News from Rohde & Schwarz

Solid-state transmitter
for terrestrial digital video broadcasting

On-site power calibration
using cost-effective calibration kit

Remote control processor
enhances shortwave communication

1998/I
157

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Number 157 1998/I Volume 38

"Three media – one partner": you'll find the name Rohde & Schwarz, no matter whether digital TV signals are transmitted via cable, satellite or terrestrial equipment. Rohde & Schwarz is the only supplier worldwide to offer the complete range of operations and test equipment for DVB. For more information on DVB see the articles on pages 4 (DVB-T solid-state transmitter), 20 and 22 (DVB measurements).

Articles

Application notes

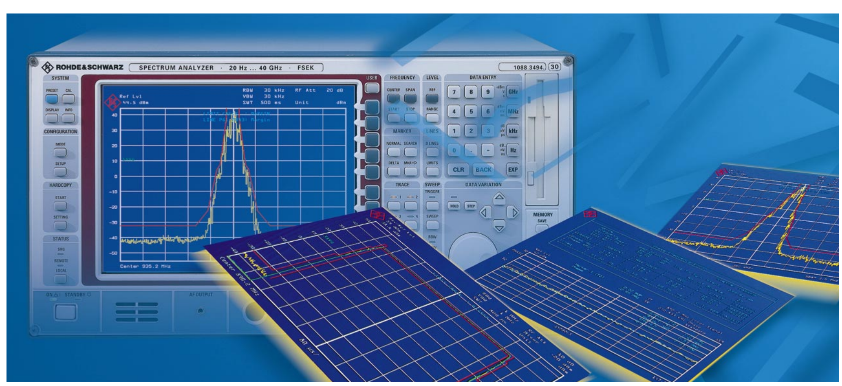
The easy-to-operate emergency call radio from Rohde & Schwarz can be installed anywhere in next to no time. It does not need a telephone line to the emergency call center – and thanks to solar panels – it can do without external power supply. Moreover, it can be integrated in every ACCESSNET® trunked radio system (page 12).

Software

Refresher topic

Panorama

Regular features



Application Firmware FSE-K10 and -K11 together with spectrum analyzers of the FSE family considerably simplifies RF measurements to standard on GSM mobile phones and base stations. The firmware performs all required analyzer settings so that the user can fully concentrate on the results (page 30).

Imprint

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Solid-State DVB-T Transmitters NV500

Terrestrial digital video broadcasting – TV for the discerning

Just in time for introduction of the terrestrial digital TV standard DVB-T, Rohde & Schwarz comes up with the NV500 transmitter family. These solid-state transmitters operate in band IV/V and, thanks to modular design, transmitters with DVB output power of 250 W through 4 kW can be implemented in various standby configurations.

FIG 1 2 kW Solid-State Transmitter NV5200 for terrestrial digital TV Photo 43 059

An international system specification for terrestrial digital TV – DVB-T – was mapped by renowned research institutes, broadcasters and representatives of industry as part of the European DVB project and published in March 1997 under the name ETS 300 744. Rohde & Schwarz played an active role in this work from the very beginning [1]. The NV500 transmitters (FIG 1), deriving from the analog NH500 transmitter family [2], meet the variety of requirements set down for the terrestrial digital TV standard DVB-T. The new DVB series reflects tried and tested Rohde & Schwarz transmitters in design, quality and operating philosophy. **Main features** of the NV500 transmitters are:

- clear modular design,
- high transmitter efficiency,
- plug-ins (amplifiers and power supplies) replaceable during operation,
- optimum signal processing in exciter,
- DVB-T modulator integrated in exciter,
- broadband amplifiers and power combiners from 470 to 860 MHz,
- bipolar high-power transistors,
- low junction temperature of output transistors (<120°C)
- power transistors sourced by several manufacturers,
- extremely high redundancy,
- microprocessorized operation, monitoring and remote control,
- no signal degradation upon failure or removal of amplifiers,
- protection facility in each amplifier and power supply,
- parallel and serial remote-control interface,
- optional bitbus remote-control interface,
- flexible air inlet/outlet configuration.

Design and operation

Interface-attuned **modular design** throughout allows almost any transmitter configuration to suit the site and standby concept. A transmitter for 2 kW DVB output power, for instance, is made up of an exciter rack and an output-stage rack. The exciter rack can hold an exciter for passive standby operation, a transmitter control unit with display, remote-control interface and isolating point. The output-stage rack accommodates power amplifiers with power combiner, absorber, harmonic filter and power supplies. For higher power (eg 4 kW) a further output stage with amplifier plug-ins is simply added on. A monitoring unit fitted in each rack signals operating states to the central control unit.

Amplifiers and power supplies have self-engaging connectors and can be replaced while the transmitter is operating. Releasing the locking lever on the power supply interrupts the supply voltages and thus the RF power of the amplifier to be replaced, allowing it to be removed during operation.

FIG 2 outlines the **principle of operation** of a 2 kW transmitter. The MPEG2 data stream is routed via the input interface of the exciter to the internal DVB-T modulator [3], where the COFDM signal is generated in the baseband, filtered and modulated to IF. An analog COFDM signal at IF with center frequency of approx. 36 MHz and bandwidth of 7.61 MHz appears at the output for further processing. A SAW filter in the IF filter suppresses unwanted spurious of the IF COFDM signal that is then controlled to constant level. After this the signal is equalized in magnitude and phase and converted to RF. The output amplifier in the exciter provides the drive power for the subsequent amplifiers via a power splitter. The RF power of the individual amplifiers (eight VH501 units for 2 kW DVB power) is combined via 0° power combiners in triplate technique. The associated absorbing resistors are

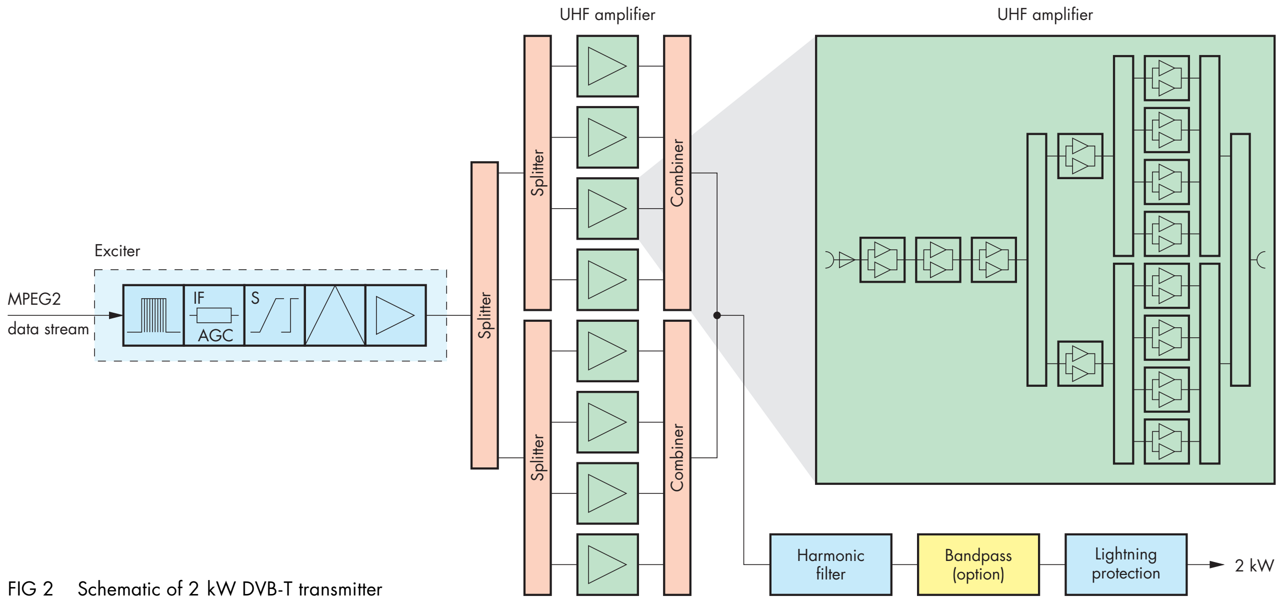

FIG 2 Schematic of 2 kW DVB-T transmitter

mounted on a heatsink in the path of the transmitter cooling air. The sum power is applied via a harmonic filter to an external, six- or eight-circuit bandpass filter (option). A lightning protection facility at the transmitter's output protects it against overvoltages.

Modules

Exciter SD100D with integrated DVB-T modulator (FIG 3) generates a high-quality RF COFDM signal (FIG 4) from the MPEG2 data stream at the LVDS (low-voltage differential signalling) input interface. The signal fully complies with ETS 300 744 standard. An IF input (36 MHz/–10 dBm) is provided on the exciter for connecting an external DVB-T modulator. Comprehensive control and monitoring facilities protect the transmitter and prevent signal emission if the input signal is not to standard or the operating mode is not correct. Nonlinearities in the output stages are also corrected at IF in the exciter.

Another major feature of the exciter is its menu-guided user interface. All parameters can be set by keys and rollkey from the display unit and saved in non-volatile memory. With special operating modes, eg power cutback, or in the case of repair, four different configurations can be stored and recalled by a keystroke or remote control. The setups include operating mode, levels and equalization parameters. The modular design of the exciter ensures high reliability of operation and allows fast and simple replacement of faulty modules. After module replacement all specific settings (also saved in the main processor) are transferred to the new module automatically.

Power Amplifiers VH501 deliver DVB output power of 250 to 315 W (table in blue box), depending on

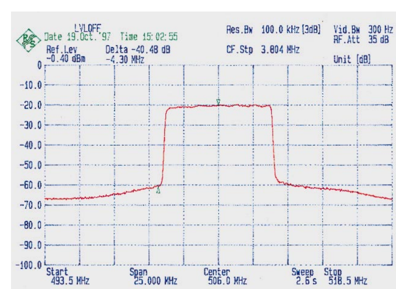

FIG 4 Passband characteristic of DVB-T transmitter for 506 MHz center frequency (without output bandpass filter)

the required shoulder distance. Each amplifier is made up of a predriver with integrated input monitor, level and phase control circuit, plus a class A driver for drivers and output stages operating in class AB. Eight decoupled output modules are combined to obtain nominal power. The power control circuit prevents modules from being driven high if one of them fails, ie all other power modules maintain their level and operating point. This guaran-

FIG 3 Exciter SD100D Photo 43 062/1

Type	NV5025	NV5050	NV5100	NV5200	NV5400
Output power at: shoulder distance −40 dB shoulder distance −35 dB shoulder distance −32 dB	 250 W 285 W 315 W	 490 W 565 W 630 W	 950 W 1080 W 1200 W	 1795 W 2045 W 2275 W	 3340 W 3805 W 4230 W
Amplifiers	1	2	4	8	16
Power supplies	1	1	2	4	8
Air volume	8 m^3/min	15 m^3/min	25 m^3/min	50 m^3/min	100 m^3/min
RF connector	7/16	7/16	$1^5/_8$ EIA	$1^5/_8$ EIA	$3^1/_8$ EIA

Transmitter-specific data

tees stable performance data at the transmitter output.

Two amplifiers are powered from one **power supply** module. To ensure maximum reliability, the power supply unit comprises three identically designed, separately operating, primary-switched regulators for collector current and two DC voltage converters for the base current of RF transistors. The high switching frequency of around 100 kHz allows reduction in the size and weight of the power supply to a minimum while at the same time ensuring high efficiency of approx. 86%. Integrated monitoring circuits protect the power supply against overcurrent, overvoltage and overtemperature. Carefully devised splitting of power among the amplifiers considerably enhances redundancy if a module fails.

Cooling concept and transmitter control

Heatsinks for amplifiers and power supplies, optimized for low pressures, permit low-pressure cooling systems to be used. The **flexible cooling concept** allows adaptation to all site conditions. Blowers and filters of the 250 W and 500 W transmitters are integrated in the transmitter rack, transmitters of all other power classes use external blower and filter units. At transmitter sites with temperatures below freezing point an air mixing chamber is used to prevent icing. The air filter chamber, fitted with coarse and fine filters and differential pressure gauge, is designed for long service intervals.

The **microprocessorized transmitter control unit** is the control center of a transmitter. It provides for a correct switch-on sequence of the cooling system, power supply and transmitter power, and monitors air flow, inlet and outlet temperatures as well as the operating status of amplifiers, power supply units and the entire transmitter. A clearly arranged display permits simultaneous indication of forward and reflected power and of inlet and outlet air temperatures. Any fault occurring in a transmitter is immediately signalled with top priority in the display's status line. Basic settings like power level, RF thresholds and temperature alarm thresholds are set by keys or rollkey and saved in nonvolatile memory. Up to 40 transmitter faults can be stored with time and date of occurrence and displayed as required. An automatic switchover unit is fully integrated for standby configurations with passive exciter, passive transmitter and active dual output stage. The required function is activated by a suitable front-panel control or via software.

All relevant messages and commands are available at the remote-control interface serially (RS-232-C) or in parallel. A bitbus interface (to IEC 864-2) is offered as an option.

Valentin Sarreiter

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Condensed data of Solid-State DVB-T Transmitters NV500

Frequency range	470 to 860 MHz
Output power	250 W to 4 kW
Input	
Data stream	MPEG2 (LVDS interface)
Reference frequency	1, 2, 5, 10 MHz
IF center frequency	35.95 MHz ±200 kHz
Standard	ETS 300 744
Harmonic suppression	>70 dB
AC supply	3 x 230 V/400 V (+10%/–15%), 47 to 63 Hz
Remote-control interface	parallel or serial RS-232-C
RF output	$1^5/_8$ EIA, $3^1/_8$ EIA (depending on power)

Reader service card 157/01

Calibration Kit NRVC

Power calibration up to 18 GHz

With the introduction of ISO9000 standard specifications and the growing number of related accreditations, manufacturers of measuring equipment are required to cope with an increasing volume of calibration. On-site calibration by the manufacturer or the user is often the fastest and most cost-effective solution, especially when using Calibration Kit NRVC from Rohde & Schwarz.

NRVC features high measurement speed for all types of calibration, so only about 15 min are needed to measure a DUT in several positions of its RF connector and for the complete logging of results. Any SWR values measured at a separate test setup can be transferred to the calibration program in the form of an ASCII file. The program checks values for compliance with specifications and includes them in the calibration report.

Calibration Kit NRVC (FIG 1) is used for fast, program-controlled calibration of Rohde & Schwarz NRV-Z and URV5-Z sensors [1; 2]. All Rohde & Schwarz branch offices as well as users of these sensors all over the world are thus able to perform calibration with accuracy to data sheet specifications and comparable to that of factory calibration.

FIG 1 Calibration Kit NRVC with power standard as main component
Photo 43 074/1

Functions

Calibration Kit NRVC comprises three sets: NRVC for absolute calibration, option NRVC-B1 for verification, and option NRVC-B2 for linearity checking. The core of the absolute calibration set is a broadband power standard consisting of a power splitter and thermocouple power sensor. The power standard, operated on Dual-Channel Power Meter NRVD [3], enables exact determination of the measurement accuracy of power and voltage sensors throughout their frequency range and at the relevant reference level. The power range of –10 to +20 dBm (100 μW to 100 mW) can be extended to –30 dBm (1 μW) by means of a high-precision 20 dB attenuator for the calibration of diode power sensors. Depending on the frequency range, test signals are supplied by an RF or microwave source, eg Signal Generator SMP (FIG 2).

Display linearity across a wide power range can be checked by means of option NRVC-B2 of the calibration kit. Linearity checks, not commonly performed in the classic calibration of power sensors, prove very useful for modern sensors with their numerically linearized characteristics. A highly linear insertion unit is used as a linearity reference, and test signals are supplied by Power Signal Generator SMGL at a frequency of 50 MHz.

Measurement accuracy and traceability

All important components of the calibration kit, ie power standard, 20 dB attenuator and linearity standard, carry the label of the German Calibration Service (DKD), which certifies traceability to national standards. The

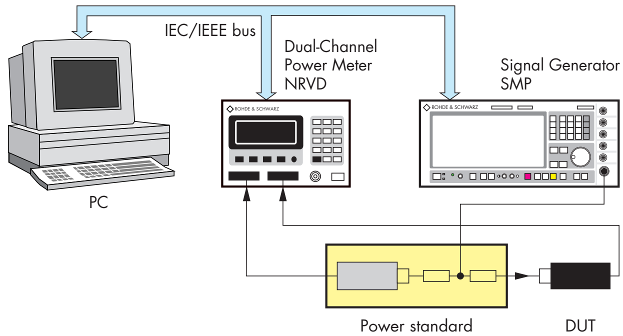

FIG 2
Test setup for calibration of Thermocouple Power Sensor NRV-Z51

power standard is measured at more than 50 frequencies for enhanced accuracy; from 100 MHz a transfer standard is used that can be traced directly to the corresponding primary standard of the German Standards Laboratory (PTB) in Braunschweig. This together with mismatch correction reduces measurement uncertainty to nearly that of the transfer standard.

The user can check the accuracy of his calibration kit any time before recalibration in two ways. The power standard and reference attenuator can be tested by applying DC voltage, which already affords a high degree of reliability. Or NRVC can be checked across the whole frequency range by means of Verification Set NRVC-B1. This set contains a thermocouple power sensor and a diode sensor calibrated at Rohde & Schwarz on the associated Calibration Kit NRVC, the results of calibration being stored in the correction data memories of the sensors. The user can thus easily determine any differences between NRVC and the verification set. Calibration Kit NRVC and its options are recalibrated at Rohde & Schwarz at yearly intervals.

Operation

Operation of the test setup is largely menu-controlled by the "Recal" calibration program, running under Microsoft Windows 3.1 or Windows 95. An IEC/IEEE-bus interface is all that is needed for communication with Power Meter NRVD and the signal generators. The program supports various types of signal generator and up to two NRVDs, one of which may take up the power and linearity standards and the other the DUT. This configuration is useful when switchover is made between absolute calibration and linearity measurements.

Although the program is largely self-explanatory, a context-sensitive help file is provided to explain all steps of sensor calibration, making it extremely easy to familiarize with NRVC. The program further supports configuration and modification of test setups.

Sensor calibration with a few mouse clicks

Calibration basically comprises **four steps:**

- reading of current correction data from sensor memory as a basis for recalculating the data set,
- checking of sensor against a power or linearity standard with the components of the calibration kit (up to 18 GHz) or of another calibration system (eg for sensors above 18 GHz); in the latter case a test file (ASCII) that can be read by the program must be generated,
- recalculation of correction data from measured data,
- programming of sensor EPROM with the new data.

Each of the above steps requires just a few mouse clicks. The program allows execution of a step only if the previous step has been properly performed. The sensor calibration data, eg the levels and frequencies at which absolute accuracy is measured (FIG 3), as well as instrument settings are stored in two separate configuration files for the sensor and the associated instrument.

For **documentation** an "Incoming Inspection Test Report" or a "Calibration Report" can be generated at a keystroke and output on a printer. The reports conform to ISO9000 requirements.

The calibration kit comes with all components required for connection to a signal source and Dual-Channel Power Meter NRVD. This includes a low-loss microwave connecting cable, a precision termination for insertion units, a harmonic filter and a power splitter for linearity measurements, various adapters, accessories for DC voltage measurements and the complete software. The calibration kit is supplied in three sturdy boxes at an

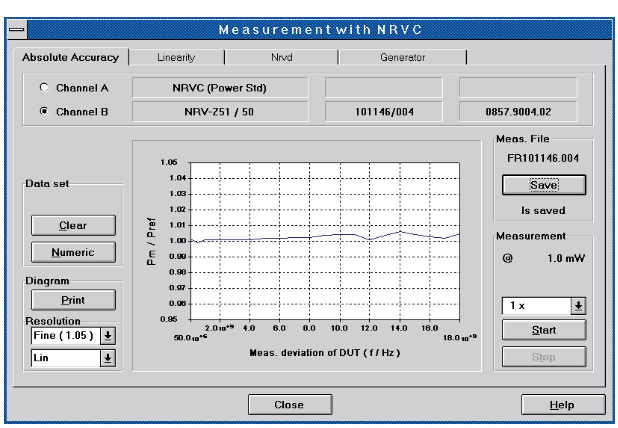

FIG 3
Interactive mask for automatic absolute accuracy measurement

attractive price, making it a worthwhile investment for many calibration centers and industrial users.

Dieter Köhler; Thomas Reichel

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Condensed data of Calibration Kit NRVC

Supported sensors (required signal source)	NRV-Z1, -Z2, -Z51 (SMP02/03/04, SWM) NRV-Z4, -Z5, URV5-Z2, -Z4 (SME06, SMT06) NRV-Z53, -Z54 (SMP22)
Absolute accuracy measurement range	−30 to +20 dBm / DC to 18 GHz, depending on signal source
Expanded calibration uncertainty (k = 2)	0.02 to 0.2 dB, depending on frequency and sensor
Linearity measurement range (NRVC-B2)	−30 to +33 dBm / 50 MHz with SMGL
Expanded calibration uncertainty (k = 2)	0.02 to 0.03 dB

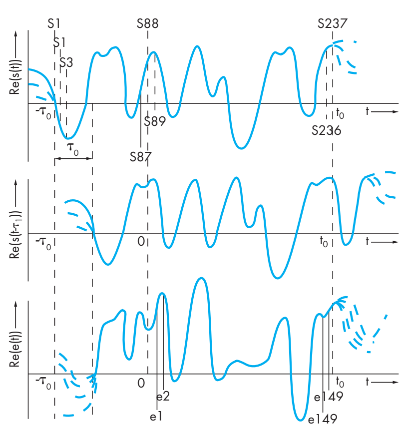
Reader service card 157/02

Method for determining complex impulse response of radio channel

In networks where radio signals are transmitted to a receiver by one or more transmitters, multipath propagation causes interference that can be expressed in the complex impulse response of the radio channel. Interference from multipath propagation in digital mobile networks is perceived as intersymbol interference. If the impulse response is longer than the duration of the bits transmitted in the radio channel, parts of the received signal of a symbol are disturbed by parts of symbols sent before. To measure the complex impulse response, a test signal from a generator is normally applied to the radio channel and the impulse response of the channel is determined from the receiver input signal by correlation with the transmitted test signal. A special signal generator and an unused radio channel are required for this well-known method. So the aim of the invention is to present a simpler method that, in particular, does away with the extra signal generator.

Patent claims:

1. The method for determining the complex impulse response of a radio channel, particularly of a digital mobile network, utilizes the fact that sampling values (S1 to S237) are obtained at the transmitter from specified data of a selected section ($-\tau_0$ to t_0) of the useful signal transmitted in the radio channel or by sampling this signal section, that several time-shifted signal sections (S88 to S237, S87 to S236, … S1 to S150) forming the



columns of a matrix S are derived from this, that the signal vector e is determined at the receiver from sampling values (e1 to e150) obtained by sampling a signal section that corresponds to the signal section selected at the transmitter (0 to t_0), and that vector h of the impulse response to be determined is calculated by the linear representation of vector e according to the following expression: $h = (S^{*T} \cdot S)^{-1} \cdot S^{*T} \cdot e$, where S^{*T} is the transposed complex matrix to matrix S.

2. The method according to claim 1 utilizes the fact that a correction factor α with a diagonally dominant matrix E, particularly a unit matrix, is included in the calculation according to the expression:

$h = (S^{*T} \cdot S + \alpha E)^{-1} \cdot S^{*T} \cdot e$

3. The method according to claims 1 and 2 utilizes the fact that the training sequence signal section of the mobile radio network is used for determining the impulse response of a digital mobile network radio channel.

Extract from patent specification EP 0 539 750 B1

Patent applied for by Rohde & Schwarz on 01 Oct 1992

Issue of patent published on 27 Nov 1996

Inventors: Otmar Wanierke; Peter Riedel; Martin Stumpf

Used in Digital Radio Analyzer PCSD

Reader service card 157/03 for further information on PCSD

Remote Control Processor GP2000

The wild card in shortwave communication

Remote Control Processor GP2000 is the latest member in the XK2000 family of shortwave transceivers. This is a highly versatile unit for use in complex split-site applications, as a favourably priced upgrade of the HF850 transceiver family, as well as for adaptation of transceivers, transmitters and receivers of another make to the Rohde & Schwarz XK2000 standard.

FIG 1 Remote Control Processor GP2000 makes it possible: shortwave communication with remote Tx and Rx components Photo 43 075

Split site

High transmitting power or the use of several transmitting antennas in shortwave communications (1.5 to 30 MHz) frequently requires that transmitters and receivers be located at separate sites. Ideally, transmitters and receivers are spaced several kilometers from each other. In most cases it is sufficient to install only the transmitters at a separate site, leaving the receivers at the central station – the converse arrangement is comparatively rare. The more seldom split-site application with remote receivers has been implemented without any problems. But what has not been solved satisfactorily is a configuration with the transmitting site or both the transmitting and receiving sites away from the central station. This is now possible with Remote Control Processor GP2000 (FIG 1). The processor allows remote control of transmitters and receivers from any location (FIG 2) whilst fully retaining the functions of HF Transceivers XK2000 [1; 2].

At the receiving end, VLF-HF Receiver EK895 [3] or Receiver/Exciter GX2900 [2] is generally used, and at the transmitting end shortwave transceivers of the XK2000 and HF850 families. Besides Rohde & Schwarz equipment, non-R&S transceivers, transmitters and receivers can be integrated for the first time. Communication networks based on Rohde & Schwarz equipment can now be extended by existing shortwave stations from other manufacturers.

HF850 upgrade

Remote Control Processor GP2000 is the ideal solution for upgrading the older HF850 shortwave transceiver family [4] to match the current and future XK2000 standard. Fitted with XK2000 options as required in each case, GP2000 is connected to HF850 transceivers and controls them. This allows realization of the latest procedures, protocols and applications with such HF850 transceivers. The following **XK2000 features** are available for an upgrade:

- automatic link establishment (ALE) in line with FED-STD 1045/46/49 and the Rohde & Schwarz ALIS procedure [5],
- fast data transmission with HF Modem GM2100 offering waveforms to MIL-STD-188-110 A, STANAG 4285 and a Rohde & Schwarz-specific waveform [6],
- HF voice link to telephone network with automatic phone patch [1],
- improvement of voice quality in shortwave communications with voice processing unit [1].

ARINC and non-R&S equipment

Processor GP2000 can be fitted optionally with a special ARINC interface (Aeronautical Radio, Incorporated) for controlling aeronautical HF transceivers equipped with interfaces to ARINC-429. Both Rohde & Schwarz Transceivers XK516 and suitable transceivers of another make can be controlled. If there are deviations from ARINC standard or the customer wishes control facilities beyond those of the standard, the software must be modified in line with customer's requirements.

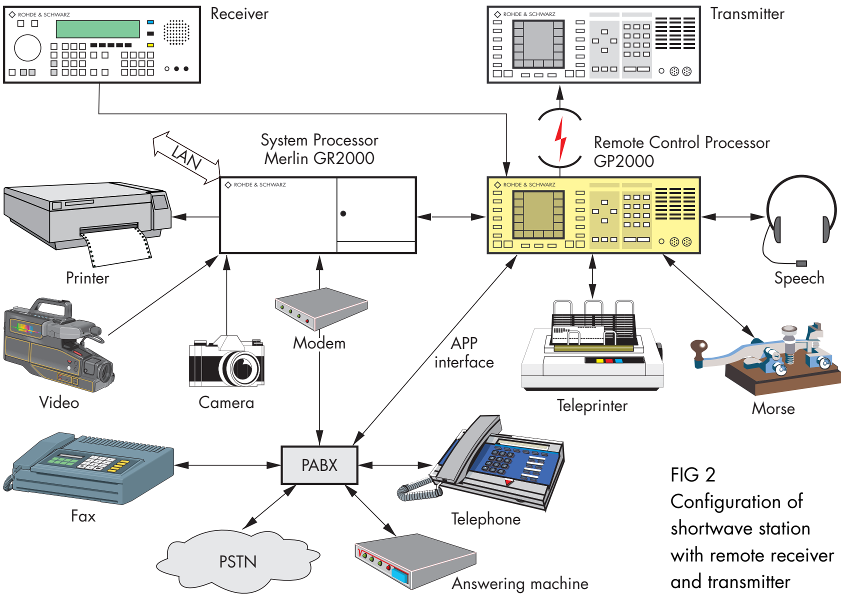


FIG 2
Configuration of shortwave station with remote receiver and transmitter

Customized software modification is required also if GP2000, using XK2000 functionality, is to control transceivers, transmitters or receivers of another make instead of Rohde & Schwarz equipment. The extent of modification depends on the particular application.

Operation

The following **operating modes** can be realized with GP2000 providing there are no constraints imposed by the remote link or remote equipment:

- Morse,
- teletype,
- speech,
- data,
- telephone,
- independent sideband,
- link 11,
- automatic mode.

Rohde & Schwarz offers a range of computer-based **software products,** eg Message-Handling Software PostMan [7], for setting up nationwide or worldwide communication networks with integrated shortwave. The software packages – designed for use with XK2000 transceivers – provide full functionality also with Remote Control Processor GP2000, which allows the so far unparalleled features of the software products to be utilized to the full also with HF850 transceivers and even with transceivers of another make.

In split-site applications, interface signals often have to be taken to external equipment across large distances by **remote transmission.** This is most frequently implemented by cable links (up to 1 km), modems and lines (up to 100 km) or microwave links (up to 50 km). Transmission links must of course meet common standards with respect to signal delay and fail-safe characteristics.

Featuring excellent characteristics, Remote Control Processor GP2000 rounds off the range of products and applications offered by the XK2000 transceiver family. The facility of adapting non-R&S equipment to the XK2000 standard puts GP2000 in a key position, opening up a wide field of applications for the future-oriented software products from Rohde & Schwarz.

Thomas Kneidel

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Condensed data of Remote Control Processor GP2000

Frequency range	
Transmission	1.5 to 30 MHz
Reception	10 kHz to 30 MHz
Classes of emission (depending on equipment connected)	A1A (CW), J3E (SSB), H3E (AME), J7B (A7J, radio data), F1B (FSK/AFSK), B8E (ISB), F3E (FM)
Interfaces	
Serial	RS-232-C, RS-485/RS-422 (bus-compatible)
Tx/Rx control	V.10, asynchronous, 300 to 38 400 baud
ARINC (optional)	to ARINC-429 (command and answer)

Reader service card 157/04

Emergency Call Radio System ECRS

Help is just a call away – anytime, anywhere

More and more road traffic unfortunately means more accidents. Accidents of every kind, whether during work or leisure time, cause injuries and losses to the economy. And increases in crime are also posing a considerable threat to people, property and capital. As a consequence, immediate help in emergency situations is a must. Rohde & Schwarz Emergency Call Radio System ECRS, based on trunked radio technology, greatly improves the effectiveness and life-saving deployment of relief and rescue organizations.

The solar-powered Emergency Call Radios ECR from Rohde & Schwarz can be installed practically anywhere. In case of emergency or danger – be it a car breakdown, accident, fire or assault – this wireless system involving minimum financial outlay is ideal for getting the right help fast (FIG 1). The easy-to-operate ECR allows anybody in need to inform an emergency call center about precisely what has happened and so ensures speedy, coordinated and optimized deployment of mobile and stationary relief and rescue services. ECRs can be monitored from local, regional or central stations and are cyclically checked for proper functioning by control calls. When a call arrives, the location of the ECR from which it is made is shown on a monitor in the emergency call center.

FIG 1 Free-call ECR whenever help is needed fast

Emergency Call Radio System ECRS

ECRS can be integrated in all Trunked Radio Systems ACCESSNET® from Rohde & Schwarz [1 to 3]. Up to 10 000 emergency call radios can be operated in a single system. In addition, ACCESSNET® enables all the different relief and rescue organizations (police, ambulance, fire department, coast guard, technical emergency relief service, civil defence, disaster control, etc) to communicate with one another from vehicle or hand-held radios during a mission.

ECRS (FIG 2) consists of the following **components:**

- ECRs,
- emergency call center,
- Trunked Radio System ACCESSNET® (possibly already implemented).

An **ECR** is a stationary, stand-alone radio unit within Trunked Radio System ACCESSNET®. It can be installed easily and quickly at any **location** such as:

- expressways, country roads, urban roads,
- car parks and rest areas,
- tunnels, bridges, underpasses,
- airports, harbours, industrial plants,
- national and other parks, recreational areas,
- beaches (sea, lake),
- river and canal promenades,
- footpaths and hiking trails, biker trails,
- pedestrian areas,
- ski slopes, cross-country ski trails, fitness trails, golf courses.

The readily transportable ECR can also be installed anywhere for a limited period, eg during exhibitions or sporting events.

The emergency call radio basically comprises a pole, concrete base, voice box, radio and solar-power box as well as an SOS sign. The front of the sturdy voice box is equipped with a loudspeaker and microphone as well as a call button, with a symbolic guide explaining their use. A plate indicating ECR number, longitude and latitude and possibly other information clearly identifies the location. The duplex radio set with its solar power supply and maintenance-free battery is accommodated in the radio and solar-power box. A solar panel generates sufficient electric power for stand-alone operation of an ECR in all weathers.

The free call to the emergency call center is established by pressing the call button on the voice box. An acoustic signal confirming transmission is output at the moment the button is pressed. The emergency call center immediately answers the call, and the location of the caller is shown on a screen in the center. The caller can exchange information with the center without having to work any other buttons or keys.

Depending on the organization concerned, an **emergency call center** will comprise one or more operator positions with screens to display ECR locations and operational status (FIG 3). Several local stations can be grouped to form a regional center. A dispatcher receives emergency calls via ACCESSNET® and initiates the necessary steps. Direct communication with other relief and rescue services is possible via radio or wired links, and incoming calls can automatically be routed to another station.

As regards types of call and data transmission, the familiar performance features of **trunked radio** can be utilized to the full. It is also possible to record and evaluate the calls. The origin of an emergency call appears as a red symbol on a digitized map on the dispatcher's screen. The emergency call radios are cyclically called from the dispatcher workstation and checked for operational and technical availability.

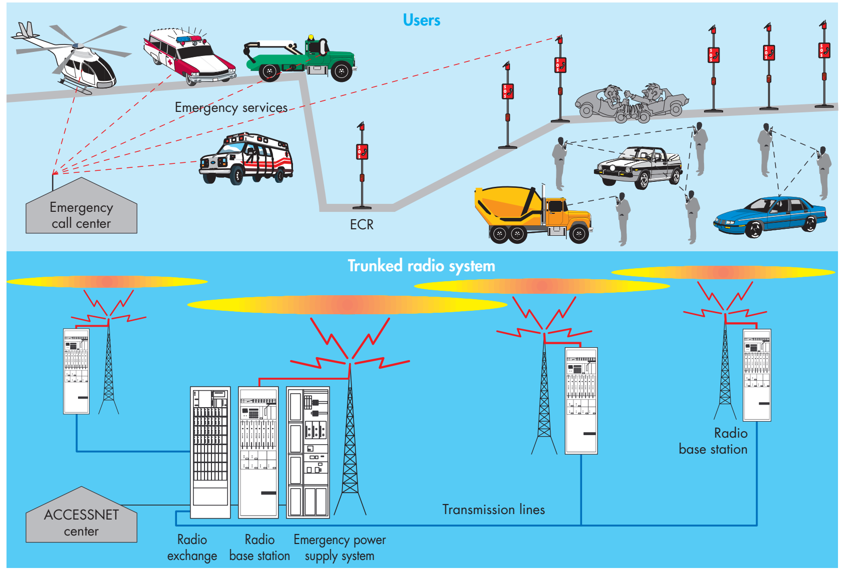

FIG 2 Emergency Call Radio System ECRS set up on ACCESSNET® basis

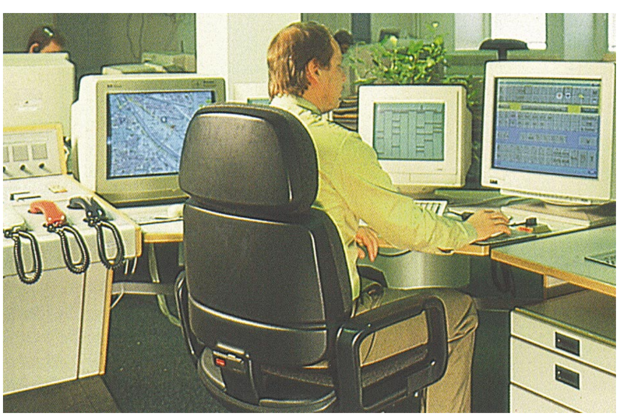

FIG 3 Dispatcher workstation in control center Photos: author

Installation

Installation of an ECR simply consists of attaching the radio and solar-power box and voice box to the pole and erecting it. The duplex radio set in the radio and solar-power box is programmed and assigned a call number with exact location data. Then the ECR is registered and validated by the operation & maintenance computer (OMC) of the trunked radio system. The dispatcher workstation is accommodated in the emergency call center. After software installation, the ECRs with their call numbers are displayed on the screen map positioned according to location. That is all there is to making the ACCESSNET®-based Emergency Call Radio System ECRS an autonomous but integral part of an efficient security network.

Karl-Heinz Wagner

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

[3] Schneider, A.: ACCESSNET® – a solution for communications in Russia. News from Rohde & Schwarz (1996) No. 152, pp 49–50

Condensed data of Emergency Call Radio ECR

Frequency range of duplex radio	410 to 430 MHz, 450 to 470 MHz (others on request)
Signalling	MPT 1327/1343
Antenna gain	3 dB
Solar-panel power	22 W ± 10%
Pole height (without antenna)	approx. 4 m
SOS sign	different sizes, colours, models available

Reader service card 157/05

Spectrum Analyzer U3641N

The big little helper for CATV measurements

Spectrum Analyzer U3641N with CATV program card is the ideal tool for mobile RF measurements on CATV systems. It performs per software specific measurements to international TV standards at a keystroke. For viewing the TV picture it is equipped with a demodulator for PAL, NTSC and SECAM. U3641N is a product from the Japanese manufacturer Advantest, whose electronic and optoelectronic equipment is marketed by Rohde & Schwarz as part of a strategic alliance.

FIG 1 Spectrum Analyzer U3641N for CATV applications is ideal for on-site testing
Photo 42 774

For the best possible picture and sound quality in their broadband communication networks, operators have to check a variety of parameters during the installation and commissioning of equipment, regular maintenance and troubleshooting. Reliability is obviously a top priority because nobody wants to be left with a blank screen. **Spectrum Analyzer U3641N from Advantest** with its CATV test software, specially designed for these tasks, features comprehensive evaluation functions and proves that attributes like small size, portability and high performance do not necessarily exclude each other. This lightweight weighs in at around 8 kg, including power supply. It may draw its power from an optional battery or a vehicle's electric supply.

The analyzer operates in the frequency range 9 kHz to 3 GHz with resolution filters from 1 kHz to 5 MHz (100 Hz option or higher). Its tiltable TFT colour display and softkeys make it particularly easy to operate. One of the analyzer's "innate" values is its extremely low noise floor of a mere –26 dBµV with the internal preamplifier switched on (FIG 2). A built-in 2.2 GHz tracking generator (optional) enables scalar network analysis for transmission measurements on cable system components. Further features are a frequency counter, 50 µs sweep with zero span for examining triggered TV lines, AM/FM demodulator with loudspeaker, 5 W RF overload protection as well as a gated sweep function for detecting and examining video signals in the time domain.

Major features for broadband communication applications are:
- frequency coverage of all TV channels,
- 75 Ω impedance input,
- internal preamplifier, in particular for carrier/noise measurements,
- precision frequency reference,
- fast sweep up to 5 µs/div,
- line selection by means of H trigger,
- noise measurements in dBm/Hz and dBµV/$\sqrt{Hz}$, can be normalized to system bandwidth,
- TV colour monitor,
- AM/FM demodulator with loudspeaker,
- comparator with limit values in the frequency and time domains.

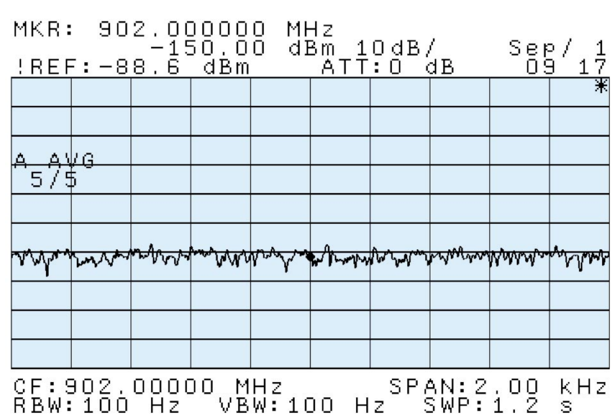

FIG 2 Average noise floor of spectrum analyzer with preamplifier and 100 Hz filter

For viewing the TV screen picture the spectrum analyzer contains a demodulator for PAL, SECAM and NTSC; internal VHF, UHF and CATV channel tables complying with worldwide standards and substandards are available for individual countries. Sequence control provided from the internal controller and PCMCIA memory card enables single-shot measurements – also during operation and with a modulated carrier – as well as complete measurement sequences documented in a printout, and all available at a keystroke. Measurements may be conducted anywhere in a CATV system, from the headend through system components – modulator, combiner, repeater – to the domestic TV socket. As far as possible measurements are performed without interrupting or affecting the running program. The analyzer's hardware and software are highly flexible and can be adapted to new requirements at any time.

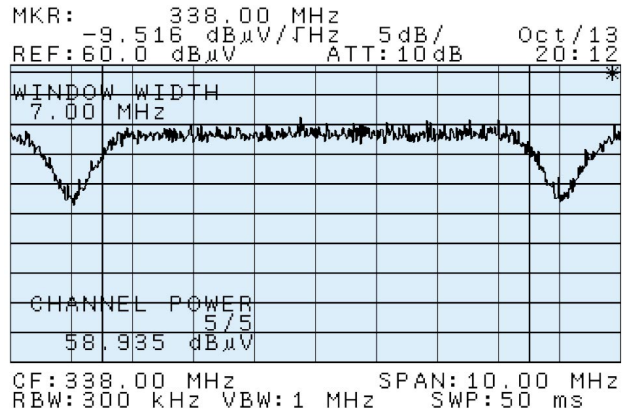

FIG 4 Spectrum of digital TV channel with average-power calculation

```
CHANNEL VHF.CHN
----------------------
E2     48.25
E3     55.25 *
E4     62.25
E5    175.25 *   CNRDMB
E6    182.25
E7    189.25
E8    196.25 *A CNRDMB
E9    203.25 *A     D
E10   210.25
E11   217.25
----------------------
```

```
CARRIER
CHANNEL   CH49
----------------------
VC         63.2 dBuV
    695.49495 MHz   FAIL

SC1       -13.7 dBc
      5.50068 MHz

SC2       -20.6 dBc
      5.74072 MHz
----------------------
FAIL
```

FIG 3 Examples of screen mask with use of CATV program card: top VHF channel table, bottom vision and sound carrier frequency and level

The software provides the following **functions and tests** at a keystroke:

- autoscan of all channels,
- vision and sound carrier frequency and level in analog channels (FIG 3),
- average power in digital channels (FIG 4),
- carrier/noise ratio,
- channel and system frequency response,
- hum,
- video signal display with TV line trigger,
- vision and sound demodulation,
- crossmodulation,
- intermodulation measurements (CSO and CTB),
- D/U ratio (desired/undesired) in digital channels.

A particularly critical parameter is the carrier/noise ratio of a modulated vision carrier, because all channels of a network are usually occupied. If no free channel is available, measurement is triggered on an unoccupied test line (quiet line) of the video signal and noise is measured using the gated sweep function. The result is converted to system bandwidth (eg 7 MHz for European TV standard B) and set in relation to carrier power.

The software also allows onscreen variation of all test parameters and editing of limit values for all test parameters with an optical pass/fail indication. The program may be interrupted for manual spectrum analyzer operation or TV picture viewing. The sweep frequencies for channels and parameters can be selected freely and single-shot or repetitive measurements may be conducted. Results can be stored on PCMCIA cards and of course may be documented as printout.

Joachim Heinze

Condensed data of Spectrum Analyzer U3641N

Frequency range	9 kHz to 3 GHz
Resolution bandwidths	1 kHz to 5 MHz; option from 100/300 Hz
Spectral purity	−100 dBc/Hz (10 kHz offset)
Noise display	−22 to +134 dBµV
Sweep time	50 ms to 1000 s, 50 µs at 0 Hz
Monitor	15.2 cm TFT colour display
Power supply	100 to 240 V (AC), 12 V (DC), battery for 1.5 h operation
Weight	<8.5 kg with power supply or battery
Options	tracking generator, TV demodulator, basic controller, FM deviation meter

Reader service card 157/16

Signal Generator SMIQ + Options SMIQB10/B11/B14

TDMA signals at the push of a button

Highly complex test signals and high operating convenience are both expected of a signal generator in mobile radio measurements. A few pushes of a button and SMIQ will generate test signals for all major TDMA mobile networks. It simulates uplink and downlink signals for NADC, PDC, PHS and GSM standards.

FIG 1 Vector Signal Generator SMIQ supplying any digitally modulated test signals for TDMA equipment and modules Photo 42 803

Signal Generator SMIQ (FIG 1) is at home in the CDMA and TDMA world [1; 2]. For measurements in TDMA mobile networks, the frame structure and data structure within the time slots are predefined in the SMIQ output signal for all main standards. The user need not bother about the data fields defined by the standard either; these are inserted automatically. All he has to do is switch on the desired time slot and select a data source. Data from the selected source are inserted into the time slot of each frame continuously in realtime. PRBS data or a data list can be selected as an **internal data source.** Data lists contain user-programmable data sequences, which are stored in SMIQ memory with up to 20 Mbits. Alternatively, **data may be applied externally** via an asynchronous serial interface (RS-232-C). Being available on every PC, this interface is very convenient. Externally applied data too are continuously inserted into the time slot from frame to frame. Signals for the envelope control required for TDMA signals are generated automatically and synchronously with the data.

All this is possible thanks to a digital signal processor (DSP) on the optional **Data Generator SMIQB11.** The DSP calculates all signals in realtime. This offers considerable advantages compared to a solution with stored data sequences. Here less memory capacity is required and long non-periodic sequences can be generated. The complex modulation is generated by **Modulation Coder SMIQB10,** also available as an option.

SMIQ offers various **trigger and operating modes** permitting measurements to be synchronized to the DUT. For instance, signal generation in SMIQ can be started with an external trigger signal immediately or with adjustable delay. Conversely, SMIQ outputs a frame clock and a multiframe clock. The bit clock and symbol clock are also available as input and output signals. Modulation parameters like symbol rate or filtering can be varied. The same applies to form and duration of the power template when TDMA time slots are switched on and off. These functions will be appreciated by design engineers as they allow the response of DUTs to be tested at range limits. In addition to the full level of the transmitted signal, a lower level can be set simultaneously for selected time slots in the TDMA frame. This function may be used to analyze impairments of transmission quality, caused by neighbouring time slots with strong signals for instance.

NADC (IS-54, IS-136) and PDC (RCR STD 27)

FIG 2 shows the main menu for operation of NADC (North American Digital Cellular). The active time slots can be

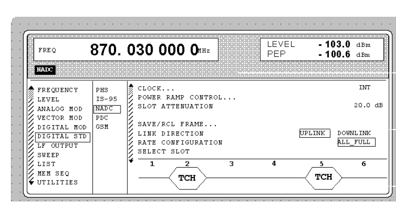

FIG 2 Operating menu of SMIQ for NADC standard

seen at a glance on the SMIQ graphics display. The TDMA structure for PDC (Personal Digital Cellular) looks the same. In both cases the six time slots of the frame can be combined to full-rate or half-rate channels as required. The data source for DATA and SACCH data fields are user-selectable. Other data fields, eg that for the sync word, are defined by the standard but can be modified. A special feature of SMIQ for PDC is that TDMA superframes can also be generated. In this case the so-called housekeeping channel (RCH) is sent in two of 18 frames instead of the SACCH. The most important feature

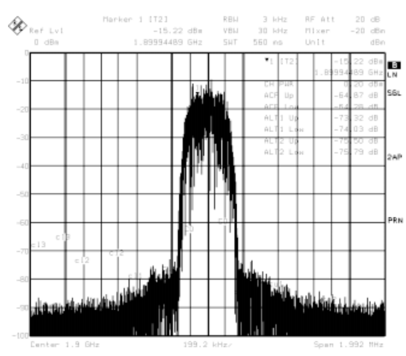

FIG 3 Output spectrum of PHS test signal with continuous modulation

however is the excellent signal quality, reflected in a typical vector error of only 0.5%. SMIQ is particularly suitable for use as an interfering transmitter operating in the adjacent channel. In the case of continuous modulation, the RFI power in the adjacent channels is more than 70 dB below the carrier power. This applies to NADC at a frequency offset of 60 and 90 kHz and to PDC at 50 and 100 kHz from the carrier.

PHS (RCR STD 28)

The TDMA structure of PHS (Personal Handy Phone System) is slightly different from the others as communication between the cell station and the personal station is performed in time duplex mode. The requirements placed on a signal generator are basically the same however. PHS equipment too operates in a frequency band containing many channels, so the effect of adjacent-channel interferers on reception quality has to be tested. SMIQ offers an excellent output spectrum (FIG 3) for this measurement. The structures of the control physical slot and those of the communication physical slot are supported. Communication channels may be configured as full-rate or half-rate.

GSM (GSM900/1800/1900)

The requirements of GSM (Global System for Mobile Communications) are also very tough on a signal generator. In addition to good modulation quality, high suppression of disabled time slots (>70 dB) is required. The switch-on/off power/time template specified by GSM has to be met and spurious emissions to adjacent channels must be particularly low. Regarding this catalog of requirements SMIQ shows its "inherent values" in a highly impressive way. The effective phase error within a burst is below 0.5° (FIG 4). Disabled time slots are suppressed by more than 80 dB and spurious emissions to adjacent channels caused by GMSK modulation are well below the stringent limits applicable to base-station transmitters. Normal and dummy bursts are supported.

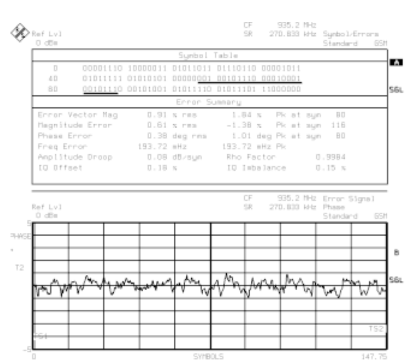

FIG 4 Phase error trajectory within GSM burst

Use for BER measurements

FIG 5 illustrates a possible test setup for measuring bit error rate on digital receivers. The test signal generated by SMIQ is a traffic channel with defined pseudo-random data sequence for instance. The DUT operates in a test mode where the received signal is continuously demodulated. Demodulated

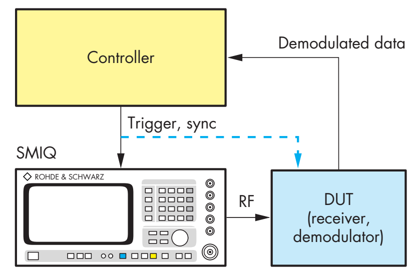

FIG 5 Test setup for BER measurements on digital receivers

data are evaluated by a controller. The BER can be determined immediately because the sent data sequence is already known. A particularly simple test setup is implemented when the microprocessor contained in each mobile or base station is used as a controller. In addition to convenient operation, SMIQ offers two important features that are required for the measurement – high level accuracy and very low vector error of less than 1% for all standards mentioned in this article. **Fading Simulator SMIQB14** is particularly useful for BER measurements. This option turns SMIQ into a radio-channel simulator, and the price advantage over a conventional radio-channel simulator is considerable.

DECT, TETRA and other TDMA standards

Thanks to digital standard menus for all mentioned mobile networks, SMIQ features high operating convenience. A menu for DECT (Digital Enhanced Cordless Telecommunications) will be available shortly. New standards can easily be implemented in existing instruments by a firmware upgrade. Digitally modulated signals for radio networks not available in standard menus can be defined with the aid of a universal menu providing a great variety of modulation types, filters and data sources. To simplify operation, the modulation parameters of many radio networks are preprogrammed. Besides NADC, PDC, PHS, GSM and DECT this also applies to TETRA, APCO25, PWT (WCPE) and IRIDIUM.

Klaus-Dieter Tiepermann

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[2] Tiepermann, K.-D.: Signal Generator SMIQ + SMIQ-B42 – Multichannel signal source for CDMA. News from Rohde & Schwarz (1997) No. 156, pp 13–15

Condensed data of Signal Generator SMIQ03 for TDMA measurements

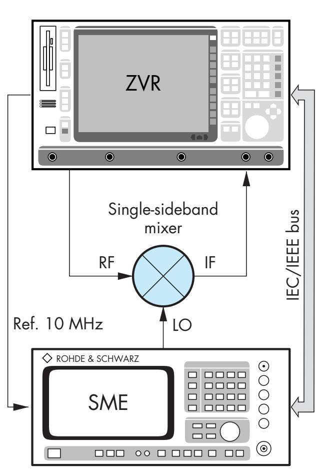
Frequency range	300 kHz to 3300 MHz
GSM	
RMS phase error	<1°, typ. 0.5°
Power density spectrum	typ. –34 dB (200 kHz), –70 dB (400 kHz), –78 dB (600 kHz)
NADC (IS-54/IS-136)	
RMS vector error	<1.2%, typ. 0.4%
Adjacent-channel power	typ. –35 dBc (offset 30 kHz), –75 dBc (60 kHz), –78 dBc (90 kHz)
PDC (RCR STD 27)	
RMS vector error	<1.2%, typ. 0.4%
Adjacent-channel power	typ. –74 dBc (offset 50 kHz), –78 dBc (100 kHz)
PHS (RCR STD 28)	
RMS vector error	<1.2%, typ. 0.4%
Adjacent-channel power	typ. –74 dBc (offset 600 kHz), –76 dBc (900 kHz)

Reader service card 157/06

Test hint

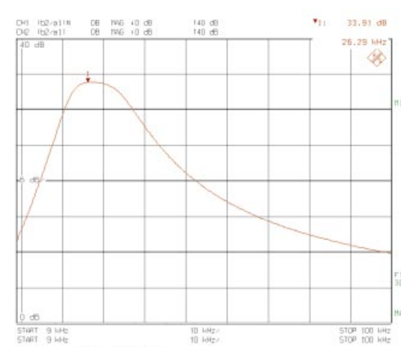
Measuring image rejection of single-sideband mixers

SSB mixers are used whenever the wanted signal occupies only one of the RF sidebands in frequency-conversion applications and interfering signals in the other band are to be suppressed. A mixer of this kind can be implemented by connecting a band filter ahead of the RF port of a conventional double-sideband mixer or by combining the two IF ports of an I/Q mixer via a 90° hybrid. A typical



application is in broadcasting with SSB modulation, which requires only half the bandwidth of DSB modulation. The image rejection of an SSB mixer is defined as the ratio of the conversion gains of wanted and interfering sideband. This ratio can be measured easily using a **Vector Network Analyzer of the ZVR family with option ZVR-B4** (Mixer Measurements). In the setup shown ZVR generates the RF and receives the IF. The LO frequency comes from an external signal generator (eg SME) that is controlled by ZVR and also receives its reference signal from it.

Two decoupled display channels are required, which are configured via the MODE: FREQUENCY CONVERS: DEF MIXER MEAS menu for frequency-converting measurements with IF sweep (softkey IF = FUND FREQ) and fixed LO (softkey FIXED LO). Using the help graphics displayed in the DEF MIXER MEAS menu, select the RF in the wanted sideband for channel 1 and that in the interfering sideband for channel 2 (softkey SEL BAND + or –). In all other respects the settings of the two channels are identical, the measured quantity is CONV GAIN b2/PWRa1. Finally, set the ratio of the two display channels DATA CH1/DATA CH2 as a trace in channel 1 using TRACE: DEFINE MATH,



and activate it with the softkeys MATH USER DEF and SHOW MATH. The trace above represents the image rejection of an SSB mixer designed for an IF around 25 kHz. Alternatively, if the external generator is controlled via the IEC/IEEE bus, as in the test setup shown, the LO can be swept at a constant IF.

Dr Jochen Simon

Reader service card 157/07 for further information on ZVR

Measuring EMC on mobile phones

With increasing demand for digital telecommunications, especially in the private sector, EMC requirements placed on terminal equipment (mobile phones and base stations) are gaining more and more importance. Rohde & Schwarz offers test systems for measuring the electromagnetic compatibility of mobile radio equipment of this type in line with most of the current European standards (GSM, DCS, DECT, NMP).

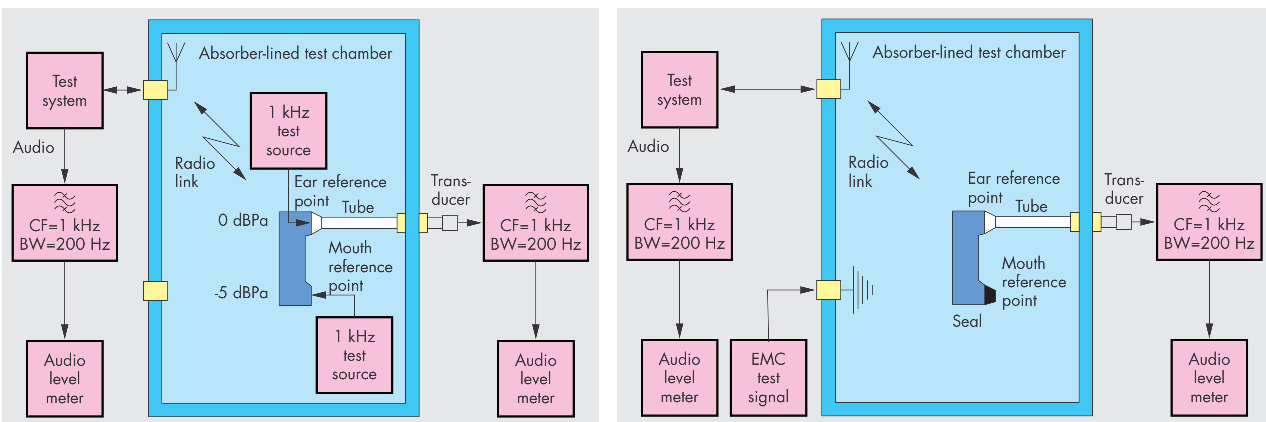


FIG 1 EMC measurements on mobile phones (EUT dark blue); left: reference measurement, right: EUT measurement

EMC measurements on mobile phones are based on the standards issued by ETSI (European Telecommunications Standard Institute), particularly ETS 300 342, parts 1 and 2 (GSM and DCS), and ETS 300 329 (DECT). These are product standards, taking into consideration the specific characteristics of EUTs. While there are no substantial differences in the measurement of interfering emissions of mobile phones to that of other electronic equipment, new techniques have been developed in the field of electromagnetic susceptibility (EMS) for monitoring parameters defined to assess the behaviour of EUTs.

On the one hand the quality of the digital link between base station and telephone is monitored, on the other possible effects on analog circuits are examined, used to pick up or generate voice signals for instance (FIG 1). Measurements are performed in both directions, from the telephone to the base station (uplink) and from the base station to the telephone (downlink).

With GSM mobile phones the quality of the digital link is determined by evaluating RXQUAL. This is a parameter measured by the GSM phone itself and signalled to the base station within the protocol frame. So a base station must be integrated in the EMC test system to produce the parameter for evaluation at each frequency of the RFI signal. The base-station function can be implemented with Digital Radiocommunication Tester CMD for instance [1]. The communication quality of DECT telephones is determined by evaluating bit error rate. For this purpose the phone is operated in loopback mode, ie test data emitted by the base station are sent back by the phone and the two data streams are then compared in the base station.

To ensure that an interfering electromagnetic field modulated with 1 kHz and 80% AM has no noticeable effect for the user on analog circuits, the level of the demodulated audio signal sent by the mobile to the base station (uplink) is measured by a communications tester. FIG 2 shows a typical result. In the direction base station → telephone the sound pressure level produced by the mobile at the earphone (downlink) is measured with a sensitive test microphone.

In both cases only the noise level is measured, ie no audio signal is present. The measured level is referred to a reference level determined in a separate measurement prior to the actual EMC test. The noise measured in the presence of an RFI signal should be at least 35 dB below the reference. The reference for the uplink is determined by applying an acoustic level of –5 dBPa at the EUT's mouth reference point and for the downlink by applying 0 dBPa to the test microphone. The reference levels are produced with the aid of an artificial mouth driven by a 1 kHz generator.

Rohde & Schwarz EMS test systems are operated with **System Software EMS-K1** [2]. Measurements on mobile

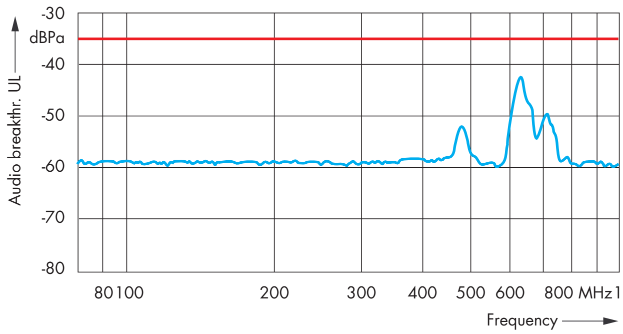


FIG 2
Typical curve measured for uplink audio level of DECT base station

phones are supported by special scripts and device drivers, designed to meet all requirements:

- User support by onscreen guidance for necessary hardware setup modifications.
- Determination of reference level and consideration of measured values in EUT tests.
- Automatic, broadband/narrowband evaluation to standard for a nogo result of the EUT.
- Control of Rohde & Schwarz testers (CMD, CMS, CMTA) in line with various digital standards. In this case call setup and evaluation of respective parameters (RXQUAL, demodulated AF level) can be software-controlled.

The described test system from Rohde & Schwarz is a turnkey solution enabling manufacturers of mobile telephones and EMC service providers to evaluate EMC characteristics of mobile phones in line with standards. With measurement routines integrated in System Software EMS-K1, precompliance measurements can also be performed during development beyond those prescribed by the standards .

Dr Juan Antón; Dr Klaus-Dieter Göpel

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[2] Göpel, K.-D.: System Software EMS-K1 under Windows – Automatic measurement of electromagnetic susceptibility. News from Rohde & Schwarz (1995) No. 148, pp 12–15

Reader service card 157/08

DVB – coverage measurements, program monitoring and production testing

Introduction of digital TV to various DVB standards (satellite, cable and terrestrial transmission [1]) is fast gaining ground. DVB broadcasts have already commenced in many countries all over the world. The advantages of digital transmission – frequency economy, integration of multimedia data services, adaptation of modulation to transmission link – are pointers to the rapid development of this market. Rohde & Schwarz has been offering instruments and systems for measurements on transmission links for quite some time. It has now extended the line of equipment to coverage measurements, program monitoring and production tests (FIG 1).

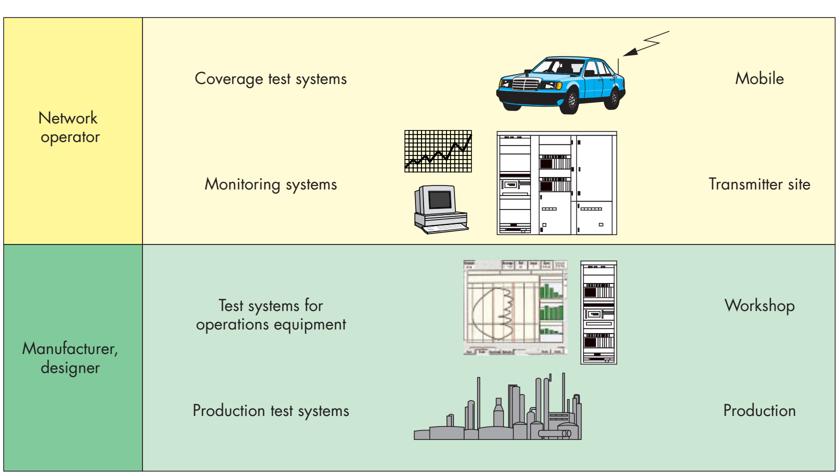

FIG 1 Main applications of DVB test systems

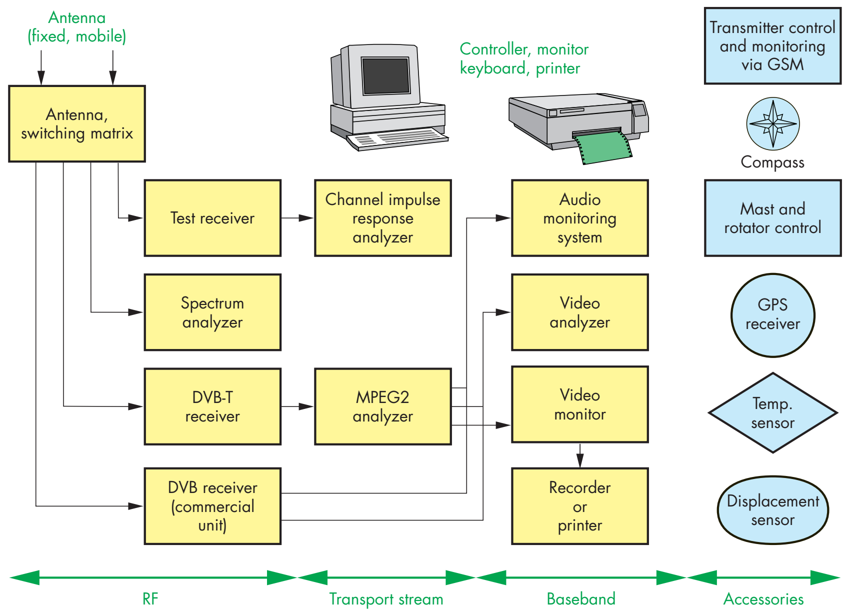

FIG 2 Example of DVB-T coverage test system

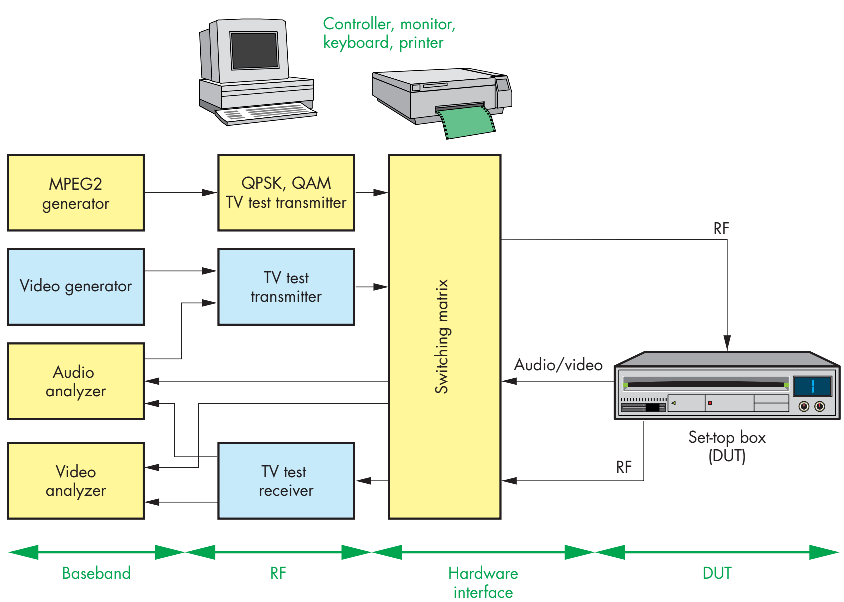

FIG 3 Set-top box test system (options in blue)

A single-frequency network is used for terrestrial digital video transmissions (DVB-T), ie all transmitters send the same signal simultaneously on the same frequency. To minimize interference caused by multipath propagation and neighbouring transmitters, a guard interval of approx. 100 µs was introduced for the DVB signal. During this period the receiver (set-top box) ignores the incoming signal. So reflections and signals from neighbouring transmitters arriving with a delay in reference to the main signal that is shorter than the guard interval do not cause intersymbol interference. It is possible for longer delay differences to occur however, which impairs reception or causes total program outage. To avoid this, network operators need to carry out measurements when the network is planned and perform automatic coverage measurements during operation. For this purpose Rohde & Schwarz offers a **DVB coverage test system,** which automatically measures channel impulse response, field strength and bit error rate (FIG 2).

Broadcasters are expected to ensure that their programs are transmitted or distributed with guaranteed reliability – in most cases 99.9%, which means no more than nine hours outage per year. Rohde & Schwarz has now extended the **TV Monitoring and Test System Family TS6100** [2] so that digital TV signals can also be monitored. Major features of the system are:

- monitoring of the incoming MPEG2 signal,
- monitoring of a DVB transmitter via RS-232-C or bitbus interface,
- monitoring of the transmitted DVB signal via a DVB demodulator/ MPEG2 analyzer,
- statistical evaluation of all collected results permitting faults to be pinpointed before they occur,
- remote control and query.

DVB test systems are also used in the **production of consumer set-top boxes.** Here the MPEG2 data stream from an MPEG2 generator is applied via a DVB test transmitter to the set-top box, where it is demodulated and decoded (FIG 3). The output signals from the DUT are then measured with an audio and a video analyzer and evaluated. In this way the limits of the receive characteristics of the DUT can be determined, for instance by varying RF level, adding noise or changing I/Q phase or I/Q balance on the test transmitter.

Michael Lehmann; Walter Deschler

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Reader service card 157/09

Measuring and monitoring DVB systems

FIG 1 TV Test Transmitter SFQ and TV Test Receiver EFA – indispensable reference units in DVB
Photo 43 072

The output of an MPEG2 multiplexer (when measuring a transmission link) or of an MPEG2 generator produces video, audio and other data in the form of TS (transport stream) packets with a defined data rate [1]. In the German cable network for instance, this is 38.1528 Mbit/s for 8 MHz channel bandwidth and 64QAM (quadrature amplitude modulation). That means a symbol rate of 6.9 Msymbol/s. In the case of 64QAM each symbol transmits 6 bits of the MPEG2 data stream, 3 bits each for the I and Q components. For measurements to DVB standard this signal is applied to **TV Test Transmitter SFQ** (FIG 1), where all **test signals** are conditioned **in line with the standard** both for DVB-C (digital video broadcasting cable) and DVB-S (satellite) [2]. For straightforward adaptation to TS signal parameters, SFQ measures the data rate and converts it into the current symbol rate and vice versa according to the QAM order. Data are then modulated to DVB standard and converted to RF.

The **output power of a DVB transmitter** cannot be measured as simply as that of an analog transmitter. In the analog world the rms power at the sync pulse base is measured with sufficient bandwidth and displayed as rms sync peak power. In the case of DVB however, power density is constant within the Nyquist bandwidth of the signal because of energy dispersal and symbol shaping in the DVB modulator (FIG 2). If you use a conventional spectrum analyzer to measure power, the maximum bandwidth is not enough for either an 8 MHz QAM cable channel or a 33/36 MHz QPSK satellite channel. Modern spectrum analyzers perform a broadband power measurement between two user-defined frequencies, so the Nyquist bandwidth of the transmission channel is irrelevant. In addition, all kinds of amplitude frequency responses are taken into account, irrespectively of whether echoes or departures from flat frequency response are concerned. Based on this principle Rohde & Schwarz Spectrum Analyzer FSE [3] measures the average power in DVB channels accurately to within ±1.5 dB using a test signal from TV Test Transmitter SFQ.

Digital TV uses a clearly defined operating range. Because of the Reed-Solomon forward error control (FEC), which corrects transport stream data onwards from a bit error ratio (BER) of 1×10^{-4} to yield a quasi-errorfree (QEF) data stream, the limit for total system failure is clearly laid down. The **bit error ratio** to be measured is determined by known error sources. Errors can be classified as those produced in the DVB modulator/transmitter and those superimposed on the signal during transmission. Errors caused by the modulator/transmitter are different amplitudes of the I and Q components, phase between the I and Q axes not equalling 90°, phase jitter produced in the modulator, insufficient carrier suppression in DVB modulation, amplitude and phase response errors impairing I and Q pulse shaping during filtering, as well as noise produced in the modulator and superimposed on QAM signals. Further distortions of amplitude and phase response occur on the transmission path. QAM signals are distorted by nonlinearities, adjacent-channel intermodulation impairs signal quality, and interference and noise are superimposed on the useful signal. While errors occurring outside the modulator can be simulated by auxiliary equipment, modulator-specific distortions can only be reproduced accurately with a professional test transmitter. For this purpose TV Test Transmitter SFQ becomes a stress transmitter, permitting any parameter to be detuned until digital TV transmission completely fails.

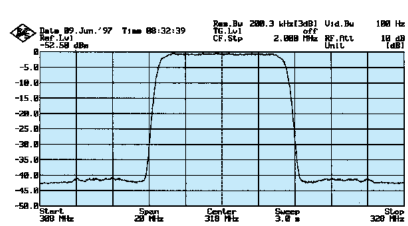

FIG 2 Constant power density in 64QAM digital TV channel

TV Test Transmitter SFQ can also **simply determine DVB system margin.** If quality parameters are degraded as required until the system fails completely, the system margin can be read off the screen. SFQ is worldwide the only DVB stress transmitter to show the limits of DVB in laboratory, test department, production, quality assurance and during operation.

In addition to the indispensable TV Test Transmitter SFQ for monitoring a DVB system, a demodulator is required

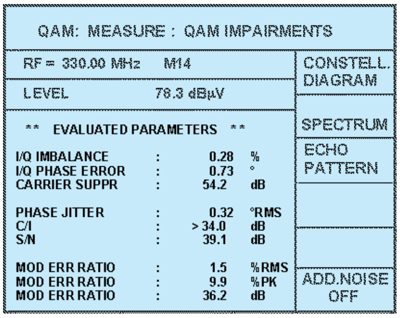

FIG 3 Measurement menu of TV Test Receiver EFA

for **monitoring the digital TV signal** after DVB-C transmission by cable. The solution offered by Rohde & Schwarz is **TV Test Receiver EFA** [4] (FIG 1). The bit error ratio is the most important receiving parameter besides the channel center frequency and the level of the received DVB cable channel. A precondition for measuring BER is comparison of data bits before and after error correction. This yields accurate results to a bit error ratio of max. 3×10^{-3}, because error correction is able to restore an evaluable data stream as far as this figure.

Synchronization is performed before EFA determines BER: the DVB-C receiver synchronizes to the RF carrier, the symbol rate is detected and synchronized, the adaptive equalizer corrects amplitude and phase responses, and the transport stream frame is detected via the corresponding sync byte. The QAM test demodulator of EFA displays the current status so that state and progress of synchronization can be checked at any time.

As long as BER is below 1×10^{-3}, the QAM test demodulator measures the quality parameters described for TV Test Transmitter SFQ. In addition to the single parameters, the **sum parameter MER** (modulation error ratio) is also important for monitoring a DVB system. Experience has shown that the MER of a good 64QAM modulator, as is internationally employed for DVB-C, should not exceed 1.0% RMS. MER figures substantially below 1.5% RMS cannot be obtained in public cable networks. The EFA measurement menu reveals the reason (FIG 3): the excellent S/N ratio of 39.1 dB after cable transmission alone corresponds to a MER of 1.11% RMS. So all other parameters together should not deteriorate the MER by more than 0.4%. For the QAM test demodulator this means that parameters must be measured reliably and with extremely high accuracy. How could the effects of individual kinds of interference be distinguished otherwise at such small sum values? Statistics play a supporting role here for the professional instrument (FIG 4). The noise superimposed on each symbol cluster in the constellation diagram allows the QAM parameters to be calculated with accuracy of at least two decimal places. But a sufficient number of symbols has to be evaluated per time unit of course. One second is sufficient for a realtime monitoring system. Within this period EFA calculates all parameters prescribed by the ETR 290 [5] standard using about 800 000 symbols. So approx. 12 000 symbols/s are available for evaluation in every symbol cluster of the 64QAM constellation diagram. Considering the stringent measurement requirements, this number of symbols is absolutely necessary anyway.

An **error report** is also required for professional monitoring. Besides the main parameters RF input level and

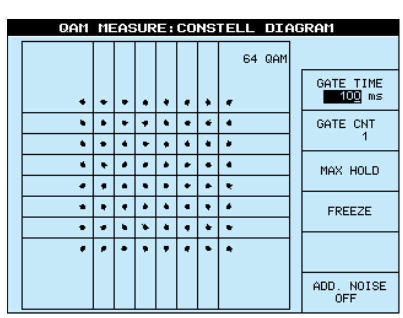

FIG 4 64QAM constellation diagram

sync conditions, the BER and, as an indicator for the margin in DVB-C, the occurrence of non-correctable data errors are recorded with date and time. Operators of digital cable networks know full well that disturbances visible in the decoded picture on the TV screen are an indication that the limits of secure DVB transmission are by far exceeded. As is the case with any digital system, the transition from secure operation to total failure is very abrupt. So TV Test Receiver EFA warns in good time before DVB-C signal failure.

TV Test Transmitter SFQ and TV Test Receiver EFA are indispensable reference units for putting DVB systems into operation, in the production of set-top boxes, in quality assurance or for monitoring ongoing broadcasts in digital cable networks.

Sigmar Grunwald

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Reader service card 157/10 for further information on SFQ and 157/11 for EFA

Signal Generator SMP: automatic user correction of RF level with Power Meter NRVS or NRVD

FIG 1 Signal Generator SMP and Power Meter NRVD – a powerful team guaranteeing high output levels and precision up to 40 GHz
Photo 43 071

More and more satisfied customers are becoming familiar with the name SMP, which stands for microwave generators with excellent signal characteristics in the frequency range 10 MHz to 40 GHz [1; 2]. In the SMP signal generator family, Rohde & Schwarz has proven once more its ability to offer outstanding technical features and high quality at an attractive price. Despite utilizing all the potential of modern microwave and microprocessor technologies, there is one thing the four SMP models (TABLE) cannot do of course, ie turn elementary laws of physics upside down. Still, thanks to their built-in intelligence, they do make the innate difficulties of microwave measurements extremely easy to get along with. This is exemplified here by automatic determination of level correction data with the user correction function.

First a closer look at the **measurement task** itself. In most test setups you find you need a somewhat longer RF connecting cable between the generator output and DUT input. Plus, you may have to loop RF switches, power splitters, phase shifters and the like into the signal path. At 20 GHz for example, this quickly adds up to an insertion loss of a few dB. Unfortunately the same setup at a lower frequency, say at about 2 GHz, will produce no more than a few tenths of a dB in insertion loss, which generally means significant frequency response. Things are further aggravated by the effects of SWR which, as a result of the inevitable matching errors, is superimposed on the frequency response. Although you can set SMP output level with high precision and stability, you do not initially know the exact driving level at the DUT input. So you cannot perform those measurements correctly that, in one way or another, are dependent on level, eg transmission measurements on frequency multipliers or RF detectors, but also compression and harmonics measurements on limiters, amplifiers, mixers or YIG bandpass filters. Here you often need to know the driving level to within a few tenths of a dB.

All **SMP models** have two functions that help you get the required accuracy with the aid of an external power meter. First there is **external level control.** This requires Power Meter NRVS for continuous measurement of the nominal level [3]. The other possibility is the **user correction** function. This is based on a table stored in SMP in which you can enter level correction data for up to 160 selectable frequencies. You can do

Model	Frequency range	Guaranteed level at f_{max}
SMP02	10 MHz/2 GHz to 20 GHz	+11.5 dBm
SMP22	10 MHz/2 GHz to 20 GHz	+20 dBm
SMP03	10 MHz/2 GHz to 27 GHz	+13 dBm
SMP04	10 MHz/2 GHz to 40 GHz	+10 dBm

TABLE Overview of SMP models

this manually via the front panel, but it is far more convenient to let SMP do it. The required test setup is shown in FIG 1. Basically, all you need in addition to SMP is Power Meter NRVS or NRVD [4] – of course with a suitable sensor for the operating frequency range in question – and an IEC/IEEE-bus cable so that SMP can automatically control the power meter and read results from it (FIG 2). So, with SMP acting as the bus controller in correction-value measurements, you must make sure that there is no second active controller connected to the IEC/IEEE bus.

Automatic correction-value measurement is performed as follows:

- Set the required level on SMP.
- Select the "Level-Ucor" menu.
- Set "State" to "On" – this activates user correction.
- Select your power meter (NRVD or NRVS).
- Select a table and enter the desired frequencies. (To generate an equi-spaced frequency table, use the fill function of the list editor.)
- Start correction-value measurement by activating the "Measure Connection via Power Meter" menu item.

SMP first determines the IEC/IEEE-bus address of the power meter and the type of sensor connected. Then it measures the correction values and enters them in the table. When the measurement is completed, you can display the results with the Edit/View function of the list editor. As many as ten different correction tables can be generated and recalled in this convenient way.

After correction-value measurement, simply remove the power sensor. If you now connect the DUT instead, it is fed with precisely the RF level set on SMP. If you select frequencies in between the frequency points of the tables, it is no problem, because SMP determines the correction values for these frequencies by interpolation. But if you select a frequency outside the ranges covered by the tables, the RF level will not be corrected – which is stating the obvious.

Compared to the above-mentioned external level control, which can likewise be used for RF level correction, the **automatic user correction** function offers the following **advantages:**

- The power meter and its sensor are only needed for the duration of the correction-value measurement. After that you can use them for something else.
- With external level control, the sensor must be connected via a power splitter or directional coupler. Here these components are superfluous. Please remember – the less components connected, the smaller the loss in useful microwave power.
- The user correction function is a pure control function. So obviously it operates faster than external level control, because there are no control loops that have to settle. This is a big advantage for fast frequency changes on the IEC/IEEE bus.

Wilhelm Kraemer

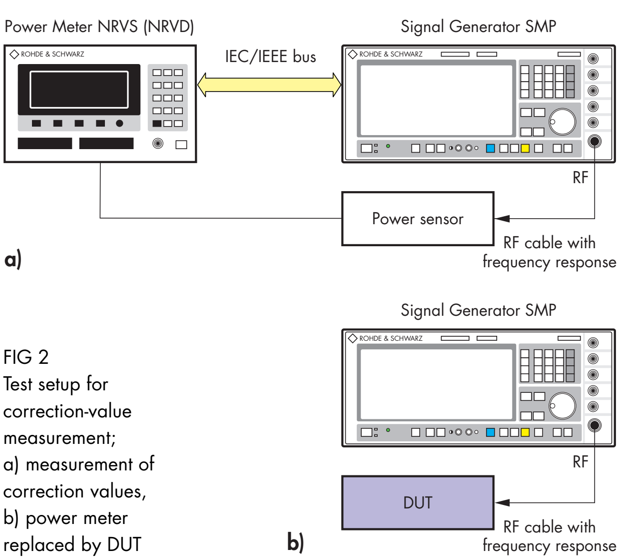

FIG 2
Test setup for correction-value measurement;
a) measurement of correction values,
b) power meter replaced by DUT

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Reader service card 157/12

Measuring bit error rate of transmitter ICs with EMI Test Receiver ESMI

A major quality criterion in data transmission with state-of-the-art communications equipment is low bit error rate (BER). When the whole communications system – consisting essentially of data source, possibly a coder, modulator plus transmitter output stage, receiver with demodulator (and decoder) as well as data regeneration and evaluation facilities – is examined with a view to BER, attention normally focuses on the demodulator. Nevertheless, manufacturers of digital transmission equipment must also be able to characterize their products by specifying the achievable BER.

Since the introduction of ISM (industrial, scientific, medical) bands, a variety of applications involving wireless data transmission can be implemented worldwide without a license in these frequency bands, provided the prescribed useful and interfering signal power and bandwidths are maintained [1]. In Germany, for instance, the 433 MHz band (433.050 to 434.790 MHz) can be used for remotely controlled alarms, garage door controls, meter reading or keyless entry. For such applications a number of major semiconductor manufacturers offer integrated circuits that are mainly designed for ASK (amplitude shift keying) and FSK (frequency shift keying).

Thesys Microelectronics of Erfurt, Germany, has been on the national and international markets since 1994 with devices for RF applications. Recent developments include two ICs integrating all ASK or FSK functions on a single silicon chip: TH7101 for ASK and TH7106 for FSK. The two ICs operate in the frequency range 280 to 480 MHz and use PLL synthesis for frequency generation (FIG 1). The external circuit to the reference signal generator consists of no more than

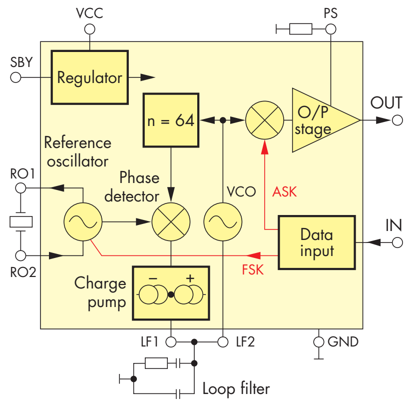

FIG 1 Block diagram of 434 MHz ASK/FSK transmitter ICs

a crystal and two capacitors. The loop filter components, eg two capacitors and a resistor, are also externally connected. This permits the PLL to be tuned for a specific application by adjusting filter components. The VCO and the power-adjustable output stage are completely integrated and feature low phase noise of approx. –76 dBc/Hz (at 10 kHz offset), low harmonic distortion (better than –30 dBc) and output power of approx. 1 dBm (into 50 Ω). In the TH7106 the FSK is generated by adjusting the integrated pulling capacitors of the crystal oscillator to the rate of the data signal. With the ASK model TH7101 modulation is performed by multiplier keying.

EMI Test Receiver ESMI from Rohde & Schwarz [2] is ideal for measuring transmitter ICs (FIG 2). Besides its excellent characteristics as a spectrum analyzer (20 Hz to 26.5 GHz), scalar network analyzer (20 Hz to 5 GHz), EMC test receiver and noise figure meter (with noise source and Software FS-K3 [3]) in **receiver mode,** ESMI is able to demodulate AM and FM signals. For this purpose it comprises an AM IF amplifier with ALC (> 60 dB), an FM IF limiting amplifier plus AM and FM demodulators. After selection of the type of modulation, frequency deviation/modulation depth, center frequency, resolution and video bandwidths as well as sweep time, the demodulated information content can be displayed on ESMI in the time domain. If the modulation signal is within the audio frequency range, the signal can also be aurally monitored via the built-in loudspeaker. So basi-

FIG 2
Test setup with EMI Test Receiver ESMI for BER measurement at Thesys Microelectronics
Photo: Thesys GmbH

cally all measurements required for assessing the quality of ASK and FSK ICs can be performed.

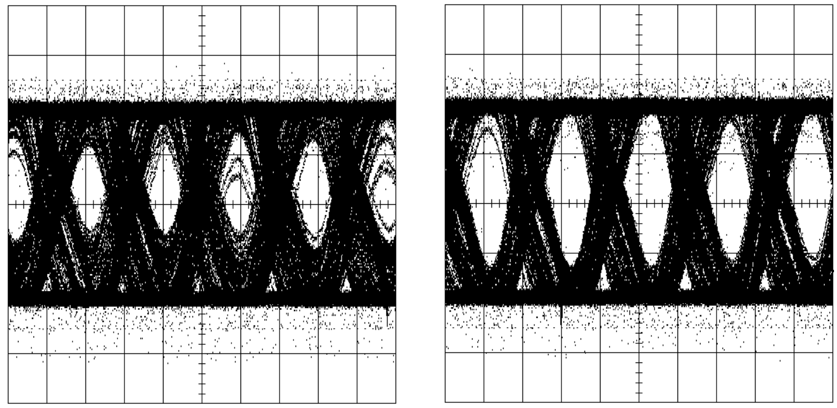

FIG 4 Eye pattern at $P_e = 10^{-3}$ (left) and $P_e = 10^{-6}$ (ordinate 200 mV, abscissa 2 µs)

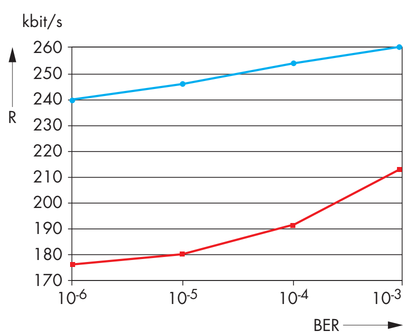

FIG 3 Bit rate R as function of bit error rate (ASK blue, FSK red); measurements with modulation using pseudo-random sequences of 2^{15}-1 length, carrier frequency 433.9 MHz, output power 0.5 dBm

In addition to parameters like output power, spurious emission or phase noise, **measurement of BER** (bit error rate) is of particular importance for quantitative assessment of the functions of a digital transmitter IC. Although BER is not a common parameter in manufacturers' data sheets, specifying the minimum BER is a useful criterion for determining the operating range (temperature and supply voltage). The demodulated signal can be displayed on ESMI and coupled out at the video output at the rear of the instrument. This permits qualitative assessment by an oscilloscope or BER measurement by applying the data to a test system.

Resolution and video bandwidths of ESMI can either be selected according to the theoretical values specified for the required bandwidth of an ASK- or FSK-modulated signal or adapted to receiver parameters. In the first case an optimum receiver bandwidth of $B_{RX} = 1.4 \cdot f_b$ should be available for ASK and FSK according to [4], where f_b is the bit repetition frequency (in Hz) or the bit rate (R in bit/s), which corresponds to the reciprocal value of bit period T_b ($f_b = 1/T_b$). The ESMI demodulators perform non-coherent detection of ASK and FSK signals. In this case the functional dependence of bit error probability (or BER) P_e on signal/noise ratio is the same for both types of modulation. Due to normalization of S/N to bit energy E_b at a given noise density N_0 in the receiver, the following expression is obtained according to [5]:

$$P_e = \frac{1}{2}\exp(-\frac{E_b}{2N_0})$$

For a transmitter IC the gap between the actually generated and the theoretically possible modulation signal becomes greater with increasing modulation frequency. The reason is the lowpass behaviour of the modulators and the finite bandwidth of the transmitter output stages of the IC. Consequently, transmission quality decreases with increasing bit rate. BER decreases according to the relationship $P_e = P_e(f_b)$. FIG 3 shows the recursive dependence of the maximum possible data rate on BER for both ICs TH7101 and TH7106.

The quality of digital communications systems is often described by means of **eye patterns.** Conclusions can be drawn from the shape and size of the pattern on the type of interference occurring in the transmission system. FIG 4 shows eye patterns at $P_e = 10^{-3}$ and 10^{-6} displayed on a digital oscilloscope operating in cumulative mode. The two patterns illustrate the effect of superimposed noise, the eye opening being considerably wider in the case of $P_e = 10^{-6}$ of course.

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Reader service card 157/13 for further information on ESMI

Type approval of GSM900/GSM1800 multiband mobiles using System Simulator TS8915

Digital mobile radio networks to the European GSM standard have been divided to date into two worlds: those operating in the **GSM900 frequency band** (eg D1 and D2 in Germany) and networks using the **GSM1800 band** (eg EPlus in Germany). GSM900 offers 124 carrier frequencies in the 900 MHz band, GSM1800 up to 374 carrier frequencies in the 1800 MHz band. The standard also allows GSM900 to be extended by the E-GSM band (extended GSM), ie by another 50 channels. Although signalling in the two bands has been fully compatible as of phase 2, it is not possible for a GSM900 mobile to access the GSM1800 network because of the different frequency bands. So the GSM subscriber has had to opt for one of the two bands when purchasing his single-band mobile, which was then able to roam only in GSM900 or GSM1800. But the introduction of **multiband mobiles** has done away with this problem. These are able to access both GSM900 and GSM1800 networks, and three-band mobiles (GSM900/1800/1900) are already in sight as well.

Like single-band units, multiband mobiles must be subjected to an internationally recognized **type approval test.** First they are tested separately in the two bands: the GSM900 type approval test is performed with the FTA (full type approval) system simulator and Digital Radiocommunication Test Set CRTP02 [1] from Rohde & Schwarz, the GSM1800 test with System Simulator TS8915 or TS8925 [2; 3].

Multiband-specific test cases have also been specified (GSM 11.10-1), and these are all provided by Simulator TS8915. The basic principles of the required test cases are as follows.

Cell selection/reselection
(GSM 11.10-1, section 20.20)
A multiband mobile is faced with the task of choosing a suitable cell. It has to search the two bands – GSM900 (935 to 960 MHz) and GSM1800 (1805 to 1880 MHz) – for frequency channel 0 (C0), and after analyzing the level of the received signal and cell-specific access parameters it must select a cell. Once the mobile has found a suitable cell, it must register (location update). To test this procedure, TS8915 simulates several GSM900 and GSM1800 cells as prescribed by the test specifications. During the test the mobile has to choose a cell by selecting a special signal level and access parameters (eg location area information or cell barring) and access it. Up to six GSM900 or GSM1800 cells are required for these tests and provided by TS8915.

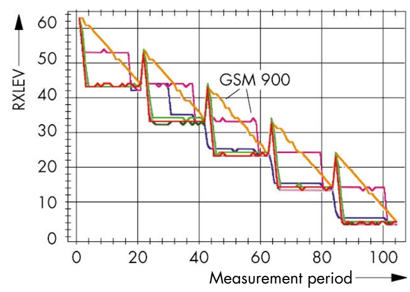

FIG 1 Result of signal-strength measurement in GSM900 and GSM1800 bands; RXLEV value 0 = ≤110 dBm, 63 = ≥–48 dBm, linear 1 dB steps in between

Signal-strength measurement
(GSM 11.10-1, section 21.1)
A GSM mobile must continuously monitor those cells defined by the active one as neighbouring cells. The level of the received neighbouring C0 carriers has to be measured by the mobile with defined accuracy and signalled to the base station. This information is important for the base station so that it can promptly hand over the mobile when a better cell is found in the neighbourhood. This test checks whether the mobile is able to measure the neighbouring cell's level with sufficient accuracy. To do so the test system simulates an active cell S1 where the mobile utilizes a traffic channel (ie one voice channel is active). The mobile has to signal the average level determined during the last measurement period (104 TDMA frames = 120 ms) to the base station, in this case to the test system, at a defined interval. With the active cell altogether five C0 channels are simulated, two in the GSM900 band and three in GSM1800. During the test the level of the C0 channels is varied in precise 1, 10 and 20 dB steps. FIG 1 shows a graphical representation of the test result obtained from a multiband station. The measured RXLEV signalled by the mobile corresponds to the absolute average.

Signalling test
(GSM 11.10-1, section 26.11)
Special signalling procedures are required in multiband networks. Firstly the network has to inform the mobile that it is in a multiband environment, and secondly the mobile must transfer its multiband-specific parameters to the network. So the mobile sends a

8	7	6	5	4	3	2	1	Bit
0	Mobile station classmark 3							Byte 1
Length of mobile station classmark 3 contents								Byte 2
0	Band 3	Band 2	Band 1	A5/7 Cipher algorithm	A5/6	A5/5	A5/4	Byte 3
Associated radio capability 1				Associated radio capability 2				Byte 3bis
0 Spare	0	0	0	0	0	0	0	Byte N to 14

FIG 2 Mobile provides network with details of its multiband capability in classmark change message.

classmark change message to the base station, containing an information element called "mobile station classmark 3" (FIG 2). The "band 1" bit indicates whether the mobile supports GSM900, the "band 2" bit whether the station is E-GSM compatible and the "band 3" bit whether it is able to operate in the GSM1800 band. The "associated radio capability 1 and 2" bits tell the network the power class of the mobile in the GSM900 or GSM1800 band. In this way the network knows the maximum possible output level of the mobile in the various bands.

Conformity of the contents of the classmark change message is checked in various signalling tests. FIG 3, for example, shows the log of a location update sequence where the mobile registers in a cell and provides the required multiband information by a classmark change message. Other signalling tests check handover from a

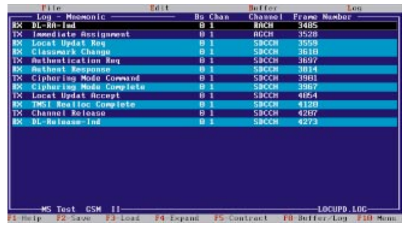

FIG 3 Log of location update sequence in multiband environment, represented with message editor of Digital Radiocommunication Test Set CRTC02

GSM900 to a GSM1800 cell and vice versa. As in the case of the signal-strength test, the mobile has to inform the active cell permanently about available neighbouring cells. The actual signalling procedure is again explicitly tested. The test system in turn simulates the required number of neighbouring cells in the various bands and checks the measurement report for conformity. The network (test system) informs the active cell about available neighbouring cells as part of system information. This contains the neighbouring frequency channels C0 of the active band and also the neighbouring cells in the other band. In this way the multiband mobile can search both bands for neighbouring cells.

Heinz Mellein

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Reader service card 157/14 for further information on TS8915

Communications Receivers

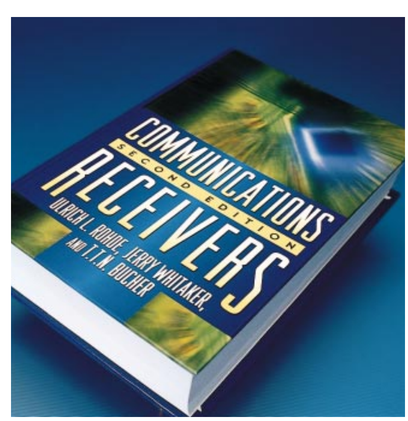
by Ulrich L. Rohde, Jerry C. Whitaker and T. T. N. Bucher. The second edition of this book (full title: Communications Receivers, Principles and Design) was published in 1997 by McGraw-Hill, New York. ISBN 0-07-053608-2, 669 pages, more than 450 illustrations (eight from Rohde & Schwarz), price $ 65. Prof. Dr. U. L. Rohde is the son of the co-founder of Rohde & Schwarz and now a partner in the company. He has lived in the USA for more than ten years, where he has set up and managed a number of high-tech firms.

This book is the revised edition of a comprehensive work on receiver design that first appeared in 1988. Following a general introduction to radio reception technology and a historical review, it looks at the principles of the major parts of a receiver and gives a wealth of details about designing them. For every aspect there are examples of circuits that have already been built and tried in practice. There is also a whole section on receiving antennas that is very well worth reading.

Revision naturally focused on those areas where there have been the biggest technical advances in recent years, ie frequency synthesis and the application of digital signal processing. But a comparison of the two editions shows that the earlier one still reflects the state of the art in very many respects, especially in the case of the analog high-tech solutions presented for mixers for instance.

The book is divided into ten chapters, each finishing with many useful recommendations for further reading. This makes up for the fact that the book itself, because of its wide-ranging subject matter, cannot go into everything in depth. Overall the book is a valuable source of information for anyone involved in designing communications receivers.

Karl-Otto Müller



Application Firmware FSE-K10/K11 simplifies measuring RF parameters of GSM transmitters

Output signals of mobile-radio transmitters – base stations and mobile phones alike – must fulfill stringent demands in terms of modulation quality and spectral purity to ensure optimum link quality and maximum coverage, and to avoid interference with other network subscribers. The required performance has to be verified in complex and time-consuming tests defined in specifications of the various network standards. Application Firmware FSE-K10/FSEK11 supports such tests together with spectrum analyzers of the FSE family [1–3]. **FSE-K10** serves for measuring the RF parameters of mobile phones and **FSE-K11** for base station tests according to the following **standards:**

- GSM900, Phase I and II (11.10/ 11.10-1 and 11.20/11.21),
- GSM1800, Phase I and II (11.10 DCS/11.10-1 and 11.20 DCS/ 11.21),
- PCS1900 (J-STD-007).

The application firmware is integrated into the firmware of FSE and turns this instrument into an RF tester for mobile or base stations. All the user has to do is enter the standard and power class of the mobile or base station, all other settings such as bandwidth, span, sweep time, detectors, limit values and test sequences being taken care of by the software. It makes the required settings and performs test routines automatically without burdening the user with the complex details of standards. Measurements are started on a keystroke. This speeds up procedures in acceptance testing or development and does away with incorrect settings. The user can concentrate on results – in the simplest case pass/fail information – instead of test procedures. This increases measurement throughput and reduces error rates. The excellent characteristics of FSE spectrum analyzers are of course an indispensable prerequisite for correct measurements.

In conjunction with the Vector Signal Analyzer Option (FSE-B7), FSE determines **phase and frequency error** (rms and peak) over an adjustable number of bursts (FIG 1). Numerical results for phase error (rms and peak) and frequency error are displayed together with pass/fail information. Plus, phase error versus time is shown graphically with limits for phase-error peak value. Phase error versus time is represented by three traces for instantaneous, maximum and minimum error over the selected number of bursts.

Using the carrier power function, FSE measures the absolute **output power** and relative power for the selected power class and the different power control levels (static power control level and dynamic power control level). Test data are output in tabular form including pass/fail information for fast evaluation of results. Uncertainty for absolute power measurements is <0.6 dB with the Increased Level Accuracy Option (FSE-B22). For relative power measurements, uncertainty is <0.2 dB. With the Vector Signal Analyzer Option installed, time reference by

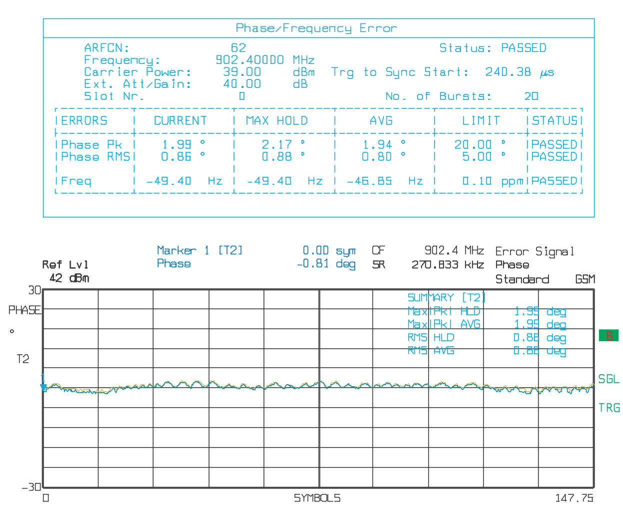


FIG 1 Results of phase/frequency error measurement

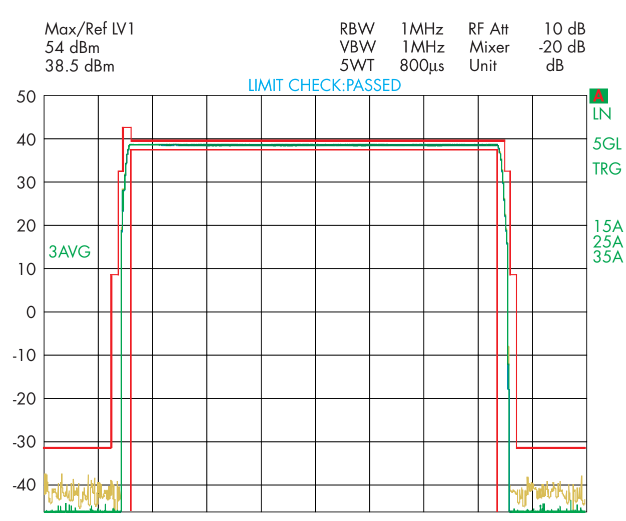


FIG 2 Power versus time of GSM burst. FSE automatically synchronizes to midamble of burst.

P-GSM 900 II	MODULATION SPECTRUM LIST				ARFCN ±1.8MHz
ARFCN:	1		Status:	PASSED	
Frequency:	890.20000 MHz				
Carrier Power:	39.0 dBm		Ext Atten:	40.0 dB	
Ref Pwr (RBW 30 kHz)	34.74 dBm		No of Bursts:	2	
No.:	Offset Freq.	+Offset	-Offset	Limit	Status
	100 kHz	-12.1 dB	-8.1 dB	0.5 dB	PASSED
1	200 kHz	-39.8 dB	-35.3 dB *	-30.0 dB	MARGIN
	250 kHz	-40.0 dB	-43.5 dB	-33.0 dB	PASSED
	400 kHz	-73.0 dB	-72.1 dB	-60.0 dB	PASSED
	600 kHz	-81.0 dB	-81.4 dB	-66.0 dB	PASSED
	800 kHz	-82.2 dB	-81.6 dB	-66.0 dB	PASSED
	1000 kHz	-81.0 dB	-80.0 dB	-66.0 dB	PASSED
	1200 kHz	-83.1 dB	-82.8 dB	-66.0 dB	PASSED
	1400 kHz	-83.1 dB	-81.9 dB	-66.0 dB	PASSED
	1600 kHz	-82.8 dB	-81.8 dB	-66.0 dB	PASSED
	1800 kHz	-84.3 dB	-80.3 dB	-69.0 dB	PASSED

FIG 3
Modulation spectrum in tabular form with limit values and pass/fail information

P-GSM 900 I	SPURIOUS LIST			<>TX
ARFCN:	62	Status:	PASSED	
Frequency:	902.40000 MHz			
Carrier Power:	33.0 dBm	Ext Atten:	23.0 dB	
No.	Frequency	Level	Limit	Status
	100.00000 kHz --- 50.00000 MHz	-66.8 dBm	-36 dBm	PASSED
	50.00000 MHz --- 500.00000 MHz	-57.6 dBm	-36 dBm	PASSED
	500.00000 MHz --- 860.00000 MHz	-38.2 dBm	-36 dBm	MARGIN
1	860.00000 MHz	-38.2 dBm	-36 dBm	MARGIN
2	854.94990 MHz	-39.2 dBm	-36 dBm	MARGIN
	860.00000 MHz --- 870.00000 MHz	-40.4 dBm	-36 dBm	MARGIN
3	869.61924 MHz	-40.4 dBm	-36 dBm	MARGIN
4	862.84569 MHz	-40.6 dBm	-36 dBm	MARGIN
5	863.34669 MHz	-41.0 dBm	-36 dBm	MARGIN
6	868.99800 MHz	-41.1 dBm	-36 dBm	MARGIN
7	867.67535 MHz	-41.1 dBm	-36 dBm	MARGIN
8	867.05411 MHz	-41.2 dBm	-36 dBm	MARGIN
9	868.65731 MHz	-41.2 dBm	-36 dBm	MARGIN
10	866.05210 MHz	-41.3 dBm	-36 dBm	MARGIN
11	864.80962 MHz	-41.6 dBm	-36 dBm	MARGIN
12	869.89980 MHz	-41.6 dBm	-36 dBm	MARGIN
13	862.30461 MHz	-41.8 dBm	-36 dBm	MARGIN
14	865.11022 MHz	-41.9 dBm	-36 dBm	MARGIN
15	868.37675 MHz	-41.9 dBm	-36 dBm	MARGIN
	870.00000 MHz --- 880.00000 MHz	-42.1 dBm	-36 dBm	PASSED
	880.00000 MHz --- 890.00000 MHz	-45.2 dBm	-36 dBm	PASSED
	915.00000 MHz --- 925.00000 MHz	-47.1 dBm	-36 dBm	PASSED
	925.00000 MHz --- 935.00000 MHz	-46.6 dBm	-36 dBm	PASSED
	960.00000 MHz --- 1.00000 GHz	-44.0 dBm	-36 dBm	PASSED
	1.00000 GHz --- 12.75000 GHz	-39.1 dBm	-30 dBm	PASSED

FIG 4
Spurious emissions. Display of maximum level for each subrange with limit value and pass/fail information

synchronization to the midamble can be established. Other trigger modes provided by FSE include video trigger, external trigger and RF power trigger.

The power vs time function displays a **TDMA burst versus time** and evaluates the burst by means of limit lines (FIG 2). The limit lines inserted depend on the selected standard, power class and output level of the transmitter. FSE displays the complete burst or parts of it with high level resolution. With the Vector Signal Analyzer Option, FSE establishes an exact time reference to the midamble, ie to the transition from bit 13 to bit 14. Alternatively, an external trigger or the internal video trigger can be used. The measurement is performed with three traces displayed at the same time with the maximum peak, minimum peak and sample detectors. Measurements over several bursts allow even single outliers to be reliably detected.

The **modulation spectrum** can be measured in the zero span mode, strictly in line with standards, with the specified frequency steps, or in the sweep mode to provide a better overview. In the zero span mode, results are output in tabular form including pass/fail information (FIG 3). In the sweep mode, the spectrum with associated limit lines is displayed. An external trigger or the internal RF power trigger is used for trigger of measurements on 50 to 90% of the useful part of the burst.

To determine the **spectrum due to transients,** level peaks caused by switching are measured using the peak detector and the peak hold function. The spectrum due to transients results from the modulation spectrum and the spectrum due to switching of the TDMA burst. Here the spectrum analyzer should have a very wide dynamic range especially at high power levels since an absolute limit value of –36 dBm is to be met. The high overdrive capability and low phase noise of FSE enable this measurement to be performed without additional filters even for high transmit levels. As with the modulation spectrum, results are displayed graphically or in tabular form.

Determination of **spurious emissions** is the most time-consuming of all measurements, the range through to 12.75 GHz being divided into many subranges with different analyzer settings (FIG 4). The FSE-K10 and FSE-K11 software packages fully support these measurements. With its high overdrive capability, low noise floor and phase noise, FSE performs these measurements at output levels up to 39 dBm without the use of complex notch filters, requiring only a simple highpass filter to suppress the fundamental. Simple bandstop filters are sufficient at higher levels. This reduces equipment complexity as well as measurement time.

All measurements can of course be remotely controlled using an external controller or the internal computer function (option FSE-B15). All required settings are available in FSE so that only results – in the simplest case pass/fail information – have to be transmitted via the bus. So the application firmware is an efficient tool in production too, saving time through automatic settings and routines and, with a minimum of external hardware, cutting down on costs.

Josef Wolf

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

[3] Wolf, J.: Spectrum Analyzer FSEM/FSEK – Fast spectrum analysis now through to 40 GHz. News from Rohde & Schwarz (1996) No. 152, pp 7–9

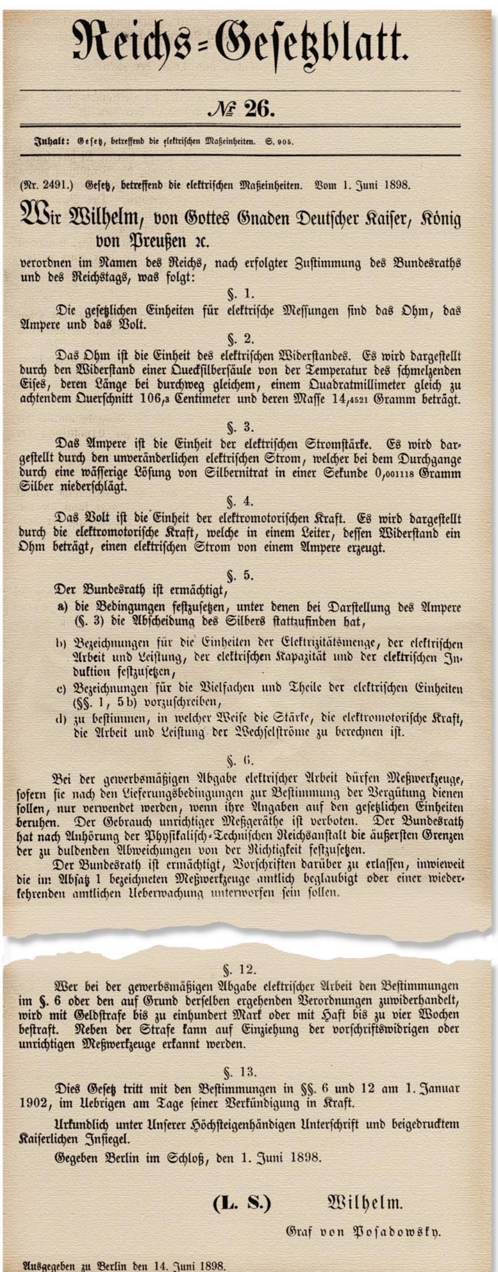
Reader service card 157/15

Correct usage of quantities, units and equations (I)

100 years ago the first German law on electrical units of measure came into force (FIG 1). This anniversary is a good opportunity of pointing out the importance of uniform scientific notation – more important than ever nowadays in the international arena. This refresher topic is limited to electrical quantities and units; a detailed description covering all areas of physics is given in [1].

DIN No.	Designation	DIN paperback
461	Graphical representation in coordinate systems	202
1301 Part 1 Part 2	Units; Unit names, unit symbols Generally used submultiples and multiples	22*
1302	General mathematical symbols and terms	202
1304 Part 1 Part 6	Letter symbols; General letter symbols Letter symbols used in electrical communications engineering	202
1313	Physical quantities and equations Terms, notation	22
1338	Notation of formulas	202
5493 Part 1 Part 2	Logarithmic quantities and units Fundamentals Logarithmic ratios	22*
40 146 Part 2	Terms used in telecommunications; Useful level, interference level, dynamic range, S/N ratio	22

TABLE 1 Basic standards quoted (standards marked * were revised after publication of stated DIN paperback. New issues are separately listed under REFERENCES.)



Reichs-Gesetzblatt.

№ 26.

Inhalt: Gesetz, betreffend die elektrischen Maßeinheiten. S. 905.

(Nr. 2491.) Gesetz, betreffend die elektrischen Maßeinheiten. Vom 1. Juni 1898.

Wir Wilhelm, von Gottes Gnaden Deutscher Kaiser, König von Preußen ꝛc.

verordnen im Namen des Reichs, nach erfolgter Zustimmung des Bundesraths und des Reichstags, was folgt:

§. 1.

Die gesetzlichen Einheiten für elektrische Messungen sind das Ohm, das Ampere und das Volt.

§. 2.

Das Ohm ist die Einheit des elektrischen Widerstandes. Es wird dargestellt durch den Widerstand einer Quecksilbersäule von der Temperatur des schmelzenden Eises, deren Länge bei durchweg gleichem, einem Quadratmillimeter gleich zu achtendem Querschnitt 106,3 Centimeter und deren Masse 14,4521 Gramm beträgt.

§. 3.

Das Ampere ist die Einheit der elektrischen Stromstärke. Es wird dargestellt durch den unveränderlichen elektrischen Strom, welcher bei dem Durchgange durch eine wässerige Lösung von Silbernitrat in einer Sekunde 0,001118 Gramm Silber niederschlägt.

§. 4.

Das Volt ist die Einheit der elektromotorischen Kraft. Es wird dargestellt durch die elektromotorische Kraft, welche in einem Leiter, dessen Widerstand ein Ohm beträgt, einen elektrischen Strom von einem Ampere erzeugt.

§. 5.

Der Bundesrath ist ermächtigt,

a) die Bedingungen festzusetzen, unter denen bei Darstellung des Ampere (§. 3) die Abscheidung des Silbers stattzufinden hat,

b) Bezeichnungen für die Einheiten der Elektrizitätsmenge, der elektrischen Arbeit und Leistung, der elektrischen Kapazität und der elektrischen Induktion festzusetzen,

c) Bezeichnungen für die Vielfachen und Theile der elektrischen Einheiten (§§. 1, 5 b) vorzuschreiben,

d) zu bestimmen, in welcher Weise die Stärke, die elektromotorische Kraft, die Arbeit und Leistung der Wechselströme zu berechnen ist.

§. 6.

Bei der gewerbsmäßigen Abgabe elektrischer Arbeit dürfen Meßwerkzeuge, sofern sie nach den Lieferungsbedingungen zur Bestimmung der Vergütung dienen sollen, nur verwendet werden, wenn ihre Angaben auf den gesetzlichen Einheiten beruhen. Der Gebrauch unrichtiger Meßgeräthe ist verboten. Der Bundesrath hat nach Anhörung der Physikalisch-Technischen Reichsanstalt die äußersten Grenzen der zu duldenden Abweichungen von der Richtigkeit festzusetzen.

Der Bundesrath ist ermächtigt, Vorschriften darüber zu erlassen, inwieweit die im Absatz 1 bezeichneten Meßwerkzeuge amtlich beglaubigt oder einer wiederkehrenden amtlichen Ueberwachung unterworfen sein sollen.

§. 12.

Wer bei der gewerbsmäßigen Abgabe elektrischer Arbeit den Bestimmungen im §. 6 oder den auf Grund derselben ergehenden Verordnungen zuwiderhandelt, wird mit Geldstrafe bis zu einhundert Mark oder mit Haft bis zu vier Wochen bestraft. Neben der Strafe kann auf Einziehung der vorschriftswidrigen oder unrichtigen Meßwerkzeuge erkannt werden.

§. 13.

Dies Gesetz tritt mit den Bestimmungen in §§. 6 und 12 am 1. Januar 1902, im Uebrigen am Tage seiner Verkündigung in Kraft.

Urkundlich unter Unserer Höchsteigenhändigen Unterschrift und beigedrucktem Kaiserlichen Insiegel.

Gegeben Berlin im Schloß, den 1. Juni 1898.

(L. S.) Wilhelm.

Graf von Posadowsky.

Ausgegeben zu Berlin den 14. Juni 1898.

FIG 1
Facsimile of law on electrical units of measure, enacted in 1898

A very familiar argument in Germany is that notation rules abroad, and especially in the USA, are different and less stringent. This opinion is totally unfounded, being based merely on poorly edited publications that do not comply with national standards and regulations. Properly edited publications such as those of IEEE conform strictly to national and international standards.

The legal units

The "Gesetz über Einheiten im Messwesen" (Units of Measure Act) of 2 July 1969 and the implementing regulation of 26 June 1970 made the international system of units (SI units) part of German legislation [2]. The law lays down the SI basic units with their definitions as well as the prefixes for decimal multiples and submultiples of units. The implementing regulation defines the legally derived units. Except for some minor details, the electrical SI units are identical with the units stipulated by the 1898 law on electrical units of measure.

Following the EC directive of 1981 the "Units of Measure Act" and its implementing regulation had to be revised. The amendment is dated 22 February 1985, the implementing regulation 13 December 1985. The wording of law, implementing regulation and EC directive is to be found in [3]. The amended law and implementing regulation no longer include definitions of units, but refer instead to standard DIN 1301-1, edition December 1985. While the law and implementing regulation are only applicable to official and business usage, DIN 1301 standard is valid without any such restriction.

DIN paperbacks 22 [4] and 202 [5] give an overview of DIN standards on quantities, units, symbols and equations. The standards quoted in this refresher topic are listed in TABLE 1 and are published by NATG, division

SI basic quantity		SI basic unit	
Name	**Notation**	**Name**	**Notation**
Length	*l*	Meter	m
Mass	*m*	Kilogram	kg
Time	*t*	Second	s
Electric current	*I*	Ampere	A
Thermodynamic	*T*, *Θ*	Kelvin	K
Amount of substance	*n*, *v*	Mole	mol
Luminous intensity	I_v	Candela	cd

TABLE 2 SI basic quantities and units [7]

Quantity		Derived SI unit	
Name	**Notation**	**Name**	**Symbol**
Energy	*W*	Joule	J
Power	*P*	Watt	W
Electric potential	*U*	Volt	V
Electric charge	*Q*	Coulomb	C
Electric capacitance	*C*	Farad	F
Electric resistance	*R*	Ohm	Ω
Electric conductance	*G*	Siemens	S
Magnetic flux	*Θ*	Weber	Wb
Magnetic flux density	*B*	Tesla	T
Inductance	*L*	Henry	H
Frequency	*f*	Hertz	Hz

TABLE 3 Derived electrical quantities and units with special unit symbols [7] (NB: if it is clear from context that electrical quantity is referred to, adjective "electric" can be omitted)

Prefix	Symbol	Factor
Yocto	y	10^{-24}
Zepto	z	10^{-21}
Atto	a	10^{-18}
Femto	f	10^{-15}
Pico	p	10^{-12}
Nano	n	10^{-9}
Micro	µ	10^{-6}
Milli	m	10^{-3}
Centi	c	10^{-2}
Deci	d	10^{-1}
Deca	da	10^{1}
Hecto	h	10^{2}
Kilo	k	10^{3}
Mega	M	10^{6}
Giga	G	10^{9}
Tera	T	10^{12}
Peta	P	10^{15}
Exa	E	10^{18}
Zetta	Z	10^{21}
Yotta	Y	10^{24}

TABLE 4 Prefixes and prefix symbols for decimal submultiples and multiples of units [7]

A: units and quantities, which is the competent technical committee of DIN (Deutsches Institut für Normung e.V. or German Standards Institution). They have been agreed upon with the competent international organizations (eg ISO and IEC) and describe the internationally recognized state of the art [6].

SI basic quantities and units are listed in TABLE 2, TABLE 3 shows the derived quantities and special units important in electrical engineering. TABLE 4 specifies the prefixes and prefix symbols for decimal multiples and submultiples of units. The prefixes and their symbols are used exclusively with unit names or unit symbols. There is no space between the prefix and the unit symbol, ie prefix and unit symbol form the symbol for a new unit.

SI units must be written as specified by legislation and standards and may not be modified by additional information such as superscripts and subscripts. Units are neither put in brackets nor parentheses (DIN 1313, DIN 461).

To be continued

Dr Klaus H. Blankenburg

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[1] Draht, P.: Leitfaden für den Gebrauch des Internationalen Einheitensystems. Physikalisch-Technische Bundesanstalt, Braunschweig (1996)

[2] Sacklowski, A.; Röhrl, E.: Einheitenlexikon, Begriffe, Größen, Einheiten in Physik und Technik unter Berücksichtigung des neuen Einheitengesetzes. Deutsche Verlags-Anstalt, Stuttgart, 4th edition (1973)

[3] Sacklowski, A. (edited by Drath, P.): Einheitenlexikon, Entstehung, Anwendung, Erläuterung von Gesetz und Normen. Beuth-Kommentare, publisher: DIN Deutsches Institut für Normung e.V., Beuth Verlag GmbH, Berlin, Cologne, 1st edition (1986)

[4] DIN paperback 22 (AEF paperback 1): Einheiten und Begriffe für physikalische Größen, Normen. Publisher: DIN Deutsches Institut für Normung e.V., Beuth Verlag GmbH, Berlin (1990)

[5] DIN paperback 202 (AEF paperback 2): Formelzeichen, Formelsatz, Mathematische Zeichen und Begriffe, Normen. Publisher: DIN Deutsches Institut für Normung e.V., Beuth Verlag GmbH, Berlin (1994)

[6] Garlichs, G.: Grundlegende Normung für die Elektrotechnik. telekom praxis (8/93)

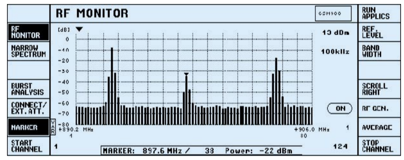
[7] DIN 1301-1: Einheiten, Einheitennamen, Einheitenzeichen (12/93)

New measurement functions for Radiocommunication Tester CMD55

Digital Radiocommunication Tester CMD55 for testing GSM mobile phones in production and high-level service environments [1] now features new measurement functions that provide additional applications and improved performance.

The sensitivity of a digital mobile phone is determined from its bit error rate (BER), for which purpose a specific RF signal level is applied to the tester. GSM specifications say that class II BER of handhelds should be lower than 2.5% for a signal level of –102 dBm. CMD55 now also features a **class II BER search routine.** The user selects a BER and the tester varies the RF signal level until the given BER is obtained. This yields a very simple definition of sensitivity (RF signal level in dBm) and is comparable to sensitivity measurements on analog radiotelephones.

In production the sensitivity of GSM mobile phones is usually checked by a BER measurement on three different RF channels. This is quite time-consuming since a large number of bits have to be selected to obtain conclusive results. CMD55 is now capable of performing **burst-by-burst BER measurement,** which cuts the time required for sensitivity measurements in production to a fifth. GSM differentiates between protected (class I) and unprotected bits (class II). The number of class I bit errors is a measure of error correction quality, the number of class II bit errors expresses RF receiver hardware quality. Seeing as the primary aim of production tests on GSM mobile phones is to check RF characteristics, it is sufficient to measure class II bit error rate. A GSM speech frame consists of class I and class II bits. GSM BER measurement is made in loopback mode, ie received speech frames with given pseudo-random bit contents are sent back immediately and then compared.



RF monitor of CMD provides fast overview of entire GSM band.

The new fast BER measurement uses **burst-by-burst loopback** where the bits are returned without passing through the channel coder and decoder, meaning that all bits are unprotected. In normal BER measurement however, only 78 out of 456 bits are unprotected. Which is why burst-by-burst BER measurement is faster for class II bits.

GSM stipulates power ramp and phase/frequency error measurements for transmitters. In both cases the test signals must have a training sequence in the middle of the burst (midamble). CMD55 can now carry out **transmitter measurements on signals without midamble.** A power trigger signal is used for power ramp measurement timing. This allows testing of RF modules that have no GSM-conformant modulation contents, because the modulation generation circuit is not yet ready designed for example, or because a digital module supplies the modulation.

Optionally CMD55 can be fitted with a narrowband spectrum analyzer for the alignment of I/Q modulators [2]. Now CMD55 also supports an **RF monitor** covering all GSM bands (FIG). This measures every 200 kHz and displays graphic results. Measurements are carried out on both the uplink and downlink band, so RF signals can easily be searched for on RF modules or mobiles in service mode if the channel number is unknown or wrong (uplink) for example. On the downlink a receiving antenna and the sensitive RF input of CMD55 make it possible to verify whether there are any signals from GSM base stations and what their strength is. This prevents erroneous measurements, since sensitivity measurements at very low RF levels can be corrupted by adjacent base stations emitting direct into the mobile phone.

Dual-band mobile phones of the future will offer GSM900 and GSM1800 or GSM1900 capability in a single unit. CMD55 can already perform **dual-band handover,** ie change between GSM900 and GSM1800 or GSM1900 bands. On the one hand, this function allows a dual-band mobile phone to be checked for proper handover. On the other, it reduces test time in production since only handover to the second network is needed instead of call cleardown and subsequent call setup in the second network.

Incidentally, class II bit error rate search routine and RF monitor are now also available for Base Station Testers CMD54/57/59.

Werner Mittermaier

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[2] Mittermaier, W.: Alignment of I/Q modulators by narrowband RF spectrum analysis. News from Rohde & Schwarz (1996) No. 151, p 36

Reader service card 157/17 for further information on CMD55

Antenna calibration site of BAPT in Itzehoe

The German Post and Telecommunications Office (BAPT) in Mainz is a government authority responsible for, among other things, radiomonitoring and radio interference suppression. The Radio Monitoring and Inspection Service (PMD) with 53 branch offices all over Germany is equipped with state-of-the-art test and measurement equipment. Maintenance, repair and calibration of this T&M equipment are mainly carried out in BAPT workshops and calibration centers. Regular calibration ensures high precision of results including the required traceability to recognized methods and standards.

FIG 1 Open-area antenna test site of BAPT in Itzehoe with its two 8 m high antenna rigs
Photo 42 965/1

Since March 1997 the BAPT office in Itzehoe (Schleswig-Holstein) has been using a new test system for highly precise antenna calibration to CISPR 16-1 and DKE 767.4.2/Ant-Cal. No. 31-93 (dated 19 July 1993) in the frequency range 30 to 1000 MHz. This is the first standard-conformant test equipment of its kind in Germany. Acceptance carried out by the internationally accredited research and test institute Seibersdorf near Vienna was successfully concluded and, in autumn 1997, the calibration system was additionally accredited by the German Standards Laboratory (PTB) in Braunschweig.

The system was evolved from an existing Calibration System for Test Equipment TS9099 from Rohde & Schwarz*. The core of this enhanced system is an open-area site (test distance 10 m) on a reinforced concrete platform 20 m x 17 m in size. The site has an unobstructed overall area in the form of an ellipse with axes of 100 m x 85 m (FIG 1). It is constructed so that not only mobile antennas but also antennas on test vehicles can be calibrated. The maximum permissible load on the test platform is 7.5 t. The conducting reference plane consists of a metal groundplane made of a weatherproof V2A grid with mesh width of 2 cm x 2 cm. This groundplane is spring-loaded, maximum unevenness amounting to only 5 mm. The site is provided with two 8 m high antenna rigs in the form of double masts, both fitted with elevators for vertical positioning of antennas. In addition, the receiving mast can be rotated horizontally through 360° in steps of 2°. All antennas are positioned by electromechanical drives accommodated in the pit below the antenna rigs. During non-operational phases the rigs, because of their height, are secured by wires.

The open-area site is linked to the test system, about 100 m away (FIG 2), by power supply, signalling and control cables in underground conduits. Low-attenuation Flexwell cables are used for signal transmission and optical cables for system control. To avoid AC power line effects on measurement

* Pedersen, J.: Calibration System TS9099 – Automatic test equipment calibration to ISO9000. News from Rohde & Schwarz (1996) No. 152, pp 10–11

FIG 2
Germany's first standard-conformant antenna calibration system at BAPT in Itzehoe
Photo 42 965/10

results, shielded cables are used for the power supply. The site is safeguarded against lightning strokes by a grounding ring with the same potential as the test system in the building.

The calibration system for test equipment is complemented by an antenna controller with software for positioning antennas as required. On-site tests and measurements are monitored by special video equipment that covers every point of the active test area and provides special zoom facilities for high-resolution display of details on the monitor in the test room. Special calibration software was implemented to measure VSWR, antenna gain, radiation pattern and antenna factor. All tests are automatically controlled by Calibration System TS9099 and results are output as calibration reports.

Rohde & Schwarz as the main contractor planned the automatic open-area antenna calibration site, supervised its construction and handed over the turnkey system to BAPT on schedule. The test site is the first of its kind in Germany.

Alexander Klein (BAPT Mainz)

Reader service card 157/18 for further information on open-area antenna test sites

Mobile DF system for Danish Army

In 1993 the Danish Army drew up a concept for a new version of its mobile DAISY system (Danish Automated Intercept and Direction Finding System). The new concept was based on high operational requirements, eg 100% mobile, manual and automatic direction finding in the frequency range 0.3 to 1300 MHz (control from a mission center), search mode with optional suppression of selected frequencies and operation at both spot frequencies and through frequency bands, demodulation of AM, FM, SSB and CW signals, high bearing accuracy (maximum error after calibration 2° RMS), access by up to three operators and protection against overvoltage (lightning). And naturally user-friendliness was also a must.

After thorough investigations, calculations and product comparisons the commission decided in favour of analog Direction Finders PA510A (HF) and PA1555 (VHF/UHF) with the associated antenna systems from Rohde & Schwarz, plus the option

FIG 1 DAISY transport vehicles with shelters and folded-down VHF-UHF DF antenna from Rohde & Schwarz

FIG 2 Trailer for transporting power generator of DF system and HF DF antenna
Photos: Madsen

of changing to the newly developed Digital Monitoring Direction Finder DDF06M [1; 2], which offers higher accuracy and sensitivity at a better price thanks to its digital technology. The superiority of the digital solution was conclusively proven in comparison tests of the analog and digital direction finders, and so DDF06M direction finders were purchased for the DAISY project.

DAISY consists of subsystems, each made up of three DF vehicles with trailers, an escort vehicle, also with trailer, and a mission center. The Danish Army uses all-terrain vehicles from MAN as a platform for the direction finders (FIG 1). Existing shelters were modernized for this application. In the middle of 1997 the first DF systems were tested to standard specifications and passed with flying colours.

The Danish configuration of DDF06M comprises an HF DF converter, a VHF-UHF DF converter and a digital processing unit, permitting position finding of GSM stations in addition to standard system requirements. The system also by far exceeds the demands set for both accuracy and sensitivity.

One of the problems of using mobile direction finders for localizing shortwave transmitters is the size of the antenna system, making transportation difficult and requiring lengthy installation. Finding an ideal site is not easy either. So it was decided to divide the detection of HF signals in groundwaves (near field) and skywaves of low elevation angle, and in skywaves arriving with a high elevation angle.

Thanks to its low weight (approx. 25 kg including tripod) and reasonable dimensions, permitting fast setup and dismantling, the compact HF Antenna ADD115 is used for detecting groundwaves from 1 to 30 MHz. HF DF Antenna ADD011 was chosen for skywaves from 0.3 to 30 MHz. The antenna system weighing 400 kg can be set up by a trained team easily in about 45 min. VHF/UHF DF Antenna ADD051 is used for the frequency range 30 to 1300 MHz. It is mounted on a 9 m high telescopic mast with tilting facility allowing very fast installation. For transportation the dipole elements are stowed away in tubular containers located on the outside of the shelters.

The DF units in the shelters are fitted in shockproof 19-inch racks. Two operator positions complete the system equipment in the shelter: one for manual direction finding/radiolocation and one equipped with two receivers (0.3 to 512 MHz) and a controller for data transfer to the mission center during automatic operation. Four VHF transceivers for communication with the mission center are accommodated in an RF-tight cabinet. If the radio link fails, data can also be transmitted via modem on a dedicated telephone line.

The system power supply (3.5 kW generator) and HF Antenna ADD115 with accessories are transported on the trailers of the all-terrain vehicles. The trailer of the escort vehicle (Mercedes GD) carries the complete VHF/UHF DF Antenna ADD011. Located in this vehicle is the 150 m long antenna cable on motor-driven cable reels.

The cooperation team of DAISY ensures that the automated intercept and direction finding system of the Danish Army is fully operational at all times. The task of the team is to create a synthesis of hardware, software and operational requirements. The standing working team of DAISY includes representatives of material command, users of DAISY and members of the signals school of the Danish Army.

Bjarne Aagaard Jensen
(Danish Army)

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[1] Demmel, F.; Unselt, U.; Schmengler, E.: Digital Monitoring Direction Finders DDF0xM – State-of-the-art monitoring direction finding from HF to UHF. News from Rohde & Schwarz (1996) No. 150, pp 22–25

[2] Demmel, F.; Hinkers, G.: Networking digital direction finders for improving radiomonitoring efficiency and locating frequency-agile emitters. News from Rohde & Schwarz (1997) No. 156, pp 24–25

Reader service card 157/19 for further information on DDF0xM

Test equipment for electronics production

At productronica, the international show for electronics production staged in Munich in November last year, Rohde & Schwarz presented turnkey solutions for production and final testing, demonstrated live by a fully functioning section from a production line with an integrated LaserVision optical inspection system and a Combinational Test System TSU (photo above). The approximately 6 m long and $2\frac{1}{2}$ m wide, in-line test installation was designed and created in close cooperation with the firm CRS Prüftechnik. It is an extremely compact, self-contained system shielded by a metal enclosure, containing all necessary components and requiring only compressed air and power from the exterior.

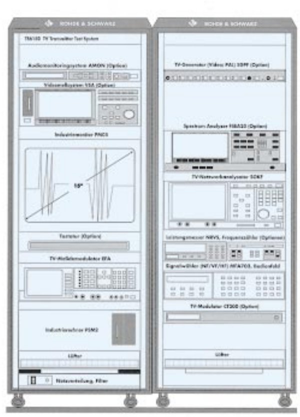
Circuit boards for testing are taken from a tray at the beginning of the line and undergo optical inspection as well as an in-circuit and functional test. Then they are stamped for identification and finally stacked in two trays, one for fault-free boards and one for faulty ones. An integrated quality management system collects the test data for paperless repair and evaluation. For the in-circuit and functional test the boards are interfaced on both sides by a short-wire cassette system, enabling inexpensive exchangeable adapters to be constructed as well as allowing fast and simple exchange of adapters. The feeder system sets automatically to the width of the boards, read from their serial number or type designation.

Industrial controls were tested on the demonstration system during productronica. The automatic test system integrates easily into any electronics production environment thanks to its high flexibility and compact design, and is also suitable for other applications like the automobile or communications industry.

PI

R&S test system in use by RTÜK

The Turkish Radio and Television Supreme Council (RTÜK) is responsible for the quality of radio and television transmissions in Turkey. For automatic measurements on and off the air, RTÜK selected a TS6150 system from Rohde & Schwarz (photo below). The system satisfies the strict specifications of German Telekom, which are ranked equivalent to a standard. Equipped with this installation, RTÜK is also able to test the quality of various makes of transmitter and so frame recommendations for different program broadcasters about what transmitter is most suitable for a site.



The first TS6150 is intended for use at RTÜK's headquarters in Ankara. Mobile systems will follow later so that RTÜK can visit transmitter stations and perform measurements on site.

M. Lehmann

Rohde & Schwarz participates in international shortwave program

Rohde & Schwarz is cooperating with Britain's University of Manchester in an international program to measure shortwave occupancy and utilization by the many radio services. A network of fully automatic radio observation stations will be set up all over Europe, the results from which are then to be centrally collected and evaluated. Following those in England and Sweden, the German station is the third in the network. It commenced operation in 1992 and is located at Rohde & Schwarz's antenna test site in especially low-noise surroundings outside Munich.

The nucleus of each of the stations is a Test Receiver ESH3, which is computer-controlled to cover the entire shortwave range and record the detected radio traffic. Active Antennas HE010 and HE015 are used in reception, being especially attractive for their frequency-independent electrical characteristics. All stations are controlled from Manchester through the normal telephone network. Here too the measured data are evaluated and then made available to interested parties like PTT administrations, governments as well as the partners in the program. In addition to the possibility of cooperating in an international research project, Rohde & Schwarz thus has access to data that are of considerable importance for designing and planning shortwave radio links. The findings will also appear in a number of scientific publications, in this way regularly highlighting Rohde & Schwarz's equipment and its role in the project.

Dr C. Rohner

DAB transmitters for China

Rohde & Schwarz is supplying three sound broadcast transmitters (band III) of 500 W output for a DAB pilot project in China. The trials are to start in the capital Beijing and the region as far as the port city of Tianjin 100 km away. The DAB transmitters are currently set up for testing at Rohde & Schwarz in Munich and were demonstrated in operation to a delegation of experts from the Chinese ministry for film and broadcasting when they recently visited Rohde & Schwarz on an information-gathering trip. An extra presentation of a DAB test receiver, receiving seven DAB programs live from the broadcaster Bayerischer Rundfunk, rounded off

the practical part of the visit. This was followed by discussions among the specialists about creating the DAB network in China. Systems for measuring DAB coverage will also be needed here, so the guests showed great interest in a software presentation of DAB field-strength measurement. True to the Chinese maxim "Seeing something once is better than hearing it a hundred times", the visitors were able to convince themselves of the performance of our products on a trip to the Wendelstein station of Bayerischer Rundfunk (photo above) to see the DAB transmitter from Rohde & Schwarz that is installed there.

J. Beckmann

New digital module for Production Test Systems TSA and TSU

In DSD Rohde & Schwarz is offering a new, realtime digital module for test systems of the TSAx and TSUx families (see News from R&S Nos. 145 and 150). It was designed specifically for functional tests on electronic boards with high voltage levels, so it is especially suitable for applications in control engineering and automotive electronics. Existing TSAx/TSUx systems can easily be retrofitted.

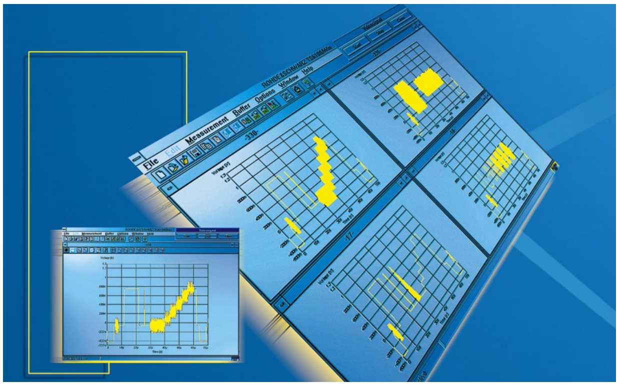
Digital module DSD presents a unique combination of high output level and high data rates, plus the capability of working in both source and sink mode. Drivers and sensors are programmable from 0 to 30 V and produce a data rate of 5 MHz. A maximum data rate of even 10 MHz is possible up to level offset of 15 V. The module has 32 test channels, each of which can source or sink up to 20 mA in both high and low state. Each test channel also features pullup/pulldown resistors, a pin memory (4 k x 5 bits) plus overvoltage and shortcircuit safeguards.

DSD now allows realtime tests up to 10 MHz on circuits that operate with higher digital levels for better noise immunity. Previously this was only possible at reduced data rates. The new kind of source and sink function, enabling the outputs of the tested circuit to be loaded up to 20 mA, means that real loading of the outputs can be simulated even at high data rates. Low level is also user-programmable (eg low = 10 V, high = 11 V), so parametric functional tests are possible with the DSD module too. PI

Attractively priced video measurements with PC card

Video PC Card VPC1000 is an inexpensive alternative to the familiar video instruments and systems from Rohde & Schwarz. It is primarily intended for monitoring video signals, eg of TV transmitters or in studios, but could also be used in production test systems. The card comes in different system configurations with the matching software. Or a ready installed PC like Process Controller PSP7 with batteries for mobile applications is obtainable. VPC1000 is an AT card (ISA bus, 8 bits) and can be multiply integrated in a PC for simultaneously monitoring several video signals. Signals are displayed live or averaged between four and 128 samples, optionally in trace form (photo below) – up to four displays each with a maximum of eight traces or limit lines – or as a parameter list with indication of status referred to the specified limits (reader service card 157/21).

C. Habermann



RSE surges ahead

At its 5th international sales manager meeting in autumn last year, in Anif near Salzburg (photo above), Rohde & Schwarz Engineering and Sales GmbH (RSE) was not only able to report a further increase in turnover, in the last business year it achieved the best result in all the 25 years of its existence. The biggest sellers – as in the years before – were the products of the Japanese manufacturer Advantest. So all sales managers responsible for these products from 14 time zones were again invited to the meeting, representatives from Poland and New Zealand attending for the first time. To pave the way for RSE's continuing success, group discussions were staged with important decision-makers for hardware and software developments, who travelled from Japan especially for the purpose.

At this meeting too there was recognition of special achievement at home and abroad. Brazil and the Nuremberg office produced the biggest turnover growth, the strongest selling agency abroad, for the second time, was France. Italy was awarded a special prize for exceptional achievement. Cologne's results were quite spectacular: not only the best home sales for the fifth time in succession but also the most successful agency worldwide.

To terminate the event and as a small thank-you for the successes achieved, the managers were able to demonstrate their team spirit and endurance while canyoning in the Almbach gorge. P. Wollmann

R&S France receives award for 1000th NGSM

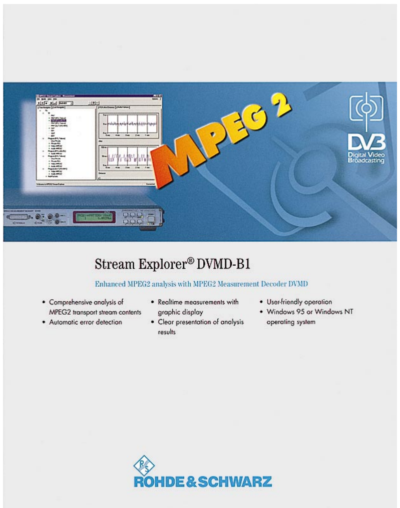
A special trophy (photo below) recently went to Rohde & Schwarz France (RSF), awarded by Rohde & Schwarz Engineering and Sales GmbH. RSF sold the 1000th Power Supply NGSM32/10 (of more than 1500 in the meantime). NGSM32/10 is a compact, high-performance laboratory power supply with arbitrary function. Its major uses are in the mobile radio and automotive electronics sectors.

High resolution for standby current measurement on the one hand and high output power with pulse load resistance on the other make this linear regulated and moderately priced power supply an ideal source for devices under test. Drivers for different applications (eg LabView, LabWindows) allow easy integration into sophisticated test environments.

L. Fischer

Video PC Card VPC1000 measures video signals cost-efficiently and without supervision; Windows 3.1 driver (DLL), several cards can be used in one PC.

Data sheet PD 757.3528.21 enter 157/21



Stream Explorer® DVMD-B1 Windows NT or Windows 95 software for MPEG2 transport stream analysis with automatic error detection and graphic display.

Data sheet PD 757.3628.21 enter 157/22

Stream Combiner® DVG-B1 This software enables generation of MPEG2 transport streams under Windows NT or Windows 95; insertion of internal/external elementary streams, setting of nonconformal states.

Data sheet PD 757.3611.21 enter 157/23

DVB-T Modulator SDB-M (to ETS 300 744) converts MPEG2 transport streams into OFDM signals for IF or RF range; optional SFN adapter.

Data sheet PD 757.3634.21 enter 157/24

DVB-T Transmitter Family NV500 (470 to 860 MHz) to ETS 300 744 is compact and of modular design, cost-efficient, system-compatible (SFN) and available in eight different power classes (250 W to 4 kW (rms)).

Data sheet PD 757.3640.21 enter 157/01

Vector Signal Analyzer FSE-B7 The new eight-page data sheet now includes analysis of analog mobile radio signals; Spectrum Analyzers FSEM and FSEK are also described.

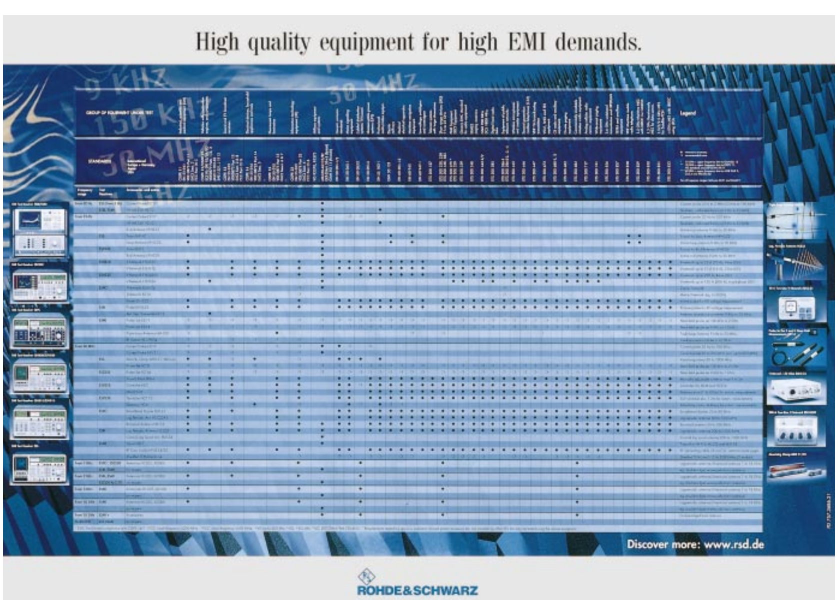
Data sheet PD 757.2167.22 enter 157/25

Audio Monitoring System AMON monitors the quality of audio transmission equipment during program time by simultaneously measuring the program signal at source and sink and transmits remote-control data; automatic measurement to CCITT 0.33 possible, optional sound generator.

Data sheet PD 757.3534.21 enter 157/26

Audio Data System ADAS transmits parallel and serial data (also RDS) within the program signal (carrier 14.85 kHz, amplitude −50 to 35 dB) at 2 x 400 bit/s via audio lines, 34 Mbit/s links, ADR or ISDN.

Data sheet PD 757.3540.21 enter 157/27

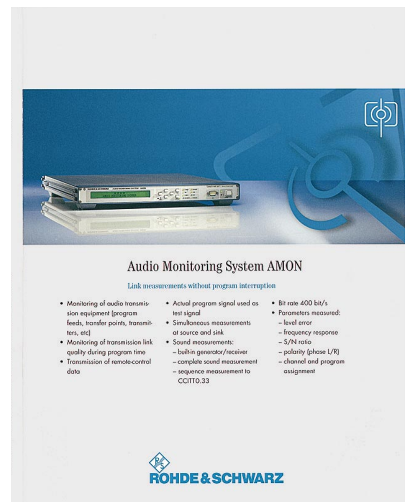


Audio Analyzer UPL The data sheet now also includes options UPL-B6 (extended analysis functions: transfer, rub & buzz as well as extended multisine generator), UPL-B7 (for measurements on hearing aids) and UPL-U3 (analog generator output 150 Ω).

Data sheet PD 757.2238.22 enter 157/28

TV Test Transmitter SFQ (0.3 MHz to 3.3 GHz) The specifications of the analog model 90 as well as those of the digital/analog model 50 (models 10 + 90) have been included.

Data sheet PD 757.3334.22 enter 157/10



TV Test Receiver Family EFA (45 to 860 MHz, demodulator up to 900 MHz) has been extended by models 72 and 83 (analog receiver and analog demodulator) for M/N standard; new options: residual-carrier measurement with EFA-B8 and 6 MHz SAW Filter EFA-B11.

Data sheet PD 757.2421.22 enter 157/11

High-quality equipment for high EMI demands This poster (DIN A1 format) lists EMI measurements standards and the appropriate R&S equipment.

Poster PD 757.3686.21 enter 157/29

New application notes

Multiport Measurements using Vector Network Analyzer ZVR
Appl. 1EZ37_0E enter 157/30

Measurement of Modulation Spectrum on GSM/DCS/PCS Mobiles according to GSM 11.10-1
Appl. 1MA01_0E enter 157/31

Schz

The June/July issue of the Dutch telecommunications magazine "Verbinding" brought out Digital Radio Tester CTS55 big on its cover spread and devoted an article inside to the best-selling features of this Rohde & Schwarz product.

Air mail on Internet

The European edition of "Telecommunications" (9/1997) presented the Message-Handling Software PostMan from Rohde & Schwarz:

More and more, especially from the USA, there is a call for integrating shortwave and VHF/UHF radio links into international communication networks. With its Message-Handling Software PostMan, Rohde & Schwarz is first to satisfy the demand in the case of the trusty and inexpensive shortwave medium. Access to global communication networks used to be a wired reserve, but now PostMan opens up the world of international networks to users in out-of-the-way regions.

Rohde & Schwarz supplies gauge for ICO mobiles

At the signing of the contract for the development and production of reference test equipment for satellite-supported dual-mode mobiles between London's ICO Global Communications and Rohde & Schwarz, a press conference was held in Munich. Many magazines reported the event, including "Elektronik Praxis" (15/1997):

The reference test equipment for the dual-mode mobiles of the future will be developed by Rohde & Schwarz. This was agreed between ICO Global Communications and the Munich firm. "We're proud of the trust ICO is putting in us", said Dr Wolfgang Winter, Managing Director of Rohde & Schwarz UK, at the official contract signing. And Olaf Lundberg, CEO of ICO, commented: "This cooperation with Rohde & Schwarz means a lot for us".

A burn-in scenario decorated the title page of the European issue of the US electronics magazine "Test & Measurement" (4/1997). The accompanying article emphasized, with reference to Board Test System TSAP from Rohde & Schwarz, that burn-in can reduce the number of early failures and so substantially enhance reliability for electronic boards too, and not only for individual components.

◁ ▷

Twice more, Vector Signal Generator SMIQ has won a place in the sun. "Funkschau" (21/1997) showed it on its cover and presented it in a focus article "Test equipment for professional digital radio". "hf-praxis" (9/1997) highlighted SMIQ in its role as a signal generator plus fading simulator (see also report in right column "Taming of the fade").

DAB forever

"FAZ" of 2 September 1997 looked into the subject of digital radio in its "Technology and Business" column, interviewing Jürgen Nies, Director of Marketing and Applications of the Broadcasting, Paging and Broadband Communications Division at Rohde & Schwarz:

After lengthy discussion industry is now convinced that DAB will make its way. There is no stopping digitization, according to Jürgen Nies, Director of Marketing of Rohde & Schwarz in Munich, the world's leading supplier of DAB installations with 60% market share. …For one thing most DAB programs can also be received on FM, which, for DAB specialist Nies, is also due to the "extra benefits neglected until now" in the form of receiving data, text and pictures.

Taming of the fade

The monthly "Elektronik-Journal" was highly appreciative in its August issue of the combination of fading simulator and signal generator implemented in the new SMIQ from Rohde & Schwarz:

Three instruments were needed until now to generate real-world test signals: a signal generator, a local oscillator and a fading simulator. But Signal Generator SMIQ with fading simulator option from Rohde & Schwarz unites all three functions in a single unit and offers the full fading simulation functionality prescribed in the test specifications of various mobile radio standards.

Five years of Rohde & Schwarz subsidiary FTK

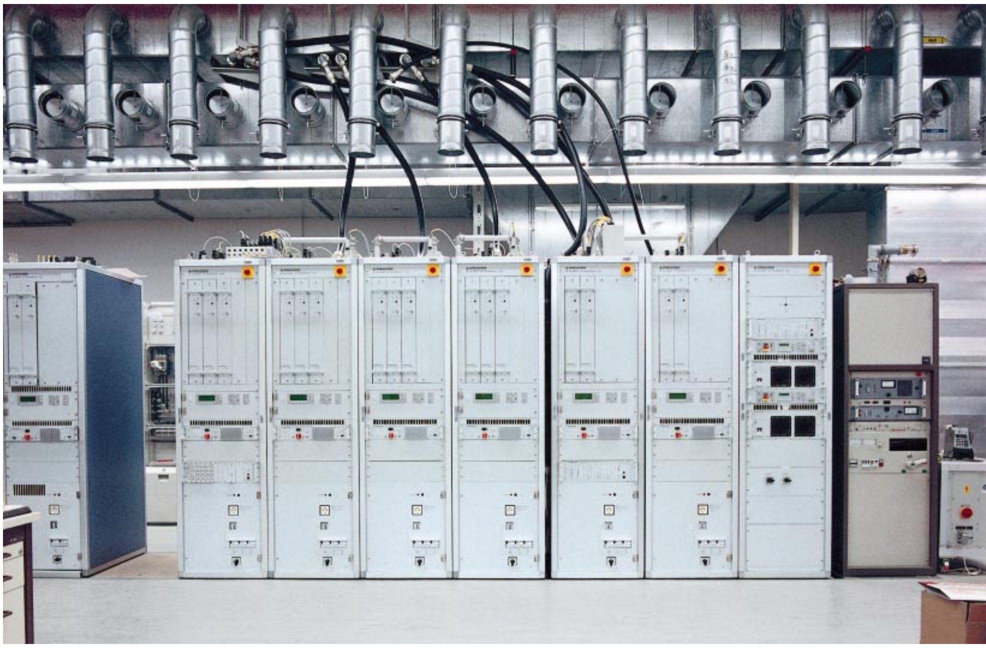
FIG 1 The Rohde & Schwarz FTK team

FTK Funktechnik Köpenick was founded in September 1992 as a wholly owned subsidiary of Rohde & Schwarz. FTK develops, produces and markets VHF FM transmitter systems and amplifiers worldwide for research and technical applications. It is located in the Berlin district of Köpenick, the largest and, thanks to its extensive woodlands and lakes, one of the most scenic parts of Berlin. FTK succeeded the former Funkwerk Köpenick, founded in 1949, which developed and produced a wide range of radio equipment, in particular large long-, medium- and shortwave transmitters as well as VHF sound transmitters and TV transmitter systems. Initially, in 1990, Rohde & Schwarz and Funkwerk Köpenick concluded an OEM agreement for the production of transmitters and antennas at the Köpenick works, and when FTK Funktechnik Köpenick was set up in 1992, Rohde & Schwarz took over part of the personnel engaged in transmitter construction. The first challenging project for the new corporate formation (FIG 1) was a major order from Russia. Within eight months a total of 56 tubed 10 kW transmitters were manufactured, tested, packed and shipped to their destinations. As of the beginning of 1996, all VHF sound broadcast activities of Rohde & Schwarz have been handed over to FTK and the equipment is sold worldwide under the name of this subsidiary.

In organizational terms FTK is closely linked to the parent company in Munich and to the Rohde & Schwarz plants in Memmingen and Teisnach. Prefabrication is handled in Memmingen and Teisnach, while Berlin performs final assembly and testing. The products are marketed through the worldwide Rohde & Schwarz sales network. Data links between Berlin and Munich guarantee rapid and automatic exchange of information .

The production and design activities of FTK focus on **VHF FM transmitter systems** and include everything from planning through manufacture and assembly to commissioning of the ready systems (FIG 2). The output power of the line of VHF sound broadcast transmitters – with or without RDS coder – ranges from 20 W to 20 kW. Sturdiness, modularity and clarity are distinguishing design features of all transmitters, which are particularly renowned for their high reliability and serviceability. The standard exciter is microprocessor-

FIG 2 VHF transmitter system in FTK's test department. This system is to be sited at Aurich in East Frisia and consists of 3.75 kW, 2.5 kW and 600 W transmitters.



ized with synthesizer technology and also includes the transmitter control unit as well as diverse fault-detection and diagnostic facilities. Serial and parallel interfaces allow remote transmitter monitoring. The solid-state transmitters

FIG 3 Compact solid-state VHF FM Transmitter SR610E1 for 10 kW output power

are of advanced MOSFET design, and microstrip circuits are exclusively used in power couplers and splitters as well as amplifier stages to reduce alignments to a minimum and guarantee high operational reliability. The use of identical exchangeable modules in all power classes makes for economical servicing.

Sound broadcast transmitters from FTK are used by many big-name broadcasters in Germany and abroad. Examples at home are the ARD (public German broadcaster) stations at Steinkimmen (NDR), Nordhelle (WDR), Perl (SWF) and Hohenpeissenberg (BR). Deutsche Telekom equipped its transmitter stations at Inselsberg, Brocken, Dresden and Leipzig with FTK equipment. The countries where systems have been sold include Austria, the Netherlands, Slovakia, Norway, Thailand, Iran and Poland.

At the international IBC 1997 show in Amsterdam the new family of high-power solid-state transmitters SR6..E1 with output power of 2.5 to 10 kW was presented. Visitors' response was extremely positive, commending in particular the price, which is considerably lower than that of predecessor models, and the very compact and clear design, allowing a 10 kW solid-state transmitter to be housed in a single 19-inch rack for instance (FIG 3). Efficiency, improved by 18% to 65%, also made a good impact.

FTK is also very successful in the field of **RF amplifiers for scientific applications.** Customers include BESSY in Berlin, DESY in Hamburg, MPI in Heidelberg, CERN in Geneva (Switzerland) and INFN in Frascati (Italy), whose systems

FIG 4 75 kW klystron amplifier system (500 MHz) for scientific applications

accelerate particles and investigate them through the application of high-frequency energy. Accelerated electrons and deflection are used to produce synchrotron radiation, which can be described as a highly brilliant light. This is more intense and more strongly coned than laser light, lies in the infrared to X-ray frequency range and is continuously variable. Fields of application are research in various disciplines (eg lithography, medicine, biology, materials science, micromechanics).

Besides the 75 kW klystron amplifier for 500 MHz (FIG 4), presented in NEWS No. 156, and a planned 150 kW model, a number of tubed amplifiers for scientific applications are also available from FTK: 50 kW (73 MHz), 20 kW CW and 90 kW pulse power (108 MHz) as well as 3 kW CW and 16 kW pulse power (482 MHz). The 482 MHz amplifier was developed for a weather radar. Noise attenuation in the pulse pauses is 160 dBc per Hz bandwidth, which is almost at the physical limit. The ground-based weather radar can measure air movements at altitudes of up to 20 km.

Summarizing, VHF sound broadcast transmitters as well as amplifiers for scientific applications are both areas in which the brand name Rohde & Schwarz FTK has become synonymous with competence, reliability and value-for-money.

Elke Schulze

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