. But listening to sine tones over an extended period of time is not exactly pleasant. So how can the problem be solved?

Although **Audio Analyzers UPL and UPD** manage more than 100 measurements per second, a mere level measurement will not do since only extremely strong interference will have an effect on the overall signal level. However, any interference will show up as spectral lines, and these signal components can be detected by THD+N measurement. But the measurement speed achievable in this way will not suffice to provide continuous coverage. Audio Analyzers UPL and UPD solve the problem by digital signal analysis, using a sine tone as a test signal. To ensure continuous detection of any noise or interference, the peak measurement function is used. Here each digital measured value is checked; this means that 48,000 samples/s are processed by the 22-kHz analyzer of UPL/UPD (also with analog measurements). If the test signal is also passed through a notch filter, a quasi-distortion measurement is obtained in which the peak residual distortion is checked for each audio sample. The time-chart function allows continuous measurements to be made and the results plotted against the time axis. To extend measurement over long periods of time without displaying a vast amount of test values, an interval can be defined for the peak measurement function. As in the case of a maximum hold function, this will cause the maximum peak to be held for the interval defined. By combining the interval with the number of plotted values, short-term monitoring with very fine time resolution is possible as well as measurements over several hours without any interference being missed.

The measurement described is illustrated by the plot below. Pulsed $\sin^2$ interference with pulse width of 50 μs and level of −40 dBu was superimposed on a test signal of 0 dBu at intervals of 10 s. Each instance of interference was detected and recorded with the correct level. Pulses narrower than 50 μs (corresponding to 20 kHz) practically do not occur in the audio band. Simulated interference at this frequency is no longer perceivable by the human ear, not even with earphones, but can be measured without any problems. So the described measurement method not only goes easy on the otherwise strained hearing of the test engineer but, at least in this example, is superior to it.

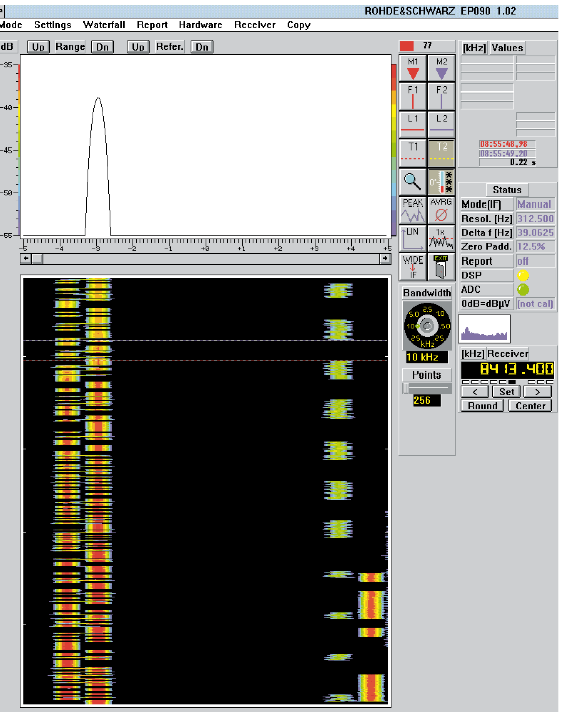
Klaus Schiffner



Reader service card 153/12

Analyzing radio signals with Digital IF Spectrum Display EP090

Digital IF Spectrum Display EP090 supports the monitoring of complex signals with commercial receivers in the VLF through SHF bands. EP090 comprises a long ISA module operated in a standard PC together with the software supplied. The module may be connected to the IF and AF inputs of almost any receiver. Special software drivers are available for Rohde & Schwarz receivers such as ESM500, ESMC or EK895/EK896. For precise measurements an external reference signal can be applied, derived from an ESMC for example.



Waterfall display of three simultaneously received signals in 10-kHz channel (from left): FSK, ARQ, morse

EP090 performs four different tasks: **rapid search** for RF signals in a frequency band up to 1 MHz with high resolution down to 0.1 Hz and high sensitivity. Thanks to the combination of analog and digital receiving techniques, scan speeds of 1 MHz/s can be obtained in spite of high resolution of 450 Hz for instance. **Frequency-occupancy records** show short-term and long-term variations in the RF band and can be output on a high-resolution printer. **Signal analysis** uses a digital signal processor to display the frequency spectrum and its variations with time in a waterfall display at a rate of up to 200 spectra per second (FIG). All main **receiver settings** can be made on EP090, including automatic centering of FSK signals.

Even experienced users of monitoring systems will appreciate EP090 when it comes to assessing signals with unusual modulation. The panoramic display is also indispensable for segmentation of signals in a densely occupied environment: the center frequency and bandwidth for the receiver can thus be set even in the presence of co-channel interference.

Dr. Klaus Rieskamp

Reader service card 153/13

Communication signals with a few mouse clicks

Universal signal generators, which provide the required test signals simply and precisely, are needed for the development and production of base stations, handies and chip sets used by all communication systems. Software SME-K2 presented in this article simplifies the setting of **Signal Generator SME** [1–3] to different signals and greatly enhances its usability.

Program SME-K2 runs under Windows on any industry standard PC and can be operated entirely by a mouse. Hook-up to SME is preferably via the IEC/IEEE-bus interface but is also possible on one of the RS-232-C interfaces provided in any PC. The integrated help function makes working with the program especially easy: clicking the corresponding box with the righthand mouse key calls up the context-sensitive help text.

After selection of the communication system (GSM, DCS1800, DCS1900 and IS-136 are currently available) and traffic route (uplink or downlink) the required modulation data are set by clicking the mouse. Communication between base and mobile stations is by

TDMA (time division multiple access). This means that traffic is divided into individual time slots or bursts. Time slots are displayed according to the communication system selected. They can be switched on or off and provided with the desired burst data by clicking on one or more time slots. All important burst types stipulated by standards are taken into consideration by the program. For the GSM, DCS1800 and DCS1900 systems these are normal burst, frequency- correction burst, dummy burst and access burst for example (FIG 1). Operation is analogous for IS-136 (NADC). The uplink and downlink signals of this system have a different structure, which is naturally also allowed for by Program SME-K2. Burst types uplink, downlink, shortened, bit pattern, random, file input, etc are available. It is of course possible for NADC to set all eight combinations made up of three full-rate and up to six half-rate channels (FIG 2).

The sync words specific to each communication system can be selected in the program and are inserted at the correct position within the bursts. For testing the error tolerance of receivers, these sync words can also be changed specifically bit by bit. The data fields contained in the bursts can be filled with different bit patterns, which can either be entered by the user or formed by predefined pseudo-random bit sequences (PRBS) with lengths of 2^9–1 or 2^{15}–1. Loading bit patterns from saved files is also possible. Depending on configuration of SME with Data Generator SME-B11 or Extended Memory Option SME-B12 the total length of the signal can be up to 8192 or 1 048 560 bits. A noteworthy feature of PRBS is that each PRBS is continued in the next associated time slot. If these sequences are selected for several time slots, they are shifted in time. When Extended Memory Option SME-B12 is used, a PRBS of length 2^9–1 can be set so that the sequence is continuously repeated. This setting is especially useful for BER measurements.

Selection of the communication system and traffic route also determines the assignment of channel number to frequency set in SME. In Program SME-K2 the frequency is preferably set by entering a channel number, conversion to the associated frequency being performed automatically with due consideration of the selected communication system. It is also possible to enter the frequency direct, which simplifies tests at the receiver IF for example. The SME output level can also be set in Program SME-K2 in units common for SME such as dBm, dBμV, mV and μV.

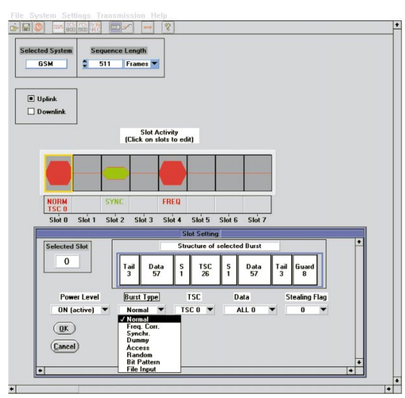


FIG 1 GSM uplink signal with different bursts in time slots 0 (normal burst with training sequence TSC0), 2 (synchronization burst) and 4 (frequency-correction burst). Signal in time slot 2 is transmitted with reduced power.

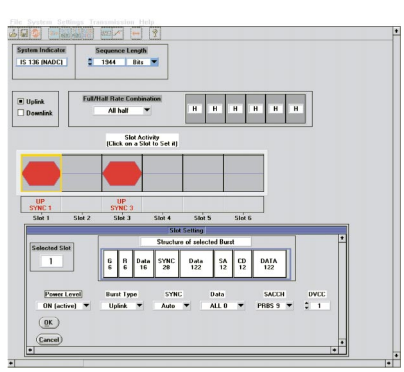


FIG 2 NADC uplink signal in time slots 1 and 3, all channels are set to half-rate.

The time response of bursts is stipulated within relatively narrow limits. Program SME-K2 automatically sets this time response correctly. For test purposes it is also possible to make the corresponding changes separately for the positive-going and negative-going edges of the signal burst. All program settings can be saved in the PC and recalled as required. When programming SME the user can select whether only the frequency and level, the type of modulation (in this case SME is completely set to the corresponding communication system), the modulation data or all parameters are to be set. If a complete setup is selected, manual control of SME is no longer required. After settings have been transferred to SME, the setups including modulation data can be stored by simply clicking the mouse on one of the 50 save/recall memories provided in SME, where they are retained even if the unit is switched off. Thus, different SME settings together with associated modulation data can be predefined. They can simply be called up again at a later time even if no PC is connected.

Albert Winter

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[1] Klier, J.: Signal Generator SME06/SMT06 – Analog and digital signals for receiver measurements up to 6 GHz. News from Rohde & Schwarz (1996) No. 151, pp 10–12

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

[3] Leutiger, M.: Economy Signal Generator SME03E – Universal signal source for digital mobile radio. In this issue, p 36

Reader service card 153/14

Power sensors now through to 40 GHz

FIG 1 Power Sensors NRV-Z15 and NRV-Z55 for microwave range Photo 42 688/3

The range of sensors for Power Meters NRVS and NRVD, Level Meter URV35 and RF Millivoltmeter URV55 [1] has been extended by Diode Power Sensor NRV-Z15 and Thermocouple Power Sensor NRV-Z55 for measurements up to 40 GHz (FIG 1). This means that a suitable power sensor is available for practically every measurement task from DC up into the microwave range (FIG 2).

More and more data-transmission systems are making use of the frequency range from 26.5 to 40 GHz. Microwave links are used to interconnect base stations of mobile-radio networks, for example, or inhouse computer networks installed in buildings scattered across a company's site, or to create extra transmission capacity for digital video and TV transmissions in densely populated areas. This results in a variety of new **applications for power sensors** in the frequency range **from 26.5 to 40 GHz:**

- measurement and monitoring of transmitted power over a wide dynamic range with high accuracy, also with digitally modulated or pulsed signals,
- setting and alignment of microwave antennas,
- measurement of communication characteristics of microwave systems between transmitting and receiving stations (lines, antennas, air interfaces),
- measurement and calibration of transmission characteristics between interfering emitter and DUT in EMC test systems,
- in-production testing and calibration of transmitters, signal generators, receivers and spectrum analyzers.

The two new power sensors together cover the power range 1 nW to 100 mW (ie 80 dB). **Power Sensor NRV-Z55** operates on the **thermoelectric principle** and offers high sensitivity and maximum accuracy in the power range 1 µW to 100 mW for input signals of any waveform and modulation. The terminating resistor is electrically isolated from the thermocouple, resulting in continuous coverage of the frequency range from DC to 40 GHz – a feature unique on the world market. The thermocouple sensor is built on a thin silicon substrate using a combination of thinfilm and semiconductor technology. The terminating resistor is a nickel-chromium thinfilm component arranged next to a metal-to-semiconductor contact that generates a thermoelectric voltage proportional to the converted RF power. The same thermocouple sensor has been used for many years in Thermal Power Sensors NRV-Z51/52 [2], where it has proved its long-term stability.

Diode Power Sensor NRV-Z15 opens up the power range below 10 µW. At these power levels the diode is operated inside the square-law region of the current/voltage characteristic, ensuring true rms measurement of the input signal. The behaviour of the diode sensor in that range is similar to that of a thermocouple sensor, so NRV-Z15 is also suitable for measurements on noisy or modulated signals or signals with high harmonic content. Extremely high measurement speed is possible at power levels above 10 µW (up to

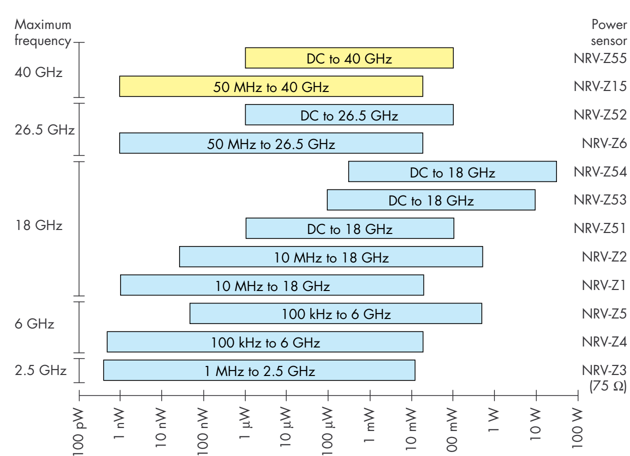

FIG 2 Rohde & Schwarz has the right sensor for virtually every frequency band and power range

20 mW) for a small trade-off in accuracy. The diode power sensor is implemented with a doped planar GaAs diode in thinfilm hybrid technology. Temperature gradients of the diode are minimal, resulting in excellent zero stability.

As with all NRV sensors, the excellent characteristics of NRV-Z55 and NRV-Z15 are due to the use of a unique **calibration concept.** Calibration data are determined separately for each sensor as a function of frequency, power and temperature (each sensor contains a thermal detector) and saved in a built-in memory so that the power meter is ready for operation immediately after the sensor is connected.

Helmut Strecker

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[1] 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 14–16

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

Reader service card 153/15

DAB multiplexer completes product line for digital audio broadcasting

DAB Multiplexer DM001 combines incoming audio and data channels to form ensemble transport interface for COFDM encoders. Photo 42 630

In its DAB Multiplexer DM001 (FIG), Rohde & Schwarz rounds off its DAB product line and is thus the only supplier worldwide to offer a complete range of equipment from a single source to cover the entire DAB path from studio to transmitter.

DAB Multiplexer DM001 is fully compatible with DAB standard ETS300401 and is a central element of a DAB network. It combines the incoming audio and data channels to form the ensemble transport interface (ETI), which drives the subsequent COFDM encoders and thus the complete transmitter network.

DM001 is of modular design, so it can be configured to customer's requirements. Up to twelve physical inputs are available that can be software-configured fast and easily for various data formats and protocols. DM001 can be equipped with one or two output modules allowing two independent ensembles to be generated by the same multiplexer for local services, for example.

DM001 supplies as standard an ETI signal at the NI layer (network independent layer to G.703) for transmission via satellite or directional radio to transmitter sites. For wired networks (eg ISDN) the NA layer (network adapted layer to G.704) is used. For this layer, automatic delay equalization, indispensable in DAB single-frequency networks, is performed at every transmitter site. Several DAB Multiplexers DM001 can be cascaded and thus used as premultiplexers. DM001 supports time-synchronized, dynamic input and ensemble reconfigurations. For this purpose it incorporates a realtime clock and can be locked to a reference time or clock.

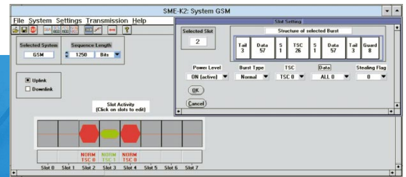
All settings and configurations of the multiplexer are made from a PC by means of user software that is supplied with the multiplexer and runs under MS Windows. All manual entries are subjected to conformance testing so that erroneous entries are practically excluded. The software further allows the output of status information and any error events. An integrated scheduler enables automatic reconfiguration of the multiplexer at times defined by the user in day plans and in a schedule plan.

Rohde & Schwarz has already supplied large quantities of DAB multiplexers to German Telekom, and a large number of orders have been placed, for example by the Swiss PTT, the German WDR broadcasting corporation and Telstra Australia.

Peter H. Frank

Reader service card 153/16

Economy Signal Generator SME03E – Universal signal source for digital mobile radio



Economy Signal Generator SME03E and SME-K2 Windows application software for generation of TDMA bursts

The newly launched Economy Signal Generator SME03E (FIG) from Rohde & Schwarz offers everything you want from a signal source for digital mobile radio: it generates all kinds of standard signals used in today's digital mobile networks and the whole range of analog signals as well. And all this for unrivalled price/performance.

The only differences between SME03E and the other members of its family – SME02 to 1.5 GHz, SME03 to 3.0 GHz and SME06 to 6.0 GHz – are that it has no list mode, which is only required for highly specialized applications, and that its frequency range is limited to 2.2 GHz. Consequently a particularly favourably priced model has been created that is exactly tailor-made for most applications. Typical uses of SME03E are in production and development of digital radio mobiles, base stations and paging receivers, and propagation measurements in mobile-radio networks. SME03E can be remotely controlled on an IEC/IEEE bus, so it is easily integrated into automatic production environments.

A particular benefit for the user is the wide range of options available for individual configuration of SME. On the one hand the customer only has to pay for functions he really needs, on the other the generator is absolutely future-safe, as new features can be added at any time. The underlying concept of the options was chosen such that SME can be upgraded to a universal generator for digital modulation but also for analog applications.

All types of digital modulation are ready integrated in the basic model of the generator, and the most important mobile radiocommunications standards are covered by its frequency range 5 kHz to 2.2 GHz. What makes SME03E a class of its own is its high spectral purity, which is indispensable for high-grade receiver measurements. The generator's favourable price in no way entails any trade-offs with regard to key performance data, and this makes it stand out clearly when compared to competing products. Other unique characteristics are its highly accurate level and excellent RF shielding, which make for precise sensitivity measurements.

SME03E offers the digital modulation types GMSK, GFSK, $\pi/4$ DQPSK, 4FSK and FSK/FFSK, which enable measurements to the digital standards GSM, DCS1800/1900, NADC and PDC as well as TFTS, TETRA and paging standards ERMES, POCSAG and FLEX. Generation of standard TDMA bursts as stipulated by GSM and DECT, for instance, is made possible by a pulse modulator with the required dynamic range.

The analog characteristics of SME03E are just as excellent. The generator comes with AM as standard, while an FM/φM modulator is available as an option. Further options are the pulse modulator mentioned above and a pulse generator for radar applications as well as an AF generator to 500 kHz for sinusoidal, rectangular, triangular and noise signals. In addition to the signals generated by the AF generator, the optional multifunction generator provides stereo multiplex signals and VOR/ILS modulation signals to 1 MHz and enables use of SME03E as a high-grade test transmitter for FM stereo and navigation receivers.

Although highly complex measurements can be performed with SME03E, it is nevertheless surprisingly simple to operate. The settings for each function are grouped in a mask on the large LCD, while help text is available at a keystroke. Operation is further simplified by the SME-K1 and SME-K2 software tools (see p 32 of this issue), which support generation of data signals in compliance with major mobile-radio standards.

Mathias Leutiger

Reader service card 153/17

Signal Generator SME03E (5 kHz to 2.2 GHz) is a particularly economical solution for common mobile radio bands up to 1800/1900 MHz, also for use in production; TDMA frame/FM/pulse only with option.

Data sheet PD 757.2821.21 enter 153/17

Digital Radio Tester CTS55 (GSM/DCS1800/1900) performs fast in-service measurements and is handy, compact and robust; TFT colour display, menus in six languages, optional reference oscillator.

Data sheet PD 757.2509.21 enter 153/18

Digital Radiocommunication Tester CMD59 is of the same design as CMD57, but is intended exclusively for PCS/DCS1900.

Data sheet PD 757.2538.22 enter 153/19

Noise Measurement Software FSE-K3 (100 kHz to 26.5 MHz) is used with Spectrum Analyzer FSE to measure noise figure (dB), noise temperature (K) and gain (dB); measurement bandwidth 1 kHz to 5 MHz, output as graph or list.

Data sheet PD 757.2380.21 enter 153/20

Mobile radio measurement technology – High-tech in perfection This brochure shows the involvement of Rohde & Schwarz in mobile communications engineering as well as the complete range of T&M equipment available.

Info PD 757.2673.21 enter 153/21

TV Test Receiver Family EFA (47 to 862 MHz) Analog tuneable receiver and broadband demodulator (B/G or D/K, I) as well as QAM receiver (4 to 256QAM) for DVB-C signals (optional MPEG2 measurement decoder can be integrated); optional RF preselection for demodulator as well as for NICAM or parallel sound; IEC/IEEE bus; RS-232 interfaces.

Data sheet PD 757.2421.21 enter 153/22

TV Test Receiver Option VSA-B10 (47 to 862 MHz; B/G, D/K, I) makes Video Measurement System VSA suitable for RF measurements; operation and display via VSA.

Data sheet PD 757.2521.21 enter 153/23

Audio Analyzers UPL and UPD are – as is illustrated by this brochure – ideal for measurements on hearing aids to IEC 118, ANSI S3.22 and S3.42 (eg also for measuring attack and release times of AGC equipment).

Info PD 757.2696.21 enter 153/24

Digital Audio Broadcasting This brochure shows that the future of sound broadcasting is digital and Rohde & Schwarz is your ideal partner in its implementation.

Info PD 757.2496.21 enter 153/25

DAB Coverage Measurement System TS9951 This brochure presents the world's first compact system for measuring coverage quality in DAB networks with the aid of Software TS51-K2 (Windows).

Info PD 757.2644.21 enter 153/26

System Processor MERLIN GR2000, GR2000X is designed for safe data transmission via different media under extremely severe conditions; highly EMI-proof (GR2000X has additional filters), 16 to 256 Mbytes, PCI VGA graphics, exchangeable harddisk, CD-ROM disk drive, up to 20 interfaces, various options (specifications on enclosed extra sheet).

Data sheet PD 757.9339.23 enter 153/27

Process analysis in a new dimension Faster, economical and efficient gas analysis is described in this brochure of the **R&S Cologne plant.**

Info 757.2467.21 enter 153/28

How Radiocommunication Success is Measured Products and Services from Rohde & Schwarz in the field of mobile radiocommunication measurements are visualized by this poster in A1 format.

Poster PD 757.2844.21 enter 153/29

Radio Communications, We connect worlds The Rohde & Schwarz Radiocommunications Division is in the business of setting up excellent links worldwide for ATC, avionics, global communications (including naval communications) and traffic management.

Info PD 757.2544.21 enter 153/30

Field installation This brochure presents Rohde & Schwarz as a partner for planning, projecting, installing and commissioning of systems – anywhere at all; organizing the transport or just supervision of installation is also possible.

Info PD 757.2221.22 enter 153/31

VHF Paging Transmitter SU330-200R ((146) 169.425 to 169.800 (175) MHz, 200 W) from **R&S BICK Mobilfunk** for ERMES, POCSAG and high-speed paging features more than 28,000 h MTBF and minimum operating costs thanks to QAM concept; standard modification via firmware.

Data sheet PD 757.2680.21 enter 153/32

New application notes

ASCII conversion of binary data from test receiver for generation of test report on PC

Appl. 1EPAN21E enter 153/33

Measurements on hearing aids with Audio Analyzers UPD and UPL

Appl. 1GPAN34E enter 153/34

Generation of test signals for IS-136 (NADC) with Signal Generator SME

Appl. 1GPAN35E enter 153/35

Schz

Photo: S.T.P.

Chinese traffic ministers at Rohde & Schwarz

As part of their visit to Germany, 21 traffic ministers from various Chinese provinces and the directors of China's three biggest seaports recently called in at Rohde & Schwarz (the photo below shows them on their tour of the company accompanied by Chief Operating Officer Hans Wagner). China is currently putting a lot of effort into the expansion of traffic and transportation infrastructure, eg airports, railroads, coastal and inland ports for container shipping.

In Germany the guests wished to gather information about modern traffic and transportation installations and the companies producing them. The focus of their visit to Rohde & Schwarz was therefore on communications technology. In addition to radio services, global communications and air-traffic control, the guests were especially interested in Container Location System COLOS (see NEWS 151). The intention is to continue this first positive contact through the Rohde & Schwarz offices in Beijing and Shanghai. J. Beckmann

NAMAS accreditation for EMC test lab in UK

The EMC test laboratory of Hitachi Home Electronics (Europe) Ltd in South Wales, equipped by Rohde & Schwarz, was awarded NAMAS accreditation in accordance with EN 55013 and EN 55020 broadcast standards. This is the only accredited laboratory of its kind in the United Kingdom and is bound to attract much interest from other companies in both the UK and the European Union. Gerry Meek, manager of the facility (left in the photo above together with Carlos Perkins and Paul Davis of Rohde & Schwarz UK), admitted that there were a few hairy moments during the twelve-month period in which the department was scrutinized by NAMAS (national accreditation and measurement assessment). He added: "The accreditation process brought it home to me just how important it is for large manufacturers who are self-certifying their products to formalize their quality procedures."

The test facility of Hitachi Home Electronics, which produces some 30,000 television sets monthly at its plant in South Wales, includes a Test System TS9980 for EMS measurements and an EMI Test Receiver ESMI for emission measurements up to 26.5 GHz running under the Windows-based EMI Software ES-K1. Hitachi uses the Rohde & Schwarz ESH3 and ESVP receivers for development and diagnostic work. The shielded chambers were supplied by Euroshield and Rayproof.

T. Stephens

DAB news

Rohde & Schwarz demonstrated its expertise and capability in Bavaria's DAB pilot project, the world's biggest single-frequency network. Acting as general contractor, Rohde & Schwarz implemented the project in just eight months, so that Bayerischer Rundfunk was able to go on the air punctually with DAB in autumn 1995 (see NEWS 149). In the meantime Rohde & Schwarz has received further orders for a total of 90 DAB transmitters from German Telekom (L band), Teracom Sweden (band III) and the Swiss PTT (L band). Most of the installations have already passed acceptance, so there is nothing in the way of start-up of the networks to schedule. P. H. Frank

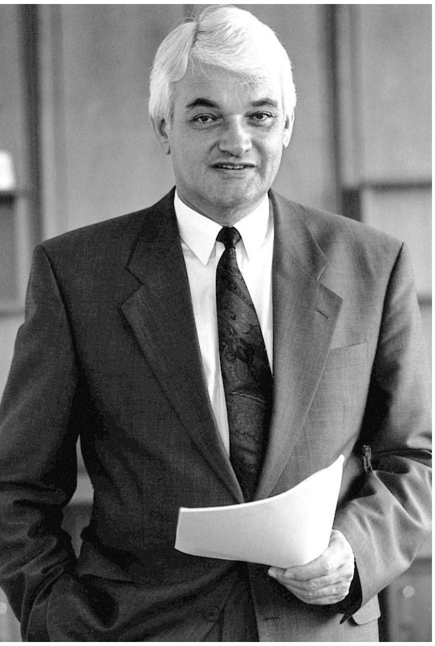
Shanghai Int'l Comm 96

The Shanghai Int'l Comm is the biggest telecommunications show in Eastern China and last year attracted almost 200 companies from all over the world. Modernization of China's communications infrastructure presents enormous market potential for all producers of advanced technology and equipment. So many big names in industry took this opportunity to present their latest products and ideas, including ISDN, fiber-optic technology, multimedia and video conferencing.

The Rohde & Schwarz stand, showing a wide variety of test and measurement equipment, drew more than 200 visitors. The vice-mayor of Shanghai, Jiang Yiren, showed a lot of interest in the products and talked at length with Campbell Morrow, Managing Director of Rohde & Schwarz China (photo left). He referred to the communications sector as ranking second in Shanghai's pillar industries for the 90s, development of which was vital to the city's economic growth and to the success of important industries.

Zhang Ying

Expansion of Rohde & Schwarz executive board



Reinhard Bruckner (55), Dipl.-Ing., who has been at Rohde & Schwarz for 31 years and previously headed the Test and Measurement Division, was appointed Head of Central Marketing and Engineering in July 1996 and, in October 1996, took up a position in the company's executive board.

After studying communications engineering, Bruckner joined Rohde & Schwarz as a design engineer in 1965. In 1981 he was appointed senior departmental manager, responsible for the design of synthesizers and signal generators, radiocommunication test sets, voltmeters and power meters. He pushed the development of test and measurement technology for digital communications and helped Rohde & Schwarz take on a leading role in the market for test equipment for analog and digital mobile radio. From 1993 he headed the Test and Measurement Division, which now accounts for almost half of Rohde & Schwarz business. The Rohde & Schwarz executive board is thus now made up of Friedrich Schwarz, Hans Wagner and Reinhard Bruckner. Pl

ASIC handover to Rohde & Schwarz

Dr Otto Wiesheu, Bavaria's minister of state (right in the photo), recently officially handed over to Rohde & Schwarz COO Hans Wagner the first application-specific integrated circuit (ASIC) produced by the Fraunhofer institute for solid-state technology. This marks a decisive step on the path of the Bavarian microelectronics cooperative of medium-sized industry towards its own ASIC. The latter undertaking focuses the microelectronics activities of the Fraunhofer institutes in Erlangen and Munich on economical production of ASICs in small numbers. Availability of these devices is vital for international competitiveness. On the one hand certain technical features can only be implemented by such microelectronic circuits, and on the other they protect intellectual property, which is becoming increasingly important in view of the high costs involved in designing competitive products.

The services offered by the Bavarian microelectronics cooperative range from design of the integrated circuit through industrial production to final testing to customer specifications. That makes these small-batch ASICs fully equivalent in quality to devices from volume fabrication. Single-source design and manufacture offer transparent costs and schedules – important for increasingly tough, worldwide markets.

K.-O. Müller

Photo: Müller

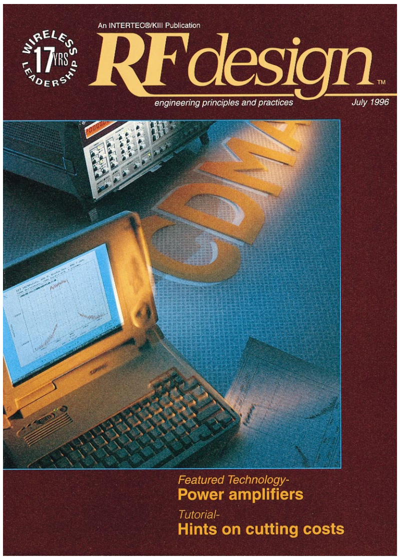
R&S sound and TV broadcast transmitters for RTBF in Belgium

"The most important thing for us is that we have a supplier for our special needs and problems. And that's precisely what led to the choice of Rohde & Schwarz as the contractor for our sound and TV broadcast transmitters", explains Franco Fantuzzi, head of broadcasting systems at RTBF (the Belgian broadcaster for the French-speaking community) in Brussels. Rohde & Schwarz has already supplied a large number of transmitters to RTBF, which are installed throughout Walloon, for example two medium-power TV and FM transmitters in Tournai, another medium-power TV transmitter in Profondeville and an FM transmitter for the first radio program plus two high-power TV transmitters in Wavre, one for Télé 21 and another for Canal+ (the photo below shows André Masson, service manager at Wavre, in front of TV Transmitter NT414). The pay-TV network operates a medium-power Rohde & Schwarz TV transmitter in Liège and the first program has an installation in Léglise. Another high-power TV transmitter was delivered to Anderlues. Various systems have also been supplied for monitoring operation of the transmitters and the broadcast programs.

The criteria for selection of Rohde & Schwarz were the company's reputation, especially good price/performance and attractive maintenance aspects. "RTBF is bent on saving", says Franco Fantuzzi. "We have to cut maintenance costs, so we put a lot of emphasis on system quality and reliability. At present it takes between 15 and 20 years for a transmitter to pay for itself. Where this is concerned we're fully satisfied with Rohde & Schwarz. And the company offers us flexible service, ready for new situations and developments. The transmitter in Anderlues was originally intended for Wavre for example. Rohde & Schwarz newly defined the project and changed the frequency for the new location."

And the perspectives? A digital transmission system for data and programs will very likely replace the present analog technology in 1997, which will mean a substantial improvement in reception quality.

RSB



Of late the press has been focusing on the very topical subject of CDMA. The cover of edition 7/1996 of the US electronics magazine *RF design* presented Signal Generator SMHU58 plus an article inside entitled "CDMA signals – a challenge for power amplifiers". The same topic was also dealt with in edition 18/1996 of the Munich-based R & D journal *Design & Elektronik*.

Fighting early failures

Early failures can be some of the most unwelcome faults in electronic products. The magazine *SMT* (issue 5-6/1996), which focuses on electronics production, quality assurance and testing, showed how to prevent them with a Rohde & Schwarz test system:

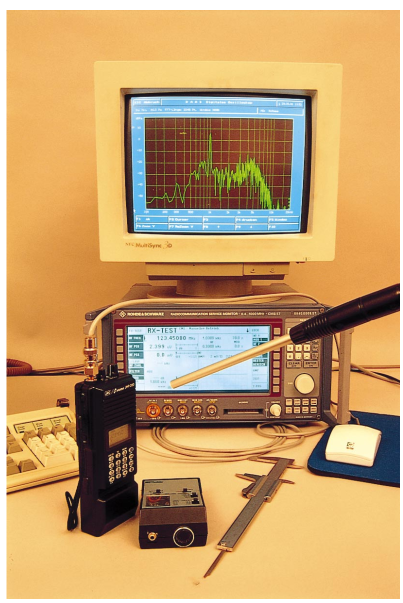
Experience has shown that early failures can be reduced substantially by an active run-in test. The controlled conditions and detailed information about failures enable much more precise analysis of the causes than waiting for reaction from the field. … Depending on the problem you can use a TSAx or TSUx as your test platform, and both analog and digital tests are possible according to system configuration.

Price breaker

Matthias Carstens of the magazine *ELRAD* tested Audio Analyzer UPL in edition 9/1996 and came to the following conclusions:

Although you could hear snide remarks like "The UPL is just another version of the UPD – one cheap enough to sell" at the AES in Copenhagen, I bet that some producers have had some stormy meetings in the meantime. There is no doubt about it: UPL is an extremely powerful, flexible, fast and accurate test set, at a price that will force the competition to react.

Aeronautical mobile phones with navigation features are an indispensable part of a pilot's gear when he goes onboard. They do valuable service as a lightweight standby if communication breaks down or for getting the go-ahead to start engines in the manoeuvring area. Number 8/1996 of the avionics magazine *Aerokurier* tested the four commonest mobile phones of this kind using Radiocommunication Service Monitor CMS57, which first enabled their characteristics to be examined precisely.



Antennas, antennas and even more antennas …

In its September 1996 issue, *HF-Report* looked at Rohde & Schwarz's inexhaustible selection of antennas for mobile-radio base stations:

Besides all the test instrumentation for operators of radio networks, Rohde & Schwarz also offers antennas for base stations. These omnidirectional and directional antennas can be used in all networks operating in the 900-MHz or 1800-MHz band, like GSM, DCS1800 (PCN), TACS, Qualcomm, NMT900, NTT and so on.

Cellular-phone test over the counter

Edition 18/1996 of *Funkschau* showed how retailers can use Go/NoGo Tester CTD52 to distinguish truly defective units from simple cases for servicing when customers bring their cellular phones back because something is wrong with them:

In many cases of complaints it is not the electronic modules of the cellular phone that are the cause. That is something the customer would like to know straight away, from the retailer. And if the man behind the counter cannot tell him this, the customer loses trust. A cellular-phone test is the solution to the problem, and it is now possible to perform it inexpensively on the spot. Test-equipment specialist Rohde & Schwarz is offering a tester for less than 10,000 DM that is just right for the job. All major functions of a mobile can be checked out there and then and the real cause of the fault pinpointed.

Hamburger special: new mobile test unit for HHA

***Funkspiegel* reported in issue 3/1996 about the equipping of Hamburg's railroad system HHA, one of the biggest private radio operators in North Germany, with mobile Field-Strength Measurement System TS9955 from Rohde & Schwarz:**

With the introduction of the SINGLE and IGNIS systems, radiocommunications have taken on special significance in underground railroad operations too. … Together with the expansion of its railroad communications the HHA upgraded its pool of test equipment and added a new Field-Strength Measurement System TS9955 from Rohde & Schwarz. To enable use away from the underground railroad network and produce more flexibility, a new mobile service unit was created with the system. This incorporates all aids like antennas, power supply, satellite-supported positioning and odometer.

SIT – Security in Information Technology

SIT, Gesellschaft für Systeme der Informationstechnik mbH, a subsidiary of Rohde & Schwarz based in Berlin, specializes in solutions to the problems of security in information technology (IT security). The main activities of the company are consulting and IT security analysis for industry and public authorities as well as the development of crypto products to protect data in modern information and communication systems.

SIT's fields of activity at a glance:

- hardware and software crypto products,
- crypto systems,
- consulting and IT security analysis,
- crypto modules to customer specifications.

Observers of the scene say that the world is undergoing a dramatic transformation from an industrial to an information society. In Germany only about 13% of the working population are still involved in production, whereas 60% deal with the generation and processing of information. According to forecasts, up to 1.5 million new jobs will be created in Germany in the next five to ten years by information highways.

Today's information processing and transmission work through complex **global communication networks,** such as Internet, which can be accessed by a large number of users. In addition to information for the public, eg press releases or promotional material, sensitive data on corporate strategies and proposals plus information related to customers and markets are being transmitted to a greater extent. Via the SWIFT network alone, banks handle electronically sums of several billion DM in a single day.

Modern communication networks no longer consist of purely data-processing systems but integrate different services in a single network: voice services (telephony), video services (video conferences, digital TV, video on demand) and data services (electronic mail, fax, remote access), etc. So today it is possible to send electronic mail from a conventional GSM-standard cellular phone to Internet via network gateways and to receive messages from it. These worldwide communication networks also provide access to a company's own local networks for sales and field staff for example. Network components and telecommunications systems are remotely maintained via these links by outside firms to an increasing extent. The potential for telejobs in Germany alone is estimated to be four million.

The sensitive company information processed in such communication networks not only attracts hackers who try to intrude into the networks for the kick they get out of it but also – and this is even admitted in public – organizations wanting to gain advantages for their national economies in increasingly tough international competition. Cases of **computer abuse and espionage** have greatly increased and headlines like the following can be read almost daily in the press:

- "Companies spied on by secret service"
- "Hackers eavesdrop on secret talks"
- "Sabotage – frustrated employees ruin company"
- "Charge theft at airport – radio pirates lying in wait for unsuspecting cellphone users"
- "Computer system of a big company cracked"
- "Pentagon: files destroyed"

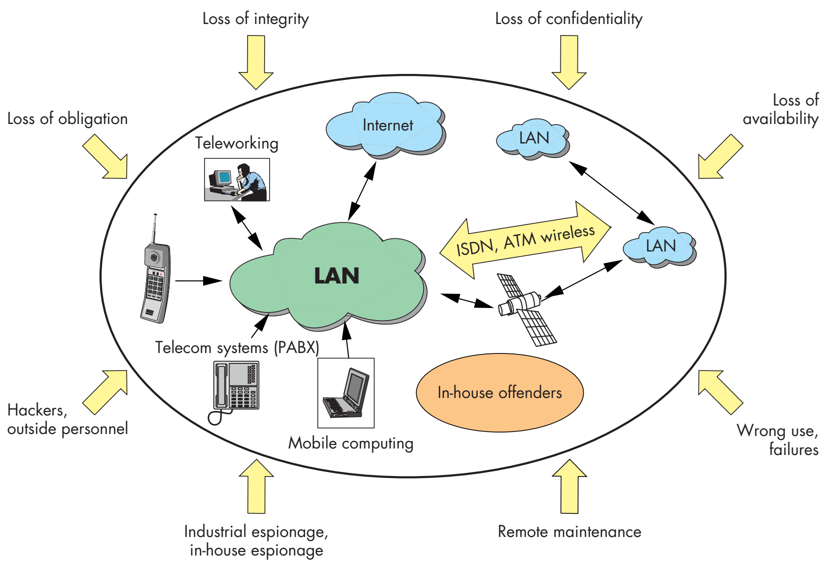


FIG 1 Threats to communication networks are many and varied.

- "City Bank New York: Russian hackers divert 11 million dollars to accounts in USA, Germany and Switzerland"
- "Intercepted fax costs German company high-speed train contract"

So there is increasing interest in protecting **sensitive data and information** against such threats. The **principal threats** can be categorized as follows:

- loss of confidentiality (unauthorized reading of sensitive or confidential information),
- loss of integrity (unauthorized modification of information),
- loss of availability (accidental destruction of data or destruction of data by persons),
- loss of obligation (eg non-recognition of agreements/contracts concluded in electronic media).

FIG 1 illustrates the complexity of modern communication networks and schematizes the principal threats. Each threat has to be countered by appropriate measures to reduce the risk to an acceptable level. The most widely used measure to prevent loss of availability of information is regular backup. Much more effort is required to guarantee confidentiality and integrity of data. Many information systems are inadequately equipped in this respect. The password protection of a PC is no help against theft of the unit or its hard disk containing confidential data. The situation becomes more complicated when information is transmitted by electronic mail, file transfer or news groups. It is difficult to predict the data transfer path which can be accessed by anyone without it being immediately noticeable.

The increasingly complex structure of communication networks on the one hand and the growing number of naive users on the other is a serious problem. Data-processing systems used to be operated only by qualified specialists. Today, in principle, communication networks are open to anyone wishing access. But apart from communication experts, only few users know, for example, that an electronic mail message sent from Berlin to Munich by Internet may make a detour via a computer in the US. An undesirable but likely course for a sensitive document in a local network is shown in FIG 2.

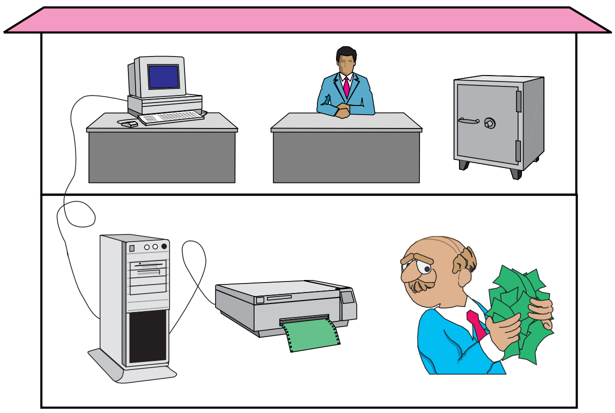


FIG 2
Electronic path of sensitive message from sender to recipient can be long and take many turns, and there is no guarantee that it will not fall into wrong hands.

It is extremely important to approach the security problem in communication networks in a systematic way. What it boils down to is: overall security is only as good as the weakest mechanism in the system allows it to be. An expensive system to protect network access is useless if the password is commonly known. Prior to taking actions to improve data security, the system to be protected should first be subjected to a threat and risk analysis, to reveal its weak points and the resulting risks.

The starting point for a **threat and risk analysis** is on the one hand the specific security requirements of the particular communication network and basic knowledge as well as proposed procedures of analysis on the other. In Germany such procedures may be taken from the IT base line protection manual and the IT security manual issued by the German Information

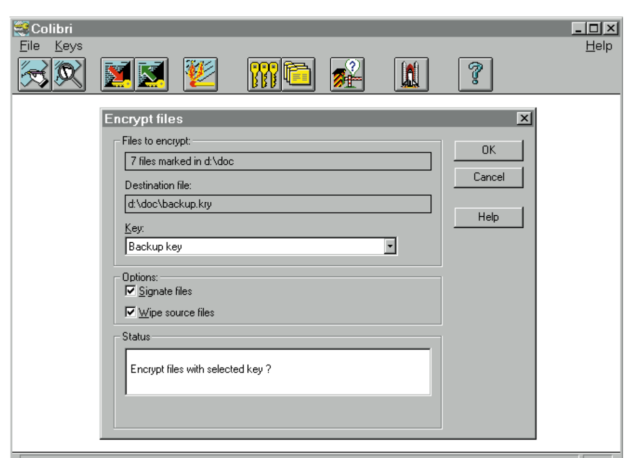


FIG 3
SIT security product Colibri as seen by user. Colibri can be adapted to different applications.

Security Agency (GISA). Criteria for approaches to IT security problems (ITSEC) have also been formulated in a European context. The analysis is the precondition for implementing a comprehensive IT security concept to increase security in a network. The objective is to weigh up existing risks against the costs involved to eliminate them and devise an acceptable concept with concrete proposals and cost estimates.

Modern **crypto techniques** make an invaluable contribution to data security. They allow transmitted information to be effectively protected against unauthorized use or access. With their help it is also possible to determine whether a document has been modified and whether it really originates from the author indicated. The main task of SIT lies in the development of professional crypto techniques and their application to protect customer information. In addition to integrating crypto modules into communication or other IT systems, SIT also provides **security products of highest cryptographic quality** such as:

Colibri (FIG 3)
- file encryption for the secure transfer of data by electronic mail or other networks,
- digital signature – to guarantee the genuineness of a note or instruction,
- physical deletion of data no longer required.

NetSave for secure Novell networks (FIG 4)
- online encryption of transmitted data and server areas,
- secure data transmission to the server and to other protected workstations,
- smart card authentication and boot protection,
- online hard disk encryption.

ComSaveBox (FIG 5)
- online encryption of a modem link (also via ISDN modems), eg for mail boxes, remote maintenance, network access,
- fully transparent for the user and for application programs,
- external unit, eg for laptop or PC.

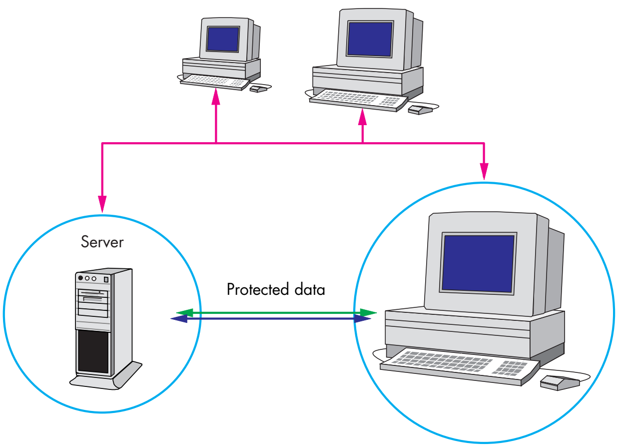


FIG 4
Crypto product NetSave 4 protects Novell networks (NetWare v4).

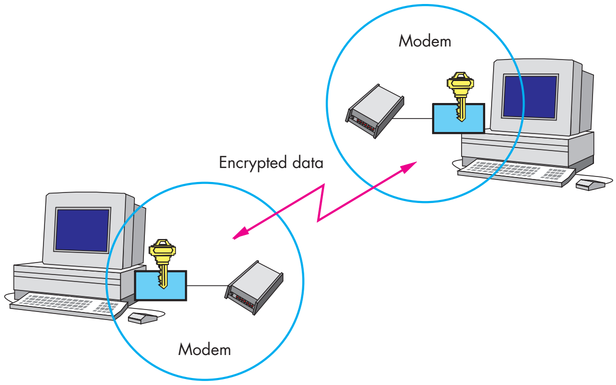


FIG 5
ComSaveBox encrypts any modem link online.

An extremely important factor in the efficient and effective implementation of security products is user acceptance. What is the point of ingenious security mechanisms if they are so difficult to configure or work with that it would be easier to just deactivate them? It is our job to meet the requirements for easy installation and intuitive user guidance. Whatever the protection level required for securing your important information may be – SIT is your partner in finding the right solution. By taking into account the specific requirements of your system, appropriate investments can be made to enhance data security.

SIT makes your data secure.

Henning Krieghoff; Dieter Sörgel

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News from Rohde & Schwarz 153 (1997/I) · PD 757.2280.21 · B42622