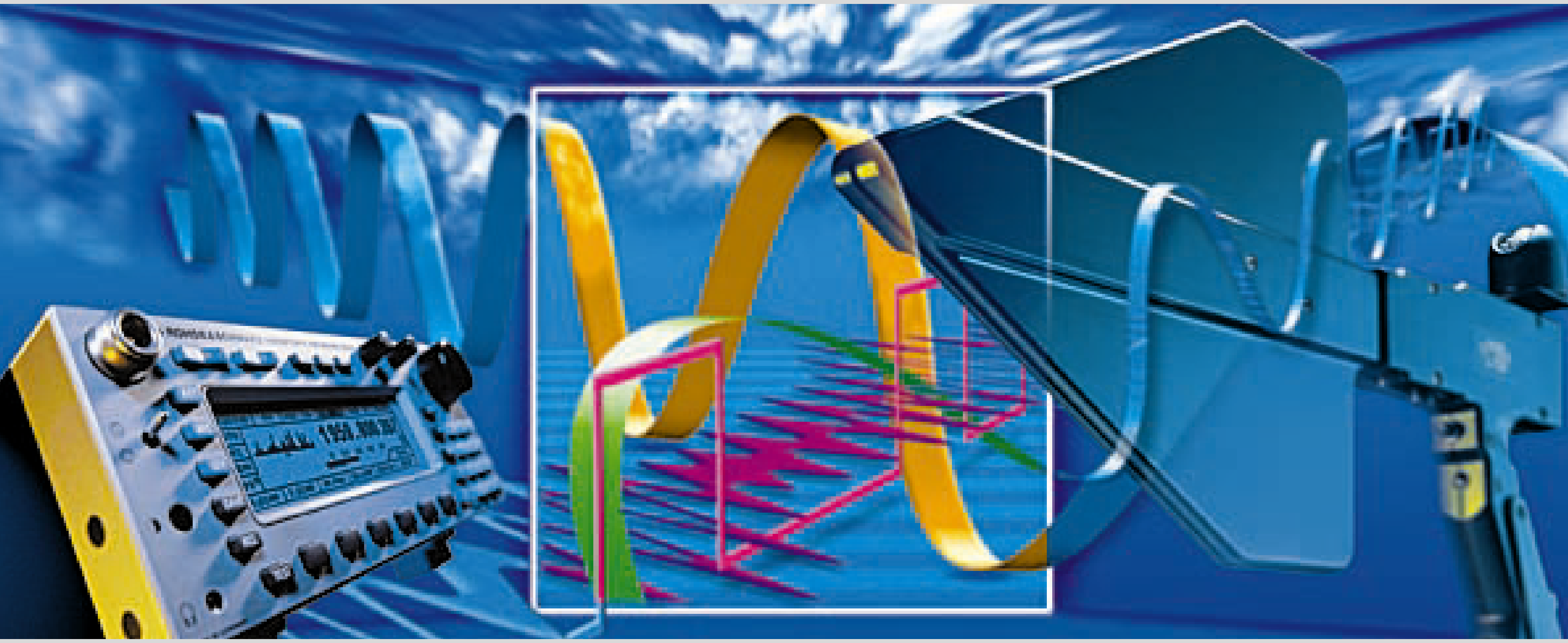
News from Rohde & Schwarz



Cost-efficient and portable
radiomonitoring up to 3 GHz

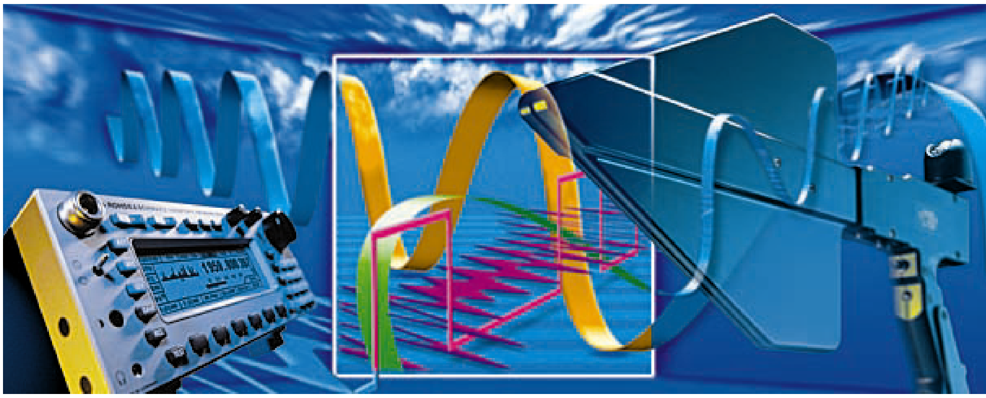
EMC measurements
– the right equipment for every application

Controlled RF amplifier
for physical applications

1997/IV
156

ROHDE & SCHWARZ

Number 156 1997/IV Volume 37



Compact, portable, yet professional: Radiomonitoring Miniport Receiver EB200 reliably detects every emission from HF to UHF. Together with Handheld Directional Antenna HE200 it can even determine the transmitter position. The clear-cut display of the receiver shows frequency, level and IF spectrum in alphanumeric and graphical form. Photo 43 017

Articles

Application notes

Software

Brand-new: standard DVB-T for digital terrestrial television, yet Rohde & Schwarz already has the suitable modulation source on hand (page 19); another innovation for DVB: optional input interface for TV Test Transmitter SFQ (page 34).

Refresher topic

Panorama

Regular features

New risks: going over to digital telephone and fax poses dangers for IT security. If you wish to know how to protect your ISDN telecommunication system against manipulations via PSTN, read our final article on page 42.

Imprint

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Miniport Receiver EB200 and Handheld Directional Antenna HE200

Radiolocation from 10 kHz to 3 GHz now with portable equipment

Radiolocation in the frequency range 10 kHz to 3 GHz has now become portable: with Miniport Receiver EB200 and active Handheld Directional Antenna HE200 for searching and monitoring emissions, detecting interference and locating miniature transmitters even in difficult terrain – with performance characteristics so far unparalleled by equipment of this size. Moreover, when accommodated in a rack, EB200 is a cost-effective, compact receiver that can be remotely controlled via LAN interface.

FIG 1
With a weight as little as 4 kg, Miniport Receiver EB200 can conveniently be carried and operated, leaving one hand free for Directional Antenna HE200.
Photo 43 016/1

Designed for portable use

The **ergonomic front panel** of Miniport Receiver EB200 makes for convenient operation in portable applications (FIG 1). The connectors for antenna and headphones are located on the left side of the front panel, providing an unobstructed view of receiver settings. All settings can be made with one hand since all important keys and controls are within easy reach without blocking out the graphic display, which not only furnishes alphanumeric information but also displays symbols and spectra. Various display modes are available to allow for zoomed representation of parameters important for a given application (FIG 2). Digital recording and subsequent evaluation of emissions is possible by means of a recorder connected to EB200.

EB200 is **powered from a battery pack** (optional) plugged to the unit. The battery pack can be replaced easily and conveniently. It can be charged from the power supply unit and the integrated electronics while the receiver is powered from a second battery pack. The power-saving receiver concept enables about four hours of continuous operation, which is sufficient for most applications. 24-hour operation is possible with an additional, commercial battery belt for which EB200 has a separate connector.

The **sturdy aluminum housing** withstands even major impacts without any damage. Because of its compact size it can be accommodated in the glove box of a car. Powered from the car battery (10 to 30 V), the receiver can be operated for several days since it requires less than 22 W. This also means that no blower is required so that the receiver – with the loudspeaker switched off – operates absolutely noiselessly.

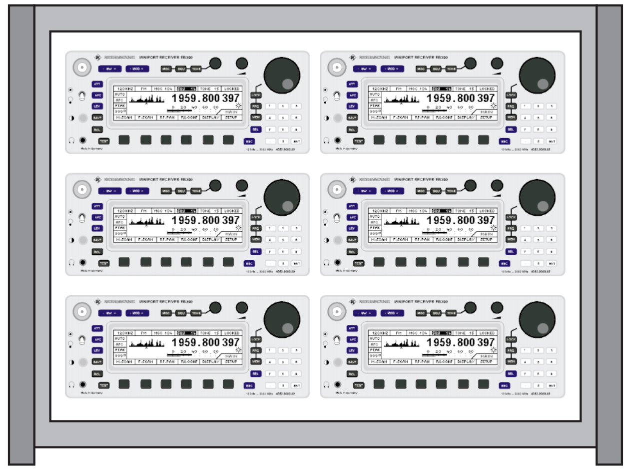
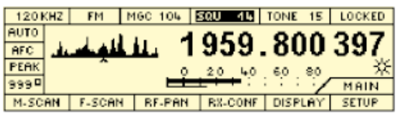
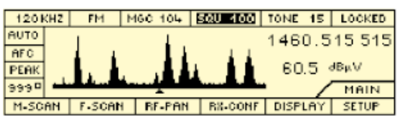


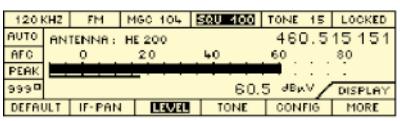
FIG 3 Receiver bank with six Miniport Receivers EB200



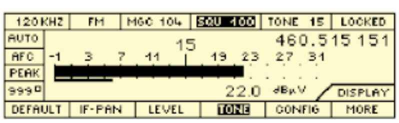
Frequency



IF panorama



Level



Level, zoomed

FIG 2 EB200 offers optimum display mode for any application.

System-compatible for stationary use

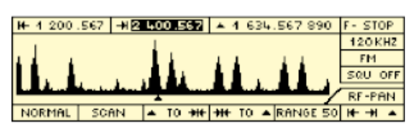
EB200 is a compact, budget-priced and high-quality solution for use in stationary systems. Due to the small size of the receiver, a bank of six EB200 units will take up no more space than a PC (FIG 3). This allows the configuration of compact radiomonitoring systems including analyzers, direction finders and recorders. **Networking via LAN** makes for simple cabling and fast transfer of commands. Since EB200 is controlled by means of SCPI commands, any existing control software for Monitoring Receiver ESMC can be used for operating EB200. The receiver incorporates as a standard an input filter that tracks frequencies in the range 20 to 1800 MHz. This allows undisturbed reception of weak useful signals even in the vicinity of powerful transmitters. For the range 10 kHz to 30 MHz, EB200 can be fitted with an optional external input filter.

Optimally equipped for all operating modes

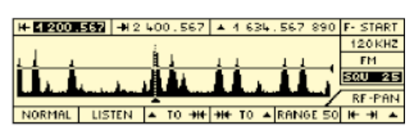
Fitted with the **Frequency Spectrum** (DIGI-Scan) option, EB200 scans the frequency range of interest with digital control and displays the associated spectrum (FIG 4). Emissions detected can be seen at a glance. Aural monitoring of the information is possible by simply pressing a softkey. EB200 then goes to the DIGI-Scan listen mode. The stored spectrum is displayed in the background, and the emission of interest can be selected and monitored by marking it with the frequency cursor.

Location of miniature transmitters at close range is possible in the differential mode of the DIGI-Scan option. In this mode, the displayed spectrum is stored as a reference. Current spectra are superimposed on the reference spectrum, and any new signals or variations in signal strength are clearly discernible as peaks. If the measurement is made with the distance, the field strength of transmitters at close range varies to a greater extent than that of transmitters located far away. This differential display allows the fast and reliable location of miniature transmitters even with spread-spectrum transmission.

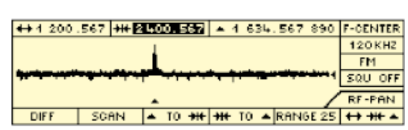
EB200 and Handheld Antenna HE200 are an ideal combination for the **determination of transmitter location.** The handheld antenna helps to find the direction of a transmitter, which is useful especially in difficult terrain where even four-wheel drive DF vehicles have no chance to get there. For long-term monitoring, an adapter comes with the antenna for mounting it on any commercial tripod. A high-sensitivity amplifier accommodated in the antenna han-



Scan mode



Listen mode



Differential mode

FIG 4 Displaying, monitoring and detecting signals with DIGI-Scan option

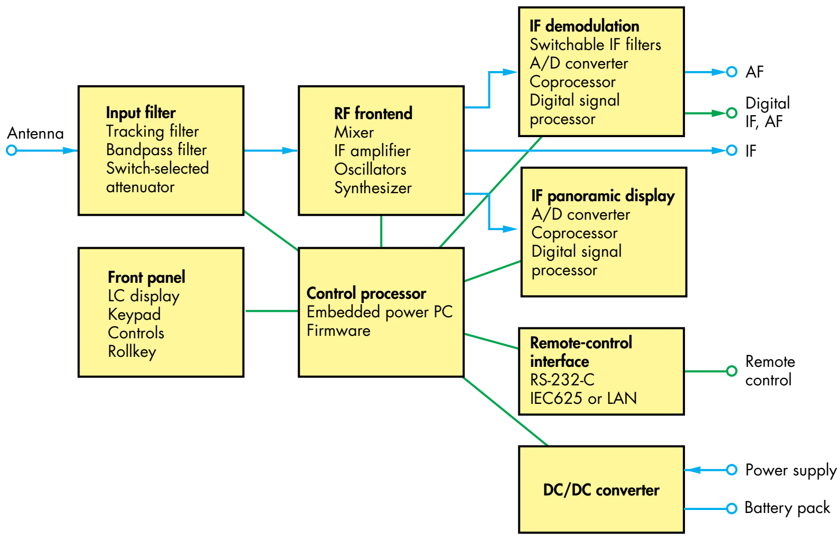


FIG 5 Modular design of EB200 (green: digital data exchange; blue: analog RF, IF, AF)

dle detects even extremely weak emissions. Direction finding is very easy by means of a synthetic tone whose pitch corresponds to the signal level. Monitoring this tone and direction finding is possible at the same time by matching the tone to the signal contents. This tone is switched on also with pulsed transmitters, and level changes can be recognized by the change in pitch.

Signal evaluation is based on the signal contents and the signal spectrum. Especially with digital transmission, the spectrum is often the only means of identifying a signal without resorting to more sophisticated analysis equipment. Since signals are emitted at different bandwidths, a fixed IF spectrum can at best be a compromise. Therefore, an **IF Spectrum** option is offered for EB200 that allows variation of the resolution. This enables the signal spectrum to be displayed at the optimum bandwidth in each case, and the user is always provided with the correct information for evaluating the emissions received.

Ten bandwidths from 150 Hz to 120 kHz are available to cater for any requirements. EB200 demodulates as standard not only AM and FM, but also LSB, USB and CW. A telephone filter is not necessary since the AF filter automatically follows the bandwidth. With extremely broadband signals (up to 1 MHz), the IF Spectrum option comes into its own, adding five more bandwidths, so that EB200 will display the spectrum, level and offset for any signal. The broadband signals are however not demodulated. With the IF Spectrum option, virtually any type of emission can be identified.

Future-proof with digital signal processing

Accommodating the functionality of a unit of much larger size in the compact EB200 has been possible through the use of LSI components and digital signal processing in the IF filters, demodulators and synthesizer modules (FIG 5). These design features give a wide variety of selectable bandwidths and demodulators and offer a future-proof solution since additional functions or special analysis methods can subsequently be integrated at the customer's by simply downloading them from a PC. Any new features and improvements, too, can in this way be added to the receiver. With EB200, the user will therefore always have a state-of-the-art instrument.

Günther Klenner

Condensed data of Miniport Receiver EB200

Frequency range	10 kHz to 3 GHz
Dynamic range	–10 to 110 dBμV
Demodulation	AM, FM, USB, LSB, CW (further modes as options)
Bandwidths with demodulation	10 (150 Hz to 120 kHz)
Bandwidths for signal analysis	15 (up to 1 MHz with IF Spectrum option)
Display	full graphics, 240 x 64 pixels, backlit
Operator controls	numeric keypad, softkeys, controls, rollkey
RF connectors	for antenna, IF (10.7 ± 1 MHz), reference
Audio connectors	balanced, unbalanced, 600 Ω mono output, stereo output, ext. loudspeaker, headphones
Digital connectors	IF as I/Q signal, AF
Remote control	via RS-232-C, IEC625 or LAN (RJ45) interface, SCPI-conforming command syntax
Dimensions of case	88 mm x 210 mm x 270 mm
Weight	4 kg; 5.5 kg with battery pack
Continuous operation	typ. 4 h with battery pack
Power consumption	<22 W

Reader service card 156/01

PCS1900 System Simulator TS8915

Exclusive type certification of PCS1900 mobile stations in the US

The European mobile radio standard GSM is conquering the globe, and the US market is an integral part of this development. Like in Europe, type certification for mobile stations to PCS1900 has become obligatory since the middle of this year. Rohde & Schwarz is the only company to offer the required test equipment: PCS1900 System Simulator TS8915.

FIG 1 PCS1900 System Simulator TS8915 provides more than 200 test cases for type certification of US mobile phones to PCS1900 standard. Photo 42 284

In the US, the PCS1900 standard is currently being drawn up within GSM N.A. (GSM North America) as a derivative of the European GSM standard phase 2 (in future also called GSM1900). PCS1900 stands for Personal Communications System in the 1900 MHz band. Rohde & Schwarz has responded to this development in good time by providing the corresponding test equipment [1; 2]. PCS1900 System Simulator TS8915 (FIG 1) is based on Test System TS8915B [3] which includes Digital Radiocommunication Test Set CRTC02. Thus, all required signalling tests and high-precision RF parameter tests are possible. Besides the PCS1900 System Simulator TS8915 as a complete system for type testing, CRTC02 is accepted as an alternative platform for signalling tests within type certification.

On the way towards PCS1900 type certification

In line with CTIA (Cellular Telecommunications Industry Association), the Permanent Reference Document PRD NATWG.03 [4] defines the procedure of GSM N.A. type certification for PCS1900 mobile stations. PCS1900 System Simulator TS8915 and Test Set CRTC02 from Rohde & Schwarz are cited in this document exclusively as reference platforms for type certification. This certification is based on the GSM specifications including the corresponding modifications for the North American standard. These modifications are defined and maintained by the GSM N.A. network operators.

The test specification is documented in GTS (Global Telecommunications Standard) recommendation PCS 11.10-1, derived from GSM 11.10-1 specification. Rohde & Schwarz was involved at a very early stage in the creation of this test specification initiated by the German test house and service enterprise CETECOM [5] and implemented the test cases on PCS1900 System Simulator TS8915 and Test Set CRTC02. Thus, within six months, more than 200 test cases could be implemented and validated in due time for the official start on 1 June 1997. The test implementations were again validated by CETECOM in close cooperation with the development engineers from Rohde & Schwarz.

After an initial phase of 18 months other independent test labs can be accredited by GSM N.A. for PCS1900 mobile station certification. During this phase, cooperation with other test houses is possible. The PCS1900 Type Certification Review Board (PTCRB) defines the required test cases. Currently, the list contains 315 tests that will be available by autumn this year. FIG 2 gives an overview of the PCS1900 type certification process.

Differences between European GSM and GSM N.A.

Type certification of PCS1900 mobile stations using the PCS1900 system simulator is via the air interface, ie via the radio channel between the mobile and base station (simulated by the system simulator). Corresponding modifications by CTIA or GSM N.A. had to be considered for the test equipment. First of all, PCS1900-specific frequencies have to be adhered to. TABLE 1 gives an overview of all the frequency bands currently occupied in the digital mobile radio world according to GSM standard (channel spacing 200 kHz).

Moreover, three power classes have been defined. TABLE 2 compares the current standards. The PCS1900 system simulator considers these parameters by a corresponding configuration of the RF switching matrix [6]. Thus, the complete frequency and level range can be tested. Further modifications have been introduced to the network management. The GSM standard defines the location area identifier for determining the position of a base station by three parameters: MCC (mobile country code), MNC (mobile network code) and LAC (location area code). MNC is the network indicator. A mobile station in Germany (MCC 262), for example, recognizes from the MNC whether it is in D1 (MNC 01), D2 (MNC 02) or in E1 network (MNC 03). Because of the 2-digit BCD coding of MNC the number of network operators in the GSM standard is limited to 99. This parameter was extended to a value allowing to identify 999 (!) network operators in the North American PCS1900 world. All this is taken into account by the corresponding signalling software. Another innovation is the enhanced full rate vocoder (EFR) which can also be supported by PCS1900 Simulator TS8915.

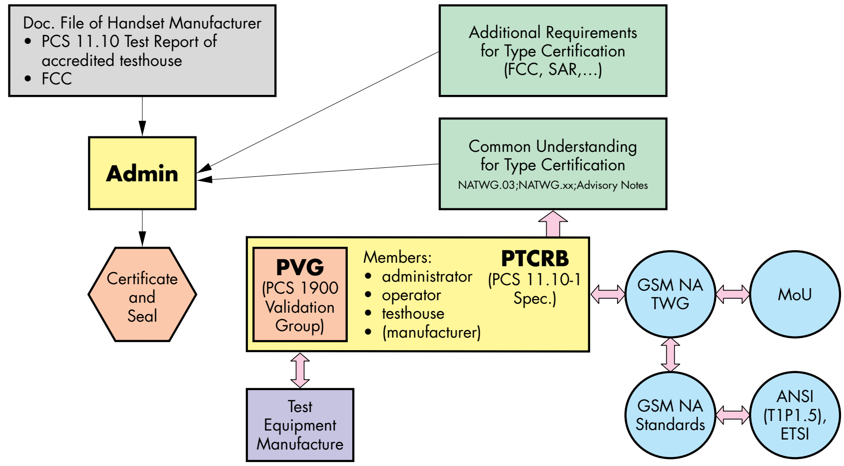


FIG 2 PCS1900 type certification diagram (source [4])

Test system configuration

The PCS1900 system simulator comprises three CRTC02 units allowing simultaneous simulation of up to six mobile radio cells (base stations). Moreover, Signal Generators SME02 and SMP02 provide the necessary spurious signals as required for selectivity measurements. A fading simulator in the PCS band ensures a realistic simulation of the mobile radio channel by exactly simulating standardized fading profiles. Spectrum Analyzer FSM allows frequency-selective measurements of the stimulating end of the DUT – eg for spectral analysis of the transmit signal of the mobile station – as well as the frequency-selective analysis of spurious emissions. Dual-Channel Power Meter NRVD can carry out high-precision level measurements due to the fully automatic RF path compensation by the system itself. All relevant RF signals are applied to the DUT via a complex RF switching matrix. The required accuracies for the RF parameters of the test signal are thus ensured for type testing. As an option TS8915 can also comprise audio test equipment so that this type of testing is also possible.

Service	Uplink	Downlink	Channel number
P-GSM	890 to 915 MHz	935 to 960 MHz	1 to 124
E-GSM	880 to 890 MHz	925 to 935 MHz	975 to 1023
DCS1800	1710 to 1785 MHz	1805 to 1880 MHz	512 to 885
PCS1900	**1850 to 1910 MHz**	**1930 to 1990 MHz**	**512 to 810**

TABLE 1 Mobile radio services and associated frequencies (P-GSM/E-GSM = Primary/Extended GSM, DCS1800 = Digital Communications System at 1800 MHz)

Service	Power classes	Maximum power	Minimum power
GSM	2, 3, 4, 5	39 dBm (8 W)	5 dBm (approx. 3.1 mW)
DCS1800	1, 2, 3	36 dBm (4 W)	0 dBm (1 mW)
PCS1900	**1, 2, 3**	**33 dBm (2 W)**	**0 dBm (1 mW)**

TABLE 2 Power classes of mobile radio standards

The test requirements of PCS1900 11.10-1 include the same test ranges as those known from GSM or DCS1800 type testing. It is noteworthy that the system simulator – due to its flexible concept – is not only suitable for PCS1900 type certification but also for type testing of DCS1800 mobile stations. Corresponding test cases are also available in the GSM band and so TS8915 is optimally prepared for final GSM type-approval testing. These characteristics make the simulator fit for providing multiband test cases without elaborate modifications being required: this means a single system suitable for all possible applications in the GSM world.

Heinz Mellein

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[3] Rohde & Schwarz: Type Approval Systems for Mobile Radio TS8915A/B (Info 4/96).

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Condensed data of PCS1900 System Simulator TS8915

Frequency range (useful band)	
Uplink	1850 to 1910 MHz
Downlink	1930 to 1990 MHz
Modulation	GMSK
Power (uplink)	1 mW to 4 W

Reader service card 156/02

Electromagnetic compatibility

by Joachim Nedtwig and Martin Lutz (editors). The handbook "Electromagnetic Compatibility" published by the German WEKA Fachverlag in Augsburg in the form of a loose-leaf edition was printed for the first time in February 1996, when it comprised around 700 pages. It has since then been updated by six supplements and is now available as a 1200-page edition including a CD-ROM. It is available from WEKA Fachverlag für technische Führungskräfte GmbH, Morellstrasse 33, 86159 Augsburg, Germany; price: 298.– DM (only in German).

With the help of 30 experts, each contributing their specialized knowledge on EMC, the editors have created a publication covering all aspects of electromagnetic compatibility for engineers and technicians. Volume 1 of the compendium, which by now consists of two volumes, deals with the relevant EC directives, the implementation of EMC Directive 89/336/EEC in the form of the German EMC law and its implications as well as with the EMC standards. It also lists the standards for the protection of personnel and the low-voltage directive. In the last chapter of volume 1 the physical principles of EMC are described and interference source, coupling and interference sink explained.

Volume 2 deals with the electronic and mechanical development of equipment from the viewpoint of EMC and provides an insight into EMC in motor vehicles and the interrelation of EMC and lightning protection in aircraft. One chapter is dedicated to the legal consequences of the EMC law. Two further sections are provided for measurement and test procedures according to EMI and EMS standards. The contribution on electromagnetic interference measurements was made at Rohde & Schwarz by Dipl.-Ing. Karl-Otto Müller, who over the past 20 years has been in charge of the development of R&S EMI test receivers, which are in use all over the world.

The handbook is rounded off by a section dealing with a cost and economic analysis of EMC testers. This section may help those who have to decide between buying their own tester or having measurements performed at a test house. A list with the addresses of companies offering EMC services in the German-speaking countries and the relevant bodies and authorities is also provided.

The handbook offers a wealth of information that has not been compiled in such a comprehensive way before. The expected penetration of electric and electronic products into all spheres of life will make further EMC standards and legislation necessary. The handbook is published as a loose-leaf edition and will be regularly supplemented (partly also on CD-ROM), so it will be possible to keep the compendium up to date at all times. AS

EMI test receivers from 5 Hz to 26.5 GHz

Concept of EMI instrumentation has proven itself

The adoption of the European EMC Directive 89/336/EEC at the beginning of the 90s has created a need for instruments that are able to perform accurate measurements in line with the applicable EN standard. Rohde & Schwarz took up this challenge in time by introducing a new EMI test receiver generation in 1991.

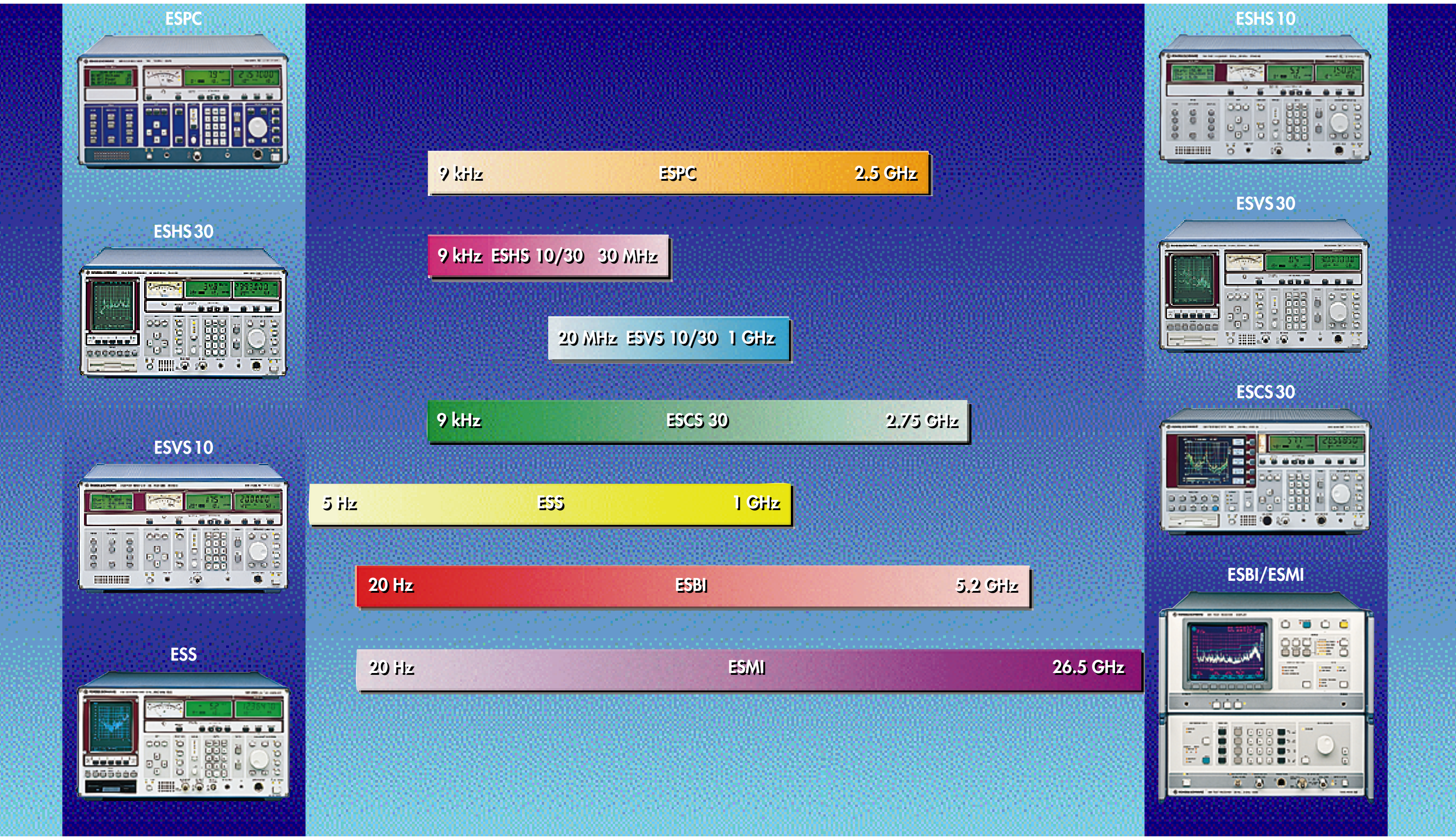

FIG 1 Overview of spectrum of Rohde & Schwarz EMI test receivers

Standard-conformal measurements of interfering emissions (EMI) place highest demands on the characteristics of a test receiver which must be able to correctly detect and evaluate pulsed or sinusoidal, modulated or intermittent interferers. The necessary pulse weighting with a CISPR quasi-peak detector demands on the one hand high immunity to overdriving and on the other high sensitivity for RFI field-strength measurements that take into account cable losses and antenna correction factors, ie a dynamic range that can be obtained only with the aid of advanced circuit design. To further increase the efficiency, time-saving test methods are of great importance. They are mostly implemented in the instrument firmware in the form of intelligent test routines, interactive macros and automatic evaluation functions. In addition, EMI software packages for commercial PCs allow automatic control of complete EMI test systems via IEC/IEEE bus.

The legal provisions prescribing compliance of devices or systems with EMC (electromagnetic compatibility) standards in all countries of the European Union since the beginning of 1996 made it necessary to adopt a new strategy for planning, development and assembly of electrical and electronic devices. EMC measurements are to be performed at all stages of development, construction and quality assurance through to market introduction and marketing of the ready-to-sell product. Besides the test setups stipulated by EMC standards, precision measuring instruments complying with CISPR 16-1 standard are a prerequisite for performing reproducible measurements at the specified accuracy.

The instruments

Basically, all measuring instruments in line with the basic CISPR 16-1 specifications meet the demanding EMI measurement requirements. Conformity to EMC standards may be confirmed by an independent, accredited organization. All Rohde & Schwarz full-compliance test receivers conform to CISPR standards [1]. FIG 1 gives an overview of EMI test receivers and their frequency ranges.

Full-compliance sector

EMI Test Receivers ESHS10 and ESVS10

All test receiver of series 10 are able to automatically control artificial mains networks via macros and allow at the same time test reports to be output on a plotter or printer. Optional AC-supply-independent battery operation makes the instruments ideal for mobile, open-site measurements at EMC service providers, test houses and technical inspection authorities, and particularly for development and acceptance tests in industry in line with EN 55011 to EN 55022 standards.

EMI Test Receivers ESHS30 and ESVS30

Test receivers of series 30 differ from models 10 mainly by a built-in, low-leakage screen, IF spectrum analysis and built-in 3.5″ floppy-disk drive for storing and calling measurement results, limit lines, correction tables and scan data records. They are equipped in addition with a tracking generator for two-port measurements or for determining cable losses. Users of ESHS30 and ESVS30 are the same as those of model 10, but the main field of application for series 30 instruments is acceptance testing at accredited EMC test houses, authorities and quality assurance departments of large companies.

EMI Test Receiver ESS

ESS [2] is the flagship of the EMI test receiver family. It covers the frequency range above 5 Hz and offers all CISPR and MIL bandwidths up to 1 MHz. The strength of this unit is its compact design combined with an extremely high sensitivity and high pulse loading capacity. Three RF input modules each using a different mixing principle guarantee excellent RF characteristics. Because of its elaborate design, ESS is mostly used by test houses and EMC service providers. Other main fields of application include computer and car manufacture, quality assurance at large companies as well as measurements up to 1 GHz in the military sector.

EMI Test Receiver ESCS30

ESCS30 [3], the latest member of the test receiver family, offers a number of unique features making it an important extension to the family. Highlights such as continuous frequency range from 9 kHz to 2.75 GHz, colour LCD with VGA resolution for displaying traces along with an analog bar for up to three parallel-operating detectors as well as time domain analysis for assessing the time response of EMI emissions are all packed into one compact receiver which, to top it, features an excellent price/performance ratio. ESCS30 complies with all commercial EMC standards to CISPR and VDE. An advanced operating concept using macros for fully or semi-automatic test runs combines convenient operation with fast and reliable receiver setting. Low weight, optional AC-supply-independent operation up to four hours from internal batteries and the built-in 3.5″ disk drive make ESCS30 ideal for mobile operation. Users of ESCS30 are national authorities, approval offices, test houses, EMC service providers and industrial EMC laboratories. It is particularly noteworthy that a large number of these receivers is used by the German Post and Telecommunications Office (BAPT).

EMI Test Receivers ESBI and ESMI

These test receivers are based on the principle of a spectrum analyzer, ie they utilize the advantages of fast sweeps for prescan measurements. These features are combined with the accuracy, selectivity, dynamic range and sensitivity of a test receiver in a single compact unit. The frequency range 20 Hz to 5.2 (or 26.5) GHz and the technical concept make this receiver type ideal for test houses, military applications, research and education as well as aerospace industry.

Precertification sector

EMI Test Receiver ESPC

ESPC was especially developed for precertification measurements. Although the unit has a slightly reduced functionality, it yet features a clearly higher measurement accuracy and reliability of results than many other instruments of its class. It is mainly used for development-accompanying measurements in all sectors of industry and for all types of products, but also in research and education and even by test houses as an add-on unit.

All Rohde & Schwarz EMI test receivers are able to perform fast prescan measurements with the aid of parallel detectors, store a great number of limit lines and compare measurement results with active limit lines. To increase the measurement accuracy, transducer correction tables may be taken into account in the level display. EMI Test Receiver ESPC is the only exception regarding full compliance with EMI standards. Being mainly intended for precertification measurements, it is not fully compliant to CISPR16 when evaluating pulsed interferers using the quasi-peak detector.

Accessories and software

All Rohde & Schwarz EMI test receivers can be operated with a comprehensive range of accessories including artificial

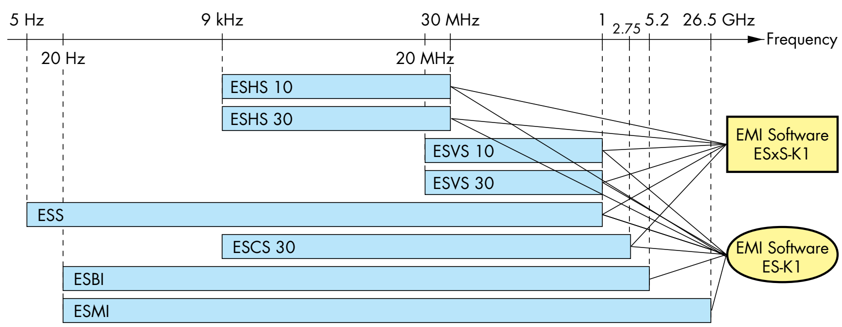

FIG 2 Software packages for full-compliance EMI test receivers

mains networks, active and passive probes, inductive probes, preamplifiers, current probes, absorbing clamps, test antennas for magnetic and electric fields, turntables, antenna masts and slideways for absorbing clamps.

Software Packages ES-K1 [4] and ESxS-K1 [5] (FIG 2) – operating under Windows™ 3.1 or 95 on any commercial PC with IEC/IEEE bus or PCMCIA card – perform all receiver settings for EMI measurements to standard. If external extras like mast, turntable and slideway systems are also to be controlled, height and polarization parameters as well as angle positions and positions of absorbing clamps are accurately monitored, set for subsequent measurements and stored.

Volker Janssen; Karl-Heinz Weidner

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Condensed data of EMI test receivers

Type	Frequency range	Preselection/ preamplifier	IF bandwidths	Tracking gen./ IF analysis	Other extras	Options	Recommended extras
ESHS10	9 kHz to 30 MHz	yes/yes	200 Hz/9 kHz	no/no	macros, battery	none	rechargeable batteries
ESHS30	9 kHz to 30 MHz	yes/yes	200 Hz/9 kHz	yes/yes	macros, floppy	none	
ESVS10	20 to 1000 MHz	yes/yes	9 kHz/120 kHz	no/no	macros, battery	impulse-resistant attenuator up to 1 GHz	rechargeable batteries
ESVS30	20 to 1000 MHz	yes/yes	9 kHz/120 kHz	yes/yes	macros, floppy	none	
ESS	5 Hz to 1 GHz	yes/yes	200 Hz/9 kHz/120 kHz 2 Hz to 1 MHz	yes/yes	macros, floppy, bal. input, MIL measurements	int. oven crystal frequency	Magnetic Field Pickup Coil HZ-10
ESCS30	9 kHz to 2.75 GHz	yes/yes	200 Hz/9 kHz/120 kHz/ 1 MHz	yes/yes	macros, battery, floppy, time domain analysis	battery-supplied controller, rechargeable batteries, IF analysis, oven crystal reference, tracking gen. 9 kHz to 2750 MHz	EMI software, pulse limiter
ESBI	20 Hz to 5.2 GHz	yes/yes	200 Hz/9 kHz/120 kHz 10 Hz to 1 MHz 6 Hz to 3 MHz (–3 dB)	up to 5.2 GHz/ no	2nd RF input, MIL measurements	none	EMI Software ES-K1
ESMI	20 Hz to 26.5 GHz	yes/yes	200 Hz/9 kHz/120 kHz 10 Hz to 1 MHz 6 Hz to 3 MHz (–3 dB)	up to 5.2 GHz (opt. 26 GHz)/ no	2nd RF input, MIL measurements	tracking generator extension to 26.5 GHz	ext. mixer (up to 110 GHz), EMI Software ES-K1
ESPC	150 kHz to 1 GHz	yes/no	200 Hz/9 kHz/120 kHz	no/no	macros, battery	frequency extension 9 to 150 kHz + IF bandwidth 200 Hz, freq. extension 1 to 2.5 GHz, int. batteries	pulse limiter, El. and Magn. Field Probe Sets HZ-11, HZ-14

Reader service card 156/03

Signal Generator SMIQ + SMIQ-B42

Multichannel signal source for CDMA

SMIQ is an extremely versatile instrument for the generation of digital modulation. Fitted with the optional modulation coder and data generator, it is capable of generating both TDMA and CDMA signals. Now a new, cost-effective software option is available that turns SMIQ into a powerful IS-95 CDMA signal generator. With this option, SMIQ can simulate the transmit signals of base and mobile stations.

FIG 1 Signal Generator SMIQ, versatile RF source for research, development and production in digital mobile radio Photo 42 979/1

Simulation of signals

With the IS-95 CDMA software option (SMIQ-B42), Signal Generator SMIQ (FIG 1) [1] supplies signals conforming to standard for testing IS-95 CDMA transceivers. In **forward link** operation, where SMIQ simulates the transmit signal of a base station, two modes are available. Mode 18 provides up to 18 code channels. Walsh code and data source can be set separately for each channel. The powers of the pilot channel and two further code channels (eg sync channel and paging channel) are freely selectable in this mode. The other code channels (usually traffic channels) have uniform power. This exactly conforms to IS-97 specifications for the "Base Station Test Model". FIG 2 shows the corresponding setting menu of SMIQ, in this case with nine active channels.

The second forward link mode provides as many as 64 code channels. The power of the pilot channel is freely selectable; the powers in the other channels are uniform. This mode is used to simulate maximum channel usage of a base station, since the forward link contains a maximum of 64 code channels. Modulation data are supplied by a PRBS generator; in addition, simple data patterns (00.., 11.., 01..) are available. PRBS data are ideal for component testing, for example of amplifiers. Data patterns are used for basic tests on demodulators of mobile station receivers. With a chip rate of 1.2288 Mchip/s, the modulation data rate is 19,200 bit/s. Channel coding or interleaving is not performed by SMIQ.

In **reverse link** operation, SMIQ simulates the transmit signal of a mobile station. This signal comprises only one code channel. SMIQ performs orthogonal modulation stipulated by IS-95 as well as spreading of modulation data. In full-rate mode, an offset-QPSK-modulated signal with constant output power is generated. For measurements on the output stages of a mobile station, half-rate mode with power gating can be simulated. A switchable burst randomizer is integrated, which is of advantage in burst measurements. Like with forward link, PRBS data or simple data patterns can be selected as a data source. The modulation data rate is 28,800 bit/s, the long code is set to zero.

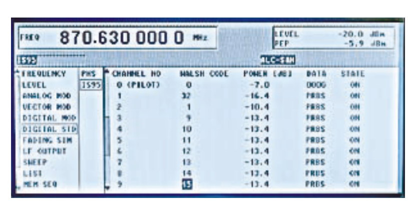

FIG 2 SMIQ setting menu for forward link code channels

High-quality reference source

Signal generators are often used as a reference source, so the accuracy of the generated modulation signal is an important quality criterion. SMIQ meets these requirements with an extremely low error vector of typically 1%. This corresponds to a ρ factor of 0.9999 for the CDMA signal. In the case of a forward link signal with several code channels, this small error vector makes for very low crosstalk between the code channels. The purely digital generation and addition of the code channels in conjunction with the small error vector results in highly accurate setting of the channel powers. FIG 3 shows that the setting error for the code channel powers is less than 0.1 dB. The time offset or phase difference between signals of different code channels is extremely small. Typical measured values are 1 ns or 0.3°.

High spectral purity for amplifier measurements

Two characteristics of a signal source are of particular importance for measurements on the power amplifier of a CDMA base station: a large and selectable number of code channels and a frequency spectrum with low adjacent-channel noise power. Here, SMIQ sets unique standards. FIGs 4 and 5 show the measured spectra of

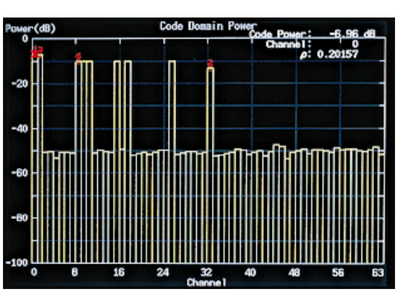

FIG 3 Verification of accurate code channel power setting by code domain power measurement using Spectrum Analyzer R3465 from Advantest

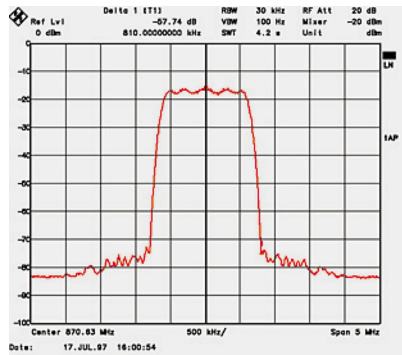

FIG 4 Spectrum of pilot signal measured with Spectrum Analyzer FSEA

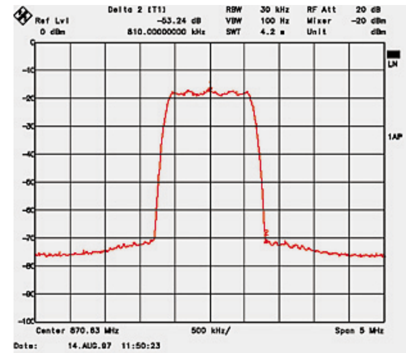

FIG 5 Spectrum of CDMA signal with nine code channels

a pilot signal and of a signal with nine code channels. The ratio of peak power to average power, ie the crest factor, which is critical for measurements on power amplifiers, is greater than 10 dB for the nine-channel signal [2]. Measured at a bandwidth of 30 kHz, the noise power of the adjacent-channel spectrum is 70 dB below total channel power. Adjacent-channel power is thus more than 20 dB below IS-97 limit values for base stations.

Ideal signal source for component testing

Excellent signal quality of SMIQ and versatile setting facilities of CDMA option make the unit an ideal source for measurements on CDMA components of any type. Passive components, eg filters, cause deterioration of modulation quality through linear distortion. The good ρ factor of SMIQ is therefore required to evaluate frequency-response errors and group-delay distortion of such components. In the case of active components such as transistors or amplifiers as well as mixers, the effect of nonlinear distortion is predominant. Third-order nonlinearities result in intermodulation products in the adjacent CDMA frequency channel (spectral regrowth). High spectral purity as offered by SMIQ is a must for spectral regrowth measurements. A particular asset is the possibility of crest factor variation by modifying the number of active code channels (forward link).

Receiver measurements

SMIQ offers a variety of trigger modes for receiver measurements. Frame and superframe clock as well as 2-s clock are available as trigger output signals. Conversely, CDMA signal generation in SMIQ can be started by means of an external trigger. For use as an OCNS (orthogonal channel noise simulator), output frequency and chip clock can be externally synchronized, too. These setting facilities provided for the data source already allow a number of basic tests to be performed on the receiver. With an extension of the CDMA option (currently under development) it will also be possible to measure the frame error rate (FER) on base station receivers. This requires generation of a reverse link signal with a length of several hundred frames.

An add-on to SMIQ which is of particular importance for FER measurements should not be left out: Fading Simulator SMIQ-B14. This option turns SMIQ into a fully-fledged radio channel simulator with six propagation paths [3]. In terms of accuracy, the fading option clearly exceeds the stipulations of IS-97, while offering an enormous price advantage compared to conventional RF fading simulators.

The next step: broadband CDMA

SMIQ provides an extremely powerful hardware platform for baseband generation. CDMA signal generation is effected in a chip rate range between 1 kchip/s and 7 Mchip/s (0.1 Hz resolution). For baseband filtering, a Nyquist filter with adjustable roll-off factor can be used instead of IS-95 filters. Further developments towards broadband CDMA are therefore to be expected. SMIQ offers the great advantage that any extensions required to this effect come as software options and can thus be retrofitted very easily. For chip rates above 7 Mchip/s, too, SMIQ is a good choice. With an RF bandwidth larger than 50 MHz, the vector modulator offers ample reserves for externally applied I/Q signals.

Klaus-Dieter Tiepermann

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Condensed data of Signal Generator SMIQ with CDMA IS-95 Option SMIQ-B42

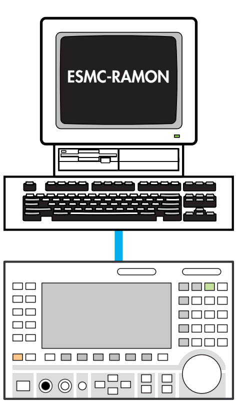
Frequency range	300 kHz to 3300 MHz
Chip rate	
IS-95 standard	1.2288 Mchip/s
SMIQ range	1 kchip/s to 7 Mchip/s
Forward link	to IS-95 and J-STD-008
Number of code channels	1 to 64
Fraction of power of each code channel	0 to –30 dB, selectable for up to 4 channels
Modulation data (19,200 bit/s)	PRBS, simple data patterns
Reverse link	to IS-95 and J-STD-008
Modes	full rate, half rate
Modulation data (28,800 bit/s)	PRBS, simple data patterns
Modulation accuracy (pilot)	ρ >0.9995
Adjacent-channel power (pilot)	typ. –75 dBc (at 30 kHz bandwidth)

Reader service card 156/04

Simple bandwidth measurement in radiomonitoring

Test hint

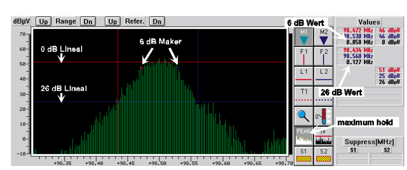
In radiomonitoring it is sometimes necessary to determine the bandwidth of a signal. This is usually performed with a test receiver, but now **Radiomonitoring Receiver ESMC with Software Package ESMC-RAMON** can also be used for this task.



ESMC

ITU Recommendation 443 defines signal bandwidth at the 6 dB or 26 dB point. Section 3.4.2.2.4 of the ITU manual describes a method of bandwidth measurement using a spectrum analyzer with maximum hold function. ESMC provides an equivalent measurement in frequency scan mode. The signal of interest is scanned with a narrowband filter at small stepwidths. The signal levels are displayed in the overview window of ESMC-RAMON software. This window also contains the maximum hold function, so that only results with maximum level are displayed. The signal bandwidth can easily be determined by means of lines and markers.

In addition to this level-based bandwidth measurement, an example of power-related measurement is given in Annex 1 to Section 3.4 of the ITU manual. This example defines the bandwidth limit at 0.5% of the signal power. This type of bandwidth measurement, too, can be performed by means of Receiver ESMC, Software ESMC-RAMON, the Evaluate option and a spreadsheet routine. The signal is scanned in the same way as in level-based bandwidth measurement, but data are stored not only for display but also in the processor. The analyzer program of the Evaluate option transfers the stored data to the spreadsheet routine, where they are processed as described in the ITU manual.



Radiomonitoring Receiver ESMC provides very good results for simple, manual bandwidth determination as described above. For fast, automatic bandwidth measurements, a test receiver, eg ESVN40 from Rohde & Schwarz, is the obvious choice.

Günther Klenner

Reader service card 156/05 for further information on ESMC

75 kW RF Amplifier VD741K1

High-power RF amplifier for physical applications

Physical applications in the field of particle acceleration and synchrotron radiation sources require safe high-power amplifiers with simple, reliable control, regulated amplitude and stable phase position. This is the domain of 75 kW RF Amplifier VD741K1 from Rohde & Schwarz.

With RF Amplifier VD741K1 (500 MHz), Rohde & Schwarz is adding another component to its range of transmitter equipment (FIG 1). The amplifier essentially consists of a klystron for RF power generation, to which various modules are assigned that can be set up separately from the klystron, ie cooling-water supply, high-voltage supplies, collector power supply as well as control cabinet. This is invaluable for systems taking up a lot of space such as particle accelerators or storage rings. The modular concept of the amplifier thus allows the various components to be set up in the system according to their functions: control unit in the operator room, collector power supply at the AC supply inlet, and RF generator next to the RF load. In general, there is not enough space to set up all the amplifier components at any one of these locations. Special site planning of the system components may also be necessary if, for example, air coolers are not to be used in order to save costs.

The klystron is safely protected without the use of a high-voltage crowbar. The connections between high-voltage section and control section are made by means of optical fiber cables. Any high-voltage accidents are thus excluded right from the start. The amplifier can be fitted, and also retrofitted, with klystrons of different make. So every user can choose the klystron of his preference and change over to another product during the life of a system. For applications requiring powers above 75 kW, several amplifiers can be combined. Moreover, the power of a single amplifier can be boosted up to 150 kW through the use of a special klystron and a larger collector supply.

FIG 1
Control cabinet of 75 kW RF Amplifier VD741K1 (not including collector power supply)
Photo 43 020

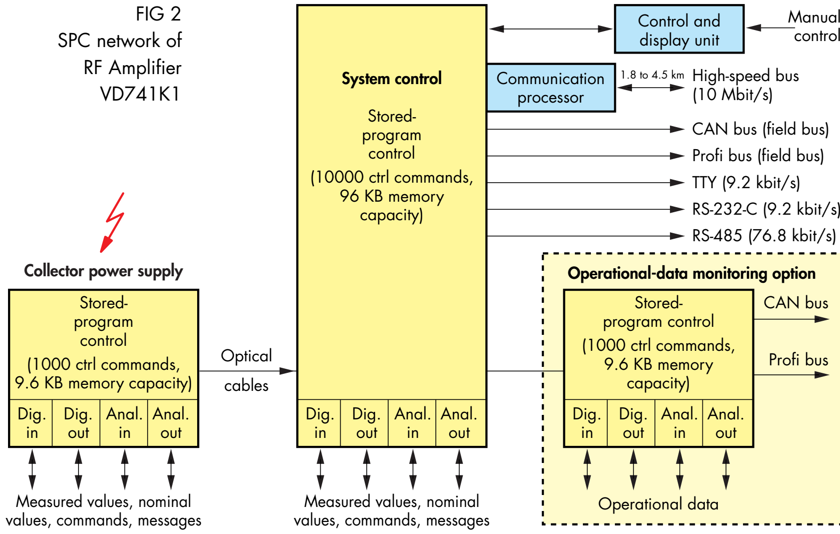
Applications

The essential criterion determining the use of the amplifier is what might be referred to as the “experimental environment”. This means that, apart from the definition of limit values for the various parameters, all intermediate values too play a role for the experiment on hand and must therefore be settable and controllable. Moreover, the output values need to be controlled automatically rather than manually. RF Amplifier VD741K1 offers the following **characteristics:**

- selection of output power from 75 W to 75 kW,
- adjustable, regulated, constant RF amplitude at load, ie at the cavity of the storage or accelerator ring,
- resonance-tuning of cavity,
- absorption of reflected power of cavity from 0 to 100%,
- variation of operating point of klystron to save energy in cases where maximum power is not required.

Thanks to graphical status display, minimum operator control and high accuracy and stability of the regulation and control circuits, all of the above functions can be performed without the support of an RF expert on site. The amplifier also informs the user of the causes for activating cavity, klystron or personnel protection against RF or other forms of high energy. It further requests a change of experimental conditions, where necessary, and indicates

FIG 2
SPC network of
RF Amplifier
VD741K1



any supply faults (water, air or power supply, temperature) as well as defective modules. Experiments can also be performed automatically. To this end, the amplifier can be integrated into a control bus configuration using, for example, field buses such as CAN or Profi, which operate simply and reliably over the large distances of a particle experimentation system.

Control and operation

The amplifier optimally performs all of the above tasks with its stored-program controls (SPCs). Apart from system control, a further SPC is provided in the collector power supply and one in the operational-data monitoring unit (FIG 2). All these units are networked. The operational-data monitoring unit can thus be offered as an option and the collector power supply as an independent unit. The **SPC network** has the following **functions:**

- testing of all safety-relevant amplifier components upon power-up (if amplifier is switched on several times a day, a short test is run),
- sequence-controlled RF switch-on,
- RF amplitude stabilization to digital setpoint value by regulation of RF input level,
- RF amplitude stabilization to digital setpoint value by regulation of anode modulator voltage of klystron,
- dissipated-power optimization of amplifier through appropriate selection of klystron operating point (setting of collector and anode voltage for intended output power),
- monitoring of all nominal and actual values,
- warning without lowering of RF levels in the event of abnormal operating states or acceptable out-of-tolerance parameters,
- storage of causes of automatic RF or AC supply switch-off,
- communication with high-voltage circuits (collector supply) via optical cables,
- communication with control and display unit, operational status display, acceptance of new nominal values, output of warnings and error messages,
- communication with programming unit for program analysis or step-by-step program run,
- linking of amplifier to bus systems (CAN and Siemens Profi field buses, Siemens H1 high-speed bus),
- communication via interfaces (RS-485, RS-232-C, TTY).

Operator control of the amplifier is reduced to a minimum. The hierarchical states AUX ON (auxiliary supplies on), HV ON (high voltage on) and RF ON are activated at the push of a button. A higher state in the hierarchy encompasses all lower states. For example, the command RF ON will trigger all the required sequences up to emission of the preset RF level, including preceding functional testing of all safety-relevant amplifier components. Operational sequences are shown quasi-graphically on the control and display unit (FIG 3). The nominal values for the operational sequences can be set on the control and display unit. As a default setting, the values for maximum output power are selected. Any other values can be set over the complete dynamic range; any values not permissible for reasons of safety will be recognized and rejected. The amplifier can thus be operated virtually without requiring any basic knowledge of klystron functions on the part of the user.

Safety measures

Safety comprises two essential components: safety for personnel and protection of critical system parts against damage caused by maloperation or malfunction.

Personnel safety is implemented in Amplifier VD741K1 by applying the proven concepts of the Rohde & Schwarz sound and TV broadcasting transmitters. These include:

- emergency shutdown,
- positively operated door switches in the high-voltage and AC supply inlet areas (for blocking of AC supply),

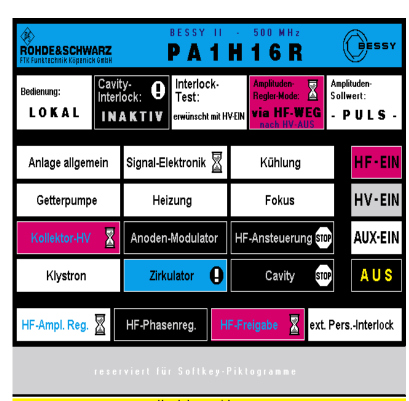


FIG 3 Status indication of control and display unit

- separate emergency switch for amplifier,
- lockable grounding switch; key for opening high-voltage section accessible only after grounding,
- grounding rods in high-voltage section,
- interlock circuits connecting all modules and cables.

The above measures ensure enhanced safety for personnel, who themselves can do one more thing by applying the five golden rules of electrical safety; the amplifier is appropriately equipped for this.

Safety for the klystron is ensured without the use of a high-voltage crowbar. In the event of a high-voltage short circuit in the klystron, the energy released in the klystron is limited to 10 Joule. This is achieved through appropriate dimensioning of the high-voltage circuitry and rapid switch-off of RF and high voltage. The thyristor regulator is disabled and the inductance on the power line discharged. For fast and reliable triggering of this protection mechanism, the following **test points** are provided:

- high voltage,
- current,
- current rise (arcing),
- loading of klystron body (focusing fault),
- RF arcing in klystron or circulator,
- klystron input power (to prevent overloading/saturation),
- auxiliary supply of klystron (focusing).

The test points trigger the required safety actions via optical cables and are interlocked, so that the cause of an action can be identified unambiguously in each case. The SPC of the system control reads the actions taken and outputs an analysis thereof on the control and display unit. SPC initiates and controls all further actions required until the amplifier is ready for operation again. Until the output of a start command, the amplifier remains in the highest hierarchical operating state possible without any risks or danger upon occurrence of the fault. Similar actions are taken to protect the RF-fed cavities in the storage and accelerator ring. An action will be triggered in the event of arcing, poor vacuum or defective vacuum pumps, for example.

In addition to these high-speed actions, the SPC of the system control checks and analyzes all values and commands entered. Monitoring also covers power, water and air supplies, common operational parameters, power supply and distribution units, communication network, operability of auxiliary supplies and modules, and a large number of interlock circuits in the amplifier components. The operating speed of the SPC is in the 100 ms range, so analysis will produce rapid information, warning or switching to a lower hierarchical state, ensuring that the amplifier is always in a safe operating state. In the event of a failure of the SPC itself (time-out), any supply voltages to the amplifier are automatically disconnected.

Amplifier components

The **collector power supply** (30 kV, 6 A) operates on the principle known from Rohde & Schwarz TV transmitters, ie primary-circuit thyristor control of a high-voltage transformer with a choke connected in the neutral point. The AC supply is filtered effectively so that the output signal contains only 0.1% of the fundamental.

The **control cabinet** comprises the system control, control and display unit, instrument panel, floating auxiliary supplies, operational-data monitoring, optical-cable communication interface, RF processing section with amplitude and phase control, RF preamplifier, RF demodulators, RF control circuits and cavity resonance tuning.

The **high-voltage cabinet** accommodates all auxiliary supplies and test points of the klystron that are at high potential, as well as the high-voltage circuit. The klystron can be cut off from high voltage at all connecting points via grounding switches.

The **klystron** is mounted on a trolley and set up with a supply rack for cooling water and cooling air separately from the other amplifier components. The RF is taken to the circulator via the common RF test points.

Horst Wolf

Condensed data of 75 kW RF Amplifier VD741K1

RF output power	75 W to 75 kW into 50 Ω (EIA 6 $^1/_8$"/SMS 6 $^1/_8$")
Level setting range	13 dB (via predefined nominal value)
Dynamic range of control	30 dB
RF input	0 dBm into 50 Ω (N)
1 dB bandwidth	0.5 MHz
VSWR	1.4 (∞ with circulator)
Power consumption	200 kVA
AC supply voltage	3 x 400 V
Control	locally via control and display unit or via interfaces
Interfaces	CAN bus, L2 bus, TTY, RS-485, RS-232-C and other interfaces

Reader service card 156/06

DVB-T Modulator SDB-M

Start into digital terrestrial TV

Almost simultaneously with the adoption of the new terrestrial TV standard Rohde & Schwarz is introducing a matching digital modulation source: DVB-T Modulator SDB-M which is equally suitable for use with high-power TV transmitters and as a test transmitter in laboratories and production.

The high demands to be met by the terrestrial digital TV transmission standard DVB-T [1] are manifold: high program capacity is required in conjunction with excellent picture quality as well as transmission of data for supplementary services. Other requirements are highly reliable transmission even at low receiving field strengths and an excellent frequency management that leaves sufficient room for other radio services of the present and the future. All this is achieved by processing source-coded MPEG2 signals, adding a highly efficient error correction code, which takes into account the characteristics of the transmission channel, and the use of OFDM (orthogonal frequency division multiplexing) permitting single-frequency networks with widely spaced transmitters.

DVB-T Modulator SDB-M (FIG 1) was developed for use in high-power TV transmitters and as a test transmitter in the development and production of DVB-T components. Its distinguishing **characteristics and parameters** are:

- functions fully compatible with ETS 300 744 [2],
- LVDS (low voltage differential signalling) input interface with data rates from 5 to 40 Mbit/s depending on selected transmission parameters,
- code rates 1/2, 2/3, 3/4, 5/6 or 7/8 selectable,
- modulation modes QPSK, 16QAM or 64QAM selectable,
- optional hierarchical modulation,

FIG 1 DVB-T Modulator SDB-M and solid-state TV Transmitter NH520 – ideal partners for terrestrial digital TV Photo 42 961/1

- OFDM with 2k or 8k mode,
- guard intervals of 1/4, 1/8, 1/16 or 1/32 of symbol period selectable,
- digital I/Q modulation to prevent phase errors,
- 12-bit digital/analog converter with 27.43 MHz sampling frequency,
- analog IF output for driving high-power transmitters,
- optional upconverter with output frequency adjustable from 47 to 860 MHz and 0 dBm output level,
- SFN (single-frequency network) option for time and frequency synchronization in SFNs, including MIP (megaframe initialization packet [3]) decoder for optional automatic configuration of modulator via data input,
- integrated PRBS (pseudo random binary sequence) generator for BER (bit error rate) measurements,
- test mode permitting energy dispersal, Reed-Solomon coder, bit interleaver and frequency interleaver to be disabled individually,
- parallel interface with floating contacts for signalling or integration in interlock circuits,
- serial interface for configuration via standard PC using the convenient user interface supplied.

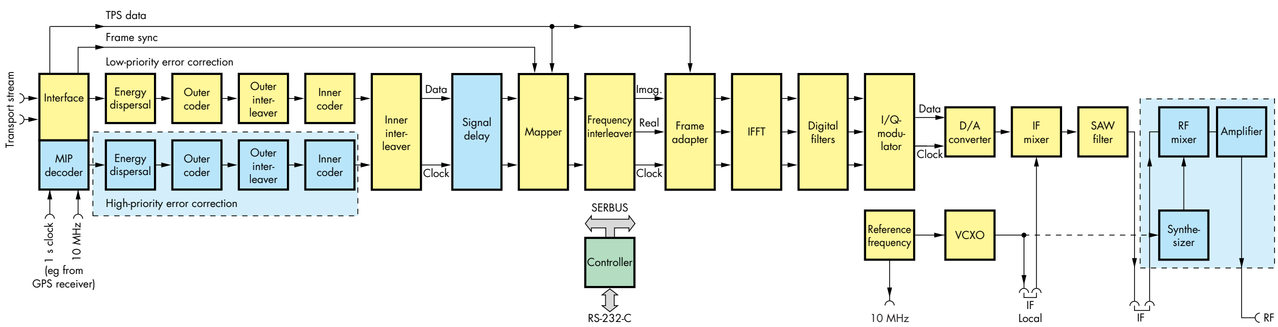


FIG 2 Block diagram of DVB-T Modulator SDB-M (options in blue)

Function

The MPEG2 data and control signals at the **LVDS input interface** are regenerated and the required clock frequencies derived for further processing (FIG 2). The transport packet may have a length of 188 or 204 bytes. An **optional MIP decoder** separates the data of the megaframe initialization packet and forwards them to the system controller for further processing.

For **energy dispersal** the data are linked to a PRBS sequence so that an even power distribution is obtained in the transmission channel. The **outer coder** uses a shortened Reed-Solomon code (204, 188, t = 8) which adds 16 bytes to each transport packet for error control, allowing up to eight errored bytes to be corrected in each transport packet. A convolutional interleaver distributes the data in the form of bytes to twelve blocks to improve correction of several successive errors. The **inner coder** operates bit by bit and generates a punctured convolutional code with code rates of 1/2, 2/3, 3/4, 5/6 or 7/8.

Two sets of the mentioned error correction blocks are available for **hierarchical coding** (option) allowing the different data (programs) of the MPEG2 transport stream to be transmitted with either high error correction and low data rate (high priority) or with low error correction and high data rate (low priority).

The **inner interleaver** distributes these data to a maximum of six serial bit streams (bit interleaving) depending on modulation and code rate: two (QPSK), four (16QAM) or six (64QAM) bit streams with non-hierarchical coding, or two (QPSK) streams for high-priority data plus two (16QAM) or four (64QAM) for low-priority data with hierarchical coding. From these serial bit streams, words with a width of two,

IFFT mode	8k	2k
Number of subcarriers	6817	1705
Symbol period	896 µs	224 µs
Carrier spacing	1116 Hz	4464 Hz
Useful bandwidth	7.61 MHz	7.61 MHz

TABLE 1 OFDM parameters for 2k and 8k mode

Modulation	Code rate	Guard interval			
		1/4	1/8	1/16	1/32
QPSK	1/2	4.98	5.53	5.85	6.03
	2/3	6.64	7.37	7.81	8.04
	3/4	7.46	8.29	8.78	9.05
	5/6	8.29	9.22	9.76	10.05
	7/8	8.71	9.68	10.25	10.56
16QAM	1/2	9.95	11.06	11.71	12.06
	2/3	13.27	14.75	15.61	16.09
	3/4	14.93	16.59	17.56	18.10
	5/6	16.59	18.43	19.52	20.11
	7/8	17.42	19.35	20.49	21.11
64QAM	1/2	14.93	16.59	17.56	18.10
	2/3	19.91	22.12	23.42	24.13
	3/4	22.39	24.88	26.35	27.14
	5/6	24.88	27.65	29.27	30.16
	7/8	26.13	29.03	30.74	31.67

TABLE 2 Input data rates in Mbit/s with non-hierarchical coding depending on modulation, code rate and guard interval (values rounded to two digits)

IFFT mode	8k				2k			
Guard interval	1/4	1/8	1/16	1/32	1/4	1/8	1/16	1/32
Symbol period	896 µs				224 µs			
Guard interval	224 µs	112 µs	56 µs	28 µs	56 µs	28 µs	14 µs	7 µs
Symbol period + guard interval	1120 µs	1080 µs	952 µs	924 µs	280 µs	252 µs	238 µs	231 µs

TABLE 3 Values for symbol period and guard interval

four or six bits are formed, which determine the vector of a subcarrier. In 2k mode, 1512 of these words form a symbol (6048 in 8k mode) and their position within the symbol will be scrambled (symbol interleaving).

In SFNs, the different delays of the transport stream feeders to the transmitters can be compensated by means of an optional **signal delay.** Differences of up to 1000 ms with 100 ns resolution can be compensated manually or automatically by comparing the time stamp in the transport stream with an external 1 Hz reference.

In the **mapper,** the words are Gray-coded and represented at the constellation points of the complex level. The **frame adapter** adds 176 (701) subcarriers as sync information in 2k mode (8k mode) and 17 (68) subcarriers as control information so that a total number of 1705 (6817) carriers is obtained (TABLE 1).

Inverse fast Fourier transform (IFFT) converts the subcarriers represented at the complex level from the frequency to the time domain. During the guard interval of 1/4, 1/8, 1/16 or 1/32 of the symbol period, the beginning of the symbol is repeated with the respective length.

After forming a spectrum by means of **digital filters** and subsequent **digital I/Q modulation,** the time signal is applied to the **D/A converter** where it is converted to an IF of 35.764 MHz.

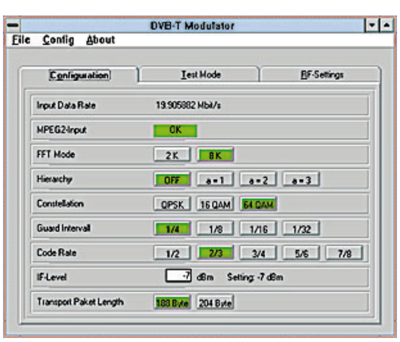


FIG 3 User interface of DVB-T Modulator SDB-M

The required local frequency is generated internally but can be locked to a frequency standard or applied from an external source.

A synthesizer with upconverter is used for optional **conversion to an RF output frequency.** It converts the 7.61 MHz wide OFDM signal to an adjustable center frequency from 47 to 860 MHz at an excellent S/N ratio.

Selection of operating parameters and operation

The input or net data rate is determined by setting code rate, modulation and guard interval. The selection of code rate and modulation enables a trade-off between the added error correction code and the useful transmission capacity (TABLE 2). Selection of IFFT mode and guard interval depends on the network structure and is dictated by multipath reception (echo signals, SFN transmitter at any distance to the receiver) for which the delay differences must be shorter than the guard interval (TABLE 3)[4].

The integrated controller configures the individual modules of DVB-T Modulator SDB-M power-failure-proof, monitors their operation and provides information at a parallel and a serial interface. At the serial interface this information can be called up under Windows™ using a standard PC and the convenient user interface supplied (FIG 3). Moreover, any parameter can be modified at this interface.

Rainer Wießmeier

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Condensed data of DVB-T Modulator SDB-M

Input data rate	5 to 40 Mbit/s, depending on operating mode
IFFT mode	2k and 8k
Modulation	QPSK, 16QAM or 64QAM
Guard interval	1/4, 1/8, 1/16 or 1/32
Inner code rate	1/2, 2/3, 3/4, 5/6 or 7/8
Inputs	
Transport stream	MPEG2, LVDS, 25-contact sub-D, female, 100 Ω
Reference frequency	10 MHz, –10 to +10 dBm, BNC, 50 Ω
Outputs	
IF, COFDM	35.764 MHz, –7 dBm, BNC, 50 Ω
or RF (option)	band I to V, 0 dBm, BNC, 50 Ω
SFN mode (option)	to SFN-DS
MIP data	read-out via serial interface
TS delay	<1000 ms, automatic or manual setting
Reference pulse input	1 Hz, TTL, BNC
Interfaces	serial RS-232-C, 15-contact parallel sub-D

Reader service card 156/07

Precise S-parameter measurements are the key to modelling electric circuits

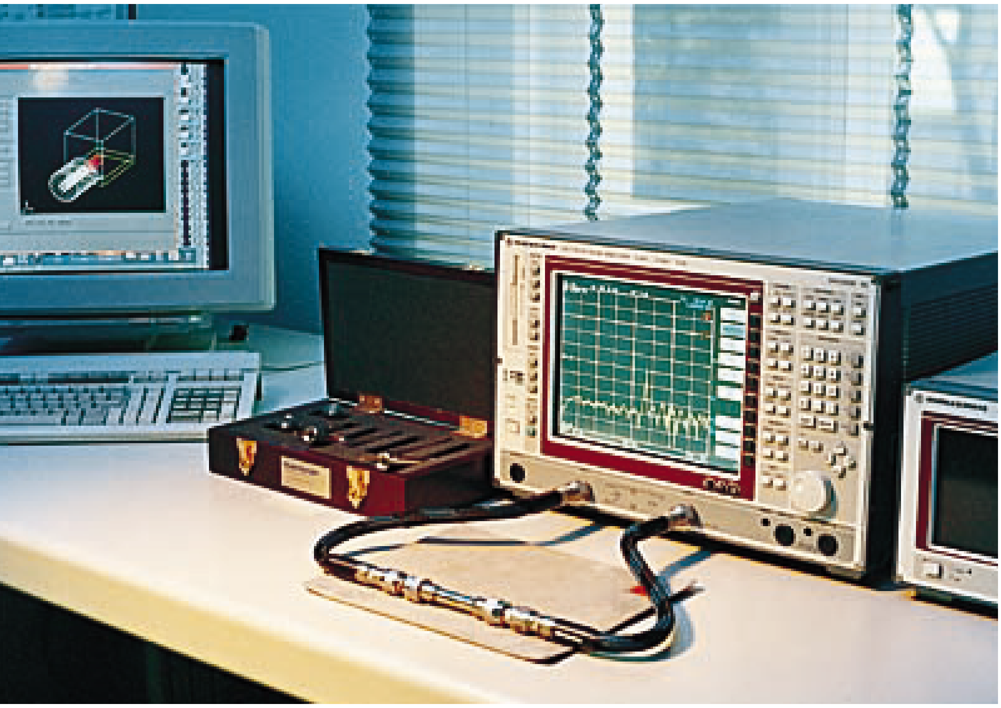

FIG 1 Vector Network Analyzer ZVR used by Rosenberger Hochfrequenztechnik
Photo: Schröck-Freudenthaler

High-precision S-parameter measurement is the basis for characterizing a circuit component. The outstanding measurement accuracy of **Vector Network Analyzer ZVR** from Rohde & Schwarz [1] offers the possibility of efficiently modelling well-matched DUTs. Precision measurements call for ultra-modern calibration techniques and high-quality calibration standards along with excellent hardware.

All modern network analyzers claim very high measurement accuracy since the S-parameters are displayed with an extremely flat frequency response. Unfortunately, this is a fallacy as precision measurements still call for sound background knowledge. The need to calibrate a vector network analyzer as precisely as possible is illustrated by the following simple example: a well-matched DUT (return loss 20 dB) is to be measured and modelled. To carry out this task to approx. 0.8 dB or 5° accuracy, the analyzer must have a directivity of more than 40 dB. In this case, matched loads cannot be used as calibration standards since their return loss is not sufficient.

Only precise lines can be used as impedance standards for such measurements. ZVR supports the use of lines with **calibration technique TRL** (thru, reflect, line) [2]. Besides direct connection of the two test ports and a precise reference line, this technique requires a reflection standard whose S-parameters need not be known. These calibration standards can be produced very precisely in both planar and coaxial line systems. Difficulties with the TRL technique occur if the line has a length of n $\cdot \lambda/2$. In this case, the line shows the same electric characteristics as the through-connection which leads to dependent equations for the corrective parameters. The following results show, however, that this only plays a minor role in practice.

To determine the measurement accuracy of Vector Network Analyzer ZVR in the frequency range from 10 MHz to 4 GHz, a high-quality coaxial PC7 air line from **Rosenberger Hochfrequenztechnik*** was employed for calibrating the ZVR.

In different verification measurements using the precision PC7 line system, the 63.5 mm long **air line** behaves like a T standard at lower frequencies and around 2.36 GHz:

$$f = \frac{c_0}{2 \cdot n \cdot 63.5\ \text{mm}}\ ; \quad n = 1.$$

As already mentioned, the TRL technique does not call for a known reflection standard. Reflection standards

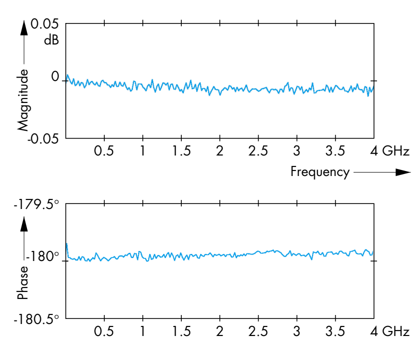

FIG 2 Reflection characteristic of short after TRL correction in Vector Network Analyzer ZVR

* The company based in Upper Bavaria was founded in 1958 and has become a leading manufacturer of coaxial connectors and test equipment for high-frequency applications.

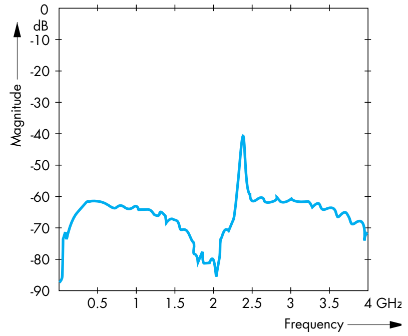

FIG 3 Reflection characteristic of second air line after TRL correction in ZVR

with the same electric characteristics have to be measured at both test ports during calibration. For the "sexless" PC7 system, this requirement can be met with high precision since the same standard can be contacted at both analyzer test ports (FIG 1). Therefore, the calibration standard requirements of TRL technique are almost perfectly met. The only shortcomings are the finite reproducibility of contacts which are better than –70 dB for PC7, the phase stability of the test cable (0.1° short-time stability for precision cables) and the deviations from ideal air-line geometry values. The latter are around 2 µm and limit the return loss of air lines to approx. 60 dB.

Shorts can also be produced as precisely as air lines. Since a **precision short** in the TRL technique is never used as a calibration standard, it is good for verification. FIG 2 shows a TRL-corrected reflection measurement of a short. Given the small deviations of the reflection measurement of 0.01 dB and 0.1°, ZVR can be concluded to have an effective matching of more than 55 dB after system error correction [3].

This excellent matching value can also be determined directly through the measurement of a **second air line.** This measurement is thus ideal for verification since narrowband effects such as the (n ·λ/2) errors can be analyzed very precisely. It can be seen that matching drops to 30 dB at 2.36 GHz (FIG 3). The consequences of limited measurement capability at 2.36 GHz are illustrated by FIG 4 which shows the verification measurement of a 25 Ω precision air line used as DUT. The result – just like that in FIG 3 – also shows that the ZVR measurement accuracy is extremely good at 10 MHz although measurement is very close to 0 ·λ/2.

A very popular verification measurement is the **ripple test** [4] in which a 300 mm long precision air line terminated with a short is measured (FIG 5). Calibration with opens or shorts of finite goodness shows instead of a linear curve a clear superimposed ripple which is twice the attenuation of this long air line. This ripple also helps to make conclusions regarding network analyzer matching. The ripple invisible here attests the excellent quality of the ZVR hardware.

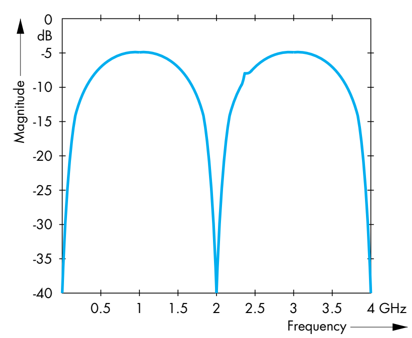

FIG 4 Reflection characteristic of 25 Ω air line after TRL correction in ZVR

Excellent quality of the hardware and system error correction software of ZVR is confirmed by all four verification measurements performed in the precision PC7 line system to analyze the measurement accuracy of Vector Network Analyzer ZVR after TRL calibration. The minimal errors found can be fully attributed to the finite performance data of the calibration elements, verification elements and test cables. Thus, ZVR is an ideal platform for modelling electric circuits and components to an accuracy of a few degrees.

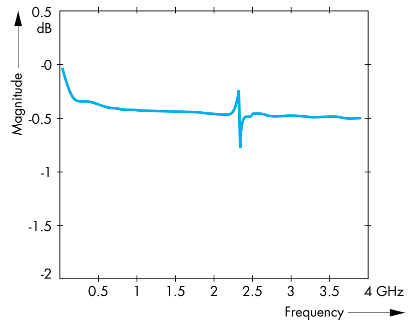

FIG 5 Reflection characteristic of 300 mm long air line terminated with short after TRL correction in ZVR

Dr. Holger Heuermann
(Rosenberger Co.)

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Reader service card 156/08 for further information on ZVR

Networking digital direction finders for improving radiomonitoring efficiency and locating frequency-agile emitters

The rapidly increasing variety of communication media and growing shortness of suitable DF sites require wide-area networking of DF instrumentation and operator positions of large radiomonitoring systems. A condition for networking is that the detected data are reduced and processed at the DF site considering that an extremely large volume of raw data is obtained by the direction finder when frequency-agile signals and short-term emissions are monitored. Rohde & Schwarz has taken up this challenge with scanning and monitoring direction finders of the DDF (digital direction finder) family coupled with new software.

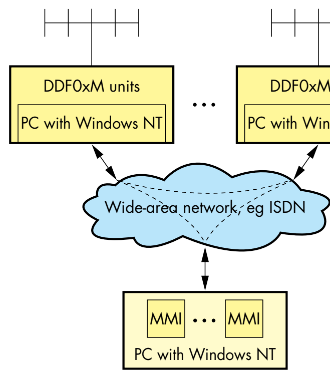

FIG 1 Remote control and multiple use of Digital Monitoring Direction Finder DDF0xM

DF units

Digital Direction Finder DDF190 is a DF unit with antennas for monitoring and test receivers covering the frequency range 20 to 3000 MHz [1]. It allows bearings to be taken in line with ITU guidelines and offers a yet unrivalled combination of compact design, sensitivity and accuracy. System linkup is made via the RS-232 interface of the DF unit.

While DDF190 has been designed for direction finding of conventional signals with a dwell time of at least 30 ms, **Digital Monitoring Direction Finders DDF0xM** [2] allow also very short and wideband signals to be detected. Depending on the antennas and DF converters used, a frequency range from 0.3 to 3000 MHz can be covered in the fixed-frequency, search or scan mode. A built-in or external PC is used for control and result processing. System linkup is established by a two-stage adaptive data compression for each RS-232, Ethernet or ISDN interface of the PC section. Corresponding to the achievable data rate, only fixed-frequency operation is possible via RS-232 and telephone lines, while the connection via Ethernet or ISDN permits almost unrestricted operation also in the scan mode.

Digital Scanning Direction Finders DDF0xS (0.5 to 1300 MHz) are optimized for fast scanning and operation as automatic search tools in complex systems [3]. Multistage data compression provides the conditions required for integrating the DF tools via data lines at low operating costs.

Remote-control software DDFREMM

Software **DDFREMM** permits the graphical user interface (man-machine interface or MMI) of **Monitoring Direction Finder DDF0xM** to be set up detached from the direction finder and connected via common communication links (FIG 1). In addition to bearings the demodulated audio signal is transmitted. The available transmission bandwidth is optimally used so that even at low data rates full system operation and almost constant detection probability is achieved. Since one or several direction finders can also be remote-controlled from different operator positions, full-area direction finding can be performed with very few personnel. The position of the transmitter can be calculated from the bearings of several detached stations and marked on a digital map.

Location software DDFLOC

DDFLOC is a powerful, network-compatible software package of the RAMON (radiomonitoring) system family [4] for radiolocation applications. DDFLOC is used with **Direction Finders DDF0xM and DDF190** in computer-controlled direction finding and location of HF, VHF and UHF signals for

- radiolocation at single frequencies,
- automatic monitoring of frequency bands and frequency lists,
- result display on digitized map,
- preparation of reports for location results.

Detached DF stations are controlled by the system controller with the aid of serial interfaces (RS-232) normally via modems. Bearings and radiolocation results are entered online in geographical or UTM coordinates on a digitized map on the system controller monitor. A variety of auxiliary functions simplifies **result evaluation:**

- short-term history (display of last location results),
- position marking using icons, lines, areas and text elements,
- spherical triangulation,
- single-station locator (option for HF range),
- postprocessing of recorded results.

In a networked system, DDFLOC can be optionally used with other RAMON operator positions. Measurement results,

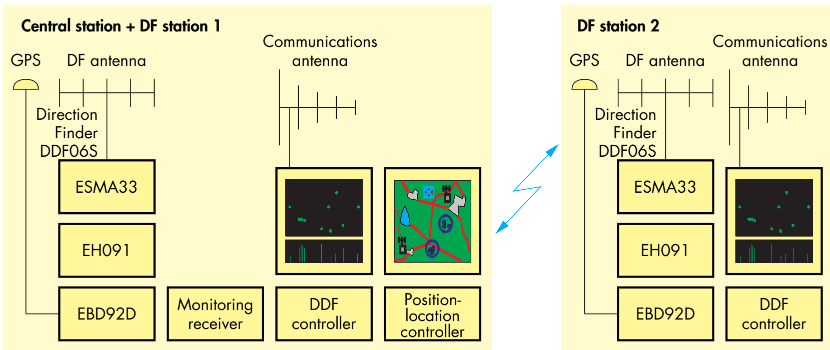

FIG 2 Mobile SCANLOC system with two stations, each comprising Direction Finder DDF06S with VHF/UHF DF Converter ESMA33, HF DF Converter EH091 and Digital Processing Unit EBD92D

signal contents, location results, etc, can of course be administered in a data base.

With a local direction finder connected, system functions are available that cannot be used in detached direction finders, or with restrictions only, because of limited transmission capacity. In an unknown signal environment, first an overview of activities of interest can be obtained in the scan mode and displayed in different types of graphs. The user may then select a signal from this graphical overview and locate it using the fixed-frequency mode. Another possibility is to check a predefined list of frequencies or frequency ranges for activities (search) and then automatically trigger a bearing.

Location software SCANLOC

The radiomonitoring and location system **SCANLOC,** another powerful software package of the RAMON system family, is used with **Direction Finders DDF0xS** for **interception and location of short, broadband and frequency-agile signals** at HF, VHF and UHF. An accurately synchronized scan of all direction finders ensures high probability of acquisition and accuracy of results in the location of short-term emitters and frequency-agile transmitters, and permits realtime display of detected emissions on digitized maps. Time synchronization is achieved by means of GPS receivers. FIG 2 shows a simplified system comprising two stations. Detected emissions are preprocessed at the site of the detached direction finder and stored with time stamps. These data can automatically be called by the central DF station. With the use of powerful algorithms for data compression, all key information can be transmitted between direction finder and DF center at relatively narrow transmission bandwidths.

Results are graphically processed in the DF center and displayed on two screens. On one screen signal activities are displayed online in the form of different **diagrams:**

- signal activity versus time and frequency (waterfall),
- azimuth versus frequency,
- level versus frequency (RF spectrum).

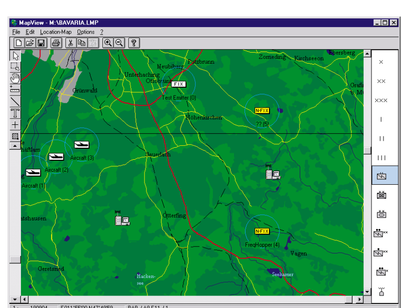

FIG 3 SCANLOC map display

On the second screen the detected signals are displayed on a digital map after processing (FIG 3). If desired, different bearings of a transmitter are automatically combined into plots containing all main signal parameters, eg the detected single frequencies of a hopping emitter. The movement of mobile transmitters can automatically be traced and stored. The system automatically recognizes known signals that are in a signal library and marks them so that new emissions can easily be identified.

Franz Demmel; Günter Hinkers

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Reader service card 156/09

Planning and monitoring VHF and TV transmitters

FIG 1 Vehicle-mounted Spectrum Monitoring System for Broadcast Applications SMSB
Photo 42 882/3

The German Post and Telecommunications Office (BAPT) as well as the telecommunication organizations in other countries are responsible for frequency planning for VHF and TV transmitters together with broadcasting companies, for coordinating these transmitters with broadcasting companies at home and with relevant telecommunication organizations abroad and for monitoring the transmitter parameters. Mobile **Spectrum Monitoring System for Broadcast Applications SMSB** (FIG 1) from Rohde & Schwarz is an extremely cost-effective and technically advanced solution to efficiently perform these tasks.

Normally, the organization to perform these tasks has a **frequency planning service** and a **monitoring service.** Based on certain models, the frequency planning service makes theoretical calculations regarding the coverage of the region by a given or planned transmitter. Measurements are prepared to check these calculations. To this effect, different frequency ranges are defined as well as lists of transmitter frequencies to be measured and test sites required for the measurements. The monitoring service then carries out the measurements with a test vehicle (FIG 2). The quality of the measurements can be assessed from initial evaluations carried out on Spectrum Monitoring System for Broadcast Applications SMSB. This evaluation is based on selectable guidelines. These guidelines, which are defined by international and national bodies, stipulate the assessment and mathematical evaluation of interfering transmitters, for example. The measurements may be repeated as required. Final evaluation of test results is performed by the frequency planning service.

The **measuring equipment** of onboard Spectrum Monitoring System for Broadcast Applications SMSB operating with Spectrum Monitoring Software ARGUS consists of **Test Receiver ESVN40** (9 kHz to 2.7 GHz) for measuring field strength, modulation, frequency offset and reflection at VHF, **RDS Decoder DEF** for decoding transmitter information at VHF, **RDS Codec DMC01** for decoding transmitter information in the TV band, **Video Measurement System VSA** for measuring reflections in the TV band, and a system controller (FIG 3). **Antenna System FT01** covering the frequency range from 47 to 860 MHz is used for reception. The antenna is mounted with an azimuth and a polarization rotator. The individual antennas of the system are selected by means of an antenna selector switch.

Spectrum Monitoring Software ARGUS contains the activities to be carried out during a measurement run. Measurements may last several days and nor-

FIG 2
Test vehicle with Spectrum Monitoring System for Broadcast Applications SMSB
Photo 42 882/2

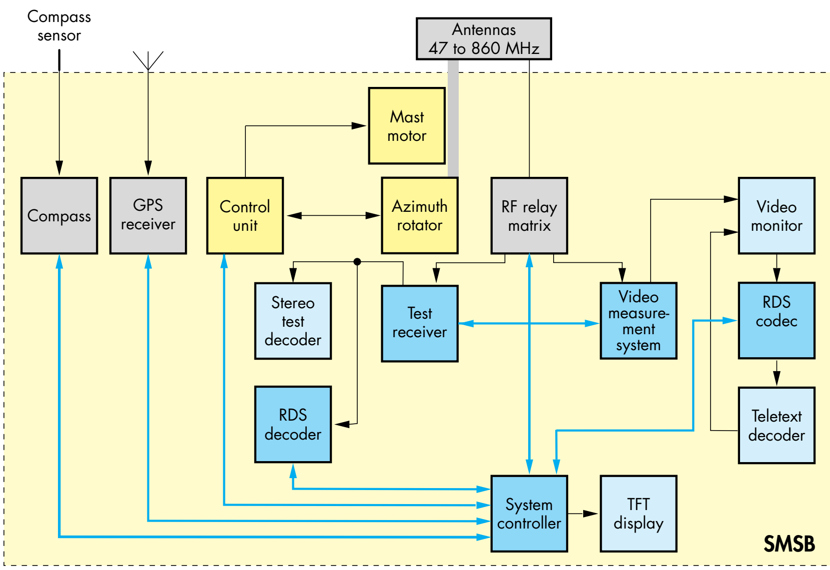

FIG 3 Structure of Spectrum Monitoring System for Broadcast Applications SMSB

mally cover several test sites. The same measurements are performed at all test sites. They are carried out automatically after definition of the relevant parameters. Software ARGUS supports the following modes: frequency list scan, occupancy measurement, single measurement, channel measurement, polar measurement and control measurement.

Frequency list scan is defined by a frequency list. It is used for detecting individual channels. Frequency list scan can be carried out in two ways, ie with an aligned antenna or with a rotator. When it is carried out with an aligned antenna, measurements are performed for all channels at a certain azimuth stepwidth over the complete angular range. At every angle of measurement all channels are detected by the test receiver. If a measurement over 360° is to be carried out at an azimuth stepwidth of 10°, for example, 36 data records are obtained for each channel. Since only the data record with the highest field strength per channel is of interest, the result with the maximum field strength is stored. All other results are discarded. With a rotator used, measurements are carried out with the antenna aligned to the transmitter for each channel. In this case, the sites of the transmitter and the test system have to be known. This type of measurement corresponds to a single measurement since only one data record is obtained per channel. Each data record can be repeated with different test parameters.

Occupancy measurement is a scan which is defined by start and stop frequency and stepwidth. It monitors the coverage of test sites by transmitters.

Single measurements are used to provide an overview of the particular test-site conditions. The results are intermediate results which are not stored. Another purpose of single measurements is to test the settings of connected units in order to use them for other types of measurements. Moreover, single measurement can be used as a repeat measurement after a frequency list scan or occupancy measurement to identify transmitters and programs, for example. In this case, the results can be stored.

Channel measurement is only carried out in the TV band and serves for measuring the in-channel offset of transmitters.

Polar measurement is an azimuth-dependent measurement at a frequency.

Control measurement provides information about the state of the test system. Measurements are carried out at fixed control test sites on transmitters of known data. They provide information about the current state of the test equipment and thus about the quality of the measurement. Control measurements are frequency list scans with additional evaluations. In contrast to the other types of measurement, several measurements can be carried out per test site. The results are displayed so that the field-strength values obtained from different measurements at a test site can be compared.

VHF and TV transmitter lists are required to measure and identify transmitters and programs. They provide characteristic features of the transmitter, ie frequencies as well as information about the current or future status. Transmitter lists also contain information about planned and project-specific transmitters. These types of data can be entered manually or loaded into Software ARGUS from the customer's database.

Jörg Pfitzner; Wolf D. Seidl

Reader service card 156/10

New PropWiz software makes shortwave link prediction even more convenient

Communication via shortwave is influenced by a variety of factors that make it appear a rather changeable medium. The quality of shortwave transmission is substantially affected by weather conditions, position of sun, geographical location and number of sunspots, to name just a few parameters, which sometimes make it even impossible to establish a link between two points on the earth. Therefore, attempts have been made worldwide for quite some time to find solutions that enable reliable prediction of shortwave link quality [1]. Propagation Wizard, abbreviated PropWiz, introduced by Rohde & Schwarz about a year ago, is one of the most convenient and powerful software programs for shortwave radio link prediction available on the market [2].

PropWiz not only calculates the MUF (maximum usable frequency) but also determines the availability of a radio link for the various times of day as well as the appropriate frequency ranges. Results are output in easy-to-read graphical form (FIG 1). In addition to environmental effects, device parameters such as transmitting power, modulation methods and antenna characteristics are taken into account. Especially as far as antenna parameters are concerned, PropWiz stands out from competitive products. While most prediction programs take ideal isotropic radiators as a basis for calculations, PropWiz takes into account the antenna types actually available at the transmission and reception sites. In the new PropWiz version, users can choose among a large number of Rohde & Schwarz antennas (dipoles, log periodic antennas, rod antennas, etc) and also define antenna types of their own. Each antenna has its own characteristic (gain), which is determined by the frequency and the elevation angle. This antenna characteristic is described by the vertical radiation pattern (FIG 2). Antenna patterns are stored under PropWiz in tabular form in files. An editor enables easy generation of new patterns for non-R&S antennas as well as modification of existing patterns. Moreover, the new version also covers the new HF Data Modems GM2100 of the XK2000 transceiver family and runs under Windows 3.1, Windows 95 and Windows NT.

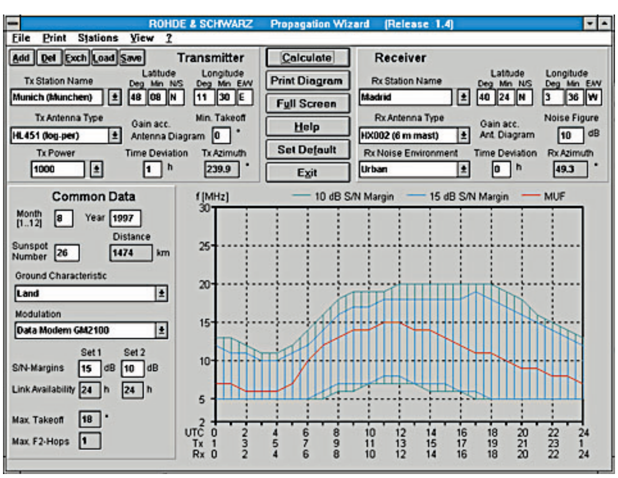

FIG 1 PropWiz user interface in its familiar form

With these new features, PropWiz ranks top among available radio link prediction programs. This is good reason to visit Rohde & Schwarz once more on the Internet home page (http://www.rsd.de). So far, hundreds of callers on the Internet have loaded down the PropWiz software. Customers who already have a dongle for PropWiz can easily update their old software version. Anyone else interested in the new software version can operate PropWiz in the demo mode.

Thomas Kneidel; Dr. Hans Waibel

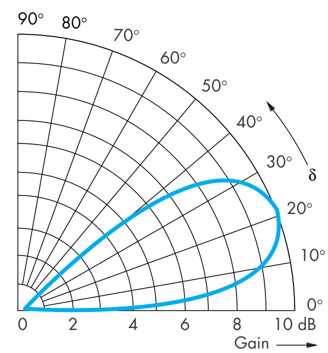

FIG 2 Example of vertical antenna pattern

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Reader service card 156/11

Digital Direction Finder DDF190 goes RAMON

Radiomonitoring System RAMON® detects and monitors emissions in the frequency range 10 Hz to 18 GHz [1]. Thanks to the new driver for DDF190 [2], this direction finder (20 MHz to 3 GHz) can now also be integrated into customized radiomonitoring systems like Digital Scanning Direction Finders DDF0xS and Digital Monitoring Direction Finders DDF0xM. The direction finder is used together with Compact Receiver ESMC [4] and can be operated in fixed-frequency or search mode.

DDF190 is handled by the software as a DF unit for the receiver. In the fixed-frequency mode, ESMC can be tuned as usual. An additional window is opened for **DF control** where parameters can be set: DF mode, DF bandwidth, averaging time. The receiver frequency can be directly tuned in the DF window. Bearings are displayed (graphically and numerically) as well as the bearing quality and relative level (FIG 1). For mobile use in a vehicle, either north or the vehicle axis can be selected as a reference for the bearing display by a mouse click. An azimuth diagram is permanently displayed in the righthand section of the window. Here the user can see clusters of bearings which simplifies an assessment of the scenario when bearings have a spread (eg because of noise or reflection), particularly in the case of duplex operation.

When ESMC is in the search mode, DDF190 is switched off during the search run and direction finding is restarted after ESMC has detected a signal above the set threshold and has stopped. While search is interrupted, ESMC and direction finder are controlled in the same way as in fixed-frequency mode. Search is restarted either manually by a mouse click or automatically after the set hold time. Thus, the user is also informed of the bearing of a new frequency detected in a search or when duplex operation is monitored at different frequencies.

The ESMC driver has been supplemented by a **log window** where measured data can be stored on the hard disk in an MS-Excel-compatible text format (.CSV) (FIG 2). Data are stored cyclically as a function of signal level (fixed frequency), or once when the signal is above a set threshold (search). Statistics and diagrams can be prepared by evaluating the files using Excel. When ESMC is used with DDF190, bearings are stored in separate columns together with the receiver data.

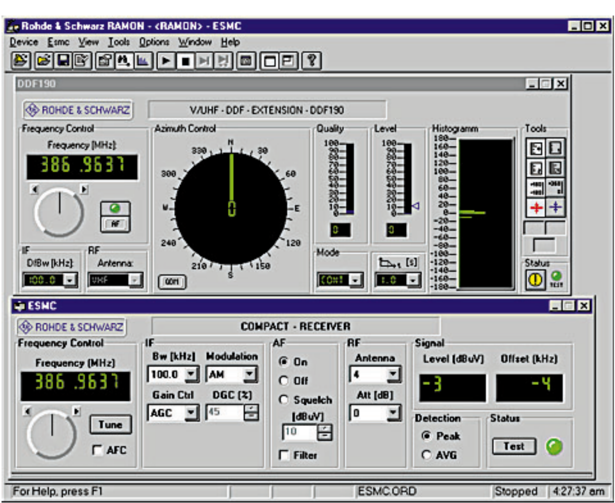

FIG 1 RAMON with ESMC/DDF190 windows

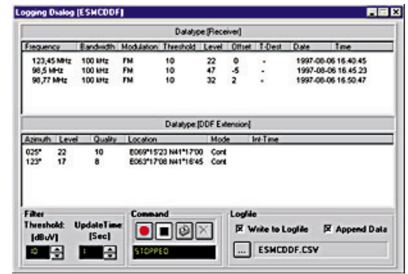

FIG 2 Log window for long-term monitoring

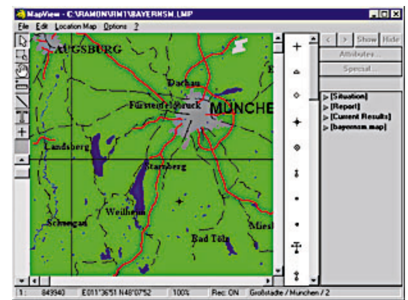

FIG 3 MapView digital map

RAMON permits Direction Finder DDF190 to be connected to a **digital map** (MapView [5]) with beam display (FIG 3). This considerably enhances the operating convenience and simplifies the assessment of DF scenarios.

Claus Holland

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[3] Holland, C.; Reimann, R.: RAMON basic software for Digital Direction Finders DDF0xM and DDF0xS. News from Rohde & Schwarz (1997) No. 153, pp 30–31

[4] Klenner, G.: ESMC-RAMON – entry into computer-aided radiomonitoring. News from Rohde & Schwarz (1997) No. 155, pp 26–27

[5] Rohde & Schwarz: Technical Information MapView

Reader service card 156/12

Digital modulation and mobile radio (VII)

3.2.4 Architecture of GMSK modulator

Before the data stream is fed to the modulator, it is differentially encoded using the rule $d(k) = a(k) \oplus a(k-1)$ where $d(k) \in \{0; 1\}$. Adding –0.5 and then multiplying by a factor of 2 gives a sequence of bipolar delta functions $\delta(k) \in \{-1; +1\}$. The rest of the modulation process depends on the structure of the hardware and firmware used for the modulators, the only proviso being that the tolerances stated in TABLE 5 must be met for bursts lasting 562 µs.

Max. frequency error	Max. phase error peak/rms
1×10^{-7}	20°/ 5°

TABLE 5 Tolerances for modulated carrier

These parameters depend on the accuracy of the modulating signals $c_I(t)$ and $c_Q(t)$, on the frequency and phase stability of the oscillator and the exact orthogonality of the I and Q carrier components. The exact solution involves finding the convolution of $p_c(t) \cdot h_{Gauss}(t)$. The $\delta(k)$ are interpolated using a bipolar NRZ function in a digital filter with an oversampling rate of up to x16, before they are transformed into the function $c_{fil}(t)$ by a further filter with Gaussian characteristics. The next part of the modulator is the same as the MSK modulator that has already been described. In other words, the instantaneous phase is calculated by integrating $c_{fil}(t)$ to obtain $\varphi_{fil}(t)$, $\cos[\varphi_{fil}(t)]$ and $\sin[\varphi_{fil}(t)]$ are calculated and these functions are multiplied by the two orthogonal carrier components (FIG 21).

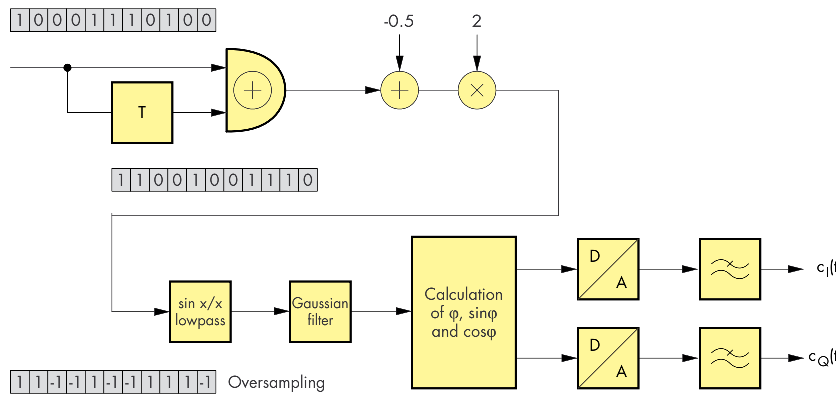

FIG 21 Generating modulation signals cI(t) and cQ(t)

In practice, however, there is no need to follow the exact sequence of operations that flow from the theory. As there are a large number of mobile stations, it is essential to adopt a cost-effective approach while at the same time meeting the requirements listed above. A concept developed by Philips shows how complexity can be reduced drastically. With this approach, differential encoding need not be performed as a separate operation and the tables for calculating $\cos[\varphi_{fil}(t)]$ and $\sin[\varphi_{fil}(t)]$ can be dispensed with entirely – a major improvement. To do this, the original data sequence that has been converted into a bipolar signal is multiplied by a phasor $e^{-jk\pi/2}$. The complex coefficients $\underline{c}(k)$ that result are fed to a filter with Gaussian-like characteristics. A complex function appears at the output of the filter. Its real part approximates the modulation signal $c_I(t)$, while its imaginary part approximates the modulation signal $c_Q(t)$. From the resulting direction of rotation of the RF vector, it can be verified that this form of modulation and the modulation produced by the original, differentially encoded signal are identical (FIG 22).

3.2.5 Demodulating MSK and GMSK signals

As equation (20) shows, MSK signals are frequency-modulated RF signals. In the case of GMSK signals, only the baseband function, which is proportional to the output frequency, is filtered. The RF signal can also be thought of as being frequency-modulated. Consequently, simple frequency demod-

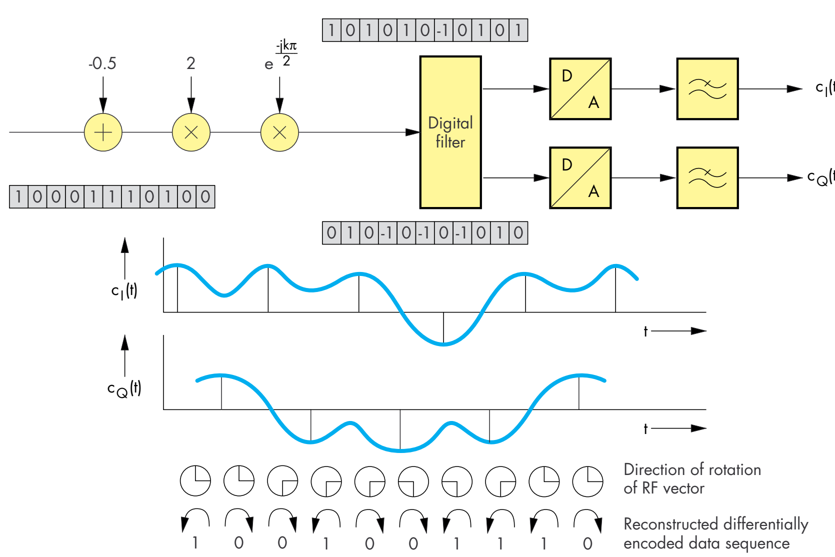

FIG 22 Efficient implementation of GMSK modulator

ulation using conventional frequency discriminators or an indirect approach using FM to pulse frequency modulation conversion would be sufficient to recover the transmitted data. Nevertheless, the considerably more complex route of coherent demodulation, described in chapter 2.6, is taken. There are two main reasons for this:

1. Under the same transmission conditions, coherently demodulated RF signals exhibit lower bit error rates than those that are not.
2. Because of the transfer function of the mobile-radio channel, the RF signal is altered in such a way that demodulating the received signals without equalization would in most cases lead to unacceptably high error rates. However, equalization is only possible if the characteristics of the radio channel over time are known, in other words its transfer function must be continuously estimated.

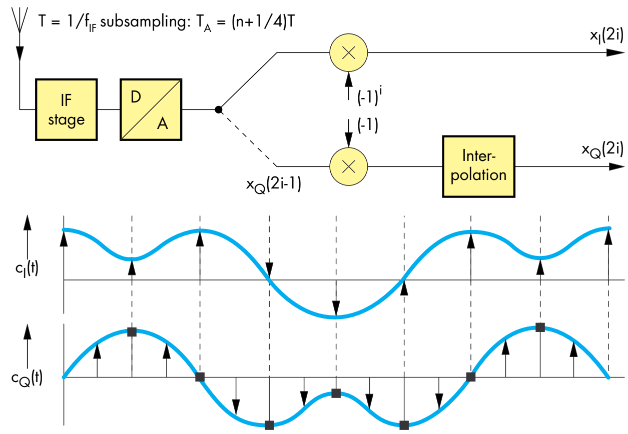

FIG 24
Top: demodulation with A/D converter.
Bottom: signals $c_I(t)$ and $c_Q(t)$ recovered by IF sampling
(↑ sample,
■ interpolated value)

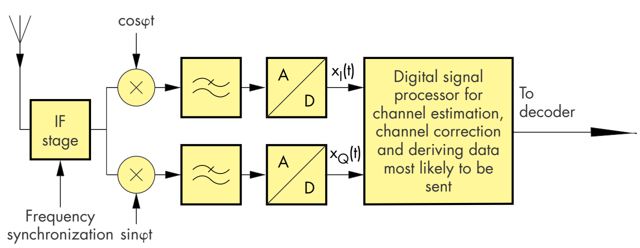

FIG 23
GMSK demodulator

As described in chapter 2.6, coherent demodulation gives the complex envelope of the RF signal, which is also modified by the radio channel. If the undistorted baseband signal is known as well, the transfer function of the channel can be calculated. A sequence of 26 bits, referred to as the training sequence and a copy of which is stored in the receiver, is transmitted in the middle of every burst of 156 bits. By finding the cross-correlation of the received equivalent baseband signal and the complex envelope that the training sequence would generate if reception were ideal, the characteristics of the radio channel can be estimated.

The block diagram of the demodulator is shown in FIG 23. After reception, the RF signal is converted to an IF and fed to the two mixers. The frequency of the superheterodyne oscillator is synchronized by means of a frequency-correction burst transmitted at regular intervals by the base station. This oscillator provides the two orthogonal signals $\cos(\omega t)$ and $-\sin(\omega t)$. After passing through the mixers and lowpasses, the two components of the equivalent baseband signal undergo D/A conversion and are fed to a digital signal processor that, from the distorted complex envelope, reconstructs the sequence that is most likely to have been transmitted.

For the demodulator too there are less involved solutions. FIG 24 shows a concept that uses just one A/D converter. The received signal that has been converted to an IF is undersampled using a sampling period of $T_s = (n + 1/4)T$, where T is the IF period. The samples x_i are multiplied by $(-1)^i$, in other words the samples with odd indices have their signs inverted. Samples with indices of the form 2i are the I-component samples of the received signal, those with (2i – 1) the Q-component samples. The delay between the two components is equalized by an interpolation filter.

Peter Hatzold

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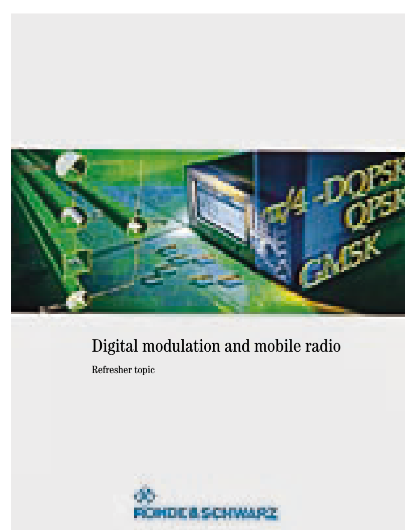

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Insertion Units URV5-Z2 and URV5-Z4 for voltage, level and power measurements up to 3 GHz

New Insertion Units URV5-Z2 and URV5-Z4: versatile, compact and attractively designed
Photo 43 021/1

Coaxial voltage measurement probes are among the standard accessories of RF voltmeters and power meters. Coming as insertion units, they are particularly versatile as they can be connected into a test circuit without interrupting the signal flow. They can thus be used for a wide variety of applications, such as monitoring tasks of any kind as well as level control and terminated power measurements.

The two new insertion units (FIG) for Voltmeters, Level and Power Meters URV35, URV55, URV5, NRVS and NRVD were developed on the basis of the successful predecessor models* of which nearly 10,000 units have been sold since their market introduction in 1984. Accommodated in an attractively designed plastic enclosure, their distinguishing feature is the frequency range, which has been extended from 2 to 3 GHz to allow for new applications. Other features have remained essentially the same, for example the calibration data memory. This concept, introduced by Rohde & Schwarz and meanwhile state of the art, makes for easy operation and high measurement precision through the numeric correction of results using calibration data separately determined for each insertion unit.

Each of the new insertion units offers a dynamic range of over 90 dB for spectrally pure sinusoidal signals with an unmodulated envelope (CW, FM, φM, GMSK, FSK, etc). This gives a voltage measurement range of 200 µV to 10 V (–60 dBm to +33 dBm into 50 Ω) for URV5-Z2, and 2 mV to 100 V (–40 dBm to +53 dBm into 50 Ω) for URV5-Z4. The frequency range is from 9 kHz (URV5-Z2) or 100 kHz (URV5-Z4) to 3 GHz. The units are made up of a short, coaxial line between the two RF connectors, in the middle of which the voltage is tapped: directly with URV5-Z2, and via a capacitive 20 dB divider with URV5-Z4. If the insertion unit is match-terminated, the voltage is constant over the whole length of the line, so a fixed relationship is obtained between applied RF power and test voltage. In this configuration, the insertion units provide precise absolute power and level measurements. They are calibrated so that the source power available into 50 Ω is indicated. With a poorly matched load, precise absolute-value measurements are not possible, but relative measurements can be performed and system applications implemented in which subsequent calibration of the complete test setup takes place. Switchover between voltage, level and power indication is made at the basic unit.

With modulated envelope or high harmonic content, the insertion units should be operated only within the square-law region of the RF rectifier, which for URV5-Z2 ends at approx. 22 mV (–20 dBm into 50 Ω) and for URV5-Z4 at 220 mV (0 dB into 50 Ω). In this region, the behaviour of the insertion units is similar to that of a thermal power meter, ie the rms voltage or the equivalent average power is measured.

Thanks to the high decoupling of the rectifier from the RF connectors, insertion loss of URV5-Z4 is very low, ie not exceeding that of a line of equivalent length. URV5-Z4 is therefore truly transparent and can be inserted into any test circuit without influencing the measured parameters. This yields a nearly ideal voltage and power sensor which, compared to conventional power sensors, stands out for its exceptionally wide dynamic range.

Due to their high versatility, the insertion units will open up a wealth of new applications, continuing the success story of the predecessor models. Sounds interesting? Try them out: simply "plug and play".

Thomas Reichel

* Betz, T.; Köhler, D.; Reichel, T.: RF Millivoltmeter URV5 – voltage and power measurement into the gigahertz range. News from Rohde & Schwarz (1984) No. 106, pp 16–18

Reader service card 156/14

From dual-mode to multimode radiocommunication tester – IS-136 standard now implemented in CMD80

Digital AMPS TDMA system (IS-136 standard) is a mobile radio standard that has attained a degree of importance in the US and other countries almost equalling that of analog AMPS and CDMA. For this reason Rohde & Schwarz has decided to support this standard with its Digital Radiocommunication Tester CMD80, in addition to analog AMPS and CDMA already covered by this tester [1; 2]. The basic design of CMD80 makes it ideal for this added feature: CMD80 is a compact tester covering the whole frequency range from 800 to 2200 MHz. Transmit and receive frequencies can be handled independently of each other. The tester's measurement functions are based on state-of-the-art digital signal processing techniques. This allows test results to be available within very short time, which is an invaluable asset in mass production where speed of operation is a crucial factor. The use of DSP technology yields two more significant benefits: measurement functions can be enhanced by means of software updates, and even totally new measurement techniques (TDMA) can be adopted through software alone.

When used for **transmitter testing,** CMD80 awaits the signal emitted by the mobile station transmitter at a particular frequency and power level both defined in advance. It then records the signal and interprets it under various aspects:

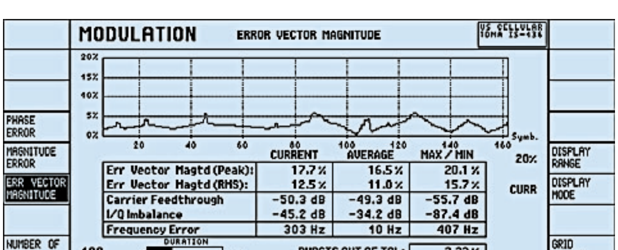
- Error vector magnitude, a modulation measurement specially matched to the modulation mode used in this system. The vectorial deviation of the measured signal from the ideal signal is calculated and the magnitude of this vectorial error function represented as a time function (FIG). Derived error parameters are peak and rms value of this time function. In addition, the measurement algorithm also provides the frequency error as well as I/Q offset and I/Q imbalance.
- Magnitude error; this measurement is used to determine amplitude errors arising during modulation.
- Phase error arising during modulation.
- Power versus time; an important measurement in all TDMA systems.
- Adjacent-channel power; the power pulses occurring in the TDMA system and the type of modulation used can affect the adjacent channels, so adjacent-channel power measurement is of particular importance. It is performed in six adjacent channels altogether (three channels left and three channels right of the user channel).

When used for **receiver testing,** CMD80 emits a test signal at a selectable frequency, whose level can be chosen from a wide range. The signal contains a known bit sequence that is suitable for bit error rate measurements. This signal is fed to the receiver. The bits demodulated in the mobile station are compared with the known bits. This is done either by the mobile station or by the controller of the mobile station.

User prompting and instructions given in plain text allow manual operation of CMD80 without detailed knowledge of the individual networks. When CMD80 is remotely controlled via the IEC/IEEE-bus interface, top measurement speeds are obtained. This together with the compact size of the unit is an important prerequisite for its effective use in a production environment.

Around the world, new mobile communication standards are being developed or existing standards modified to match country-specific requirements. Offering the user convenient dual- and multimode mobiles is common not only in the US. This is why it is a great plus for manufacturers of radio equipment to have several mobile radiocommunication standards combined in a tester like CMD80, whose design also enables future standards to be integrated at a later date.

Thomas Maucksch



Result of error vector magnitude measurement to IS-136 standard with Digital Radiocommunication Tester CMD80

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Reader service card 156/15

Optional input interface for TV Test Transmitter SFQ

FIG 1 TV Test Transmitter SFQ for testing TV receivers Photo 42 961/1

TV Test Transmitter SFQ (FIG 1) for testing analog and digital TV receivers and set-top boxes as well as ADR (Astra Digital Radio) receivers is used in development and production as well as in service and EMC test labs [1]. From the MPEG2 input signal SFQ generates a signal coded and modulated according to DVB specification up to a frequency of 3300 MHz. Channel coding and modulation are performed either for cable or satellite transmission. The input signal whose data rate may be between 2 and 60 Mbit/s is applied to SFQ via a synchronous parallel interface. In this case, input data rate and output symbol rate of the modulated signal are directly linked to each other. The conversion factor is obtained from the selected puncturing rate of channel coding and the number of bits per symbol according to the type of modulation chosen. If the **output symbol rate** is to be selected **independent of the input data rate, optional input interface** is the right solution. A synthesizer in the module generates the exact symbol rate even if no MPEG2 input signal is available.

The **MPEG2 transport stream** is a continuous data stream which serves for the transport of video, audio and data signals. It consists of data packets with a constant length of 188 or 204 bytes (for Reed-Solomon coding). Each packet starts with a header consisting of a sync word, a packet identification (PID) and various control bits. The remaining data bytes of a packet comprise the information to be transmitted. This information may be part of a video stream, audio stream or table containing information about the transmitted programs of the transport stream. Packets are allocated to a certain program via the PID. Null packets can be inserted to adapt the data rate of the transport stream to the data rate required by the transmission channel. These null packets do not contain any information and can be recognized by their specific PID.

With the optional input interface provided, SFQ has two different input interfaces: an **asynchronous serial interface** (ASI) and a **synchronous parallel interface** (SPI). The two interfaces meet the DVB specification and cover most of the applications. The input interface treats the two interfaces in the same way by internally transforming the serial data of the ASI into parallel form according to SPI. In the first processing step, the input data rate and packet length of the transport stream are determined and displayed for information and monitoring (FIG 2).

In the next step, a device-internal output data stream is generated from the input data stream. The output data rate is linked to the output symbol rate of SFQ. For this **data rate conversion,** existing null packets are removed from the data stream. The data rate thus obtained represents the minimum output data rate of the module. The required output data rate is generated by adding null packets. The added null packets may optionally contain a pseudo-random binary sequence (PRBS), allowing bit error measurements. Data rate conversion can of course also be switched off. In this case, only SPI is available and SFQ operates like a unit without an input interface (TS Parallel mode).

If a transport stream is modified by removing or adding null packets, as described above, the relative position of MPEG2 packets is changed since

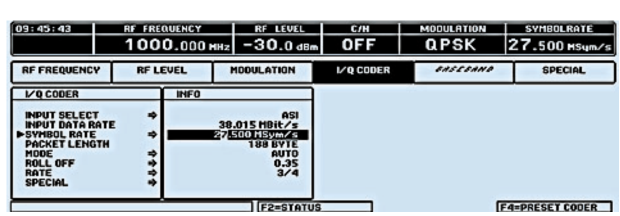

FIG 2 Menu for input interface

the null packets now have a different position in the transport stream. This means that the program clock reference (PCR) values in the transport stream are no longer correct. (PCR values indicate the program time at which the packets leave a processing unit [2]). For **correcting the PCR values** the actual dwell time of the packets on the input interface is added to the original value.

To keep the deviation from the original values to a minimum, a constant value, ie the minimum dwell time of a packet, is subtracted from the corrected PCR value. The jitter added by correcting the PCR value is far below the limit value stipulated by DVB specification.

Peter Schmidt

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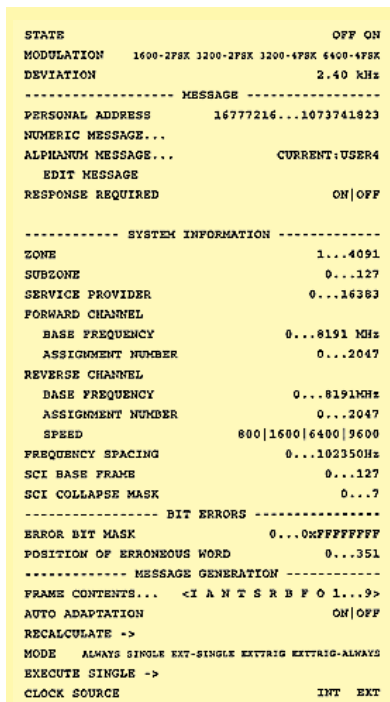
Reader service card 156/16

ReFLEX25 and FLEX roaming in Signal Generator SME

Together with FLEX protocol option (SME-B41) Signal Generator SME was in the past already able to generate standardized messages of the FLEX radiopaging service and to simulate a FLEX base station which can be used as a general test signal source in the development and production of pagers*. Now Rohde & Schwarz has created a **new software option** (SME-B43) which enables SME to generate also messages **for ReFLEX25**, another member of the FLEX protocol family. The FIG shows the manual control menu of this option in which all relevant parameters for the generated ReFLEX25 message and for the simulated base station can be varied as required. All settings are also possible via IEC/IEEE bus, of course. The parameters meet all the requirements that may occur in practice. Some of the parameters can even be set to values not complying with the standard in order to activate special modes of a receiver, for example.



Possible settings for ReFLEX25 messages in manual control mode of SME

The Frame Contents menu used to determine the contents of the individual message parts allows to set frames with user messages as well as frames with control messages such as SCI frame, switchover to a bit error test mode or emergency resync frame. For applications beyond this, up to nine frames with user-defined data can be processed by a PC and inserted anywhere in the ReFLEX25 message. Bit error tests with customer-specific test pattern can thus be implemented, for example, or user messages can intentionally be corrupted.

Moreover, Rohde & Schwarz has clearly **extended** the previous **FLEX Protocol Option** SME-B41. In its new version, the FLEX protocol defines far-reaching roaming characteristics for paging receivers also permitting the reception of messages outside the home network. Therefore, SME can now generate standardized roaming information in FLEX messages and thus allows comprehensive testing of the new roaming pager generation. NID and SSID roaming information is generated, for example, and besides normal user messages, secure messages, instructions for SSID subscribers, emergency resync frames, filler data and simulated data of other pager protocols can be transmitted. Another innovation is mixing different types of messages within a cycle. Furthermore the timing sequence of the output information can be controlled more precisely. These two additional characteristics further reduce the critical time of final testing in receiver production.

Daniel Schröder

* Leutiger, M.; Schröder, D.: Signal Generator SME for tests on ERMES, FLEX and POCSAG pagers. News from Rohde & Schwarz (1996) No. 150, pp 38–39

Reader service card 156/17

Rohde & Schwarz naval communications systems for joint Dutch-Spanish project

HF Broadband System XB2900 for the "Rotterdam" of Royal Netherland Navy (art impression by courtesy of Royal Shelde Shipyard Netherlands) Photo 43 019/1

The increasing demand for naval communications – notably in the HF band – has led to the development of new concepts in recent years, which must also take into account the limited space for antennas onboard ships. A comparison with other navies shows that the Royal Netherland Navy has a great deal of experience in the field of HF broadband systems. This experience was put to use in the design and definition of the shipboard antenna system when planning of the Amphibious Transport Ship/Landing Platform Dock (ATS/LPD) was started in spring 1992 as a part of a joint Dutch-Spanish project. Among the major tasks of the two ships are transport and landing of and supply to crisis reaction forces as well as humanitarian relief operations in times of peace. Besides a docking area for landing craft the ships also provide accommodation facilities for helicopters.

Based on the wealth of experience gained in the field of HF naval communications systems with the German Navy and international naval projects, Rohde & Schwarz won the order for the joint-venture HF communications system in 1995 against a strong field of international competitors. Prior to this, **HF Broadband System XB2900** was developed based on RF components of Transceiver Family XK2000 [1; 2] and in close cooperation with the experts for naval system engineering of Rohde & Schwarz Hamburg and Rohde & Schwarz Netherlands. A functioning XB2900 prototype was then presented in good time to the decision makers of the Dutch and Spanish Navy who were convinced by the following **excellent characteristics** of the HF broadband system:

- The system consists exclusively of standard components, which is an important aspect for onboard logistics.
- The individual components are small and lightweight and can thus be accommodated even where space is limited.
- The system allows intelligent and extremely flexible power management, ie the exact number of communication lines needed is activated with the currently required HF output power.
- A separate HF amplifier is assigned to each broadband line, thus ensuring optimum linearity characteristics. If the corresponding line is not required, its amplifier will not be driven, thus saving power, increasing reliability and reducing interference/collocation problems.
- The major part of the dissipated power is not given off in the amplifiers but in separate load resistors which are optimally cooled (eg with water).
- Receivers/exciters can be operated as additional receivers via a separate receiving antenna when they are not required for transmission.
- Only the power level required for a given link is generated in each HF broadband power amplifier; this increases the lifetime of the units.
- Thanks to the fully passive configuration of the output circuits the system is suitable for fast data transfer and also for adaptive and frequency-agile radiocommunication methods.
- A frequency spacing of 1% is sufficient for operation of the individual lines free from mutual interference.
- Continuous operation of the complete system is guaranteed for a temperature range from –25 to +55°C.

Standardized double racks form the basis of the HF broadband system. These racks accommodate four 1 kW Transceivers XK2900, power management unit, broadband couplers and junction panel for cabling (FIG). The output signals of the racks are combined using couplers and fed to the three-section broadband antenna system via a triplexer. The broadband antenna system is adapted to the specific onboard environment, ie the ship superstructure. The Royal Netherland Navy has carried out preliminary measurements on a brass model to optimize the impedance characteristics. The results were of course taken fully into account by Rohde & Schwarz throughout the design of the system.

Rohde & Schwarz not only supplies the HF radiocommunications system required for this joint project but also a complete internal and external communications system. The future tasks to be fulfilled by these platforms indicate a high demand for close-range communications, which is reflected by a variety of transmit and receive lines for VLF, HF, VHF and UHF onboard the ship. An intercom and a shipboard public address system provide, among others, internal communications.

To verify that this communications system fully complies with the characteristics stipulated by the contract prior to being installed onboard the ship, Rohde & Schwarz set up the racks in a hall near Hamburg that was specifically rented for this joint project. To guarantee successful acceptance testing of the system, a whole series of preparations had to be made. It was first necessary to ensure the cooling water supply of the HF broadband system, considering that more than twenty 1 kW Transceivers XK2900 need to be cooled sufficiently under all operating conditions. The power supply of the complete communications system was not that simple either: the power offered by the local mains distributor was not high enough and an additional generator had to be used to attain peak powers. Another challenge was the large number of test cables and distribution boxes. Within only two months 4000 m of cable had to be run and fitted with connectors or wired into terminal boxes.

After a successful "rehearsal", the "premiere" is currently being prepared at the Dutch and Spanish shipyards with the active aid of the local Rohde & Schwarz representatives. End of February this year, the first ship was christened "Rotterdam" at the Dutch shipyard Royal Schelde in Vlissingen and is now being fitted out. The "Rotterdam" is to be put into service at the beginning of next year. The Spanish ship named "Galicia" was built at the Spanish shipyard in Ferrol and will be handed over to the Spanish navy in spring 1998.

Norbert Linge; Robert Träger

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Reader service card 156/18

Passenger telephone system Jetcall 2000 up and away

Rohde & Schwarz and its French partner Mors have already installed 96 of the jointly developed terrestrial flight telecommunication systems in short- and medium-haul aircraft of Air France. After a year's testing under commercial and technical aspects carried out on domestic and international flights, the French airline in June this year placed another order for fitting out 13 airplanes – among them Airbus A320, A321, A319 and Boeing 737 – as well as an option for another eight aircraft. The complete short- and medium-haul fleet of the Air France group will thus be equipped with Rohde & Schwarz/Mors units.

More than 180 European aircraft to date are equipped already with the TFTS (terrestrial flight telecommunication system) air-to-ground-to-air passenger telephone (FIG). Compared to telephone systems installed so far which are based on satellite transmission, this service is attractive because of its higher speech quality and phone charges reduced by half. JetPhone, currently the only TFTS service provider in Europe, expects up to 20 telephone calls per day per aircraft. JetPhone is at an advanced stage of negotiations with Crossair, a subsidiary of Swissair, and with Aer Lingus and Braathens. Precontract negotiations on the installation of TFTS Jetcall 2000 systems are being conducted with four other airlines.

With the Jetcall 2000A version Rohde & Schwarz/Mors are offering an extremely lightweight and cost-efficient TFTS solution for use in business, VIP and regional airplanes. A Falcon 20 of Aero Leasing was the first airplane to be equipped with Jetcall 2000A.

Jetcall 2000 is an extremely favourably-priced air-to-ground-to-air passenger telephone system.
Photo 41 900/1

Ekkehardt Claußen

Reader service card 156/19 for further information on TFTS

Signing of contract for development of test equipment for global-coverage dual-mode mobiles

In early July 1997 ICO Global Communications, renowned mobile-radio service provider with headquarters in London, and Rohde & Schwarz signed a contract for the development and production of test equipment for dual-mode mobiles, which in the future will enable particularly convenient communication worldwide via satellite and within local digital networks. Most important for Rohde & Schwarz in this contract is the section on ICO 11.10 testing requirements (similar to GSM 11.10), in which the methods for executing the test cases are described. The contract has a duration of 30 months and encompasses a volume of about US$18.5 million.

Following the contract signing ceremony, Olof Lundberg, Chief Executive of ICO (in photo second from left), said: "This represents a major milestone for ICO. Rohde & Schwarz's unrivalled expertise in test and measurement systems for digital communications terminal equipment makes it the perfect partner for ICO. In forging this true partnership with Rohde & Schwarz, ICO demonstrates once more its commitment to offer high-quality and world-class user terminals to all our customers." Dr. Wolfgang Winter, Managing Director of Rohde & Schwarz UK (second from right), said: "The growing demands for mobile communication require highly sophisticated engineering on a worldwide basis, which is guaranteed by Rohde & Schwarz. ICO has chosen the best partner to fulfil its challenging targets to introduce the next generation of dual-mode cellular/satellite user terminals, which will open up a new level of communication services to the world market." PI

R&S supplies new test vehicles to Federal German Post and Telecommunications Office

A new generation of test vehicles (photo) was handed over to the German Post and Telecommunications Office (BAPT) in June this year. The test vehicles are equipped with Spectrum Monitoring System for Broadcast Applications SMSB from Rohde & Schwarz for VHF and TV transmitters (see also page 26 in this issue). The five test vehicles are used in the whole of Germany to support transmitter frequency planning and monitoring. What is new in the implementation of these government tasks is the fully computer-controlled integration of the wide variety of measurement tasks to be performed, their automatic evaluation and linkage to the central BAPT database system. This has become possible through the further development of Spectrum Monitoring Software ARGUS, providing BAPT with a complete solution for radiomonitoring, radiolocation and measurements in the field of sound and TV broadcasting.

J. Pfitzner

New aeronautical radio network with control center for SAR service of German air force

By order of the Federal German Minister of Transport the German armed forces established a national search and rescue (SAR) service for aircraft. This service, based on helicopters that are always on standby, can also be deployed for civil tasks to provide support in emergency situations. In the past few years, a concept for setting up a new SAR control center and radio stations for the SAR service of the air force was developed in close cooperation with representatives of the air force, government and industry, and with due consideration of state-of-the-art technologies. Rohde & Schwarz as the prime contractor was entrusted with the task of translating operative requirements into technical solutions. Rohde & Schwarz has been known for decades as a reliable partner in the implementation of radiocommunication projects and is cooperating with the renowned company of Frequentis, Vienna, in the field of voice communication switching systems. The new system, which in its full configuration will comprise 33 radio stations, will be ready for operation at the end of 1997. A subnetwork encompassing 20 transmit and receive stations was put into operation in July. On the occasion of the official handover of this subnetwork in Münster in the state of Westphalia, Hans Wagner, President and COO of Rohde & Schwarz, handed over to Major General Back, head of the rescue service center, the coat of arms of the SAR control center (photo above).

An essential new feature of the aeronautical radio network is the linking of the communications system to database systems which provides access to rescue control centers, lists of hospitals, airports, etc. The system operates nonblocking throughout, ensuring that any radio call reaches its destination, which helps to save human lives day-to-day. The SAR control center of the air force in Münster is responsible for the whole of Germany except for its northern state of Schleswig-Holstein for which the German navy with headquarters in Glücksburg, which has its own radio network, is competent.

M. Fraebel

News from all over the world for hotel guests

The hotel "Am Stadtgarten" in Freiburg offers its guests a very special service. If they wish, they can have a room with a shortwave receiver. Rohde & Schwarz Receiver EK07 of long standing has recently been replaced by a modern EK896 (photo). Frequencies covering the guests' home regions can be preprogrammed. Thanks to the clear and simple user interface of EK896, the guests can carry out their own settings without special knowledge. This service is appreciated and used in particular by guests from overseas. Besides a long-wire antenna Active Rod Antenna HE011 ensures optimum reception quality.

R. Mayerhofer

Joint exhibition by Rohde & Schwarz and Tektronix in Athens

It is almost a tradition since this is the third time that the joint Rohde & Schwarz-Tektronix exhibition with symposium took place in the "Athens Hilton" hotel in April this year. A large number of invited visitors from ministries, authorities, universities and industry were welcomed in a congenial atmosphere. The visitors were particularly interested in digital TV transmission and test equipment as well as in GSM radio testers. Lectures on theoretical aspects were followed by practical demonstrations on the equipment (photo).

The visitors' favourites were Digital Radio Tester CTS55 and EMI Test Receiver ESPC from Rohde & Schwarz as well as the new oscilloscopes from Tektronix which use digital real time and InstaVu(TM) techniques. They allow individual events to be detected in full bandwidth and randomly deviating signal waveforms to be displayed. Digital Radio Tester CTS55 which provides fast function testing of GSM and DCS1800/1900 mobiles is highly interesting for use in Greece since the third Greek GSM network is being installed by the PTT in line with the GSM1800 standard. Tektronix's pocket-size PAL Signal Generator TSG95, which for example can generate 20 of the most important test patterns, met also with great approval.

The exhibition in Athens was a great success within the framework of the sales cooperation between Rohde & Schwarz and Tektronix.

B. Mohacsy

ISO 9002 certificate for Rohde & Schwarz Canada Inc.

In June 1997 yet another Rohde & Schwarz sales agency was granted certification of its quality management system in line with the ISO 9000 standards. Rohde & Schwarz Canada Inc. received confirmation that it meets the requirements of ISO 9002-1994 (photo). This certification, which includes both sales and service, not only confirms the high quality standard of Rohde & Schwarz products, but is also an evidence of Rohde & Schwarz's efforts to implement worldwide quality assurance as a management method.

H. Penning

QMI

90 Burnhamthorpe Road West, Suite 300
Mississauga, Ontario, Canada L5B 3C3
Telephone: (905) 272-3920
Facsimile: (905) 272-3942
A Division of CSA

CERTIFICATE OF REGISTRATION

ISO 9000

QMI issues this certificate to:

ROHDE & SCHWARZ CANADA INC.
555 March Road
Kanata, Ontario
K2K 2M5 CANADA

which has demonstrated that its quality system is in compliance with:

ISO 9002-1994

The following scope of registration applies:
Sales, Service and Distribution of Rohde & Schwarz Products and Systems.

Certificate Number:	002497
SIC Numbers:	5084, 7629
Date of Original Registration:	June 25, 1996
Date of Current Registration:	June 3, 1997
Date Registration Expires:	June 3, 2000

President

Optical module testing with enhanced model of LaserVision System

Compared with very successful LaserVision System LV1 (see News from R&S No. 150), LV2 from Rohde & Schwarz (photo) features additional test capabilities and higher test speed. The system is particularly suitable for testing SMDs whose in-circuit testing is very limited because of the difficult adaptation involved. The main fields of application include testing of mobile communication terminals as well as of consumer and car electronics, where large quantities call for cost-effective and fast testing. Compared with other common optical test systems, LaserVision features a unique combination of image processing and laser height measurement and provides an extraordinarily high level of fault detection, ultra-low pseudo-fault rate and an excellent price-performance ratio thanks to low investment costs.

As compared with LV1, the measurement speed has been considerably increased by a new image processing method. With a test rate of more than ten components per second, the speed corresponds to that of modern automatic mounting machines and allows the system to be directly used for process control on the assembly line. LaserVision System LV2 offers additional test capabilities. An improved position determination provides the X-Y coordinates of SMDs and the actual angle of mounting. Another new feature is the measurement of the height profile of the whole DUT, allowing easy and fast checking even of complex structures. The new array test software enables simple duplication of similar tests, so that a lot of time can be saved in program generation in particular when testing frequently occurring components. LaserVision System LV2 can be used as a stand-alone test set or in combination with a conventional in-circuit or functional test system from the TSAx or TSUx families. PI

Reader service card 156/20

Power Reflection Meter NRT (200 kHz to 4 GHz; 0.3 mW to 2 kW) measures peak and burst power as well as crest factor and simultaneously displays power and reflection digitally and as a bargraph; new sensors (for direct connection to PC): NRT-Z43 (from 400 MHz) 7 mW to 30 W (peak 75 W), NRT-Z44 (from 200 MHz) 30 mW to 120 W (peak 300 W), compatible with main digital modulation standards (average power values independent of modulation mode); Sensors NAP-Z.. can be connected via option; built-in battery charger.

Data sheet PD 757.2396.21 enter 156/21

Security Management System USEIT from **SIT** (Gesellschaft für Systeme der Informationstechnik mbH) detects and automatically or manually eliminates weak spots of UNIX operating systems on single PCs or in networks. (Data sheet only available in German for the time being).

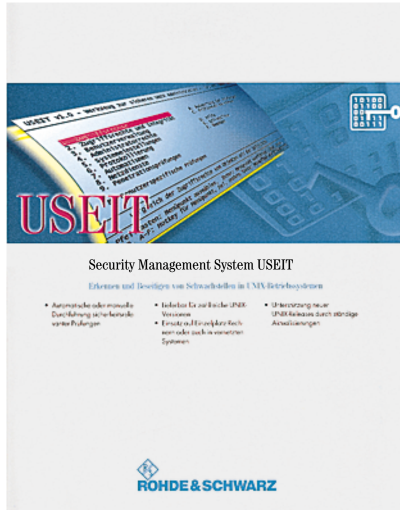
Data sheet PD 757.3505.11 enter 156/22

Vector Signal Generator SMIQ (model 02 for 0.3 to 2.2 GHz, model 03 for up to 3.3 GHz) allows – depending on the type of application – digital, vector and classic modulation modes (digital standards at a keystroke) with short setting times and high spectral purity as well as for the first time 6-path and 12-path fading simulation; level range −140 to +13 dBm, internal data generator, broadband I/Q modulator, broadband FM and AM, frequency hopping, RF/AF/level sweep; economy models for use in production.

Data sheet PD 757.2438.21 enter 156/23

Standard Signals at the Touch of a Button This poster (DIN A1 format) shows settable parameters of digital communication systems covered by Vector Signal Generator SMIQ.

Poster PD 757.3463.21 enter 156/24



Four-Line V-Network ENV4200 (150 kHz to 300 MHz) with 50 µH || 50 Ω impedance is an artificial hand and designed for 4 x 200 A continuous current.

Data sheet PD 757.3428.21 enter 156/25

Tracking Generators FSE-B8 to FSE-B11 (-B8/-B9: 9 kHz to 3.5 GHz, -B10/-B11: up to 7 GHz) enhance Spectrum Analyzers FSE for selective scalar network analysis; attenuation measurement to typ. 120 dB, output level optionally to −90 dBm, -B9/-B11 with I/Q modulator.

Data sheet PD 757.3434.21 enter 156/26

ACCESSNET® Trunked radio for professional users is presented by **R&S Bick Mobilfunk** in this brochure: comprising everything from design support through to service after commissioning.

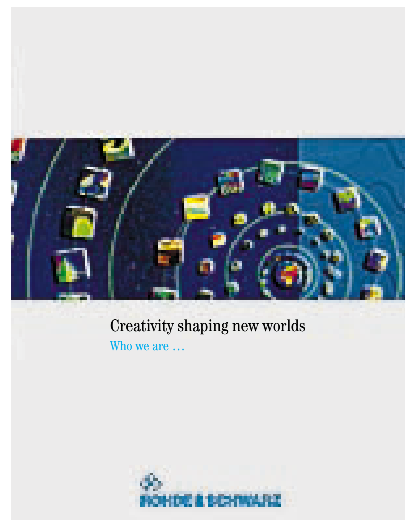
Info PD 757.3170.21 enter 156/27

Our services at your service "Rohde & Schwarz Cologne Plant helps you all along the line" is the promise of the R&S service center. For more details, have a look at the new brochure.

Info PD 757.3386.21 enter 156/28

Creativity shaping new worlds (Who we are...) and **Competence for a communicative world** (...and what we do) are the titles of a brochure in two parts, in which Rohde & Schwarz presents itself as top in test & communications, explains its quality- and customer-oriented philosophy and describes its business fields and product groups.

Info PD 757.3557.21 enter 156/29



New application notes

Group and Phase Delay Measurements with Vector Network Analyzer ZVR
Appl. 1EZ35_0E enter 156/30

File Transfer between Analyzers FSE or ZVR and PC using MS-DOS Interlink
Appl. 1EZ34_0E enter 156/31

Accessing Measurement Data and Controlling the Vector Network Analyzer via DDE
Appl. 1EZ33_0E enter 156/32

Collection of Setups for Measurements with Audio Analyzers UPL and UPD
Appl. 1GA36_1E enter 156/33

Automatic Run of Rec. 11.10 Testcases (Remote Control of MS Function)
Appl. 1CMAN30E enter 156/34

BER Measurement with 50 kHz Frequency Offset and Blocking 2 Measurement
Appl. 1CM29_1E enter 156/35

Schz

John Watkinson, editor of the US journal *TV Technology & Production,* chose the photo on the left for the April issue as an eyecatcher for his report on digital video broadcasting. He described among others test and measurement requirements in this field. The photo shows MPEG2 Generator DVG and MPEG2 Measurement Decoder DVMD which fully comply with MPEG2 and DVB specifications.

Around-the-clock in Japanese

In its 4/97 edition, the radio journal *TV Technology & Production* describes the Japanese broadcaster NHK's preparations for setting up round-the-clock operation, the support given by Rohde & Schwarz for this project and the use of TV Monitoring and Test System TS6100 for monitoring the programs:

Up to now NHK has been broadcasting up to 18 hours a day which left a few hours free for maintenance work to be carried out on the transmitters. NHK intends to transmit 24 hours a day as from January 1998. This requires a new maintenance philosophy. To this end NHK turned to Rohde & Schwarz for support. Rohde & Schwarz has been supplying TV transmitters and test equipment for 50 years. The company has now developed a new concept for its TV monitoring systems and plans to install a pilot system at NHK. With this system failures can be predicted before they occur (active instead of passive maintenance).

… and once again DVB

Dr. Jürgen Lauterjung, head of the T&M ad-hoc group in the Technical Module of DVB and responsible for new technologies and strategic cooperations at Rohde & Schwarz, gives an overview of the state of the art in the leading article on DVB in the television, film and electronic media journal *FKT* (7/97). He moreover refers to an article by R&S employee Michael Fischbacher in the same issue on the subject of testing the realtime characteristics of coders and distribution networks for digital TV networks:

Digital video broadcasting is now here to stay irrespective of what one thinks of it. We will probably look back on 1996 and 1997 as the beginning of this revolutionary technique. As a rule in such cases, the first onsets are not that revolutionary at all. Market penetration, ie reaching the customer, is as fast or slow as with other high-quality consumer goods. But those who have intensively been engaged in DVB for the past three or four years can't help thinking that the breakthrough to success will soon be made if it has not happened already.

Go or NoGo

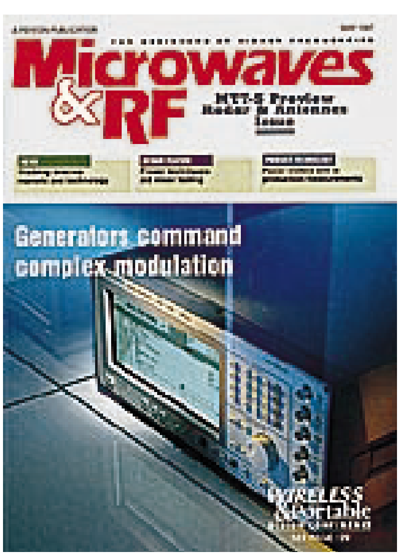
The 16/97 edition of *Funkschau* deals with the testing of GSM telephones and presents among others Digital Radio Tester CTS55:

CTS55 too offers automatic test functions. The quick test allows a very fast check of the most important functions with a go/nogo message. A second autotest version gives more detailed results on three RF channels but it takes a little more time. These functions enable the mobile-phone dealer to prove competence and carry out reliable diagnosis in presence of the customer. Operating CTS55 with the autotest routines does not require technical expertise. The graphics on the TFT display afford easy and fatigueless work over a long period of time.

Solution provider with basket of products

The journal *Elektronik Produktion & Prüftechnik EPP* (No. 6/97) interviewed Klaus Kundinger, manager for production T&M equipment and systems, on the subject of in-production testing at R&S:

The different sections of our T&M division supply a large proportion of their instruments for use in production, in particular for testing mobile communication devices and automobile electronics. The close integration of these sections will continue to increase. Our cooperation with Tektronix has enabled us to have a respectable presence in US mobile-telephone production plants. … Production test technology at Rohde & Schwarz is on the way to becoming a strategic field of activity, creating optimum solutions in long-term partnership with customers.



The clear favourite on the covers of the international journals *Microwaves & RF* (5/97), *EPN Asia* (6/97) and *Communications Products* (3/97) was Vector Signal Generator SMIQ which represents a new generation of signal generators from Rohde & Schwarz with digital modulation capability. It offers high-quality digital modulation based on precision I/Q modulation, short measurement times through fast synthesis and a large dynamic range thanks to its high spectral purity.

D-channel filter – essential contribution to increased security of ISDN telecommunication systems

By order of the German Information Security Agency (BSI), the Rohde & Schwarz subsidiary SIT, Gesellschaft für Systeme der Informationstechnik mbH, Berlin, is developing a device to increase the security of ISDN (integrated services digital network) telecommunication systems. This device performs filtering of the D channel which is used for ISDN control.

The primary **protection afforded by the D-channel filter** is the prevention of unauthorized access to services and performance features, the aversion of deliberate misdirection of information and the possibility of detecting and preventing intrusions within the network and from the outside. The filter also prevents concealed information transfer

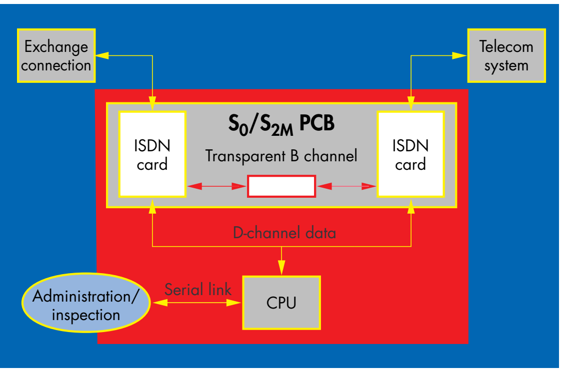


FIG 1 Principle of D-channel filter

in the D channel for any purpose whatsoever. It responds to any intrusion by detecting the attempt, preparing a comprehensive report and clearing down the link. All D-channel packets not infringing the defined filter conditions are through-connected to their destination. The filter supports the high transmission capacity of the ISDN channels, ie the D-channel capacity of 16 kbit/s for the S_0 bus and 64 kbit/s for S_{2M}. B channels are not affected either. The D-channel filter is able to protect telecommunication systems with more than 10,000 subscribers.

What is such a filter good for, or ISDN interpreted differently: **i**s **s**uch a **d**evice **n**eeded? Any subscriber having changed from the good old analog telephone to digital ISDN surely would not like to do without the **advantages of the integrated services network,** and this not only because of the higher dialling and transmission speed. For instance, telephone traffic, digital data transfer, fax transmission and other services with a multitude of features can now be handled via the same telecommunication lines. It is convenient to take one's own extension number into the conference room or to route calls to any other telephone extension. Who has not yet made use of the multiparty service or the handsfree facility? Not to speak of system administration. The service technician need not come to the site anymore, he simply dials himself into the network from any point outside the system and makes all the settings requested by the network subscriber.

However, what happens if the call transfer function is used to talk to auntie in Australia every day free of charge (for the person calling)? What harm can be done when the telephone's handsfree microphone is activated by an outsider just at the moment when strategic decisions are being made in the very room or last details of an offer discussed? Can a user of a telecommunication system be sure to know the exact configuration of his system or not to make mistakes in system handling? What about attempts to intrude into the company-internal telecommunication system for the purpose of industrial espionage? It is hardly a secret that intelligence services both in the East and West resort to every means and utilize large personnel resources to reach their objectives. These are only a few examples to demonstrate that the **emergence of digital technologies** has brought **new threats for IT security.** If such threats cannot be avoided, protective

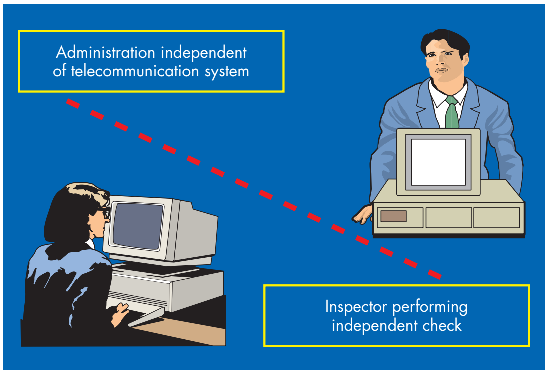


FIG 2 Separation of administrator and inspector

measures have to be found to reduce the risk to an acceptable minimum. The D-channel filter is an effective means for this purpose.

Basically, the **D-channel filter** is an **ISDN firewall.** A survey of the market has shown that there is no comparable product worldwide. This has also been confirmed by the great number of customer queries at CeBIT 97. The design of this filter is as follows: all (incoming and outgoing) information on the D channel is separated from the user data in the B channels by means of two ISDN interface cards (1 or 3 x S_0 or 1 x S_{2M}), which are accommodated on one PCB, and then forwarded to a processor board (FIG 1). The actual filter software is installed on the processor. Filtering is performed according to the following basic principle: all services and performance features that are not explicitly activated for a specific extension number or group of extensions are barred. Any unauthorized attempt to use barred services and features is met by the filter with a link cleardown.

An administrator and an inspector are responsible for **configuring and adapting the filter to the telecommunication system to be protected** and for carrying out performance checks (FIG 2). They can access the filter via a commercial PC. Complex functions are available to the administrator; they can be handled via a familiar graphical user interface (Windows 95, Windows NT). Internal filter conditions can be set via easy-to-understand menus. A difference is made between protocol-specific and subscriber-specific filter conditions. Protocol-specific conditions ensure transmission in the D channel conformal to 1TR6 or DSS-1 ISDN protocol. They also prevent or detect unauthorized access attempts via protocol elements. The subscriber-specific filter conditions assign authorized services and performance features to the extension numbers. Up to 256 different subscriber profiles are configurable.

Another essential function of the D-channel filter is the recording of any violation of filter conditions and of all security-relevant events in a report which is stored in a nonvolatile memory. Only the inspector is authorized to view, copy and clear the report data. Access of the administrator/inspector to the filter is protected by a strict authentication using cryptographic algorithms. Any attempt to violate this mechanism is recorded and prevented after a selectable number of unsuccessful attempts. Highly security-relevant events are signalled by an optical and acoustic alarm. Further cryptographic functions guarantee the integrity of programs and filter conditions.

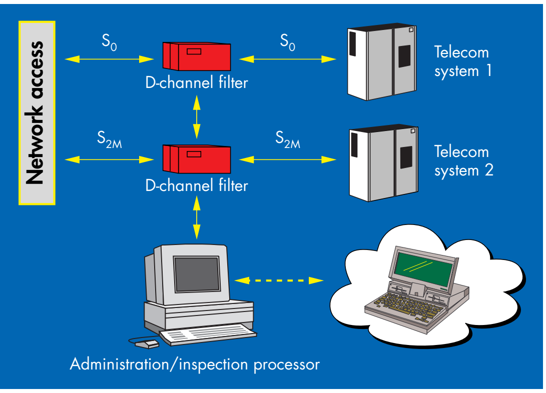


FIG 3 Configuration of individual systems

To protect telecommunication systems against manipulations via PSTN or private networks, the D-channel filter can be connected to any S_0 or S_{2M} interface of a **single** or **networked telecommunication system** (FIGs 3 and 4). Each filter can serve one or three S_0 interfaces simultaneously, for S_{2M} one filter is provided per interface. Thus practically all main applications can be covered.

As the **D-channel filter** is an **external unit,** it can easily be integrated into existing systems. No modifications have to be made to the system when the filter is installed. As a result, the filter can be easily replaced. Since the D-channel filter is completely system-independent, the make of the system is of no importance. The special design of the filter reliably prevents any attempt to manipulate the system electrically from the network via the ISDN system connector. Management of the D-channel filter in general does not require any special knowledge. The D-channel filter is noteworthy for its great flexibility. New filter conditions can be set without any technical modifications being required. This, in conjunction with the protocol functions, allows quick reaction regarding adaptation to new, presently unknown attacks. Thanks to the modular design, the software can effectively be adapted to other ISDN protocols or protocol versions. The cryptographic techniques and algorithms used for authenticating and safeguarding the program integrity can be tailored to customer requirements.

The filter is being developed according to structured development methods in line with the procedures of the Central Office for Information Technology

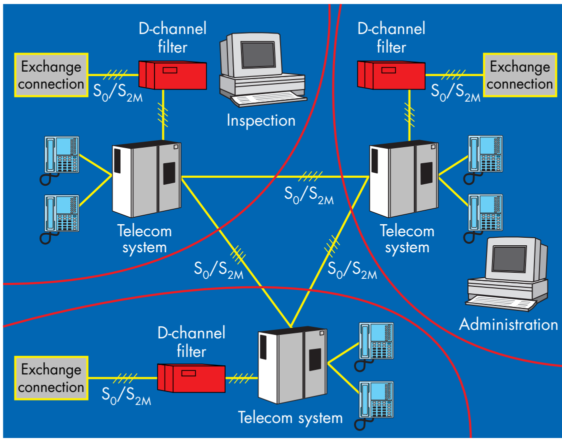


FIG 4 Configuration of networked systems

Coordination in the Federal German Administration. A project-accompanying evaluation by the German BSI sets high quality standards reflected, among other things, by the fact that level E4 of ITSEC criteria has been stipulated for software development. Hardware and software are developed by SIT, the device itself is produced by R&S Messgerätebau Memmingen.

All in all, the D-channel filter provides effective protection against existing and future threats to ISDN telecommunication systems – an **i**ndispensable factor for the **s**ecurity of **d**igital telecommunication systems **n**ow.

Günter Hornauer

Reader service card 156/36

Visit us on Internet under www.rsd.de

ROHDE & SCHWARZ

ROHDE & SCHWARZ GmbH & Co. KG · Mühldorfstraße 15 · D-81671 München
P. O. B. 80 14 69 · D-81614 München · Tel. (+49 89) 41 29-0 · Fax (+49 89) 41 29-21 64

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