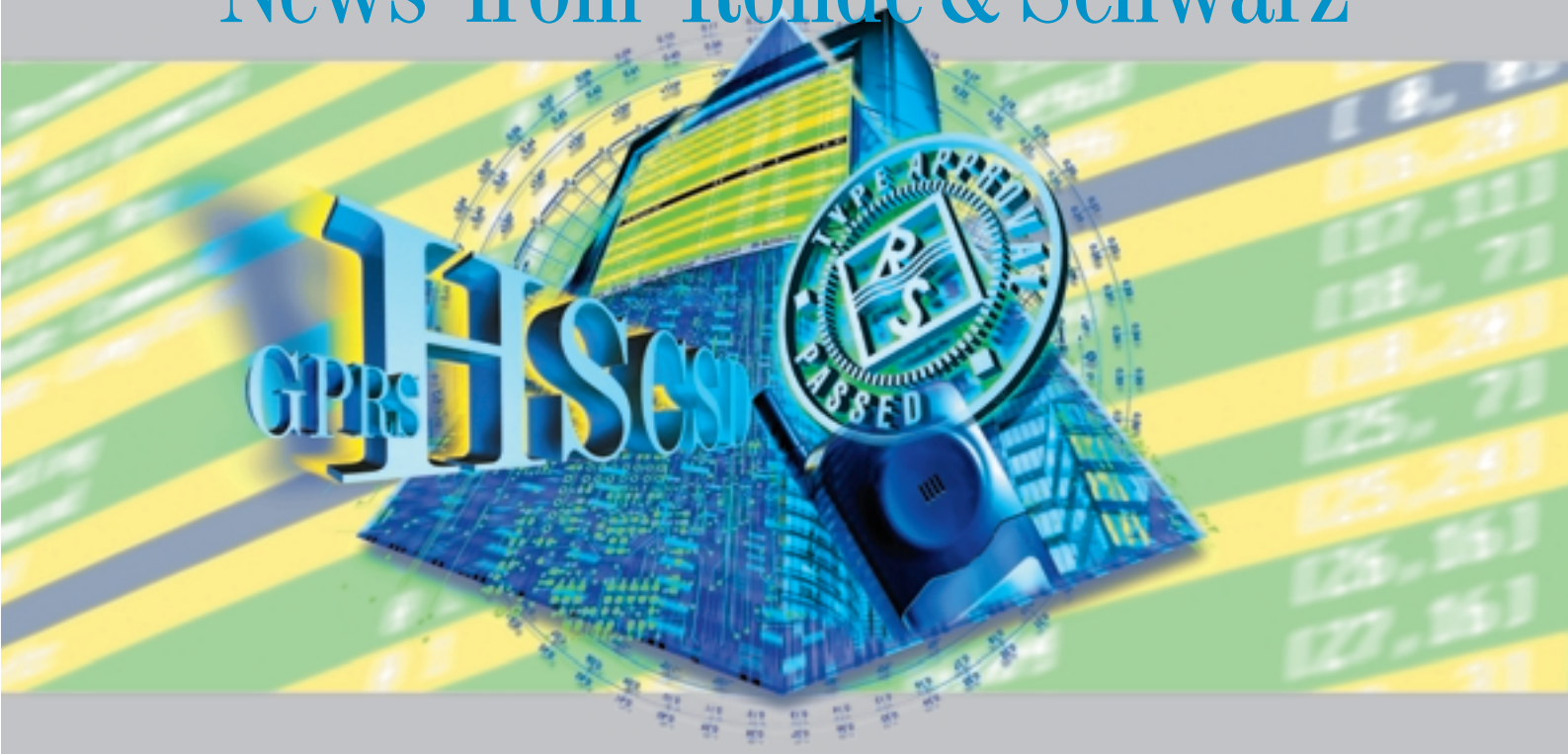
News from Rohde & Schwarz



New for HSCSD and third-generation mobile radio:
software and spectrum analyzers

World premiere: digital video quality analyzer
allows objective measurement of subjective perception

Installation test systems for automobile industry:
testing built-in communication equipment

1999/III
163

ROHDE&SCHWARZ

Number 163 1999/III Volume 39

Development in mobile radiocommunications continues at a rapid pace: transmission speeds are getting ever faster and open up completely new fields of applications. HSCSD is a first step in the expansion of GSM networks towards fast data services. With its new spectrum analyzers (page 14) and associated software (page 28) Rohde & Schwarz is optimally prepared for this evolution and especially for third-generation mobile radio (UMTS)

Photo 43 365

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Photo: Photodisk

The essential links that ensure modern worldwide communication can be found at the bottom of the seven seas. Submarine cables allow transmission of enormous and ever increasing amounts of data (final article page 42).

Imprint

Published by ROHDE & SCHWARZ GmbH & Co. KG · Mühldorfstraße 15 · D-81671 München · Support Center: Tel. (+49) 01805124242 · E-mail: customersupport@rsd.rsd.de · Fax (+4989) 4129-3777
Editor: Ludwig Drexl, Redaktion – Technik (German) · English translation: Dep. 5CL4 · Photos: Stefan Huber · Artwork: Stefanie v. Hösslin · Circulation 90 000 six times a year · ISSN 0028-9108 · Supply free of charge through your nearest Rohde & Schwarz representative · Printed in Germany by peschke druck, München · Reproduction of extracts permitted if source is stated and copy sent to R & S München.

Digital Video Quality Analyzer DVQ

Getting the picture on picture quality

Automatic assessment of picture quality allowing for criteria of subjective perception by the human eye is something long dreamt of by those concerned with TV measurements. Rohde & Schwarz is now staging a world premiere with its Digital Video Quality Analyzer DVQ, an instrument designed to perform this task excellently and in realtime. The patented method of video data analysis requires no original picture as a reference and shows the way to a whole variety of applications in network monitoring as well as in development, production and quality control.

Photo 43318/5

FIG 1 World premiere – DVQ determines subjective picture quality in realtime and requires no reference signal

Successful and innovative

With the increasing spread of digital TV to standards like DVB or the North-American ATSC (Advanced Television Systems Committee) – two methods based on MPEG2 coding of video and audio data – the reliability of the new technology is growing too. A lot of credit for this goes to successful Rohde & Schwarz products like MPEG 2 Measurement Generator DVG and MPEG 2 Measurement Decoder DVMD [1]. Digital Video Quality Analyzer DVQ is now following on in their steps.

Quality features at a glance

DVQ is capable of processing both MPEG 2 compressed and uncompressed or re-expanded video data in line with ITU-R 601 (SDI 270 Mbit/s). With the latter types of data, the effects of coding artifacts on picture quality can also be measured on decoded video material. DVQ features in addition a decoder for all MPEG 1 or AC-3 coded audio data.

DVQ presents calculated quality values numerically or as bargraphs on its LC display (FIG 1) and also in the decoded analog video picture, updating these values continuously. So, using a video recorder, not only the video material but also quality data are acquired for subsequent evaluation. Longterm monitoring of picture quality is possible by recording data and presenting them in a diagram (FIG 2). Data can also be produced in the form of a histogram. Via RS-232-C and Ethernet (10BaseT) interfaces, all recorded values can be read out and remote control of DVQ is possible.

DVQ offers a special mode for comparative analysis that measures two different signals (actual and reference). Differences in delay between the two

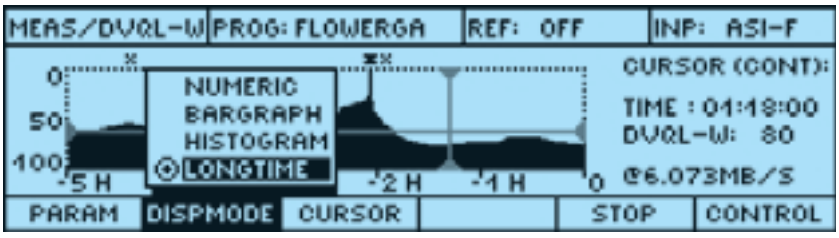


FIG2 Example of longterm recording of video quality over five hours

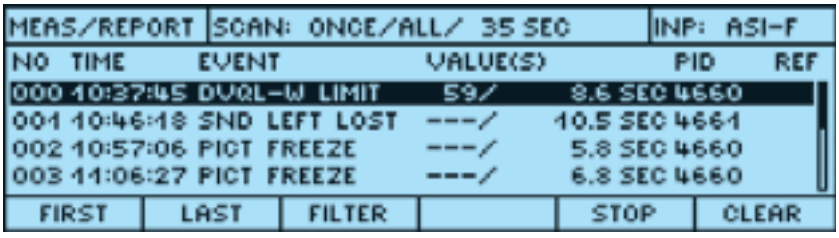


FIG 3 Error report generated by DVQ with all video and audio failures sorted by time

signals can be taken into account. Quality reduction relative to the reference signal is output as a realtime result. This mode is a particular advantage for separate measurement of the qualitative effects of only one processing stage during program transmission.

In addition to computing and recording various quality parameters, DVQ checks video and audio data for the following failures:

- sound loss left or right,
- picture loss/picture freeze,
- failure to reach a freely selectable threshold for picture quality.

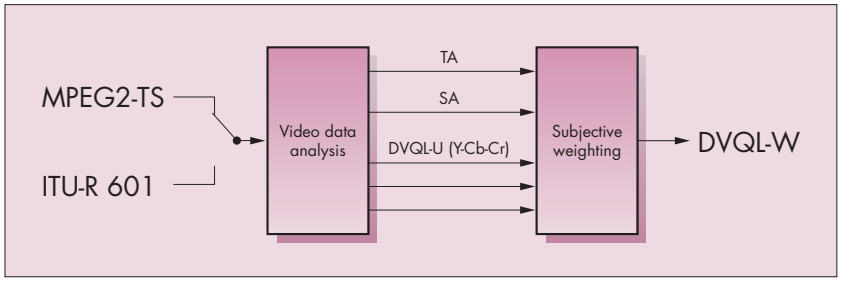
DVQ records these events in error statistics sorted according to type, and sums the duration of each type of failure in seconds. At the same time a report is generated with the failures sorted according to their time of occurrence (FIG 3). This report, together with the quality profile, can be used to document troublefree performance conforming to contract.

An MPEG 2 transport stream transmits several programs at the same time. In its scan mode DVQ sequentially analyzes all programs or a subset for picture quality and possible failures over a selectable period of time (typ. 6 to 10 s per program). Results are presented as a clear, continuously updated status on the LC display and also in the decoded picture as an on-screen display.

Applications of DVQ

The unique combination of realtime capability and independence from a reference signal opens up a wide field of applications for DVQ. Of primary importance are **quality monitoring in distribution networks** and **program quality assessment**, for which DVQ is the ideal instrument. Degradations in signal quality and transmission failures

FIG 4 Principle of realtime analysis of video data in DVQ



What is new about this technique

The new technique, allowing determination of quality data correlating with subjective assessments to more than 90%, was developed in collaboration with the Institute of Communications Technology of Braunschweig Technical University headed by Prof. Ulrich Reimers [2 – 3]. Some interesting facts about this development were presented earlier [4].

First the video data are analyzed in realtime and an unweighted video quality value (DVQL-U) is determined separately for luminance and chrominance. From these values and temporal and spatial activities of the picture, a picture quality value weighted according to subjective perception criteria (DVQL-W) is calculated in realtime (FIG 4). This ranges from 0 (bad) to 100 (excellent) on a standardized ITU scale in accordance with the SSCQE (single stimulus continuous quality evaluation) method.

The technique is completely new in two aspects:

1. Subjective quality data determined objectively in realtime are immediately available.
2. Longterm qualitative assessment of video material is now possible (without any test persons being required), and the previous limitation to more or less typical, short test scenes no longer exists. The former approach reflects more closely the real situation of TV viewers.

are detected immediately so that remedial action can promptly be taken. This is supported by twelve alarm contacts fitted as standard that provide switching functions in the case of failures.

DVQ is an equally indispensable tool in the **development, qualification testing and alignment of operational and transmission hardware**. It allows fast, automated and objective evaluation of encoder algorithms and multiplex methods according to subjective criteria. The advantage here is that measurements are made under real conditions of use and with real programs for extended periods of time. DVQ further provides the means of optimizing the operational settings for digital TV so that transmission can be as efficient and with as few resources as possible while maintaining the required minimum quality. This is shown in FIG 5 by the example of a playout center, where measurements are made ahead of and after a multiplexer stage.

Another important field of application is **quality testing of set-top boxes and DVD players in development and production** (FIG 6). Thanks to the two remote-control interfaces, DVQ can ideally be integrated into automatic production systems. If the MPEG2 transport stream is available at the common interface of the set-top box, the effects of the receiver and demodulator stages on picture quality can easily be determined in the reference mode by comparison with the input signal.

If the MPEG2 data stream is not available at the common interface, ie if the analog output signal of the box is taken to DVQ via an analog/digital converter, even failures and degradations of picture quality caused by the MPEG2 decoder and the output stage are detected.

Providing fast and direct access to subjective, continuous quality data and doing away with the need for an original signal as a measurement reference, DVQ is ushering in a new era in TV measurements. This accelerates the optimization process as regards utilization of frequency bands and promotes the merging of TV transmission and telecommunication networks.

Alexander Wörner

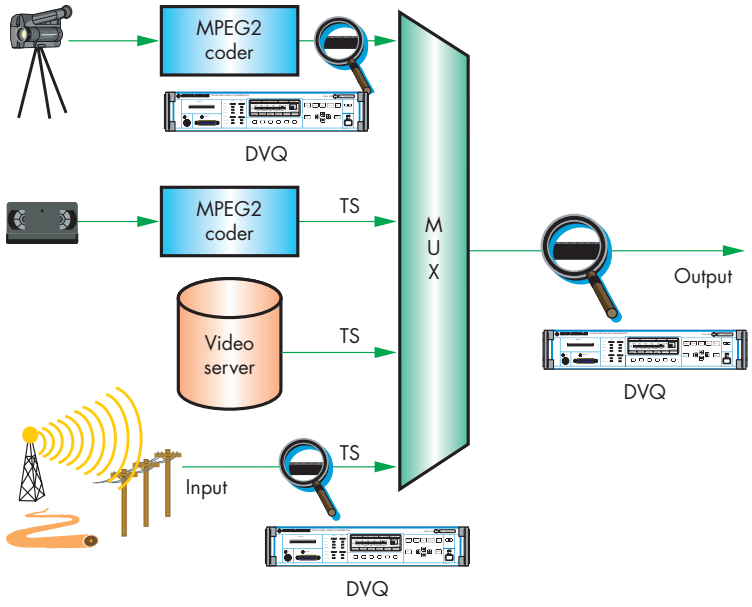


FIG 5 DVQ can be used at any point in a network to measure MPEG 2 transport streams

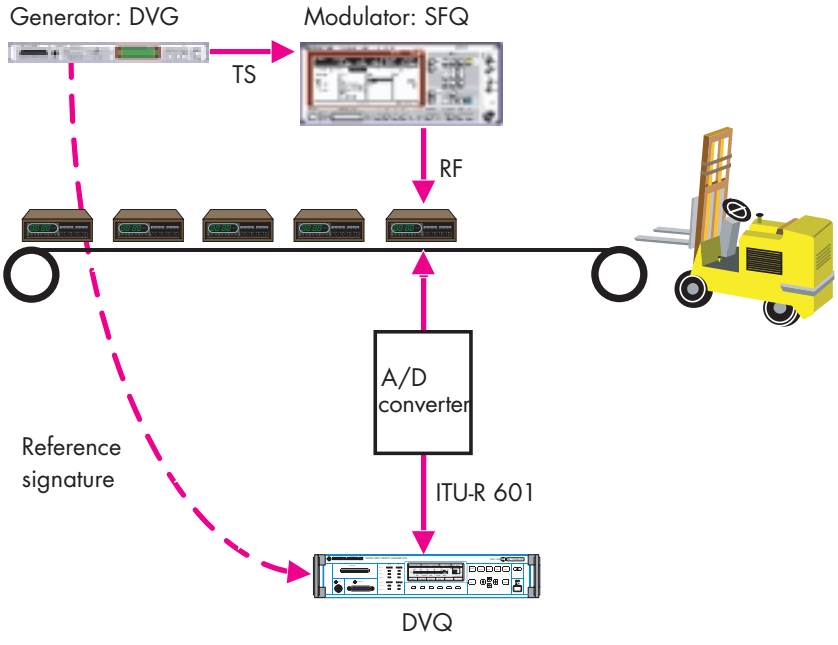


FIG 6 DVQ for testing set-top boxes in production

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Condensed data of Digital Video Quality Analyzer DVQ

Signal inputs	TS-ASI (looped through), TS-SPI, ITU-R 601 and AES/EBU
Video formats	MPEG2 MP@ML, MPEG2 422P@ML
Audio formats	MPEG1 layers 1 and 2 Dolby® AC-3
Recorded events	sound loss right/left, separate picture loss picture freeze quality below threshold
Realtime measurements	temporal picture activity spatial picture activity digital video quality, unweighted digital video quality, weighted to subjective criteria
Buffer for elementary streams	32 Mbits
Remote-control interfaces	RS-232-C and Ethernet (10BaseT)
Alarm outputs	12 DC-isolated relays

Reader service card 163/01

Virtual Spectrum Analyzer R3131 – it can do everything except measure

CD-ROM

Rohde & Schwarz has created a "virtual" analyzer with the new CD-ROM for Spectrum Analyzer R3131 from Advantest. The CD is an aid for operation and a demonstration in one, giving the user a detailed description of the instrument and many chances for interaction.

After an introductory animation a large selection menu is displayed. High-resolution animated pictures of the instrument are provided under "Properties". Animated screen displays can also be produced for applications such as signal tuning, frequency counter or power measurement.

A detailed description of Analyzer R3131 is given under "Basic Operation" and "Functional Description". The menus allow interactive operation or demonstrate instrument functions. The virtual front panel can be used like a real one. Instrument functions and procedures are simulated onscreen and explained.

Another menu guides the user interactively and step by step through the main measurement functions of R3131, eg channel power, occupied bandwidth or ACP.

The CD also contains documentation like the brochure "Spectrum Analysis Fundamentals" as well as operating instructions in PDF format. Technical data of the instrument are listed from frequency, amplitude range and sweep through to dynamic range and general specifications.

The CD-ROM is very user-friendly with a clear layout. The comprehensive information in conjunction with interactive, graphical presentations make the CD suitable not only for customers interested in the product but also for instrument operation, demonstrations and training purposes.

The CD-ROM "R3131 Spectrum Analyzer Simulator" is obtainable free of charge from your local Rohde & Schwarz representative.

It can be run under Windows™ 95, 98 or NT on a Pentium PC with at least 16 Mbytes of RAM.

Stefan Böttinger

Signal Generators SMIQ 04B and SMIQ 06B

I/Q modulation now up to 6.4 GHz

Radiocommunication growth continues unabated. The high density of occupancy in the range below 3 GHz means that there will be an increasing need for measuring instruments for the range above 3 GHz, where applications like WLAN (wireless local area network), WLL (wireless local loop) and ETC (electronic traffic control) have become established. Other future-oriented applications are already on the way. In line with the trend, Rohde & Schwarz has extended the frequency range of Signal Generator Family SMIQ.

Photo 43 334

FIG 1 Frequency range, speed and bandwidth of new Signal Generator SMIQ 06B already meet future measurement tasks

FIG 2 Signal Generator Family SMIQ now produces I/Q signals up to 6.4 GHz

State-of-the-art signal generators for future applications

SMIQ models 02B and 03B for up to 3.3 GHz set standards for setting time and bandwidth [1]. The new generators produce I/Q-modulated signals (FIG 2) up to an even higher frequency. Just like their predecessors for lower frequencies, SMIQ 04B and SMIQ 06B (FIG 1) are notable for high signal quality and unrivalled versatility in signal generation.

Digital modulation is a common feature of all new communication techniques. SMIQ with its high-quality I/Q modulator is ideal for these applications. The synthesizer of high spectral purity also features excellent phase stability to further enhance the quality of vector modulation. The low phase error with GSM proves that great importance was attached to these characteristics from the very beginning. SMIQ features a phase accuracy of 0.3° (rms). Another essential criterion besides the noise is intermodulation, which determines the adjacent-channel power in digital modulation. With its high linearity and spectral purity, SMIQ attains values that meet even the stringent requirements of W-CDMA. The **low ACP option** of SMIQ sets standards in this field too: ACPR of 68 dB can be obtained for W-CDMA

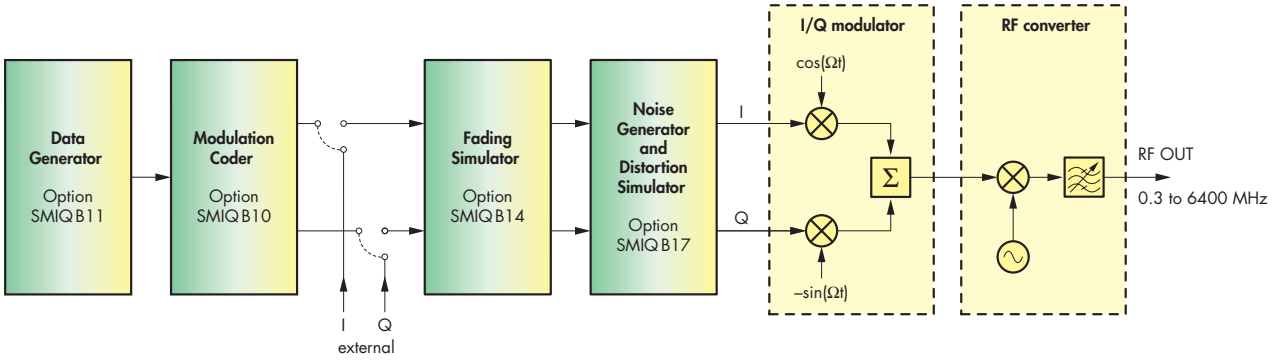


FIG 3 Options in signal path of Signal Generator SMIQ

at 5 MHz from the carrier. The I/Q modulator with its 30 MHz baseband width allows also complex modulation signals to be generated with RF bandwidths of up to 60 MHz. This makes SMIQ not only ideal for mobile radio applications but also in broadband systems as will be needed in the future when fast access to the Internet is required.

Modularity for every requirement

Four basic models and a great variety of options including fading simulator and noise generator and distortion simulator meet individual customer wishes: from the favourably priced basic model to the allrounder – all come as a single unit. This saves space and does away with complicated test setups. The benefit is obvious: integrating comprehensive systems with calibrated test signals in one unit minimizes time and costs (FIG 3).

The **modulation coder** option (FIG 4) is able to handle digital modulation formats ASK, 2FSK, 4FSK, GFSK, GMSK, BPSK, 8PSK, QPSK, OQPSK, π/4-DQPSK and 1QAM to 25QAM with clock rates of up to 7 Msymbol/s. New is ASK (amplitude shift keying), which is required particularly for the ETC market.

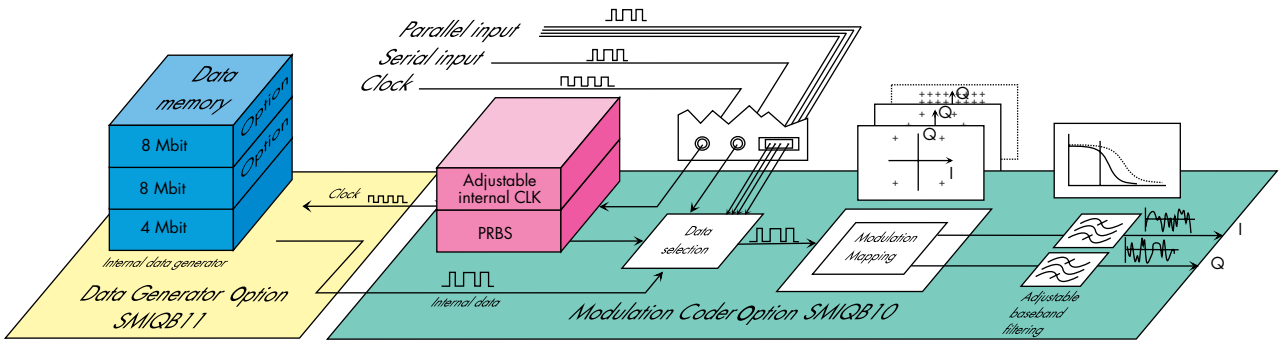
The **data generator** option (FIG 4) provides the data sequences and control signals required for generating frame structures to standard. There is a choice between the TDMA standards GSM, DECT, NADC (IS-54C, IS-136), PDC and PHS. The CDMA standard IS-95 can be selected when **option SMIQB42** is implemented and W-CDMA to NTT DoCoMo or ARIB with the aid of **option SMIQB43**.

The **fast CPU option** makes SMIQ a real sprinter. Setting times of SMIQ are short even without the fast CPU but this option makes SMIQ unique in its class: frequency and level setting is speeded up by a factor of 5. Frequencies can be set in less than 3 ms in the whole range and level setting is possible in less than 2 ms in a dynamic range of up to 90 dB. This fast level setting is also achieved thanks to the analog level control element, which is used among other things for level setting when the adjacent-channel timeslot suppression for TDMA is measured. The fast CPU is used in all cases where milliseconds count, like in the production testing of integrated circuits.

And you can have it even faster: frequency and level setting times of less than 500 µs are achieved by SMIQ in the list mode. Precalculated frequency and level settings are called one after the other. SMIQ can thus be used for frequency hop measurements or for fast determination of RSSI (receiver signal strength indicator) characteristics.

The **fading simulator** [2] as well as **noise generator and distortion simulator options** complete the SMIQ

FIG 4 Block diagram of data generator and modulation coder options



allround solution. With these options fitted, SMIQ produces digitally modulated test signals including fading and additional noise of calibrated level in only one unit: a novelty in this field. The complex test signals are needed for realistic simulation of operating conditions for instance in CDMA test scenarios. Operators who have ever had to assemble an equivalent test setup from single units will know the effort involved and particularly appreciate the compact solution in a single unit.

With the noise generator and distortion simulator option, noisy and distorted signals can be generated as are required for testing satellite receivers. The noise generator allows an AWGN (additive white Gaussian noise) signal to be superimposed onto the SMIQ output signal. Here the carrier-to-noise ratio can be accurately set in a wide range with high resolution. The distortion simulator produces amplitude and phase distortions as may originate in practice from the economical use of travelling-wave-tube amplifiers in satellites.

That is by no means the end of the story. The noise generator may also be used for other applications. It is an excellent replacement for multichannel simulation in CDMA systems. The IS-98 standard prescribes this method for measuring frame error rate when an AWGN stress signal is present. The noise generator can also be used for speeding up BER tests. With low BERs the BER measurement is normally very long. Additional signal impairments produce more bit errors and this shortens the measurement time. The true BER value can then be calculated. This method is normally used to reduce BER measurement time.

The fading simulator option handles Rayleigh, Rician, pure doppler and lognormal fading profiles. Depending on whether one or two options are fitted in SMIQ, six-path or twelve-path fading can be performed. Two-channel fading (six paths per channel) as may be required for base station receivers with two separate antenna inputs (diversity) can be performed when two SMIQs are used. Attenuation, delay and doppler frequency or speed can be set in each path over a wide range. Programmed channel models as prescribed for GSM, NADC, IS-95 CDMA and TETRA standards permit convenient setting practically at the push of a button.

These applications are only a few examples of SMIQ's wide application spectrum. But they prove that the great variety of options makes this modern generator suitable for highly complex measurement tasks without having to keep a pool of extra instruments on hand.

Johann Klier

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FURTHER REFERENCE

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Condensed data of Signal Generator SMIQ

Frequency range	
SMIQ02B/03B/04B/06B	300 kHz to 2.2/3.3/4.4/6.4 GHz
Frequency setting time	
Standard	<15 ms
with SM-B50	<3 ms
in list mode	<500 µs
SSB phase noise	
(f = 1 GHz, carrier offset 20 kHz)	<–123 dBc
Level range	–144 to 13 dBm
Analog modulation	AM, FM, φM, BB-AM, vector, burst, pulse
Digital modulation	ASK, 2FSK, 4FSK, GFSK, GMSK, BPSK, QPSK, OQPSK, π/4-DQPSK, 8PSK, 16QAM, 32QAM, 64QAM, 256QAM

Reader service card 163/02

Baseband Fading Simulator ABFS

Reduced costs through baseband simulation

Radio channel characteristics can seriously impair signal transmission between a transmitter and a receiver, in particular a mobile one. The new Baseband Fading Simulator ABFS from Rohde & Schwarz generates signals allowing simulation of real receiving conditions in mobile applications. In this way receivers can be checked for practical performance during development and acceptance testing. The fact that ABFS simulates signals at baseband level also cuts costs.

Photo 43 346/2

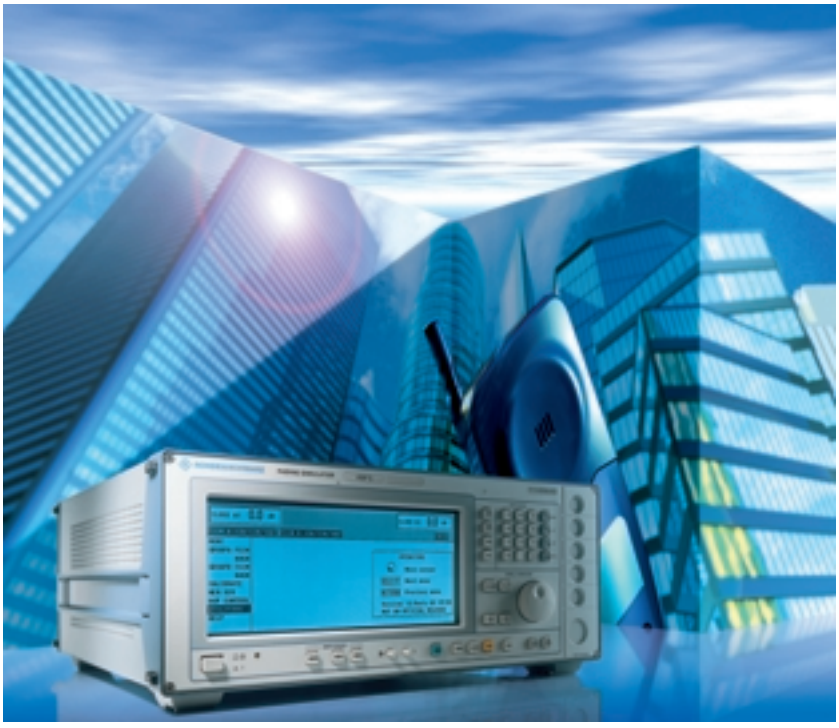

FIG 1 Baseband Fading Simulator ABFS – flexible radio channel simulation for all communication systems

Benefits of baseband simulation

Most fading simulators convert the signal of the radio channel to the IF, then perform fading and subsequently reconvert to the correct frequency. But it is more cost-effective to connect the simulator **prior** to the first conversion to the carrier frequency in the transmitter, ie to simulate at baseband level (I and Q) and perform conversion to the correct frequency in the test system afterwards. In this way there is no signal degradation through multiple conversion.

Fit for the future

Baseband Fading Simulator ABFS (FIG 1) is **a universal instrument for research, development and production** in the field of digital mobile radio. It encompasses all simulation scenarios as well as mathematical-statistical models for simulating sporadic fading as stipulated in mobile radio standards (eg GSM, IS-54/US-136, IS-95). Its open concept allows **radio channel simulation of today's and future communication systems**, no matter if required for mobile radio, broadcasting, flight telephone, WLL or WLAN systems.

The baseband fading simulator is a cost-effective solution not only for protocol tests in conjunction with a test system but also for testing under difficult receiving conditions. **Frequency hopping systems** can also be simulated, ABFS being fast enough, for example, to follow frequency hopping of the test system within a response time of only 4 ms (GSM frame time).

Applications

Receiver tests at I/Q level can be performed together with a baseband source (eg I/Q Modulation Generator AMIQ [1] from Rohde & Schwarz) even if the corresponding RF link is not available. The ruggedness of receive algorithms to different fading conditions can thus already be tested during the development phase of a receiver (see box on next page). The same applies to correction circuits in the receiver, eg for the equalizer.

Even in its basic configuration ABFS offers **two independent channels for six-path fading** that can be interconnected as required (FIG 2), eg:

- One input (with different fading profiles) is split to two outputs. Several antennas with different characteristics or frequency diversity methods can be simulated.
- Simulation of two inputs with individual profiles and then addition at the output. This configuration is of interest for testing cell handover or for the superimposition of interferers.
- The two channels can also be fully coupled to produce a channel with twelve paths.

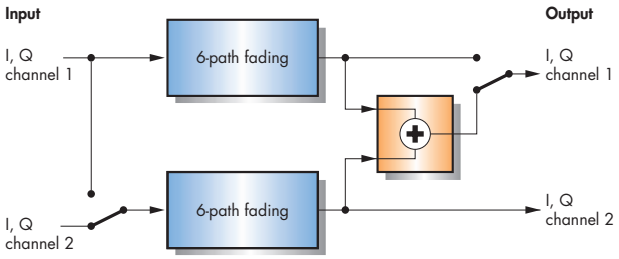

FIG 2
Example of ABFS channel interconnection to perform different measurements

the paths irrespective of the selected circuit [2].

In addition to the kinds of fading mentioned above, the following characteristics can be defined for each path:

- attenuation,
- delay,
- doppler frequency or speed between transmitter and receiver,
- coupling to another channel.

By integrating ABFS into test systems for digital mobile radio, it is possible to perform tests under fading conditions. The sole prerequisite is that the test system have an I/Q output and input, between which ABFS is then connected (FIG 3).

- **Second Noise Generator ABFS-B3**
  Second noise source for an additional output.

One of the fading profiles (Rayleigh, Rician, pure doppler, lognormal or Suzuki) can be assigned to each of

To simplify the use of this variety of parameters, complete default settings are ready programmed for many channel models, eg rural and typical urban GSM. The settings can be quickly called up for the particular tests and also modified.

Wolfgang Kufer

More versatility through options

- **Noise Generator ABFS-B1**
  Adds an extra noise source to the output of the first channel. This allows simulation of interferers in the frequency band examined.
- **Second Fading Simulator ABFS-B2**
  Two additional channels with the same characteristics in addition to the two channels of the basic configuration.

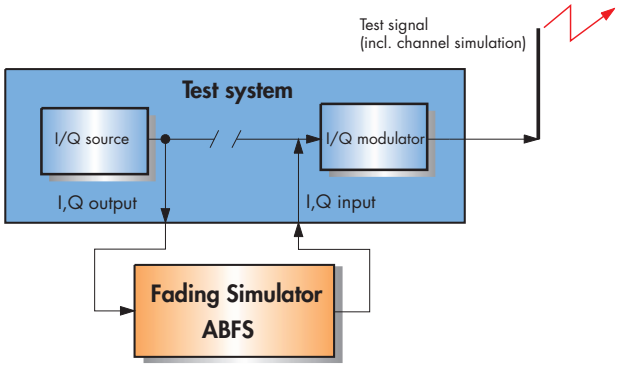

FIG 3
Integration of Baseband Fading Simulator ABFS into test system

How the transmission channel is influenced by multipath reception

The characteristics of the radio channel vary with time and frequency, which gives rise to time and frequency-selective fading. The receive signal is influenced mainly by the following factors:

Multipath propagation (multipath fading) Due to reflection and diffraction a signal formed by several paths (up to twelve) is obtained at the receiver. These paths have different delays, amplitudes and phases, which may lead to signal cancellation. As a rule the delay difference is greater than the symbol period.

Signal loss Depending on the delay, narrowband, frequency-selective notches can be caused within the bandwidth of the communication channel. These notches also occur if the receiver is stationary.

Delay spread A time spread of the receive signal (time dispersion) is caused by multipath reception.

Intersymbol interference If delay differences are greater than the symbol period, impairments are caused by the components of previously sent symbols.

Local dispersion (local scattering) A large number of waves are produced by scattering in the immediate vicinity of the receiver. Thus, for each path, a cluster of signals of low delay differences is taken to the receiver. Due to the arbitrarily changing amplitudes and phases of the individual echoes, time-selective fading **(fast fading)** is caused in mobile receivers.

Doppler shift Moving the receiver results in frequency shifts. At the same time, signals arriving from different directions are spread in the frequency range **(doppler spread)**.

Slow signal variations (longterm fading, slow fading) Field strength variations caused by shadowing in hilly environments.

And how mobile radio systems can be protected

Mobile radio systems are designed so that they are not impaired by any anomalies of the radio channel. The following techniques are used to eliminate the effects of multipath reception:

- forward error correction,
- algorithms for delay compensation (equalizing),
- interleaving of message contents,
- frequency matching circuits.

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Condensed data of Baseband Fading Simulator ABFS

Bandwidth	7 MHz (ie RF bandwidth of 14 MHz)
Channels	2 (4 with option ABFS-B2)
Paths	12 (24 with option ABFS-B2)
Max. number of paths per channel	12
Path loss	0 to 50 dB, resolution 0.1 dB
Path delay	0 to1600 µs, resolution 50 ns
Doppler shift	0 to 600 Hz
Fading profiles	Rayleigh, Rican, pure doppler, lognormal, Suzuki

Reader service card 163/03

WorldSpace satellite broadcasting put to the test

When completed, the WorldSpace broadcasting system will operate with three geostationary satellites, one each for the reception areas Africa, South-East Asia and Central and South America. The satellite for Africa, named AfriStar, is already in position above the Congo and has been transmitting since late 1998. And its performance quality is excellent, as was demonstrated convincingly at the Rohde & Schwarz plant in Munich in March 1999. WorldSpace radios are made by the four manufacturers Hitachi, Panasonic, Sanyo and JVC. The photo shows a Panasonic receiver with a detached antenna, which was used to put the system to the test. Although Munich is situated outside the intended reception area, the station Nigeria B01 as well as a whole number of other stations were received crystal-clear and without any interference. This evidences the high quality of the radio as well as the satellite technology.

The receivers are tested by Rohde & Schwarz instruments: Vector Signal Generator SMIQ 02 W or SMIQ 03 W [1] will detect any weak spots, as it simulates the receive signal realistically, including all the interference such as superimposed noise and nonlinear distortion that is common to satellite broadcasting.

Franz Lüttich

REFERENCES

[1] Kernchen, W.: Vector Signal Generator SMIQ 02W/SMIQ 03W – Test signals for digital WorldSpace satellite sound broadcasting. News from Rohde & Schwarz (1998) No. 160, pp 7–9

FIG WorldSpace radio received in Munich: despite being located outside the planned receive area, the receiver produced excellent signal quality

Photo 43 185/3

Advantest and Rohde & Schwarz have been cooperating in sales and design since 1992. The products of the two partners, particularly the spectrum analyzer families, are aimed at different market segments and customers and so perfectly complement each other. This strategy continues with the introduction of Spectrum Analyzers R 3267 and R 3273 and Signal Analyzer FSIQ [1], specially developed for measurements on mobile radios of the third generation. The two instrument families suit any requirement and budget and come from a single source.

Signal Analyzer FSIQ

Two spectrum analyzer families for third-generation mobile radio …

Application	Family FSIQ	Family R3267/R3273
Development	•	
Verification	•	
Production test of base stations	•	
Production test of mobile stations		•
Quality assurance	•	
Installation		•
Service		•

… an ideal match offering solutions for every requirement

Spectrum Analyzer R 3267/R 3273

Photo 43 232/1

With its extremely wide dynamic range, minimal measurement uncertainty and high flexibility, FSIQ from Rohde & Schwarz is the ideal instrument for development, verification and quality assurance but also in the production of base stations.

By contrast, the new Analyzer Families R3267/3273 from Advantest are especially suitable for service and installation and for the production of mobile stations. Features of the units that particularly count here are portability, standard-conformal test routines and price.

Spectrum Analyzer Family FSIQ from Rohde & Schwarz

The FSIQ family is a follow-on development from spectrum analyzers of the FSE series. Characteristics like dynamic range, accuracy and phase noise were further improved for highly demanding measurements on W-CDMA signals. FSIQ comes in three models

- FSIQ3 20 Hz to 3.5 GHz
- FSIQ7 20 Hz to 7 GHz
- FSIQ26 20 Hz to 26 GHz

Because of the CDMA transmission used in mobile radio of the third generation, adjacent-channel power measurement is of particular importance. FSIQ's wide dynamic range is an essential feature especially when components like high-power output stages are measured, whose specifications must be far superior to those of the overall system. With a TOI of 20 dBm (FSIQ7), noise figure of 15 dB and typical phase noise of –153 dBc/Hz at 5 MHz from the carrier and –155 dBc/Hz at 10 MHz, FSIQ achieves more than 75 dB dynamic range in the adjacent channel and more than 85 dB in the alternate channel. In response to customer requests, phase noise at 5 MHz and 10 MHz from the carrier was improved by more than 5 dB compared to first-generation FSIQ. This ensures that the analyzer is 10 dB better than the DUT even when measuring a component in the alternate channel, so measured results are not influenced. Built-in routines simplify simultaneous measurement of adjacent-channel power in up to five channels.

Due to the improved phase noise, even spurious emissions of GSM base stations can be measured without any need for complex external filtering.

The amplitude distribution of a W-CDMA signal – which considerably deviates from white noise – means that reliable and reproducible power measurement results can only be achieved on an rms basis. For this reason FSIQ and the analyzers of the FSE family comprise an rms trace detector as standard, which is able to accurately measure signal power at any point of the trace.

(cont'd on next page)

New spectrum analyzer family from Advantest

The concept of the new analyzers is based on a traditional spectrum analyzer with a digital section for the different digital telecommunication standards in use today and intended for the near future. Model R 3267 covers a frequency range of 100 Hz to 8 GHz, model R 3273 through to 26.5 GHz.

All mobile-radio standards are available as software options: GSM 900, GSM 1800/1900, DECT, PDC, PHS, IS-136, IS-95, W-CDMA (NTT DoCoMo, ARIB, 3 GPP), etc, and upgrades can be loaded from disk drive. Up to three standards at a time can be combined in the same analyzer.

To meet the high RF performance requirements of the new digital standards GSM+ (HSCSD, GPRS), GSM++ (EDGE) and W-CDMA, Advantest enhanced the specifications of its spectrum analyzers. Major specifications such as a noise floor of –150 dBm/Hz at frequencies up to 3.6 GHz, phase noise down to –148 dBc/Hz at 5 MHz and <–153 dBc/Hz at 10 MHz from the carrier, plus typical TOI of +15 dBm meet the most stringent demands on ACPR (adjacent-channel power ratio) measurements. Typical ACPR values achievable for W-CDMA signals with 16 code channels are –72 dBc/Hz for the adjacent channel (5 MHz) and –80 dBc/Hz for the alternate channel (10 MHz). The analyzers additionally feature input attenuation in 5 dB steps, which also helps to meet requirements for a wide dynamic range.

Advantest spectrum analyzers comprise a 3.5" disk drive, a 6.5" TFT colour display and are equipped with GPIB, RS-232-C interfaces, parallel ports and a VGA output. Weight: 17 kg.

The analyzers offer a large number of keystroke functions such as adjacent-channel power, occupied bandwidth, power (channel, total, average), spurious emissions, harmonics and frequency counter. Also provided are four detectors, two of which can be simultaneously displayed on the screen, eg for

(cont'd on next page)

Signal Analyzer FSIQ (cont´d)

With a measurement uncertainty of <±1 dB up to 2.2 GHz or <±0.5 dB when the increased level accuracy option is used, FSIQ can be employed in many applications instead of a thermal power meter. An additional advantage is that power can be measured selectively and in a much wider range than with a thermal power meter.

Four traces – even with different detectors – can be simultaneously displayed, so the crest factor of W-CDMA signals, for instance, is very easily determined. FIG 1 illustrates this on a signal with 15 code channels. One trace shows the average power measured with an rms trace detector, the second the peak power using a peak detector. The crest factor depends very much on the code channels used, besides playing an important role in the design of amplifiers and meeting adjacent-channel power specifications, so fast and simple measurements are of particular importance in development.

A vector signal analyzer capable of measuring modulation errors up to a symbol rate of 6.4 Msymbol/s with very low inherent error (<1 % for QPSK, 4.096 Mchip/s) is standard equipment in FSIQ. Preset standards (GSM, PDC/PHS, DECT, IS-95 and many others) can be called up, or modulation parameters can be user-selected (demodulator, symbol rate, baseband filtering, etc). Analog modulation too can be analyzed, the settling and spurious FM of synthesizers with the FM demodulator for instance. This high flexibility in modulation measurements is enhanced by application software packages. FSE-K4 for instance supports automatic measurement of phase noise. Using the noise measurement software option, noise

Spectrum Analyzer R3267/R3273 (cont´d)

measurement of crest factor. Fast time domain sweep down to 1 µs and gated sweep are standard functions.

The software options for the digital communication standards are continually updated to satisfy future developments. A precondition for their use is digital modulation analysis (option 01), which uses DSPs and a fast A/D converter for six-fold oversampling (approx. 24 Msample/s). W-CDMA signals can thus be measured on the uplink or downlink without any constraint on the number of coded channels (128 with W-CDMA). Digital modulation analysis can also be performed for QPSK signals provided they are not spread or coded in a complex way. The same signals can also be measured on I/Q baseband inputs (DC to 2.5 MHz/channel).

Using the W-CDMA option, modulation analysis can be performed and the error vector magnitude (EVM), rho, the power of the individual codes and their timing determined. In conjunction with the ACP test, which requires a wide RF dynamic range, and other special W-CDMA measurements such as VOX on/off, time synchronization error, OBW, transmit power (calculated rms) and out-of-band spurious, the analyzers from Advantest cover all relevant W-CDMA measurements.

FIG 1 shows the power in the code domain of a signal with one perch channel (code 0) and three DPCHs (dedicated physical channels, code 16, 32, 64). By analyzing the time domain power of each individual code, the power of each pilot, TPC and data symbol can be evaluated for instance.

figures throughout the frequency range of the particular analyzer can be detected. The two programs run under Windows™ on an external computer or under the FSIQ's internal Windows NT™.

Herbert Schmitt

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

Reader service card 163/04 for further information on Signal Analyzer FSIQ

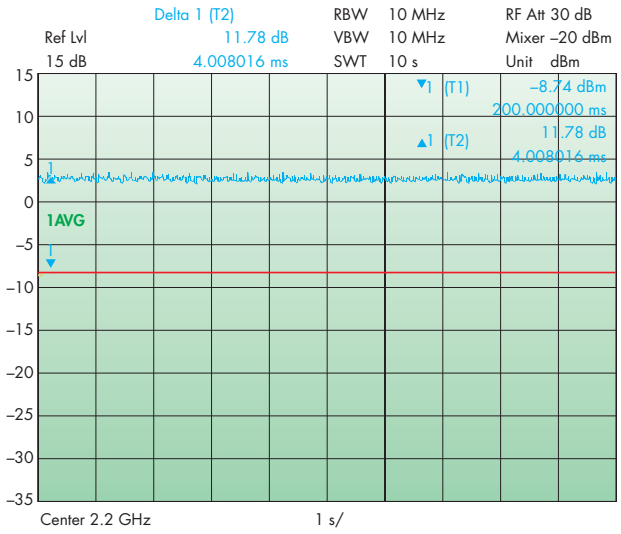

FIG 1 Signal with 15 code channels. One trace shows average power measured with rms trace detector, the second peak power with peak detector

The W-CDMA option allows simultaneous numeric listing of waveform quality, time alignment error, I/Q origin offset as well as phase, modulation and frequency errors in tabular form. Graphic presentations such as constellation diagram, eye pattern, EVM vs time, etc can also be selected for either complex-coded or QPSK signals.

Jan Bo Nielsen

Reader service card 163/05 for further information on Spectrum Analyzers R3267/R3273

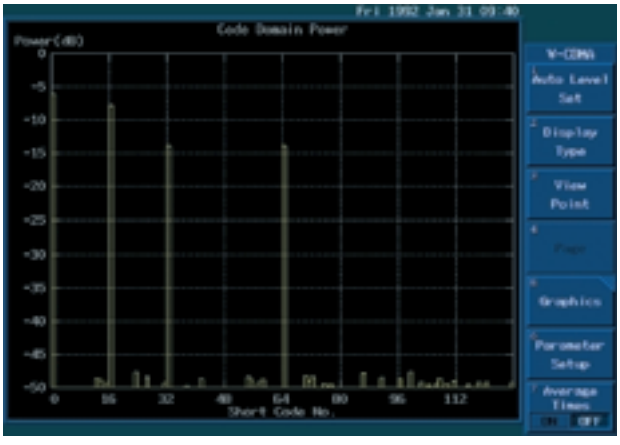

FIG 1 Power in code domain of signal with one perch channel (code 0) and three DPCHs (code 16, 32, 64)

DAB Transmitters NA 6... and NL 6...

Cost cutting through modularity and plug & play

DAB transmitters are mainly used in single-frequency networks in which many transmitters of a similar type are combined. So the costs of purchasing and operating such transmitters can be drastically reduced by standardized logistics and servicing concepts. Redundancy and the possibility of replacing important components during operation make for a high degree of availability and frequently do away with elaborate reserve concepts. The precondition for these cost-reducing effects is an optimized and completely modular transmitter concept.

Photo 43 212/3

FIG 1
DAB transmitters of the NA 6.../NL 6... series are a sophisticated concept for cutting costs in large broadcast networks

A principle proves its success

The new DAB L band and band III transmitters from Rohde & Schwarz are based on the company's more than 40 years of experience in developing radio and TV transmitters. The result is a plug & play transmitter concept that sets standards in terms of signal quality, standardization and ease of servicing (FIG 1). The flexible, modular transmitter design has won international recognition.

Details of the circuitry and technical data were presented in an earlier issue of the journal [1]. This article focuses on the plug & play concept and the well-thought-out modular design, two principles that form the basis for the exceptionally high economy of the transmitters and have proven the key to their success.

Modularity throughout

Standard 19-inch racks of identical basic design for all transmitters

Standard 19-inch racks of identical basic design are used throughout the transmitter family – for all power classes and frequency bands. This ensures fast and easy installation and simplifies servicing. The mechanical design is so transparent and user-friendly that operators can set up the transmitters on their own (plug & play).

Power supplies exchangeable during operation

The base of the transmitter rack can take up to four power supplies, fitted as necessary for the required output power. Each power supply is made up of one or two 1 kW modules mounted on a slide. The power supplies are designed as plug-in units and can be replaced during transmission. Each power supply feeds one amplifier, thus yielding maximum availability.

Ventilation concept: open allround

The racks feature redundant air cooling with two blowers operating simultaneously. The blowers are so powerful that one of them alone can provide adequate cooling for an extended period of time. The intelligent concept allows for air intake from above, below or behind, as well as from the ambient air or via air ducts. The outlet air is expelled from the top.

Plug-in power amplifiers

The 19-inch transmitter racks can accommodate four amplifier modules, likewise designed as plug-in units. This modularity offers decisive advantages:

- transmit power selectable in steps,
- replacement during operation,
- no cabling required,
- plug-in power couplers, no cabling required.

Each amplifier plug-in comprises two units: a band III module with four 50 W amplifiers and an L band module with four 40 W amplifiers. The power amplifiers feature high linearity, excellent efficiency and compact design.

Power couplers with minimum loss

For higher transmit powers, several amplifiers are combined via power couplers. Two different couplers are available, which are simply plugged onto the amplifier modules. So neither cables nor alignment are required. The new power couplers minimize power loss in the event of amplifier failure. This considerably enhances transmitter availability, and in many cases complex reserve concepts can be dispensed with.

Control and operating concept: cost cuts by remote control

Exciters synchronous with GPS signal

The exciter too is identical for all transmitters. For applications in single-frequency networks it incorporates a GPS receiver that supplies a time reference (1 pps) as well as a frequency reference (10 MHz). By means of the seconds pulse, the NA/NI converter evaluates the time stamps included in the ensemble transport interface (ETI) signal and automatically compensates the delay. The reference frequency synchronizes the synthesizer and ensures an exact center frequency of the DAB signal. Even in the event of loss of the GPS signal, the output signals of the GPS receiver remain so stable that the transmitter can continue to operate for another twelve hours.

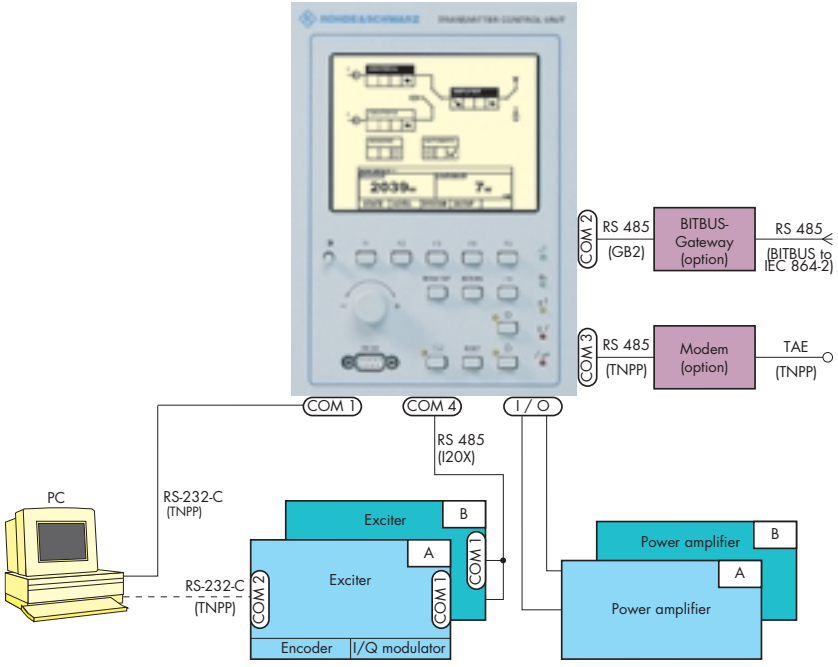

FIG 2 One Control Unit SDB 600 for all transmitter types

The control unit (FIG 2) is used for central transmitter control. It communicates with all components of the transmitter via internal data lines, allows local and remote control, provides complete system status indication and reacts to faults by automatically activating standby circuits depending on the chosen reserve concept.

All setting parameters are stored in nonvolatile memory. Administration of up to four complete parameter sets makes the exciter ideal for use also in (n+1) systems.

Remote monitoring via modem

The optional modem makes it easy to integrate the transmitter into the telephone network for central monitoring. The system can be configured for automatic link setup to a central station in the event of a failure or warning. This concept does away with costly cyclic polling of the system by the central monitoring station. An authorization algorithm is used to prevent unauthorized access via the public telephone network.

Reinhard Scheide; Cornelius Heinemann; Manfred Reitmeier

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Reader service card 163/06

VLF-HF Receiver EK 2000

A "quick-change artist" with every modulation in its repertoire

With VLF-HF Receiver EK 2000 Rohde & Schwarz is adding an attractive receiver featuring state-of-the-art technology to its XK 2000 family of shortwave radio equipment. This receiver is able to handle all relevant types of modulation, includes an HF modem as an option, and can also serve as a modulator for separate transmitters. In next to no time the receiver can be changed into a transceiver or exciter.

Photo 43 353

EK 2000 not only handles all types of modulation, it can easily swap roles thanks to a removable power supply.In next to no time it can be turned into either a 150 W transceiver or receiver/exciter

Proven technology growth

The need for HF receivers equipped with the reliable modules of the XK 2000 family [1; 2] and featuring versatile system interfaces led to the development of this new equipment. The sturdy design and water- and dust-proof front panel (IP 42 protection class) taken from XK 2000 allow use even in the toughest conditions. Of course, the receiver complies with the environmental specifications of MIL-ST-810E.

Understands every modulation

VLF-HF Receiver EK 2000 (FIG) is envisaged not only for **classic reception**, it is also ideal for **broadcast reception**, eg in BRASS (broadcast and ship to shore) marine use and **split-site mode**. Remote Control Processor GP 2000 [3] is best suited for controlling the receiver.

Due to the use of DSP technology, EK 2000 features the outstanding characteristics of the latest generation of receivers and **is able to handle all types of modulation** used in military and civil communication. For the reception of morse, speech, teletype and data signals, the receiver can be operated in the modes SSB (USB/LSB), ISB, AME, CW, FSK, AFSK, F1C and

FM, and meets MIL-STD-188-141A thanks to its excellent receive characteristics.

Equipped with the appropriate options it provides:

- link 11 mode to MIL-STD-188-203-1A or STANAG 5511,
- link 22 mode to STANAG 5522, and
- reception in SLEW mode (single-tone link eleven waveform) and with link Y Mk-II modem.

With its built-in HF Modem GM 2100, the receiver fulfills every conceivable requirement. The modem option enables EK 2000 to receive data signals transmitted in single-tone mode (PSK) in accordance with MIL-STD-188-110A, STANAG 4481 (without FSK), 4285 and 4529. And the receiver has ready functionality for future modulation modes, which can be quickly and simply installed by software upgrades.

A whole lot of extras

One of the special advantages of EK 2000 is that it can be used as a **modulator for separate transmitters in** FSK and PSK modes (STANAG 4285, 4529 and MIL-STD-188-110A). All that is needed is a line to the transmitter and audio signals at the receiver.

EK 2000 integrates a **fast frequency scan** with freely selectable step size as well as a **channel scan**. In both cases the dwell time, hold time and RF thresholds can be set individually.

All settings can be performed either manually on the menu-guided **man-machine interface, optimized for reception**, or conveniently via the **remote-control interface** using Radio Remote Control Software DS 110.

Quick-change artist

The receiver includes its own power supply unit for 97 to 253 V AC (47 to 440 Hz). Alternatively, it can be operated with DC voltages from 24 to 31 V, eg from a backup battery. **The removable power supply makes EK 2000 a "quick-change artist"**. This power supply can be taken out by undoing a few screws and replaced by a 150 W power amplifier or an interface board. This simple operation transforms EK 2000 into either a **150 W Transceiver XK 2100** or a **Receiver/Exciter GX 2900 L** for controlling a 500 W or 1 kW transceiver of type XK 2500 or XK 2900.

Robert Träger

Unmistakable family likeness

EK 2000 features numerous characteristics for which the transceivers of the XK 2000 family are outstanding:

- 17 group-delay-compensated IF filter bandwidths between 50 Hz and 8 kHz
- Automatic and manual gain control with settable control voltage
- Settable notch filters
- Passband tuning
- Syllabic squelch
- Noise blanker
- Voice Processing Unit (GN 2110), an option for enhancement of speech quality that can be equipped with speech encryption
- High-performance mixer in receiver input, ensuring brilliant large-signal characteristics (IP2 typ. +70 dBm and IP3 typ. +35 dBm)
- Outstanding receiver noise figure
- High input sensitivity and large-signal immunity
- Fast-switching Preselection FK 2010, easily integrated and digitally tuned and offering minimum attenuation of 20 dB at 10 % frequency offset, thus allowing critical operation under simultaneous conditions; it increases input voltage immunity to 200 V EMF
- Motor-tuned Preselection FK 2850 for 40 dB attenuation at 10 % frequency offset

Condensed data of VLF-HF Receiver EK 2000

Frequency range/resolution	10 kHz to 30 MHz/1 Hz
Frequency error	2 x 10^{-8}/°C (TCXO) 1 x 10^{-9}/°C (OCXO)
Modes (standard)	A1A, J3E, H3E, J7B, B8E, F1B, F3E, F7B, F1C, A3E
Modes (optional)	B7D, MIL-STD-188-203-1A, STANAG 5511, 5522, 4481 (w/o FSK), 4285, 4529, MIL-STD-188-110A
Sensitivity (w/o preamplifier)	
for S/N =10 dB, A1A, BW = 300 Hz	typ. 0.4 µV EMF
J3E, J7B, BW = 2.7 kHz	typ. 1.1 µV EMF
H3E, 1 kHz, m = 60 %, BW = 6 kHz	typ. 3 µV EMF
Signal/noise ratio (H3E)	>46 dB SINAD for 1 mV EMF to CCITT (O.41/P53)
Operating temperature range	–25 °C to +55 °C
Dimensions	19", 3 HU (bench version or rackmount)
Weight	approx. 13 kg (without options)

Reader service card 163/07

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[2] Träger, R.: HF Transceiver XK 2500 and XK 2900 – The new members of HF Transceiver Family XK 2000. News from Rohde & Schwarz (1997) No. 153, pp 12–13

[3] Kneidel, T. A.: Remote Cotrol Processor GP 2000 – The wild card in shortwave communication. News from Rohde & Schwarz (1998) No. 157, pp 10–11

PSK Demodulator GM097

Detecting signals that hardly differ from noise

Modern digital HF modems handle many different types of modulation. Radio detection is therefore confronted with a variety of signals, a number of which can hardly be distinguished from noise. PSK Demodulator GM097 is able to reliably detect signals where conventional instruments are just fumbling in the dark.

Radiomonitoring faces new challenges

Rapid advances in digital radiocommunication equipment created a need for a new generation of monitoring equipment. The architecture of this type of equipment and its functionality differ very much from that of analog systems. Classic radiomonitoring functions such as searching, localizing and classifying can no longer be seen as sequential operations. Instead processes will work simultaneously for the most part or will overlap. The basic functions of state-of-the-art demodulators and their system performance are therefore not specified too tightly. Although it is not a universal unit, PSK Demodulator GM097 from Rohde&Schwarz performs all activities from searching through to demodulation (FIG 1).

Conventional instruments fail on serial PSK modulation

Many modern HF modems use serial PSK modulation for fast digital transmission. Transfer rates of up to 2400 Bd can be achieved depending on the quality of the transmission link. Such emissions often prove to be an insurmountable barrier for conventional monitoring equipment. As early as while searching, the operator comes up against signals that look and sound like noise (FIG 2).

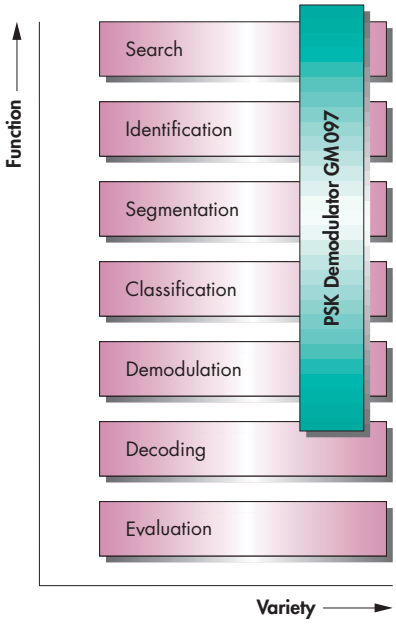
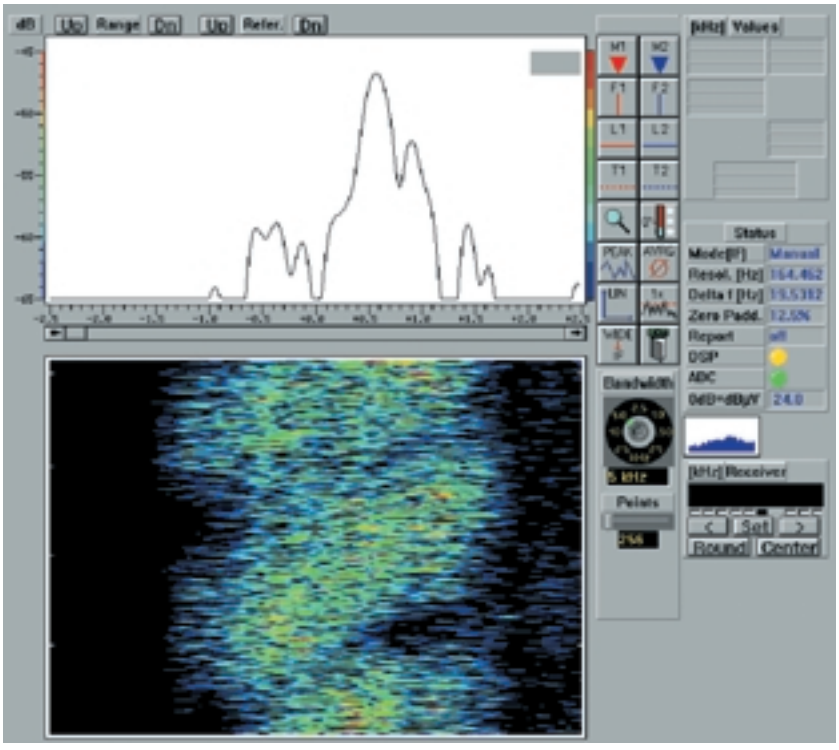


FIG 1 PSK Demodulator GM097 performs many tasks simultaneously

FIG 2 Spectrum and waterfall display of serial PSK signal



The plait-like structure in the lower half of FIG 2 (sonogram) is produced by frequency-selective fading, which is typical of HF transmission and not signal-specific. The spectrum in the upper window shows a snapshot. Averaging over an extended period of time produces envelopes that theoretically and in favourable practical cases approach a sin x/x function. However, the spectrum of a PSK8A signal illustrates the harsh reality of the HF detection scenario (FIG 3). It shows the spectral characteristic of HF modems

that resembles noise and is familiar from DSSS (direct sequence spread spectrum) signals. Automatic classifiers or search receivers using only the power density spectrum are confronted with the same almost irresolvable problem.

modules with different demodulator programs can be used in one controller. Operation of several demodulators in parallel allows the time required for searching and verification to be reduced considerably.

Dr Klaus Rieskamp

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[1] Morse Decoder GM094 – New dimensions in Morse decoding. News from Rohde & Schwarz (1997) No. 155, pp 14–16

A "home match" for GM097

PSK Demodulator GM097 offers a solution for demodulating PSK signals. The demodulator identifies the modulation form (FIG 3) while searching and determines the exact carrier frequency through continuous classification. The horizontal line marks the bandwidth used for transmission and the baud rate is automatically displayed (here 2400 symbols/s). During demodulation the operator can simultaneously view the phase constellation diagram (top right of FIG 3). GM097 also displays a new type of graph showing a differential phase constellation diagram that helps to identify modulation such as PSK4A, PSK2B, OQPSK. Functions like enlarging and smoothing of points are measures of demodulation quality. Classification is no longer possible in unfavourable conditions for transmission however. In such cases the effective and non-cooperative equalizer supplied with the demodulator is switched into circuit.

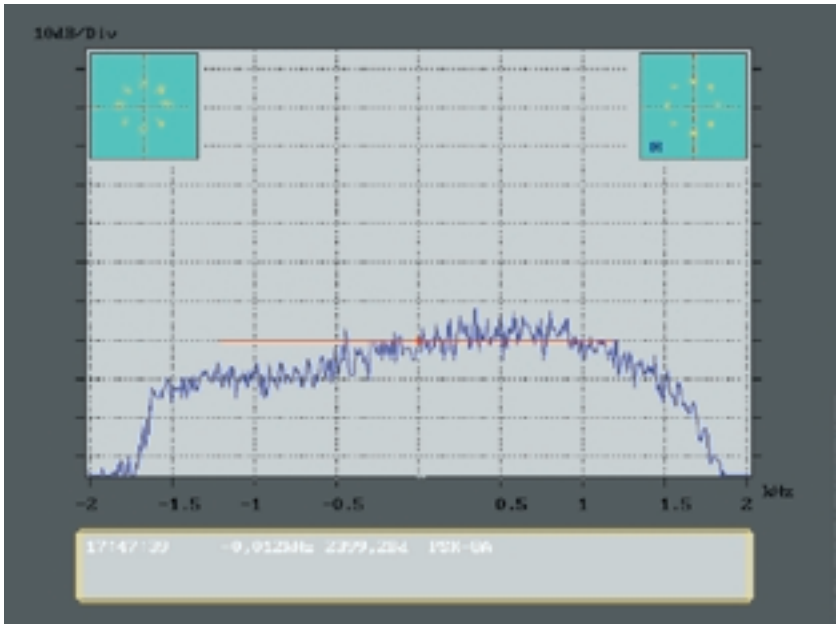


FIG 3 Spectrum and phase constellation diagram of PSK8A signal

If the operator is sufficiently familiar with the operation of the instrument, he may correct demodulation parameters or specify them more tightly. A signal decoding function was deliberately omitted in GM097. But customers´ decoders can be connected to the outputs for clock and data. The bit stream is stored on hard disk, so it can also be subsequently evaluated.

PSK Demodulator GM097 is based on a processor board with DSPs and appropriate software. This module – which is also used by Morse Decoder GM094 [1] – allows all entries to be made for the receiver IF. Up to six

Condensed data of PSK Demodulator GM097

Functions	search, monitoring, classification, demodulation
Types of modulation	PSK2A, PSK2B, PSK4A, PSK4B, PSK8A, PSK8B, OQPSK
Baud rate	PSK: 50 to 2500 symbols/s OQPSK: 25 to 1250 symbols/s
Bit error rate (with white noise)	PSK2A, PSK2B: <0.1% (S/N = 12 dB) PSK4A, PSK4B: <0.1% (S/N = 15 dB) PSK8A, PSK8B: <0.1% (S/N = 18 dB) OQPSK: <0.1% (S/N = 15 dB)
Frequency centering	AFC
Spectrum display	FFT, bandwidth 8/4 kHz
Resolution	20/10 Hz for search/demodulation
Search ranges	max. 3
Output	1 clock channel, 1 data channel

Reader service card 163/08

Security Management System BSI Tool

Secure UNIX Administration

The transition to an information society means that the factor information as well as the technology used for information processing (IT) assume strategic importance. The role of IT far exceeds cost savings through rationalization. Effective and efficient use of information is an inestimable competitive advantage. So protection of these valuable resources is of vital importance. Information is often processed in complex networks, meaning greater outlay and effort for consistent IT security. This article shall illustrate that such efforts are nevertheless manageable with the support of dedicated tools like the BSI Tool Secure UNIX Administration.

Photo 43 216

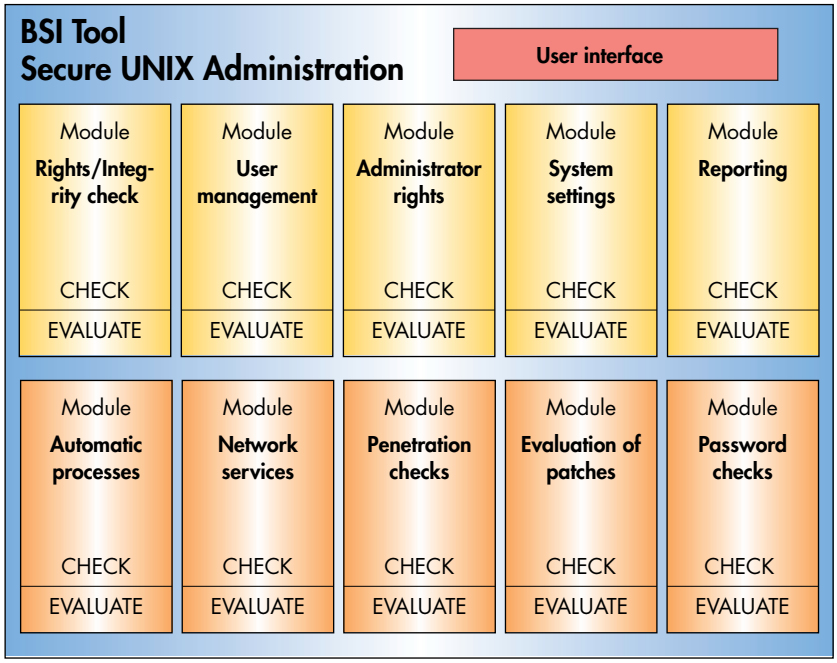
UNIX Administration is time-consuming

UNIX is a mature computer operating system offering a great variety of configurations and security mechanisms depending on the manufacturer. But experience has shown that often little or no use at all is made of the security mechanisms in standard installations. New weak points or attempts to penetrate UNIX systems are reported almost daily. Although manufacturers respond fairly quickly with updates or patches, the system administrator, who is normally in charge of a lot of other tasks besides security, often has little time to thoroughly analyze the problems. Significant improvements of IT security are possible through a correct or optimized configuration – but how do you go about it?

BSI Tool supports in UNIX security matters ...

BSI Tool Secure UNIX Administration offers convenient techniques for checking security-relevant settings and pinpointing respective problems. The program system was developed by SIT GmbH, a subsidiary of Rohde & Schwarz, under contract to the BSI (German Information Security Agency). The tool simplifies secure administration of UNIX systems, if not implementing it in the first place. It indicates how to close security gaps and supports system administrators with information on how to eliminate detected sources of danger. It is a valuable aid for all administrators responsible for the operation of UNIX systems.

Structure of
Secure UNIX Administration
BSI Tool



… is user-friendly and manipulation-proof …

The BSI Tool integrates individual programs under a common user interface, each performing a special configuration test of the operating system core, the file system or the network configuration. Each program can also be started manipulation-proof in batch mode (also automatically) from a CD-ROM without a call from the user interface. Results are recorded in a file and displayed onscreen.

The BSI Tool does not require a specific technical environment and does not impair normal UNIX or network operation. It runs on standalone computers as well as in networked UNIX systems.

… and provides messages of different categories

A number of different messages are output to support the system administrator:

- Information text on test steps is displayed in the INFO category.
- WARN signals deviations from standard settings that may be a security risk.
- FAIL indicates a weak point that must be eliminated.
- ALERT tells you about traces of unauthorized access to the system or an attack.
- ERROR indicates that a test or parts of it could not be performed because of an error.

The file containing results is stored on a hard disk of the computer tested.

BSI Tool supports numerous UNIX systems

The BSI Tool runs on a variety of different UNIX operating systems. The software is continually adapted to ward off new threats and regular updates are issued.

The example above shows that UNIX operating systems can be optimally configured for IT security using the right tools. The product presented here enables this in a convenient way even if personnel resources are limited.

Volker Thieszen

Reader service card 163/09

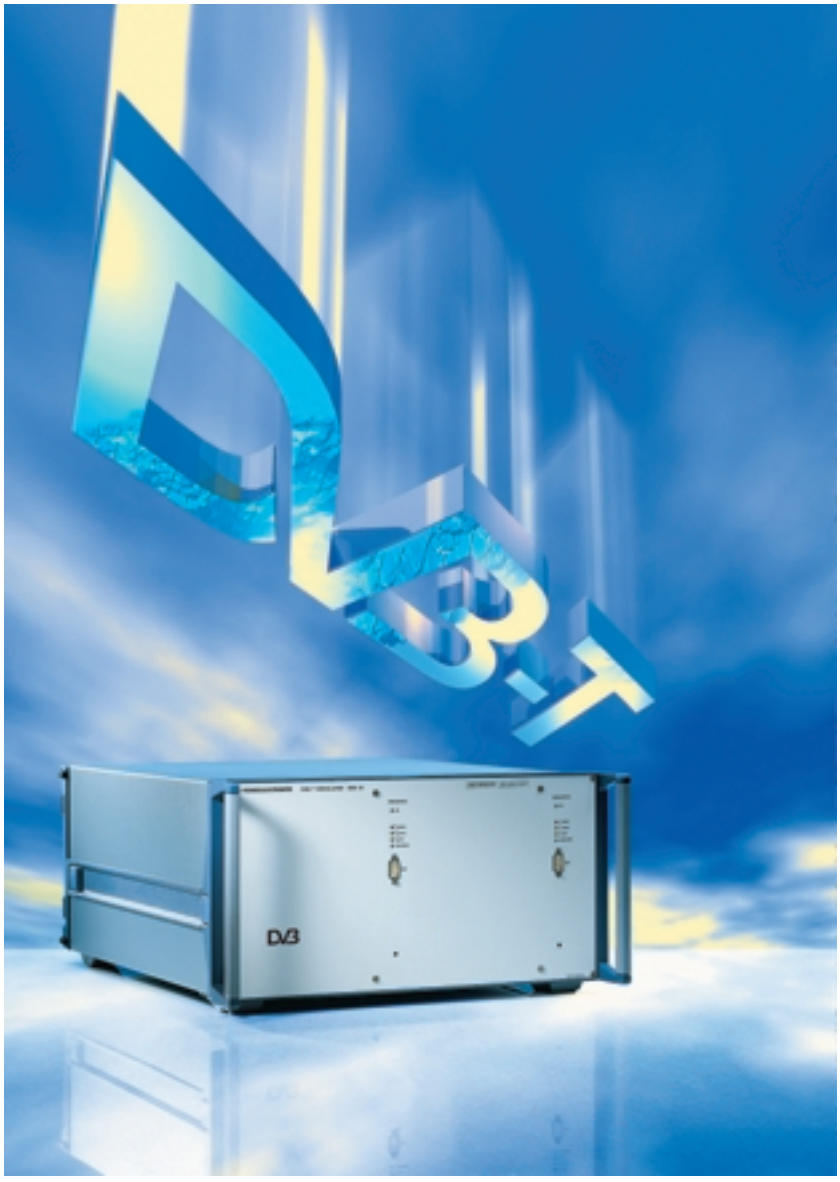
DVB-T Modulator SDB-M

One of the first on the market – now in use worldwide

The new DVB-T television standard had hardly been issued when in May 1997 Rohde & Schwarz, as one of the first producers worldwide, already launched its new DVB-T Modulator SDB-M [1]. Besides its use as an integrated modulator in Rohde & Schwarz's DVB-T Transmitter Family NV 500 [2], SDB-M has proved itself a successful solution in design and production of many renowned companies.

FIG 1 Modulator SDB-M is used in development and production of most receivers for the new digital TV standard DVB-T

Photo 43 191/4



Know the market

Manufacturers of electronic consumer goods were under considerable time pressure: development and production of receivers for the new TV standard DVB-T [3; 4] had to be started up as speedily as possible. No matter whether set-top boxes or receivers integrated into new TV sets were concerned, industry needed reliable signal sources fast for testing the new digital environment.

Rohde & Schwarz recognized early what the customer required and implemented it in good time. Today SDB-M is used in design and production by companies like Nokia, Philips, Sagem, Pace, Sony, Hitachi, Pioneer, Panasonic, Toshiba and Sanyo. Hitachi and Panasonic for instance set up a complete internal DVB-T network with four digital multiplexers at their factories in Britain. The four DVB-T signals of different frequencies are distributed in the factory by a cable. Manufacturers of integrated circuits also use SDB-M as a reference source.

Fully proven in practice

In addition to the fact that SDB-M was capable of handling, from the very beginning, all DVB-T modes in terms of modulation (QPSK, 16QAM or 64QAM), number of carriers (2k or 8 k), guard interval and code rate, the following features were of particular importance for its users:

- An analog IF signal or – after the integrated upconverter – a frequency between 47 and 860 MHz with level of 0 dBm can

be selected as the output. The advantage of this is that the receivers can be tested together with their front end in the whole operating range.

- The energy dispersal, Reed-Solomon coder, bit interleaver and frequency interleaver functions can be separately switched off during testing. This means that the individual receiver circuits can be testet on their own.
- All settings can also be made automatically by software via the serial interface so that receivers in production can be rapidly tested in all operating modes.
- A special advantage for the design engineer is that SDB-M already integrates a pseudo-random binary sequence (PRBS) generator for measuring bit error rate.

A completely new feature of the current models is the insertion of PRBS data both before or after the inner coder. PRBS sequences 2^9, 2^{15}, 2^{20} or 2^{23} can be selected as required by the BER test system used.

The mechanical design of the instrument has also proved to be a good solution, because two modulators can be accommodated next to each other in an enclosure of five height units. This is important when several modulators are used in production.

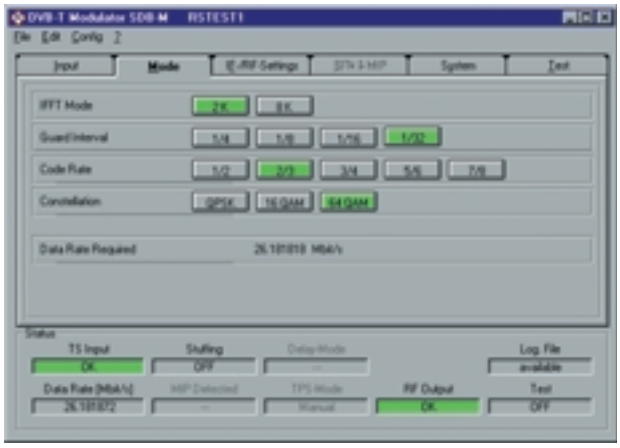
Whether used in design and production or as an integrated modulator in transmitters, SDB-M is suitable for a whole variety of applications.

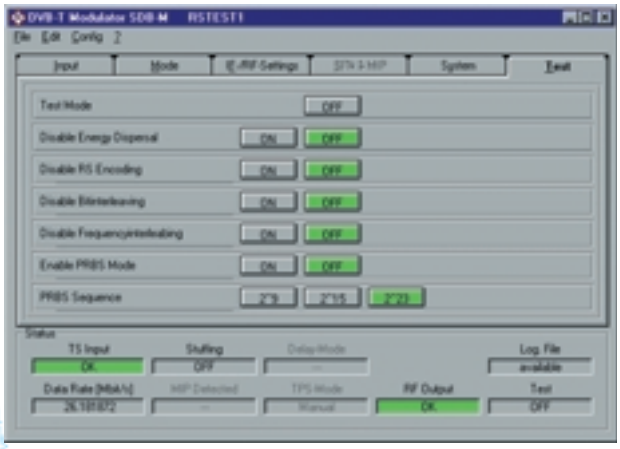
Luc Haeberlé

FIG 2
Ideal for use of Modulator SDB-M in automatic production environments: all parameters can be set via serial interface

Top: convenient selection of operating mode

Bottom: individual functions can be switched off for tests





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Reader service card 163/10

HSCSD test software for GSM Phase 2+

Measurement software and test cases for new, fast GSM data services

High Speed Circuit Switched Data (HSCSD) is a new service that will be introduced in the next expansion phase 2+ for GSM standards. HSCSD allows a substantially higher data transfer rate than with present GSM networks (9600 kbit/s). With the introduction of the new service, manufacturers of mobile and base stations will need to perform numerous new tests. Digital Radiocommunication Test Set CRTC from Rohde & Schwarz, two of which can be combined to produce a multislot test platform CRTx-DUO [1], is ready for the new service.

With a large number of new signalling elements added, HSCSD places many new demands on a GSM test platform. HSCSD test sets must be capable of multislot channel reception and transmission and of supporting the protocols necessary for multislot data transmission.

Rohde & Schwarz has created new software packages to make its test systems fit for HSCSD: test systems CRTx-SAT, CRTx-DUO and TS 89xx are available to meet different requirements.

CRTx-SAT (standalone CRTx) enables HSCSD tests with maximally 2+2 multislot links where a C0 carrier is needed on the TCH only during link setup but not during the data link. This test set is appropriate also for single-slot tests at 14.4 kbit/s.

For HSCSD tests with maximally 3(4)+3 multislot links, **CRTx-DUO** is the most appropriate platform. **TS 89xx** test systems are suitable for multislot RF tests where stringent demands are made for RF accuracy.

Operation Software CR02P2P for CRTx02 provides all signalling messages required for HSCSD and enables multislot reception with this test system. **Software option CRT-K8** allows use of the HSCSD channel combinations, and **software option CRT-K9** makes the 14.4 kbit/s channel coder available.

FIG 1 CRTx-DUO is ready for the new, high-speed GSM data service

Software option CR29P2P provides the protocol for non-transparent data services. This protocol includes the extensions for the radio link protocol (RLP, version 2), which is required for NTDS multislot channels. Symmetric and asymmetric data links can be set up (eg 3+1) with NTDS.

Software option CR49P2P provides the protocol for transparent data services, which was extended in accordance with the specifications for Phase 2+ for TDS multislot channels. With TDS only symmetric data links are possible (eg 2+2).

For the Phase 2+ software packages Rohde & Schwarz offers a **variety of test applications** that are programmed in C and can easily be adapted to individual requirements. Included are the major HSCSD test applications such as bit error rate measurements, TDS and NTDS data transfer on 14.4 kbit/s channels and multislot. These applications run on each of the above mentioned test systems. They automatically detect the maximum number of channels, dependent on the test system, that is available for multislot configurations.

For the new HSCSD service, ETSI (European Telecommunications Standards Institute) introduced into GSM 11.10-1 test specifications **27 new test cases for type approval** of HSCSD mobile stations. All these test routines are implemented by Rohde & Schwarz

The new HSCSD service

HSCSD is a first step in the expansion of GSM networks towards fast data services. In the next step the packet-oriented GPRS (General Packet Radio Services) data service will be implemented in GSM networks. Like the speech and data channels currently used in GSM networks, HSCSD is based on circuit-switched links with defined, complete timeslots assigned to each subscriber for the duration of a call. GPRS, the future, packet-oriented (packet-switched) service, can split timeslots dynamically among several subscribers, thus achieving more effective use of resources.

The higher data rates of HSCSD are achieved through the following extensions of the GSM specifications Phase 2+:

- New channel coder for 14.4 kbit/s data transfer in one timeslot
- Multislot: simultaneous use of several timeslots for data transmission

In most cases HSCSD can be implemented in existing networks merely by software modification, ie no alterations of the network structure itself are required. HSCSD will consequently be introduced in some GSM networks this year already.

HSCSD multislot mobile stations are organized in multislot classes from 1 to 18, depending on the maximum possible number of receive and transmit timeslots. A distinction is also made between multislot type 1 and 2, depending on whether a mobile station can transmit and receive at the same time [2].

Theoretically, all eight bidirectional timeslots of a TDMA frame can be made available to a subscriber for a data link, yielding a maximum transfer rate of 115.2 kbit/s.

The first HSCSD development stage provides for multislot type 1 mobile stations with up to four receive and two transmit timeslots.

The simplest configurations are asymmetric links, for example with the mobile station receiving in three or four timeslots and transmitting in one or two.

Such configurations are suitable for the most frequently used data services (eg Internet). An HSCSD mobile station with three timeslots for reception and one for transmission (3+1 link) can receive data at a rate as high as 43.2 kbit/s (3 x 14.4 kbit/s).

on CRTx-DUO and TS 89xx systems and validated by an accredited test house, and are now available for type approval of HSCSD mobile stations. Eleven of the HSCSD test cases, which can be run on CRTx-DUO, are offered as **Test Case Package CRTK-HSC**. The other 16 are intended for use with TS 89xx test systems.

Franz Segerer

Reader service card 163/11

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[2] GSM 05.02 version 6.3.0 release 1997 (EN 300 908)

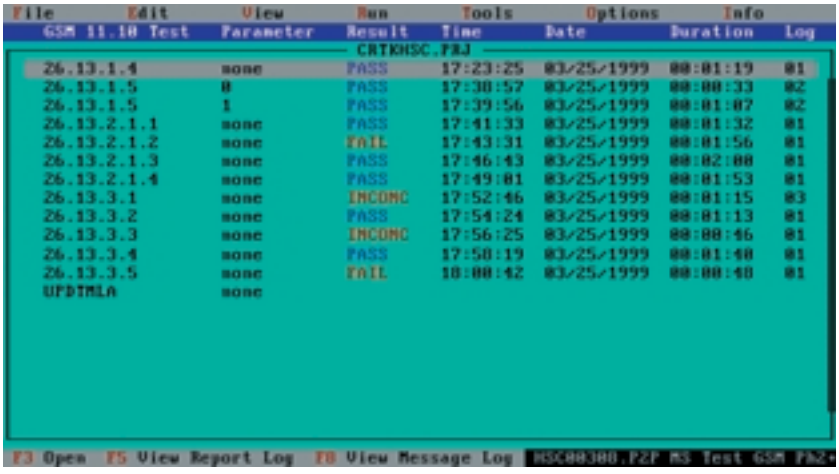
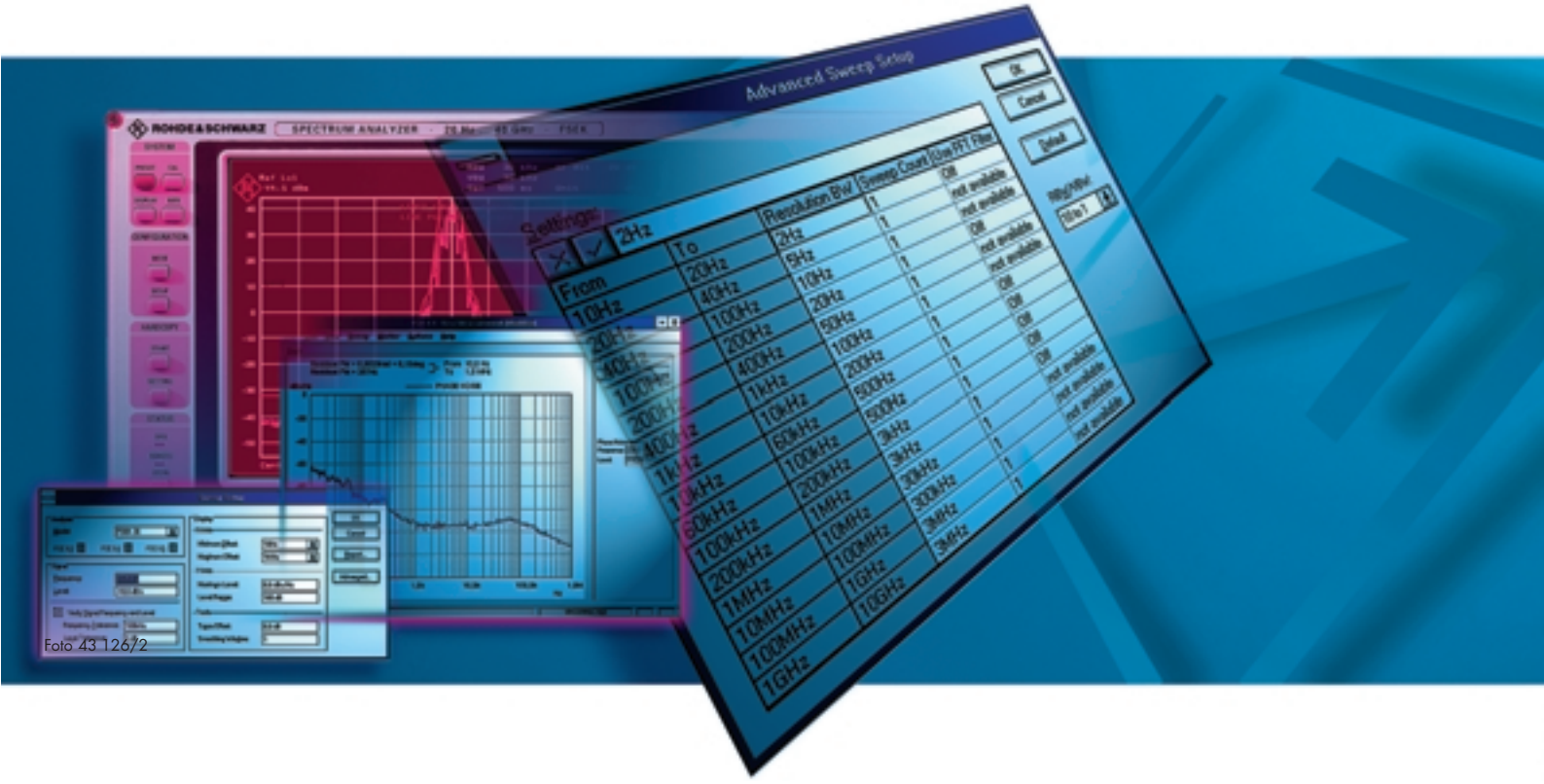


FIG 2 HSCSD test cases on CRTx-DUO

Phase Noise Measurement Software FSE-K4 for Analyzers FSE/FSIQ

Cost-effective and versatile alternative to special-purpose phase noise test sets



Phase noise – an evil with consequences

The phase noise of oscillators essentially determines the transmission quality of radiocommunication systems. In a transmitter, it affects the modulation quality of the transmit signal and the power radiated into the adjacent channel. In a receiver, it determines selectivity and demodulation quality. The higher the order of modulation, the more important is low phase noise of the conversion oscillators, for example to produce low bit error rate.

Instruments used in development and production should consequently allow simple, high-precision phase noise measurement over a wide dynamic range. The frequencies to be covered go up into the microwave range, eg for measurements on downconverters for satellite or microwave links.

How FSE and FSIQ turn into phase noise testers

With their low phase noise and low noise figure, the spectrum analyzers of the FSE family and the signal analyzers of the FSIQ family are an ideal choice for phase noise measurements up into the microwave region. Used in conjunction with Phase Noise Measurement Software FSE-K4, the analyzers are a considerably more cost-effective and versatile alternative to phase noise test sets, which are usually very expensive (FIG). Depending on the analyzer model, measurements are possible up to 26.5 GHz (with FSIQ) or 40 GHz (with FSE).

FSE-K4 – versatile and convenient

The dynamic range attainable in phase noise measurements by means of a spectrum analyzer is limited by the analyzer's inherent noise, thermal noise and overload capacity [1]. To make optimum use of the resulting dynamic range, not only the signal level at the RF input is crucial but also correct setting of RF attenuation and reference level on the analyzer. FSE-K4 automatically optimizes these parameters after entry of carrier frequency and level.

Equally important for correct measurement is selection of the right resolution bandwidth. Measurements close to the carrier, for example, require a very narrow resolution bandwidth. Featuring a minimum IF bandwidth of 1 Hz (FSEx30 and FSIQ), these analyzers allow measurements to a minimum offset of 10 Hz from the carrier. Alternatively, FFT filters can be used for this purpose.

The use of narrow IF filters for phase noise measurements close to the carrier results in long sweep times. So, to increase speed, measurements are carried out in subranges. The resolution bandwidth is automatically increased at greater distance from the carrier so that the sweep time and thus the total measurement time reduce to a minimum.

Starting from the presettings described above, the user selects the resolution bandwidths and FFT filters for the individual subranges. The frequency range is freely selectable in decade steps. The number of decades is not limited.

The software can smooth traces optionally by averaging over several measurements (trace averaging) or by forming the average of neighbouring test points. The number of averaging measurements or test points is selectable.

In many cases not only phase noise is of interest but also residual phase modulation and residual frequency modulation. FSE-K4 calculates these quantities within any limits in fractions of a second after measuring a trace.

Clear-cut presentation and documentation of results

The measured phase noise is displayed along a logarithmic frequency axis. In addition to marker and delta marker functions for easy evaluation of results, FSE-K4 features a zoom function for looking at traces in detail. Tolerance masks (limit lines) can also be displayed, which particularly simplifies fast functional checks of DUTs.

For documentation, results together with the selected settings plus freely editable comments can be output to a printer. Additionally it is possible to store traces, settings and tolerance masks together or separately. Traces are stored in ASCII format, so measured data can easily be read into spreadsheets.

FSE-K4 can operate both on a separate PC with an IEC/IEEE-bus card or on the computer integrated in the analyzer (FSIQ or FSE + FSE-B15). The software runs under Microsoft Windows™ 3.1/3.11/95/98 and Windows NT™ 4.0.

Christoph Rauscher

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[1] Wolf, J.: Phase noise measurements with spectrum analyzers of FSE family. Application Note 1EPAN16E, Rohde & Schwarz

Reader service card 163/12

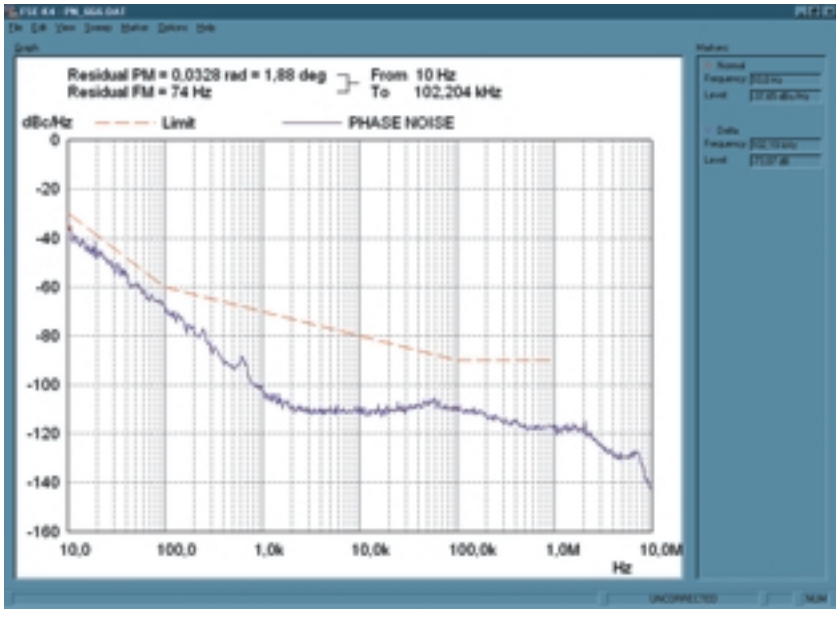

FIG Phase Noise Measurement Software FSE-K4 turns analyzers of FSE/FSIQ family into versatile, value-for-money phase noise test sets

Installation test systems for automobile industry

Test now to save costs later

For a long time a radio was the only form of communication found in automobiles. This has changed a lot in the past few years. Mobile radios, GPS navigation equipment and TV sets are increasingly becoming standard in many modern vehicles (FIG 1). The equipment is ready tested but normally it is manually fitted, and this means that installation faults cannot always be excluded. The result can be expensive corrections or even recall actions on a worldwide scale.
All this can be avoided: Rohde & Schwarz offers custom-tailored test equipment and system solutions for checking correct installation during vehicle production.

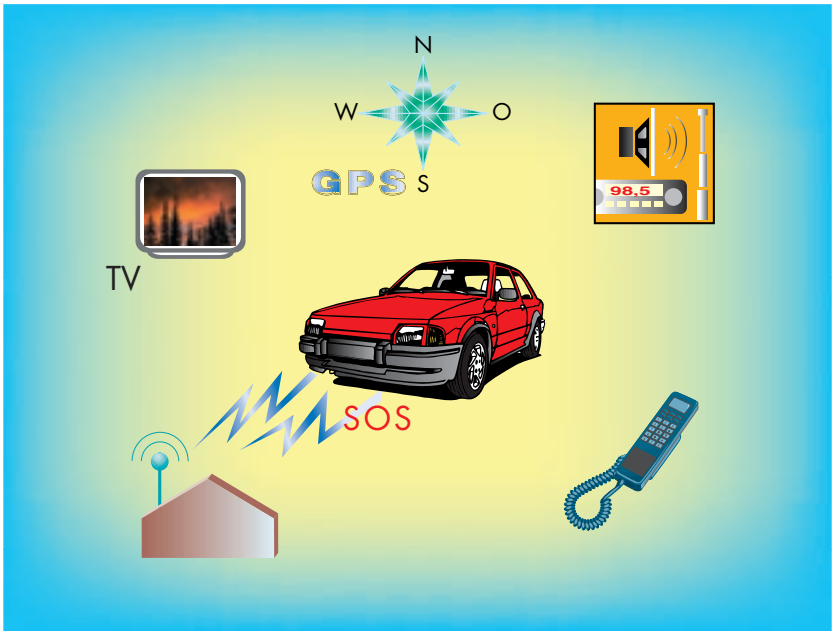

FIG 1 Mobile radios, GPS navigation equipment and TV sets are increasingly becoming standard in many modern vehicles

Production lines are a special challenge

As a result of globalization, automobiles for all countries in the world can be produced practically at any location. This means that test equipment able to handle all worldwide standards for the different communication media is required at the individual production sites. For instance, even American and Japanese mobile radio and TV standards must be available at a European automobile plant.

A frequency range from 70 MHz to 2 GHz is required to cover all transmit and receive signals needed for the different tests. Other problems are that the vehicles are continually moving along the production line during the tests, RF shielding is not possible and that wired interfaces are normally not available. Transmission of test signals and communication with test systems must therefore be through the air interface.

For this reason a **common slot antenna** is used for signal emission and reception, this **being installed along the production line** to output a relatively constant level (FIG 2). The antenna is able to supply production lines of up to 40 m length. Connection between the transmitter/receiver and slot antenna is established via combiners.

Rohde & Schwarz test systems covering all ranges

Mobile phone and emergency call systems

Emergency call systems are gaining ground besides mobile phones. To ensure correct working of the different kinds of communication systems, fixed antennas must be installed and these require testing.

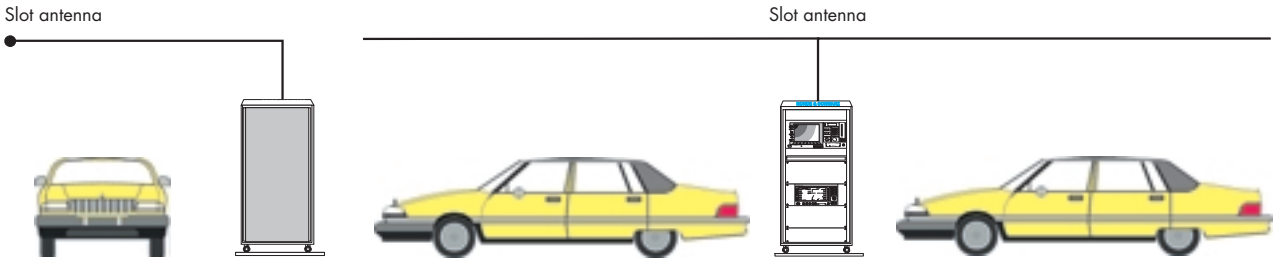

FIG 2 Slot antenna supplying production lines (up to 40 m length) with test signals of relatively constant level

Mobile testers from Rohde & Schwarz are able to handle almost any standard worldwide, so the standard used by the particular equipment is of no importance:

Digital Mobile Station Tester CMD 52
GSM 900

Digital Mobile Station Tester CMD 55
GSM 900/1800/1900

CMDA Tester CMD 80
AMPS/NAMPS, CDMA, TDMA, NTACS/JTACS, ETACS/TACS

Mobile phones and emergency call systems are tested with the aid of level measurements and the echo test. In the latter case the transmitted signal, ie the voice, is returned with a certain delay by CMD acting as a base station. If the installed mobile is able to perform level measurements of its own without prior registration to a base station, it will be sufficient to continuously emit the BCCH signal of a base station. This can easily be done with **Signal Generator SME** in conjunction with **Software SMIQ-K1**.

Rohde & Schwarz offers special test SIM cards for CMD to prevent individual tests in the narrow production environment from impairing or influencing each other. These cards and a special operating mode of CMD ensure correct assignment of the tested mobile phone to the particular base station.

Car radios and loudspeakers

AM and FM radio checks are based on the emission of an amplitude- or frequency-modulated RF carrier that is then received by the vehicle. **Signal Generator SMY** provides a sufficiently high output level so that no extra power amplifier is required. Rohde & Schwarz supplies the **RDS Codec DMC01** for FM stereo signals.

The loudspeakers in a vehicle are tested with **Audio Analyzer UPL**. To test different loudspeakers (treble, medium-frequency and bass) together and as fast as possible, UPL generates a multitone signal that is emitted via Signal Generator SMY. The loudspeaker signal is picked up by a radio microphone in the vehicle and returned to UPL, which evaluates the individual levels using FFT analysis.

The advantage of this method is that it is independent of the subjective hearing capability of a test person. This is important because the failure of just one loudspeaker is hardly perceivable by the human ear in the difficult conditions of a production line.

GPS receivers/navigation systems

The worldwide available GPS signal is received by an antenna installed on the plant roof, routed into the shop, amplified and then emitted via an antenna. For this purpose Rohde & Schwarz offers a GPS repeater permitting signal emission via up to two antennas.

TV receivers

The test system emits TV patterns for PAL, SECAM and NTSC standards. Because of the considerably higher levels required for TV, additional preamplifiers and power amplifiers are included. The received signal is evaluated either subjectively by the test person on the screen in the vehicle or, if possible, automatically by means of a level measurement in the TV receiver.

Rohde & Schwarz services along the line

These examples of test configurations can of course be adapted to individual requirements. Rohde & Schwarz offers a variety of services from comprehensive consulting through trial measurements on site to delivery and commissioning of turnkey systems, not forgetting complete hardware and software support after going into operation.

Manfred Gruber

Reader service card 163/13

EMC testing more important than ever

The *Regulatory Authority for Telecommunications and Post* (Reg TP) in Germany checks all units of equipment and systems for compliance with EMC regulations. The importance of EMC testing is underlined by the results obtained last year: a surprisingly large number of "EMC offenders" are trying to get their products onto the market.

Legal basis and purpose of governmental control

Member states are bound by the EMC Directive of the Council of the European Union to ensure sufficient protection of radio services as well as of devices, units and systems whose operation might be disabled by electromagnetic interference emitted from electrical or electronic equipment. The same applies to the protection of power distribution networks and equipment fed by them since they might also be impaired by electromagnetic interference.

The EMC directive includes protection requirements so that emission of and immunity to interference fully comply with the limit values stipulated in the standard.

The German law on the electromagnetic compatibility of equipment (EMVG) that entered into force on 13 November 92 and which was supplemented on 30 August 95 by the first amendment EMVG (1. EMVGÄndG) is the harmonization of the European EMC directive into German jurisdiction.

EU directives comprise regulations that oblige member states to take all necessary actions so that the relevant products fully meet the stipulated requirements. The national authorities of the member states are responsible for this.

In Germany, the **Regulatory Authority for Telecommunications and Post** (the former German Post and Telecommunications Office BAPT) was entrusted in 1992 with the task of ensuring that equipment is tested according to EMVG (§ 6, paragraph 1). This task, which is often called "market surveillance", is performed for products mentioned above by the public authorities of the EEA states.

Reg TP – the "EMC police" in Germany

The third part of EMVG, which defines the rights and obligations of the relevant authority, details the competence of Reg TP in §6. Accordingly, Reg TP is obliged to check equipment launched on the market for compliance with

- EMC protection requirements
- CE conformity mark regulations
- EC conformity declarations

The EC conformity declaration is to be issued in accordance with the regulations of the EC directive stated in the declaration. It supplements the affixing of the CE conformity mark to the relevant product. The CE conformity mark confirms the compliance of a product with the regulations.

Testing and control through Reg TP is legitimized by EMVG. Reg TP also has the right to obtain any informa-

FIG 1 Individual product groups and results obtained in 1998

Product group	Number of testet units	Number of outliers	Quota
Household appliances	2004	223	11%
Electric tools	1233	306	25%
Lighting fittings	464	167	36%
IT equipment/office machines	502	120	24%
Consumer electronics	805	347	43%
Telecommunications equipment	473	64	14%
Radio equipment	366	116	32%
Industrial equipment	81	10	12%
Medical equipment	20	5	25%
Scientific equipment	48	0	0%
Installation material	115	15	13%
Miscellaneous	10	0	0%
Total	**6121**	**1373**	**22%**

tion or other support required to perform its tasks. Technical documentation has to be permanently accessible for the purpose of testing and control. The obligation to provide such documentation is also defined in detail in EMVG.

To avoid manufacturers having to submit technical documentation several times to different authorities, Reg TP makes use of a central electronic data acquisition system to register the tested and especially noted equipment.

If it is found during testing that equipment does not comply with the CE conformity mark regulations to § 5 EMVG, Reg TP must take all necessary actions to prevent or limit the placement on the market or the operation of the equipment. If EMC testing reveals that equipment with a CE conformity mark does not meet EMC protection requirements, Reg TP issues an official directive to remedy the deficiency and so to prevent any further infringement.

Result of 1998 testing is sobering

Up to 65000 different types of equipment with a total of 250 million units and components with electrical/electronic components are launched every year in Germany. This quantity corresponds to a market share of approx. 30% of the European Economic Area.

In1998 (by 3 December) Reg TP checked 45000 items of equipment. Deficiencies with regard to CE conformity mark or conformity declaration were found in 6.5% of the cases. Moreover, 1261 series comprising 6121 units were tested, of which 22.5% did not comply with standards (FIG 1).

In 1998, 188 cases were prosecuted and fines to the tune of DM 166000 had to be imposed. Proceedings against many of these cases are still open.

FIG 2 reflects the results obtained for 36% of all equipment tested (3237 units: household appliances and handheld electrical tools). 20% of the DUTs that did not even pass the initial standard test had to be returned to their distributors. During orientation testing that follows the standard test approx. 64% of the equipment passed. 16% of the equipment is then subjected to a full standard test. The failure rate of equipment subject to the full standard test increased from previously 50% to 70%. The overall failure rate for mass products is typically a good 23%.

Conclusion

The extraordinarily high nonconformity rate reveals that many manufacturers of electrical and electronic products do not pay enough attention to EMC. It is strongly recommended that manufacturers invest more in EMC testing. Such investments are the more economical alternative in the long run. In many EU member states there is a stronger need for action in this respect than in Germany.

Wolf-Ekkehardt Schreyer

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Reader service card 163/14 for further information on comprehensive line of EMC test equipment from Rohde&Schwarz

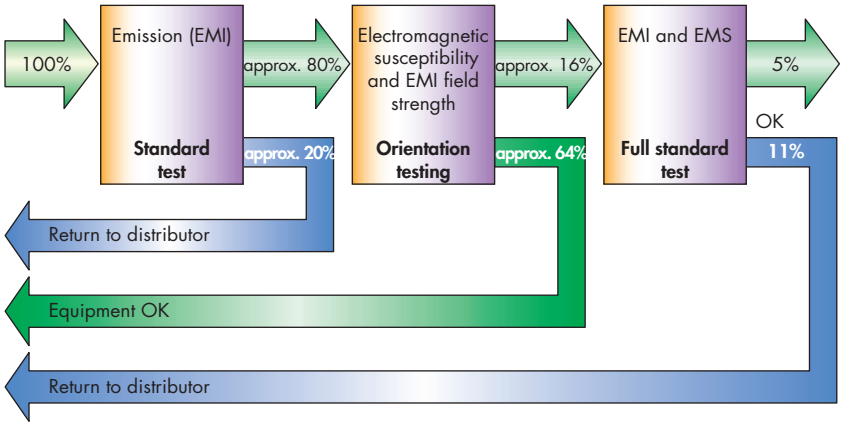


FIG 2 Procedure of equipment testing conducted by Reg TP (example for electric household appliances and handheld tools)

Trunked Radio System *ACCESSNET*® proves a blessing at Pope's visit

Early in October 1998 Pope John Paul II visited Croatia for the second time during his pontificate. The focus of this visit was the beatification of Cardinal Alojzije Stepinac, which was to take place at the pilgrimage town of Marija Bistrica. Rohde & Schwarz's *ACCESSNET*® system took care of the wide-ranging communication needs at this major event.

Photo: Robert Kunštek

Pope John Paul II during his visit to Croatia in October 1998

Marija Bistrica is situated 25 km north east of the country's capital Zagreb and is the most important Croatian pilgrimage center. Cardinal Stepinac himself – whose beatification was at the focus of the Pope's visit – often led pilgrims to the village, where a famous statue of the Virgin Mary with the Infant Jesus is kept.

The Pope's visit was an event of great national importance, more than 350 000 people were expected in the small community. Consequently it was an enormous challenge in terms of logistics for both national and local authorities, ie infrastructure, medical facilities, transport to and from the town, security, information and installations for the local and international press, to name just a few of the needs. And all these activities had to be well coordinated of course, a task undertaken by the organization committee of the Krapina district. Communication, coordination and fast response being of such overriding importance, the committee needed efficient and reliable radiocommunication, and this is where the Trunked Radio System *ACCESSNET*® from Rohde & Schwarz played its role perfectly.

What makes *ACCESSNET*®-mini so attractive

ACCESSNET®-mini was specially developed for setting up single-cell networks. The system is suitable for stationary applications like communication within companies as well as for mobile use, eg organization of open-air concerts or sporting events. *ACCESSNET*®-mini combines high performance with low cost, making it an attractive option. The complete system can be set up without tedious installation and adjustment procedures. The only extras required are an antenna system and a PC with printer.

The Croatian RADIOPLUS is the only trunked radio enterprise with a state concession for the north-western regions of the country including the capital Zagreb and Marija Bistrica. RADIOPLUS operates a trunked radio network from Rohde & Schwarz, covering a large part of this area. So the company was able to offer its services for the Pope's visit in the Zagreb area using its existing *ACCESSNET*® system.

However, the situation at Marija Bistrica was a little more complicated, requiring extra capacity (for the coordination of large user numbers) and high coverage efficiency (Marija Bistrica is located in a valley surrounded by hills). The solution was provided by *ACCESSNET*®-mini, a particularly fast and flexible trunked radio system from Rohde & Schwarz satisfying all the needs of the organization committee.

It took RADIOPLUS, Rohde & Schwarz Austria and R & S BICK Mobilfunk a great deal of coordination and effort, but the *ACCESSNET*®-mini system was delivered to Marija Bistrica and set up within a very short time. The system performed excellently during the preparations as well as during the visit itself, presenting all the advantages of *ACCESSNET*® trunked radio. Feedback from the users showed that they were fully satisfied. The Croatian and the international public also benefited from the capabilities of the system, as the press center was equipped with trunked radio too. This application under very demanding conditions demonstrated once more that the Trunked Radio System *ACCESSNET*® from Rohde & Schwarz is a singular combination of fast response, great flexibility and reliability.

Davor Jarnjak

Reader service card 163/15

Conversion of C/N or SNR to E_b/N_0 in DVB

Often BER diagrams do not have C/N as abscissa (FIG) but E_b/N_0, which is the energy per information bit E_b referred to the normalized noise power N_0 [1]. C/N describes the ratios in the transmission channel, SNR the signals after the $\sqrt{\cos}$ receive filter. The following applies:

$$C/N = SNR + k_{roll\ off}\ [dB]$$

In converting the two quantities, some factors have to be taken into account as shown by equations 1 and 2 on the right.

To determine C/N [dB] or E_b/N_0 [dB], the logarithmic ratios have to be corrected using the following factors:

- Factor for Reed-Solomon FEC*

$$k_{FEC} = 10 \times \lg \frac{188}{204}$$

$$k_{FEC} = -0.3547\ [dB]$$

- Factors for QPSK/QAM modulation

$$k_{QPSK/QAM} = 10 \times \lg(m)$$

Modulation	m	$k_{QPSK/QAM}$ [dB]
QPSK	2	3.0103
16QAM	4	6.0206
64QAM	6	7.7815
256QAM	8	9.0309

- Factor for coding rate (P = 1 for QAM)*

$$k_P = 10 \times \lg(P)$$

Modulation	P	k_P [dB]
QPSK	1/2	–3.0103
	2/3	–1.7609
	3/4	–1.2494
	5/6	–0.7918
	7/8	–0.5799
QAM	1	0

- Factor for $\sqrt{\cos}$ roll-off filtering in demodulator/receiver

$$k_{roll\ off} = 10 \times \lg\left(1 - \frac{\alpha}{4}\right)$$

Modulation	α	$k_{roll\ off}$ [dB]
DVB-C	0.15	–0.1660
DVB-S	0.35	–0.3977

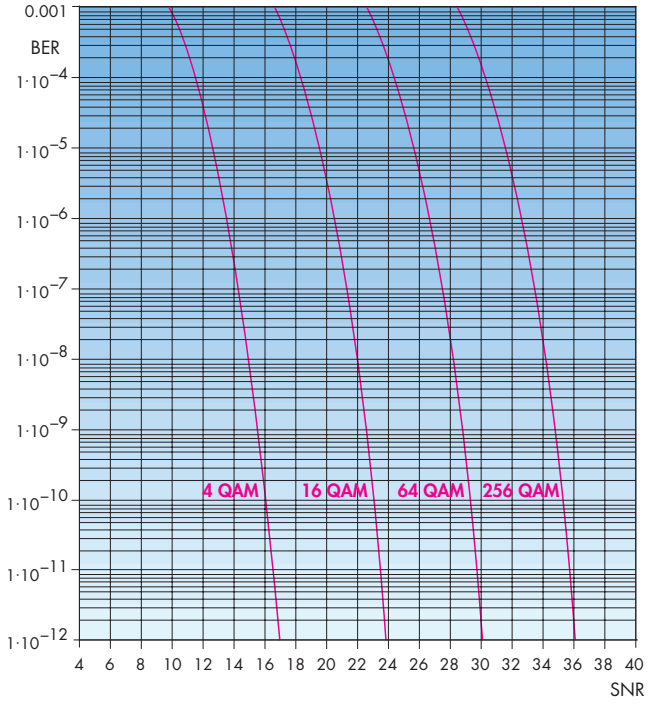
* To be taken into account if E_b only refers to the information bits; not to be taken into account if E_b refers to all bits transmitted (information plus error control bits)

$$C/N = E_b/N_0 + 10 \times \lg \frac{188}{204} + 10 \times \lg(m) + 10 \times \lg(P) - 10 \times \lg\left(1 - \frac{\alpha}{4}\right)[dB]$$

Equation 1

$$E_b/N_0 = C/N - 10 \times \lg \frac{188}{204} - 10 \times \lg(m) - 10 \times \lg(P) + 10 \times \lg\left(1 - \frac{\alpha}{4}\right)[dB]$$

Equation 2



BER referred to SNR for 4, 16, 64 and 256QAM

The types of correction factor required depend on whether measurement is made

- in the transmission channel,
- before or after Viterbi correction,
- with QAM or QPSK modulation.

Examples of conversion equations

For **in-channel** measurements with QAM transmission, the following applies:

$$E_b/N_0 = C/N - 10 \times \lg \frac{188}{204} - 10 \times \lg(m)\ [dB]$$

The factors for $\sqrt{\cos}$ roll-off filtering and puncturing rate are not needed.

For measurements in the **QAM demodulator**, $\sqrt{\cos}$ roll-off filtering filtering has to be taken into account.

$$E_b/N_0 = C/N - 10 \times \lg \frac{188}{204} - 10 \times \lg(m) + 10 \times \lg\left(1 - \frac{\alpha}{4}\right)\ [dB]$$

For measurements in the **satellite demodulator** with QPSK, the equation for determining the BER as a function of E_b/N_0 after Viterbi FEC is as follows:

$$E_b/N_0 = C/N - 10 \times \lg \frac{188}{204} - 10 \times \lg(m) - 10 \times \lg(P) + 10 \times \lg\left(1 - \frac{\alpha}{4}\right)\ [dB]$$

In the latter case all correction factors are included.

Sigmar Grunwald

REFERENCE
[1] ETR 290 Digital Video Broadcasting (DVB); Measurement Guidelines for DVB Systems

EMI Test Receivers ESI These three models (20 Hz to 7/26.5/40 GHz) are as versatile and fast as spectrum analyzers and meet the stringent dynamic requirements for EMI measurements in compliance with all industrial and military standards; options such as vector signal analysis and tracking generator of the FSE family as well as software of the ES-K.. series may be connected.

Data sheet PD 757.4576.21 enter 163/16

Microwave Signal Generator SMR (1 GHz to 20/27/40 GHz; option for down to 10 MHz) Pulse modulation, which comes as standard, can be optionally supplemented by AM, FM, and AF generator, analog ramp sweep, digital IF input (DC up to 700 MHz) and a pulse generator with single/double pulses up to 10 MHz, pulse widths between 20 ns and 1 s as well as triggering and gate mode; frequency resolution 1 kHz (0.1 Hz optional), output level depending on model: >+10/11/9 dBm.

Data sheet PD 757.4418.21 enter 163/17

Digital Video Quality Analyzer DVQ measures digital video quality in realtime without a reference signal and assesses it on a SSCQE scale; monitoring of picture and audio loss; Quality Explorer™ software option for complete data analysis.

Data sheet PD 757.4601.21 enter 163/18

Modulation Generator AMIQ/Simulation Software WinIQSIM The option differential I/Q outputs and updated AMIQ data as well as new information on W-CDMA applications, BER measurements and improved specifications for WinIQSIM made a new data sheet necessary.

Data sheet PD 757.3970.22 enter 163/19

Vector Signal Generator SMIQ and **Specifications** (0.3 GHz to 6.4 GHz) This data sheet was extensively revised and supplemented by the options for W-CDMA applications and rear-panel connectors. The new data sheet for SMIQ covers SMIQ-B17 as well, the range of devices comprises SMIQ 02 B, 03 B, 04 B and 06 B; the wide range of data made a separate data sheet for the specifications necessary.

Info PD 757.2438.23 +
Data sheet PD 757.4582.21 enter 163/20

VHF FM Solid-State Transmitter SR600 (87.5 MHz to 108 MHz) with output powers of 2.5 kW (SR 602 E1), 5 kW (SR 605 E1) and 10 kW (SR 610 E1) cover large areas, are extremely reliable and feature an optimized price/performance ratio; transmission of all standard signals, all customary standby systems possible, integrated pressure cooling; ease of servicing thanks to modular 19" design with reduced need for spare parts.

Data sheet PD 757.4453.21 enter 163/21

D-Channel Filter ISDNwall The revised data sheet also contains illustrations of dialogs and detailed ordering and delivery information.

Data sheet PD 757.3770.22 enter 163/22

Analysis and Simulation Software NetHawk™ is supplied with plug-ins for PCs for both stationary and mobile use at the interfaces of modern transmission techniques like GSM, ISDN, GPRS, W-CDMA and DECT; user-generated programs run on NetHawk™ servers.

Info PD 757.4830.21 enter 163/23

New application notes

Frequently Asked Questions about Vector Network Analyzer ZVR
Appl. 1EZ38_3E enter 163/26

Measurements on Frequency-Converting DUTs Using Vector Network Analyzer ZVR
Appl. 1EZ31_1E enter 163/27

ASCII Conversion of Binary Data from Test Receiver for Generation of Test Report on PC
Appl. 1EE21_6E enter 163/28

Controlling External Generators and Power Meters with Network Analyzer ZVR
Appl. 1EZ46_0E enter163/29

Virtual Embedding Networks for Vector Network Analyzer ZVR
Appl. 1EZ45_1E enter163/30

Frequency Range Extension of Spectrum Analyzers with Harmonic Mixers
Appl. 1EF43_0E enter 163/31

BER Measurements on IS-136 Signals under Fading Conditions
Appl. 1MA20_0E enter 163/32

Mobile Tests for GSM 900/1800/1900 under Fading Conditions
Appl. 1MA19_0E enter 163/33

AMIQ-K2 Application Software for the Transmission of I/Q Data of Different Formats to I/Q Modulation Generator AMIQ
Appl. 1MA10_1E enter 163/34

Pulsed Measurements on GSM Amplifier SMD ICs with Vector Network Analyzer ZVR
Appl. 1EZ42_1E enter 163/35

Group and Phase Delay Measurements with Vector Network Analyzer ZVR
Appl. 1EZ35_1E enter 163/36

AutoCal: Automatic Calibration of Vector Network Analyzer ZVR
Appl. 1EZ30_2E enter 163/37

Measurement Uncertainties for Vector Network Analysis
Appl. 1EZ29_1E enter 163/38

3-Port Measurements with Vector Network Analyzer ZVR
Appl. 1EZ26_1E enter 163/39

4-Port Measurements with Vector Network Analyzer ZVR
Appl. 1EZ25_1E enter 163/40

Demonstration of BER Test with AMIQ Controlled by WinIQSIM
Appl. 1MA16_0E enter 163/41

Creating Alternating GSM/EDGE Signals with AMIQ and WinIQSIM
Appl. 1GP37_0E enter 163/42

Using the Frequency Conversion Mode of ZVR Vector Network Analyzer
Appl. 1EZ47_0E enter 163/43

GPIB-Bus Device Finder
Appl. 1MA17_1E enter 163/44

Measuring Frequency Settling Time for Synthesizers and Transmitters
Appl. 1MA15_0E enter 163/45

BER Measurement with 50 kHz Frequency Offset and Blocking 2 Measurement
Appl. 1CM29_2E enter 163/46

Schz

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"Pro Audio Review" decorated its title page with Audio Analyzer UPL and followed up with a four-page pictorial of the instrument:

Rohde & Schwarz Audio Analyzer UPL is an extremely well featured and well thought-out instrument for measuring analog and digital audio signals as well as combinations of analog and digital audio equipment. It is a good example of the world-class test equipment that Rohde & Schwarz is able to come up with.

Mobile radio test engineering from Rohde & Schwarz was a focus in the January issue of "hf-praxis". The cover spread set the pace with a photo of Digital Radio Tester CTS 65. Inside – in addition to an information file on W-CDMA from Rohde & Schwarz – the reader was presented with the entire spectrum of mobile radio T & M products:

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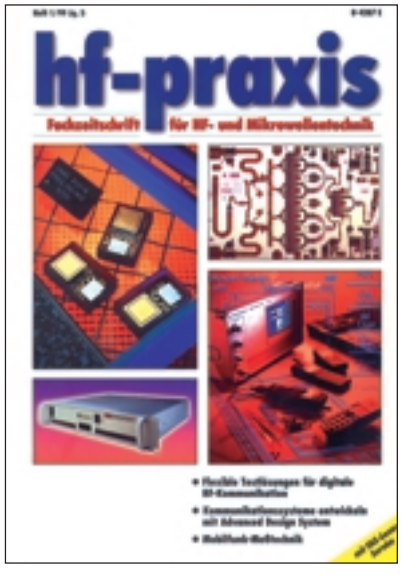
From CTS 65 (...in addition to DECT measurements CTS 65 offers every possibility for testing GSM mobile phones in the 900, 1800 and 1900 MHz bands...) through the new FSIQ (...the FSIQ series of signal analyzers allows fully integrated spectrum, modulation and time analysis for W-CDMA applications and all current standards for wireless communication like



GSM, IS-136 and IS-95 CDMA...) to SPIQ (...in SPIQ designers and producers get a complete, ready to work solution for especially attractive price/performance, in particular for multicarrier applications...).

Playing your cards right

Following the annual press conference of the central association of the electrical and electronic industry, focusing on the success and innovative power of businesses in Bavaria, broadcaster BR reported on Rohde & Schwarz in its evening program of 16 February:

If you play your cards right, you need have no worries. Take Rohde & Schwarz for example. Starting in the 1930s this company has become Europe's biggest producer of electronic T&M equipment. It is also a world leader in radio and television transmitting systems, and especially in mobile radio T&M products. Hans Wagner, COO at Rohde & Schwarz, remarked in the interview: this is a booming market, since digital technology – which found its way into mass communication – made it possible to implement this technology in products for the mass market.

75 years of broadcasting in Bavaria

To mark the 75th anniversary of sound broadcasting in Bavaria, broadcaster Bayerischer Rundfunk staged a special exhibition.

Besides historical transmitters and receivers, all kinds of technical equipment from the history of broadcasting and numerous curiosities and finds from the history of Bayerischer Rundfunk are on show. Recordings of legendary programs and their moderators can also be heard. The exhibition presents a look behind the scenes in radio and television broadcasting. This is a scenario where Rohde & Schwarz has always played a big role of course. In addition to Germany's first FM transmitter, the first FM receiver from Rohde & Schwarz is on show, as well as the world's first portable crystal clock, which served for a long time to produce the time signals transmitted by Bayerischer Rundfunk. The exhibition is open to visitors daily from 9:00 to 18:00 until 4 July 1999.

Broadband into a new millennium

This was the title of a report in issue 1 – 2/99 of the German magazine "F & M" on the subject of W-CDMA, the third generation of mobile radio and the test solutions offered by Rohde & Schwarz:

It is already clear that the GSM follow-on standard W-CDMA will be the benchmark for test equipment. Especially critical is measurement of adjacent-channel power, providing information about phase noise and intermodulation. Modern signal analyzers like FSIQ exhibit capacity and dynamic range matching the standards for mobile and base stations.

Interesting partner

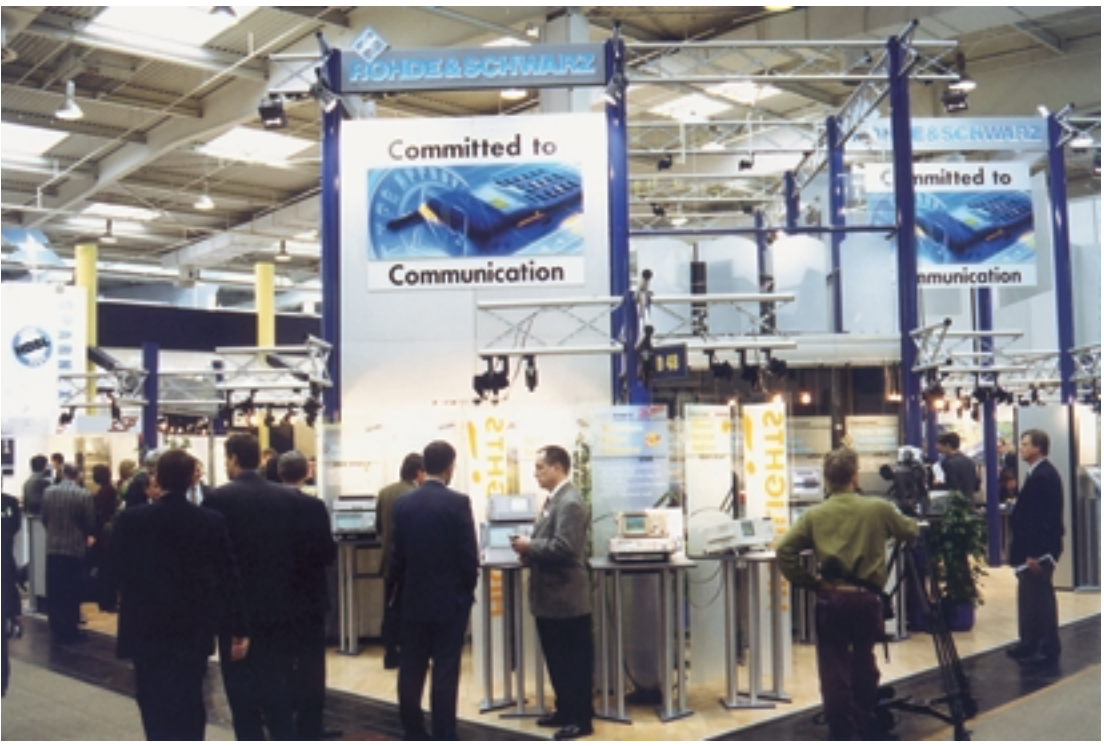
"World Broadcast News" reported in its February edition on a DVB-T pilot project in Germany in which Rohde & Schwarz is playing a major role:

Digital video broadcasting through terrestrial transmitter networks (DVB-T) is a simple and versatile alternative to TV reception by cable or satellite. ...Field trials are being conducted with DVB-T transmitters and modulators from Rohde & Schwarz. As the world's only supplier of a complete assortment of products for DVB-T transmission and testing from a single source, Rohde & Schwarz is an interesting partner for field trials of DVB-T.

Solid basis

In its latest issue the EMV journal "EMV-ESD" presented Test Receivers ESI. Under the title "EMC measurements on a solid basis" it wrote:

Today's demands of EMC test equipment are extremely complex. In addition to fast measuring speed and large dynamic range, equipment has to be especially versatile. These are requirements satisfied by the new ESI family of EMI test receivers.



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Rohde & Schwarz at CeBIT 99

In March the CeBIT was the event of overall importance: the big one among the trade shows – held at Hanover from 18 to 24 March – once again attracted record numbers of both exhibitors and visitors.

Rohde & Schwarz presented its innovations in communications and T&M technology under the motto "Committed to Communication". At the center of attention was the new Microwave Signal Generator SMR, which saw its world debut at the exhibition. This new product generation offers three different functions in one. The three SMR models operate as pulse-modulated continuous-wave generators, amplitude-modulation and frequency-modulation signal generators, and as synthesized sweepers with fast analog ramp sweep.

The EMI test receivers of the ESI family were also presented at CeBIT. They are based on the tried and tested FSE family of spectrum analyzers, which guarantees maximum performance and safety of investment. TV Test Transmitter SFQ for DVB-T was presented for the first time. In accordance with DVB-T standard ETS 300744 it operates at bandwidths of 6 MHz, 7 MHz and 8 MHz, and with hierarchic coding in the 2 K and 8 K COFDM modes.

The Rohde & Schwarz stand was also visited by the Bavarian minister of trade and commerce, Otto Wiesheu, who showed special interest in the future-oriented products for DVB-T and DAB technologies as well as the third generation of mobile radio. When discussing the introduction of DAB in Bavaria with Hans Wagner and the Bavarian TV broadcaster Bayerisches Fernsehen, the minister said: "I intend to speak with the regulatory authority so that the licence will be granted as soon as possible. …At any rate the matter will be raised".

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Measuring equipment for engineering and architecture college in Bern

The Rohde & Schwarz subsidiary in Switzerland, Roschi Telecommunication AG, has equipped the faculty of electrical engineering and electronics at the engineering and architecture college in Bern with high-grade measuring instruments. The equipment includes a Spectrum Analyzer FSEA30, an EMC test receiver as well as a bit-error-rate test set. They are to enhance research and development with the focus on industrial networks and wireless communications systems.

Fritz Dellsperger, head of the faculty, expressed his thanks for this generous support: "These instruments are a great asset for both teaching and research at our faculty."

UHF TV transmitters for Turkish broadcaster

The Turkish network operator EKO-TV recently awarded Rohde & Schwarz an order for analog TV transmitters worth around 5 million DM. By the end of July this year, Rohde & Schwarz will supply and commission 52 UHF transmitters of the SH and NH series from 100 W to 10 kW. The transmitters are intended to complete nationwide TV coverage.

EKOTV opted for Rohde & Schwarz TV transmitters because of their excellent price/performance ratio, their low power consumption and the fact that they require practically no maintenance. The transmitters have broadband solid-state output stages and are therefore very versatile as the channel can be changed any time. A dual-exciter configuration ensures redundancy.

Stefan Böttinger

Global players under the sea: market leader for fault location in submarine cables

The essential links that ensure modern worldwide communication can be found at the bottom of the seven seas. Submarine cables allow transmission of enormous and ever increasing amounts of data. Rohde & Schwarz offers T & M equipment dedicated to quickly and accurately locating faults in these cables. Together with its partners, Rohde & Schwarz has become a worldwide leader in this market segment.

It is a good 500 years since we started to discover that other continents existed. Communication with these continents has seen many a change, characterized by increasing speed. In the beginning ships with emigrants carried messages several times a year between the old world and the new world. Later, once regular shipping services had been created, they took over this task. Postal delivery by air was started at the beginning of this century. Compared to a phone call or telegram this was quite slow however, it could not offer realtime service. An entirely new age of information transmission really began in 1858 when the first submarine telegraph cable connected London with Chicago. This masterstroke in communication engineering enabled the transmission of up to 245 characters per minute, which today corresponds to about 33 bits per second. More cables – also for telephony purposes – were laid on the seabed, and the next milestone was of course the installation of telecommunication satellites, enabling for the first time realtime transmission of moving pictures.

Even if it might sound like a step backwards, most people in industrial nations today still use submarine cables, generally without knowing it. They do so when surfing on the Internet, for example, since the transmission capacity of submarine cables has grown by whole multiples compared to that of satellites. This was made possible by the **introduction of fiber-optic technology**. The first fiber-optic cable was laid in 1988, producing an enormous increase in bandwidth and economy. Intermediate repeaters in submarine cables are only required about every 100 km. Over distances of up to 300 km, submarine cables even get by without any repeaters and power feed. The signal still had to be reconverted into electrical signals in repeaters for regeneration at the very beginning, but meanwhile only optical repeaters have been used for new cables since 1996, and they allow simultaneous boosting of several wavelengths in a wavelength multiplexing system with little effort. Today data rates of 20 Gbit/s are handled commercially and worldwide submarine cable networks with capacity in the terabit range (1 Tbit = 1000 Gbits) will have been installed in only a few years.

Submarine cables beat satellites and not only in terms of data rate. While the useful life of satellites is rated for 10 to maximally 15 years – with the permanent risk of total loss – the lifetime of submarine cables can be twice as high. This is a result of modern error location methods and possibilities of repairing them. Although submarine cables are laid up to one meter deep under the seabed, they can still be damaged or destroyed by the anchors of large ships in the vicinity of harbors. Cables in the North Sea, which is rather flat, are repeatedly damaged by fishing nets.

Quick and accurate fault location is thus a key factor for reliability and economy. Once a fault has occurred, a trial and error process is still adopted in many cases. The defective repeater section is normally located quite quickly, but the cable then has to be lifted out at its center, cut in half and

checked in both directions. Lifting the cable out may be very time-consuming and thus one or two working days are easily lost.

Direct and accurate fault location has been possible since a few years ago thanks to **coherent optical time domain reflectometers (COTDRs),** which can even measure through intermediate repeaters. This technology is based on patents of the Japanese longhaul cable provider KDD (Kokusai Denshin Denwa Co. Ltd) and was further developed by ADVANTEST, a Rohde & Schwarz partner in the T&M sector for many years. Thanks to its cooperation with ADVANTEST, Rohde & Schwarz has become a worldwide market leader in this new T&M technology for development, production and fault location. Systems were supplied for several submarine cable projects in Europe and South America, contributing to safeguarding trouble-free operation in intercontinental data transmission.

The next time you read or hear about a new submarine cable link being put into operation, you may very likely remember this article. For this new cable too, Rohde & Schwarz will probably have contributed to ensuring trouble-free operation. So when you are strolling through cyberspace, gliding along new data highways or surfing around the world on the Internet, remember that you can count on Rohde & Schwarz.

Peter Wollmann

Sources for further information about submarine cables:

- http://ftl.savvy.com/misc/subcable1925.htm
- http://www.teleport.com/~iscw/iscw/rmenu/atlan.htm
- http://www.oxygen.org/
- http://smw3.fcr.fr
- http://www.submarinesystems.com/tssl/NewsWire/columbus.htm
- http://nicewww.cern.ch/~davidw/public/ICFASubCables/Outlinee.htm

Some modern submarine cables

Name	Line	Commissioning	Data rate
TAT-12/13	Green Hill, Rhode Island, USA — Lands End, England — Penmarch, France — Shirley, New York, USA: 6321 km	August 1996	2 x 5 GBit/s
FLAG	Fiber Optic Link Around The Globe	1988	2 x 5 GBit/s
Gemini	Manasquan, NJ, USA — Green Hill, RI, USA — Oxwich Bay, UK — Portcurno, UK: 12 600 km	February 1998 Mid-1999	2 x 10 GBit/s SDH Ring 2 x 15 GBit/s SDH Ring
SEA-ME-WE-3	South-East Asia — Middle East — Western Europe: 39 000 km	1999	4 x 2.5 GBit/s, can be upgraded to 8 x 2.5 GBit/s
TAT-14	Manasquan, NJ, USA — Tuckerton, NJ, USA — Widemouth, UK — St Valery en Caux, F— Katwijk, NL— Norden, D — Blaabjerg, DK: 15 428 km	2000	16 x 10 GBit/s SDH
Oxygen	Worldwide networking with 99 points in 78 countries: 168 000 km in the first phase	2000 – 2003	1280 GBit/s (at least)
By comparison:			
TAT-1	Oban, Scotland — Clarenville, Newfoundland, Canada — Terrenceville, Newfoundland, Canada — Sydney Mines, Nova Scotia, Canada: 7802 km	1956 – 1978	144 + 144 kHz analog

Visit us on Internet at www.rsd.de

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News from Rohde&Schwarz 163 (1999/III) · PD 757.4860.21 · B42622