News from Rohde & Schwarz

Up to 40 GHz:
"Mini" microwave signal generators

For EMC measurements to standards:
40 GHz EMI test receivers

Improving availability in networks: Measurement and monitoring systems for DAB-T and DVB-T

1999/II
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Compact, lightweight and enormously powerful – that is probably the best characterization of the new SMR generator family. Rohde & Schwarz engineers succeeded in packing generators with excellent signal characteristics into 19-inch rackmounts that are only 88 mm high and 450 mm deep. All three SMR models can be upgraded from a pulse-modulated CW generator to an AM/FM signal generator or synthesized sweeper with analog frequency sweep (see page 4).

Photo 43 309

Articles

Application notes

Panorama

Regular features

Illustration: RC & C

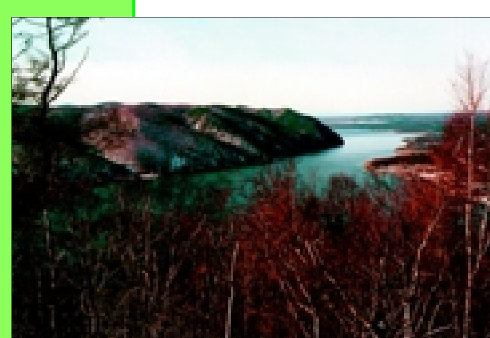

Photo: author

A countrywide trunked radio system from Rohde & Schwarz is going to be installed at the deepest lake of the earth – Lake Baikal in South Siberia (1620 m deep, 636 km long, up to 80 km wide).
See page 30

Imprint

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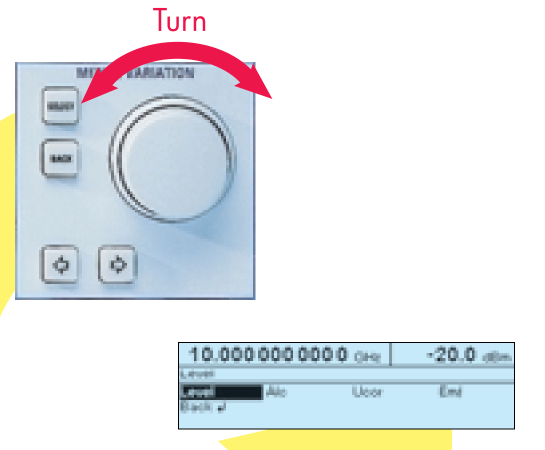
Microwave Signal Generators SMR

Microwave in handy size

Compact, lightweight and enormously powerful – that is probably the best characterization of the new SMR generator family. Rohde & Schwarz engineers succeeded in packing generators with excellent signal characteristics into 19-inch rackmounts that are only 88 mm high and 450 mm deep. Weighing less than 12 kg they are ideal for field applications. And what is more: all three SMR models can be upgraded from a pulse-modulated CW generator to an AM/FM signal generator or synthesized sweeper with analog frequency sweep. These features and the extremely attractive price make the generators highly appreciated signal sources in research, development and production as well as for EMC measurements.



The sophisticated operating concept of SMR. For example just turn the wheel to select the desired menu item (here: Level). Push the wheel and you are in the submenu.

Photo 43 264/1

FIG 1 Signal Generator SMR, the cost-effective, reliable microwave signal source versatile through options

The SMR family comprises three basic models designed as CW generators with pulse-modulation capability. All three have a lower frequency limit of 1 GHz and, depending on the model, provide coverage up to **20 GHz (SMR 20), 27 GHz (SMR 27)** or **40 GHz (SMR 40)**. The lower range limit can be extended down to 10 MHz by means of an option.

SMR as CW generator

SMR stands out for its **excellent spectral purity**. Advanced frequency synthesis with fractional-N divider makes for **low SSB phase noise** (FIG 2) and high spurious suppression, both essential for reliable receiver measurements. Modern microwave filters in the output path of the instrument ensure **excellent harmonics suppression**, necessary for precise results in scalar network analysis (see condensed data on page 6).

SMR has standard **frequency resolution of 1 kHz**, which offers a sufficient margin for most applications, eg frequency response measurements on filters and amplifiers. To satisfy more stringent requirements, eg radar cross-section measurements, frequency resolution can be improved to 0.1 Hz by means of an option.

All microwave test setups suffer from high losses. Expensive microwave amplifiers are usually the only remedy. This is not so with SMR: due to the **high output power of all SMR**

models these costly components are not needed (FIG 3).

Microwave signal generators are frequently used for level calibration of test receivers. This task calls for a highly accurate and stable output level that can be set with high resolution. In SMR this is ensured by a **highprecision, frequency-response-compensated level control** for levels above –20 dBm. The RF attenuator option extends the setting range to –130 dBm.

Pulse modulation is still the most important modulation mode for microwave applications. So each basic model is equipped with a **high-quality pulse modulator** with an on/off ratio better than 80 dB. The rise and fall times are shorter than 10 ns, pulse widths of less than 20 ns are possible. These guaranteed values make SMR ideal for use in development, production and maintenance of radar equipment.

The **pulse generator option** is an ideal complement to the pulse modulator. It generates single and double pulses with pulse frequencies of up to 10 MHz. The pulse generator can be operated automatically, triggered externally or operated in the gate mode. A pulse width between 20 ns and 1 s and a delay between 40 ns and 1 s can be set.

Sweep functions are also provided in the SMR basic model: the digital frequency sweep with step times from 1 ms to 1 s permits convenient frequency response measurements on microwave circuits. The 20 dB level sweep allows amplifier or mixer compression to be determined for example.

SMR as signal generator

With the **optional AM/FM/scan modulator** added, SMR becomes a signal generator with linear or logarithmic AM and FM capability (main application of log AM: simulation of radar antenna rotation). The bandwidth of the amplitude modulator ranges from DC to 100 kHz, the FM bandwidth from DC to 5 MHz with excellent carrier frequency stability.

The option also includes a **high-quality LF generator** based on direct digital synthesis that covers the range from 1 Hz to 10 MHz. All frequencies can be set with 0.1 Hz resolution, and sinewave as well as squarewave signals can be generated. With the aid of this option, the different SMR models provide coverage of the entire **frequency range from 1 Hz to 40 GHz**.

SMR as synthesized sweeper

After installation of the **analog ramp sweep option**, SMR offers a function that basically corresponds to the analog sweep of conventional sweep generators. There is only one essential difference: the frequency sweep is fully synchronized over the complete span. Thus the excellent frequency accuracy of digital step sweeps is almost achieved, and this with much higher **sweep speeds of up to 600 MHz/ms**. In conjunction with scalar network analyzers or suitable spectrum analyzers, realtime adjustment of microwave filters can be performed. As with the digital step sweep, the start and stop frequencies can be set as required in the whole RF range of SMR. The sweep time can be varied between 10 ms and 100 s.

To mark important frequency bands such as filter bandwidths or the position of attenuator poles, SMR has **ten user-selectable frequency markers** that can be output as pulse markers at the marker output (HCT/TTL level) or

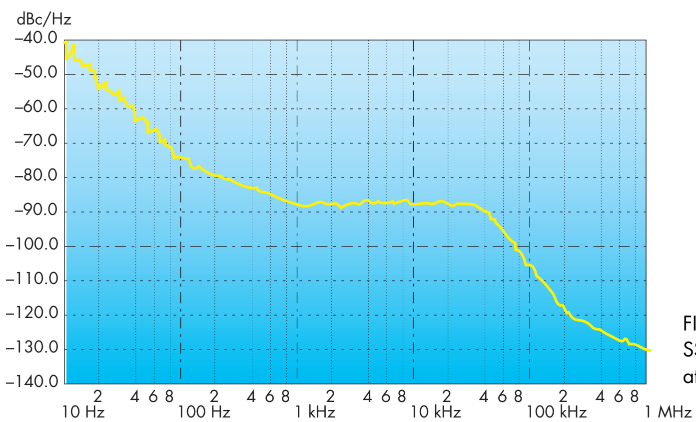


FIG 2
SSB phase noise at 10 GHz

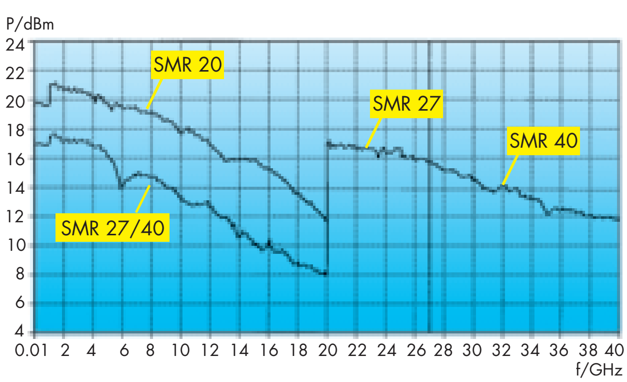


FIG 3
Typical maximum output power (without RF attenuator option)

modulated on the RF level in the form of level markers. SMR can thus simply be used in conjunction with many standard scalar network analyzers (FIG 4).

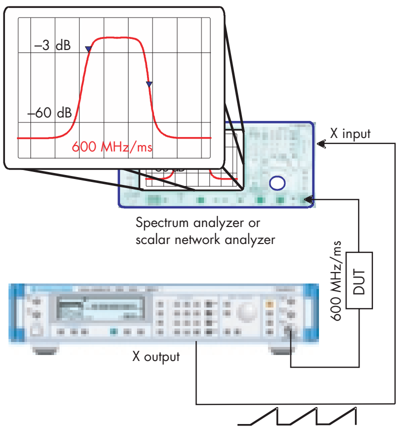


FIG 4 Network analysis with SMR as synthesized sweeper

SMR as upconverter

To generate digitally modulated signals up to 40 GHz, SMR offers **up-conversion capability by means of the IF input option**. A typical application is shown in FIG 5: vector signal generators such as SMIQ [1] from Rohde & Schwarz generate all kinds of digitally modulated signals up to RF frequencies of 3.3 GHz. I/Q Modulation Generator AMIQ [2] supplies the I and Q signals (1) for modulating SMIQ. The modulated RF signal of SMIQ (2) is directly applied to the IF input of SMR. The converted, digitally modulated signal of SMIQ is available at the RF output of SMR (3).

SMR – reliable and cost-effective

The reliability of microwave generators largely depends on the quality of the RF components. SMR does not make compromises on this point. All microwave stages are integrated in five modules, all designed in **aero-space-tried, patented thinfilm technology**. The stages are optimized for minimum power consumption, maximum reliability and long lifetime.

In the event of a fault, the **built-in diagnostics system** will simplify troubleshooting and shorten repair times. SMR excels not only through its extremely favourable price but also through low follow-up costs, particularly because it only needs **calibration every three years at the most**.

Wilhelm Kraemer

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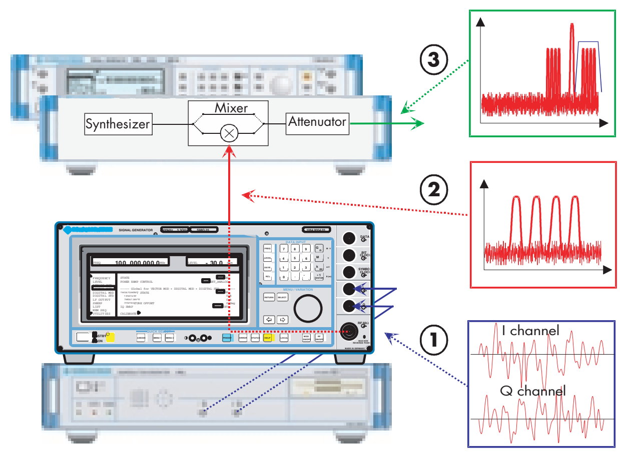


FIG 5 SMR as upconverter for digitally modulated signals

Condensed data of Microwave Signal Generators SMR

Frequency range SMR20/27/40	10 MHz to 20/27/40 GHz
Resolution	1 kHz (0.1 Hz with option SMR-B3)
Harmonics ≤20 GHz/>20 GHz	<–55 dBc/<–40 dBc
Subharmonics ≤20 GHz/>20 GHz	<–65 dBc/<–30 dBc
Spurious	
≤10 GHz/>10 to 20 GHz/>20 GHz	<–62 dBc/<–56 dBc/<–50 dBc
SSB phase noise	<–83 dBc (at 10 GHz, 10 kHz from carrier)
Level SMR 20 (at 20 GHz)	>+10 dBm (without option SMR-B15/17)
SMR 27 (at 27 GHz)	>+11 dBm
SMR 40 (at 40 GHz)	>+9 dBm
AM/FM (with option SMR-B5)	DC to 100 kHz/DC to 5 MHz
Pulse modulation on/off ratio	>80 dB
rise/fall time	<10 ns
LF generator (option)	
sinewave, squarewave	0.1 Hz to 10 MHz
Pulse generator (option) pulse period	100 ns to 85 s
IF input (option)	DC to 700 MHz
RF sweep	
Digital step sweep	1 ms/step to 1 s/step
Analog ramp sweep (option)	max. 600 MHz/ms

Reader service card 162/01

EMI Test Receivers ESI

EMI professionals through to 40 GHz

The new ESI family combines the flexibility and speed of spectrum analyzers with the large dynamic range expected of EMI test receivers. They meet all requirements to the full, making them the ideal choice for EMI measurements to standards as well as for general-purpose measurements in the development lab. ESI 40, which is the successor of the ESAI, ESBI and ESMI family of test receivers, opens up the frequency range to 40 GHz in its basic configuration already.

Photo 43 176/4

FIG 1 EMI Test Receiver ESI 40

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

- ESI 7 20 Hz to 7 GHz
- ESI 26 20 Hz to 26.5 GHz
- ESI 40 20 Hz to 40 GHz

The frequency ranges of models ESI 26 and ESI 40 can be extended further by connecting an external mixer (option FSE-B21).

The ESI models are based on the successful Spectrum Analyzers FSE with their outstanding values of sensitivity and dynamic range [1; 2]. ESI features **integrated preselection** and so ensures large-signal immunity, which is a vital prerequisite for EMI test receivers.

These instruments are therefore extremely well suited for all electromagnetic emission measurements to **industrial and military EMI standards** such as CISPR, VDE, ANSI, FCC, EN, VCCI, MIL-STD, VG, DEF-STAN, BS, DO 160 or GAM EG 13.

Complex measurements – no problem with ESI

RFI voltage

The voltage peaks occurring in RFI voltage measurements, for example during phase switchover of an artificial mains network, really make great demands on the pulse-handling capability of the RF input. ESI overcomes this problem by means of a second input for the frequency range 20 Hz to 1 GHz, which, in the case of ESI 7 for example, can handle pulses up to 1500 V with maximum energy of 30 mWs.

The **autorange function** sets the correct combination of attenuation and gain in the signal path for the applied signal. This reliably prevents corruption of measurement results by overload while maintaining maximum possible sensitivity.

RFI field strength

Measurement of RFI field strength in the frequency range 30 to 1000 MHz is carried out with the quasi-peak detector. To speed up measurements, it is best to make an **overview measurement with the faster peak detector** to identify critical emissions just above or below limit values. The critical frequencies that are found can be measured afterwards with bandwidth, detector and measurement time set in conformance with standards.

In measurements using the peak detector, the noise floor in CISPR bands C and D is typically 4 dB higher than with the quasi-peak detector. But ESI test receivers have an **integrated, switchable preamplifier** that increases sensitivity so that the noise floor is sufficiently below the limit value, also with the use of the peak detector and the antenna transducer factor taken into account (FIG 2).

The overview measurement is carried out in scan mode. ESI measures the spectra between start and stop frequencies, defined in a **user-configurable scan table**. The table may comprise up to ten frequency ranges, each of which can be combined with user-selected receiver settings such as bandwidth and measurement time to match the measurement to a given test specification (FIG 3).

ESI features **simultaneous measurement and display of four test traces**, which can be assigned different detectors and display modes. Displaying the peak value and average value both in the clear-write and max-hold mode is therefore no problem. ESI stores up to 70 000 values for each of the four traces. These are transmitted during the measurement block by block via the remote control interface and can be saved on floppy disk or hard disk.

For **final measurements in line with standards**, ESI provides graphic display of overview measurement results in one window, and receiver display with frequency and level indication in a second window. Measured values are displayed numerically and in analog form by bargraphs for up to four detectors. Critical frequencies identified in the overview measurement can be set quickly and conveniently for final measurements by coupling the frequency indicated on the receiver display to the marker on the spectrum display using the "Marker to Peak" function.

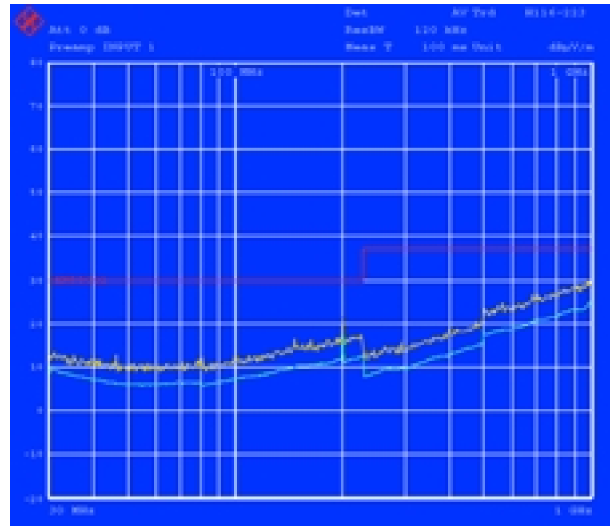


FIG 2 Noise floor of ESI 7 with preamplifier in CISPR band C/D with peak detector. Transducer factors of test antennas (HKst 116 and HL 223 from Rohde & Schwarz) have already been taken into account. Limit line for quasi-peak to EN 55022

Frequently, subbands of the spectrum have to be investigated in greater detail after the overview measurement. For this purpose, a measured trace can be displayed as a reference trace in **split-screen mode**, while in a second diagram the same frequency range or zoomed subranges of it are displayed with higher resolution, the second trace being either based on stored measured values or measured anew.

Measurements to military standards

Military standards also call for measurements at higher frequencies, eg between 30 Hz and 40 GHz in accordance with MIL-STD-461. The ESI models cover the required frequency range and offer the necessary IF bandwidths from 10 Hz to 1 MHz in decade steps. To achieve high sensitivity – required for measurements to MIL-STD-461 RE 101 in the frequency range above 30 Hz – the unavoidable feedthrough of the 1st LO is sup-

FIG 3 User-configurable scan tables in ESI allow scan to be adapted to DUTs and measurement specifications

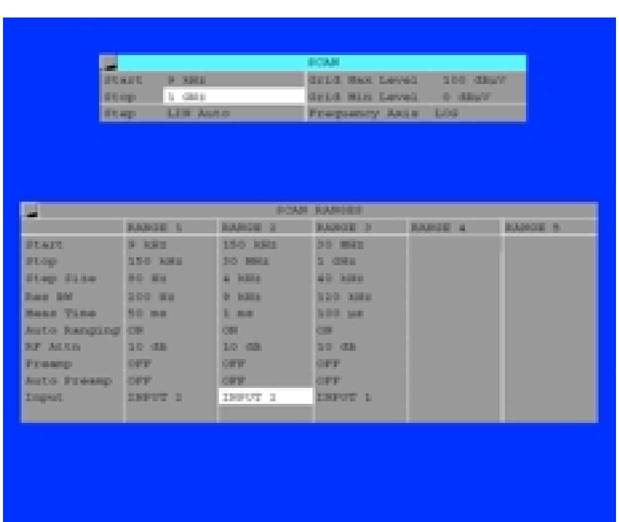
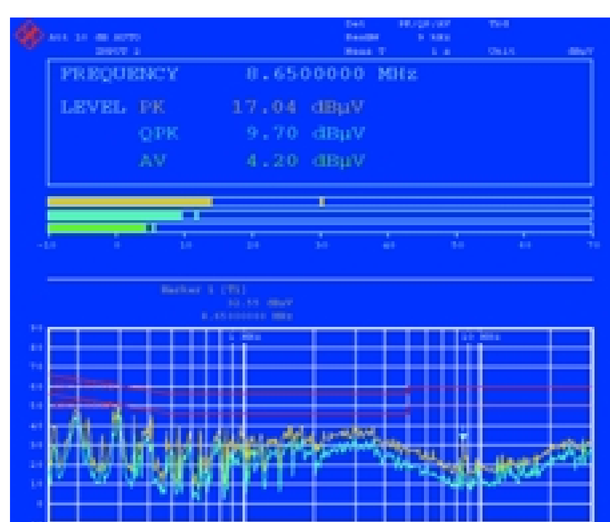


FIG 4 Split screen with parallel detectors and bargraphs



pressed in ESI test receivers by self-alignment of the mixer. ESI consequently features a sufficient margin from relevant limit values even in the lower frequency range (FIG 5).

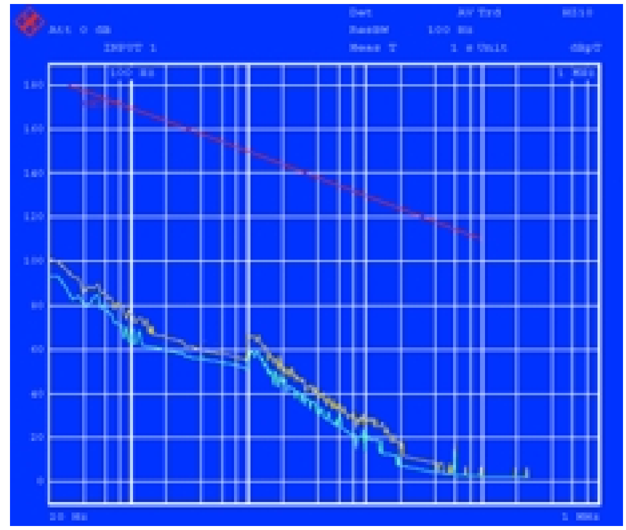


FIG 5
Noise floor from 30 Hz to 100 kHz with limit values to MIL-STD-461D RE 101. Transducer factor of Coil HZ-10 is already taken into account

Standard measurements

Apart from EMI measurements ESI is also highly suitable for general-purpose measurements as a high-grade spectrum analyzer. Its **special features** are:

- low noise floor
- high IP3
- low SSB phase noise
- automatic test routines for noise and phase noise as well as channel and adjacent-channel power measurements

With the optional Vector Signal Analyzer FSE-B7, ESI is well equipped for **modulation analysis** of analog and digital signals. **Automatic measurements of all RF parameters of mobile and base stations** are possible with firmware options FSE-K10 and FSE-K11. Thus ESI meets the demand of test houses and RF development labs for a universal instrument whose capabilities extend far beyond EMI measurements.

Automatic measurements, test systems

ESI, itself a **full-featured PC with keyboard and mouse connectors**, operates under Windows NT®, which allows the use of any Windows® software and convenient integration of ESI into network environments.

Combined with EMI Software ES-K1 for example, ESI is turned into a **fully-fledged controller of complete EMI measurement systems** capable of controlling even accessories like antenna masts and turntables [3].

New products operating at higher frequencies as well as more stringent specifications are creating increasing demand for **measurements in the frequency range above 40 GHz**. With its optional external mixer, ESI is ready for these applications too. Backed by a wide range of options (from tracking generator to vector signal analysis) ESI is a safe investment for the future.

Matthias Keller; Michael Wöhrle

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[3] Wolle, J.: EMI Software ES-K1 – Windows for EMI measurements. News from Rohde & Schwarz (1993) No. 142, pp 22–23

Condensed data of EMI Test Receivers ESI

Frequency range	
Input 1	20 Hz to 7/26.5/40 GHz
Input 2	20 Hz to 1 GHz
Preselection	9 filters (10 with ESI26 and ESI40)
Preamplifier	0/20 dB
Resolution bandwidths	200 Hz, 9 kHz, 120 kHz (CISPR)
	10 Hz to10 MHz (in decade steps, MIL)
	1 Hz to 10 MHz, in steps of 1/2/3/5 (analyzer mode)
Detectors	peak, average, quasi-peak, rms
Level measurement accuracy	±1 dB (150 kHz to 1 GHz)
	±2 dB (1 GHz to 4.5 GHz)
	±2.5 dB (4.5 GHz to 18 GHz)
	±3 dB (18 GHz to 26.5 GHz)
	±3.5 dB (26.5 GHz to 40 GHz)
Remote control	IEC625-2 (SCPI 1994.0)

Reader service card 162/02

DECT Protocol Testers TS1220 and PTW15

Coverage measurements in DECT networks

DECT (digital enhanced cordless telecommunication) has become established by now as a standard for a number of applications. In addition to the use for cordless telephones (residential application) this particularly applies to the field of WLL (wireless local loop). DECT Protocol Testers TS 1220 and PTW 15 (FIG 1) with new and enhanced modules provide optimum support for coverage measurements or for in-depth analysis in the case of faults.

Since liberalization of the telecommunication markets, the link over the last mile to the telephone subscriber has been the central theme of discussions. In addition to the classic cabled link, technologies for the wireless coverage of the last mile are coming onto the market. DECT is the clear market leader among these competitive technologies (FIG 2 in blue box).

Photo 42 907

FIG 1
DECT Signalling Test Unit PTW15 – tried and tested not only in laboratory but also in mobile applications

Decisive factors for DETC's position on the market are:

- the excellent speech quality (32 kbit adaptive differential pulse-code modulation),
- the great variety of reliable and favourably priced telephones,
- the open ETSI standard and
- the fact that DECT does not require frequency management due to DCS (dynamic channel selection).

Moreover, the high data rate specified by the DECT standard allows data transmission in addition to voice transmission. Full coverage is however essential for the DECT-based WLL application.

Enhanced channel occupancy monitor

Key information at a glance

This module implemented in the TS 1220 and PTW 15 test systems was enhanced by some new functions. It monitors the DECT air interface and displays activities and main parameters all in one (FIG 3).

The time display of physical channels also shows the bursts on the data path between fixed part (network operator) and portable part (customer). The assignment of a frequency to the physical channel is either freely selectable by software configuration (TS 1220) or by means of optional hardware modules (PTW 15). Each burst represents a data packet with 320 bits of information data (full slot, example in FIG 3: channel 6, timeslots 0 and 12). The

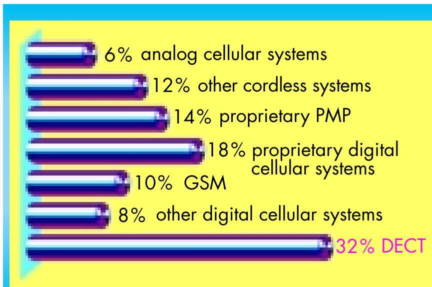

FIG 2 Different WLL technologies in comparison (source: DECT forum)

About DECT

DECT is used worldwide on the following frequencies:

Europe (and others):	1897.344 MHz to 1881.792 MHz	10 channels
China:	1902.528 MHz to 1918.080 MHz	10 channels
Latin America:	1912.896 MHz to 1928.448 MHz	10 channels

All other RF parameters such as modulation (GFSK), power (max. 24 dBm) and channel spacing (1.728 MHz) are identical

height of the burst is proportional to the field strength, which simplifies the determination of the transmission quality in a first approximation.

The DECT air interface can show the activities of different applications at the same time, eg when WLL and residential activities (cordless telephones) are performed within the receive range of the DECT test equipment. Since the DECT specification allows for non-synchronous activities, sliding collisions between the connections may occur. It is very important to detect such situations. With the aid of the channel occupancy monitor, the different activities can be displayed in different colours. For instance, FIG 3 shows

- 3 the reference activity,
- 8 activities synchronized to the reference (in the same network),
- 9 asynchronous activities, eg private telephones.

The right-hand window of the display provides detailed numerical information on the individual activities in database format. This information mainly includes channel and timeslot, receive level, sync state (reference, slot-synchronous, frame-synchronous, multiframe-synchronous, asynchronous), preamble (fixed or portable), identification codes and messages of broadcast channel Q (capabilities).

Statistical evaluation

The main display window of the channel occupancy monitor shown in FIG 3 illustrates an instant of the DECT interface (snapshot). Statistical evaluation of a great number of snapshots is however required for assessing the quality or analyzing a fault.

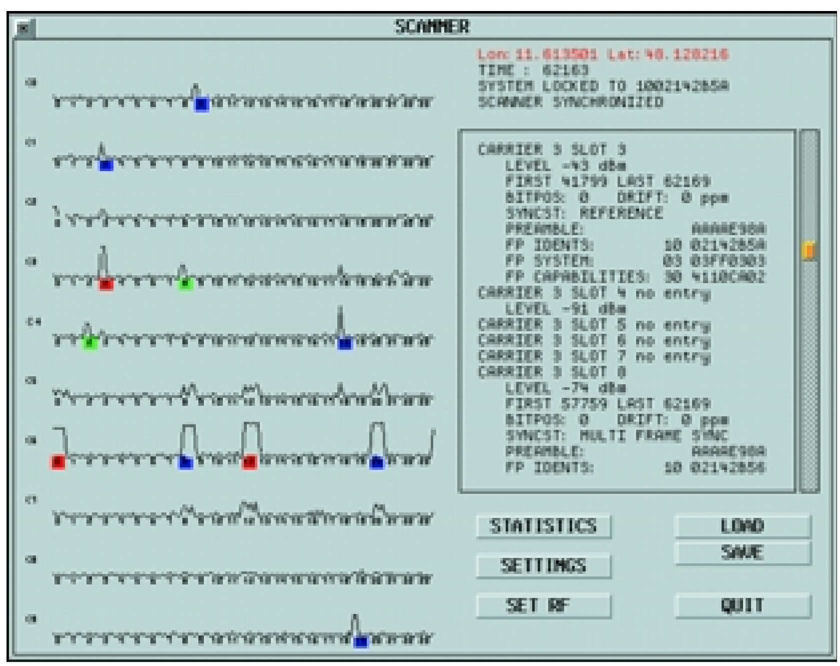

FIG 3 Channel occupancy monitor

For this purpose the module continually saves the database content in a file (a data record corresponds to a snapshot). The parameters to be stored can be selected from a table and may be complemented by superordinate units. This particularly applies to local coordinates obtained from a GPS receiver. If this receiver is equipped with a standardized NMEA (National Marine Electronics Association) interface, the coordinates can be directly read in and stored via an RS-232-C interface. FIG 4 shows the parameter selection window and the associated ASCII file. Export filters (eg to Microsoft EXCEL™) are also available.

New: the simulation module

Under certain circumstances passive monitoring is not sufficient for analyzing a scenario and the test system needs to actively simulate one of the partners in the DECT network. The implementation of a GAP (generic access profile) compatible fixed part and portable part as a reference has always been a function of the two test systems. Many manufacturers of DECT terminals are no longer satisfied with just transmitting voice, they are working on the implementation of data transmission facilities (transparent ISDN channel). The data rate required by DECT for this application is provided by slot coupling (double slot). This technique with associated protocol support (advanced connection) is available as an option for Protocol Tester TS 1220 (FIG 5).

Protocol Testers TS 1220 and PTW 15 from Rohde & Schwarz are ready for future applications and of course also ideal for the development of such applications.

Detlef Willam

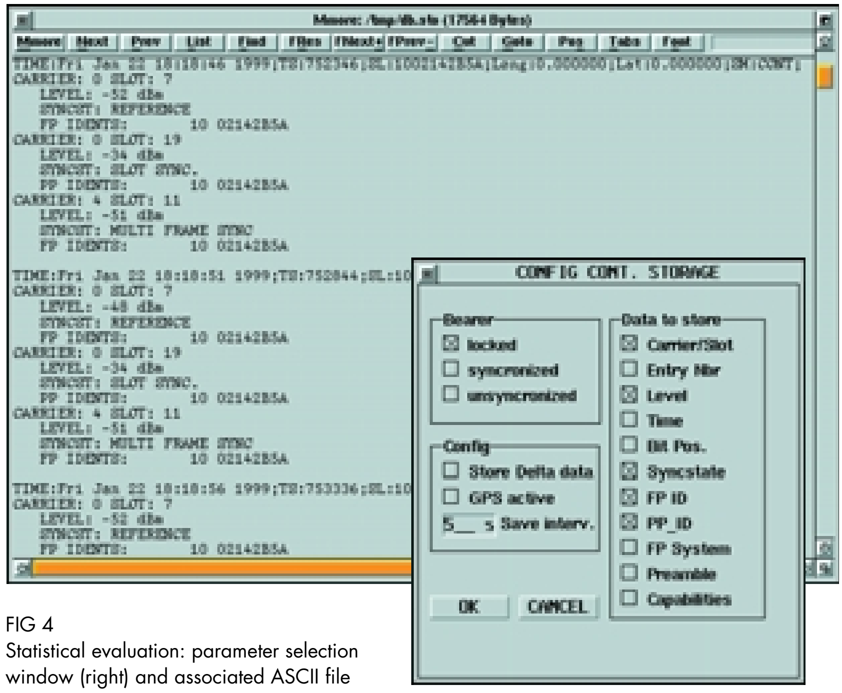

FIG 4
Statistical evaluation: parameter selection window (right) and associated ASCII file

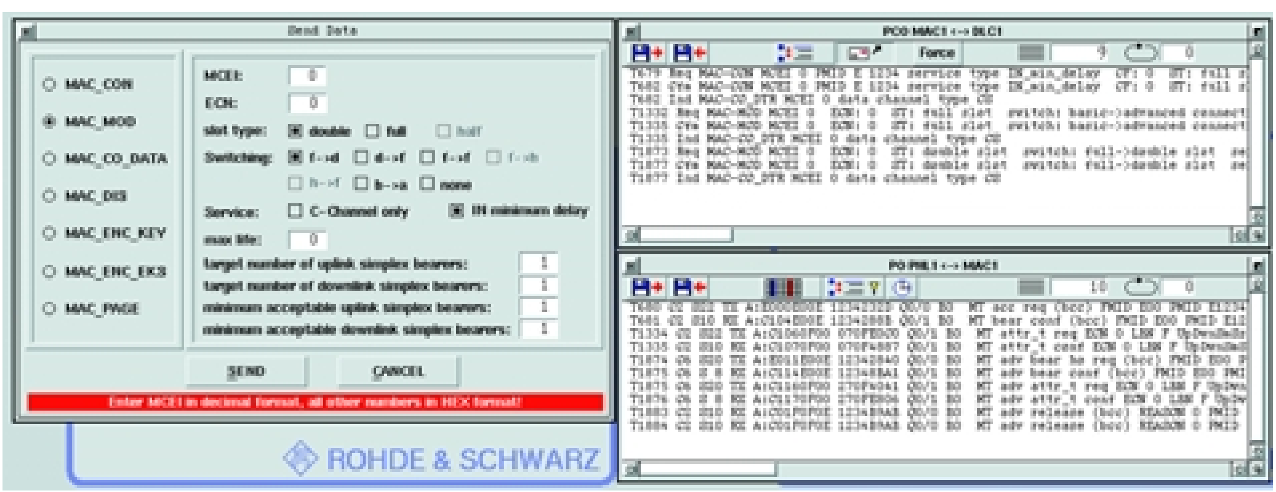

FIG 5 Protocol Tester TS1220 also analyzes double-slot connections with the aid of the associated protocol support (advanced connection)

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[2] Jauch, H.; Riedel, P.: DECT Signalling Test Unit PTW15 – Support in installation and maintenance of DECT networks. News from Rohde & Schwarz (1997) No. 155, pp 4 – 5

Condensed data for channel occupancy (TS1220)

	TS 1220	PTW 15
Scans/s	>12	>3
Resolution (time)	<10 µs	<14 µs
Resolution (level)	<1 dB	<1 dB
Level range	–30 to –100 dBm	0 to –93 dBm
Database export to Microsoft EXCEL™		

Condensed data for data services (TS1220)

Double slot	implemented
Advanced connection	implemented
LU7 protocol	implemented

The open platform concept supports the above-mentioned services

Reader service card 162/03

Spectrum Analyzers R 3132 and R 3162

New allrounders in the middle class

Mobile phones, trunked radio and digital broadcasting – the growing importance of radio systems makes increasing demands on spectrum analyzers. Advantest is now presenting its latest, powerful middle-class analyzers, two universal units in synthesizer technology designed for manual operation as well as integration into automatic test systems in development, production and service. The two Advantest instruments are ideal vertical additions to the Rohde & Schwarz product line. For this reason they are marketed by Rohde & Schwarz in Europe and in many other countries as part of a successful cooperation between the two companies.

Analyzers R 3132 (up to 3 GHz, FIG 1) and R 3162 (up to 8 GHz) are of modular design, ie they comprise a basic unit and **various extensions**. So customized solutions can be configured, which are tailored to the user's requirements, and costs reduced at the same time. Options can be retrofitted any time. User friendliness and a clear layout are also evident features.

FIG 1
New Spectrum Analyzer R 3132 from Advantest, a universal measuring instrument up to 3 GHz for diverse applications in development, production and service

The instruments have a resolution bandwidth of 1 kHz as standard. Resolution bandwidths of 30 Hz, 100 Hz and 300 Hz are optionally available to improve S/N ratio. A **preamplifier** is also **integrated** in the basic unit (max. 3.2 GHz). So even very weak signals can be measured. The permissible input level is +30 dBm and an RF attenuator with maximum attenuation of 50 dB (R 3132) or 75 dB (R 3162) is fitted for high-power signals. Attenuation can be varied in 5 dB steps permitting optimization of the intermodulation-free dynamic range.

The new models feature considerably **better RF characteristics** than the leaner R 3131 [1]. They have inherent noise of –118 dBm at 1 kHz resolution bandwidth, –132 dBm at 30 Hz and even –146 dBm with the preamplifier switched on. The dynamic range was also extended: the range free of 2nd order harmonics and 3rd order intermodulation products is at >80 dBc (with –30 dBm mixer level), the 1 dB compression point >0 dBm. Thanks to direct digital synthesis, the frequency span error is only 1%, while the maximum total

Photo 43 265/1

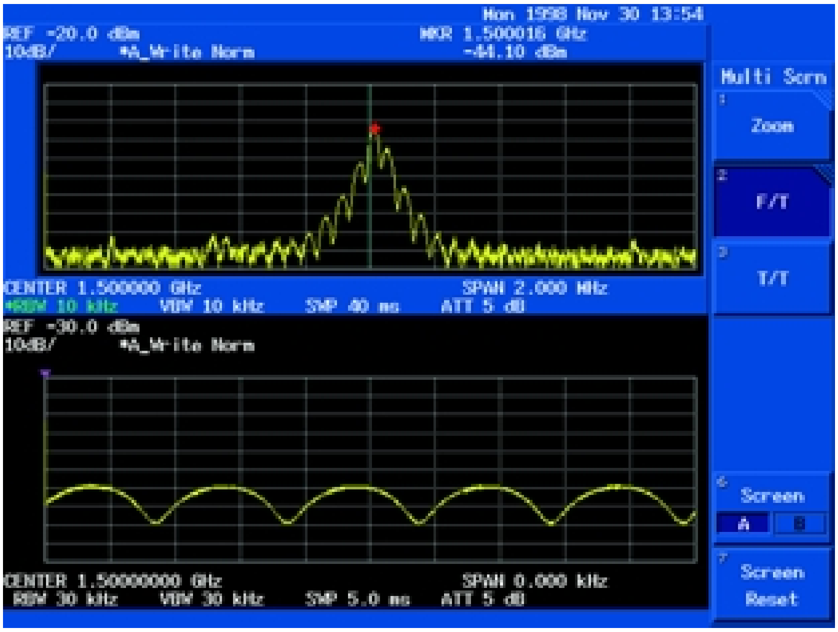


FIG 2
With the multi-screen function selected, two signal windows are displayed

amplitude error is reduced to ±1.5 dB through internal calibration.

The analyzers excel in a **very short sweep time** of 20 ms and can display 20 traces/s – a high refresh rate unrivalled by measuring instruments of this price class. As a result waveform variations are perceived in an almost analog way. With mobile communications standards such as GSM, an even shorter sweep time is needed in the time domain for burst display. To meet this requirement an option with a sweep time of only 50 µs is available.

Basically the instruments are equipped with a number of other useful functions such as gated sweep and delayed sweep for measurements in line with different mobile radio standards. In the gated sweep mode, TDMA signals can be examined in the frequency domain, while with delayed sweep detailed analysis of the rising and falling edges of a single burst can be made.

Thanks to their universal characteristics, the spectrum analyzers can easily be integrated into production lines. Fast data transmission via the IEC/IEEE bus is of great advantage for automatic in-production measurements.

Another highlight is the large **TFT colour screen** with a diagonal of 16.5 cm. Its features include a multi-screen function (FIG 2), high resolution (1001 horizontal pixels) and a logarithmic display range of 100 dB. Large level differences can thus easily be determined. The picture content can also be viewed on an external monitor via the VGA output.

Their versatile capabilities also make the analyzers suitable for **TV applications**. Noteworthy is the trigger on vertical and horizontal TV lines, which is standard in all basic units. A model with input impedance of 75 Ω is available for cable TV measurements.

The **EMC functions integrated** in the analyzers allow precompliance EMC measurements using different detectors. For the quasi-peak detector, 6 dB resolution bandwidths of 9 kHz, 120 kHz and 1 MHz are provided in the basic unit. A resolution filter of 200 Hz is optional.

Other **major measurements and functions** can be performed at the press of a button:

- various power measurements,
- noise measurement,
- adjacent-channel power,
- occupied bandwidth,
- limit lines with pass/fail verdict,
- full-range search for highest signal level (autotune),
- frequency counter with 1 Hz resolution,
- determination of AM depth (% AM).

Just as with almost all spectrum analyzers from Advantest, a tracking generator (up to 3 GHz) is available as an option. This allows various transmission parameters to be measured, eg cable loss or filter frequency response. With the aid of an additional SWR bridge, matching characteristics can also be measured.

Measured data, parameters and traces can be stored on diskette in three different formats. When saved in binary format, the data can be reloaded any time in the analyzer. In CSV format, the individual pixels are stored as numeric values permitting subsequent use in spreadsheets and thus data editing by PC. The whole screen content can be stored as a monochrome or colour bitmap, which is very useful for the documentation of results.

The analyzers are provided with a Centronics interface in addition to an IEC/IEEE bus and a serial interface. So test results can be output direct to a printer (ESC/P and PCL standard) or plotter (via IEC/IEEE bus).

With these instruments Advantest sets new standards in the middle class. Users will find these universal spectrum analyzers to be the ideal tool for everyday measurements.

Patricio Dueñas

Condensed data of Spectrum Analyzers R3132 and R3162

Frequency range	9 kHz to 3/8 GHz
Sideband noise	<–100 dBc/Hz (at 10 kHz offset)
Resolution bandwidths	1 kHz to 3 MHz (30 Hz optional)
Sweep time	20 ms to 1000 s (optional 50 µs in time domain)
Data storage	binary, CSV and bitmap
Interfaces	Centronics, IEC/IEEE bus and RS-232-C
Display	16.5 cm TFT colour screen
Weight	15 kg
Dimensions (W x H x D)	424 mm x 177 mm x 300 mm

Reader service card 162/04

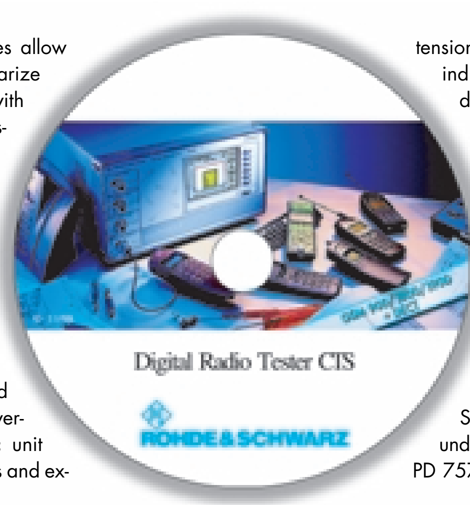
REFERENCES
[1] Wollmann, P.: Spectrum Analyzer R3131, the allrounder for the small budget. News from Rohde & Schwarz (1998) No. 159, p 32

Digital Radio Tester CTS on CD-ROM – experience interactive product information

The new multimedia CD-ROM on Digital Radio Tester CTS is a particularly attractive presentation of this mobile radio tester. Interactive sequences allow the customer to take actively part in the presentation, receiving a realistic impression of the tester's functions and operation.

The versatility of the CTS is demonstrated vividly as under real-life conditions on the customer's PC – without a demo unit being required. The user-friendly navigation enables a concise overview of the available features as well as detailed presentation of specific test runs that are commonplace in the mobile radio sector.

Interactive sequences allow the user to familiarize himself effortlessly with the unit and its measurements, with a spoken comment on each step to elucidate. The CD is therefore also an optimal tool for training purposes.



A configuration aid demonstrates the versatility of the basic unit and presents options and extensions tailored to the user's individual needs. Windows™ user programs – for instance remote-control software – are also provided as simulation versions that can be started directly from the CD.

The CD is available free of charge from your nearest Rohde & Schwarz representative under the order number PD 757.4401.51.

Walter Schmitz

Database-supported documentation

Technical documentation by high-tech methods

The capabilities of the service center for technical documentation of the Rohde & Schwarz Cologne Plant are not only available for use within the company, the center's know-how is also offered to external customers. The services go far beyond traditional hardcopy documentation. With automatic generation of documents from databases, cross-media publishing and multimedia productions, the competence center utilizes the whole range of modern publication means.

Technical documentation must be of a high standard

The general automation of daily life and increasing product complexity also place more stringent demands on technical documentation: in the meantime it must do much more than just provide information. Today products are also judged by the quality of their documentation.

Quality not only means presentation of information in correct language or optimized to the requirements of specific user groups, the user must also be able to rapidly and easily find the information he needs. And in addition, documentation has to comply with common standard specifications, regulations and laws.

Globalization of the market also means serious consequences for technical documentation. Not enough that information is required in different languages, it frequently also has to be held in data networks (Intranet or Internet) and made available to users worldwide. It goes without saying that the information must be kept up-to-date.

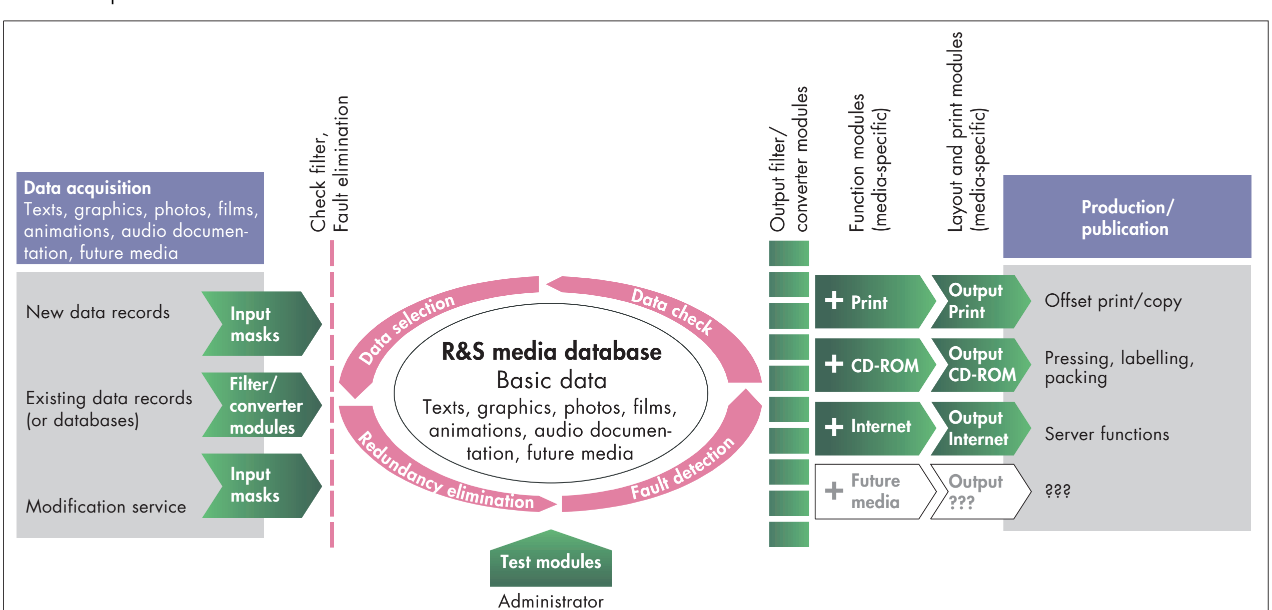
Technical documentation today must be organized differently

As development times become shorter and cost pressures increase, technical authors are compelled to create documentation parallel to product development. This requires fast, flexible and global access to development data. Information should preferably be obtained at its source and go straight into the documentation. The exchange of information and the work flow involved have to be defined and channelled by way of information organization. The requirements of documentation should consequently be taken into account already during product development or modification.

Rohde & Schwarz on a new road

About two years ago, Rohde & Schwarz Cologne Plant started to convert its documentation software into database-supported formats, editors and illustration programs. In the meantime the whole range of modern

FIG 1 Concept of media database



documentation can be offered on hardcopy or in electronic form via cross-media publishing. This particularly fulfills the requirements of public authorities in line with AECMA-Spec 1000 D and 2000 M (Association Européenne des Constructeurs de Matériel Aérospatial). It was made possible through consistent utilization of the internationally standardized and platform-independent formats SGML for text and CGM for illustrations.

Database – nucleus of the system

The nucleus of the described concept is an Oracle database that is able to handle all the needs of a modular solution in terms of both graphics and text. Standard tools are used for text (Adept Arbortext SGML editor) and graphics (ISO Draw). Hardcopy publications are prepared by means of FrameMaker + SGML.

All standard tools are configured and adapted to the database with the aid of integrated script languages so that finished sections can be automatically combined to form complete documentation.

Integrated work procedures

Cooperation between technical authors and illustrators is essential. Modular makeup and clear, predefined structures allow procedures to be performed in parallel without redundancies. Ready modules are available to everyone involved in a project (eg warnings). This ensures a uniform terminology.

The layout of a document type is defined at the beginning and cannot be changed by authors during preparation of the documentation. Thus uniform appearance of all documents is achieved.

Very often, different models are available and have to be described within a project. With the aid of the media database, the documentation can be tailored to the product model supplied to a specific customer, eg as a function of the serial number.

This work method guarantees customized documentation that meets modern quality standards. Synergy comes into play at the same time, so the total outlay involved for documentation can be reduced.

Tried and tested in practical use

As an example, the Broadcasting and Paging, Broadband Communications Division of Rohde & Schwarz decided to use this database-supported concept for its new generation of DVB transmitters. The Cologne Plant will generate the complete user and service documentation in parallel with product development.

In addition to small manufacturers of electronic equipment, large company groups like ESAB Hancock and Ingersoll have entrusted Rohde & Schwarz Cologne Plant with the preparation of their technical documentation. New projects for military customers are always documented in this way.

Fit for multimedia

In addition to integration of text and graphics, preparations are being made to include audio, video and animation data for multimedia products in the database according to the same concept.

This is the prerequisite for generating not only actual documentation but also brochures, multimedia product or company presentations at low cost and making them available for publication on CD-ROM and the Internet.

Jörg Zorenböhmer

Catalog of services (extract)

- Manuals for operation, use, maintenance, service and calibration
- Spare parts catalogs
- Training documentation
- Leaflets, brochures
- Technical manuals
- Concepts for logistics, materials management, repairs
- Integrated logistics support
- Comprehensive company presentation on Internet
- Online documentation
- Multimedia productions for maintenance, service, marketing and product presentation
- Electronic information systems
- Production of CD-ROMs

Reader service card 162/05

New for GSM mobile phones: multitone analysis via air interface

Photo 43 158/5

FIG 1 Audio Analyzer UPL with optional Mobile Phone Test Set UPL-B8 measures acoustic characteristics of GSM mobile phones via air interface

Air interface - the new alternative

The acoustic transmission and reproduction quality of a mobile phone is its most important characteristic in everyday use. Instruments and procedures for measuring acoustic characteristics are therefore essential tools for determining the quality of a mobile.

For **type-approval tests on GSM special mobiles**, Rohde & Schwarz developed Audio Analyzer UPL 16, which can perform all audio measurements in line with GSM 11.10 via the digital audio interface (DAI) [1].

Trade journals for communications, consumer test institutes or GSM network operators are interested in performing their own measurements for a comparison of the acoustic characteristics of mobiles. But on commercial mobile phones the DAI interface is not available, so measurements can only be performed during normal operation via the air interface with the voice coder and decoder included.

With the new Mobile Phone Test Set UPL-B 8 option the **acoustic characteristics of standard GSM mobile phones** can for the first time be measured **via the air interface** and the results compared with the subjective impressions of the user.

How to measure

Accurate and reproducible results cannot be achieved with static sinewave tones. In this case test signals simulating the characteristics of the human voice, ie tones that are harmonic multiples of the fundamental, are required (see blue box). Whether the results obtained for the fundamental are favourable depends on how far the values coincide with the clock of the coding algorithm. Through a skilful choice of fundamental frequencies, test signals with overlapping spectral distribution can be generated, giving a sufficient number of testpoints in subsequent measurements at different fundamental frequencies so that a practically continuous frequency response curve is obtained. Evaluation is by means of FFT analysis with a special window function and selection of result bins. The results are sorted and smoothed by the software and displayed in the form of a frequency response curve. Depending on the measurement, the program calculates the sending or receiving loudness rating in line with CCITT P.79 and shows the result in the graphics display. Just as with type-approval measurements via the DAI interface, UPL checks the measured frequency response in the transmit and receive direction for compliance with the limits specified by GSM 11.10 and outputs a "pass" or "fail".

Why the frequency response of GSM telephones cannot be determined using sinusoidal tones...

The purely sinusoidal tones normally used, eg for frequency response measurements, cannot be used in this case. This is because of the GSM coder and decoder algorithms. A so-called vocoder is used to produce the lowest possible data rate. Instead of the actual voice only the filter and fundamental parameters required for signal reconstruction are transmitted. Particularly in the medium and higher audio frequency ranges, the static sinusoidal tones become a more or less stochastic output signal. For example, if a tone of approx. 2.5 kHz is applied to the telephone at constant sound pressure, the amplitude of the signal obtained at the decoder output varies by approx. 20 dB. In type-approval tests, where highly accurate measurements are required, the coder and decoder are excluded from the measurement. The special test mobile is equipped with a digital audio interface for the transmission of audio signals with linear PCM coding.

FIG 2 shows that the measurement results achieved excellently match those of a type-approval test via the DAI interface.

Measurement requirements

Rohde & Schwarz offers the **Mobile Phone Test Set UPL-B8 as an option for Audio Analyzer UPL**. It contains the complete test program with installation code and an external transformer for matching the impedance of the artificial mouth. The options **Extended Analysis Functions UPL-B 6** and **Universal Sequence Controller UPL-B 10** are also required for these measurements. The same components as for type-approval tests are needed for acoustic coupling: artificial mouth, artificial ear, test adapter, etc. **Digital Radiocommunication Tester CMD** from Rohde & Schwarz acts as a base station. Depending on the required GSM band, CMD 52, CMD 55 or CMD 65 may be used and fitted with the optional **Voice Coder CMD-B 5**. Input and output of the voice coder are connected to the 50-pin multifunction connector on the CMD front panel. A **GSM TEST SIM** card is required for operating the mobile under test.

With the aid of this test setup **all relevant acoustic measurements to GSM 11.10** can be performed on standard mobiles without DAI:

- Sending frequency response
- Sending loudness rating
- Receiving frequency response
- Receiving loudness rating
- Sidetone masking rating
- Listener sidetone rating *
- Echo loss
- Stability margin
- Distortion sending
- Distortion receiving
- Idle channel noise receiving
- Idle channel noise sending

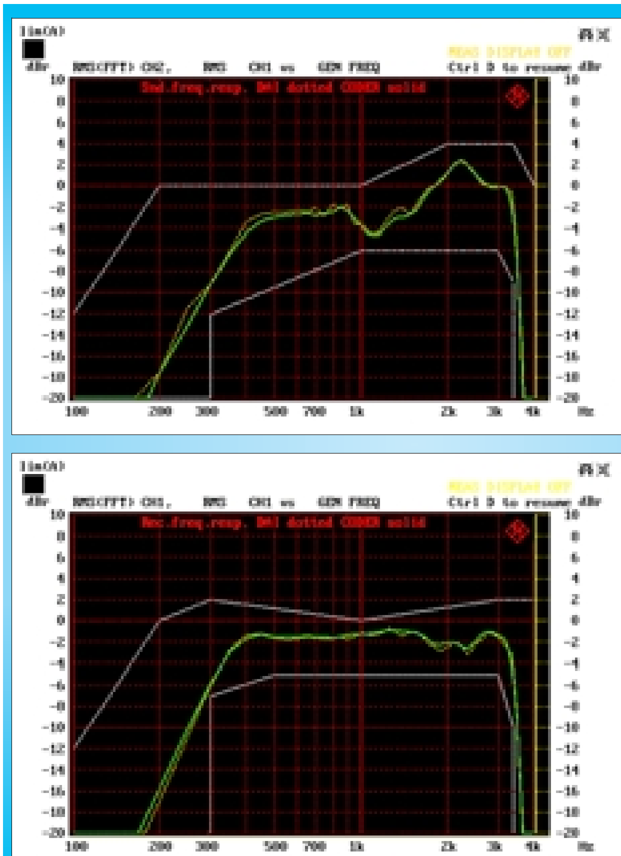


FIG 2 Comparison of frequency response measured by two methods (top: sending; bottom: receiving). Dotted trace shows measurement result via DAI, and solid trace result obtained with multitone sinusoidal signals via air interface and voice coder

Special features

Since the measurement also includes coding and decoding, the limit values specified by GSM 11.10 for type-approval tests must not necessarily be adhered to. Measurement results for sending and receiving distortion in particular will generally be slightly above or even below the specified limits. With echo loss measurements the specified value of 46 dB will normally not be achieved. But this is due to definitions in the test standard which has to be revised. Although the echo loss test is of considerable importance from an acoustic point of view, it is consequently not part of the type approval. To avoid additional confusion, the stringent limit values of GSM 11.10 for the type approval of standard mobile phones apply nevertheless. The program can easily be adapted, if required, or when different limit values are specified for commercial mobiles at a later date. If appropriate, the "fail" verdict can be ignored and only the numeric value used for a comparison.

Tilman Betz

* (For listener sidetone measurements, additional hardware is required to generate a sound field.)

REFERENCES

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Reader service card 162/06

I/Q Modulation Generator AMIQ – more applications through differential I/Q outputs

Photo 43 213

FIG 1 Making four out of two: new option doubles number of generator outputs for inverted I/Q signals and considerably extends AMIQ application range

FIG 2 AMIQ menu of WinIQSIM: with new differential I/Q output option, menu item "Differential Output" with various setting possibilities is available

AMIQ becomes even more versatile

Rohde & Schwarz developed I/Q Modulation Generator AMIQ (FIG 1) for convenient generation of baseband signals [1] for complex I/Q modulation, which is increasingly used in modern communication. AMIQ is operated either from Vector Signal Generator SMIQ [2] or Software WinIQSIM [3] supplied with it.

In addition to uses at the RF, more and more applications are being performed in the baseband or at IF level, where RF carrier modulation with SMIQ is not required.

Thanks to its excellent characteristics, AMIQ equipped with the differential I/Q output option can be used for **numerous new applications**. The option adds two outputs to the front panel of the generator, where the inverted $\bar{I}$ and $\bar{Q}$ signals are available.

Some DUTs like I/Q modulators have balanced differential amplifiers at their inputs to reduce or avoid the coupling in of unwanted signals or to compensate the offset drift of their input transistors. AMIQ with its differential outputs is ideal for examining DUTs of this kind because it provides **highly accurate and highly stable I/Q signals and DC bias voltages** for setting operating points.

New features

- A **DC (bias) voltage** between –2.5 V and +2.5 V can be superimposed on the modulation signal. This bias affects both the I and $\bar{I}$ (or Q and $\bar{Q}$) signals but can be set separately for the I and Q channels.
- **Output impedance selectable** in the OFF state:
  50 Ω: for experimental purposes the modulation signal can be switched off without changing the operating point of the DUT set via the bias voltages. The bias voltage is maintained at the output.
  HIGH Z: the output is high-impedance, the bias voltage is switched off.
- The output level of the basic unit is always referred to a 50 Ω termination to ground. With the new option, the output level is the **open-circuit voltage between the non-inverting and the inverting output**, since most DUTs have a high input impedance. The level at the DUT can easily be calculated from the open-circuit voltage and the input impedance. Since the impedance of an active AMIQ output is al-

ways 50 Ω, the voltage division across high-impedance loads (>5 kΩ) is negligible in most cases (error <1%).

Operation: convenient as usual

When **AMIQ is controlled via WinIQSIM**, the AMIQ operating menu is displayed (FIG 2). With "Single Output" activated, the generator acts like the basic unit without the option. The modulation signals are looped through to the non-inverting outputs and the inverting outputs are disabled. This is a useful feature when only unbalanced signals are needed and very high performance is called for, eg the best values for output offset.

Clicking on "Differential Output" makes all features of the option available. Not only modulation signals are applied to all four outputs, a DC voltage can also be superimposed on these signals (see example in blue box).

Burkhard Küfner

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[2] Klier, J.: Signal Generator SMIQ – High-quality digital modulation up to 3.3 GHz. News from Rohde & Schwarz (1997) No. 154, pp 4–6

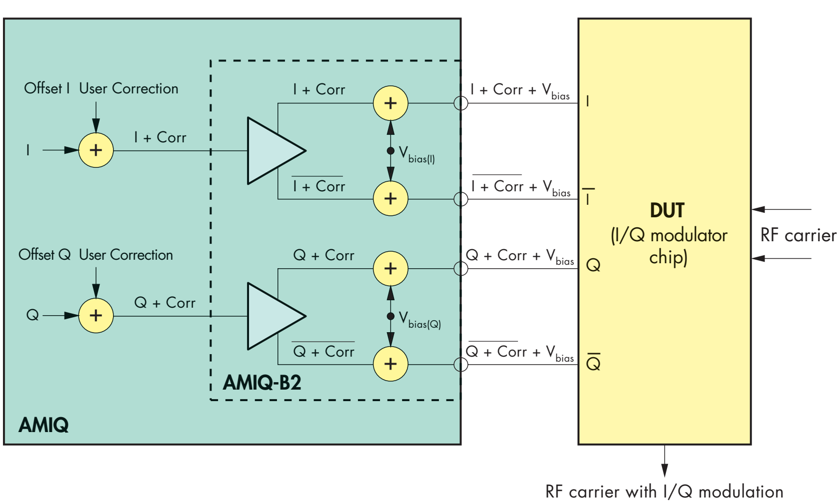
[3] Pauly, A.; Holzhammer, J.: I/Q Simulation Software WinIQSIM – New approaches in calculating complex I/Q signals. News from Rohde & Schwarz (1998) No. 159, pp 13–15

Condensed data of AMIQ-B2

Outputs	I, $\overline{I}$, Q and $\overline{Q}$
Bias voltage	–2.5 V to +2.5 V (suitable for ECL)
Resolution	<1.5 mV
Difference between I(Q) and $\overline{I}$($\overline{Q}$)	<0.5 % + 1.5 mV
Output voltage	
Fixed mode	2 V
DC residual offset	<1 mV
DC fine variation	typ. ±120 mV
Resolution	120 µV
Variable mode	0 mV to 4 V
DC fine variation	typ. ±280 mV
Resolution	280 µV
Maximum output voltage	<2.5 V (to ground)

Reader service card 162/07

FIG 3
Driving modulator chip



Example: Driving an I/Q modulator chip

The modulation input of a typical chip comprises a balanced semiconductor circuit with constant current source, which normally has a high input impedance so that it can also be driven by high-impedance generators. Differences in the base-emitter paths cause a DC offset, which produces inadmissibly high LO amplitude at the output and has to be eliminated for optimum LO suppression.

Using AMIQ with the new option this can be achieved as follows (FIG 3): AMIQ generates the desired modulation signals with frequencies up to 25 MHz. The operating point of the chip is adjusted via the bias voltage. By superimposing the bias voltage with an offset voltage set in the basic unit (under "User Correction"), the selected bias voltage can be influenced and the offset differences eliminated.

The circuit of the option causes the originally set bias voltage of the respective channel (I or Q) to diverge. The additional DC voltage applied via "User Correction" is looped through unaltered to the non-inverting output. This increases the set bias voltage by 0.24 mV for example. In contrast, the offset at the inverting output reduces the set bias by 0.24 mV. The difference between the I and $\overline{I}$ or Q and $\overline{Q}$ signal is therefore twice as great as the "User Correction" set on the basic unit (ie 0.48 mV). This balancing of bias voltages corrects unsymmetries and minimizes the residual RF carrier at the output of the DUT.

Coverage measurement and monitoring systems for DAB-T and DVB-T

How to increase the availability in the network at low cost

Photo 43 125/1

FIG 1 Vehicles equipped with Rohde & Schwarz test systems support planning and ensure high availability of DAB and DVB networks

After successful completion of numerous European pilot projects, **d**igital **a**udio **b**roadcast (DAB) is about to be introduced also in Germany. With **d**igital **v**ideo **b**roadcast (DVB), various pilot projects are in progress that furnish the necessary know-how for an implementation in the near future. For all parties concerned from the program provider to the customer, the **availability of a defined signal quality** at the receiver input is decisive for the quality of the service offered (apart from the program content) and an essential criterion for user acceptance.

Definition of availability

All transmitters of DAB or DVB networks use the single-frequency method, ie each transmitter emits the same information on the same frequency at the same time. The signals pass through different network modules along the whole transmission chain from the studio to the DAB/DVB receiver.

Availability within this chain is defined as follows: all network parameters have to be complied with so that a defined BER (bit error rate) is obtained at the receiver site. Unimpaired reception of say 99.9% per year means that the receiver has to put up with a signal below the defined minimum quality in the network for no more than 8 hours over the whole year.

To **assess the availability of a module in the network,** a **priority factor PF** is assigned to each module in the transmission chain. This factor depends on the task performed by the module, its position in the transmission chain and its effect on the overall availability in the case of a failure. The PF of each network module therefore indicates its importance in the measures taken to maintain the required availability of the transmission chain.

It is obvious that in a network with several transmitters a higher priority is assigned to the multiplexer and the satellite link than to the individual transmitters (FIG 2).

With reference to the whole transmission chain, the (total) network availability can be defined as a sum of the availability

- in the transmission chain (from the studio to the transmitter inputs),
- of individual transmitters in the network (transmitter input to transmission antenna),
- of reception in the radio channel,
- and of the parameters of the single-frequency network.

The sum of the individual availabilities gives the required availability at the receiver.

FIG 2 Assigning priority factors (PF) to network modules

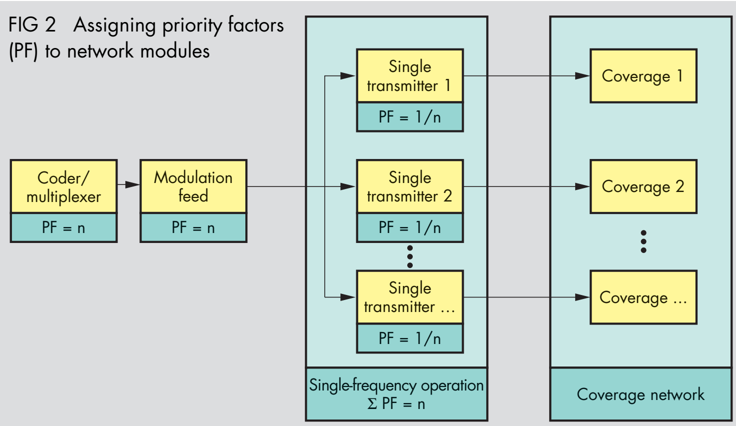
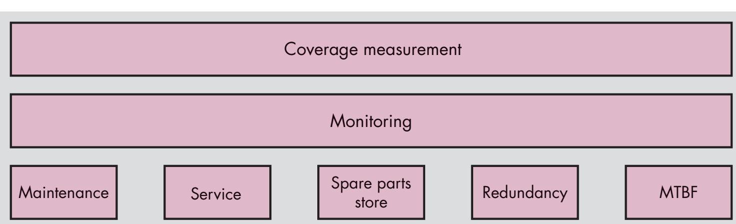


FIG 3 Submodules in transmission network ensure high availability



How to achieve a high availability

To achieve the required availability, submodules are added to the network modules (FIG 3). Together with the network modules they maintain network operation and ensure the stability of the defined network availability. The **monitoring and coverage measurement** submodules are essential tools for implementing and monitoring the required availability in the network.

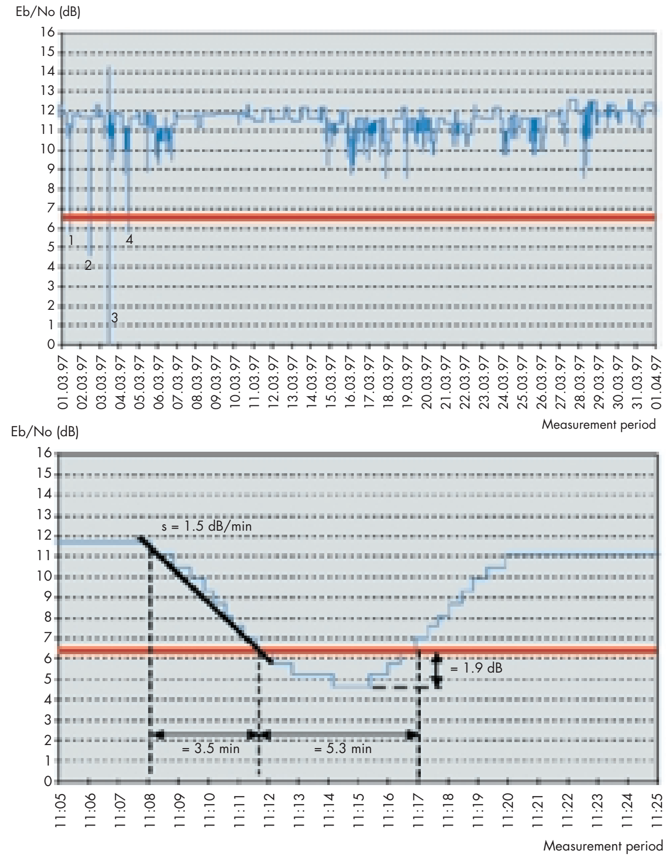


FIG 4
Top: four failures at DAB transmitter site in March 1997 (1 to 4);
bottom: parameters of failure 2

Monitoring

Monitoring systems continuously check the physical parameters of the individual network modules during operation. This is done at the site of the module (indoor monitoring) or in the single-frequency network (outdoor monitoring). The probability of predicting the failure of a network module should be very high **(principle of "Looking into the future")**. This is the main feature of monitoring systems and indispensable for high availability.

Monitoring can be defined as the continuous surveillance of specific parameters at the module (eg multiplexer, transmitter), in the transmission link (eg multiplexer through to transmitter) and the network (at a specific geographical location).

The monitored parameters are selected depending on the task the network module performs in the transmission chain. **Relevant points for indoor monitoring** in the DAB/DVB chain are for example

- the multiplexer output (digital ETI/TS signal),
- the uplink signal (frequency, bandwidth, power, spectrum) in the case of satellite transmission,
- the received ETI/TS signal (Eb/No) and transmitter parameters (mask, etc) at the transmitter site.

With **outdoor monitoring**, the network is monitored at a fixed location, eg at a place where the coverage areas of different transmitters overlap. Information on single-frequency behaviour is obtained by measuring channel impulse response and/or performing a Go/NoGo test. The parameters are monitored according to the "Looking into the future" principle. This allows the time of failures to be predicted within certain limits and measures to be taken to minimize the failure or the downtime.

FIG 4 gives an example for the availability of the ETI signal at the modulator input of a transmitter site monitored in March 1997. When the value Eb/No <6.5 dB is attained, the satellite receiver can no longer detect the signal and switches off. Therefore the modulator does not have an input signal and no signal is output by the transmitter.

Measurements have shown that slope classes can be defined as indicators for specific failures, eg faults in the uplink or satellite or weather effects. The failure time can be predicted fairly exactly from the gradient of the slope. In the above example the time for the power decrement (from maximum to Eb/No = 6.5 dB) is 3.5 minutes. After the time required for determining the slope there will be enough time left to inform the network center. To avoid a complete failure of the station(s), the center could for example increase the power on the uplink by a certain value (0.7 to 1.9 dB) for about 5 minutes.

This monitoring philosophy can also be used for other modules in the network and their parameters within the transmission chain. **This means that suitable monitoring methods increase the network availability at a minimum of outlay and cost.**

Coverage measurement

Coverage measurements (CM) determine the signal quality in the network. They can be carried out in the planning phase (to support calculated values) or during normal operation.

If faults are detected in the network (network monitoring), the source can be located with the coverage measurement system and the effect eliminated with the aid of the other submodules.

In contrast to monitoring, coverage measurements are mostly performed with mobile equipment so that the coverage quality can be determined within the propagation area. With stationary and mobile CM, receive parameters (eg field strength, BER) are measured with respect to time and location in the network. Single network parameters (eg field strength), channel characteristics (Gaussian, Rice, Rayleigh distribution) and the conditions of the single-frequency network can also be determined in stationary or mobile measurements. Measurements can be performed in two ways: preventive to avoid failures and in response to a warning from the monitoring system.

Preventive measures are required because the propagation conditions in the network may be different, for example, at different times of the year. It could be of advantage to use a simple, mobile and therefore favourably priced coverage measurement system that moves through the network area for 24 hours (eg in taxis, public service buses, etc). Coupled with GPS this system may perform Go/NoGo tests (signal received/not received). The outlay required for equipment and installation is relatively low. Data exchange can be performed via GSM and a clear picture of the network status can be obtained by superimposing the different measurements versus time and distance covered.

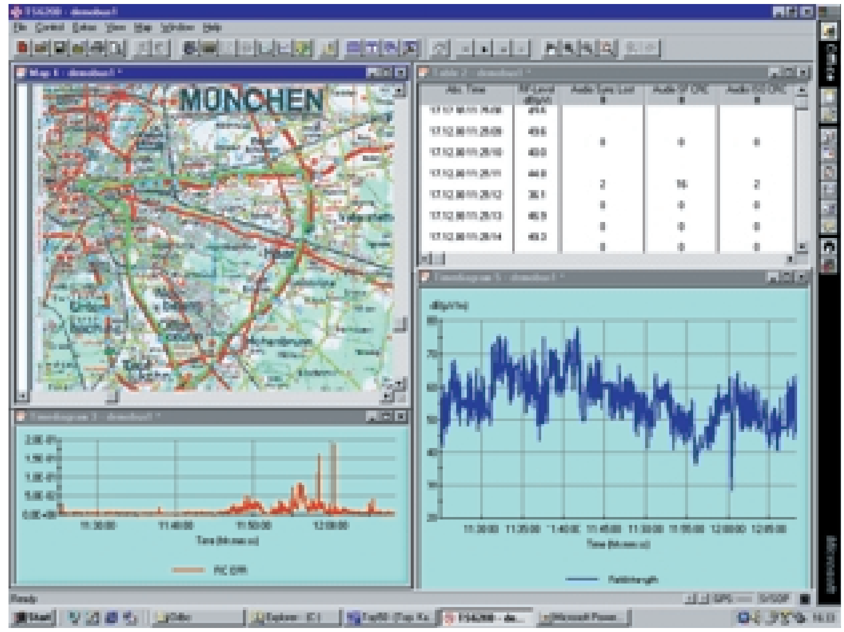


FIG 5 Results recorded during test trip

To obtain **more exact and comprehensive results**, the test system is installed in a vehicle (FIG 1) to measure eg RF spectrum, field strength and BER. On the basis of the monitoring results, the test vehicle is directed to specific points in the network to locate the sources of expected or already occurred failures. All measurements are coupled to GPS and can in addition be supported by displacement sensors. Results can be viewed online, displayed after the test trip by means of the replay function or forwarded to the network center for evaluation. It is also possible to access the individual monitoring systems at the transmitter sites from the test vehicle via GPS and to check the prevailing parameters.

FIG 5 shows measurement results of a CM system. The distance covered together with associated measured values is shown on the map. The test parameters may also be marked on the covered route after the measurement so that the values shown in different colours can be evaluated any time.

Conclusion

All three (sub)systems (for indoor monitoring, outdoor monitoring and coverage measurements) help in different ways to detect faults in the network before their effects show.

The systems developed by Rohde & Schwarz are used successfully worldwide in DAB and DVB networks.

Michael Lehmann; Dr Manfred Schukat

Reader service card 162/08 for further information on coverage measurement and monitoring systems

Extending EMC test systems for determining antenna parameters

Measurements via antenna more and more important

To ensure undisturbed operation of the continuously increasing number of mobile and cordless communication equipment, narrow tolerances have to be defined in the specifications. In the future, manufacturers will have to cope with more stringent measurement regulations, eg standardized type-approval tests or EMC measurements including measurements of antenna parameters.

Since more and more standards prescribe measurements via the antenna, conducted measurements have become of minor importance. As a result, manufacturers of mobile communication systems require facilities for measuring the antenna parameters of their products.

Antennas considerably influence the function of mobile communication systems eg of mobile phones. It is therefore important to optimize their characteristics.

It must also be taken into account that the user's head or even his hand may influence the antenna characteristics during a call and that transmission conditions are different in this case to those in free space. To simulate these external influences, an artificial head or an artificial user can be integrated in the test setup.

Measuring antenna parameters of mobile communication systems

Antenna parameters of mobile phones or other cordless communication systems cannot be measured with the well-known methods (two- and three-antenna measurements or reflector method) because the antennas of these products are mostly screwed to the equipment for reasons of cost and a standard 50 Ω or 75 Ω interface is not available for the measurements. Since antenna characteristics are also influenced by the equipment housing, measuring the antenna separately is not appropriate.

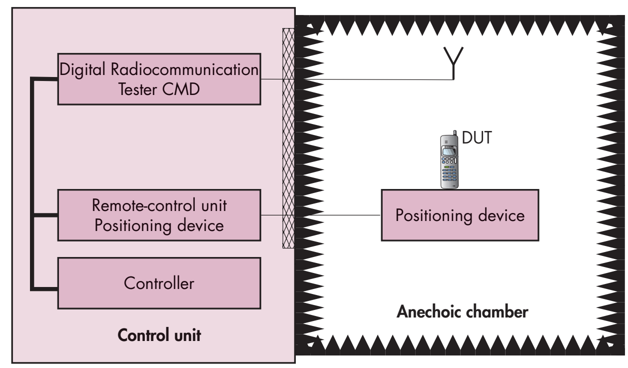


FIG 1
Test setup for BER measurement

To obtain informative results nevertheless, auxiliary parameters are measured and the antenna characteristics calculated therefrom. Since different frequencies are used for transmission and reception (eg with GSM and DECT), the measurements have to be performed separately in the transmission and reception mode.

Measurements in reception mode

An auxiliary parameter in reception measurements is **BER** (**b**it **e**rror **r**ate). It is normally evaluated in the data stream in the base station. In the test system this measurement is for example performed by Digital Radiocommunication Tester CMD from Rohde & Schwarz. The S/N ratio and/or the sensitivity and thus the relative antenna gain can be indirectly calculated from the BER. FIG 1 shows the basic test setup. A precondition for a correct measurement is that the radio link between the DUT and the radiocommunication tester is undisturbed as otherwise the BER measurement will yield incorrect results.

Two different **test methods** can be used:

1. Fixed signal level – measurement of actual BER

A signal generator applies a signal to the DUT (eg a mobile phone) with the worst-case level expected in practice. The mobile is moved over the whole hemisphere with the aid of a positioning device and the BER is measured at predefined angle steps. The resulting diagram shows the BER referenced to zero (direction of maximum radiation of mobile to source antenna) or absolute values. This method can only be used when the DUT is provided with a so-called **EMMI** (**e**lectrical **m**an **m**achine **i**nterface) which allows automatic call setup between base station and mobile without any manipulations from the outside. If the signal level received by the DUT is too low, the connection is interrupted. To continue the measurement, the call has to be set up again without intervention from the operator. Such intervention would impair measurement results or require the measurement to be restarted.

2. Controlled signal level – fixed BER

The other possibility is to set a constant BER (reference BER) with the aid of a controlled signal level. The signal generator first supplies a high level which is reduced after each BER measurement until the reference BER is attained. Positioning the DUT and drawing the diagram is performed in the same way as with method 1 with the only difference that not the BER but the signal level at which the reference BER is attained is displayed. The advantage is that the measurement is not interrupted each time a signal of insufficient level is received, but on the other hand a much longer time is required for the BER measurement over several information data packets. This measurement may take up a few seconds and require several control steps at each antenna position.

Measurement in transmission mode

In the transmission mode, information on antenna characteristics can be derived from the auxiliary parameter **EIRP** (**e**ffective **i**sotropically **r**adiated **p**ower), which is the power emitted by the DUT referred to an isotropic radiator.

The test environment has to be calibrated prior to the measurement for a subsequent determination of the power emitted by the DUT. A simple test setup consisting of signal generator, power meter and antennas (transmitting antenna with known gain replacing the DUT) will do for calibration. The RF output power of the signal generator should be high enough for obtaining a sufficiently high level at the power meter positioned at the required measurement distance (1 to 3 m). The power meter (eg NRVD with Peak Power Sensor NRV-Z31 from Rohde & Schwarz) should have a wide enough dynamic range and allow correct measurement and evaluation of the digital pulsed signal with a sensitivity <–40 dBm.

During the measurement the digital radiocommunication tester (replacing the base station) sets up a call and the DUT is driven to maximum output power. The emitted power is measured with a receiving equipment consisting of an antenna and a power meter. Based on the results obtained in calibration, the measured values are referred to an isotropic radiator (FIG 2).

A diagram can also be drawn in this case which shows the EIRP referred to zero (direction of maximum radiation of mobile to source antenna) or as absolute values.

Required test site conditions

Measurement uncertainties are closely related to the characteristics of the test chamber. The quality criteria **NSA** (**n**ormalized **s**ite **a**ttenuation; measurement in comparison with theoretical free-space loss) or **UA** (**u**niform **a**rea; field-strength variation above a defined plane) used for EMC measurements are not sufficient for accurate measurements of antenna parameters.

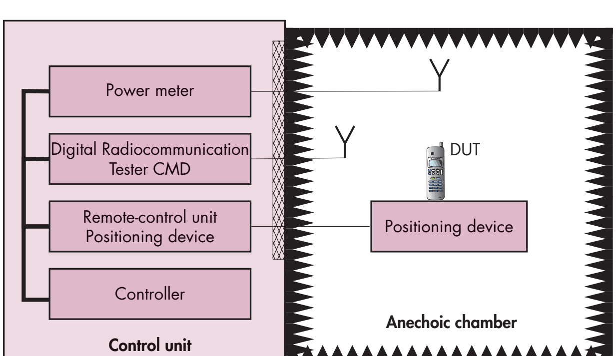


FIG 2 Test setup for EIRP measurement

To obtain small measurement errors, **a quiet zone** is required, ie a return loss of >40 dB for measurement errors <±2 dB.

Antennas with a highly **directional radiation pattern** (high gain in main direction of radiation; nulls with considerably lower gain, eg <–25 dB referred to main direction of radiation) can only be measured in a sufficiently quiet zone. In this case the antenna may receive the signal reflected by the floor or the walls in its main direction of radiation but the signal to be measured is received/transmitted via a null in the antenna pattern (FIG 3). With a gain difference of more than 25 dB, the signal power received in the main direction of radiation may then be just as high or only insignificantly lower than that received via the null.

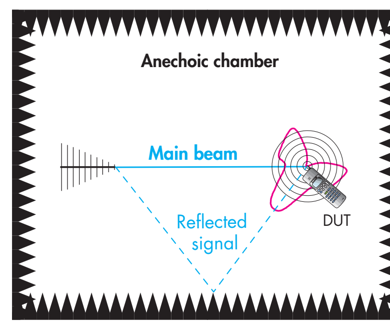


FIG 3 Test setup in anechoic chamber with rotated DUT featuring highly directional pattern

To remedy this, additional absorbers (on the floor and/or mobile absorber walls) can be used, which feature a reflection attenuation of >35 dB in the useful frequency range.

Extending available EMC test systems

Many manufacturers are therefore looking for ways to perform rapid and convenient measurements via the antenna in the development phase and to measure antenna characteristics without having to resort to a test house or an antenna lab. Other manufacturers of mobile communication systems already possess EMC test systems that can be easily upgraded to antenna test systems.

Rohde & Schwarz offers a comprehensive line of measuring equipment from radiocommunication testers via antennas to absorbers and highly accurate measuring heads. This allows almost any EMC test system to be extended for measurements of antenna parameters, no matter whether the characteristics of a mobile phone, a vehicle antenna or of other DUTs are concerned. The described measurements can also be performed with stand-alone antenna test systems.

Klaus Ilgenfritz

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Reader service card 162/09

Fading simulation with TV Test Transmitter SFQ

After the start of digital TV transmission via cable (DVB-C) and satellite (DVB-S), terrestrial digital transmission (DVB-T) is about to be introduced. In contrast to analog programs, DVB-T programs are broadcast via single-frequency networks, which allow a much more economical use of frequencies than conventional analog multifrequency networks. Influences of the terrain and the resulting problems of multipath propagation however prevail in this case as well (see blue box on next page).

Photo 43072

FIG 1 TV Test Transmitter SFQ, complete solution for testing digital TV links and receivers

The simulation of realistic receiving conditions in the terrestrial transmission channel is therefore an absolute necessity in the development of DVB receivers. **Fading simulators** [1] are used to create the corresponding scenarios.

TV Test Transmitter SFQ [2] introduced on the market with great success **for all DVB standards** is now available with **Fading Simulator SFQ-B11** (option). It is therefore ideal for testing and simulating receiving conditions particularly since all necessary features are combined in a single unit.

SFQ comes in two versions: with one option SFQ-B11 for simulating 6-path fading and with two options for 12-path fading. A fading profile using Rayleigh, Rician or pure Doppler distribution can be assigned separately to each path.

Pure Doppler fading simulates transmission on a single direct path between transmitter and mobile receiver. The Doppler shift is at its maximum when the receiver is moving on a direct path towards the transmitter or away from it.

Rayleigh fading simulates a radio traffic area where many strongly scattered waves evenly distributed in amplitude and phase arrive at the mobile receiver from all directions. With unmodulated signals, the Doppler spectrum typical of Rayleigh fading is obtained.

Rician fading simulates a radio traffic area where a strong direct wave is received in addition to many scattered

Multipath propagation

A signal emitted by the transmitter arrives at the receiver not only on the direct path. The transmission channel may be influenced by local conditions, eg topographical obstacles which cause reflections. The transmission behaviour also depends on the transmission frequency and in mobile operation on the vehicle speed. The sum signal at the receiver input may be made up of many single waves arriving with different delays phase and amplitude (FIG 3). In the worst case, the field strength at the receiver can be zero due to the mutual cancellation of the various waves. The Doppler effect has an additional degrading effect.

Impairment of mobile reception

The DVB-T standard was originally defined for stationary and portable reception but not for mobile operation. Detailed laboratory tests and field trials have shown however that the multicarrier method OFDM (orthogonal frequency division multiplexing) used with DVB-T is very reliable and also suitable for mobile reception. Mobile TV receivers are not equipped with roof antennas common for stationary analog receivers but with rod antennas that feature neither directivity nor gain. Due to this design aspect, the impairments caused by multipath propagation are difficult to eliminate.

TV Test Transmitter SFQ with option SFQ-B 11 is able to simulate the complex conditions in the transmission channel and so furnishes information on the response of mobile receivers in such situations.

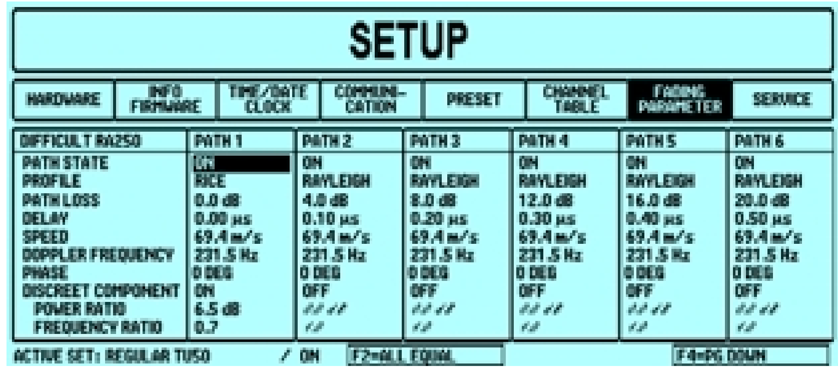

FIG 2 Predefined fading parameter set "DIFFICULT RA 250" in SFQ with six paths

waves. The fading spectrum of an unmodulated signal is the superimposition of the classic Doppler spectrum with a discrete signal line.

Log normal fading simulates an additional, rather slow variation of the receiving amplitude of a mobile receiver. If **Rayleigh fading** is switched on at the same time, **Suzuki fading** is obtained.

For each path, attenuation, delay, Doppler frequency and speed as well as the parameter denoting slow fading can be entered in addition to the above-mentioned fading types. Predefined channel models are stored in SFQ (FIG 2) and can be readily selected. The parameters can be varied as required.

In autumn 1998, the suitability of several DVB-T receivers for mobile operation was tested at the technology center of Deutsche Telekom within the MOTIVATE (mobile television and innovative receivers) project. On this occasion, SFQ with optional Fading Simulator SFQ-B 11 and Noise Generator SFQ-B 5 demonstrated its merits in this field of application in an impressive way.

Erhard Kretschmer

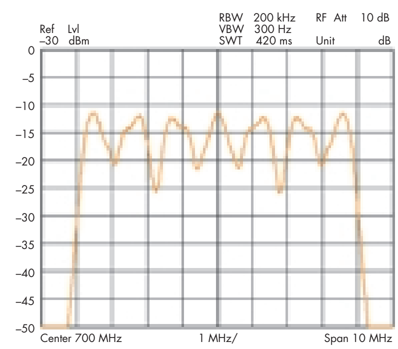

FIG 3 Spectrum of three-transmitter DVB-T single-frequency network. Signals are received with different delays

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Condensed data of Fading Simulator SFQ-B11

RF bandwidth (3 dB)	14 MHz
Paths	12 (using 2 options SFQ-B 11)
Path attenuation	0 to 50 dB, resolution 0.1 dB
Path delay	0 to 1600 ms, resolution 50 ns
Doppler shift	0 to 1600 Hz
Fading profiles	Rayleigh, Rician, pure Doppler, log normal
Predefined fading parameter sets	5 for 6 paths, 8 for 12 paths

Reader service card 162/10

Shortwave direction finding on ships

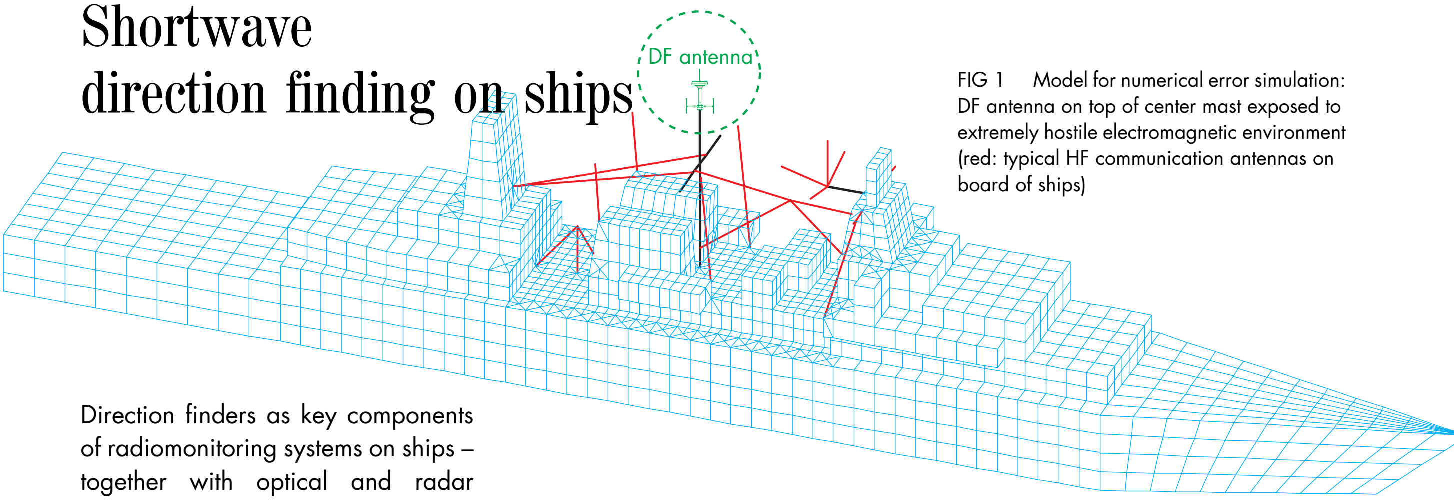


FIG 1 Model for numerical error simulation: DF antenna on top of center mast exposed to extremely hostile electromagnetic environment (red: typical HF communication antennas on board of ships)

Direction finders as key components of radiomonitoring systems on ships – together with optical and radar equipment – considerably expand the detection range in terms of frequency spectrum and distance. **In the shortwave band, however, direction finding systems on ships have to cope with extremely unfavourable electromagnetic environments** (FIG 1):

- Field distortion caused by scattering is highest in the shortwave band, where masts, communication antennas and shipboard structures produce marked resonances.
- Requirements made on electromagnetic compatibility with communication transmitters installed on board the ship are very high in the HF range – several 1 kW transmitters operating on an antenna less than ten meters from the DF antenna are not uncommon.

Whereas electromagnetic compatibility can be provided by means of suitably dimensioned antennas, filters and protective circuits, it takes a large number of measures and processes which are combined to handle the effects of scattering. Such measures became possible only when **modern computing and signal processing concepts** were available.

Interference in the incoming wave field calls for **DF methods** which take into account the actual behaviour of DF antennas in the surroundings of shipboard structures. There are essentially two methods:

- Direction finding based on the classic **Watson-Watt principle** by evaluation of the signals from two orthogonal loop antennas and an omnidirectional reference antenna. Bearings are then corrected by means of a correction table based on measurements.
- **Direction finding by comparison against a reference** (correlation principle, direction finding by vector matching), in which a measured set of antenna voltages (measured vectors) is compared with reference vectors stored in a table. The value that offers the best match together with the associated azimuth value yields the actual DF value. The table is created on commissioning the DF system by determining the reference vectors as a function of azimuth and frequency.

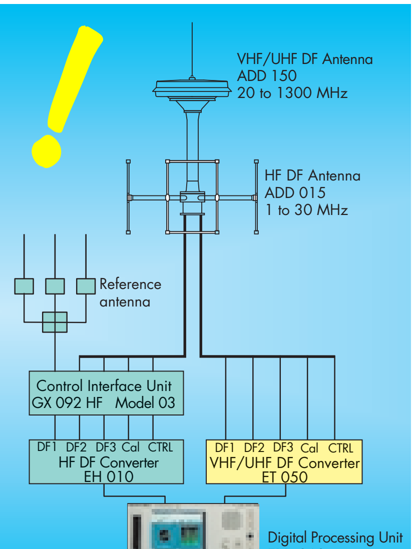
The method that yields more accurate bearings depends on the antenna configuration, the electromagnetic characteristics of the shipboard structures, the stability of the electrical parameters of the structures, and on the accuracy of the reference and correction data.

Principal requirements for solving the specific problems of HF direction finding on board of ships are the optimization of the antenna setup, the accurate measurement of correction data and evaluation of measured data (FIG 2).

Rohde & Schwarz offers optimum prerequisites for meeting the diverse re-

Direction finding on ships from 1 MHz to 1300 MHz

Example of shipboard direction finding in frequency range 1 to 1300 MHz with **Digital Monitoring Direction Finder DDF 06M**. **HF DF Antenna ADD 015** covers the HF range together with reference antennas used in diversity operation (group of three or four HE 010P rod antennas). Selection of antenna signals and conversion to IF is effected by triple HF DF Converter EH 010. The HF antenna is designed so that it can easily be combined with **VHF/UHF DF Antenna ADD 150**, which operates on the principle of the correlative interferometer in the range 20 to 1300 MHz. Triple ET 050 is used as DF converter. The frequency range can be extended to 3000 MHz simply by adding UHF Antenna ADD 070 and DF Converter ET 070.



quirements in this field: a **wide range of fast, digital direction finders** [1; 2], a **comprehensive choice of services** and, last but not least, long-standing experience in direction finding at all frequencies:

- Direction finding based on correlation or Watson-Watt principle
- Antenna diversity methods to minimize 180° ambiguity
- Correction memory integrated in direction finder
- Comprehensive service packages: assistance in optimizing antenna position by numerical simulation, support in determining correction data (measurement, error compensation, handling of ambiguities, interpolation of frequencies and angles)

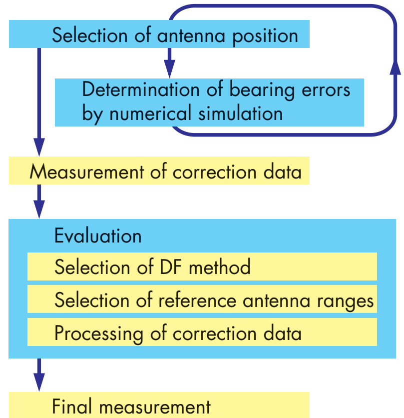


FIG 2 Minimization of bearing errors through computer-aided selection of antenna position and accurate measurement and evaluation of correction data

For example, the DF system from Rohde & Schwarz (see blue box on page 29) reduces the effects of shipboard structures to the extent that, despite non-correctable errors remaining (caused by changes in the mast surroundings or by field singularities), **total measurement uncertainty** will not exceed **5° for single-mast ships** and **7° to 10° for two-mast ships** (typical rms values, samples evenly distributed across frequency and azimuth ranges). In the VHF/UHF range, inaccuracy without bearing correction is just about 3° (rms).

Franz Demmel

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Reader service card 162/11 for more detailed information on shortwave direction finding on ships

Countrywide *ACCESSNET*® trunked radio system in South Siberia

Irkutskenergo is a big Russian utility company operating in the vast region west of Lake Baikal in South Siberia (FIG 1). The Irkutsk administrative region (FIG 2), where Irkutskenergo operates, has an area of about 770 000 km^2 and a population of around three million people. In this area, there are several huge power plants (among which the Bratsk and Ust'-Ilimsk plants are the biggest) and major industrial enterprises, including an aluminium plant.

A year ago, the company's administration decided to upgrade its telecommunications and information network. The old system could no longer provide the necessary reliability and performance.

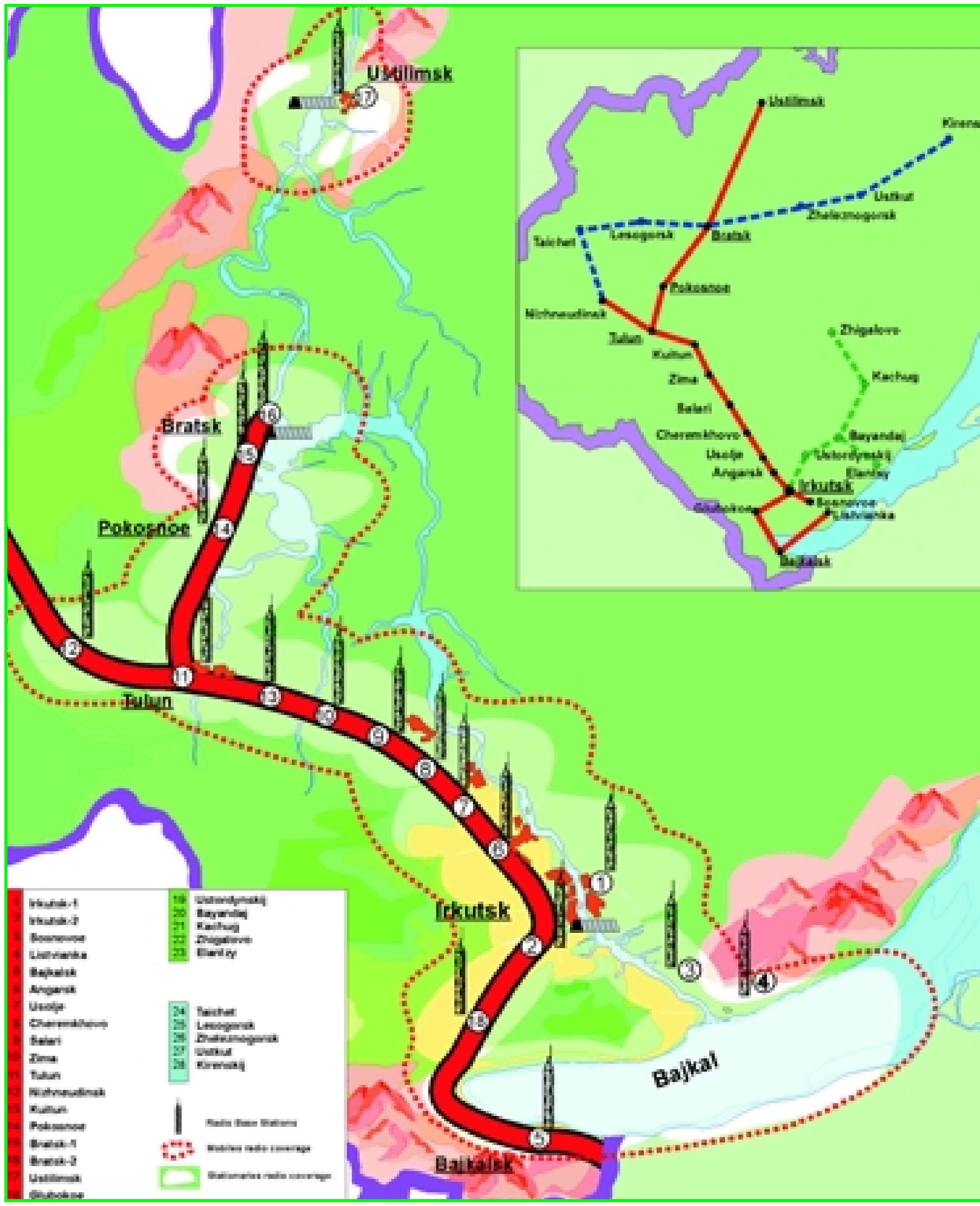
To provide the company with state-of-the-art communication facilities, a countrywide *ACCESSNET*® multicell trunked radio system which includes a high-speed ATM (asynchronous transfer mode) backbone is being built. Special measures have been taken to ensure long-term and reliable operation of the network. The trunked radio system is envisaged to contain

Photo: author

FIG 1
A countrywide trunked radio system from Rohde & Schwarz is going to be installed at the deepest lake of the earth – Lake Baikal in South Siberia (1620 m deep, 636 km long, up to 80 km wide)

FIG 2
The Irkutsk administrative region has an area of about 770 000 km^2 and a population of around three million people

Illustration: RC & C



both mobile and fixed terminals, and subscribers should be able to make calls between one another and connect up to the PSTN (including long-distance and international calls).

It was particularly important to provide for reliable means of communication for service teams that should immediately arrive on site in the event of a failure. Reliable mobile communication is vital not only for service teams but also for Irkutskenergo's executive personnel, expediters and other employees who often have to work far from their base. In addition, Irkutskenergo's infrastructure comprises many smaller sites, which need to have a wireless connection to the communication network since they are so small and so far away from main sites that it would be unreasonable to install wired links for them.

So, the new communication network was to meet the following requirements:

- The system should consist of several cells, and users should be able to make calls both within a cell and between cells.
- Call setup time should be very short, also for calls between cells.
- Both individual and group calls should be possible.
- Both voice and data calls should be provided.

IIrkutskenergo decided in favour of an MPT 1327 *ACCESSNET*® trunked radio system from Rohde & Schwarz – as did the United Arab Emirates some time ago [1] –, because this system optimally fulfils all the above requirements, and this at a very favourably price (see blue box on page 32).

The order for installing the new network was placed with RC & C Moscow, the Russian partner company of Rohde & Schwarz. The system intended for South Siberia is called IRTRANK. The first stage, which was commissioned in late 1998, covers a 800 km section of the ATM network and comprises 13 base stations and nine *ACCESSNET*® trunked site controllers, with a total of 80 radio channels. After completion of the second stage of the project, 31 base stations, 26 trunked site controllers and 150 radio channels will be available.

The IRTRANK system is based on the MMX trunked site exchanges of the *ACCESSNET*® family (mobile-to-mobile exchange). The master controller, a fast digital MMX 64/64 controller, is installed at Irkutskenergo headquarters (FIG 3). This central controller provides for the linkup of mobile subscribers to the PSTN via the Meridian PBX from Nortel. It is also connected to the network management and administration system. Two smaller MMX 64/32 digital controllers are used at two other sites where traffic is expected to be particularly dense. At all other sites, MMX 4 and MMX 8/16 controllers are used.

The base stations of the IRTRANK network also belong to the *ACCESSNET®* family. Stations of three different types are used: ND 950 (four, six, eight or twelve radio channels), ND 951 and ND 953 (four radio channels each). Subscriber terminals are mostly half-duplex stations from Motorola (GP 1200, GP 600 and GM 1200). Irkutskenergo's corporate management is provided with full-duplex H 70 and R 72 mobiles from Nokia.

Links between cells of the first stage are on the whole based on an ATM network. A typical node of the network includes an *ACCESSNET®* trunked site controller, an *ACCESSNET®* base station, a Meridian 1 PBX and an ATM switch from FORE Systems. The PBX integrates all the voice signal streams from the wired and wireless subscribers allocated to the node and routes the integrated stream to the ATM switch via a digital ISDN channel. For the connection between cells, 2 Mbit/s channels are provided in the ATM network based on the circuit emulation protocol.

IRTRANK subscribers can use the following network services:

- Voice calls
- Transmission of status messages
- Data transmission
- Alarm signalling

IRTRANK subscribers can initiate individual and group calls of standard and high priority. The system administrator determines which subscribers may only initiate calls between trunked system users, which subscribers can connect up to the users of the corporate phone system, and those allowed to make calls to the PSTN. The system administrator also defines the subscribers who can participate in group calls. The group configuration can be changed very quickly by means of the network operating system (NeOS), which is especially important for organizing emergency teams.

Alarm messages are calls of the highest priority. The system administrator therefore determines which subscribers are allowed to initiate such calls.

Why *ACCESSNET®* won over competitive systems

- *ACCESSNET®* allows building systems of arbitrary topology. This factor turned out to be very important for Irkutskenergo because if the "pure" star topology were used, the traffic between adjacent cells would be forwarded to the central controller, leading to unnecessary loading of the network links.
- Only *ACCESSNET®* allows the use of 2 Mbit/s links between network controllers, thus providing for very fast establishment of calls between cells.
- Only *ACCESSNET®* provides for a smooth transfer from analog to digital trunked radio networks based on the TETRA protocol.

Status information can be transmitted to exchange messages with predefined contents. The total number of such messages is 30.

Data can be transmitted in short and extended blocks and in contiguous streams of arbitrary length. Short and extended data blocks are transmitted in the control channel (maximum length of short block 184 bits, of extended block 736 bits), whereas contiguous streams are sent via the traffic channel.

Dr Alexej Jalyschko

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Reader service card 162/12 for more information on *ACCESSNET®*

Photo: author

FIG 3 Central exchange of trunked radio system

ISDNwall – intrusion detection and protection for telecommunication systems

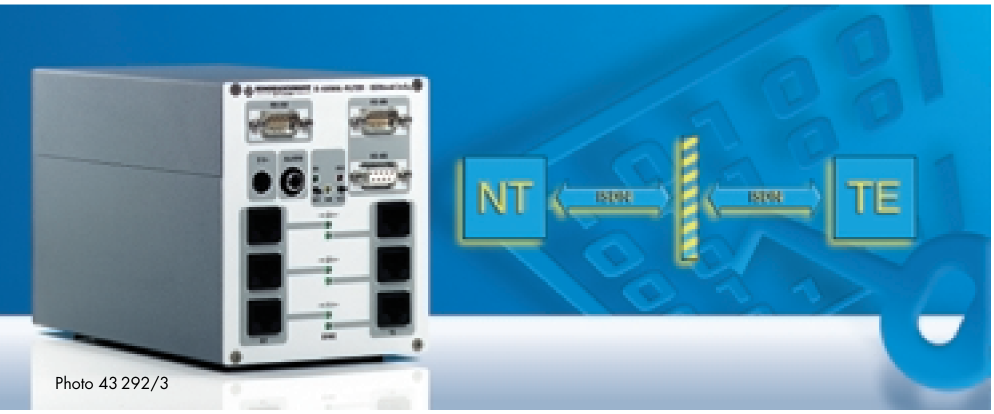

FIG 1 D-channel filter ISDNwall for intrusion detection and prevention of unauthorized access to ISDN telecommunication systems

The increasing digitization of information is gradually eliminating the differences between classic communication networks and modern digital IT networks. **Consequently, communication networks are confronted with the same security problems as classic IT networks.**

Information and communication are of great strategic importance these days. This applies to industry as well as to military and government authorities. The vulnerability of information transmission means that the protection of IT resources and communication infrastructure becomes more and more important, as attacks on information may have disastrous consequences.

ISDN telecommunication systems are vulnerable

The aim of intrusion is to find weak spots in the telecommunication infrastructure

- to obtain or manipulate information without physically entering buildings and systems,
- to manipulate telecommunication systems so that they fail or alter the information they transmit.

Threats to ISDN telecommunication [1] are for example eavesdropping in rooms or listening in on conversations by secretly activating the hands-free facility or misuse of the three-party conference feature, and the manipulation of charges by activating call forwarding.

Up to now targeted and massive intrusions into telecommunication networks and equipment at the information level have not often made the headlines. It is unquestioned among experts, however, that organized crime for example has the necessary technical and intellectual potential for such actions. If the intruder succeeds in manipulating the displayed calling party number, he will also be able to conceal his intrusion.

Intrusions to the information level of telecommunication systems imply an access to the system. This **access** could be made **via the administration interface**, which is normally used for local or remote configuration, servicing and maintenance of the system. Such an interface must therefore be protected by identification and authentication methods like those known from IT systems.

Another characteristic way to **access** ISDN telecommunication systems is **via the ISDN D-channel**. All digital information for the control of call setup, services and performance features are exchanged via this channel. Normally it cannot be used by the subscriber, but that does not exclude misuse. With the aid of suitable technical equipment and special know-how, services and features or special system functions can be activated by manipulating the command sequences in this channel and thus be used for criminal purposes. Professional intruders are able to feed special byte sequences into telecommunication systems, which have a similar devastating effect than viruses and Trojan horses in computers. This has also been confirmed by experts. If a break-in is successful, the intruder practically controls the telecommunication system.

Users with increased security requirements are not only interested in preventing intrusions but also in **early detection** of access or manipulation attempts.

The solution: ISDNwall

A great variety of mechanisms are known and being used in classic IT networks for the detection and prevention of intrusions. Firewall facilities have nowadays become an integral part of security concepts for LAN connections to the Internet, and intelligent tools for the detection of intrusions are under development and in use.

An effective means of detecting intrusion attempts and of preventing illegal access via the D-channel is to monitor and evaluate all information transmitted in the D-channel between the PSTN and the telecommunication system. This protection method is also referred to as **D-channel filtering** [2].

In the D-channel filter the information is packetized and the packets are checked and compared to presettings (filter conditions). Protocol-based filter rules ensure protocol-conformal information transmission. User-specific filter rules assign activated services and features to the dialling numbers of individual subscribers.

A comparison of D-channel packets with the configurable filter conditions reveals any infringement of filter rules that may point to intrusion and manipulation attempts. Infringements are signalled by appropriate facilities, registered and stored in a nonvolatile memory. The general filtering principle "All services and features not explicitly activated are barred!" ensures that any infringement of filter rules is met by a link cleardown so that intrusions become impossible.

The **D-channel filter ISDNwall** (FIG), **a product of SIT Gesellschaft für Systeme der Informationstechnik in Berlin, a subsidiary of Rohde & Schwarz**, was developed by order of and in close cooperation with the German information security agency BSI. In addition to the protection of telecommunication systems against illegal access, ISDNwall may be used as a device for **intrusion detection**, independent of the make of the telephone system. By using the wide-ranging and versatile capabilities for defining filter rules as well as the comprehensive protocol information, detected infringements can be evaluated and illegal access and intruders identified.

The D-channel filter allows the firewall principle for IT networks to be used also for access via ISDN telecommunication systems. But the D-channel filter not only complies with the classic principle of intrusion detection by monitoring the control information in both directions, it also detects and prevents infringements of conditions and illegal access of "internal intruders".

ISDNwall can be supplied as a separate unit for basic access (S_0) or primary rate access (S_2M).

Volker Schneider

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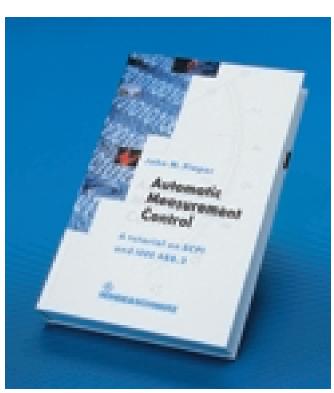
Reader service card 162/13

Booktalk

Automatic Measurement Control – a tutorial on SCPI and IEEE 488.2

John M. Pieper's tutorial appeared in January 1999 as an Rohde & Schwarz publication (hard cover, 295 pages, numerous programming examples, tables and diagrams) and is obtainable from our sales representatives for approx. 45 EUR. The author was over many years a member of the standardization bodies dealing with IEC 625, IEEE 488 and SCPI, and has thus acquired an enormous expertise in the field of remote-controlled T & M instruments. He is running his own business called ACEA, which offers consulting in ATE and SCPI matters.



This tutorial is the first book worldwide describing the basic concepts of SCPI (Standard Commands for Programmable Instruments) and of the standards IEEE 488.2 and IEC 625.2, on which SCPI is based. It is written for all users of instruments and systems involved in programming automatic test systems via the remote interface or for those wishing to understand the basic concepts of these standards. The various ways in which instruments can be remote-controlled are described in detail, providing valuable information for the effective generation of application programs.

With the bulky reference manual of the SCPI standard compiled in alphabetical order it is often very difficult to find the appropriate command for remote-controlling a particular instrument function. The standard resembles a dictionary rather than a tutorial – and no one can learn a new language just from a dictionary. Pieper's book is a help in this respect: The author explains the basics of the "SCPI language", ie the communication protocols and the syntax defined in the IEEE 488.2 standard, and then discusses the SCPI approach to programming the remote control of device functions. John M. Pieper describes the device model and the signal flow between subsystems as well as the way in which they are linked to the programming commands defined in SCPI. Further chapters deal with the synchronization of internal processes such as data collection or signal generation as well as the modelling of the device status and the concept of device classes, which will increasingly gain in importance in the future.

Comprising ten chapters and comprehensive appendices, this book is an indispensable reference and a useful supplement to users' manuals for all involved in the SCPI programming of instruments for use in automatic test systems.

Jochen Wolle

Test systems reaching for the skies: measuring the EMS of large DUTs

If the dimensions of the DUT exceed the half-power beamwidth of the antenna used for measuring the DUT's immunity to electromagnetic fields, most standards prescribe tests to be repeated at different antenna positions changed in steps. This ensures at least that each part of the DUT is exposed to the required field strength.

Utility vehicles, aircraft, booster rockets and their payload can only be tested in sufficiently large chambers or on open-area test sites. Commonly used concepts will do as long as the DUT is no more than about four meters in height. Mobile tripods or remote-controlled antenna masts can be used for example in the frequency range up to 1 GHz. To attain the required field strength, transmitting antennas are fed via low-loss cables.

A customer from the aerospace industry had to test an eight-meter-high DUT, which could not be laid flat, in the frequency range 10 kHz to 18 GHz with a field strength of 100 V/m.

After detailed investigations it became clear that the required field strength at 18 GHz can be obtained with a 200 W amplifier only if the RF amplifier is lifted up together with the transmitting antennas. Otherwise the power loss would be too high because of the required cable length. A load of approx. 500 kg would have to be lifted. This excluded the use of plastic masts or light steel constructions.

Rising high from a solid base: test systems "growing" with DUTs

Photos 43 119/1...3

Rohde & Schwarz found an economical solution which could be used as a universal antenna support for the whole frequency range. The test equipment was mounted on a highly stable, telescopic and scissor-type lifting platform which meets all requirements (FIG):

- Permanently installed EMS Test System TS 9983 (1 to 18 GHz)
- Hoisting range 1 to 8 m (upper platform end)
- Low-torsion and low-swing scissor-type concept ensuring high positioning accuracy
- Electro-hydraulic drive and hoisting (lead accumulators)
- Antenna arms for electric field generator and antennas (f <1 GHz)
- Use of test receiver (1 to 40 GHz) with horn antennas on platform possible
- Power cables, coaxial cables and fiber-optic IEC/IEEE-bus cables in dragchain
- Carrying capacity for one person
- Remote-controlled height adjustment (option)

The installed EMS Test System TS 9983 from Rohde & Schwarz contains

- a Microwave Signal Generator SMP,
- two Dual-Channel Power Meters NRVD with four Power Sensors NRV-Z2,
- four 200 W amplifiers with travelling-wave tube and

- four horn antennas with remote-controlled polarization on tiltable support (elevation 0 to –20°).

The field-strength sensor is connected to the monitor in the control room. For an EMS test using the substitution method, the sensor need not be moved to a great height because the reference calibration performed at a height of say two meters is also valid higher up. If a field-strength measurement is nevertheless desired during the test, the antenna mast of an EMI test system can be used.

Amplifiers with sufficient output power have been chosen for the frequency range below 1 GHz and installed in a shielded room. Connection to the antennas on the platform is via the coaxial cable in the dragchain.

The telescopic, scissor-type lifting platform with the EMS test system is of particular interest for EMC laboratories that have to test large DUTs. If the test frequency range is to be extended at a later stage, the described platform is the ideal choice.

Reinhard Göster

Reader service card 162/14

Motorola Service Test System GATE 22: Faster with T&M from Rohde & Schwarz

CMD 55 reduces test times

Faster – further – higher. This principle is the driving force not only in sports but also for measurements. Fast service of good quality throughout is essential for successful marketing, particularly of mass products like mobile phones.

This is why Motorola also uses the **fast Digital Radiocommunication Tester CMD 55** from Rohde & Schwarz in its GSM Service Test Systems GATE 22. Because this digital multimode, compact tester offers considerably shorter test times than comparable solutions. Short test times for each phone increase the throughput rate for repairs, particularly in a standardized shop environment similar to that in production.

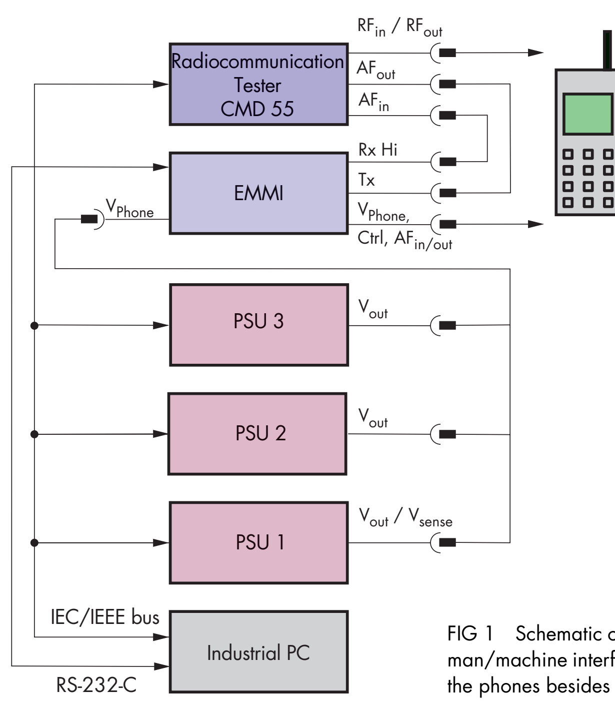


FIG 1 Schematic of GATE 22: EMMI (electric man/machine interface) is the only interface to the phones besides the RF link

High quality through standardization

Motorola expects its authorized service partners to use standardized systems for the alignment and testing of GSM mobile phones. The same tests worldwide guarantee high repair quality, and firm test times allow optimum planning of resources. Service Test System GATE 22 (generic automated test environment) was developed by Motorola's service engineering departments. Hardware design was harmonized in close cooperation with two manufacturers of the instruments used in the system. These manufacturers are also responsible for assembly, final inspection and dispatch to the user. Service Test System

GATE 22 thus comes in two versions and the Motorola service centers can choose their model.

FIGs 1 and 2 illustrate the **Rohde & Schwarz version**. The nucleus of the system is Digital Radiocommunication Tester CMD 55, which establishes an RF connection to the phone and performs RF and audio tests. Mobiles are powered from three power supply units connected to the EMMI (electric man/machine interface). Except for the RF connection, the EMMI is the only interface with the phones for applying power and audio signals or for controlling and programming.

Motorola software

The test systems are driven by GATE 22 for Windows software, written and continually upgraded by Motorola. It includes a number of predefined tests:

- **Call measurement** Telephone parameters are measured during a call in various, adjustable test channels
- **Phasing** All adjustable telephone parameters are adjusted without any action on the part of the user
- **Final test** Phasing and call measurement test are performed without any interruption
- **Flashing** Update of telephone firmware
- **Flexing** Matching of telephone software and features

Additional software tools are available for more complex repairs. To allow for local conditions (eg interference or work flow in the service center) that might cause problems for the test sequence, some test parameters can be adjusted within preset limits (eg test and phasing channels as well as autoprint function).

Worldwide support

Service Test Systems GATE 22 are used worldwide in all service areas. Updating of test software and development of test adapters for new telephone models are tasks centralized in Germany at Motorola in Flensburg. Regional Motorola staff and trained personnel are responsible for on-site support.

A support page from Motorola is available on Internet to all GATE 22 users. It contains the current versions of the test software, flash and flex files and lots more for downloading. A special service is the online order system for spare parts. In this way cables and other accessories can be ordered straight from the manufacturer for example.

Competence close to user

For integration of Service Test Systems GATE 22, Rohde & Schwarz has created competence centers worldwide in Europe, America and the Far East, ie as near as possible to the user and as centralized as necessary. Through close cooperation with the Motorola support groups, comprehensive support can be provided to the service centers.

Axel Schneider (Motorola); Bernd Petersen (Motorola); Martin Stumpf

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Reader service card 162/15 for more information on CMD55

FIG 2
Rohde & Schwarz model of GATE 22: Digital Radiocommunication Tester CMD 55 considerably speeds up Motorola's GSM service test system compared to solutions from other manufacturers.


Photo 43 299/1

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First test system for CDMA mobiles

In close cooperation with QUALCOMM, Rohde & Schwarz developed a ready-to-go system solution for complete tests of CDMA phones. TS 8180 comprises CDMA Radiocommunication Tester CMD 80 as well as two signal generators, a power supply and the interface for the CDMA phones. The test system meets CDMA specifications IS-98-A and J-STD-018 including AMPS, and it addresses manufacturers as well as network operators and service centers. Applications include production, conformance verification as well as service and quality assurance.

Rohde & Schwarz CDMA Test System TS 8180 was designed for a universal final test station for CDMA phones in line with QUALCOMM specifications and equipped with the test routines of the QUALCOMM terminal test set. All system components are accommodated in a 19-inch rack that can easily be integrated into any production line.

"The CDMA test system from Rohde & Schwarz provides a worldwide standard system solution for our partners, designed exactly according to our requirements. It has already proved its performance during several practical tests in our facilities", explained James W. Silk, program manager at QUALCOMM, Technology Transfer Licensing. "Rohde & Schwarz, as a leading supplier of CDMA test equipment, also stands for a high degree of quality, safety of investment as well as excellent worldwide support to its customers and partners."

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Innovative products from Rohde & Schwarz at HYPER 99 in Paris

This year Rohde & Schwarz had its own stand at the radiocommunications exhibition "Hyper & RF", held in Paris from 19 to 21 January. A large number of innovative products from different fields were presented. Rohde & Schwarz showed its new Microwave Signal Generator SMR for the very first time (see article on page 4). This new model is characterized by convenience of operation and small size. A special feature is its "EasyWheel", an innovative control allowing simplified menu selection and equipment manipulation by turning and clicking.

Another premiere was that of Spectrum Analyzers R 3132 and R 3162 from Advantest. These new middle-class units up to 3 GHz or 8 GHz are for use in production and servicing as well as consumer electronics and EMC applications during development, which makes them highly versatile tools (see article on page 13). "Hyper & RF" also saw the presentation of Miniport Receiver EB 200, which detects and monitors emissions, faults and especially low-power transmitters even in adverse terrain.

The show drew a lot of visitors. Attendance on the Rohde & Schwarz stand was very high, with many customers calling by and plenty of new contacts being made.

Stefan Böttinger

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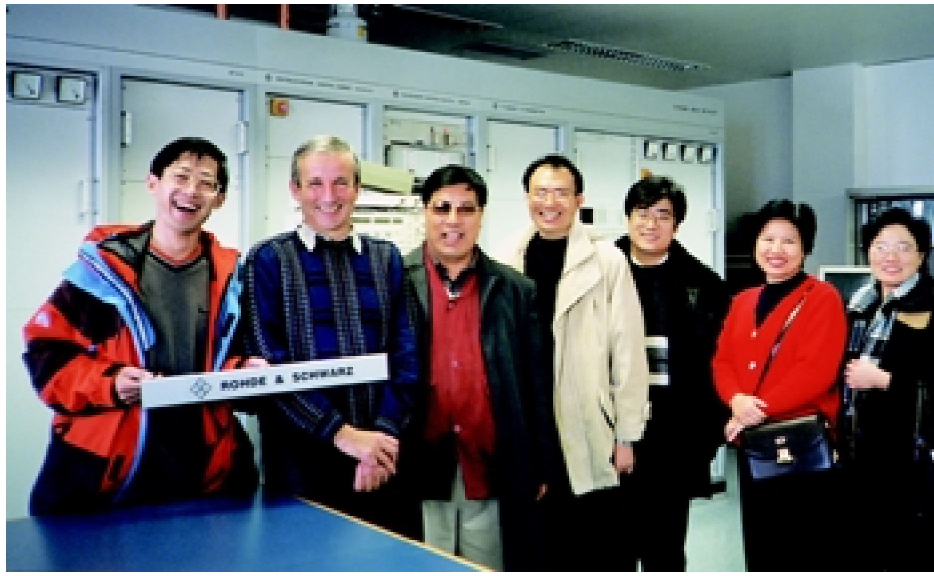
Photo: RSF

Photo: Beckmann



Shenzhen BC visits transmitter site

Late last year a delegation from the Shenzhen Broadcasting Transmission Corp. based in South China visited Rohde & Schwarz in Munich for the acceptance testing of their 20 kW UHF TV transmitters. Besides technical discussions in the plant, the visitors were primarily interested in getting to see transmitters in realtime operation. Obligingly, the management of the broadcaster Bayerischer Rundfunk arranged for a visit to the station atop the Wendelstein mountain. The head of the Chinese delegation, Mr Yu De Jiang (3rd from left), once managed a transmitter station in the Chinese mountains himself for 20 years, and was therefore very happy about this chance to see a German transmitter site. Accompanied by the splendid natural scenery of the mountains thick with snow – it was the first live encounter with snow for most of the visitors – the visit to this optimally equipped transmitter station and the precise information from the station manager formed the culmination of the delegation's stay in Germany.

Johannes Beckmann

Photo 43 117

ZVR top product of 1998

The journal "Microwaves & RF", which is circulated worldwide, declared Vector Analyzers ZVR from Rohde & Schwarz "Top Product of 1998". The choice is made by the magazine's editors and focuses on innovation and performance. ZVR found the jury's favour because, as they said, it is the first vector network analyzer enabling production lines to benefit directly from its enormous measurement speed.

Stefan Böttinger

Get-together of shortwave specialists

The "Nordic Shortwave Conference HF 98", which was held on the Swedish island Farö from 11 to 13 August 1998, is one of the most important events in the shortwave calendar. HF specialists – users and researchers alike – come together to discuss their work and to obtain information on the latest trends in research and product development in the field of shortwave.

This time Thomas Kneidel from Rohde & Schwarz presented the Postman software, which provides access to the Internet via shortwave and TCP/IP. Furthermore, Prof. Geoffrey Gott of the University of Manchester Institute of Science and Technology and his team reported on a research project for measuring the spectral occupancy of the HF band in northern Europe. One of the project's four measurement sites is in Munich and is run by Dr Christof Rohner from Rohde & Schwarz.

Günter Greiner

World DAB Symposium in Singapore

Between 13 and 15 January 1999, DAB experts met in Singapore for their most important event worldwide, the DAB Symposium. This is held only once every two or three years and is a platform for specialist papers on DAB, presentations of DAB applications in practice as well as of the latest trends and products. Rohde & Schwarz used the opportunity to show its latest solutions to a keen circle of specialists. The range of products presented here comprised DAB transmitters and multiplexers as well as encoders and DAB measurement equipment.

Set up strategically in the foyer of the show, the Rohde & Schwarz stand attracted many visitors. Even BG George Yeo showed up, Singapore's minister of information and arts and deputy minister of commerce and industry. He was mostly interested in DAB transmitters. On the occasion of the symposium the DAB transmitter system was put into operation. Rohde & Schwarz supplied the entire equipment required such as DAB transmitters, encoders and multiplexers.

Stefan Böttinger

Phase Noise Measurement Software FSE-K 4 enables Spectrum Analyzer FSE to be used as a phase noise tester with free editable sweep settings and fast residual FM/PM measurements; comprehensive marker functions, storage of results, detailed printouts.

Data sheet PD 757.4201.21 enter 162/16

High-Performance Coverage Measurement System TS 9955 Depending on its configuration TS 9955 helps in the planning, installation and optimization of analog and digital mobile radio systems as well as of broadcasting networks. It also allows mobile quality monitoring. Use in multifrequency networks is no problem.

Data sheet PD 757.2138.22 enter 162/17

Power Meter NRVS, Level Meter URV 35 and Dual-Channel Power Meter NRVD (now all to 40 GHz and from 100 pW, depending on sensor used) Among other things, the following options have been included in the revised data sheets:

- New 50 Ω Sensors NRV-Z 15 (diode, 50 MHz to 40 GHz, 400 pW to 20 mW)
- NRV-Z 55 (thermal, DC to 40 GHz, 1 µW to 100 mW)
- 2 x NRV-Z 32 and NRV-Z 33 (peak, 30 MHz to 6 GHz; 100 µW to 2 (4) W or 1 mW to 20 W)

Data sheet
NRVS: PD 756.3182.23 enter 162/18
URV35: PD 756.9497.23 enter 162/19
NRVD: PD 756.3176.23 enter 162/20

Hearing Aid Test System UPL + (test chamber and accessories) **UPL-B7** enables measurements to standards (IEC 118, ANSI S 3.22) and other tests as well as tolerance checks; for all fields of application.

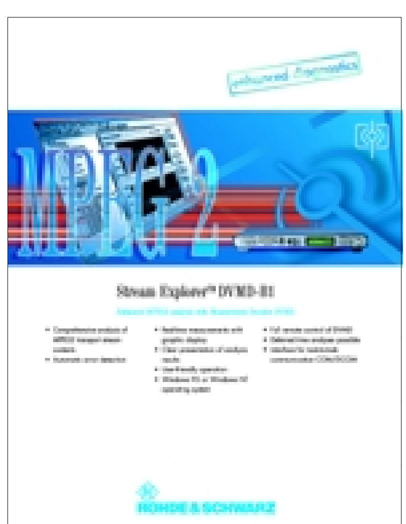
Data sheet PD 757.2696.22 enter 162/21

Stream Combiner® DVG-B 1 Enlarged transport stream capacity, remote control of MPEG 2 Generator DVG from DVG-B1 and other new features are contained in the data sheet.

Data sheet PD 757.3611.22 enter 162/22

Stream Explorer™ DVMD-B 1 Transport stream monitoring, offline operation and remote control of MPEG 2 Measurement Decoder DVMD from DVMD-B 1 are characteristics of the new model.

Data sheet PD 757.3628.22 enter 162/23



Miniport Receiver EB 200 (10 kHz to 3 GHz) The data sheet has been revised especially to update the specifications.

Data sheet PD 757.3728.22 enter 162/24

Solid-State UHF TV Transmitter NH 500 The new data sheet covers also the extended power range (from 2.5 kW and up to 40 kW).

Data sheet PD 757.1690.22 enter 162/25

50 W VHF Data Radio XU 250 D (118 MHz to 144 MHz) of Series 200 for speech and data communication in ATC is already designed to handle VDL modes 3 and 4 (to MOPS).

Data sheet PD 757.4353.21 enter 162/26

UHF DAMA SatCom Terminal XD 482 UD (Rx: 245 MHz to 270 MHz, Tx: 290 MHz to 320 MHz; 150 W) from Rohde & Schwarz and Viasat Inc. enables universal satellite communications to MIL-STD-188-181, -182, -183.

Data sheet PD 757.4330.21 enter 162/27

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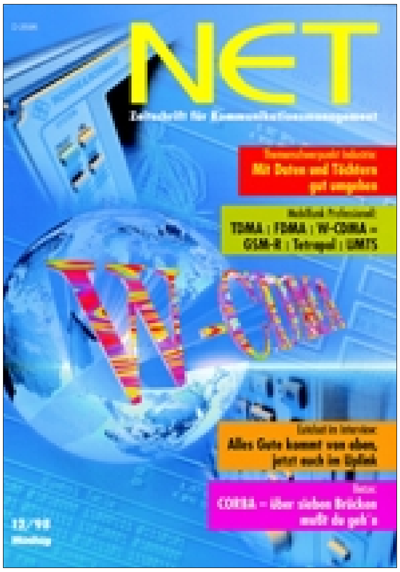


The December issue of "NET", the specialist magazine for communications management, was devoted to third-generation mobile radio. Rohde & Schwarz's pioneering role was evident on the title spread, with picture extracts of Signal Analyzer FSIQ attractively illustrating the subject of W-CDMA. The publication went on to report in detail about the status of developments in this new generation and the innovative T & M instrumentation designed specially for the purpose by Rohde & Schwarz.

Requirements met

In its 11/98 edition "Microwaves & RF", which circulates worldwide, presented Rohde & Schwarz's ZVR family of vector network analyzers in a feature titled "Vector Analyzers Pare Test Time":

Vector analyzers have become standard measuring aids in RF engineering. They detect a large amount of data during a measurement, so their sweep speed is the critical factor when using them in a production environment. With sweep speeds of 125 µs/point for measurements from 10 kHz to 4 GHz or 20 kHz to 8 GHz, the ZVR family from Rohde & Schwarz satisfies these production test requirements.

Automatic testing

In its 45/98 issue "Markt & Technik", the well-known German electronics weekly, looked at an automatic cell from Rohde & Schwarz for electrical and optical testing of electronic boards:

International competition, short product cycles, lots of product variants and small-sized batches all force the electronics producer into more and more automation, but it should not halt where testing starts. …Rohde & Schwarz's automatic test cell combines an electrical and an optical test system with automatic fixtures for inserting, interfacing, sorting and stamping the boards. The individual units are optimally attuned to one another, allowing graduated solutions, at the right price, for practically every application.

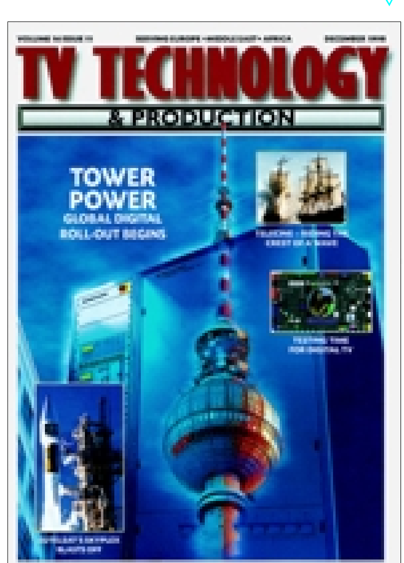
Head and shoulders

The 22/98 edition of the German trade publication "Telecom Handel" looked at the subject of GSM/DECT testers. In a comparison under the title "Service has its price", CTS60 and CTS65 from Rohde & Schwarz were out in front:

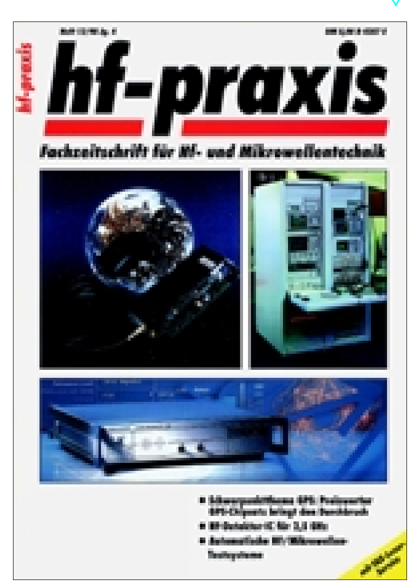
…Digital Radio Tester CTS 65 from Rohde & Schwarz, a multimode service tester for GSM and DECT, is not your ordinary instrument. For DECT alone there is CTS 60. For upwards of about DM 20,000 they offer a wide variety of test possibilities. …A direct comparison shows that the Rohde & Schwarz testers win on price/performance and can consequently be recommended without any reservations for telecom service.

"Een roterend antenne systeem" was the focus of the October issue of the Dutch mobile telecommunications magazine "Verbinding". The title page captioned Rotatable Antenna System AU 900A4 from Rohde & Schwarz as "professional quality".

Rohde & Schwarz technology also enjoyed a center-stage role on the cover of "TV Technology & Production" (12/98), a specialist journal appearing in Europe, Africa and the Middle East. It showed TV Transmitter NH 500 in conjunction with a report about the creation of a terrestrial DVB network in Great Britain, for which Rohde & Schwarz equipment is being used.



I/Q Modulation Generator AMIQ decorated the cover page of number 12/98 of "HF-Praxis". Inside, under the title "Unique duo for generating I/Q signals", there was an accompanying report on AMIQ and WinIQSIM simulation software.



GSM system simulator – the pacemaker in mobile radiocommunications

The early beginnings

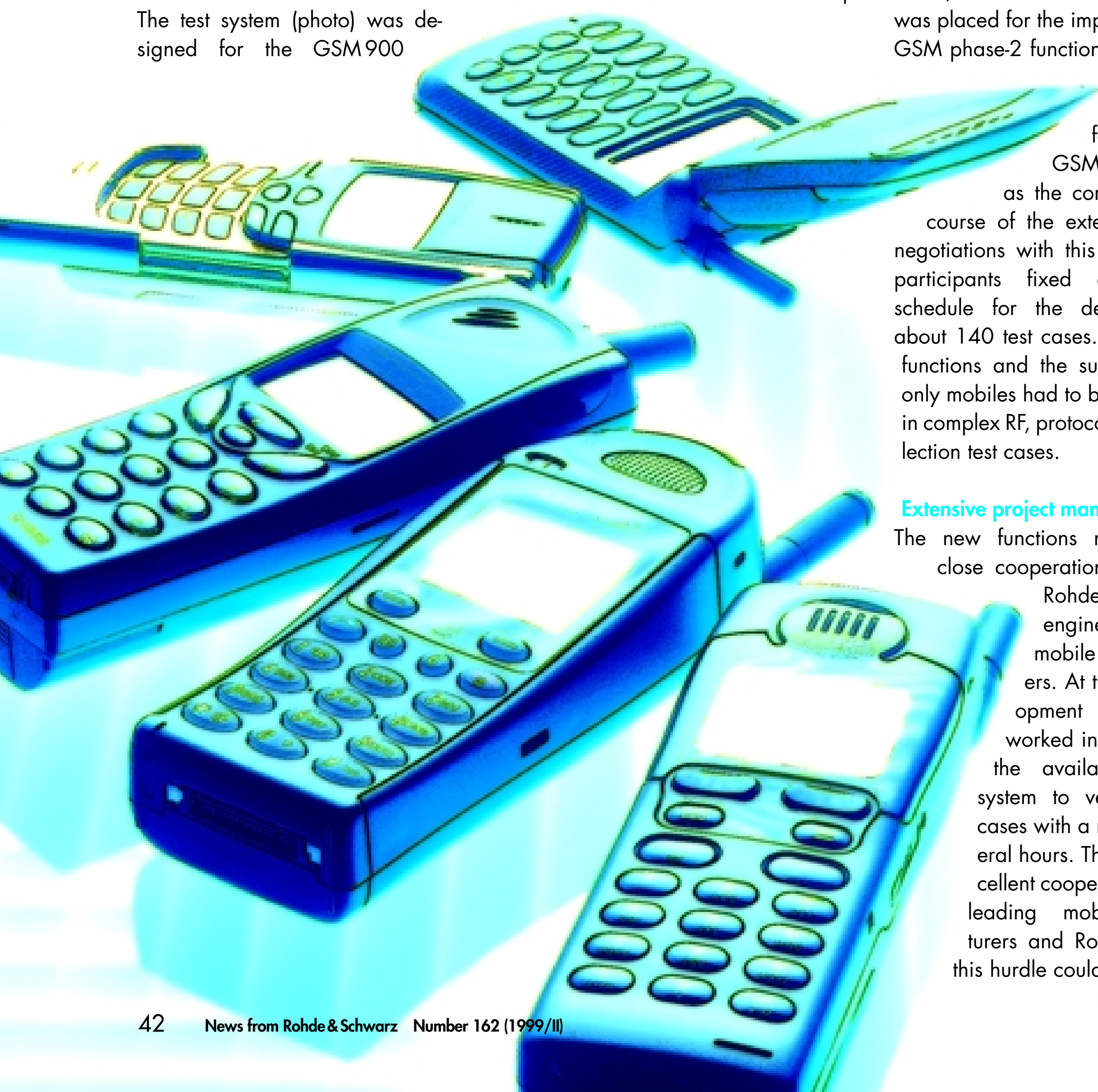
Ten years have passed since Rohde & Schwarz won the order for the development of a test system for type-approval testing of GSM mobiles in the 900 MHz band [1]. The invitation to tender was put out by a consortium of six European GSM network operators. Hardly anyone could foresee at that time the importance the simulator would have for the rapid development of mobile radiocommunications. Although originally created as a European standard, GSM soon enjoyed great popularity all over the world.

The test system (photo) was designed for the GSM900 band only because at the time of the order the mobile radio bands GSM 1800/1900, EGSM (extended GSM) or the combination of several bands in a multiband mobile were not yet defined. According to the requirements of the GSM specifications, the test system simulates up to three active base stations with different fading profiles and up to seven neighbouring cells.

Top performance in a minimum of time

Rohde & Schwarz took only one year and a half to develop the complete system together with a few demo programs for verifying the system functions. After another three years of development, around 300 highly complex test cases for phase-1 mobiles were ready for use and validated by independent test houses. On 1 April 1994, the type-approval tests of the mobiles started as scheduled.

In the past ten years the GSM system simulator went through several development phases. The system underwent the strongest expansion in 1996/97 when a follow-up order was placed for the implementation of GSM phase-2 functions. For this purpose GSM Association founded the GSM Facilities Ltd. as the contractor. In the course of the extensive contract negotiations with this company, the participants fixed an ambitious schedule for the development of about 140 test cases. New half-rate functions and the support of data-only mobiles had to be implemented in complex RF, protocol and cell-reselection test cases.



Extensive project management

The new functions necessitated a close cooperation between the Rohde & Schwarz engineers and the mobile manufacturers. At times the development department worked in three shifts on the available reference system to verify also test cases with a run time of several hours. Thanks to the excellent cooperation between leading mobile manufacturers and Rohde & Schwarz this hurdle could also be taken

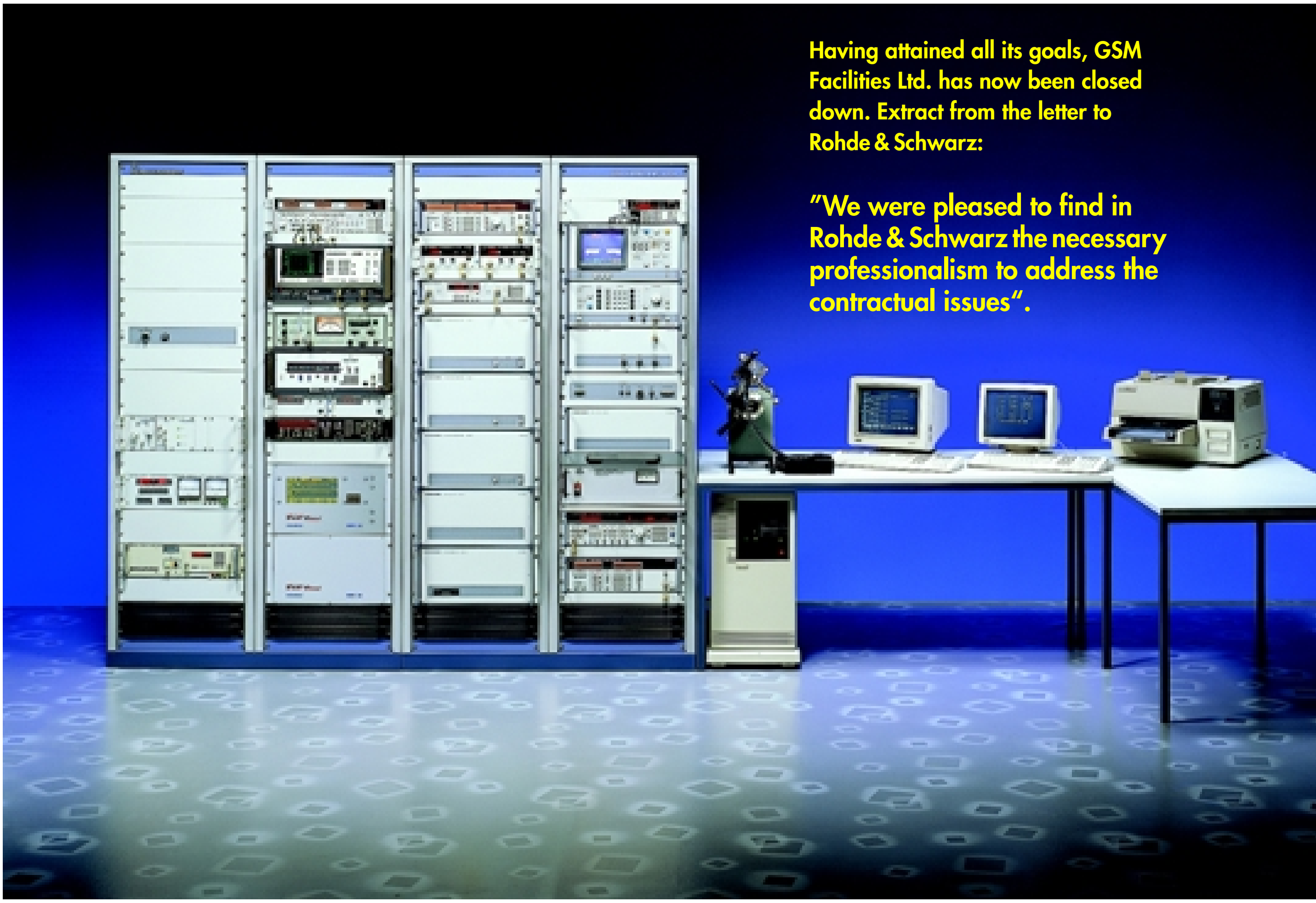


Photo 39 766/2

Ten years of history:
The GSM system simulator paved the way for the rapid development of mobile radiocommunications

cleanly. A complication in the development of GSM phase 2 was that the parts concerned with phase 1 had to remain unchanged – the certification of the GSM phase-1 mobiles should not be disrupted in any way. After the completion of defined milestones, the software and hardware modules were validated by two independent organizations against accurately defined reference implementations. The Rohde & Schwarz experts presented each milestone to the relevant European bodies.

The GSM story with open end

With the recent expiry of the warranty period and the end of the phase-2 development contract, GSM Facilities Ltd. had done its job. The close-down of the company was notified to Rohde & Schwarz in a letter of thanks (see extract in the photo above).

Twelve GSM system simulators were installed in all: in addition to the reference system at Rohde & Schwarz, ten systems are in operation in Europe and one in China.

Rohde & Schwarz Munich keeps acting as the hub of the worldwide GSM system support via its different field offices. Maintenance service contracts ensure continuous development and updating of the systems.

Axel Meier

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[1] Maucksch, T.: GSM system simulator for type-approval testing of mobile stations. News from Rohde & Schwarz (1992) No. 137, pp 36–37

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