News from Rohde & Schwarz

W-CDMA
– third mobile-radio generation

MOSFET transmitters
for TV band III

Compact antenna system
for radiomonitoring up to 3 GHz

1998/IV
160

ROHDE&SCHWARZ

Number 160 1998/IV Volume 38

Wideband CDMA is a focal topic of this issue. Rohde & Schwarz already offers a line of sophisticated test instruments for this type of wideband digital modulation – for example Signal Generator SMIQ and I/Q Modulation Generator AMIQ. A new product just launched: Signal Analyzer FSIQ for analysis of physical W-CDMA parameters (see article on page 4). Photo 43 208

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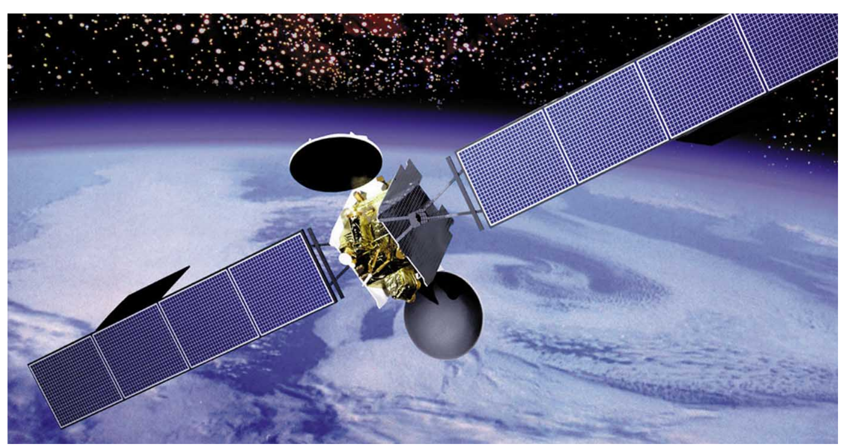

Three satellites of the US provider WorldSpace will soon be supplying approx. 4.6 billion people around the globe with sound broadcast programs. Rohde & Schwarz developed two new models of Vector Signal Generator SMIQ for production testing of portable WorldSpace receivers with built-in patch antenna (page 7).

Imprint

Published by ROHDE & SCHWARZ GmbH & Co. KG Mühldorfstraße 15 D-81671 München Telephone (0 89) 41 29-0 · international (+49 89) 41 29-0 · Editors: H. Wegener and G. Sönnichsen (German) · English translation: Dept. 5CL4 · Photos: S. Huber · Artwork: N. Kneidel · Circulation 95 000 four times a year · ISSN 0028-9108 · Supply free of charge · State company or position · Printed in the Federal Republic of Germany by peschke druck, München · Reproduction of extracts permitted if source is stated and copy sent to R & S München

Signal Analyzer FSIQ

The ideal analyzer for the third mobile-radio generation

The decision to implement digital wideband CDMA for the third generation of mobile radio – following analog FM and GSM – represents a milestone not only in transmission technology but also in the related measurement technology because of the larger bandwidth available for transmitting data and graphics. The FSIQ signal analyzer family was developed specially for examining the physical parameters of wideband CDMA signals, besides supporting the measurements used for previous transmission modes.

FIG 1 Signal Analyzer FSIQ7 for 20 Hz to 7 GHz Photo 43 185/2

The **FSIQ family** comprises **three models** with different frequency ranges:

- FSIQ3 20 Hz to 3.5 GHz
- FSIQ7 20 Hz to 7 GHz
- FSIQ26 20 Hz to 26.5 GHz

The instruments are follow-on developments of Spectrum Analyzers FSEA30, FSEB30 and FSEM30 [1; 2; 3]. These analyzers provide the ideal basis in terms of bandwidth and dynamic range to meet the requirements of W-CDMA standards (ARIB and ETSI). Signal Analyzer FSIQ (FIG 1) analyzes W-CDMA (wideband code-division multiple access) signals in frequency, time and modulation domains, meeting needs not normally fulfilled by previous instruments at the RF interface. Essential parameters of the analyzer are resolution bandwidths up to 10 MHz, wide dynamic range, fast sampling in the time domain and capability for processing high chip rates. The superior characteristics of the FSIQ family become evident when looking at the most important measurements, for example at the RF output of a W-CDMA base station.

W-CDMA measurements

For high-accuracy **power measurements,** FSIQ incorporates an rms detector that determines power within the measurement bandwidth over a wide dynamic range irrespective of waveform. No software correction factors are needed since FSIQ measures the power correctly from the start. It determines the power of a signal spectrum at each test point of a trace. The user can define the duration of power measurement and thus the stability of results by selecting the appropriate sweep time.

To make measured power comparable with results produced by a thermal power meter, special importance is attached to measurement accuracy. Up to 2.2 GHz, the guaranteed absolute level measurement uncertainty of FSIQ is max. 1 dB (from reference level to 50 dB below reference level in the display range). Statistical analyses of final production reports of the FSE family (valid also for the FSIQ family) covering over 100 units have revealed a measurement uncertainty of only 0.5 dB (95% confidence level). With option FSE-B22 (Increased Level Accuracy) this value is guaranteed. Fitted with this option, FSIQ can in many cases replace a power meter, thus eliminating the need for complex mechanical switches in automatic test systems for example.

FSIQ features easy-to-operate software routines with presettings for the W-CDMA system for measuring power and occupied bandwidth. It also offers the bandwidths (5 or 10 MHz) and detectors required for measuring the ratio of peak power to average power (crest factor), which is especially important in amplifier design for W-CDMA transmitters and receivers.

A major measurement in the frequency domain is that of **adjacent-channel power** [4]. This makes tough demands on analyzer dynamic range, especially when you are measuring at component or module level, where rated characteristics have to be substantially bettered for the complete transmitter system to meet specifications. In addition, the instrument should have a dynamic range 6 to 10 dB better than the EUT. The excellent dynamic range of the FSE family was improved even more in FSIQ by implementing new circuit concepts. For example, the 3rd-order intercept point for the W-CDMA frequency ranges is typically 18 dBm with FSIQ3, 20 dBm with FSIQ7 and 22 dBm with FSIQ26. The unparalleled noise figure of the FSE family is of course also implemented in FSIQ. The third parameter decisive for dynamic range, ie the phase noise of internal oscillators, was reduced by several dB for carrier offsets starting from 100 kHz (FIG 2).

These three characteristics of FSIQ combine in FSIQ7, for example, to yield a dynamic range for power measurements on W-CDMA signals of approx. 75 dB in the adjacent channel

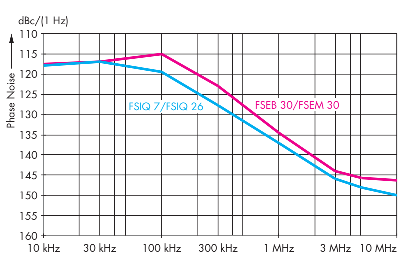

FIG 2 Phase noise of FSIQ7 and FSIQ26 at 500 MHz compared with FSEB30 and FSEM30

(4.096 MHz channel bandwidth, 5 MHz channel spacing) and approx. 81 dB in the alternate channel. FIG 3 shows the dynamic range achievable with FSIQ7. This range is determined by the inherent thermal noise power, the power of adjacent-channel intermodulation products and by the SSB phase noise power of the internal oscillators in the adjacent channel. The measurable adjacent-channel power is

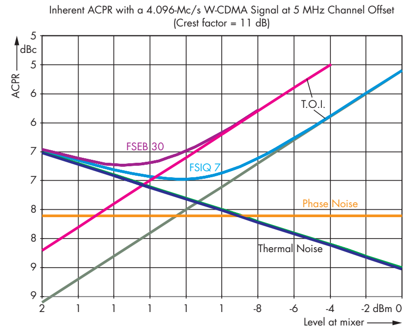

FIG 3 Comparison of achievable inherent adjacent-channel power ratio (ACPR) of FSIQ7 and FSEB30 as function of level at input mixer

largely influenced by the sum of these three power components.

With a level of approx. –12 dBm at the input mixer and an 11 dB crest factor of the W-CDMA signal, FSIQ7 attains an inherent adjacent-channel power ratio (ACPR) of about 75 dBc. This not only meets current standard requirements for mobile and base stations with a comfortable margin but also allows measurements on submodules. The routines offered for adjacent-channel power measurements on W-CDMA signals allow up to seven channels to be covered in a single sweep (power of transmit channel and power of three adjacent channels above and below transmit channel).

Measurement of spurious emissions makes exacting demands on analyzer dynamic range in any type of transmission system. High power levels have to be handled (eg 20 W of a base station), plus very low spurious emission levels are specified to avoid interference to other radio services. A special feature of third-generation mobile radio is its large transmission bandwidth. To measure spurious emission levels correctly, you need resolution bandwidth of 5 MHz for example, corresponding to the transmission bandwidth of the useful signal (5 MHz at 4.096 Mchip/s transmission rate). FSIQ not only offers the right resolution bandwidth but, thanks to its low noise figure, also the dynamic range necessary for measuring spurious emissions without any additional equipment. Only harmonics measurements require a simple highpass filter. The rms detector ensures accurate, fast and stable measurements of spurious emissions (FIG 4).

To achieve optimum capacity in a CDMA radio network, it is essential to regulate the transmit levels of all subscribers to the lowest possible value to avoid interference to other subscribers, since they all operate on the same channel. A base station, for example, is capable of readjusting the transmit power every 625 µs in steps of 1 dB. Specified power levels are to be ob-

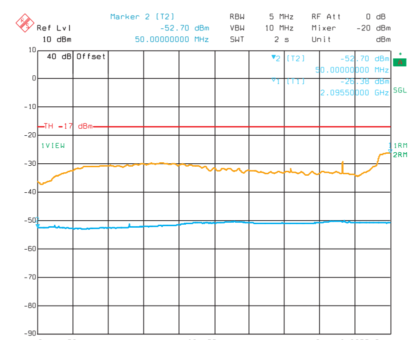

FIG 4 Measurement of spurious emissions from 50 MHz to 2 GHz with rms detector at assumed 20 W power of base station. Red line: 60 dBc limit value; yellow trace: spurious emissions of transmitter; blue trace: noise floor of FSIQ7 without input signal

served with close tolerances. To verify compliance, a signal analyzer must offer large bandwidth, highly linear level display and **fast power measurement in the time domain.** The FSIQ family is well prepared to handle these measurements on all three counts. With measurement bandwidth of 10 MHz and a 20 MHz A/D converter for digitization of the video voltage, level steps are easily followed and displayed. Display linearity is so high that tolerance margins can be allowed practically exclusively for the EUT. The

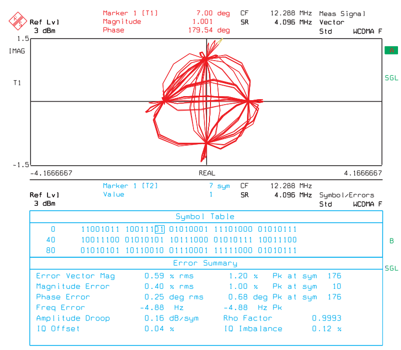

FIG 5 Measurement of modulation errors of W-CDMA signal. Top: vector diagram; bottom: list of modulation errors

rms detector measures power with high precision, and timeslot measurements are supported by software routines for power measurements over definable time intervals.

Modulation error measurements on broadband signals place very high demands on the analyzer's amplitude and phase distortion on the entire signal path from RF connector through to A/D converter. A new method for correcting both the inherent amplitude and phase response of the analyzer makes for extremely low total distortion of FSIQ across a bandwidth of 8 MHz about the receive frequency. This results in a very low instrument error in signal demodulation measurements. For W-CDMA signals (QPSK, 4.096 Mchip/s), the typical error vector magnitude (EVM) of less than 1% is low enough to allow even transmitter submodules with their stringent specifications to be measured with high accuracy (FIG 5). All errors relevant to modulation such as EVM, magnitude error, phase error, frequency error, waveform quality factor, I/Q offset and I/Q imbalance are tabulated for the operator to see all information at a glance.

The FSIQ family not only demodulates W-CDMA signals but also general digital modulation formats such as BPSK, QPSK, offset QPSK, DQPSK, π/4DQPSK, 8PSK, 16QAM, MSK, GMSK, 2FSK, 2GFSK and 4FSK as well as analog modulation like AM, FM and PM. The maximum symbol rate for digital modulation is 6.4 Msymbol/s or 8 MHz signal bandwidth. In addition, FSIQ offers presettings for the main standards such as IS95 CDMA, GSM, NADC, TETRA, PDC, PHS, CDPD, DECT, PWT, APCO25, CT2, ERMES, FLEX, MODACOM and TFTS. This makes FSIQ suitable for multistandard applications.

General applications, remote control

Apart from its use for the third mobile-radio generation, the FSIQ family is also an ideal choice for measurements in general applications. Application software is available, for example, for measurement of noise figure (FSE-K3) or phase noise (FSE-K4).

High internal computing power (233 MHz Pentium processor, transputer and DSP network) not only results in high display update rates but also makes for extremely fast response in automatic IEC/IEEE-bus operation.

Josef Wolf

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[4] Wolf, J.: Measurement of Adjacent-Channel Power on Wideband CDMA Signals. R&S Application Note 1EF04_0E (1998)

Condensed data of Signal Analyzer FSIQ

Frequency range	20 Hz to 3.5 / 7 / 26.5 GHz
Amplitude measurement range	–155 to 30 dBm
Amplitude display range	1 to 200 dB, linear
Amplitude measurement error	<1 dB up to 2.2 GHz, <1.5 dB from 2.2 to 7 GHz, <2 dB from 7 to 26.5 GHz
Modulation measurement error	EVM <1% rms (typ.) for 4.096 Mchip/s (W-CDMA)
Resolution bandwidths	1 Hz to 10 MHz in steps of 1, 2, 3, 5
Calibration	autocalibration by internal routines
Display	24 cm colour TFT LC display, VGA resolution
Remote control	IEC 625-2 (SCPI 1994.0) or RS-232-C

Reader service card 160/01

Vector Signal Generator SMIQ02W / SMIQ03W

Test signals for digital WorldSpace satellite sound broadcasting

WorldSpace of Washington is currently setting up a digital satellite system to provide a wide range of programs to countries with inadequate broadcasting infrastructure. The planned, portable sound receivers have a built-in patch antenna for direct satellite reception. Rohde & Schwarz supplies the test equipment for use in the production of such receivers.

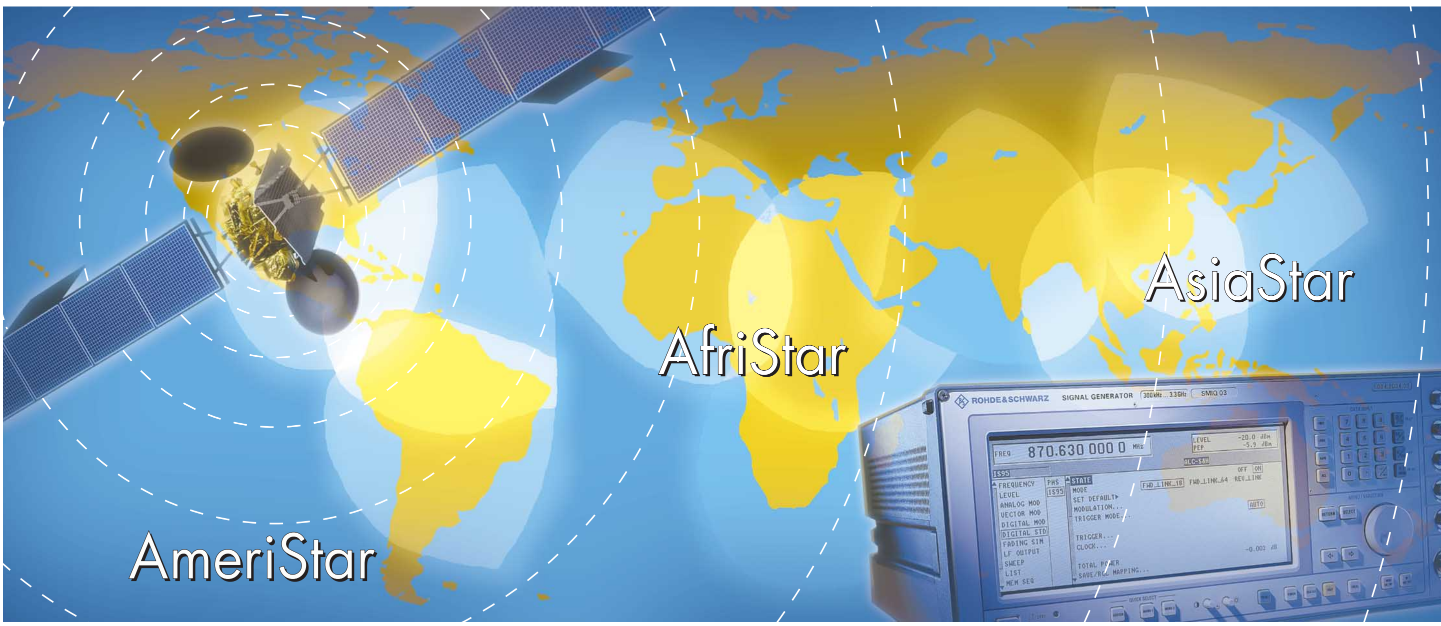

FIG 1 Three satellites of US provider WorldSpace will soon be broadcasting programs to more than 4.6 billion listeners. Vector Signal Generator SMIQ simulates real signals for tests in receiver production.

In its final configuration, the WorldSpace broadcast system will comprise three geostationary satellites. The first satellite is being brought into position above Africa in autumn 1998, the second one is to go into operation a few months later to provide coverage for the whole of South Asia, the third one is planned for South and Central America (FIG 1). According to WorldSpace, around 4.6 billion people will then be able to receive the satellite programs. The resulting demand for WorldSpace receivers is estimated to be 15 million per year!

Each satellite has three partly overlapping beams. Up to 96 program channels can be broadcast per beam, which means that one satellite is capable of transmitting up to 288 programs at a data rate of 16 kbit/s each. To enable transmission of audio signals at such a low data rate, they are first compressed in an elaborate data-reduction process (MPEG layer 3). Depending on the desired signal quality, the compressed audio signal will occupy between a half and max. eight channels. Quality categories range from "AM quality (mono)" to "CD quality (stereo)". Since a broadcasting station can change its channel assignment any time, it may for example transmit news on one program channel simultaneously in eight languages and then music in CD quality on all eight channels. Additional information such as station identification, currently transmitted language or program type sent along with the program make it easier for listeners to find the station they want. Broadcasters can also encrypt their programs so that they may only be received after entry of a code (pay audio).

Broadcasters lease their channels from WorldSpace and send the programs ready compressed in frequency-division multiplex at 7 GHz via a parabolic antenna direct to the satellite. The satellite receives the programs of all broadcasters, assigns them to the corresponding transmit beams and converts them to TDM (time-division multiplex) signals. As a result, the 96 channels of a transmit beam form a single serial bit stream. Complex error control is employed (Reed-Solomon encoding, interleaving and Viterbi convolutional encoding) to prevent transmission errors. The downlink is in the L band (1.5 MHz) with a polarized QPSK signal.

Measurement task

For measurements in the production of receivers it is necessary to simulate real receive conditions as closely as possible to ensure that each receiver leaving the factory will function properly for its user. Testing should not take too long, of course, because of the high-volume production that is envisaged. For this measurement application, Rohde & Schwarz has developed two further models of Vector Signal Generator SMIQ [1]: SMIQ02W (300 kHz to 2.2 GHz) and SMIQ03W (300 kHz to 3.3 GHz). The complete TDM signal of a transmit beam including all audio contents is calculated by means of PC program SMIQ-K3 and then loaded into the data memory of SMIQ via the IEC/IEEE bus. From the calculated signal, SMIQ generates the RF signal which is applied via a cable or an antenna to the receiver under test. Receiver functions are tested by an audio analyzer, for example UPL [2]. Nothing else – no extra encoders or data sources – is required to conduct the measurements.

Signal calculation

The first thing needed to generate a complete TDM test signal is program contents, ie audio signals. The wavefile generator of the SMIQ-K3 software can produce various audio test signals such as sine, multisine, sine sweeps and noise in mono or stereo. The sampling rate and length of the signal are selectable. The memory of SMIQ..W can hold signals up to a length of 20 s. Continuous signals are generated by repetitive output of the stored signal. The frequency of the individual audio signals is adjusted automatically so that the waveform exactly matches the TDM frame structure of 9.936 s and there is no signal discontinuity on the transition from the end to the beginning of the file. The calculated signal can be displayed in the form of a spectrum or as a waveform (FIG 2) and even monitored by means of a PC sound card. Of course, any other audio files (name.wav) can be integrated, for example an extract from Mozart's Little Serenade.

The customer can create a set of audio files and organize it with the Audio Source Manager. All files are converted to MPEG layer 3 format in a compiler. Here it is necessary to select the bit rate to which the original signal is to be compressed, depending on desired signal quality or available channel capacity.

The individual "sound broadcast programs" are generated in the TDM encoder. This is done by selecting the required audio signal and entering additional information such as program type (eg news), language, signal length or encryption mark. One or more programs of a station are combined into a broadcast channel. Extra information can be added to this channel too, ranging from codes for the decryption of pay-audio programs through to messages for display as scrolling text on the receiver panel. Calculation of the TDM bit stream includes distribution of programs to the various 16 kbit/s transmission channels, encryption of pay-audio programs, calculation of multilevel error control, multiplexing of channels to generate a serial data stream, and scrambling of the overall signal.

Signal generation

Modulation of the calculated data stream onto the downlink carrier is performed by Vector Signal Generator SMIQ02W or SMIQ03W. The data record is transferred on the IEC/IEEE bus from the PC to the SMIQ modulation data memory. SMIQ is set up in line with WorldSpace system specifications (QPSK modulation, 1.84 MHz symbol rate, square root cosine filtering), and finally the RF level and frequency are selected. Once the receiver under test has synchronized to the signal applied, the signal of the selected program can be measured or aurally monitored at its output.

Data records transferred to SMIQ remain stored in its memory, so the PC is only needed to calculate new records. SMIQ comes ready with a sample data record containing various test signals and pieces of music.

As already mentioned, actual receive conditions should be simulated as accurately as possible in receiver tests. But QPSK signals from a satellite are not as ideal as those produced by a signal generator, they are strongly distorted by the transmitter tube because this is driven at high power to increase efficiency of the satellite transmitter. This results in amplitude and phase distortion

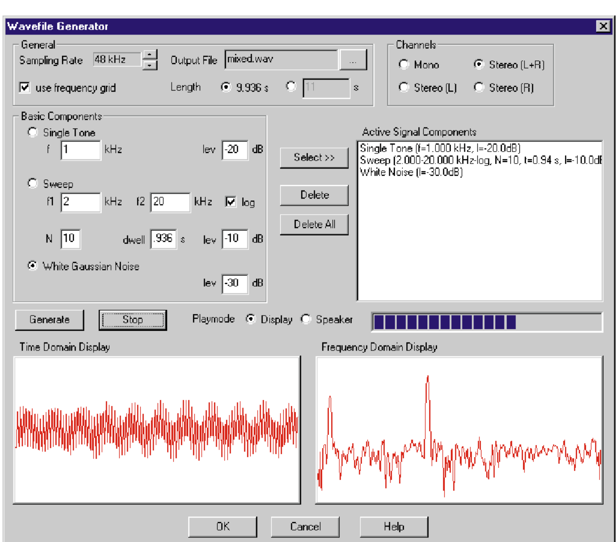

FIG 2
Wavefile generator menu for calculating audio test signals

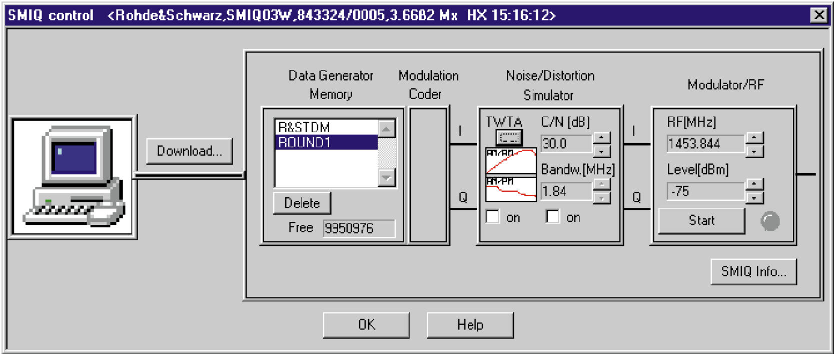

FIG 3 SMIQ control menu for downloading calculated TDM data and operating Signal Generator SMIQ02W/03W from PC

(up to 45°), a disadvantage that is accepted and taken into account in the design of sound broadcast receivers. SMIQ02W/03W is capable of simulating this type of distortion. For example, 30 points are entered for the AM /AM as well as the AM/PM characteristic to be simulated. Based on these values, the instrument calculates the complete waveforms by spline interpolation and then determines the I and Q correction characteristics. The I/Q signal from the modulation coder is corrected accordingly and the RF signal is thus output with the wanted distortion. The distortion characteristic for the WorldSpace satellite is implemented as standard. Comparisons of SMIQ output signals with actual satellite-transmitted signals have not revealed any perceptible differences. The TWTA (travelling wave tube amplifier) simulation used here is also employed in receiver circuitry design.

The generator's output signal has to be matched to real receive conditions on one more count, ie the satellite signal carries a lot of noise, whereas a signal generator normally supplies noise-free signals. Since specifications stipulate that receivers should operate properly even at a carrier/noise (C/N) ratio of about 4 dB, the generator too must be capable of producing a signal as poor as this to simulate real receive conditions. SMIQ02W/03W therefore offers the possibility of superimposing white noise of different bandwidths on the output signal. The C/N ratio can be varied between –5 and 30 dB in 0.1 dB increments. This high resolution plus the high accuracy of the C/N setting (error <0.2 dB) are necessary since, due to the complex error control mechanisms, even comparatively slight variations of C/N ratio may be decisive as to whether reception is possible or not. In production, reception quality at a defined C/N ratio decides whether or not a receiver meets specifications and can be supplied to the customer. SMIQ..W is the only instrument on the market that is capable of simulating defined modulation distortion in this way and supplying an output signal with defined noise.

Wolfgang Kernchen

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[2] Kernchen, W.: Audio Analyzer UPL – Audio analysis today and tomorrow. News from Rohde & Schwarz (1996) No. 151, pp 4–6

Condensed data of Vector Signal Generator SMIQ02W/SMIQ03W

Frequency range 02W / 03W	300 kHz to 2.2 GHz / 3.3 GHz
Distortion simulator	AM/AM and AM/PM distortion of output signal, programmable characteristic
Noise generator	
Distribution	AWGN (additive white Gaussian noise)
C/N	–5 to 30 dB, resolution 0.1 dB, error <0.2 dB

Reader service card 160/02

Antenna Switch Matrix NVX

Fast switching by network

The increasing scale of automation in radiomonitoring makes special demands on the RF parameters and switching speeds of today's antenna switch matrixes. Custom configurations are also a necessity. Antenna Switch Matrix NVX meets these requirements thanks to modular design and a flexible control system based on the optical Ethernet.

Advantages of optical network control

Control systems used in antenna switch matrixes need to fulfill different requirements from those of control systems in automated RF test and measurement. They serve for connecting numerous control units, process controllers and monitoring consoles with the antenna switch matrix. If an Ethernet network is used for the purpose, these remote controllers are connected to an interface (network card) of the antenna switch matrix controller via a star-type distribution point (hub). The maximum number of remote controllers is determined solely by hub size and can be increased through its extension.

Optical cables up to 500 m in length can be used between the hub and remote controllers (standard 10BASE-FL), so controllers may be distributed over a fairly large area. Antenna Switch Matrix NVX consequently uses optical multimode cables (62.5/125 µm) with an ST connection. An extra advantage of this type of cable is that it excludes electromagnetic interference from remote-control lines on the antenna signals.

If the LAN is connected to a WAN via a router, the antenna switch matrix can also be supervised and controlled over greater distances. For this purpose Antenna Switch Matrix NVX (FIG 1) is equipped with interfaces for WAN protocol TCP/IP.

Advanced radiomonitoring systems work with antenna switch matrixes that are primarily controlled by automated monitoring and optimization processors, so a switching speed of up to 100 operations per second is indispensable. This is easily achieved by Antenna Switch Matrix NVX thanks to the Ethernet's high data rate of 10 Mbit/s (fast Ethernet 100 Mbit/s).

Configuration and function of antenna switch matrix

The high switching rate required for automatic control also calls for special RF switch design. PIN diodes are therefore used in NVX, guaranteeing extremely fast switching times and almost unlimited service life without degraded signal quality. The tree structure and special design features ensure 50 Ω matching independently of the number of active receive branches. The output level is not affected by the number of connected receivers.

Another function that is a must for automatic operation is uninterruptible path control of the antenna switch matrix. NVX works with a test signal just outside the system's frequency band, so the useful signal is not corrupted by testing. The matrix also has comprehensive selftest facilities down to module level. These tests can be started manually

FIG 1
Antenna Switch Matrix NVX connects any number of receivers to antennas.
Photo 43 201/1

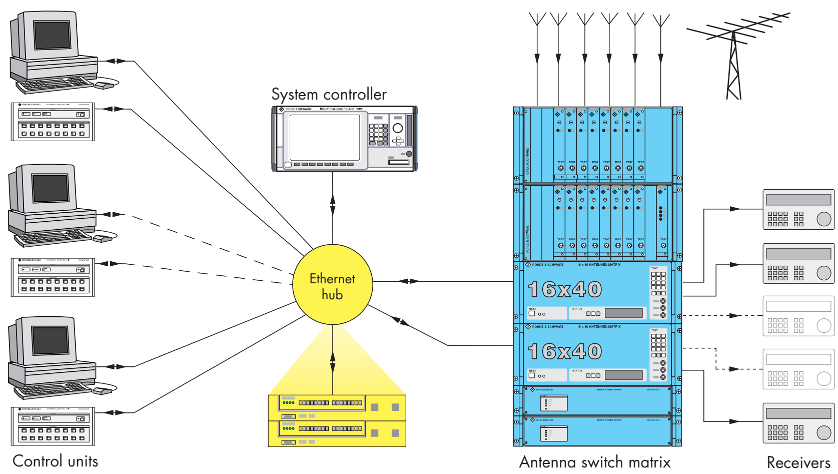

FIG 2 Configuration example comprising two Antenna Switch Matrixes NVX1640 with input stage and several control units plus remote-control sources

from the monitoring panels or automatically through timing mechanisms. They serve for testing all possible signal paths for continuity and isolation and start selftests in all system components. Results are displayed in switch status graphics, transmitted to all remote controllers and registered in a logbook. The comprehensive selftest as well as modular design throughout the switch matrix and preamplifier ensure minimum time to repair.

Antenna signals are distributed to the switch matrixes and system outputs via preamplifiers. Antenna amplifiers may be fitted with an equalizer and up to seven custom filters.

Control units are available for manual control of the antenna switch matrix and can be modified to match user needs. Active antennas and their receive directions are shown. The system is connected via the optical network.

The antenna switch matrix is controlled by low-radiation Process Controller PSP7, which interconnects the various components via network interfaces. Control units and matrixes are connected by one IPX interface each, while a total of five TCP/IP interfaces are available for control panels and remote controllers, which can also communicate with the antenna switch matrix via WAN. The interfaces are polled in separate tasks (Windows NT 4.0) to ensure fast switching when the utilization rate is high.

The controller software is operated via a graphical user interface visualizing current switching statuses. User guidance is self-explanatory, which greatly simplifies system configuration. The user interface is connected to the control program via a TCP/IP interface. This allows the user interface to be controlled locally from the controller or remotely from a panel.

Optional configurations of switch matrix

The modular design of the antenna switch matrix enables any system configuration from extremely simple to highly complex setups. At the low end there is Antenna Switch Matrix NVX1640 for stand-alone operation. All equipment functions are available locally on the NVX1640 control panel. An optional extension is remote operation from a control unit or processor connected directly to NVX1640. Both versions can work with up to 40 receivers. A further upgrade is shown in FIG 2. Thanks to its modular design, the system can be expanded to match all possible requirements.

Thomas Feldhusen

Condensed data of Antenna Switch Matrix NVX

Antenna inputs	1 to 16 per matrix
Outputs	40 per matrix, extendible without limitation
Frequency band	1.7 to 30 MHz, other bands on request
Intercept points	OPIP3: 35 dBm, OPIP2: 76 dBm
Switching time	<10 ms, 15 ms with uninterruptible path control
MTBF / MTTR	>10000 h / <0.5 h
Control units	1 to 40
Remote-control interfaces	1 to 5 TCP/IP ports
Remote control	optical Ethernet 10BASE-FL, Ethernet 10BASE-T, Ethernet 10BASE-2, AUI, RS-232-C

Reader service card 160/03

Solid-State VHF TV Transmitters NM500

New transmitters for TV band III

In the NM500 family, Rohde & Schwarz is introducing a new series of solid-state MOSFET transmitters for band III. Output power of 5 to 20 kW can be achieved simply and cost-effectively by cascading several units.

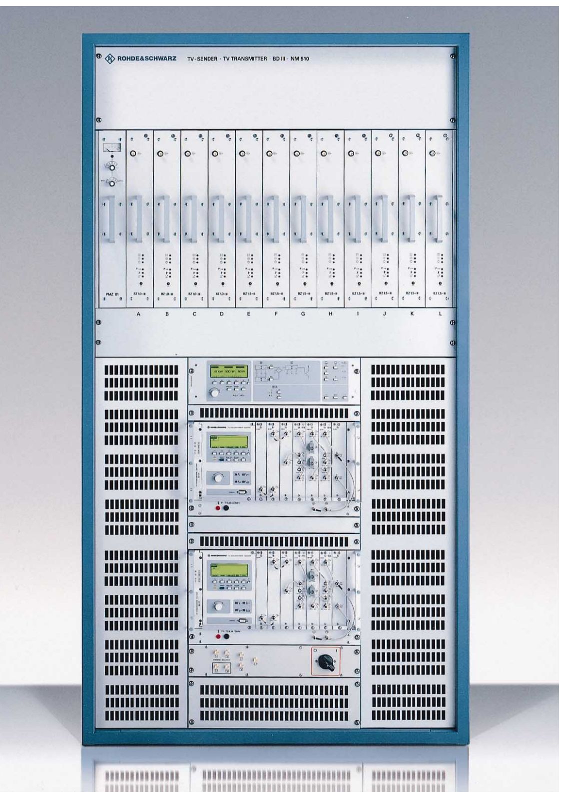

FIG 1 10 kW Solid-State Transmitter NM510 with passive exciter standby, 2 m high and only 108 cm wide and 111 cm deep
Photo 43 138

Solid-State VHF TV Transmitters NM500 incorporate highly successful, tried and tested, key Rohde & Schwarz components such as Exciter SU200 and the transmitter control unit that already feature in the NH500 series of solid-state UHF TV transmitters [1]. The individual components are integrated into transmitter racks by the Czech company Tesla, which also provides the power components. The latter include power amplifiers, switch-mode power supplies, filters, couplers, vision/sound diplexer as well as RF cabling.

Characteristics

The transmitters have the following **key features:**

- clear-cut, modular design,
- continuously tunable frequency range from 170 to 230 MHz,
- PAL, PALplus, NTSC or SECAM colour system,
- lightweight amplifier module,
- high reliability thanks to dual high-power MOSFET transistors operated at low junction temperature,
- very high redundancy due to two-level modularity,
- microprocessorized transmitter control for operation, monitoring and remote control,
- integrated automatic switchover for passive exciter standby, active dual output stage and passive transmitter standby,
- split vision and sound amplification,
- self-engaging connectors for amplifiers,
- protection facilities in each amplifier and power-supply module,
- switch-mode power supplies of very high efficiency,
- high transmitter efficiency,
- Exciter SU200 with precorrection of linear and nonlinear output stages, regulated vision and sound output power, synthesizer tuning, SAW vestigial-sideband filter, sync-pulse regeneration as well as IRT or NICAM dual-sound method,
- serial and parallel remote-control interfaces, bitbus remote control (option),
- very simple cooling system (air) with low-pressure fans,
- extremely compact design.

Design and operation

A complete transmitter for 5 kW or 10 kW RF power is accommodated in just one rack (FIG 1), interconnection of several transmitters producing power of up to 20 kW. The systems can also be configured with passive exciter or passive transmitter standby.

The **output power** from Exciter SU200 **for vision and sound** is fed to separate preamplifiers, each integrated into the exciter monitoring section. A combination of two vision preamplifiers drives eight output vision amplifiers (FIG 2). These are provided with self-engaging connectors and allow replacement without interrupting transmitter operation. An interlock circuit blocks the RF power and the power supply of the plug-in to be removed. Output amplifiers are thus securely protected against damage. Cascaded 3 dB couplers split and combine the RF signals in the output stage. A colour-subcarrier trap prevents spurious emission in the lower vestigial sideband. The sound output stage of the 10 kW TV transmitter consists of two preamplifiers connected in parallel. The vision and sound power signals are combined by a diplexer. Checkpoints at the outputs of the exciter driver amplifiers of the vision and sound output stages and at the output of the vision/sound diplexer allow complete monitoring of quality and operational data.

Modular **Exciter SU200** produces standard RF signals [2] from the video and audio signals. Comprehensive control and monitoring facilities safeguard the entire transmitter in all phases of operation. Linear and nonlinear precorrection compensates for errors in the output stage. All exciter settings can be modified using the keys and rollkey and saved in nonvolatile memory.

The **microprocessorized transmitter control unit,** already tried and tested in NH500 transmitters, controls switch-on/off sequences but is also respon-

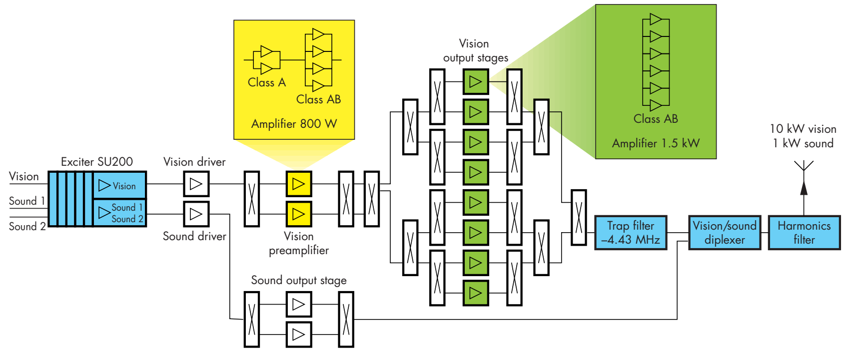

FIG 2 Modular design of 10 kW transmitter

sible for monitoring, display and control. It displays the operating parameters of the output stages and the entire transmitter, inlet and outlet air temperature and reflections. An additional analog display is available to indicate transistor currents, supply voltages at the amplifier plug-in and heatsink temperature. A maximum of 40 faults are stored with time and date information. Variable thresholds can be set to generate additional warnings for output power and cooling-air temperature. The standard, parallel remote-control interface (1864-1 relaying) provides remote-control messages and commands.

The single-stage **driver amplifier** following the exciter is configured for class A operation. The maximum output power is 10 W. The monitoring circuit of the driver amplifiers is linked to the exciter. The **preamplifier and output amplifier plug-ins** each consist of six identical 280 W power modules. These preamplifiers and output amplifiers only differ in terms of configuration and quiescent current adjustment of the power modules. In the case of a preamplifier, two modules (class A) are connected as drivers ahead of the four output modules (class AB). Power splitting and combining is implemented by means of Wilkinson circuits in stripline technique. Six of these class AB modules are combined in the output amplifiers, which are protected against reflection and overtemperature. LEDs on the amplifier front panel signal the most important operating states: supply voltage present, plug-in selected for measurement, amplifier blocked, RF output power too low (–2 dB), overtemperature or reflection. The preamplifier is used in both the vision and the sound section. In the sound section it is already the output stage. Maximum output power for the preamplifier is 800 W (sync) or 700 W (CW), and for the output amplifier 1.5 kW (sync).

The feed units are configured as single-phase **switch-mode power supplies.** To ensure maximum possible operating reliability, the power supplies include circuits to monitor overload, short circuits, overtemperature, blower failures and overvoltages at the AC supply end. These monitoring circuits are powered by their own supply. Faults are also signalled on the transmitter front panel. Efficiency of >87% makes a substantial contribution to the transmitter's high efficiency.

The TV transmitter components are **cooled** by internal and external fans. An external fan is used for amplifiers and balancing resistors. The very slight pressure drop through the transmitter allows use of low-pressure fans. The high-power supply units have their own integrated fans. Cooling air can be fed in from the top or bottom of the transmitter.

Johannes Leitenstorfer

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[2] Herwerth, T.R.: TV Exciters SD100/200, SU100/200 – New exciters for new TV transmitters. News from Rohde & Schwarz (1993) No. 143, pp 17–19

Condensed data of Solid-State VHF TV Transmitters NM500

Frequency range	170 MHz to 230 MHz
Output power, vision	1 / 2 / 5 / 10 / 20 kW
Output power, sound	0.1 / 0.2 / 0.5 / 1 / 2 kW
Output impedance	50 Ω
Output-stage technology	dual MOSFET
Standard	B, D, M, I (others on request)
AC supply	3 x 230 V / 400 V ±15%, 50 Hz ±5%

Reader service card 160/04

Spectrum Analyzer U3661

Enormous capability wrapped up small

New in the ULIS family of spectrum analyzers from Advantest is U3661, the world's first portable, battery-operable microwave spectrum analyzer in synthesizer technology.

FIG 1 Spectrum Analyzer U3661 – produced by Advantest in Japan and marketed by Rohde & Schwarz – is an extremely versatile measuring instrument for portable use. Photo 43 162/2

Measuring only 148 mm x 291mm x 330 mm and weighing just 10.8 kg – battery included – Spectrum Analyzer U3661 (FIG 1) really comes small. Powered from a normal AC outlet, an onboard 12 V DC source or from a battery, it is ideal for use in the field and for every kind of measurement requiring portability. The power supply unit is easily replaced by the battery, and the spectrum analyzer will then work for a full hour. The unit is simple to carry with its shoulder strap or it can be backpacked. Further extras include battery chargers, a front-panel cover and a transit case.

U3661 covers the **frequency range 9 kHz to 26.5 GHz.** It is suitable for field measurements on various kinds of microwave communication systems, for installation, maintenance and service. It can be used to supervise microwave links for example, to check satellite links or to analyze other signals in the microwave range, and it also covers mobile-radio bands of course.

The frequency range of U3661 is divided into four bands based on an harmonic mixing principle: 9 kHz to 3.2 GHz / 3.0 to 7.1 GHz / 6.7 to 14.5 GHz / 13.7 to 26.5 GHz. Inherent noise is –105 dBm for frequencies above 3 GHz. U3661 has resolution bandwidths from 1 kHz to 3 MHz as standard and to 5 MHz at zero span. Noise level can be improved further by narrow resolution bandwidths of 100 Hz and 300 Hz, which are optional features. An internal preamplifier can be added in the range from 9 kHz to 3.2 GHz, eg for carrier/noise measurements. The analyzer also comprises a built-in preselector for the frequency range above 1.7 GHz which eliminates unwanted emissions like image-frequency signals generated by harmonic mixing.

U3661 includes a **frequency counter** that can be operated with resolution of 1 kHz down to a minimum of 1 Hz. **Pushbutton functions** are provided for various power measurements. The **channel power** function, for example, evaluates the total power in a defined window, averaged over n measurements, and indicates the result numeri-

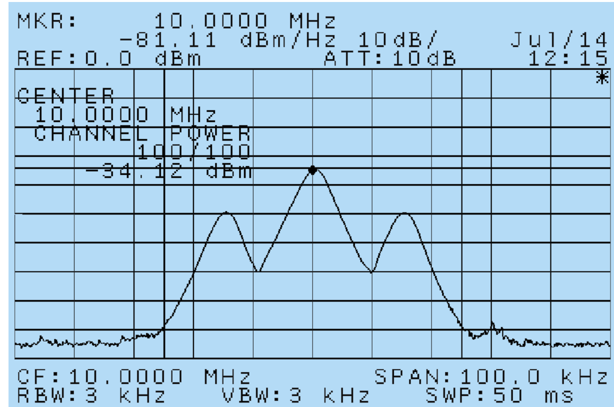

FIG 2
Channel power measured using Spectrum Analyzer U3661

cally and as a curve display (FIG 2). Such a measurement is of interest for broadband signals and when measured peak power differs from the available broadband power.

Total power, average power and carrier power can be evaluated in a similar way. The total power is measured over the whole span range, the average power may be determined for example for signals varying in amplitude that are emitted by radiocommunication systems. Measurement of **adjacent-channel leakage power** (ACP) and occupied frequency bandwidth (OBW) also works at the push of a button. Further functions such as gated sweep and a sweep time of 50 µs at zero span allow TDMA signal analysis. In this way bursts can be analyzed in the frequency domain and displayed in the time domain. The rising and falling edge of the bursts can then be observed in detail.

Thanks to the modular design of U3661, the analyzer can be ready equipped or retrofitted with the following **options:**

- precision reference frequency of 2×10^{-8}/day,
- small resolution bandwidths of 100 Hz and 300 Hz,
- CDMA functions to IS95,
- TV demodulator,
- tracking generator 100 kHz to 2.2 GHz, 0 dBm,
- channel input for various channel tables.

The optional **tracking generator** can be used to perform transmission measurements and to determine the frequency characteristic of components like filters for instance. An additional SWR bridge allows measurement of antenna matching.

Other helpful features are **limit lines,** which are entered in the form of a table and – in conjunction with a pass/fail statement – allow accurate comparison between the trace and the limit lines, as well as **correction factors** (eg for antennas). Various **marker functions** such as delta marker or a multimarker list simplify level reading. U3661 is able to determine the 20 highest levels in the set span range and display a list with level and frequency information.

Data and parameters are saved on PCMCIA memory cards. Two disk drives are provided on top of U3661. Data can be stored in binary form, CSV format or as a bitmap. The binary method allows storage and readout of large amounts of data. The CSV format serves for transferring measurement data to other programs (eg Excel), and the bitmap format provides full-screen graphical display. So results can easily be documented and stored or output on a printer (to ESC/P or HP/PCL standard) or plotter. IEC/IEEE-bus and RS-232-C interfaces are standard in the analyzer, enabling it to be remotely controlled from a computer.

Andreas Henkel

Condensed data of Spectrum Analyzer U3661

Frequency range	9 kHz to 26.5 GHz
Resolution bandwidths	1 kHz to 3 MHz; 5 MHz at zero span
Noise floor	
9 kHz to 3.2 GHz	–117 dBm +2f dBm w/o preamplifier (f in GHz) –132 dBm +3f dBm with preamplifier (f <3 GHz)
3 to 26.5 GHz	–105 dBm
Monitor	15.2 cm TFT colour display
Data storage	binary, CSV, bitmap
Weight	10.8 kg with battery
Dimensions	148 mm x 291 mm x 330 mm

Reader service card 160/05

Receiving Antenna System AU900A4

Allrounder for radiomonitoring up to 3 GHz

The capabilities of state-of-the-art receivers can only be fully utilized if an equally high-grade antenna optimizes the interface where the electromagnetic wave is brought in. Otherwise signal quality will be lost that cannot be regained anywhere in the receiving system. Compact Antenna System AU900A4 from Rohde & Schwarz is the ideal transducer for the different wavelengths throughout the frequency range 10 kHz to 3 GHz.

Antennas exhibit natural resonance; they work best if their dimensions are in a certain relation to the wavelength, depending on the type of antenna used. This is also valid for conventional broadband solutions such as log-periodic antennas. So coverage of wide frequency ranges has always been a special challenge for the antenna designer. And this is precisely where a big demand is emerging as the electromagnetic spectrum in use is continuously and systematically extended, especially towards higher frequencies. The trend is clearly demonstrated by the mobile-radio bands above 1 GHz and growing radiocommunication activity between 2 and 3 GHz. Antenna System AU900 in its A4 version was therefore designed specifically for frequencies up to 3 GHz (FIG 1).

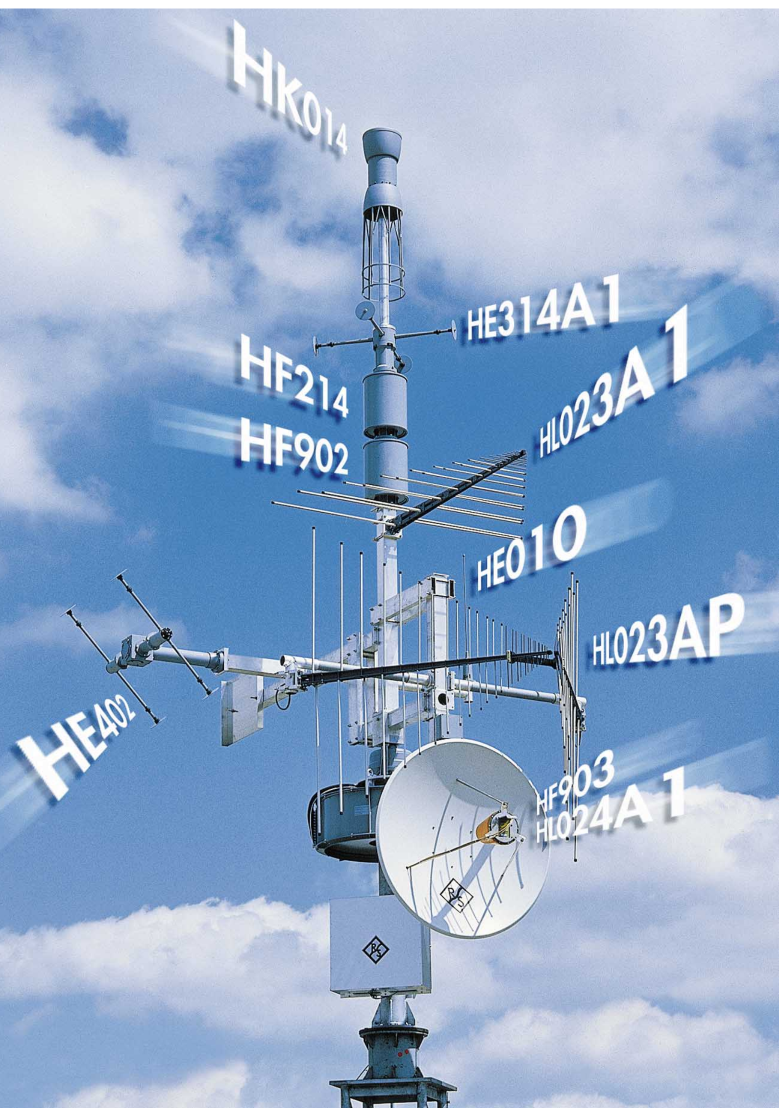

FIG 1 Receiving Antenna System AU900A4 for omnidirectional and directional reception of horizontally and vertically polarized waves in frequency range 10 kHz to 3 GHz
Photo 42 146/1

Omnidirectional reception of vertically polarized waves

To produce an overview of the reception scenario at a site, omnidirectional reception is in general useful for the frequency ranges considered. This task is handled by the following individual antennas of Antenna System AU900A4, optimized for characteristics of the particular band:

Active Rod Antenna HE010 covers 10 kHz to 80 MHz and is highly suitable for use in a compact antenna system. Being an active antenna, it is much smaller than a passive antenna of the same sensitivity. Another advantage is its low coupling to adjacent antennas and the supporting structure because of the small current amplitude of the electrically short active antenna.

VHF-UHF Coaxial Dipole HK014 covers an extremely wide frequency range from 80 MHz to 1.6 GHz for an antenna of this kind. As a passive antenna, which is also used for transmission in a different version and can thus be loaded with power, it additionally provides protection against lightning since it is the highest point of the antenna system.

Omnidirectional Antenna HF902 operates in the range 1.3 to 3 GHz. Eight vertical and eight horizontal broadband dipoles arranged in the form of a cloverleaf provide good azimuth coverage. The dipoles are grouped around the supporting pole and connected to a combining network for each polarization mode. Cables to the antennas above the dipoles are run through the supporting pole. A polyester radome offers protection against weathering.

Omnidirectional reception of horizontally polarized waves

For frequencies above 20 MHz Antenna System AU900A4 comprises omnidirectional antennas for horizontal polarization that are optimized for the particular bands. If omnidirectional reception with horizontal polarization is required at lower frequencies, Active Antenna System HE016, whose horizontal part covers 600 kHz to 40 MHz, can be set up separately; horizontal polarization is irrelevant at frequencies below 600 kHz.

Active Omnidirectional Antenna HE314A1 consists of two horizontal Active Receiving Dipoles HE302* offset by 90° and interconnected through a broadband 90° coupler. This turnstile antenna allows omnidirectional reception from 20 to 500 MHz.

Omnidirectional Antenna HF214 for 500 to 1300 MHz is a circular array consisting of horizontal broadband dipoles, similar to HF902. Due to the longer wavelengths in this frequency range, only four dipoles are required to obtain acceptable circularity of the horizontal pattern.

Horizontally polarized waves in the range 1.3 to 3 GHz are received by a circular array of horizontal broadband dipoles that make up **Omnidirectional Antenna HF902.**

Directional reception of vertically and horizontally polarized waves

Substantially **improved reception** is the benefit gained from the additional effort involved in **directional reception.** The two main effects are as follows:

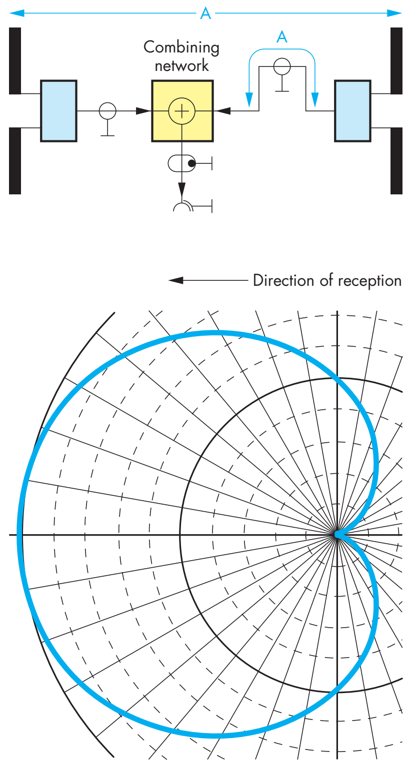

FIG 2 Principle of Active Directional Antenna HE402 and radiation pattern

- Increase of S/N ratio proportional to antenna gain. If the antenna is aligned in the direction of the received signal, signal power is increased by the antenna gain. If noise sources are evenly distributed across the surrounding space, the same noise power is obtained as from an omnidirectional receiving antenna. Greater power is received from the main direction of reception but correspondingly less from the side and rear, so the total noise power received is independent of the directional pattern.

- Unwanted or intentional interference from different directions may be reduced or suppressed by means of the directional pattern.

Active Directional Antenna HE402, just 1 m x 1 m in size, offers a cardioid-shaped directional pattern from 20 MHz. This is made possible by use of Active Receiving Dipoles HE302 – also part of HE314A1 – as the individual elements. They are connected by a combining network with corresponding phase shift and the radiation pattern shown in FIG 2 is obtained up to 87 MHz. HE402 is mounted with a slant of 45° in Antenna System AU900A4 so that vertically and horizontally polarized waves can be received.

Log-Periodic Antenna HL023A1 covers the adjoining frequency range 80 to 1300 MHz. With increasing frequency the sensitivity of the receiving antenna becomes more and more important. This is due to the lower external noise but also to the frequency dependence of the power that an antenna can feed to the receiver. At constant antenna gain the received power reduces as the square of the wavelength with increasing frequency. So at 1 GHz an antenna only produces 1% of the power that an antenna of the same gain provides at 100 MHz. Reception improves on average by about 3 dB due to the fact that, instead of a slanted arrangement as with HE402, one antenna is available for each polarization at these higher frequencies. Antenna HL023AP consisting of two HL023A1 elements in a V-shaped arrangement is used for vertical polarization and so the same azimuth half-power beamwidth is obtained for both polarization modes. HL023AP additionally offers maximum/minimum switchover for rough determination of the direction of reception.

The frequency range 1 to 3 GHz, the extra capability in this version of the antenna system, reduces received power by almost one order of magnitude. But it is easier to counteract this effect because of the shorter wave-

* Demmel, F.; Steghafner, H.: Active VHF-UHF Receiving Dipoles HE202 and HE302. News from Rohde & Schwarz (1984) No. 104, pp 21–23

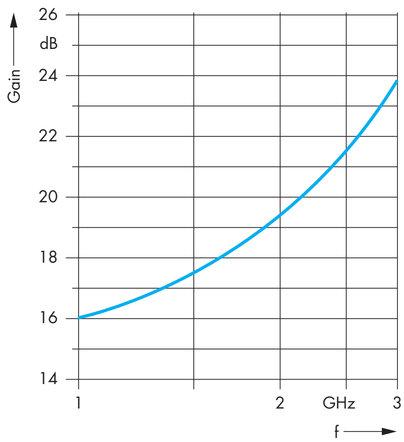

FIG 3 Gain characteristic of Directional Antenna HF903 with Feed HL024A1

lengths. Rotationally symmetrical **Directional Antenna HF903** is an especially good solution since extra gain with increasing frequency (FIG 3) is a result of greater focusing of both the horizontal and vertical pattern and is thus very distinct. **Crossed Log-Periodic Antenna HL024A1,** used here as the feed, allows reception of horizontally and vertically polarized waves.

Antenna System AU900A4

Antenna System AU900A4 is rotatable because of the directional antennas that are included. A cable antitwist fixture allows remotely controlled rotation of the antenna from 0 to 359°. The maximum number of antennas used in the system as shown in FIG 1 forms the basis for computing the physical strength and the mutual coupling of the antennas. If any bands are not required for specific applications, the corresponding antennas can simply be omitted from the system to save costs and produce a custom solution.

The compact Antenna System AU900A4 covers the wide frequency range 10 kHz through 3 GHz. Even weak signals can be picked up due to the optimized sensitivity of the bands, directional reception from as low as 20 MHz and remotely controlled rotation across the whole azimuth range. Design to withstand harsh environmental conditions and cost-effective adaptation to special customer requirements make AU900A4 a universal, high-grade receiving antenna system well fit to handle existing and upcoming radiomonitoring tasks.

Axel Stark

Condensed data of Receiving Antenna System AU900A4

Frequency range	10 kHz to 3 GHz
Polarization	vertical and horizontal
Permissible wind speed	180 km/h (without ice deposit)
Height	6.5 m
Weight	approx. 350 kg

Reader service card 160/06

In brief

W-CDMA, T&M technology for third-generation mobile radio

The next mobile-radio generation will present possibilities far beyond those presently available. With today's so-called second-generation units we can telephone and, with certain restrictions, send brief messages and faxes, but the third generation has to enable far greater access to information. Requirements range from Intranet or Internet links through multimedia to video on demand. So the radio network and the modulation used must be broadband enough to handle them. Furthermore, worldwide standardization is in the offing, which would allow global use of mobile phones and, the main benefit, make sets cheaper because of the larger numbers produced.

In January this year, big-name manufacturers met to create a standard for third-generation mobile radio in cooperation with ETSI (European Telecommunications Standards Institute). Although some details of the standard still remain to be defined, the development of base stations and mobile phones is already forging ahead in the labs of the mobile-radio manufacturers.

In technical terms the new standard presents a big challenge for the equipment. The W-CDMA (wideband code-division multiple access) modulation that will be used calls for highly linear and powerful transmit amplifiers that are able to handle the signal peaks produced by the modulation. Plus the power in the adjacent channel has to be very low so that other signals are not degraded. This is only possible through careful configuration of all components. Measuring instruments, of course, again have to be a few dB better than the equipment to be developed. Only highly versatile and highly accurate signal sources such as Vector Signal Generator SMIQ, I/Q Modulation Generator AMIQ and Vector Signal Analyzer FSIQ with its unmatched dynamic range can meet the requirements.

Rohde & Schwarz has composed an information folder on this subject, obtainable by entering 160/07 in the reader service card.

Albert Winter

ACP measurements for W-CDMA using Signal Generator SMIQ and Low ACP option

The new mobile-radio generation based on W-CDMA (wideband code-division multiple access) is aiming at high transmission quality together with high availability and economy. This is to be guaranteed by specifications like the one relating to adjacent-channel power (ACP), which will ensure unimpaired communication in adjacent frequency channels. In the special case of W-CDMA this specification makes very high demands on the measurement technology. Rohde & Schwarz's response to this was to develop Low ACP option SMIQB46 for Signal Generator SMIQ [1] .

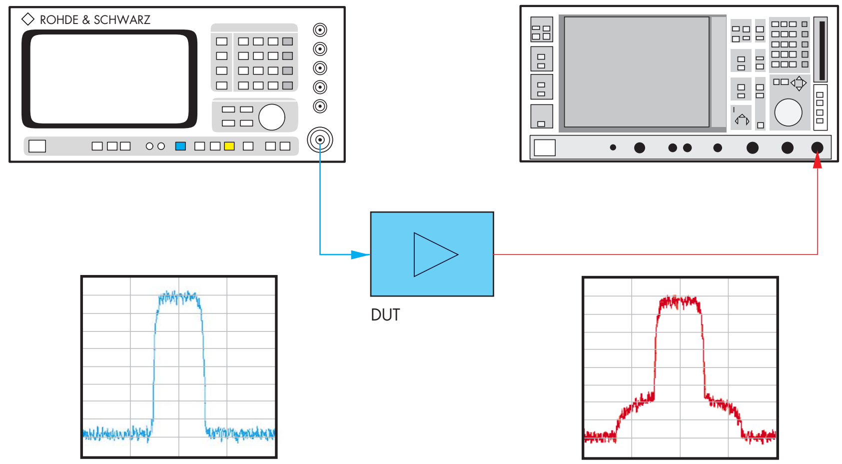

FIG 1 Setup for ACPR measurement on modules, eg amplifiers

FIG 1 shows a typical **setup for measurement of ACPR** (adjacent-channel power ratio) on a W-CDMA amplifier. Signal Generator SMIQ is the signal source feeding the amplifier. The in-channel/adjacent-channel power ratio is measured at the amplifier output by Spectrum Analyzer FSE. At 4.096 Mchip/s, the demands of the current W-CDMA standard for mobile and base stations are very high: a ratio of 40 dB at 5 MHz offset for the mobile station and 55 dB for the base station, and at 10 MHz offset a ratio of 60 dB and 70 dB respectively. To be able to measure the specified ACPR, the instruments must have a better specification, a reserve of about 10 dB is normally sufficient.

The contributions of the measuring instruments to adjacent-channel power stem from intermodulation and broadband noise. Intermodulation produces the major share of ACP at 5 MHz offset, while at 10 MHz offset only broadband noise plays a role. **Signal Generator SMIQ** features excellent values in this respect: ACPR of typically 64 dB at 5 MHz offset and 66 dB at 10 MHz offset. The **Low ACP option SMIQB46** improves these figures to 68 dB at 5 MHz and 73 dB at 10 MHz offset. The values apply to simulation of one code channel, no matter whether the baseband signal is generated internally or externally. FIG 2 shows the spectrum obtained with the Low ACP option.

W-CDMA is **multichannel,** allowing several channels to be transmitted on one carrier. This increases the peak value of modulation, which in turn has a negative effect on adjacent-channel power, since the margin from broadband noise becomes less due to the lower rms power. ACPR at 10 MHz offset, determined solely by broadband noise, degrades precisely by how much the crest factor of the modulation signal increases. Since ACPR at 5 MHz offset is mostly caused by intermodulation, it is not affected to the same extent. With 127 code

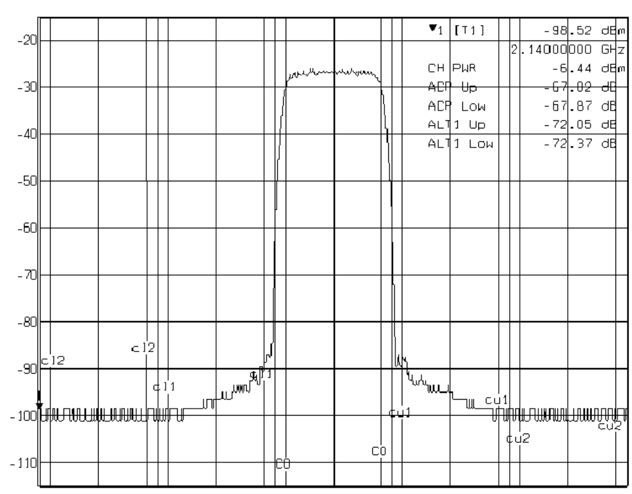

FIG 2 W-CDMA spectrum of SMIQ with option SMIQB46. ACP readings also contain components from Spectrum Analyzer FSE. Corrected values for SMIQ are –68 dB for ACP and –73 dB for ALT1.

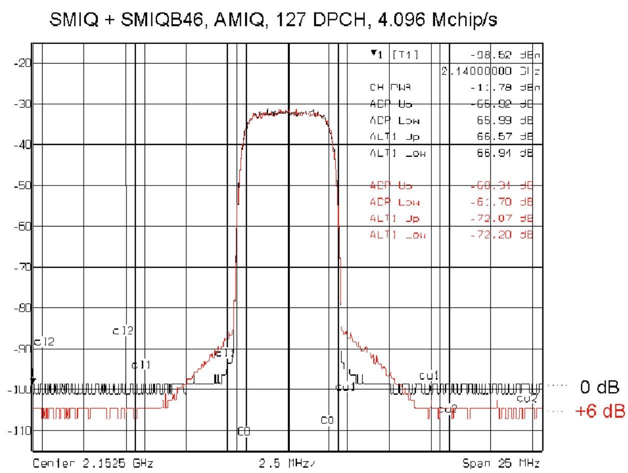

FIG 3
Comparison between normal drive (black) and +6 dB overdrive (red) for SMIQ with W-CDMA, 4.096 Mchip/s and 127 code channels. ACP readings also contain FSE components (for corrected SMIQ values see blue box).

channels in use, ACPR values of 66 dB are obtained at 5 MHz offset and 67 dB at 10 MHz offset.

Multiple code channel mode with 127 channels is possible with I/Q Modulation Generator AMIQ plus Software WinIQSIM [2; 3] and SMIQ. Generating baseband signals with AMIQ has another decisive advantage. To obtain better ACPR at 10 MHz offset, SMIQ can be overdriven externally up to 6 dB due to the high linearity of its I/Q modulator. Intermodulation increases but only occurs at 5 MHz offset. The real benefit is the bigger margin from broadband noise. This means that the ACPR value at 10 MHz offset is also improved by exactly 6 dB. So 6 dB overdrive produces ACPR of 79 dB at 10 MHz offset for W-CDMA with one code channel and 4.096 Mchip/s. Refer to the blue BOX for the results of different configurations.

Normal drive or overdrive is selected depending on whether the measurement is to be carried out at **5 MHz or 10 MHz offset.** Normal drive is ideal for 5 MHz offset measurement and overdrive for 10 MHz. Overdrive is obtained by increasing the AMIQ output voltage from 0.5 V to 1 V. At the same time the output level on SMIQ, increased by 6 dB due to higher modulation, has to be reduced. This is done quite simply by entering a level offset of 6 dB.

The figures in bold in the table indicate the best combinations for 5 MHz or 10 MHz offset measurement. FIG 3 provides a comparison between the spectra with normal drive (0 dB) and overdrive with 6 dB for a signal with 127 code channels. The higher intermodulation can be clearly seen in the range up to a carrier offset of 5 MHz. The noise level is 6 dB lower at 10 MHz offset however.

The SMIQ/AMIQ team together with the overdrive method yields ACPR values at 10 MHz offset that have not been matched anywhere in the world to date. This method now also supports users who need to check compliance with the stringent ACPR requirements at 10 MHz offset.

Johann Klier

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[3] Pauly, A.; Holzhammer, J.: I/Q Simulation Software WinIQSIM – New approaches in calculating complex I/Q signals. News from Rohde & Schwarz (1998) No. 159, pp 13–15

Configuration	Modulation	ACPR 5 MHz offset	ACPR 10 MHz offset
Internal, 1 code channel	0 dB	**68 dB**	73 dB
External, 1 code channel	0 dB	**68 dB**	73 dB
External, 1 code channel	+6 dB	58 dB	**79 dB**
External, 127 code channels	0 dB	**66 dB**	67 dB
External, 127 code channels	+6 dB	61 dB	**73 dB**

Typical ACPR values of Signal Generator SMIQ with Low ACP option and different configurations

Reader service card 160/08

Application software – making measurements easier

Many a measurement is simpler and faster with the help of a computer. Rohde & Schwarz has developed a number of programs to support a wide variety of measurements. The software – obtainable with application notes – runs under Windows 3.1, Windows 95 and Windows NT 4.

MobiDemo is an application software that simplifies testing of components used in different mobile-radio systems, for example amplifiers and filters. Such components must be driven by signals with very small inherent error. The output signals from the components are then checked for distortion like poorer modulation quality or degradation of adjacent-channel power figures. The software can handle the W-CDMA, CDMA to IS95, Iridium and PHS standards. Just a few mouse clicks in MobiDemo activate the appropriate modulation mode in Vector Signal Generator SMIQ [1] and set frequency and level. The test signals are then applied to the DUT. The output signal of a component is measured by Spectrum Analyzer FSE [2], also programmed by MobiDemo (FIG 1). When measuring adjacent-channel power for W-CDMA in particular, proper setting of FSE is important because of the special signal characteristics and the, in most cases, stricter requirements. MobiDemo automatically optimizes settings and displays results numerically and as a trace. MobiDemo can also be run on FSE by adding Computer Function FSE-B15 and a second IEC/IEEE bus.

A further application note offers some convenient conversion programs. One of them is **Power Unit Calculator,** which converts power from W to dBm and vice versa and displays the corresponding voltages into 50 Ω in V and dBμV. **VSWR Calculator** computes VSWR in percent from the reflection coefficient as well as return loss in dB and reflected power in percent and vice versa. It also estimates the measurement error that may be caused by mismatch between generator and load. By entering the source reflection coefficient of the generator and the input reflection coefficient of a connected DUT, maximum and minimum error limits through mismatch are calculated and displayed in percent and dB.

You may find you have no network analyzer on hand when you need to measure the frequency response of a filter, amplifier, coupler or the like. The alternative to manual measurement using a signal generator and power meter or receiver is **FreRes** (FIG 2). It may not be as user-friendly and fast as a network analyzer, but it does support a variety of Rohde & Schwarz signal generators and indicator instruments, from power meter through test receiver to spectrum analyzer, whatever is available. Frequencies range from audio to microwave (depending on the signal generator), the dynamic range depends on the indicator and extends to beyond 100 dB (receiver or spectrum analyzer). And FreRes also offers convenience in the form of frequency-response compensation of instruments and connecting cables by calibration, graphical display of results, a linear and logarithmic frequency axis, automatic scaling of the trace diagram on the horizontal and vertical axis as well as different possibilities for data logging.

I/Q Modulation Generator AMIQ [3] is a programmable modulation source for a very wide range of applications. Software WinIQSIM works with it as a convenient user interface for computing a large variety of signals. **Software AMIQ-K2** (FIG 3) supports users for whom this is not enough and who want to compute their signals themselves. AMIQ-K2 allows you to transfer to AMIQ any waveforms available as a file. Very different file formats are accepted, including files generated by mathematical programs like MathCad or MatLab. Also supported are COFDM signals for terrestrial DAB and DVB, computed by Soft-

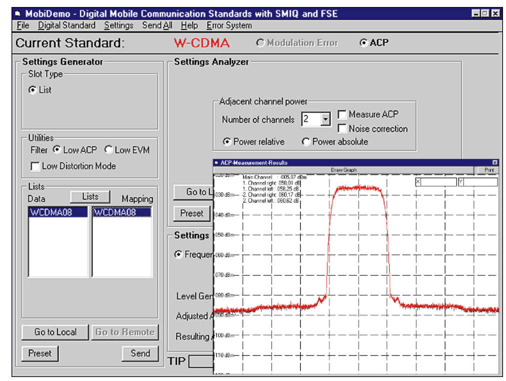

FIG 1 User interface of MobiDemo

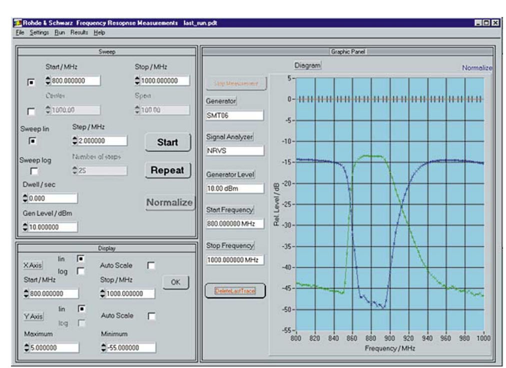

FIG 2 Frequency response of diplexer measured with FreRes

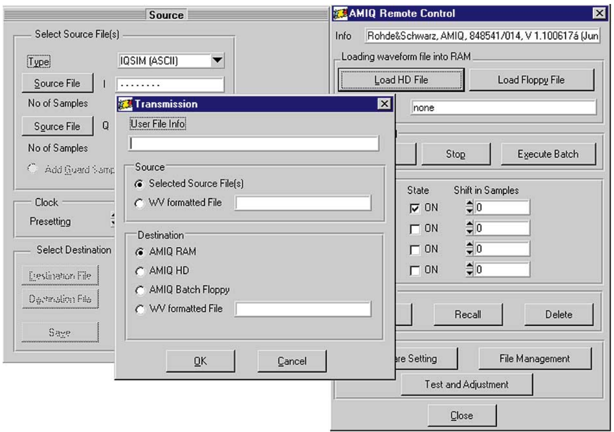

FIG 3
Waveforms of any type can be transferred to I/Q Modulation Generator AMIQ with AMIQ-K2

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ware DAB-K1. Transfer to AMIQ is possible via its IEC/IEEE or RS-232-C interface. The major functions of AMIQ like output voltage, clock rate or file management can be controlled by means of AMIQ-K2.

Albert Winter

Application notes are obtainable from all Rohde & Schwarz representatives by quoting the following numbers:

MobiDemo, Program for Generation and Analysis of Communication Signals
Application Note 1MA11_0E — Reader service card 160/09

Conversion **Calculators** for Power Units and VSWR/Reflection
Application Note 1MA12_0E — Reader service card 160/10

Program for Frequency-Response Measurements **FreRes**
Application Note 1MA09_0E — Reader service card 160/11

AMIQ-K2, Program for Transfer of I/Q Data of Different Formats to AMIQ
Application Note 1MA10_0E — Reader service card 160/12

TDMA direction finding with Digital VHF/UHF Monitoring Direction Finder DDF05M

Scarcity of frequencies means that **TDMA** (time-division multiple access) is being used to an increasing extent. The **GSM standard** for mobile phones is a classic example. User information for eight subscribers is alternately transmitted in bursts (timeslots C0 to C7) with a duration of 577 µs in a frequency channel 200 kHz wide (FIG 1). TDMA is also due to be introduced for the VHF digital link (VDL) in **air-traffic control** (118 to 137 MHz), starting up prob-

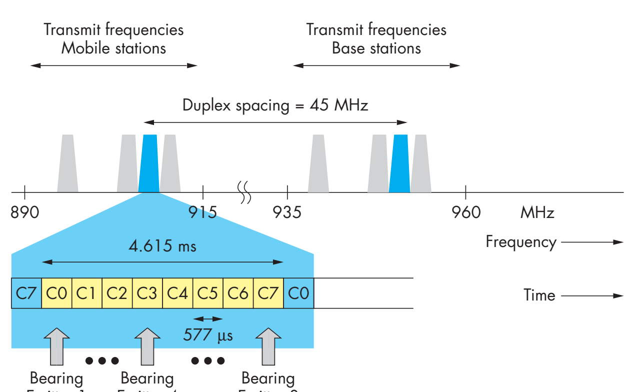

FIG 1
Frequency and TDMA schematic for GSM phone with assignment of bearings

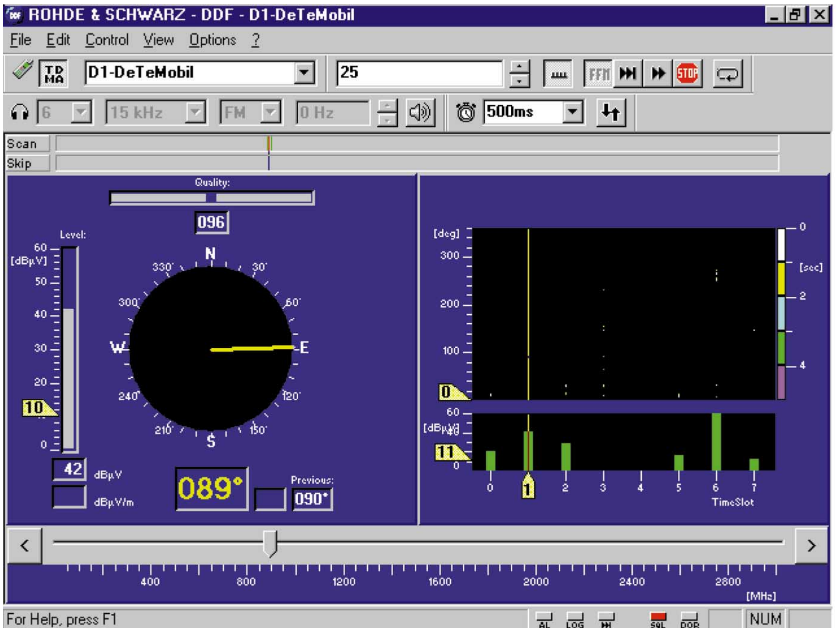

FIG 2 User interface of DDF05M during GSM direction finding. Right: levels and bearings of all occupied timeslots of set frequency channel. Left: bearing of selected timeslot as numerical value and polar diagram

ably in the year 2002. A channel spacing of 25 kHz will be used, but each frequency channel will be occupied by four sequential, 30 ms timeslots allowing simultaneous transmission of four (digitized) voice and/or data channels (A to D).

Direction finding and radiolocation are thus inevitably faced with meeting new requirements. If a direction finder were tuned to a frequency channel using TDMA, the result would be ambiguous since the users of the frequency channel constantly change in a cycle and the signals usually have different directions of incidence. To find the emitters within a frequency channel, direction finding would have to be synchronized with the assigned timeslot, assuming, of course, that the direction finder is capable of detecting such short bursts.

Digital Monitoring Direction Finder DDF05M [1] was designed in the first place to detect such short signals not only with narrow-aperture antenna systems of relatively high susceptibility but also with highly accurate wide-aperture interferometer antennas, eg **ADD150** for 20 to 1300 MHz. Its diameter of approximately 1 m guarantees high DF accuracy in a typical mobile-radio scenario with pronounced multipath propagation.

The retrofit set/option **TDMA Controller DDFTDMA** allows synchronized direction finding of the eight timeslots of a GSM frame structure. **Synchronization** is possible in two ways:

- externally via an RS-422 interface,
- internally to the BCCH (broadcast control channel) of the base station.

The RS-422 input GSM-STRB, available to standard on Digital Processing Unit EBD060, is used for **external synchronization.** Synchronization within the spacing of the multiframes (26 TDMA frames) is sufficient. Direction finding is triggered on the rising edge of the sync pulse and repeated in the TDMA frame (every 4.6 ms). The frequency-correction burst (FCB) of the BCCH of a base station is used for internal synchronization. The operator selects the channel by entering the channel number or by using simply edited lists for the assignment of BCCH and TCH (traffic channel) numbers.

TDMA direction finding is a separate operating mode selected by a button on the **user interface.** After successful synchronization the window on the right shows the occupancy and bearings of the eight timeslots. A timeslot can be selected by a ruler and indicated numerically or as a polar or waterfall diagram in the lefthand window (FIG 2).

All functions are of course also accessible via external interfaces (eg LAN, ISDN), ensuring simple **system integration** of direction finders with the TDMA controller [2].

Franz Demmel; Ulrich Unselt

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Reader service card 160/13

Mobile interference measurement in GSM networks

One of the accompaniments of constantly expanding GSM mobile networks is the occurrence of local interference pockets where signal carriers of different mobile cells superimpose on each other. Traffic capacity is then reduced and in the worst case, when no alternative channel is available, a call is disconnected. Specialists localize these pockets, identify the interference and its source and eliminate the cause through antenna adjustment, power adaptation or skilful reassignment of frequency resources.

Rohde & Schwarz has developed a mobile test system for detecting such signals (FIG 1) and tracing them back to the interfering transmitter stations. The system consists of a mobile phone, a test receiver, a navigation system and two computer units. Hardware and software components are integrated in the GSM coverage measurement system [1] and may be used simultaneously for different purposes. Interference measurement involves three steps (FIG 2): detection of the interference situation, analysis of the interference signal and assignment of detected signals to their base stations.

In the first step, **detection of the interference situation,** calls are set up to the network from one or several mobiles and transmit power and quality (RxLev and RxQual) are measured. If RxQual values increase for a specified period at sufficiently high transmit power, this is a sure sign that interfering signals are present and interference analysis is started. By this time the system has already detected the frequency and time characteristics of the disturbed connection and analyzed various parameters of the useful signal so that the latter can be distinguished from interfering signals in the signal mix.

In **interference analysis** two different types of GSM signals are searched for in co-channels and adjacent channels of the channel used: C0 interference and Cx interference. C0 is a special base-station channel used by mobiles for power measurement and synchronization. Here a constant level is continuously transmitted, causing interference irrespective of the utilization of the respective cell. A sequence of timeslots with fixed signal content is sent on the C0 for synchronization of mobiles. With the aid of this the interference measurement system can identify the channel type even if its power is considerably below that of the disturbed useful signal. To be able to find the base station of measured C0 interference, the time of arrival of the sync sequence in the M51 frame structure (T51) is stored. In the case of adjacent-channel interference, the BCC (base-station colour code) of the interfering signal is also measured.

In contrast to the C0 channel, a timeslot of the Cx channel is only used when information is to be transmitted. Furthermore, the transmitted power can be matched to the reception scenario of the mobile subscriber. For these two reasons, such interference is traffic-dependent. The arrival time of the interfering burst (signal in timeslot) and the TSC (training sequence code) are used as assignment criteria.

To allow **assignment of detected interference signals to their base stations** with the aid of the selected attributes, the data inventory of the measurement system includes information from the network operator such as site, transmit power and channels of base stations as well as measured results for transmission intervals of sync sequences and timeslots between individual base stations. These values are obtained by the system in a time-offset measurement. The time offset of interfering base stations should be measured directly before or after the interference, as the fixed transmit time pattern of the differ-

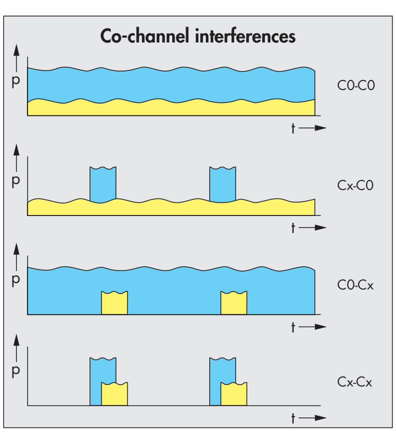
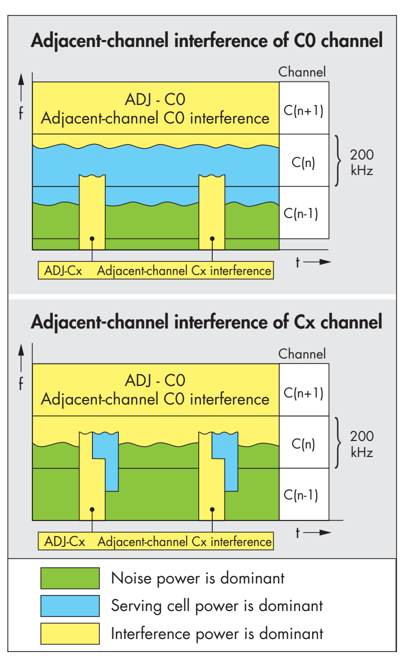


FIG 1 Carriers of GSM signals are sent continuously on C0 channels and discontinuously on Cx channels. This results in different combinations of useful and interfering signals transmitted on same (left) or adjacent channels (right) (blue: serving cell power, yellow: interference power).



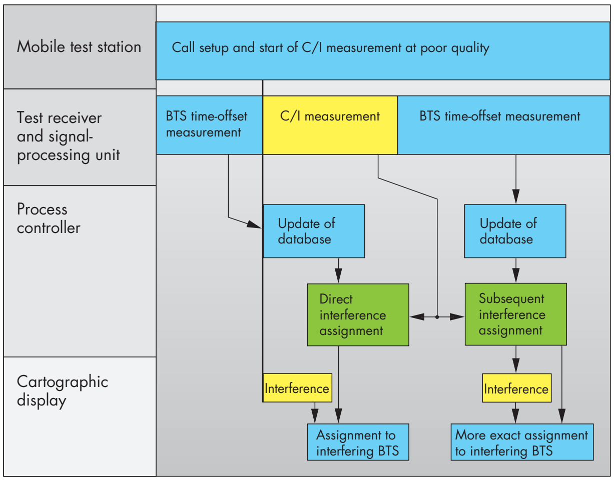


FIG 2 Automatic C/I measurement sequence: When transmission quality deteriorates, test mobile starts interference measurement. Database is periodically updated with results of time-offset measurements and provides data for immediate or subsequent assignment of interference to base stations that could be its source.

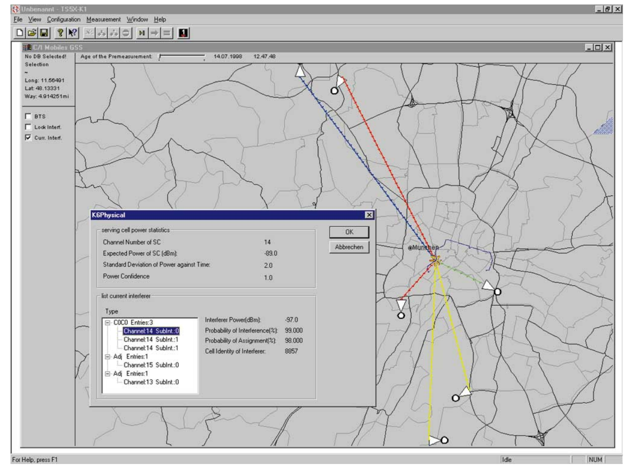


FIG 3 Interference pocket is marked red on map. Interference is shown as line indicating type of interference to base station. Detailed information on interference and base station can be obtained from dialog windows by mouse click.

ent signals may vary as a result of the different drifts of timebases and base-station resets. For measuring the frame time offset, the C0 carrier of the particular base station must be received undisturbed. Normally and particularly when two C0 carriers superimpose, this measurement cannot be performed in the interference pocket. It is carried out automatically when there is no interference situation and the system has free hardware resources, eg when performing quality measurements on its way into the interference pocket. If the collected data are not sufficient for a new interference measurement to assign signals to their base stations with high probability, the assignment result is improved each time the automatic time-difference measurement produces new data on possible interferers. In this case the interference signal is subsequently assigned with the aid of a displayed map showing possible interferers with time-offset information.

In contrast to those used for stationary interference measurement [2], the new **algorithms for mobile interference measurement** are highly resistant to fading effects and feature faster processing. The reduced dynamic range that this requires is made possible by the fact that all interfering signals are actually present during the measurement and only concealed by the useful signal, ie C/I values of not much more than 6 dB can be expected. In addition to various methods of signal filtering and probability calculation, a nonlinear classifier was developed for interference identification that responds very well to non-stationary signal variations caused by fading and unfavourable signal configurations.

Operation of the equipment is from a Windows 95 user interface. In addition to starting and stopping a measurement, the operator can activate cartographic output of the data inventory at any time (FIG 3), eg to find out when the time offset for certain stations was last measured or what interferers come into question for a particular base station.

Otmar Wanierke

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Reader service card 160/14

Probability of intercept for frequency hop signals using search receivers (I)

This article is not only intended to brush up the reader's knowledge on the subject but also presents latest scientific findings. The probability of intercept for bursts and frequency hop signals by means of search receivers or scanning direction finders is calculated on a general basis and with particular attention to multichannel receivers and overlapping search and hop frequency ranges. The article also deals in detail with the timing of the receiver sequence coinciding with the hopper sequence*. For the sake of simplicity, ideal conditions are assumed.

1 Radiomonitoring equipment

Search receivers (FIG 1) can be tuned in rapid succession to different frequencies within a wide range and make an attempt to intercept at each one [1]. When detected signals are displayed in the time domain (eg waterfall display), a CW transmitter is characterized by its mean frequency, which is constant in time, and a frequency-hopping (FH) transmitter by its typical hop pattern.

Allocating detected frequencies to individual transmitters in dense scenarios is rather difficult because of the multitude of signals present, particularly when several FH transmitters are received in the same band. This task can be simplified by using a **scanning direction finder** (FIG 2) in such a way that the angle of arrival (AoA) of each signal detected by the search receiver of the direction finder is determined in addition with the aid of a DF antenna and a DF algorithm [2]. If the measured AoAs are displayed as a function of frequency, FH transmitters can be identified by their characteristic

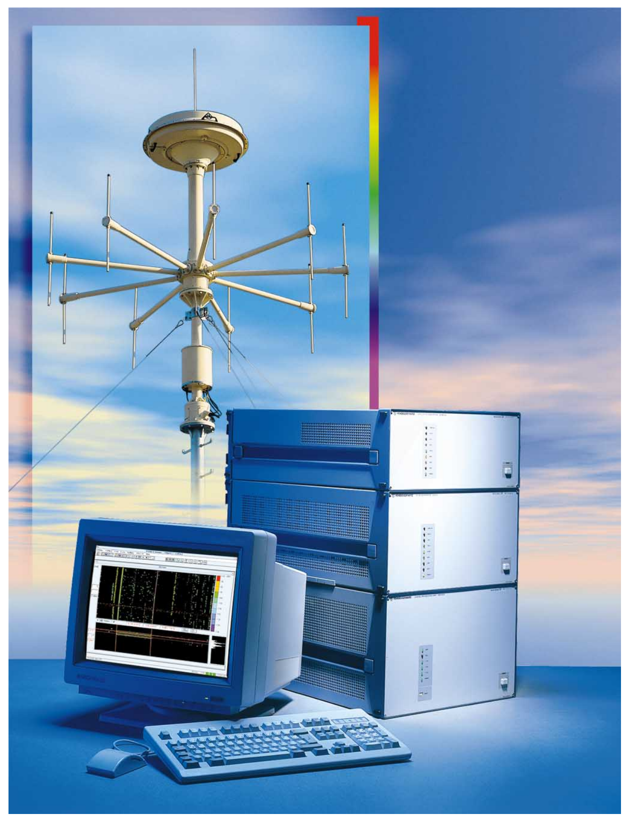


FIG 2
Digital Scanning Direction Finder DDF0xS for 0.5 to 1300 MHz
Photo 43 123

FIG 1
Search Receiver ESMA for VHF-UHF range
Photo 42 190

* A similar article by the same author was published in »Frequenz« 52 (1998) 7-8.

"string of pearls" along the direction of incidence (FIG 3).

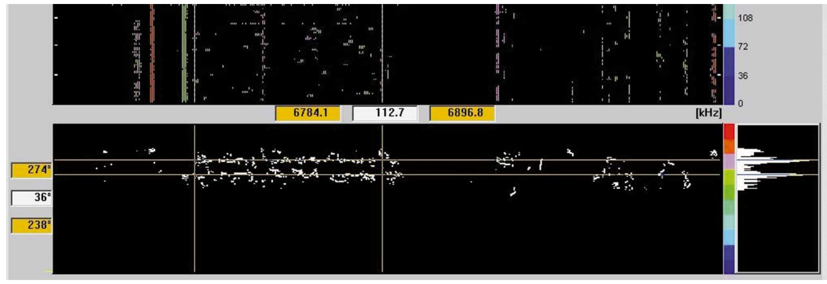


FIG 3 Detection of two FH transmitters near noise limit with Digital Scanning Direction Finder DDF01S in same frequency band 6784.1 to 6896.8 kHz marked by vertical cursor lines. In waterfall display (upper display window) two transmitters cannot be distinguished, in azimuth versus frequency display in lower window and azimuth histogram right it can be seen that two FH transmitter signals arrive with azimuth difference of 36°.

For an FH transmitter to be detected with the aid of a search receiver or scanning direction finder, the hop sequence of the transmitter and the scan sequence of the receiver must coincide. Given a random hop sequence and a hop-independent receiver sequence, only the probability of intercept can be described. Reference [3] deals with this subject for single-channel search receivers. The article however merely considers the probability of at least one hit and does not give details on the dwell time of the search receiver at the instantaneous frequency position. By contrast, reference [4] only describes a special case of overlap of hop and search frequency ranges and does not go into the timing of the receiver sequence coinciding with the hopper sequence.

2 Presumptions

The behavior of a **hopper** is assumed to be random: the channels of the hop range (M_{FH}) are used in random sequence, the current channel being selected independently of all previously and subsequently selected channels. The probability of selection should be the same for all hop channels ($1/M_{FH}$), although there is no certainty of any channel appearing at all within a given period of time. The burst time (dwell time of the hopper on an emitted frequency) is T_h. In the case of variable hop times, T_h is the average value. For the sake of simplicity, regular, contiguous channel spacings are assumed for the frequency range. The frequency range occupied by the hopper is also taken as being free from any other signals.

It is further assumed that the **receiver** (monitoring receiver or DF receiver) systematically scans the defined frequency range with the same frequency spacing as used by the hopper. The center frequencies of the scanned channels (M_{Sc}) may come in any sequence, eg linear with time (linear staircase) or as a pseudo-random sequence. It must however be certain with all hop sequences that each of the selected M_{Sc} channels is used exactly once in a scan. In this case the random sequence is not a stochastic process like the hop sequence but a systematic search, even though with complex timing. A full number of complete scans is assumed to be performed each time. The duration of a scan corresponds to T_{Sc}. Irrespective of the type of scan, the probability of a receiver operating at a certain channel during a randomly chosen time is $1/M_{Sc}$ for each of the M_{Sc} channels.

Each frequency position of the receiver is assigned a dwell time T_d (FIG 4) consisting of the integration time T_i and a remaining period T_{Syn}. T_{Syn} contains the settling time of the receiver synthesizer and the time required for signal processing (eg with direction finders the time required to calculate a bearing):

$$T_{Syn} = T_d - T_i \quad (1)$$

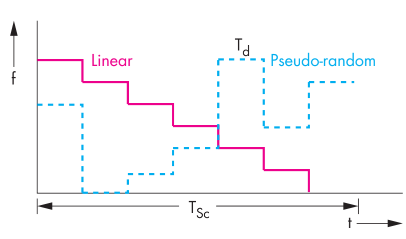


FIG 4 Search sequences of receiver

The integration time T_i depends on the settling time of the filters used. Signals with a duration of $T_h \leq T_i$ are considered not detectable, ie a signal must have a length of at least $T_h > T_i$ to be detected. The received bursts should have sufficient power to be detected when at least one integration time T_i falls within the burst interval T_h and the hop frequency and the receive frequency are identical. This is a very simple way of approaching the intercept procedure. In this consideration the relationship between the probability of a false alarm, intercept threshold, S/N ratio, averaging and probability of intercept is not taken into account. Therefore, the fact will also be ignored that, to obtain constant S/N ratio at the input of the detection device, field strength should be increased proportionally to $\sqrt{(1/T_i)}$ at short integration times T_i.

The frequency ranges of hopper and receiver should at least partially overlap by a number of channels

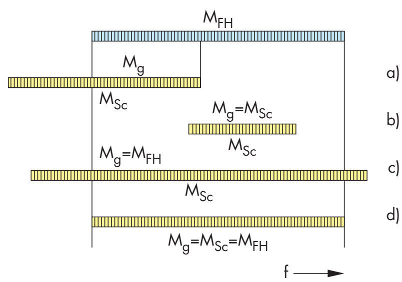


FIG 5 Frequency bands of hopper and receiver: a) general overlap; b) search range fully inside hop range; c) hop range fully inside search range; d) search range = hop range

M_g in the common frequency band (FIG 5).

With digital signal processing, receivers using parallel, identical filter/detector channels can be implemented (multichannel receiver), in the case of many channels by means of fast Fourier transform for instance. Whenever the receiver locks to a specific frequency, K filters/detectors are simultaneously active.

3 Probability of intercept for single bursts

The probability of intercept for single bursts of an FH transmitter will be examined first. The considerations are also valid for the detection of any single burst, ie of any signal with the length T_h that occurs only once within an extended observation period T_t.

3.1 Probability of intercept during single trial

As can be seen from FIG 5, the transmitter may use any of the M_{FH} channels, and the receiver be in any of the M_{Sc} channels, so M_{FH} x M_{Sc} combinations are possible. It is possible for both to meet in one of the M_g common channels. If the number M_g of a possible coincidence between the transmitter and receiver is related to the number of possible combinations, the probability of intercept for a single burst in a single trial is [3]:

$$P_1 = \frac{M_g}{M_{FH} M_{Sc}} \qquad (2)$$

The following applies to multichannel receivers. If K parallel filters with associated detectors are implemented in the receiver at channel spacing at each frequency position, the probability of hitting the burst in one of the K channels increases by the factor K compared with (2):

$$P_1 = \frac{M_g K}{M_{FH} M_{Sc}} \qquad (3)$$

This applies when the number of parallel receiver channels is less than the number of common hopper and receiver channels $(K < M_g)$. In the case of $K \geq M_g$, K should be replaced by M_g in equation (3).

In the following cases, the use of a multichannel receiver is generally assumed. The relationships for a single-channel receiver are then obtained with $K = 1$.

The following special cases should be mentioned:

1. The frequency range of the hopper is greater than that of the receiver and covers the latter completely $(M_{FH} > M_{Sc})$ (FIG 5b). With $M_g = M_{Sc}$ the following is obtained from (3) for a multichannel receiver:

$$P_1 = \frac{K}{M_{FH}} \qquad (4)$$

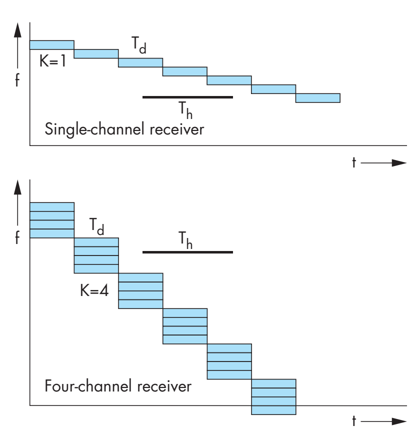


FIG 6 Search sequence of receiver and hop duration T_h (burst)

and for a single-channel receiver:

$$P_1 = \frac{1}{M_{FH}} \qquad (5)$$

The probability of intercept for a single burst in a single trial is independent of the total number of receiver channels M_{Sc} when the ranges overlap as shown in FIG 5b.

2. The frequency range of the receiver is greater than that of the hopper and covers the latter completely $(M_{Sc} > M_{FH})$ (FIG 5c). With $M_g = M_{Sc}$ the following is obtained from equation (3):

$$P_1 = \frac{K}{M_{Sc}} \qquad (6)$$

The possibility of performing irrelevant measurements outside the transmitter frequency range entails reduced probability of intercept for a single burst in a single trial as against (4) at a constant value of M_{FH}.

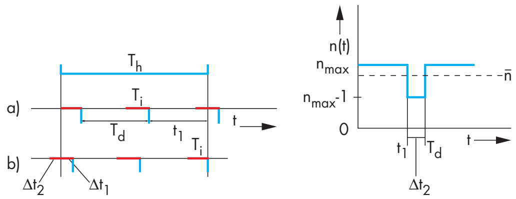
3.2 Several trials during single burst

More than one trial can be made with a scanning receiver during a burst when the dwell time of the receiver at a specific frequency position is sufficiently short in comparison with the burst duration (FIG 6). A number of n valid trials may be performed during consecutive dwell times T_d of the receiver within the burst period T_h. An intercept attempt is considered valid when the integration time is completely covered by the burst, ie if no frequency change or start and stop of a burst occurs during the integration time T_i of the detector. The number n depends on the timing of the burst T_h and the receiver dwell time T_d at a specific frequency position. The following applies for the mean number $\bar{n}$ of valid intercept attempts during the hop period T_h:

$$\bar{n} = \frac{T_h - T_i}{T_d} = \frac{T_h - T_i}{T_{Syn} + T_i} \qquad (7)$$

Derivation of equation (7)

The diagram left shows the hop interval T_h of the transmitter and part of the receiver sequence with the dwell time T_d and integration time T_i shifted in two ways (a and b) with respect to T_h. Part of the two-valued periodic function *n(t)* is shown right in relation to the shift *t* of the receiver sequence with respect to the hop period; function *n(t)* uses the dwell time T_d and describes the number of valid intercept attempts during the hop time.



Function *n(t)* is obtained as follows. The maximum number of valid intercept attempts results at position a of the receiver sequence relative to the burst. Only one of the integration times T_i contains a frequency change or the end of a burst, so only one of the intercept attempts is invalid. The maximum number of valid intercept attempts is obtained as follows:

$$n_{max} = INT\left(\frac{T_h}{T_d}\right) \quad \text{where } INT(x) = \text{integer part of } x.$$

When the receiver sequence is shifted in the direction *t*, n_{max} remains unchanged until position b is reached, ie for the shift duration t_1. Shifting the receiver sequence in the direction *t* beyond position b will yield two invalid intercept attempts, so that only n_{max}–1 valid intercept attempts remain. This situation continues until the total shift corresponds to a period T_d and the receiver sequence arrives at position a again. Consequently $n(t) = n_{max}-1$ is maintained for the time Δt_2.

The arithmetic mean of *n(t)* [3] stands for the average number of valid intercept attempts:

$$\bar{n} = \frac{1}{T_d}\int_0^{T_d} n(t)dt = \frac{n_{max} \times t_1 + (n_{max}-1) \times \Delta t_2}{T_d}$$

From $\Delta t_1 = T_h - n_{max} \times T_d$, $\Delta t_2 = T_i - \Delta t_1$ and $t_1 = T_d - T_i + \Delta t_1$ equation (7) is derived:

$$\bar{n} = \frac{n_{max}(T_d - T_i + T_h - n_{max}T_d) + (n_{max}-1)(T_i - T_h + n_{max}T_d)}{T_d} = \frac{T_h - T_i}{T_d}$$

The derivation of this equation is presented in the blue BOX.

During a search, each intercept attempt of the receiver is made at a different frequency position, so the probability of hitting the burst increases with each attempt beyond $n = 1$ during a burst period. The probability of intercepting a burst with $\bar{n}$ valid attempts within T_h is therefore defined by

$$P_{1h} = P_1 \times \bar{n} = \frac{M_g}{M_{FH}M_{Sc}} K \times \bar{n}$$

$$= \frac{M_g K}{M_{FH}M_{Sc}}\left(\frac{T_h - T_i}{T_d}\right) \qquad (8)$$

The validity of (8) has the following limitations:

a) A basic precondition is $T_h / T_i > 1$, ie a burst can only be detected if it is longer than the detection time.

b) The probability defined by (8) can theoretically be $P_{1h} > 1$ provided $(T_h - T_i)/T_d$ is long enough. However, with a long burst duration T_h, the highest intercept probability $P_{1hmax} \le 1$ is reached when the search receiver is able to scan all M_{Sc} channels during one burst (burst time longer than complete scan, $T_h > T_{Sc}$). When T_h is further increased, the probability of intercept for a single burst does not rise above P_{1hmax}. $T_h > T_{Sc}$ yields $\bar{n} = M_{Sc}/K$ and thus the following limits apply to (8):

$$T_i < T_h \le \left(\frac{M_{Sc}}{K} T_d + T_i\right) \qquad (9)$$

The maximum achievable probability of intercept in the case of long bursts depends on the degree of overlap of the hop range with the receiver scan range.

a) General case (FIG 5a):

$$P_{1hmax} = \frac{M_g}{M_{FH}} \qquad (10)$$

b) The hop range is completely covered by the scan range $M_{Sc} \ge M_{FH}$ (FIG 5c and d):

$$P_{1hmax} = 1 \qquad (11)$$

c) The scan range is completely within the hop range $M_{FH} \ge M_{Sc}$ (FIG 5b and d):

$$P_{1hmax} = \frac{M_{Sc}}{M_{FH}} \qquad (12)$$

A comparison of (8) and (3) shows that greater probability of intercept can only be reached at sufficiently high scan speeds:

$$\bar{n} \ge 1 \quad \text{for } T_d + T_i \le T_h \qquad (13)$$

If only the basic condition $T_i < T_h$ is met but not (13), it is possible that on average less than one valid intercept attempt can be made during a burst. In these cases the probability of intercept for a single burst is reduced according to (8) as against (3).

To be continued.

Dr Hans-Christoph Höring

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Virtual networks: new applications for Network Analyzers ZVR and ZVC

Virtual Embedding Networks option ZVR-K9 is a new tool that opens up a whole variety of new applications for Network Analyzers ZVR and ZVC [1]. This software allows so-called virtual networks to be taken into account in S-parameter measurements.

The measurements that can be handled with the aid of ZVR-K9 split into two complementary classes. In the first place, a component may have to be measured as if it were contained in a defined but physically non-existent circuit environment, ie embedding. The other possibility is measurement of a component actually embedded in a real circuit environment but as if the environment did not exist, ie de-embedding [2; 3].

Here is a typical **example of embedding:** a surface-acoustic-wave filter with an impedance of several hundred ohms is to be worked in a 50 Ω environment. For this purpose the filter has to be embedded in an external matching circuit, eg an RLC combination. To simplify system design for the user, the manufacturer specifies the filter together with the matching circuit in which it is also tested. This external circuit must be highly stable to minimize measurement uncertainties. If several circuits of the same type are used to increase the testing throughput, the circuits must be reproducible to a high degree. Most real matching circuits fall somewhat short of these two requirements. Option ZVR-K9 allows operation of the filter in a real 50 Ω environment and consideration of a virtual matching or transforming network in the measurement. This virtual network is a data record, so it is per se stable and reproducible. Consideration of the network in the measurement is possible by appropriate modification of system error-correction data. This means that no extra step is needed in the processing of measured results and the high speed of ZVR is maintained. The two upper diagrams in FIG 1 show the forward S-parameters S_{11} and S_{21} of a through-connection embedded in two (mismatched) Insertion Adapters ZPV-Z1. Each diagram contains two traces, one representing measurement with a real transforming network and the other a simple through-connection between the 50 Ω test cables with the network virtual. The two traces are almost identical, which is shown by the vector difference in the diagrams below. Note that the outer circle corresponds to a difference of only 0.02.

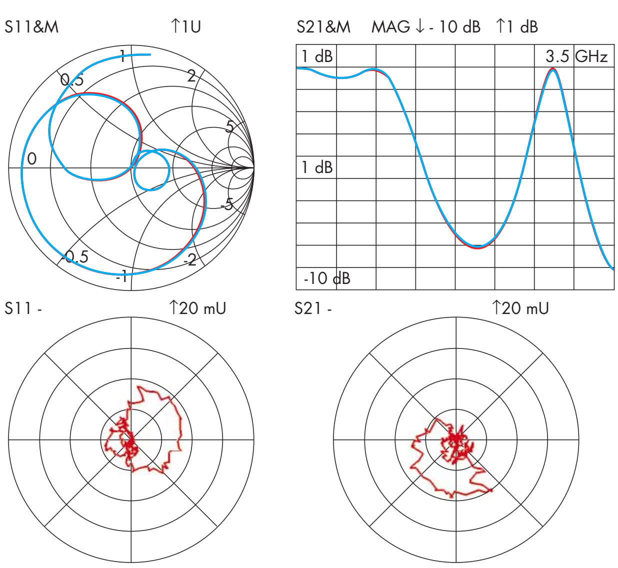

FIG 1
Upper diagrams: S_{11} and S_{21} of through-connection, embedded in physically real Insertion Adapters ZPV-Z1 (red traces) or in virtual ones (blue traces). Vector difference of two traces is shown below each diagram.

In a **de-embedding application,** the DUT ports of interest are not accessible but you know the S-parameters of the network in which the DUT is embedded. This may be a test adapter, for instance, or the package of an MMIC whose inner chip is to be measured. By virtually embedding the DUT with the real transforming network into the corresponding inverse network, the transformation can be neutralized and the de-embedding problem thus turned into one of embedding (FIG 2).

For two-port DUTs the general embedding network is a four-port network. In most practical applications however, it is sufficient to take the special case of a dual two-port. The scattering parameters of the virtual network must be known for both embedding and de-embedding. If they are not known but the network is physically available in the form of a sample circuit, this real network can be measured with ZVR-K9 (unterminating). Or scattering parameters may also be read in from a CAD simulation. The ASCII formats of Ansoft (eg Serenade®, Super Compact®) and HP-EEsof (eg Series IV®, Touchstone®) are supported in this case. Conversely, the measured scattering parameters of a network can also be exported in these data formats.

Option ZVR-K9 comes as a Windows application for ZVR or ZVC with option ZVR-B15 (controller function). It is installed with the aid of a setup program.

ZVR-K9 is controlled by a menu bar and pulldown menus. Functions requiring a lot of user entries, eg measurement of real transforming networks, are organized in successive windows. These contain help graphics in part and are easy to view. User-friendly operation is enhanced by numerous management functions for both the virtual networks and the system error-correction files that are to be modified. Selection of the required virtual network from the program's internal database, for instance, is supported by a list of important parameters such as frequency range, number of points, storage date and an optional comment. With the display channels decoupled, an individual virtual network can be selected for each channel.

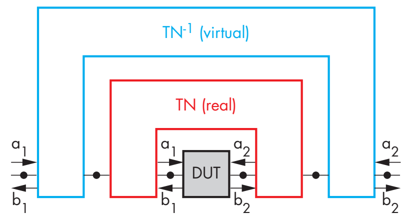

FIG 2 De-embedding solved by embedding real DUT with transforming network in virtual, inverse network

Dr Jochen Simon

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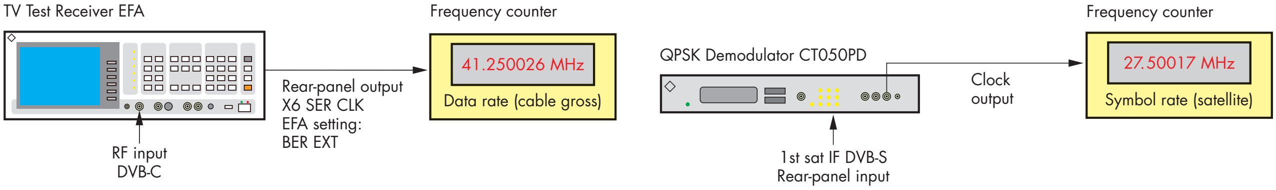
Reader service card 160/15

Accurate data-rate measurement in digital video broadcasting



Data transmission rate has to be measured frequently in digital television, independently of an MPEG2 Measurement Decoder DVMD and directly after DVB modulation. Direct measurement of the symbol rate is not always accurate enough, even if it is determined with accuracy of 1 kHz as with **TV Test Receiver EFA.** Seen in relation to the data rates of 38.153 Mbit/s and 64 QAM (DVB-C) common in today's cable systems, 1 kHz resolution is equivalent to an error of $1/(38153 \times (204/188)/6) = 1.45 \times 10^{-4}$. But what if the maximum permissible error is 1 ppm? No problem for DVB-C Test Receiver EFA. Used with a frequency counter that has the required resolution and accuracy, it measures the exact data rate. The data-clock output on the EFA rear panel is permanently locked to the data rate of the transmitted MPEG2 transport stream. So measurement of this clock yields maximum accuracy. The frequency counter shows the data rate $D_{cable\text{-}gross}$, of course including Reed-Solomon error control. The conversion

$$D_{cable\text{-}net} = D_{cable\text{-}gross} \times 188/204$$

produces the net data rate of the MPEG2 transport stream transmitted via cable at the frequency counter's accuracy, ie to 1 ppm.

With satellite transmissions (DVB-S) a data-rate clock output is normally unavailable, so you have to resort to symbol-rate measurement. This is where **QPSK Demodulator CT050PD** comes in. The procedure is basically the same, the only difference being that the effect of convolutional coder and puncturing (P_{rate}) are taken into account in calculation of net data rate. For DVB-S the equation is therefore:

$$D_{satellite\text{-}net} = S_{satellite\text{-}gross} \times 2 \times P_{rate} \times 188/204$$

The symbol rate $S_{satellite\text{-}gross}$ and puncturing P_{rate} for satellite operation are usually known and are entered into the DVB demodulator manually. The data rate can then be measured via the symbol rate if DVB-S is within the capture range of the demodulator's internal PLL used for symbol-rate synchronization. The capture range can be assumed to be ±300 kHz, which is sufficient for the proposed measurement also on DVB-S.

Sigmar Grunwald

Reader service card 160/16 for more information on EFA and CT050PD

Controlling radio transceivers on Intranet

As the PC made inroads into just about every aspect of daily life, its use for controlling equipment was obviously only a matter of time. Equipment control by PC is subject to constant change, as it is linked to what is happening in computer engineering. The latest development in radio control from Rohde & Schwarz – **Radio Remote Control Software DS110** (RRC software) – makes use of the most advanced technologies to be found in computer networks today and its concept sets standards for future developments. The software incorporates a wide variety of tools, Java-based web browsers and relational database management systems as well as client/server architectures.

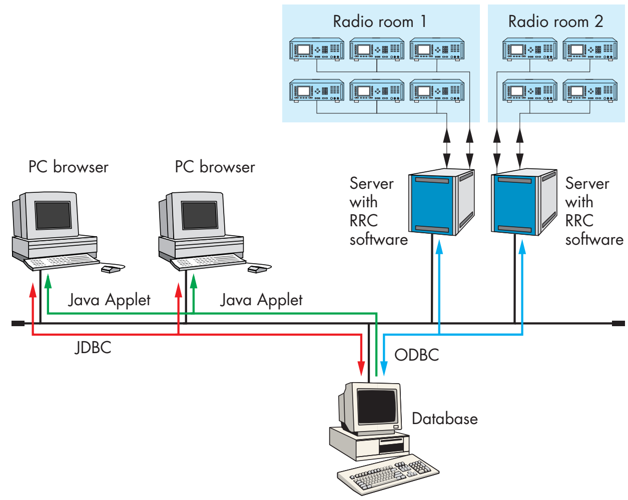
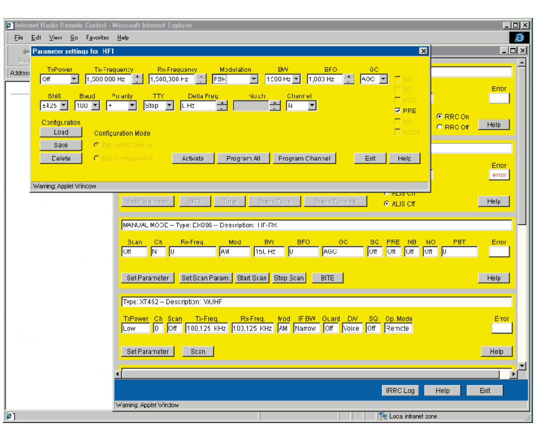


FIG 2 Use of RRC software in modern computer network with client/server architecture and distributed tasks

This radio control software allows configurations and settings such as frequency and modulation to be made from any workstation in a computer network. And, in the other direction, parameters and settings of remotely controlled radio transceivers can be queried and monitored. Errors, for example, can be detected rapidly through continuous monitoring. Settings no longer have to be performed on the transceivers themselves, but can be made from any PC within the computer network. The RRC software package has a clear menu structure, offering operational ease that transceivers with their relatively limited graphic display cannot match. As an added convenience, the panels of any transceivers can be individually grouped together (FIG 1). Settings can be both sent to the transceivers and stored in configuration files.

FIG 1 Radio Remote Control Software DS110 makes use of browsers that are destined to become standard.



There is basically no limit to the number of transceivers that can be controlled by this software in the 3 kHz to 3 GHz range (VLF, HF, VHF, UHF). The transceivers are addressed via a serial bus. RS-232-C or RS-485 interfaces are used, depending on whether distances up to 20 m or of several hundred meters are involved. The number of serial lines as well as the number of transceivers can be freely selected and depends on the system. To spread the workload, the RRC software can be installed on several workstations, each controlling a certain number of transceivers. Information about the settings or queries that the RRC software is to perform on the transceivers connected to a workstation comes from a relational database management system. Information flow between this database and the remote-control software works through the ODBC (open database connector), a standard interface that allows an application to access a database (FIG 2). This means that other applications, like intercom systems of another make, can also access the database.

The database may be installed on any server in the network, benefiting in this way from its data security and performance. Settings are entered via dialog boxes generated by Java Applets in the Internet browser (navigator, explorer). They are transmitted to the database via the JDBC (Java database connector). Similar to ODBC, JDBC is a standard interface enabling Java Applet to access the database. The Java programming language means that there are no platform restrictions, enabling use with various operating systems (eg Unix, Windows) and computers (eg IBM, Sun, Apple).

Thomas A. Kneidel

Reader service card 160/17

HF Airborne Radio XK516D1 well on course

Transceiver XK516D1 – an HF airborne radio for use in passenger and cargo aircraft (FIG 1) – has proven to be a great success worldwide, which can be attributed among other things to its capability to transmit and receive both speech and data [1].

After its introduction by Air Berlin and Eurowings, it was soon purchased also by larger airlines like Air France and Saudia Air. These were followed by American Transair and China Southern Air as well as leading leasing companies like GATX CAPITAL and ILFC. The two most recent milestones in this success story are dated late 1997: Lufthansa Condor and Lufthansa Cargo decided to fit out 96 airplanes of the types A 320 and B 757 with the HF transceiver, and an order from US Air was the first placed by a large American airline. To date more than 500 HF transceivers have been sold, while the number of airlines using XK516D1 is no less than 23. The transceiver has been certified for almost all medium- and long-haul aircraft types [2].

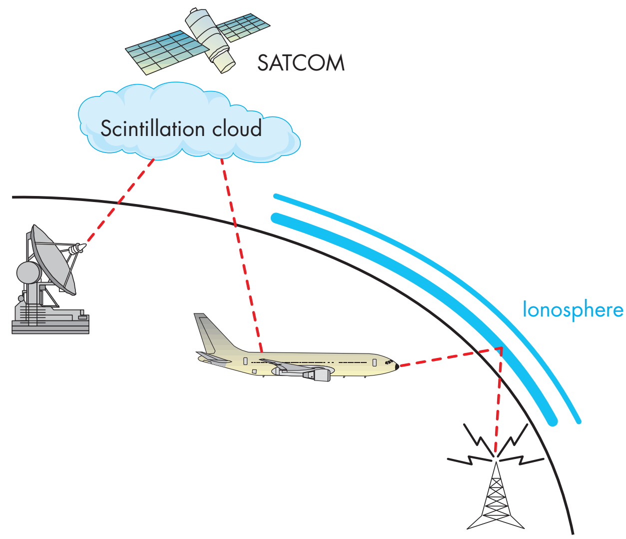


FIG 2 Ground-to-air communication via shortwave as backup for SATCOM (source: ARINC)

FIG 1 HF Airborne Radio XK516D1 is onboard 23 airlines. Photo 40 539/3

The HF transceiver is continually being updated and matched to the latest standards. Interim standardization of the HF data section was completed at the general session of AEEC (Airlines Engineering Electronic Committee) in October 1996 by adopting ARINC characteristic 753 (HF DataLink System). This led to the production of a special version of the XK516 transceiver enabling ACARS (aircraft communications and reporting system) data transfer beyond the limited VHF range, which allows integration into the worldwide airline communication system.

Supplement 2 of ARINC specification 635 (HF DataLink Protocols) was adopted in October 1997, creating a basis for the worldwide use of HF data traffic, eg for the aeronautical telecommunications network (ATN) and for ATS DataLink for automatic dependent surveillance (ADS) as well as two-way data link (TWDL). In February 1998 ARINC started providing the ARINC HF GLOBALink service with ground stations in San Francisco and Hawaii, thus covering most of the Pacific region. Another eight ground stations will be set up by spring 1999, which will then ensure worldwide coverage including the Arctic region. Approval of the SARPs (standards and recommended practices) by the ICAO (International Civil Aviation Organization) is expected for October 1998, which will mean official acceptance of the worldwide HF DataLink System. XK516D1 is fit for all the applications named.

Revival of the HF aeronautical radio network, considered well and truly on the way out by the late 80s, was lent impetus by landmark Rohde & Schwarz developments in automatic link setup and error correction. This has paved the way for cost-effective worldwide radio networks that will continue to play a role alongside satellite communications (FIG 2).

Ekkehardt Claussen

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Reader service card 160/18

EMC test center of SEE in Luxembourg

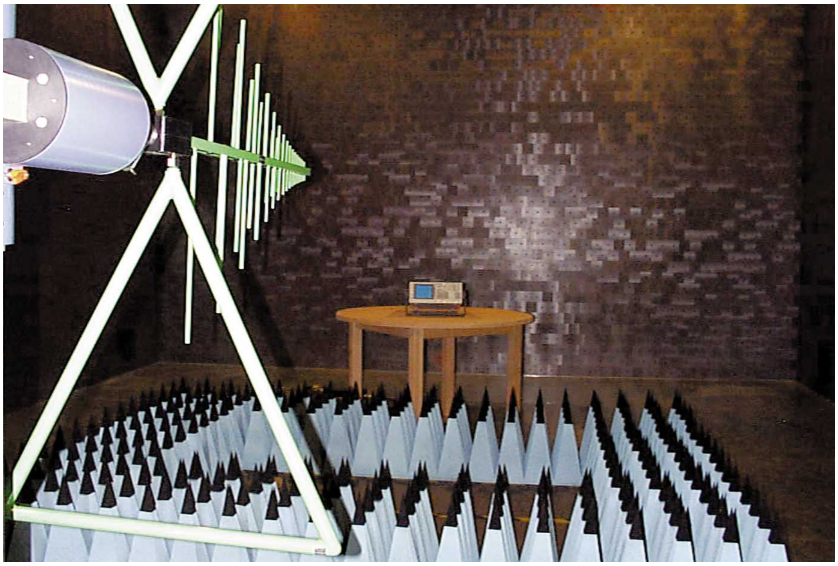


FIG 1 Size of anechoic chamber of EMC center of SEE: 9 m x 6 m x 5 m

The EMC test center of SEE (Service de l'Energie de l'Etat) in Capellen, Luxembourg, has been operational for more than one year now. A wide variety of products are tested here and certified for compliance with the European EMC directive. The center was implemented in close cooperation with Rohde & Schwarz, which was responsible for turnkey delivery and project management. An anechoic chamber (FIG 1) is used for testing radiated emission and immunity of equipment. The chamber's shielding is specified for frequencies up to 20 GHz. Adjacent to the anechoic chamber is a control room housing the test and measurement systems (FIG 2).

The core of the **RFI emission test system** is two EMI Test Receivers ESHS and ESVS. They cover the frequency range from 9 kHz to 1 GHz and combine excellent EMI RF characteristics for full-compliance measurements to CISPR16. The system also includes a bilog antenna, two line-impedance stabilization networks, an automatic Antenna Mast HCM with positioning controller, an automatic turntable with a diameter of 2 m for EUTs weighing up to 1000 kg, and an automatic Absorbing Clamp Slideway HCA plus Absorbing Clamp MDS-21.

FIG 2
Control room with test systems and process controller
Photos: SEE

All emission measurements are automated by EMI Software ES-K1, which runs under Microsoft Windows. This simplifies reporting and enables further data processing by commercial software (eg Excel and Winword).

The **immunity test system** consists of a Signal Generator SMY and two power amplifiers. Power is controlled and measured by a System Control Interface Unit SCIU and dual-channel Power Meter URV5. The 100 W amplifier for the range 80 MHz to 1000 MHz drives a log-periodic antenna and generates fields of over 10 V/m at 3 m range. The 150 W amplifier, covering 10 kHz through 220 MHz, is for conducted immunity tests using different CDNs and an injection clamp.

For the measurement of EUTs according to ETSI standards, a monitoring system was added to the EMS test system. This allows all parameters of an analog transmitter/receiver to be measured with Radiocommunication Service Monitor CMS52. Audio signals are applied to the EUT and measured using acoustic lines, artificial mouth / ear and sensors. The EMS test system permits fully automatic EUT monitoring during immunity tests thanks to the powerful EMS Software EMS-K1. The system can be extended for digital radiotelephones (GSM, DECT).

The EMC test center of SEE can also perform transient immunity tests as well as measurements of line harmonics and flicker. These measurements too are automated by the system software running under Windows. The process controllers are equipped with all input and output interfaces required to operate the test and measurement systems.

Jos Westhof-Jacobs

Reader service card 160/19 for more information on EMC measurements

Industrial Controllers PSM12 / 17 – the next generation

When it comes to professional measurements, the controller should not be the weakest link in the chain but rather be able to meet special requirements. These may include shock and vibration resistance, especially for use in vehicles or industrial environments, ultra-low temperature effect, high immunity to interference even in strong electromagnetic fields as well as low inherent emission so that measurements will not be impaired by fields produced by the controller. PSM offers ideal characteristics for all key applications, shock resistance in mobile applications, rackability, built-in measurement facilities for use in production and high EMI shielding.

Industrial Controllers PSM2 (without display) and PSM7 (with colour display) have been further developed and are now available as models PSM12 and PSM17. The major **innovations** are PCI bus, fast PCI graphics, an even faster processor, large and brilliant TFT display, CD-ROM drive, SCSI, Ethernet and two PC-card interfaces, lockable cover plus new operating systems.

The main PC components are all included in the **basic PSM.** The built-in Ethernet interface makes it extremely easy to connect the controller to intranets. A state-of-the-art ultra/ultrawide SCSI interface allows adding internal and external, standard SCSI components. The 16-bit GPIB interface as well as a large number of serial and parallel ports have always been standard in PSM, likewise the factory user port (FUP), providing a variety of extra functions required in automated test procedures. The fast CD-ROM drive makes software installation and updating a real pleasure.

The system can be tailored to suit **specific needs:** free 16-bit ISA and PCI slots provide ample space for expansion. If more space is required, the PC-card slots in the basic unit can be used for further extensions. Modules that are likely to be upgraded at some stage, such as CPU and graphics, are accommodated on a separate card for easy replacement to boost performance. This modular principle ensures a future-safe investment.

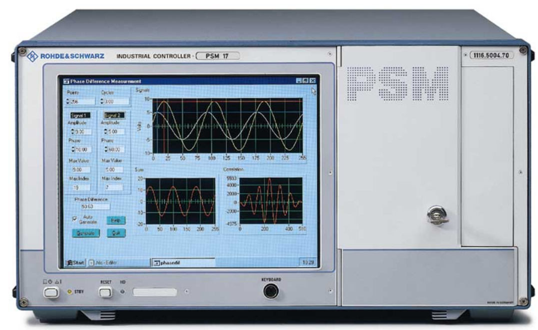
Extendibility is particularly important with memories, which were therefore designed to allow maximum versatility. Minimum RAM capacity in the basic version is 32 Mbytes, which can be extended to 256 Mbytes. Mass storage can be expanded to almost any size, and a 6-Gbyte hard disk (EIDE) is installed as standard. Any type of SCSI peripherals, for example hard disks, CD-ROM and streamer drives, can be controlled via the integrated SCSI interface. The integrated PC-card interface is especially suitable for connecting external interface and memory cards.

Data security through the use of a BIOS setup password is a matter of course today. PSM goes a step further and "hides" all drives (CD-ROM, floppy, PC card) behind a lockable cover. This not only enhances passive security but also improves the PSM's electromagnetic compatibility.

Automating test procedures requires **control lines** that are not available in standard PCs. The digital I/O interfaces, partly isolated by optocouplers, allow external processes to be controlled or analog voltages to be measured without an IEC/IEEE-bus-compatible voltmeter being needed. These interfaces are available in PSM as standard through its FUP. Various high-level language drivers are supplied for interface control: the user may choose programming the simple way with Basic under DOS or with Visual Basic or C under Windows.

A powerful computer requires powerful **software.** The optional system software not only contains the operating system but also the professional LabWindows/CVI® (C for Virtual Instrumentation) measurement software. Naturally the software comes installed on hard disk and ready tailored to the PSM hardware configuration. A CD-ROM with all drivers, LabWindows/CVI and utility programs is supplied as a backup.

Richard Gärtner



Industrial Controller PSM17 with Windows 95® and CVI application Photo 43 088/3

Reader service card 160/20

New test van for Bayerischer Rundfunk

FIG 1 New test van of broadcaster Bayerischer Rundfunk for continuous supervision of more than 350 transmitter and transposer sites

The transmitter operations department of the Bavarian broadcaster Bayerischer Rundfunk (BR) runs a mobile test laboratory for supervision of its transmitter facilities. The measurements performed throughout the broadcasting area (14 main network transmitters and 343 TV transposers) are required for rebuilding, modifying or renovating the transmitter equipment, or during regular ongoing transmitter operation. Nearly ten years of wear and tear in rough field use had left their traces on the former test van, so its replacement became due. Its successor was planned with a view to future requirements. Tried and tested features were retained, while improvements were made where appropriate.

The principle of the new test van – a Mercedes Sprinter 312D (FIG 1) – is that the signals to be tested are brought into the vehicle for measurement by the equipment installed there. Integrated cable drums provide the links to the items tested. This saves a lot of time with most measurements, because no instrumentation has to be unloaded and set up for the purpose. If any measurement does have to be performed outside the van, the equipment can be quickly removed. The spectrum analyzer, for instance, is fixed by a quick-grip lock. Antennas are mounted on a powered telescopic mast. The most important items of test equipment are permanent fixtures in the vehicle so that it is always ready to proceed to a site without time-consuming preparations.

Rohde & Schwarz made a major contribution to the van's outfit: Video Measurement System VSA, Frequency Counter R5362B from Advantest, Digital Multimeter UDL35, various measurement antennas and last but not least EMI Test Receiver ESN (FIG 2).

Special emphasis was placed on safety and ergonomic aspects. The frontal holders of the 19-inch enclosures, fixed to the vehicle frame, prevent equipment from being torn off the table top and hurled into the passenger compartment in the event of a collision. The view to the rear is limited, so a video system was installed that switches on automatically as soon as the van is put into reverse. Large windows provide ample light and the work areas are ergonomically optimized so operators can work under pleasant conditions without fatigue.

Erwin Pauly (BR)

FIG 2
The van contains all equipment required for functional checks on transmitter installations, much of it from Rohde & Schwarz.
Photos: author

EMC test system for MTU Munich of Daimler-Benz Aerospace

An EMC test system from Rohde & Schwarz has gone into operation for BCI (bulk current injection) tests at Motoren- und Turbinen-Union (MTU) in Munich. The company is now able to carry out its own EMC tests on engine control systems, test equipment for control systems and ground handling equipment throughout the development phase as well as perform type-certification tests. The system allows tests to various regulations such as EFA standard SPE-J-000-E-1000, CS-EFA2, MIL-STD-461D, CS114, ISO 11452-4 and can be extended for other test procedures.

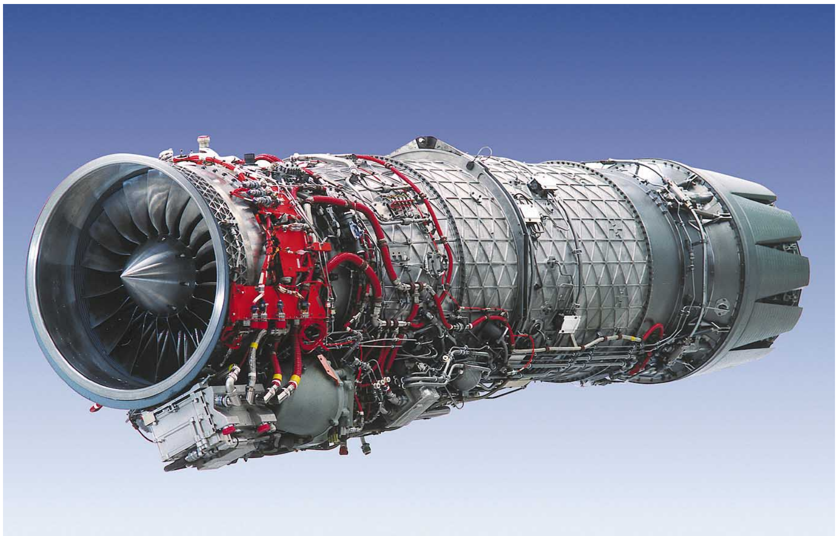
The **advantages of inhouse testing** over the previous practice of testing at external test companies are obvious:

- Prototypes can be tested at an early development stage to avoid weak spots in their design.
- Certification tests can be performed as soon as a design is completed. It is no longer necessary to transport an item to an external test lab and set up all the extra equipment required to operate it there.
- Specialists from R&D can be consulted immediately should problems occur during BCI tests. The effects of possible modifications can be investigated right away.
- Scheduling of tests is quite flexible as no reservations need to be made.

Besides elimination of travel and transport, it is the improved flexibility in particular that speeds up type certification. This results in savings that more than make good the capital spent on the new system.

The processor-controlled **BCI test system** includes Signal Generator SMY01, a relay matrix, two power amplifiers, Power Meter NRVD, current clamps and other system components [1]. The frequency range is 10 kHz to 400 MHz; the amplifiers produce 500 W (up to 200 MHz) and 100 W. Thanks to its modular design, the test system is adaptable to future changes in standards.

System Software EMS-K1 [2] supports BCI tests using the substitution method, as required by most standards. The closed-loop method is also permitted. Flexible settings allow the software to be matched to the particularities of the individual standards. The software controls and supervises all equipment and corrects the frequency response of the components used so that the operator is relieved of these routine tasks and able to fully concentrate on observing the equipment under test. The software can also be further extended for automatic supervision of the EUT.



Jet engine EJ200 from Daimler-Benz Aerospace MTU Photo: MTU

The order for this system demonstrates that MTU has confidence in the wealth of experience Rohde & Schwarz has in the implementation of EMC test systems.

Hubert Herrmann (DASA MTU); Reinhard Göster

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Reader service card 160/19 for more information on EMC measurements

Photo: Jirschik

New TV and radio transmitters for Croatia

Croatian broadcaster HRT (Hrvatska Radio Televizija) ordered a station comprising three FM and three TV transmitters for Borinci in eastern Slavonia, close to Vukovar, and three TV transmitters for installation at the Srd station on the Adriatic coast. Both stations were completely destroyed during the war in Croatia in 1991.

The Srd station was rebuilt entirely and two 10 kW UHF Transmitters NH510 and a 5 kW VHF Transmitter NM535E installed. These solid-state, dual-drive TV transmitters and their antenna system, also newly installed, cover the city and the surroundings of Dubrovnik in a radius of around 50 km.

Borinci was designed as a low-cost solution with transmitters installed in shelters (photo left). The existing FM, VHF and UHF antennas on the 150 m mast serve for broadcasting three TV and three FM audio channels. Three 5 kW FM Transmitters SR536F1 are accommodated in one of the shelters, while a 5 kW VHF Transmitter NM535E and two 10 kW UHF Transmitters NH510V are housed in the remaining three shelters. All six are of dual-drive, solid-state design and therefore highly reliable. Their cooling systems are designed to cope with the cold winters as well as the hot summers prevailing in the area. The shelters are provided with all facilities required at an unmanned station, including a diesel emergency power generating set. All transmitters are controlled and monitored remotely.

P. Kulušić (HRT)

Hans Wagner elected to board of ZVEI

Hans Wagner, President and COO at Rohde & Schwarz, has been elected to the board of the ZVEI (Central Association of the German Electrical Industry). Hans Wagner has been with Rohde & Schwarz for 34 years and became COO in 1989.

PI

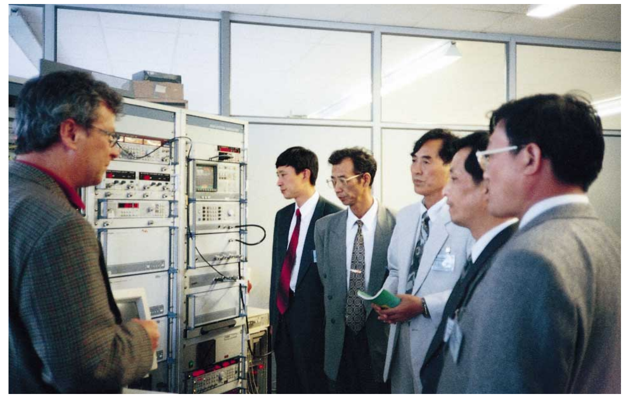


Photo: Beckmann

Tektronix and Rohde & Schwarz to expand activities into Mexico

Rohde & Schwarz and Tektronix, Inc. concluded an agreement to expand their strategic alliance for North America, which has been in existence since 1993, to include distribution rights for the territory of Mexico. Under the revised agreement, Tektronix will reserve exclusive marketing, distribution, service and support for Rohde & Schwarz RF and microwave communications and television test products in Canada, Mexico and the United States, thus confirming its commitment to the construction of an integrated NAFTA region strategy.

The unique experience of Rohde & Schwarz in providing specialized measurement solutions to mobile-radio manufacturers and wireless service companies will gain even greater impact in North America through this alliance. In Mexico, seven cellular service providers plus the numerous paging companies may benefit from the technology of Rohde & Schwarz.

PI

TV transmitters for China

Rohde & Schwarz received a further order for the installation of 20 kW UHF TV Transmitters NH520A (photo left) in Shenzhen City in the southern Chinese province Guangdong. Shenzhen is a region with special economic status near Hong Kong and is considered the most highly developed area in South China. Rohde & Schwarz won the contract against strong competition from Japan and America, because other Chinese operators have already had very positive experience with the company's transmitters.

H. Gregorek

China CISPR committee visits Rohde & Schwarz

Following the international conference of the International Special Committee on Radio Interference, held in Frankfurt/Main this year, the delegates from the People's Republic of China paid a brief visit to Rohde & Schwarz in Munich. Manfred Stecher, who was the company's delegate at the CISPR meeting in Beijing two years ago and already met the Chinese delegation in Frankfurt, welcomed the guests in Munich.

The delegation wished to find out about the effects of the new CISPR standards and the T&M instruments developed by Rohde & Schwarz specifically for these standards. A general presentation of the company was followed by a talk on EMC with the system group of the Test and Measurement Division. True to the Chinese saying that "it is better to see once than to hear a hundred times", a hardware demonstration was also organized. This visit to the company's "treasure vault" was the highlight of the delegation's stay at Rohde & Schwarz. Besides DECT and PCN measuring equipment, the committee members also took time to look at the GSM type-approval test system in operation (photo above). A system of this type is already in use in Beijing, the visitors' hometown.

J. Beckmann

VDE badge for R&S

To honour the company's 40 years of membership, the VDE (German Institute of Electrical Engineers) awarded its Golden Badge of Honour to Rohde & Schwarz. zz

Miniport Receiver EB200 (10 kHz to 3 GHz, 1 Hz setting accuracy; Handheld Directional Antenna HE200 for 10 kHz to 20 MHz as option) for portable use offers fast, accurate level indication through to 120 dB, noise figure ≤14 dB (20 to 2700 MHz), 15 IF bandwidths (150 Hz to 1 MHz, with internal panoramic unit as option), demodulation modes AM, FM, USB, LSB, CW (others as option); frequency and memory search, RS-232-C remote control, IEC 625, LAN (RJ45), battery operation 4 h.

Data sheet PD 757.3728.21 enter 160/21

Vector Signal Generator SMIQ (0.3 to 2.2/3.3 GHz) The revised data sheet now contains the fast CPU option SM-B50 (with modification kit) as well as model SMIQ03A (3.3 GHz) with integrated SM-B50 option.

Data sheet PD 757.2438.22 enter 160/22

BMS Monitor Family TS6100 serves for continuous monitoring of physical transmission parameters at a control center and various test points in transmitter systems.

Flyer PD 757.3992.21 enter 160/23

EMI Test Receiver ESBI, ESMI (20 Hz to 5/26.4 GHz) The data sheet contains only those models that are still available.

Data sheet PD 757.1302.22 enter 160/24

Compact Receiver ESMC (500 kHz to 1.3 GHz) The revised data sheet contains, among other things, the IF sections with special bandwidths, whose numbers have more than doubled.

Data sheet PD 757.1090.24 enter 160/25

DAB Source Encoder DMU is fully compatible with STI (ETS 300797) and of modular design; basic models: BASIC, EXTENSION and ISDN (different encoders, interfaces and multiplexers); ISDN and STI interfaces also as options.

Data sheet PD 757.3886.21 enter 160/26

ETI/STI Transport Frame Decoder FD1000 monitors, analyzes and protocols data streams in DAB networks; options: external D/A converter (for headphones), driver software for systems.

Data sheet PD 757.3840.21 enter 160/27

MPEG2 Measurement Generator DVG now generates an even larger variety of test signals (including NTC7/FCC signals, further test lines, teletext) and a three-program transport stream; option DVG-B1 is also covered.

Data sheet PD 757.2738.22 enter 160/28

Test Receiver ESVB (20 to 1000 MHz) The data sheet covers the available ESVB model with all its features for DAB and DVB-T measurements.

Data sheet PD 757.1777.22 enter 160/29

TV Generators SGPF, SGSF, SGMF New order numbers, option updates and withdrawal of SGDF plus inclusion of an ordering form required revision of the data sheet.

Data sheet PD 756.8749.22 enter 160/30

Accessories for Test Receivers and Spectrum Analyzers Overview of measuring aids that are still available and were previously described in separate data sheets as well as new supplements and brief descriptions of equipment without separate data sheets.

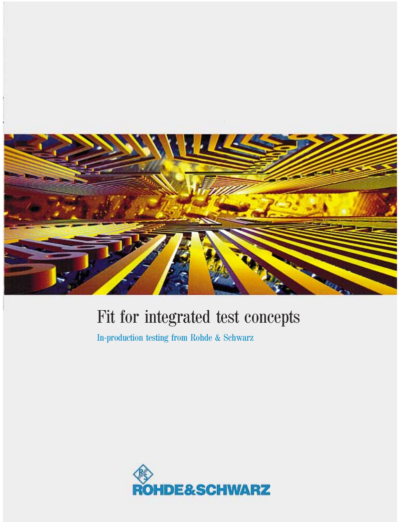
Data sheet PD 756.4320.25 enter 160/31

Radiomonitoring and Spectrum Management Solutions from Rohde & Schwarz (100 Hz to 40 GHz) comprise stand-alone systems as well as automated nationwide networks and identify even the weakest signals within microseconds.

Info PD 757.4147.21 enter 160/32

Air Operations Perfect communications ensured by radio systems from Rohde & Schwarz for military ATC, crisis management, peace enforcement and humanitarian aid are described in this information sheet.

Info PD 757.4076.21 enter 160/33



△

In-production testing from Rohde & Schwarz Fit for integrated test concepts and offering a solution to any requirement – in this information sheet Rohde & Schwarz presents itself as a partner for economical test solutions.

Info PD 757.4118.21 enter 160/34

MIL NEWS Electronics for Security and Defence; the first edition of this new publication comprises 24 pages and contains articles on communication, radiomonitoring/intelligence, products and IT security.

PD 757.4260.21 enter 160/35

DVB Solutions by Rohde & Schwarz: Solid as a Rock. The poster contains diagrams on useful bit rates, hybrid adjacent-channel mode (digital/analog) and mean field strengths.

Poster PD 757.4518.21 enter 160/36

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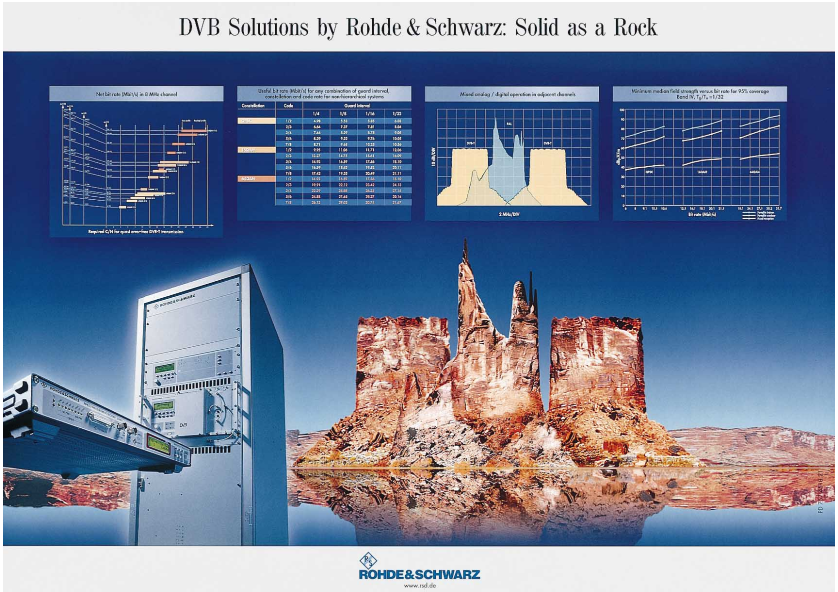


Concentration

Ute Richter, editor of Würzburg's "Elektronik Praxis" magazine, gathered opinions from major instrumentation producers for her editorial "Concentration in T&M" in issue 9/1998:

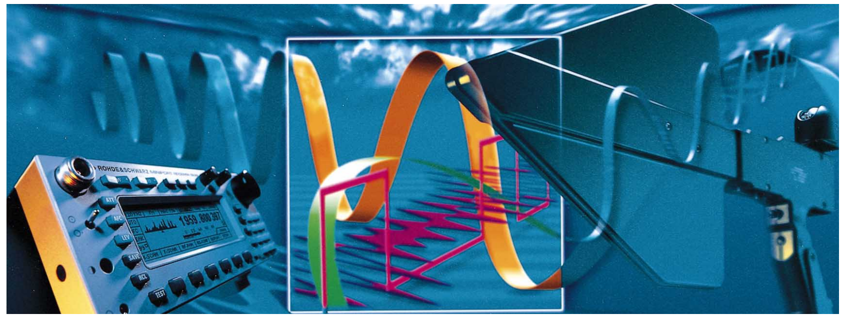
"The increasing complexity of measurement applications is speeding up consolidation", thought David Picken, Head of Central Marketing at Rohde & Schwarz. Smaller businesses no longer had the capacity needed to implement all the different, multinational and high-complex telecommunication standards in their equipment. He went on: "Consolidation produces bigger design teams with international experience." That is why the Munich-based company sealed alliances early on with partners in the USA (Tektronix) and Japan (Advantest).

Contact

"Elektronik Journal" examined the makeup and efficiency of the home pages of various test-system producers for its 6/1998 edition and concluded:

Rohde & Schwarz's information system is without doubt one of the best. Universal Test System TSU and other products are described online in full detail, there is a lot of extra information for downloading, and the address list includes every representative on earth. Pleasing to the eye are decorative pictures that do not take too long to load. What else do you want?

Digital Radio Tester CTS65, for fast and conclusive DECT and GSM measurements in the service scenario, won the coveted title spot in the July 1998 issue of the telecommunications magazine "ntz".



Competence

In edition 1-2/1998 "Printed Circuit Europe", published in Britain, presented a turnkey solution for production and final testing, designed by Rohde & Schwarz in cooperation with CRS Prüftechnik:

Rohde & Schwarz, together with CRS Prüftechnik, has created an integrated optical inspection LaserVision system and a combinational test system (TSU). The striking feature about the system is its highly compact design and the feeder that can be automatically adapted to different PCB sizes. The 6 x 2 meter inline test system is shielded by a metal enclosure and contains everything in order to be able to function. The only external supplies are compressed air and power.

In its cover story on test instruments in issue 6-7/1998, the European edition of "Test & Measurement" summed up the market for arbitrary waveform generators. Modulation Generator AMIQ received a lot of attention: cover photo, lead-in photo and a detailed technical description as evidence of its status in this market segment.

Superior features for portable reception

With this intro the British "UK EMC Journal", number 6/1998, first whetted appetites and then went on to look at Miniport Receiver EB200:

Radiomonitoring from 10 kHz right through to 3000 MHz, and now portable: Miniport Receiver EB200 from Rohde & Schwarz together with the active, handheld Directional Antenna HE200 is the portable solution for detecting and monitoring emissions. But it can also track interference and sniff out miniature transmitters in difficult terrain – with performance unmatched to date for equipment of this size.

"FKT", a specialist publication for television, film and electronic media, showed an attractive shot of MPEG2 Measurement Decoder DVMD and a DVB transmitter from the NV500 family as the title of its July 1998 edition. These are both key components of the digital terrestrial TV transmitter network DVB-T, Europe's first, that is being created in Britain. Inside the magazine there were details of monitoring the DVB transport stream in distributor networks with DVMD.

E-mail via shortwave into Internet: state of the art in HF communications

FIG 1 LAN/WAN-compatible shortwave communications system with HF Transceiver XK2000 and System Processor MERLIN Photo 42 878/1

The good old shortwave radio set has been perfected in several ways. Information data rates of a few uncertain tens of bits per second were increased to more than 3000 errorfree bit/s by sophisticated modem techniques and error correction. Intelligent algorithms were created to adapt transmission parameters to channel quality or initiate a change to a better channel. System-oriented considerations turned a unit for transmitting Morse into a LAN/WAN-compatible communications system permitting all kinds of data to be exchanged. FIG 1 shows a modern workstation based on Rohde & Schwarz's HF Transceiver XK2000.

Automated radiocommunications

At the end of the 70s, Rohde & Schwarz started to develop processors for automating radiocommunications [1]. These automatically select a frequency for link setup. One method is the use of a radio-link prediction program [2] in conjunction with passive channel analysis (free/busy), possibly supplemented by statistics on previous radio links. Another method is active channel analysis or sounding, ie sending test signals on the assigned pool frequencies. Automatic link setup is normally performed with a flexible address pattern. Automation guarantees a link setup whenever a useful frequency is found in the pool. If feedback is used for subsequent data transmission, the processor adapts radio parameters to transmission quality. Many of the numerous company-specific methods have been ousted by the American ALE standard [3]. The ALIS processor from Rohde & Schwarz is one of the few alternatives to this standard.

Modems

Serial modems with adaptive equalizers were used to solve problems of time-variant channel distortions. FIG 2

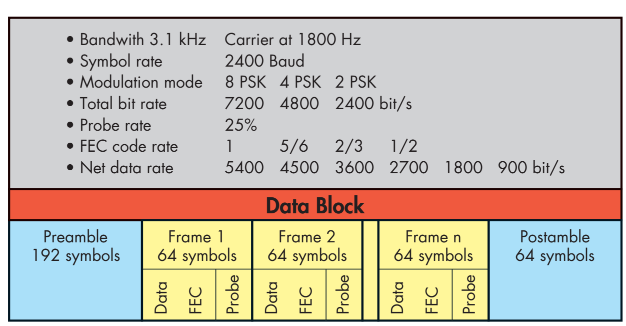


FIG 2 Most powerful waveform (5.4 kbit/s) of HF Modem GM2100

shows the most powerful of the four signal formats used by HF Modem GM2100 [4]. The preamble consisting of a fixed symbol sequence enables the receive station to synchronize with correct timing and phase. The postamble terminates the data block. Its structure is basically the same as that of the frames but it contains a stop code sequence instead of information data. Preambles, postambles and the inserted test data serve as reference signals, allowing channel distortions to be detected and compensated for by appropriate setting of the adaptive digital filters. Multipath signal components with delays of up to 7 ms are coherently combined so that rapidly varying channel conditions can be considered. The modem also includes narrowband notch filters that automatically tune to narrowband interferers. Up to three such interferers can be suppressed with these adaptive FIR (finite impulse response) filters. LSI memory ICs allow implementation of several signal formats, eg Rohde & Schwarz's 2.7 kbit/s waveform for interoperability with older systems, the 5.4 kbit/s waveform already referred to, the MIL-STD-188-110A single tone and a waveform to STANAG 4285/4481 for interoperability with systems of a different make.

The type of modulation and the FEC code rate of the modem can also be varied. This allows it to adapt to channels of different quality. Adaptation can be performed during link setup but also during actual transmission in response to changed channel quality. Coding and forward error correction are integrated in the modem. The Viterbi soft-decision method is used for decoding. Interleaving is also possible, and the code rate can be increased in steps from 1 to $^{1}/_{2}$.

Transmission protocols

Channel quality varies with time, so back-signalling methods are preferred for sky-wave transmission. One of these is the **packet radio protocol** (PRP) **RSX.25** with the following features:

- special adaptation to shortwave communication (minimum overhead, high throughput, quasi-duplex operation),
- adaptive matching of frame length and number, redundancy, type of modulation and transmission frequency to channel quality [5],
- residual error rate 10^{-32} (at bit error rate of 10^{-2}).

The RSX.25 protocol organizes the data to be transmitted in packets, which are successively transferred to the data modem. The packets contain a variable number of frames, the number per packet depending on radio-link quality and being adapted at regular intervals. The data transmitted in a packet are distributed among the frames. The length of the frame data is variable and also depends on radio-link quality. In channels of very good quality, a frame contains 250 data bytes, in strongly disturbed channels 4 bytes. The length of the transmitted data is continually adapted to link quality.

Services

FIG 3 shows the services supported by a modern communications system. These include conventional analog voice transmission, Morse and teletype but also hook-up to a private automatic branch exchange for telephone services and to the public switched telephone network. The RSX.25 protocol permits all types of digital data to be transmitted, eg for a printer, digital camera, camcorder or fax unit. Data transmission is supported by a system processor [6] that is able to access a LAN/WAN (eg the Internet).

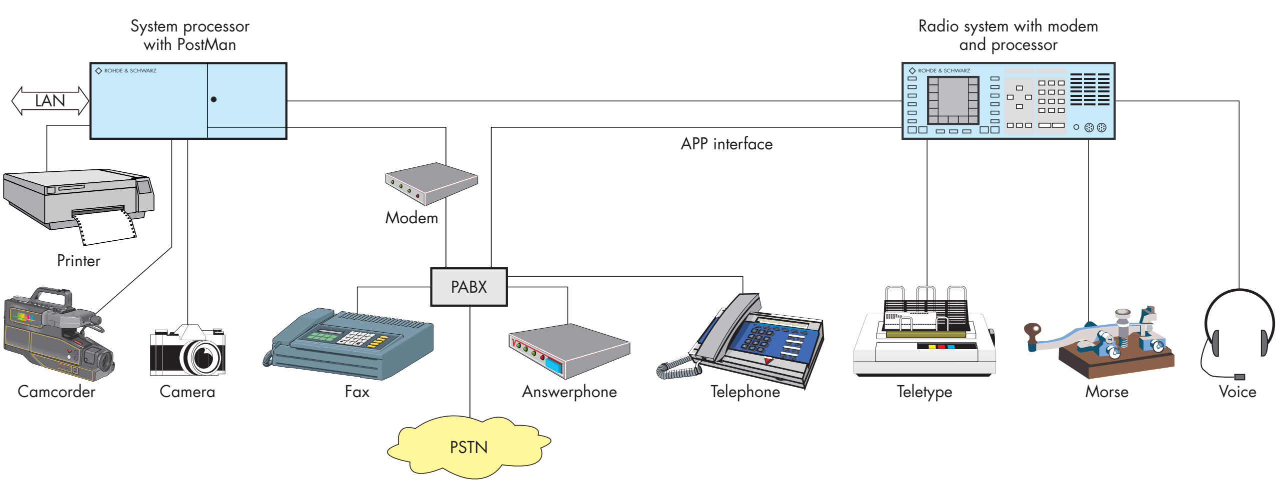


FIG 3 Services in modern communications system

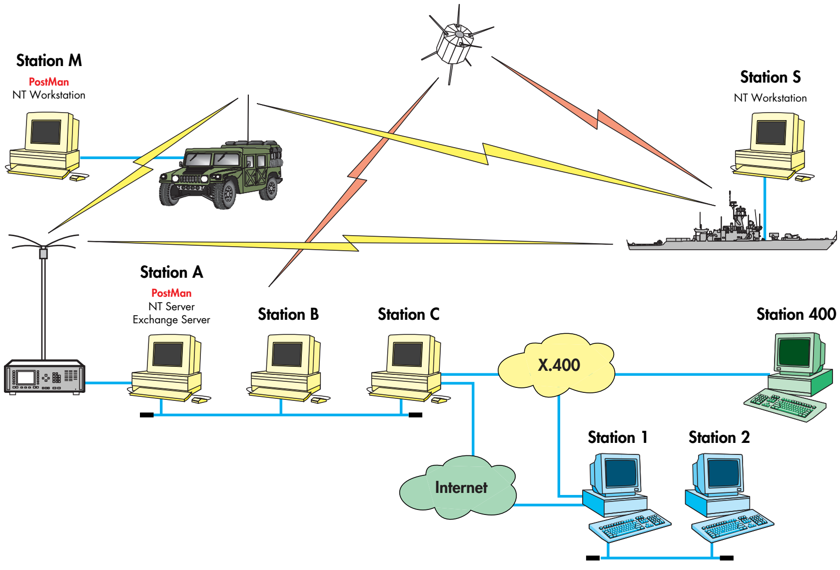


FIG 4 Global communications network

Networking

Computer networks like the Internet or X.400 can be accessed with the aid of software in the system processor, based on TCP/IP (transmission control protocol/Internet protocol) and part of the **Message Handling Software PostMan** [7]. This opens up the following possibilities:

- In contrast to earlier, file-oriented message handling and mail systems, PostMan is the first software for online access to central servers or the Internet via radio link and thus for the use of TCP/IP-based services offered by international communications networks.
- The medium radio (HF/VHF/UHF) is added to the existing transmission media of modern workstations (LAN, SatCom, GSM, telephone line, etc).
- All familiar word and image processing programs for information generation (eg Winword, Designer, Excel) can be integrated.

TCP/IP is the most widely used network protocol and supported by the vast majority of computers and software. This international standard ensures interoperability of very different platforms irrespective of equipment or operating system (FIG 4). In addition to HF/VHF/UHF radio links, PostMan is able to handle the following transmission media as an extension to the LAN: X.400, LAN, X.25 network, ISDN network, GSM network (including short message service), PSTN (leased and dialling lines) and satellite communications network.

Outlook

The next developments are expected in transmission protocols and modem technology for higher transmission speed. Wider bandwidths will be used for modems to achieve higher data rates. Higher rates will also be obtained on time-variant shortwave links, for the same channel bandwidth, by intensifying the modulation/coding association. Furthermore, throughput rates will be increased by coding schemes that are better matched to channel characteristics. Finally, optimizing the adaptation of transmission parameters to time-variant channel quality offers substantial potential for improvements.

Dr Günter Greiner

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News from Rohde & Schwarz 160 (1998/IV) · PD 757.4230.21 · B42622