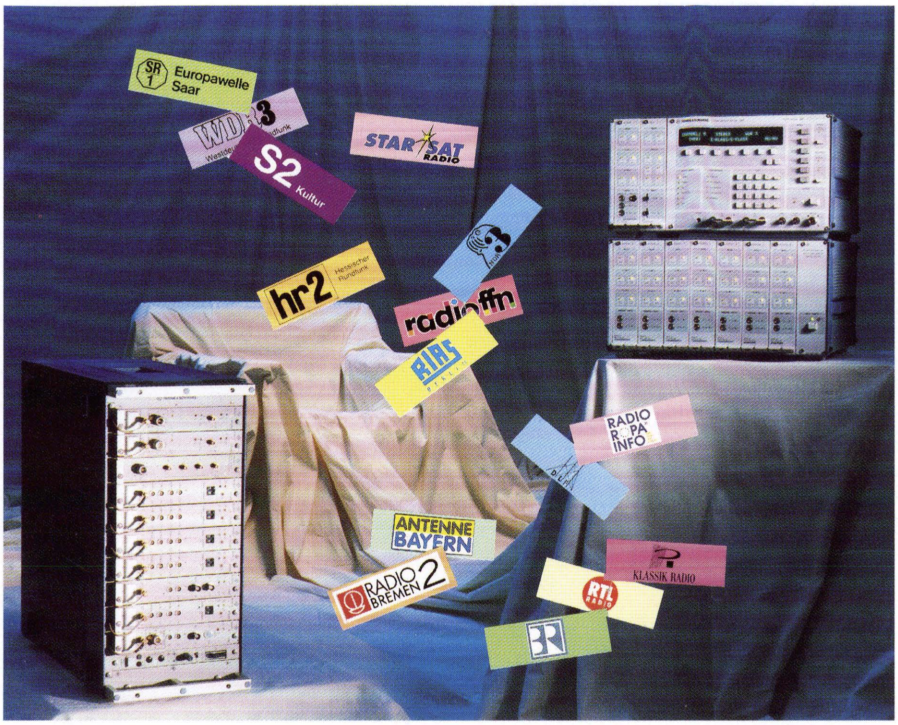
ROHDE & SCHWARZ

NEWS FROM ROHDE&SCHWARZ

135

NEWS condenser



Good sound – digital sound

Digital satellite radio (DSR) by way of the DFS Kopernikus telecoms satellite and the TV-SAT 2 broadcasting satellite has been on the air in Europe for some time now, meaning that anyone with a DSR receiver can bring in stereo programs of CD quality. For all-digital audio transmissions to DSR standard Rohde & Schwarz is now offering DSR Modulator SFP, Digital Sound Converter DSRU and Digital Sound Receiver DSRE (page 22).

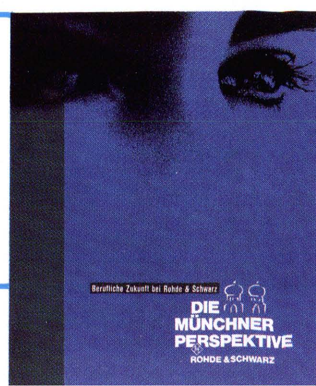
More on the subject of digital audio: as a new option for Audio Coder DCA and Decoder DDA there is an AES/EBU interface plus sampling-rate converter (48 kHz/32 kHz and vice versa), primarily for use in broadcasting studios (page 36).

Newcomer among R&S synthesizers

Power Signal Generator SMGL produces a precise, controlled output level of up to +30 dBm (overranging even to 36 dBm = 4 W) over a wide frequency range of 9 kHz through 1 GHz. This makes the latest addition to the R&S family of synthesizers a strong contender for driving power stages, frequency multipliers or high-level mixers. Its intrinsic intermodulation products are well down, so it is an ideal signal source in receiver testing, and in EMC measurements SMGL also shows to advantage (page 14).

and… learning by doing

A word to our younger readers, tomorrow's engineers and technicians who are still studying: R&S senior department manager Wolf-Rüdiger Lange recommends on-the-job training in industry and vocational training instead of further education. Fresh from the press with information about job opportunities is "Die Münchner Perspektive". Just write to Rohde & Schwarz 4M, Postfach 801469, D-8000 Munich 80 for a free copy.



Field strength

TS 9955 is the new, enhanced-feature test system for measuring coverage and quality in digital voice and radio-data networks (page 8); major components are Process Controller PSA 17 (page 4) and Test Receiver ESVD (page 34).

Mobile radio

GSM Radiocommunication Test Set CRTS 04 checks out radiophones for the new pan-European mobile-radio D network (page 11).

Diplomatic radio

Radio Processor ALIS and System Processor MERLIN revolutionize the teletype stations in German diplomatic radiocommunications (page 18).

ARB synthesis

Arbitrary Waveform Generator AMS and Dual Arbitrary Waveform Generator ADS produce a virtually unlimited variety of waveforms (application on page 25).

New too

Level Meter URV 35 with "combometer" (page 32), new functions and options for Network-analysis System ZPM (page 34), insertion-test-signal measurements with SKDF and UAF (pages 37 and 38), three TV containers for Finland (page 40) and shipboard EMC (investigations by Italy's Mariteleradar marine institute in Livorno on page 41).

Avionics

This word derived from aviation and electronics stands for electronic aviation equipment and the science and technology that go into it. The final article on page 49 tells you what modular CNI avionics systems are all about.

Number 135 1991/IV Volume 31

Turnkey system solutions from Rohde & Schwarz complete the large variety of measuring instruments: new Test System TS 9955 for pan-European, digital GSM mobile-radio networks provides all measurement and analysis functions for planning, startup and optimization.
More on page 8. Photo 39 882/1

Articles

Application note · Refresher topic

Brief items

Regular features

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"Top-class performance" is the way we describe the latest and greatest member of our family of process controllers in the data sheet – with its built-in VGA color display, EMI emissions that are held well inside the standard specs, network compatibility and numerous new tools for producing software for test applications.

Process Controller PSA 17, our top-of-the-line

PC-compatible machines are spreading into industrial applications. Process Controller PSA 17 from Rohde & Schwarz (FIG 1, right) shares with ordinary PCs the compatibility with industry standards, a high-speed processor and memory-expansion options, but also includes features that are essential for automatic test systems and which are a further advance on those of the Process Controller PSA 15 [1] introduced one year ago:

- **19-inch-rack-compatible** using R&S Design 90 case with built-in color display and keypad so that all the features are accessible when the unit is rack-mounted;
- **modular software fully customized for test systems** to minimize reprogramming for a new graphics coordinate system, to drive a new IEC-bus (IEEE-488) device or to provide a new plotter format;
- **built-in test hardware** in the form of plug-in cards so that standard tests like current or voltage measurements, FFTs or recording digital signals do not require IEC-bus equipment;
- **data protection** with password and removable hard-disk cartridge to prevent unauthorized access;
- **rugged construction** for reliability in vehicles and on the factory floor;
- **flexible LAN concept** for smooth integration into existing networks;
- **extremely low EMI output** so that sensitive signals can be measured automatically and reliably;
- **know-how and support:** we reduce your integration effort by combining the computer and controller hardware, the LAN interface and the test technology in a single package with the reliability you expect from R&S.

Controlling test equipment and test systems

With its industry-standard architecture, Process Controller PSA 17 offers two high-performance IEC-625 (IEEE-488) interfaces [2] for the toughest applications; they are DMA-compatible and have full software support. Easy-to-use IEC-bus drivers for R&S BASIC and all Microsoft languages (supported by the R&S configuration

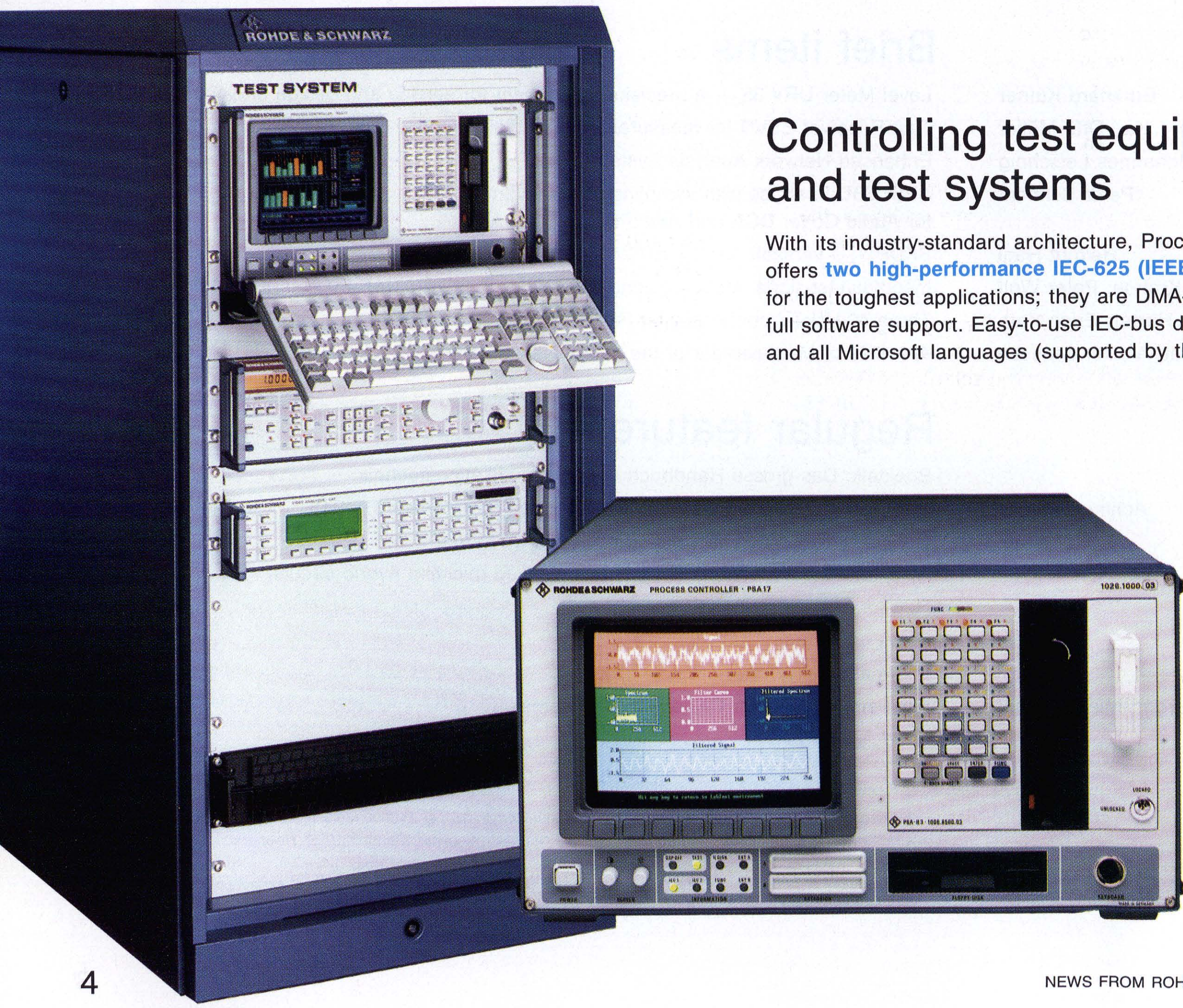

FIG 1 Process Controller PSA 17 has not only features of standard PCs but also those needed for testing, and can be fitted in 19-inch racks (example left): Audio / Video Test System TS 6020 for checking performance of video recorders. Photos 39 488 and 39 431

utility PCONF), integrated software packages for controlling test equipment and presenting the results, as well as numerous modules for typical test applications make PSA 17 suitable for all kinds of IEC-625-based test systems.

support offered by the manufacturer. For PSA 17 well-proven tools are available which can be classified as follows: program generators, programming languages and device and hardware drivers.

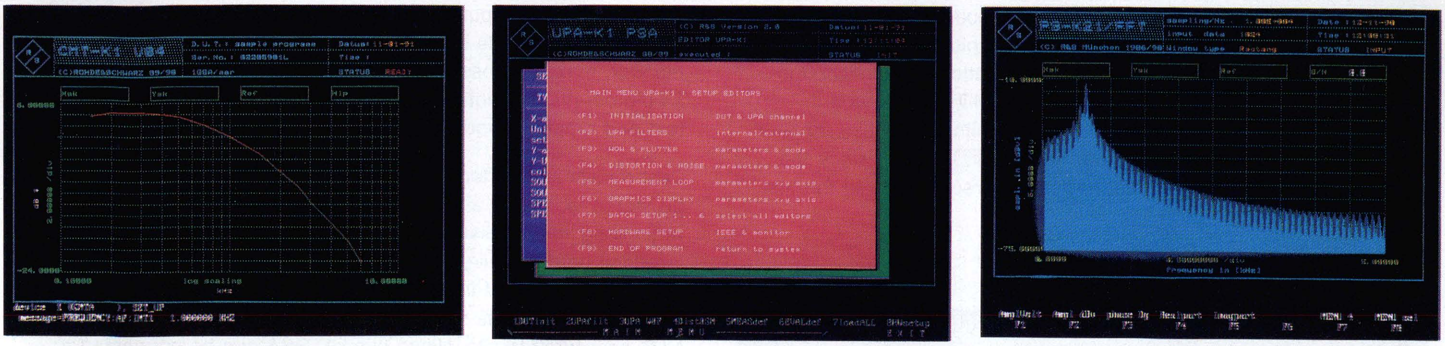

FIG 2 Three of five application programs included in standard PSA 17 package: from left, radio-equipment testing, audio testing and FFTs
Photo 39 439/9-11-8

For convenience in configuring IEC-bus test systems, PSA 17 **can be built into a 19-inch rack.** The special PSA-Z1 Keyboard with rollkey is either hinged directly from the controller (FIG 1, left) or mounted in a 19-inch drawer. The software can also be written to use the keypad and softkeys built into PSA 17's front panel.

Two LED indicators on the front panel display the states of the two IEC-bus interfaces (which are logically completely independent): green means ready to function as controller, listener or talker; red means an SRQ (system request) signal has been received. These show the system engineer the basic status at a glance while the test-system software is being checked out, and are also helpful when the system is operational.

R&S's reliable **IEC-bus driver architecture** works with R&S BASIC and Microsoft languages using the same syntax, so the system engineer can use the programming environment he is used to **with the extensions needed for test systems.** The software drivers have a wide range of features, providing instructions with easy-to-understand mnemonics that do everything from simple listener/talker sequences to serial-poll/parallel-poll setups and interrupt handling. For configuring the software of Process Controller PSA 17 R&S has written the easy-to-use **PCONF configuration utility.**

Software for test systems

The cost of developing software [3] has risen drastically over the last few years. Analyses have shown that programmer productivity will have to increase by around 250% to be able to produce software in ten years at the same cost as today. In order to achieve this goal, powerful **standardized tools and libraries** are needed. They are essential for meeting individual requirements at an affordable price yet with high quality. In the selection of software tools many criteria are important, such as the scale of the task at hand, the expertise of the programmer and the level of

The following **programs are provided with every PSA 17** (FIG 2):

CMT-K1 for testing radio equipment with Radiocommunication Tester CMT/CMTA,

UPA-K1 for testing audio equipment with Audio Analyzer UPA,

PS-K21 for Fourier transforms/Cepstral transformers using Analog I/O Interface PS-B13,

PS-K22 for field-strength monitoring with Test Receiver ESH 3/ESVP,

PS-K23 technical/scientific graphics software with 2D/3D representation, Smith charts/polar diagrams and autoscaling routines.

The **MS-BASIC Compiler Professional Development System (PDS) option PS-K10** is a new development system from Microsoft and includes the "Programmer's Workbench", which provides an integrated, uniform programming environment for all Microsoft professional development systems. By the integration of multiple tools (make, debugger, editor, source browser), PDS makes it possible to develop all kinds of professional test-system programs using the latest high-efficiency techniques. All R&S interface cards are supported by language extensions.

The **MS-C Compiler option PS-K12** is the new C development system from Microsoft which, like BASIC PDS, includes the integrated Programmer's Workbench for developing large programs. As with BASIC PDS, it supports easy-to-use language extensions for all PSA interface boards.

As an **interpreted language,** R&S BASIC continues to be included with every PSA. It offers an easy-to-use program editor as well as debugging tools. All PSA interfaces, such as the IEC bus, the analog and digital interface and the serial interface, are supported by user-friendly features. By integrating compiled Pascal routines, major software applications can be produced using modular techniques.

The **MS-Pascal Compiler option PS-K11** is particularly suitable for developing high-performance test-system applications. The syntax for accessing the interfaces is uniform, as with R&S BASIC. The CodeView debugger is used for testing.

Hardware integration means compact systems

When the **measurement hardware is on plug-in boards,** the case, power supply, front panel and communications interface needed by stand-alone equipment are unnecessary. This makes an integrated system more compact, and typically less expensive. The performance is comparable, since advances in semiconductor technology and miniaturization using SMDs have made it possible to produce analog and digital circuits which take up very little space. Generally the processing speed is higher, since the controller, via the internal bus, has more direct access to the test hardware.

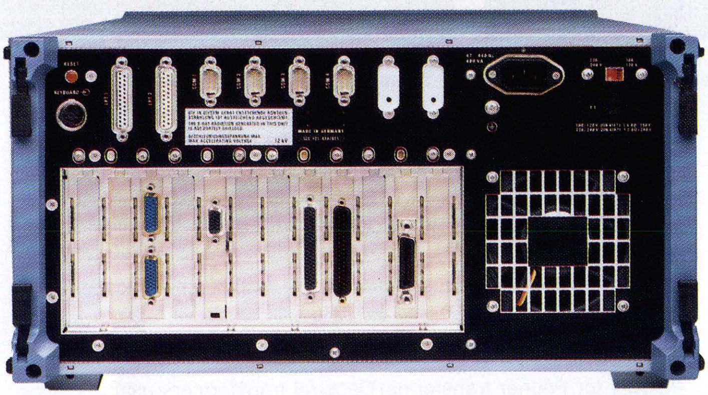

FIG 3 Rear panel of PSA 17 with temperature-controlled fan and many spare AT-compatible slots Photo 38 797

Thanks to a highly integrated multifunction board and a comprehensive selection of interfaces, PSA 17, even when fitted with two IEC-bus interfaces, two parallel interfaces, four serial interfaces, a VGA interface (external), a 200-Mbyte non-removable hard disk, a 40-Mbyte removable hard disk and two floppy drives, still has four AT-bus-compatible slots left over (FIG 3). Specially designed RF screening using spring contacts ensures that, even when interfaces are installed by the customer, EMC performance is outstanding.

The **TTL interface** (TTL I/O Interface PS-B11) is used to drive and read external, digital control lines. Analog test signals can also be switched using the version which includes eight relays. The four differential optocoupler inputs/outputs make floating connections possible. Some examples of applications for the TTL interface include: generating test patterns for analog and digital circuits, controlling external devices using a BCD interface, reading test patterns and signal states, scanning testpoints, event counting and signal monitoring. A **software package** is supplied with PS-B11: "Logic analysis with PS-B11".

The **analog interface** (Analog I/O Interface PS-B13) contains eight differential or 16 single-ended analog inputs and two analog outputs, with resolution of 12 bits and a maximum sampling rate of 50 kHz. It is mainly intended for measuring and generating waveforms in the audio-frequency range. A **software package** for digital signal processing (PS-K21), which also includes FFT and Cepstral transforms plus a general-purpose program for recording signals with an oscilloscope-like user interface, is included with PSA 17 (FIG 4).

Processing and logging results

Results displayed as columns of numbers are hard to grasp; it is much more informative to provide **graphic displays** which, when needed, can be output to a printer or plotter. Process Controller PSA 17, thanks to its built-in, VGA-compatible 8-inch color monitor, makes it possible to display vivid color graphics. The 24-pin dot-matrix printer PDN is suitable for logging test results in text and graphics modes, including color-screen dumps.

Test results must often be archived over long periods. They can be stored locally on a hard disk, but increasingly customers are requesting **network-server compatibility.** This requires standard interface hardware like Ethernet Adapter PSA-B21, which allows PSA 17 to plug right into the customer's network. The Ethernet Kit PSA-B22 consists of Ethernet Adapter PSA-B21 and the PC-NFS network software. Using this kit, PSA can be connected to networks which include a file server that is compatible with NFS (network file system). A mainframe, a mini (eg VAX from DEC), a Unix workstation (eg Sun 3/60) or even a process controller (PSA 15/17) can be used as the file server, with the SCO-Unix operating system and NFS server software.

Another example of an application for the new network options of PSA is **data acquisition in vehicles** [4]. Data captured during the journey can be dumped directly from the vehicle, eg via a

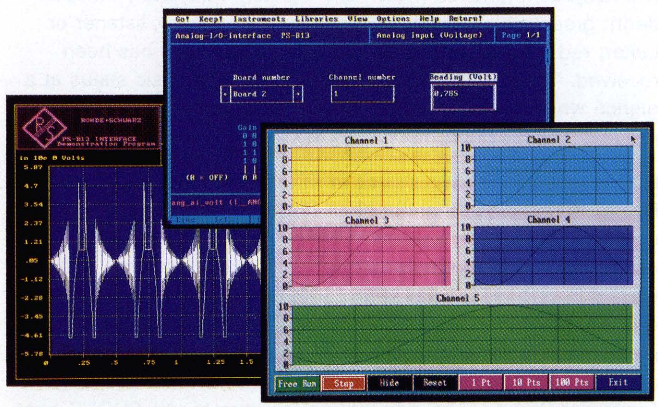

FIG 4 PSA 17 application program: storage scope using Analog I/O Interface PS-B13 Photo 39 439/16-15-12

network junction box in the garage, into the central data-processing facility of a company or a government office. All that is necessary is to connect a standard cable between the network junction box and the vehicle, and press a button to start transferring the data. It takes about as long as copying to a built-in hard disk.

To **store test results from remote locations,** the Interface Expansion board PSA-B5 can be used. This offers the user four serial and two parallel interfaces. Using this option, a modem and standard software (eg Kermit), data can be transferred to other computers via the public telephone network.

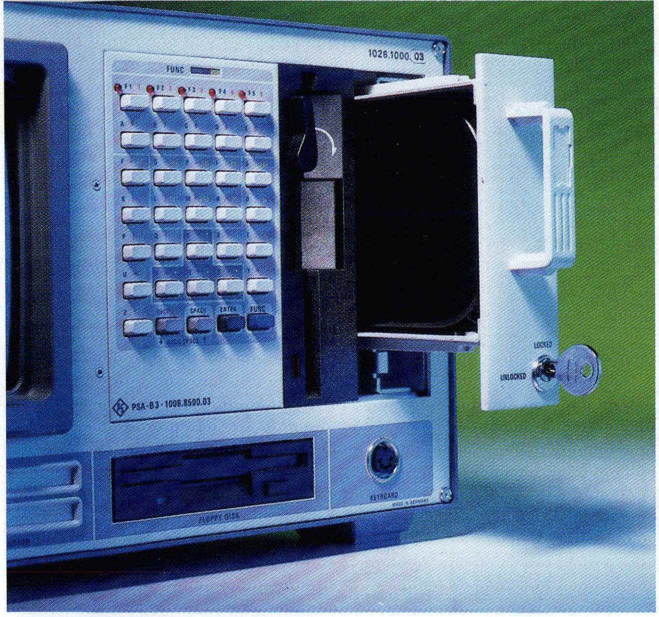

FIG 5 High storage capacity of 40-Mbyte removable hard disk in PSA 17 opens up many applications. **Photo 39437**

Data security and construction

Data-security requirements have become more rigorous in automatic test systems. Today, preventing unauthorized access to programs and data is of great importance, as is defending the system from virus attack. Viruses are programs which can destroy data and test programs normally stored on hard disks at preprogrammed times and thus sabotage an entire test system. Like organic viruses, computer virueses have a latent period: they can remain dormant, eg periodically checking the system clock, and then become active at some preset time. Thanks to its password protection and its removable hard disk, PSA 17 offers especially high data security.

PSA 17 loads the operating system from a diskette or the hard disk only when a previously stored **password** is requested and entered. This password is stored in encoded form in a battery-backed memory and therefore cannot be read by unauthorized persons after the operating system has been loaded. The password cannot be changed without entering the original one. The password can be entered either via the built-in Keyboard PSA-B3 or an external one. Thus unauthorized access to the test system can be prevented which might, whether intentionally or unintentionally, expose it to a virus. Access protection of this kind is especially important for network-compatible controllers like PSA 17: typically, when networked computers are switched on, automatic access procedures are executed to central file servers.

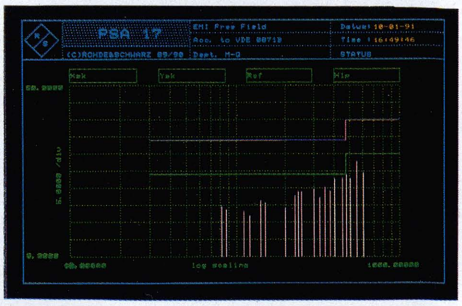

FIG 6 Proving how low EMI emissions from PSA 17 are: measured open-site, amplitude is on average 8 dBμV/m below limits specified in VDE 0871 (upper line; lower line at 10 dBμV/m for reference). **Photo 39439/3**

The switch-on password provided by PSA 17 prevents unauthorized access to the data stored on the network.

Especially sensitive data is best stored on the **removable hard disk.** On the 40-Mbyte interchangeable hard drive PSA-B9 (average access time 25 ms) you can store the operating system, compiler, programs and results, even the large amounts of data logged during test runs in a vehicle; you can also store complete programming environments (FIG 5). The removable hard disk can be locked in a safe to provide top security against unauthorized access.

Good EMC performance is a necessity, and not just for radio testing. PSA 17 has many special features, such as a sealed case, screening of internal buses and the use of filtered keyboard sockets to provide extremely effective EMI screening. Even with a full complement of options fitted, free-field strengths are typically 8 dBμV/m below the limits specified by VDE 0871, class B (FIG 6).

What also distinguishes Process Controller PSA 17 from standard computers is its **rugged design.** In harsh environments, eg in vehicles, test results can be stored in RAM set up as RAM disk areas; if the 4-Mbyte memory expansion PSA-B2 is added, RAM disk capacity of up to 7 Mbytes is available. Once measurements have been completed, data can be transferred to longterm storage, either on a diskette or the removable hard disk.

Franz A. Dosch; Dieter Bues

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CONDENSED DATA
PROCESS CONTROLLER PSA 17

Computer features	
CPU	80386, 25 MHz
RAM	4/8 Mbytes, XMS and EMS
Hard disks	40 Mbytes removable, 200 Mbytes non-removable
Standard interfaces	up to 4 serial and 2 parallel
LAN	Ethernet, 10 Mbit/s, CSMA/CS AUI and thin-wire Ethernet
Test features	
Case	19-inch-rack-compatible
Ruggedness	IEC 359, class I
EMC	8 dBμV/m better than VDE 0871/0875, class B
Display	built-in VGA color monitor
Interfaces	IEC bus (IEEE-488), analog I/O, TTL I/O
Operator input	external keyboard, rack-mountable, with rollkey, programmable front-panel keypad, array of softkeys under display
Software	MS-DOS 5.0, R&S BASIC, Pascal and C interface drivers, libraries, tools, utilities, basic software packages, applications, custom systems

READER SERVICE CARD 135/01

Test System TS 9955 is used for measuring field strength and other data required for checking out and planning transmitter sites and transmitter power figures in digital, cellular radiotelephone and data networks. The data recorded by the mobile part of the system are analyzed and plotted on maps by the stationary part.

Test System TS 9955 for field-strength measurements in digital radiotelephone and data networks

Keeping in touch at all times and from any point is no longer a manager syndrome but something that is becoming quite normal in today's society. But the increasing demand for radiocommunications is not compatible with limited frequency-band resources and growing interference, especially in densely occupied areas. So the design, installation and maintenance of modern, digital mobile-radio systems like GSM mean a new technical challenge for network operators. Radio-coverage models are no substitute for test systems that analyze the prevailing quality of reception: the models are incomplete since interference parameters can only be approximated and the effects of buildings cannot be exactly represented. Moreover, the

FIG 1
Test System TS 9955
for coverage measurements
on GSM radio networks
Photo 39 869

reception quality of digital voice channels is heavily degraded by time dispersion and reflections, and the effect of transient interference patterns caused by changing receiving situations can only be investigated in detail in the operating network.

Rohde & Schwarz is well prepared for the tasks of field-strength and coverage measurements in mobile-radio systems and has now been supplying fully automatic test systems to customers all over the world for more than five years. Test System TS 9950 [1] showed itself to be a valuable planning and analysis system for many network operators. **Expansion of TS 9950** in the form of

- new receiver technology,
- GSM test mobile station,
- GSM channel impulse response,
- GPS global positioning system,
- cartographic projections,
- enhanced computer power,
- online graphics display,
- multilingual user prompting,
- modern software concept

led to **Test System TS 9955** (FIG 1) for planning and optimizing GSM radio networks (options for PCN, Modacom, Mobitex on request).

Hardware and software

The basic system can be used allround for field-strength recording and cartographic analysis. It consists of the **mobile test system** (FIG 2) in a vehicle and the **stationary system** for test preparation and result evaluation. In addition to Process Controller PSA 15 [2] or PSA 17 [3], Test Receiver ESVD [4] featuring high sensitivity and a wide dynamic range is the core of the mobile part. This receiver allows field-strength levels at up to four frequencies in the range 20 to 1000 MHz to be recorded at speeds up to 100 km/h without violating the conditions for this kind of mapping [5]. ESVD can be fitted with an I/Q demodulator and a 2-GHz frequency extension as an option. The test system features two modes of recording: measured data recorded versus the distance covered by the test vehicle (at equidistant points or following a time frame) or versus time with the vehicle standing still.

GSM Field-strength Test System TS 9955 includes a **pulse generator** as standard. This unit is fixed to the wheel hub of the test vehicle and supplies equidistant pulse markers along the test route. The **coordinates** can be assigned either before or after tests by digitizing the distance covered on a map. A **GPS receiver** (global positioning system) with full software support can also be integrated into the system. With the aid of this option TS 95 GPS, recorded data are assigned to (absolute or relative) coordinates. As an alternative, a **Travelpilot** (TS 95 P) can be provided. This is supplied with a navigational computer and CD-ROM player with digitized maps of eleven countries. As with the GPS receiver, direction or position information can also be assigned to the measured data with this option. The standard system software supports a variety of **coordinate systems:** Gauss-Krüger, UTM (universal, transversal Mercator projection), longitude/latitude system; other coordinate systems are available on request.

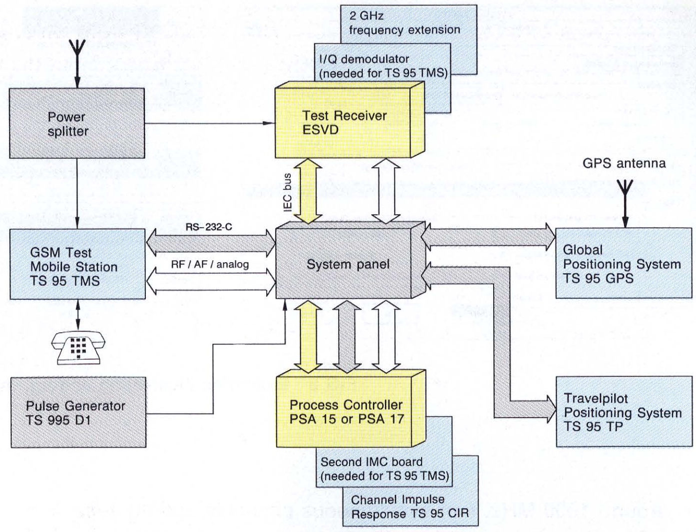

FIG 2 Mobile part of Test System TS 9955 (options in blue)

To test the quality parameters of GSM mobile-radio networks, the optional **GSM test mobile station** (TS 95 TMS) can be integrated into the system. This enables measurements like receiver level and quality (RXLEV and RXQUAL) via the bit error rate (BER). These measurements are important, since in fully digital radio networks like GSM the classic system parameters like SINAD or S/N cannot be used any more for evaluating transmission quality. The bit error rate, which is received and processed by Process Controller PSA 15 or PSA 17 via the data interface of option TS 95 TMS, provides useful information. Data can be represented graphically in cartesian or cartographic coordinates or output as a table of values. TMS is also able to provide further information, eg different bit error rates or layer 2 and 3 messages derived from the information flow by means of filter functions and stored with position and time. The system software can also be used to record residual bit erasure rate, residual bit error rate, frame erasure and frame erasure rate.

Bit error rate is an excellent criterion for evaluating transmission quality but no conclusions can be drawn about the causes of interference. System TS 9955 therefore offers the **channel impulse response** (CIR) option for analyzing the channel timing characteristics. The three-dimensional representation of the impulse response clearly shows the pulse delay times and consequently local effects like reflections and multipath reception. In mobile mode the variation with time of the channel impulse response is indicated. The impulse response is highly sensitive to nonlinearities, group delay in the IF stage and insufficient dynamic level in the receiving stage. The excellent features of Test Receiver ESVD guarantee a channel impulse response that is unaffected by receiver characteristics.

Measurement method

Hardware and software of Test System TS 9955 ensure the resolution required for field-strength mesurements (50 testpoints within 40 wavelengths) at maximum conditions, ie frequencies

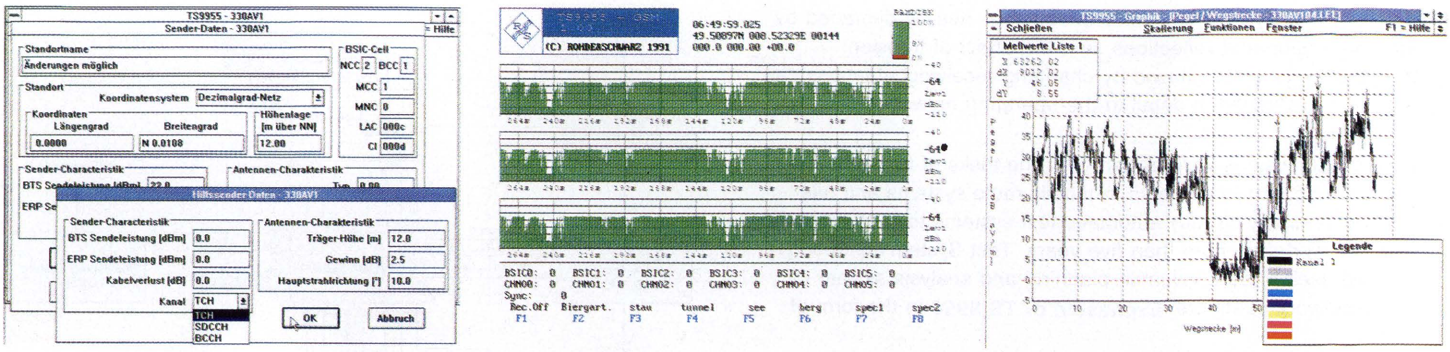

FIG 3 Examples illustrating setting, measurement and evaluation along test route

around 1000 MHz, four simultaneous channels and the test vehicle travelling at 100 km/h. **Field-strength levels are measured and recorded** in three different ways:

- **Raw field-strength data** All digitized results are saved in the RAM of the processor and stored when the test vehicle is stopped. The raw data can then be further processed as desired.
- **Averaging** During measurements the results are averaged and only the averaged values are stored. This method is used for determining longterm fading and allows the amount of data to be reduced considerably.
- **Exceeding probability classes** During measurements the results are classified according to exceeding probability (15 classes covering 1 to 99% probability). The evaluation intervals can be selected by the user, but each interval must contain at least 100 values.

Result documentation and system operation

The built-in monitor of Process Controller PSA 15 or PSA 17 or the external Color Monitor PMC 2, Pinwriter PDN or a DIN-A3 plotter are used for result graphics (FIG 3); the following **representations** are possible:

- Field-strength values measured along the test route are recorded using Gauss-Krüger coordinates (scale 1:5000 to 1:200,000).
- Using the Gauss-Krüger coordinate system, a multicoloured line is displayed to represent the route. The different colours on the line represent different levels. The user can assign six colours to the levels he has defined. The settings can be stored.
- The exceeding probability in percent (user-selectable between 1 and 99%) is shown using XY coordinates (field strength versus distance). Each value selected is assigned a colour. Up to three curves are shown in a plot.

Operation of Test System TS 9955 is extremely easy and convenient thanks to the following features:

- easy-to-understand window-type menus,
- pulldown menus,
- mouse support,
- context-sensitive help texts,
- multilingual user prompting.

Rohde & Schwarz undertakes full **system responsibility** for all system components as well as for production, integration, training and service. Specialists apply effective training methods to familiarize users with system operating procedures. Hands-on methods ensure that the user gets to know the full capabilities of Test System TS 9955.

Franz A. Dosch; Michael Malbrich

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CONDENSED DATA TEST SYSTEM TS 9955

Frequency range	20 to 1000 (2000) MHz
Field-strength measurement range	−14 to +137 dBµV
Bandwidth	10 kHz, 120 kHz, 300 kHz, 1 MHz
Number of channels	4
Speed of test vehicle	<100 km/h
Bit error rate	TCH, SDCCH
Channel impulse response	< 40 µs/26 bits TCH, < 80 µs/64 bits SCH, <150 µs/test sequence

READER SERVICE CARD 135/02

Rohde & Schwarz can already provide the test equipment for the new digital mobile-radio networks (GSM). GSM Radiocommunication Test Set CRTS comes in two models: 02 for testing mobile stations and 04 for all measurements on GSM base stations.

GSM Radiocommunication Test Set CRTS 04 for testing base stations

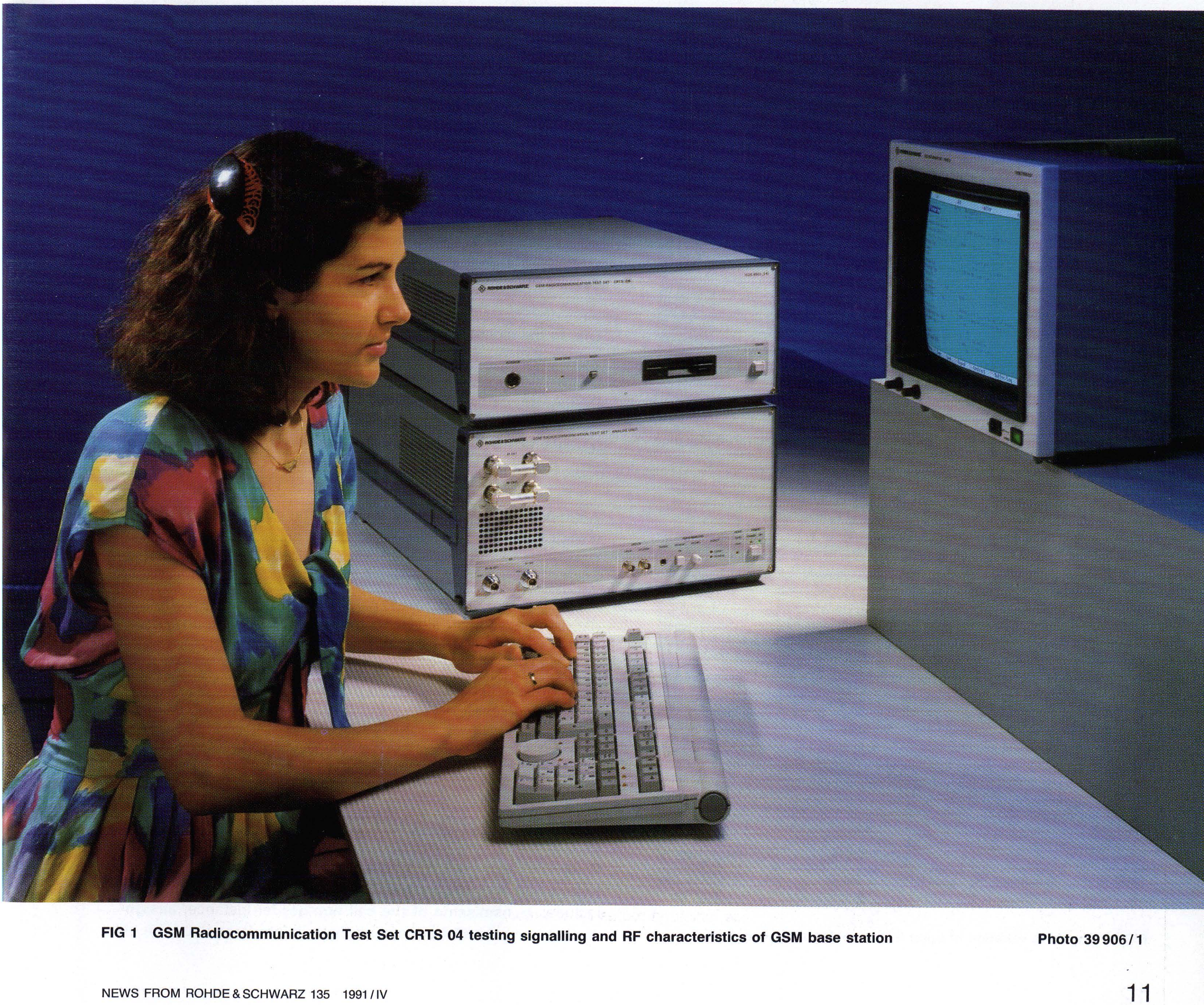

FIG 1 GSM Radiocommunication Test Set CRTS 04 testing signalling and RF characteristics of GSM base station **Photo 39 906/1**

Industry made every effort to supply the base stations and mobile stations required for the operation of the new digital GSM radiotelephone networks recently also introduced in Germany. A **mobile station** is the radiotelephone of the subscribers, usually installed in a car, but there are also pocket-sized models. **Base stations** establish the connection to the public telephone network and convert the signals transmitted on the radio link into line signalling. While well-known and established transmission methods are mostly employed for the wired part, a new method is used for the radio interface. This includes digital TDM voice transmission and new signalling protocols for call setup and cleardown. In addition, it is possible to change transmit and receive frequencies during the call (frequency hopping).

This new method also calls for new **measuring instruments to be used in development, production and quality assurance of base and mobile stations.** Rohde & Schwarz has already launched two instruments for GSM measurements: GSM Radiocommunication Analyzer CMTA 94 [1; 2] and GSM Radiocommunication Test Set CRTS [3]. CMTA 94 is a module tester for checking RF parameters like modulation and demodulation characteristics of base and mobile stations. CRTS model 02 is used for testing complete mobile stations; it simulates up to two base stations and allows comprehensive signalling tests in addition to RF measurements. Special software enables CRTS model 04 (FIG 1) to test base stations by simulating a mobile station.

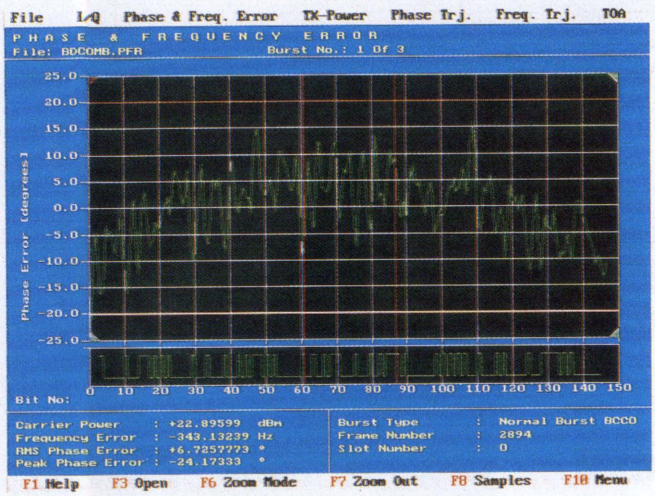

FIG 2 Phase and frequency error of GMSK-modulated signal versus time

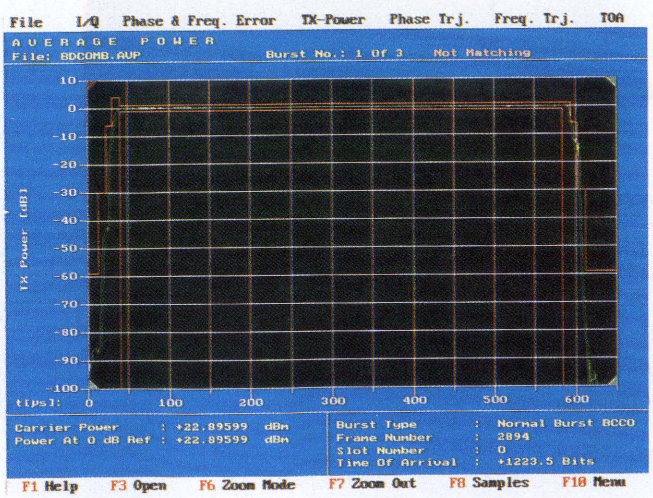

FIG 3 Checking variation of burst in time using tolerance mask

RF measurements

Gaussian minimum shift keying (GMSK) is the type of modulation used in GSM systems. **Phase and frequency error** of the modulated signals is determined by comparison with an ideally modulated signal. CRTS 04 records the phase trajectory of the signal sent by the base station and demodulates the signal to recover the bits transmitted. Using an ideal mathematical model of modulator, CRTS 04 computes the nominal phase trajectory from these bits. From the difference between measured and calculated ideal phase trajectory, the average frequency error, RMS phase error and peak phase error can be determined and presented in a diagram as a function of time (FIG 2).

Voice and data are transmitted in pulse mode as bursts of 577 µs duration. A particular call only takes up one in eight of the bursts, the other bursts being used by other calls. To avoid interference on adjacent time slots, **duration as well as on/off response** must be checked in addition to the **average power of the burst.** CRTS performs all these measurements and presents the results graphically. It also informs the user whether the tolerances defined in GSM regulations have been exceeded or not (FIG 3).

Due to the digital transmission method, **receiver sensitivity** cannot be measured with conventional methods such as SINAD. So it is determined by sending a known pseudo-random signal of low power. The bit pattern received by the base station is applied to CRTS 04 via a serial interface and compared with the bit pattern produced by CRTS 04. Receiver sensitivity is adequate if the bit error rate complies with GSM specifications.

An important task of a base station is the **simulation of burst transit times** to determine burst arrival time. The time required for a burst sent by the mobile station to arrive at the base station depends on the distance between the base and mobile stations. To prevent late bursts interfering with calls in the adjacent channel, the base station measures the time of reception and, if necessary, signals the mobile station to send earlier. To simulate this separation, burst transmission can be delayed by CRTS 04. The correction commands sent by the base station are displayed at the same time.

Signalling tests

Signalling means the data transmission required to set up a call, to terminate it or to continue it even under adverse conditions. It includes **transmission of the call number** for instance, **assignment of a new call frequency** if there is interference on the old frequency, or **handover** to a new base station if the mobile station leaves the transmission range of the old one. Full compliance with signalling protocols is a basic requirement for smooth operation of a mobile-radio network and therefore needs comprehensive testing. GSM Radiocommunication Test Set CRTS 04 is able to simulate the signalling function of a mobile station, including both correct and faulty signalling.

The signalling protocols are specified in several layers according to the **OSI reference model** (Open Systems Interconnection), so this structure is also used by CRTS 04. It allows testing at layer 1 (physical layer), layer 2 (data-link layer) and layer 3 (network layer). A typical layer-1 test involves sending a known, random bit pattern to check channel decoding in the base station. A common test at layer 2 includes simulation of the situation in which a mobile station does not understand a data burst due to interference in the radio channel. In this case you check whether the base station should send the data burst once more if reception has not been acknowledged by the mobile station. At layer 3 certain procedures are checked, eg paging of mobile station by base station or handover to another base station.

Signalling should be as transparent as possible to the user. While in a real mobile station signalling is not noticeable at all, it is displayed on CRTS 04 after all messages exchanged have been time-stamped and stored in a 4-Mbyte memory. This gives the user time for detailed analysis. Display is possible at layer 2 or layer 3 in binary, decimal or text form. Text display is very important since it avoids time-consuming looking up of message coding specifications.

Messages to be sent can also be entered in text form. This is done with a message editor which contains all the coding rules for layer-3 messages. That speeds up operation and makes it easier (FIG 4). CRTS 04 is also able to reproduce certain errors. For this purpose at layer 3, the user can directly define the signalling procedure by means of the test program. At layer 2, CRTS 04 checks the function by additional commands. Errors can thus be generated deliberately and the response of the base station tested.

CRTS 04 uses Borland **Turbo C for defining the order in which messages are sent** so that the user need not learn a special test language. The large variety of examples and service routines supplied enables test programs to be generated with little programming effort. The standard programming language C gives the user every possibility of adapting CRTS 04 to specific measurement needs.

The following **example of test-program generation** illustrates the effort required: the base station receives from the mobile stations at regular intervals a measurement report providing information on the field strength at the antenna input of the mobile station as well as on reception quality (bit error rate). If field strength is low and reception quality poor and these conditions continue for a lengthy period, the base station should cause handover to another base station, since the mobile station is obviously leaving the base station's transmission range. If, however, reception quality is poor and field strength high, it can be assumed that interference is present and a frequency change would be advisable. To test the correct reaction of the base station in such a case, a number of measurement reports must be

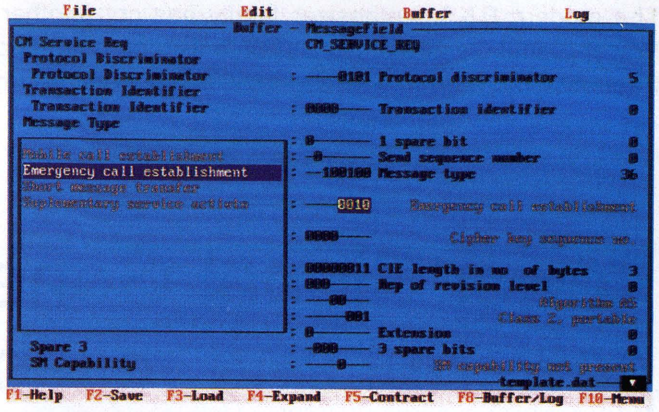

FIG 4 **Message editor to support entry of layer-3 messages**

prepared using the message editor and assigned different names. The measurement reports can be sent by expanding the example program containing the call setup. The service routine for sending the measurement report is simply inserted into the program as often as a new report is to be sent. The name of the report to be sent is treated as a routine parameter.

Roland Steffen

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[3] Vohrer, M.: GSM Radiocommunication Test Set CRTS for base and mobile stations. News from Rohde & Schwarz (1990) No. 131, pp 4 – 7

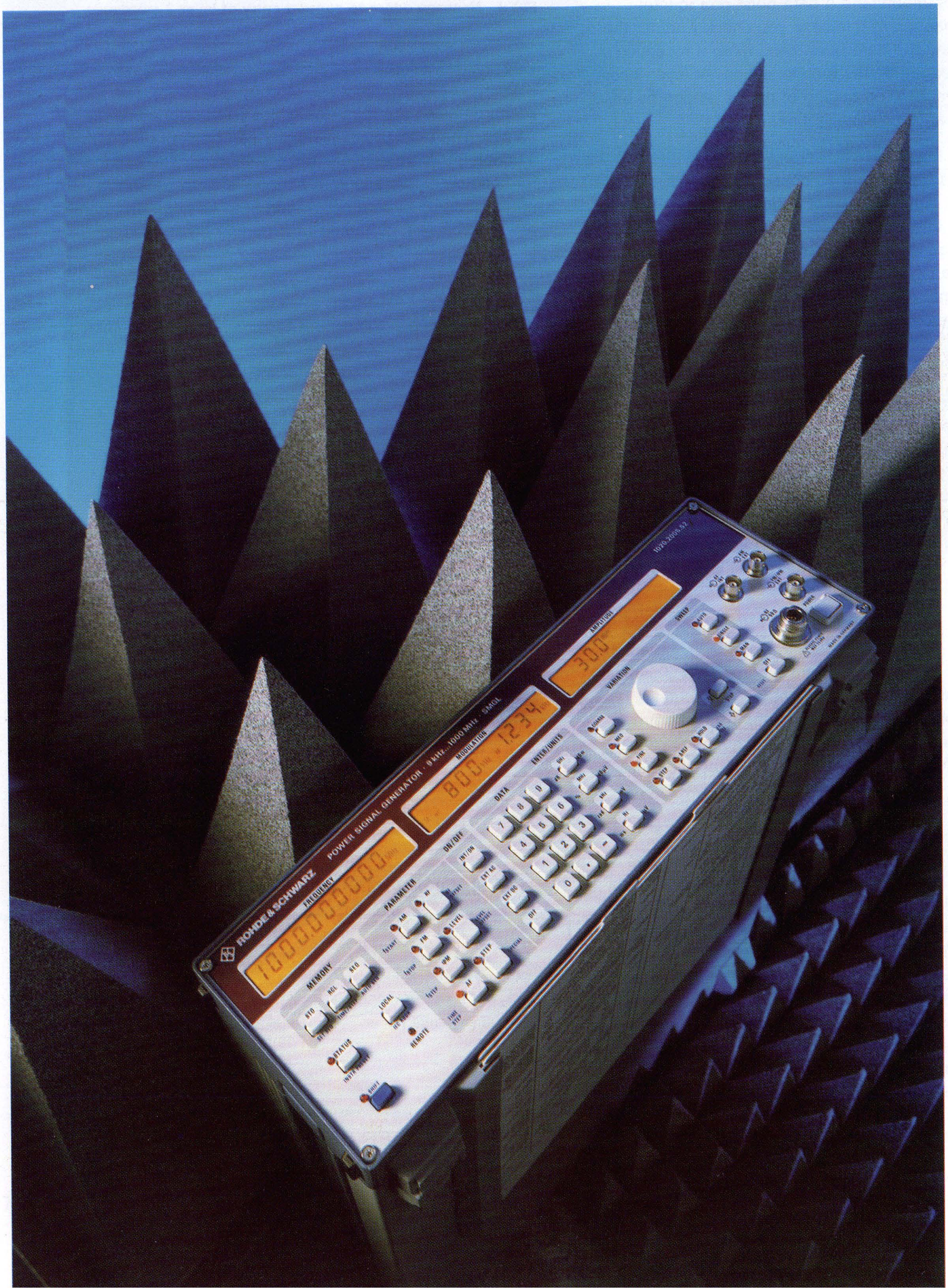
CONDENSED DATA GSM RADIOCOMMUNICATION TEST SET CRTS 04

Generator	
Frequency range	890.2 to 914.8 MHz
Output level	14 to –121 dBm
Analyzer	
Frequency range	935.2 to 959.8 MHz
Input level	19 to 47 dBm (for full dynamic range)
Signalling	automatic layer 1 and 2, layer 3 with C

READER SERVICE CARD 135/03

The modern R&S synthesizer family has got another new, effective member: Power Signal Generator SMGL. With its high output power of 30 dBm and wide frequency range from 9 kHz to 1000 MHz, it outperforms any competitor on the signal-generator market.

Power Signal Generator SMGL – powerful and reliable



Until now the spectrum of R&S synthesizers included the cost-effective SMX, the versatile generators SMG and SMH, and at the high end SMGU and SMHU [1]. Power Signal Generator SMGL (FIG 1), the sixth member, is an upgrade of the internationally tried and tested SMG [2] and replaces Power Signal Generator SMLU, which has been a resounding success for more than 20 years.

FIG 1 Power Signal Generator SMGL with more than 1 W output power from 9 kHz to 1 GHz
Photo 39 849

Characteristics

SMGL features an extremely **wide level and frequency range.** This means that it is able to supply a high-precision, controlled output level between −130 and +30 dBm (overrange up to 36 dBm = 4 W); level setting is thus possible over a dynamic range of more than 160 dB (FIGs 2 and 3). The large frequency range from 9 kHz to 1000 MHz allows extremely broadband EMC measurements. The fine frequency resolution of 1 Hz makes SMGL suitable for even extremely narrowband DUTs. Frequency setting time is maximally 15 ms, ensuring very short measurement times under computer control. The basic SMGL configuration includes of course an IEC/IEEE-bus remote-control interface.

An essential criterion for the quality of a signal generator is the **spectral purity** of the RF signal. Unwanted signals such as spurious and SSB phase noise may falsify the measurement results. SMGL features high spectral purity even close to the carrier, which is required to perform intermodulation measurements with small frequency spacings for instance. Non-harmonic spurious signals remain below −70 dBc throughout the frequency range and over a wide sector even below −80 dBc. SSB phase noise at 20 kHz from a 100-MHz carrier is −144 dBc. The harmonics of the output signal are below −30 dBc for levels up to +27 dBm.

SMGL features **versatile modulation capabilities.** In addition to AM, FM and φM, pulse modulation with an on/off ratio of more than 70 dB is also possible. A fixed-frequency generator is the standard internal modulation source. The internal and an external source can be combined for two-tone modulation. External AM and FM can be AC- or DC-coupled. High carrier-frequency accuracy is ensured even in FM-DC mode, since the frequency drift of $3 \times 10^{-6} \times f_c/h$ is practically negligible. A modulation frequency range extending beyond 100 kHz allows frequency modulation to be used from fast FSK through to high-quality stereo modulation. The amplitude-modulation frequency range extends from DC to 50 kHz (−3 dB). Distortion of a 1-kHz modulation signal with modulation depth of 30% is far below one percent.

Power Signal Generator SMGL is **easy to operate** in spite of its complexity. In addition to keypad operation, all parameters can be varied in three fixed step sizes or in any selectable size. SMGL provides two sweep modes: RF sweep from 9 kHz to 1000 MHz and AF sweep from 10 Hz to 100 kHz with the optional AF synthesizer. Both linear and logarithmic sweeps with selectable step time can be chosen. 50 complete instrument settings can be stored in a nonvolatile memory and recalled at a keystroke in any predefined sequence. A sequence of instrument setups can also be programmed automatically with selectable step time. Storage and sequence functions are particularly useful in production and test departments to minimize setting times for the operator.

Three interesting **options** are available for SMGL: in addition to an oven-controlled reference oscillator (SMG-B1), there is an X output (SMG-B3) for an oscilloscope or recorder. The optional AF synthesizer (SMG-B2) turns the SMGL into an extremely low-

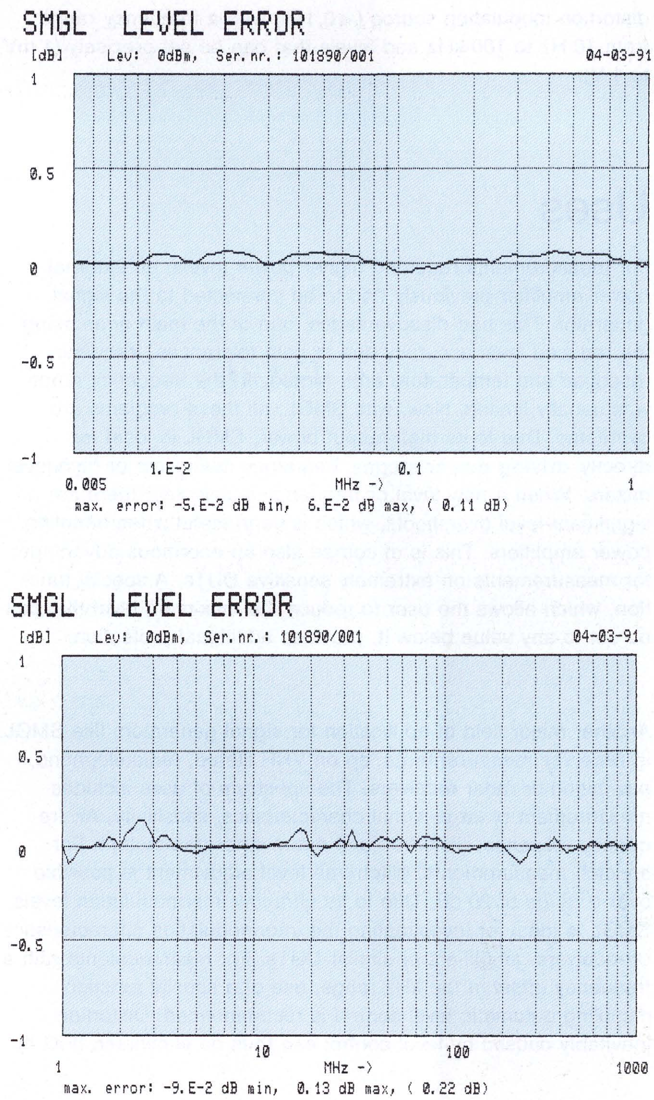


FIG 2 Level error of SMGL at 0 dBm from 5 kHz to 1 MHz and 1 MHz to 1 GHz

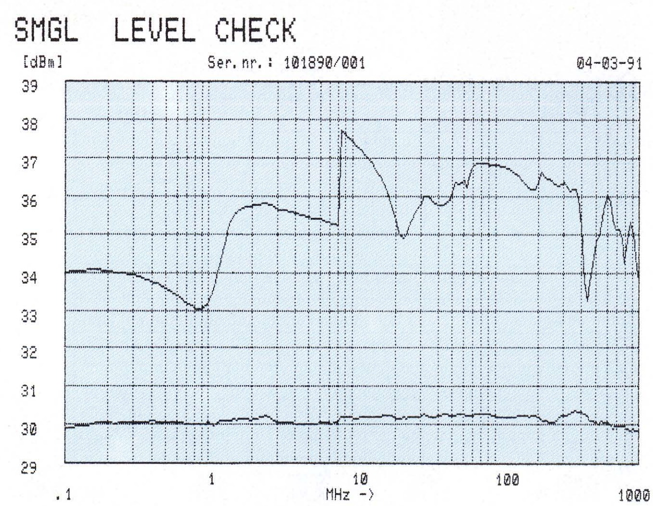


FIG 3 Maximum output level of SMGL and level error at +30 dBm from 0.1 to 1000 MHz

distortion modulation source (≪0.1 %) with a frequency range from 10 Hz to 100 kHz and levels that can be set precisely (1 mV to 1 V).

Uses

For measurements requiring higher power levels, an external power amplifier previously had to be connected to the signal generator. This had disadvantages, one of the main ones being the reduced level accuracy due to gain tolerances, frequency response and temperature drift. Moreover, the frequency range was usually limited. Now, with SMGL, all these problems are overcome. Due to its high output power, SMGL is ideal for directly **driving power stages,** frequency multipliers or high-level mixers. When a new level or frequency is selected, there are no significant level overshoots, which is very useful when handling power amplifiers. This is of course also an enormous advantage for measurements on extremely sensitive DUTs. A special function, which allows the user to reduce the maximum level that can be set to any value below it, provides additional protection.

Another major field of application for signal generators like SMGL is **receiver measurements,** eg on VHF stereo, radiotelephone, navigation or radar receivers. The spectrum of uses includes measurement of large-signal characteristics, sensitivity, AF frequency response, distortion and many other parameters. For squelch measurements, glitch-free level adjustment is possible over a range of 20 dB. Due to its ultra-low intermodulation levels, SMGL is ideal for investigating the intermodulation characteristics of receivers, amplifiers or similar DUTs. For measurements with a frequency offset in the kHz range, use of a special function disabling automatic level control is recommended. Distortion inevitably caused by level control can thus be eliminated (FIG 4).

SMGL is also highly effective for **EMC measurements,** in measuring radiated and conducted RFI. In conjunction with Log-periodic Antenna HUF-Z3 from R&S it produces, at a distance of 1 m from the antenna, an electric field strength of more than 20 V/m (FIG 5) throughout the antenna's frequency range (200 to 1000 MHz). This is much better than the minimum field strength of 5 V/m specified in MIL-STD 461B, Part 3 (RS03) for instance.

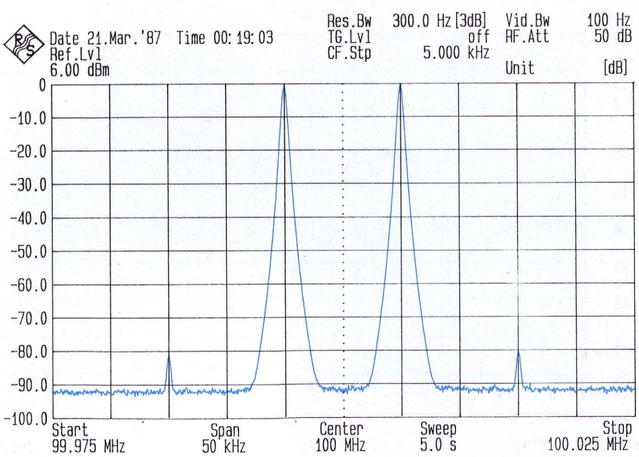


FIG 4 Intermodulation produced when two Signal Generators SMGL are combined via resistive 6-dB coupler (at 100 MHz, 12 dBm, 10 kHz offset)

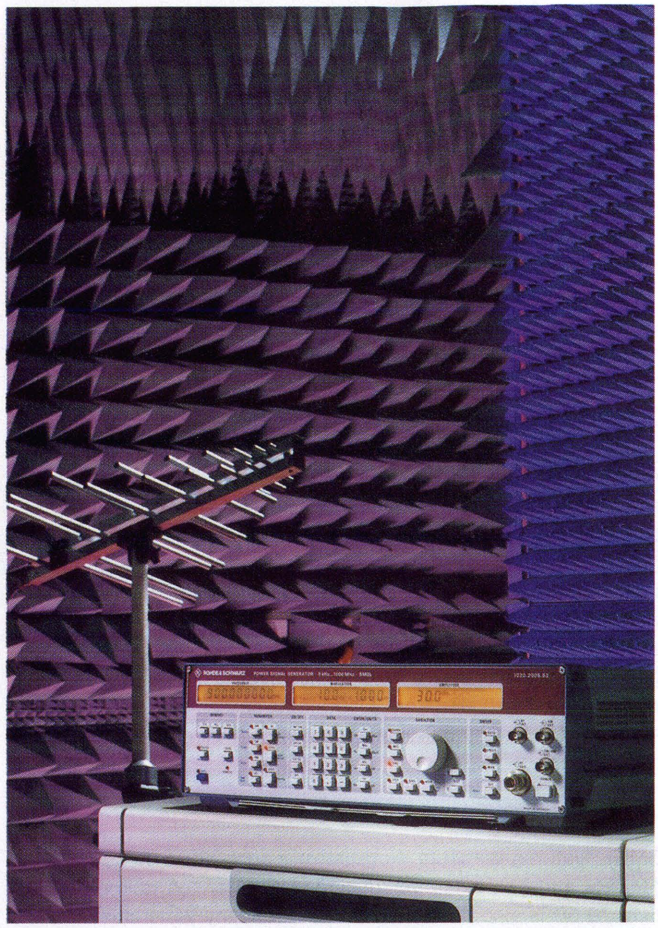


FIG 5 RFI measurements in test chamber; SMGL directly feeding Broadband Antenna HUF-Z3 Photo 39 774

Circuit description

The RF synthesis used by SMGL produces a fundamental octave of 500 to 1000 MHz. The range between 31.25 and 500 MHz is produced by frequency division. The lower frequencies are obtained by down-mixing. The entire frequency spectrum is boosted in a power amplifier to output powers of more than 4 W. The amplifier is followed by a level detector with an insertion loss of only 1.3 dB. The detector, a hybrid resistive coupler with integrated RF rectifier, provides for a temperature-stabilized output level with low SWR. A mechanically switched, high-precision attenuator with a range of 140 dB is also provided at the RF output of SMGL.

To optimize level accuracy, the level of SMGL is calibrated during the final inspection of each instrument at 50 frequency points using a calibrated power meter. The correction values obtained in this way are stored in a table in the controller-module RAM, which has battery backup, and used in each level setting on SMGL. The correction values of frequencies lying between the calibration points are derived by means of an interpolation algorithm. The resulting level frequency response of typically 0.3 dB is hard to beat.

In addition to excellent electrical data, operational safety and reliability were also a main SMGL development target. In close cooperation with R&S quality assurance, the development team made thermographic investigations on the power-supply and power-amplifier modules in order to localize and eliminate hot spots. Internal ventilation in SMGL was optimized with the aid of flow tests. Should ventilation be inhibited from the outside, the instrument will automatically be switched off in case of over-temperature. Automatic permanent monitoring of the internal status ensures immediate fault detection, thus helping to avoid erroneous measurement results. With the aid of the built-in fault diagnostics comprising 42 internal testpoints, the faulty module can be identified reliably, usually without opening the instrument or using additional test facilities. This makes service and maintenance cheaper and faster.

The RF output is, of course, proof to short or open circuits. SMGL is also overload-protected against high DC or AC voltages. The ruggedness of SMGL was demonstrated by comprehensive mechanical stress tests subjecting the signal generator to accelerations of up to 40 g. The result of all these efforts is a mature and dependable, top-class instrument with long service life and high operational reliability.

Klaus-Dieter Tiepermann

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[2] Lüttich F.: Signal Generator SMG for 100 kHz to 1000 MHz. News from Rohde & Schwarz (1986) No. 112, pp 4–7

CONDENSED DATA POWER SIGNAL GENERATOR SMGL

Frequency range	9 kHz to 1000 MHz
Overrange	1 kHz to 1040 MHz
Resolution	1 Hz
Setting time	<15 ms
Level range	–118 to +30 dBm
Overrange	–130 to +36 dBm
Setting time	<25 ms
Error	<1.0 dB for levels > –80 dBm <1.5 dB for levels < –80 dBm
Spurious signals	
Harmonics	< –30 dBc for levels < +27 dBm
Nonharmonics	< –70 dBc
Residual FM (CCITT)	<2 Hz / <1 Hz / <2 Hz / <4 Hz
at f_c	<31.25 / <250 / <500 / <1000 MHz
Modulation	
AM	DC to 50 kHz
FM	DC to 100 kHz
φM	10 Hz to 10 kHz
Pulse modulation	
On/off-ratio	>70 dB
Rise/fall time (10%/90%)	typ. 20 ns (f_c > 200 MHz)
Internal modulation source	8 frequencies between 40 Hz and 15 kHz
Optional AF synthesizer	10 Hz to 100 kHz, 1 mV to 1 V
Remote control	IEC 625-1 (IEEE 488)

READER SERVICE CARD 135/04

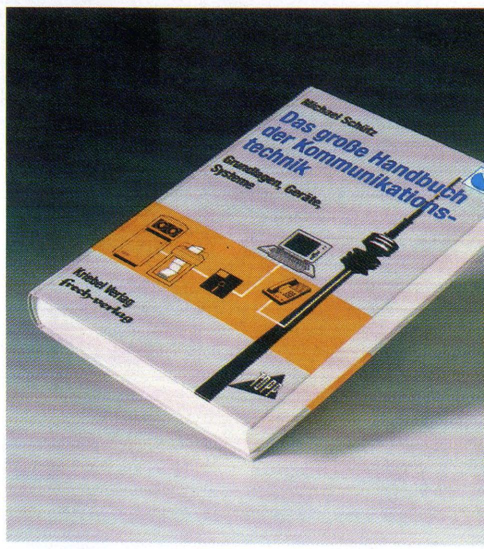
booktalk

Das grosse Handbuch der Kommunikationstechnik – principles, equipment, systems – by Michael Schütz, published in 1991 by Kriebel, Schondorf (ISBN 3-927617-02-4) and by Frech, Stuttgart (ISBN 3-7724-5399-6). 390 pages, 313 illustrations, 22 tables. Price DM 68. Only available in German.

The author modestly calls his book a 'snapshot' of present-day communication technology; in fact it is no less than a comprehensive reference book on communications. From conventional telephone and 'steam' radio to fiber-optic and satellite communications, everything related to speech, text, image and data transmission is covered. You also find out why data are transported and protected in line with ISO/OSI, and how ISDN networks the maze of communication services.

The author knows exactly how to formulate definitions briefly and to the point and to pick out the key parameters. The list of contents and subject index encompassing 32 pages makes the search for a particular topic easy. And that may be the real value of this new publication: it provides the reader – whether student or professor, engineer or technical author – with information on the various communication services and networks. Engineering staff of a long-established company in the field of measurements and communications such as Rohde & Schwarz, engaged in radio and television, Eurosignal and mobile phones, Cityruf and trunked radio, will be able to resort to the book to keep up par with their colleagues or simply to fill any gaps in their own knowledge. Taking the topic of modulation as an example: AM, FM and PM present no problem, but what about ASK, FSK, PSK, APSK and QAM, not forgetting PAM, PFM, PPM and PDM or PCM, DM and DPCM? You find all the answers on pages 260 to 280 of this handbook.

One would hope that many updated editions of the book will follow. My suggestions are: shortwave radio (ARQ, ALIS, message handling, gateways) and air navigation (VOR/ILS, direction finders) as new topics, expanding the chapters on buses and interfaces, improvements to illustrations of equipment as far as



contents and print quality are concerned, and treating some topics more internationally rather than from the point of view of German PTT regulations. The painstakingly written book does merit additions. Stw

60 embassies and consulates of the Federal Republic of Germany are presently linked by shortwave teletype with the communications center of the Foreign Office in Bonn. Shortwave, compared to wired and satellite links, has proven its worth especially in crises because of its independence from third-party facilities. Karl H. Ofer, who is responsible for introduction and trials of new methods of communication for the Foreign Office, reports here about the tasks involved in diplomatic radiocommunication and the use of Rohde & Schwarz equipment.

Crisis-proof communication by shortwave in German diplomatic service

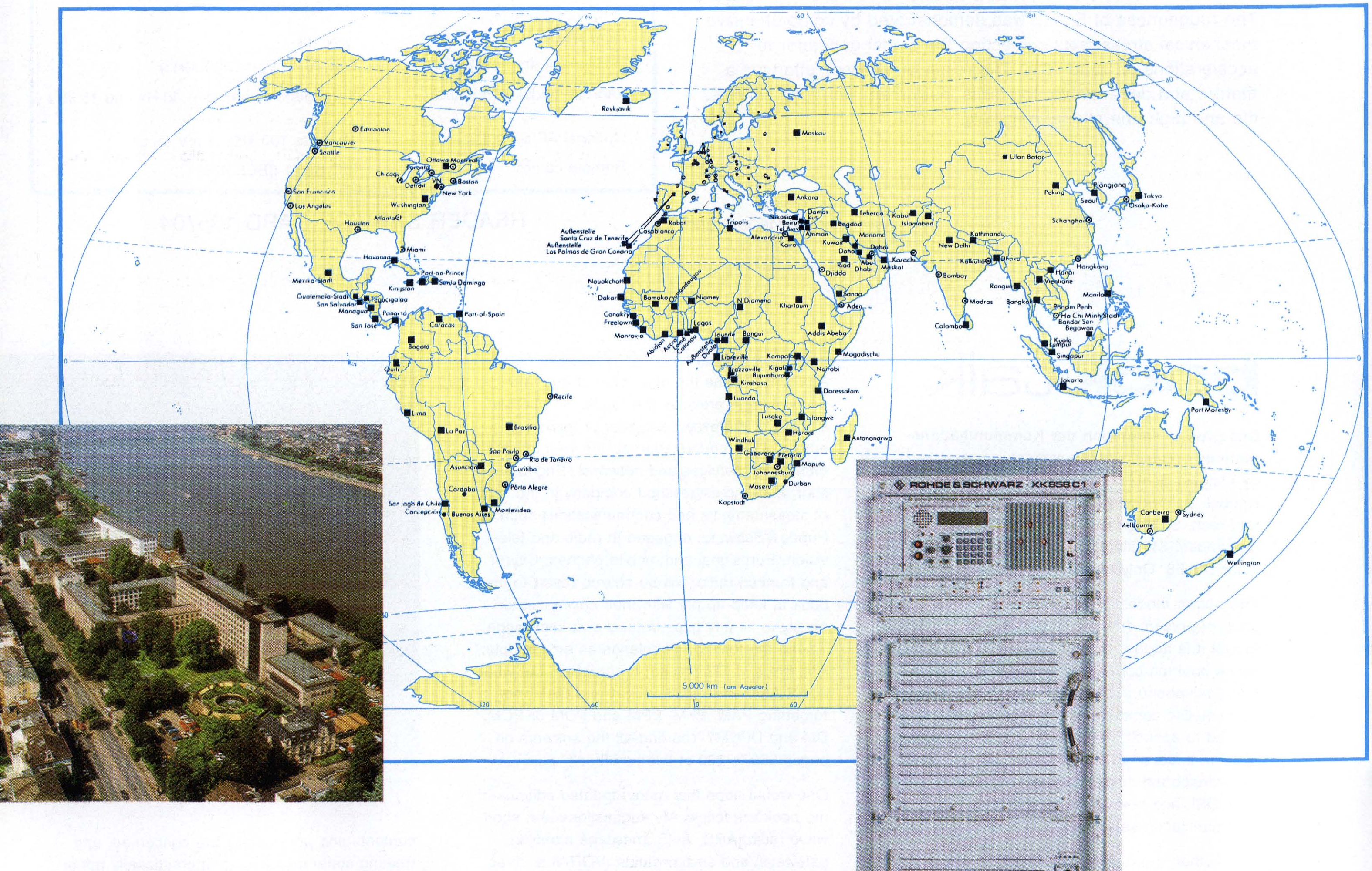


FIG 1 Embassies and consulates of the Federal Republic of Germany (as of October 1990) and the Foreign Office in Bonn – the "house of a thousand windows" together with the 1-kW Shortwave Transmitter/Receiver XK 859 from Rohde & Schwarz Source: German Foreign Office

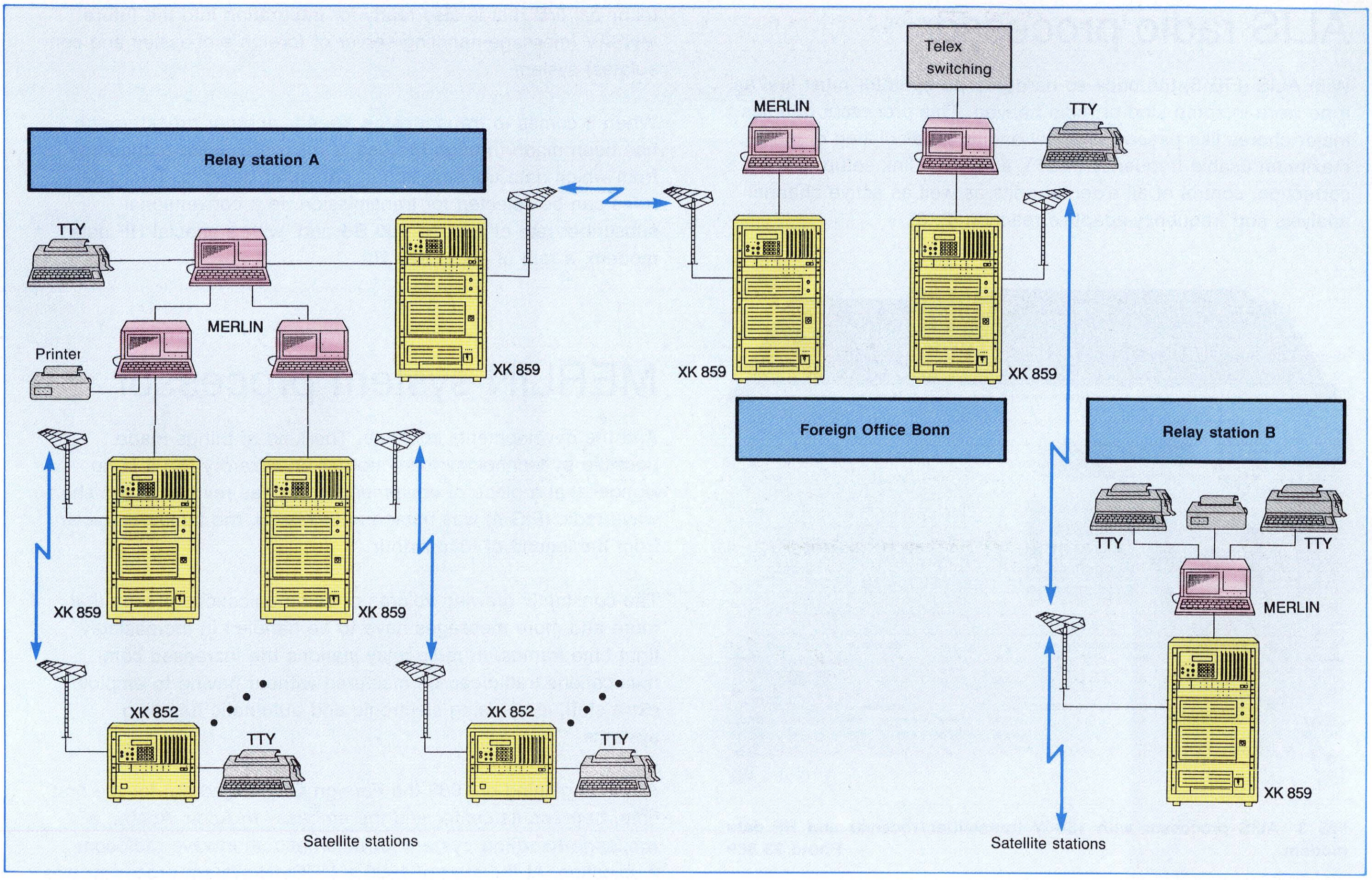


FIG 2 Schematic of shortwave links between Foreign Office in Bonn and embassies and consulates. Nine relay stations and 51 other stations are currently linked with Bonn on shortwave.

The fascination of shortwave

Shortwave radio has not lost any of its fascination as a means of communication that spans the globe, although for a while it did seem to have lost some of its former significance. But automatic and adaptive systems have put the attractiveness back into shortwave. In the early days of shortwave communication, wire reports or telegrams, as they were then called, of the Foreign Office (FIG 1) were transmitted by morse, which was a very time-consuming and strenuous business. Radioteletype at speeds of 50 Bd brought considerable relief, because only about 4 min were required for a page of A4.

Unfortunately shortwave is not an "undisturbed" transmission medium. It is affected by fading in the ionosphere, by atmospheric interference, man-made noise, by other radio services and noise signals. This meant that telexes often had to be sent a number of times in order to ensure reception of a legible message, and that could take hours in the case of a long and encrypted text. The appearance of **error-correction systems** like ARQ (automatic repeat request) and FEC (forward error correction) at the end of the 1950s produced a significant improvement. With duplex ARQ, ie the use of an error-detecting code and automatic acknowledgement and repetition of the characters not properly received, the residual error rate was reduced to such an extent that shortwave radio drew level with cabled and radio-relay links. In ARQ-secured telex communication by shortwave only one character in 500,000 will be corrupted on average. ARQ also meant that the transmission rate could be increased from 50 to 200 Bd. Nevertheless, a high level of technical expertise was called for, so only suitably trained operators could work a service and, if there was a lot of interference along the route, even they had their work cut out when it came to choosing the right frequency.

In the mid-70s German industry then revived its shortwave development activities. The impulse for this came from emerging **microprocessor technology.** Because of its own special interests, the Foreign Office used its influence to ensure that the new technology was utilized for shortwave radiocommunication too. At the beginning of the 80s a number of companies presented their initial designs for an automatic radio processor, and these were examined by the Foreign Office for their suitability. In March 1986 the prototype of an ALIS (automatic link setup) processor was trialed on a radio link [1]. This was the first step along the path that was to lead to independence of the Foreign Office from third-party telecommunication facilities – a matter of considerable importance to it – as well as from having to use specialist operator staff. ALIS is now in use at the relay stations in Addis Abeba and Ankara and at 17 other stations. And midterm all 60 embassies and consulates that work teletype links on shortwave are to be equipped with it (FIG 2).

ALIS radio processor

With ALIS (FIG 3) the once so hardpressed operator must feel as if he were in some kind of radio heaven. This processor handles major chores like passive channel analysis, calculation of the maximum usable frequency (MUF), automatic link setup, error correction, control of all external units as well as active channel analysis and frequency-adaptive reaction [2; 3].

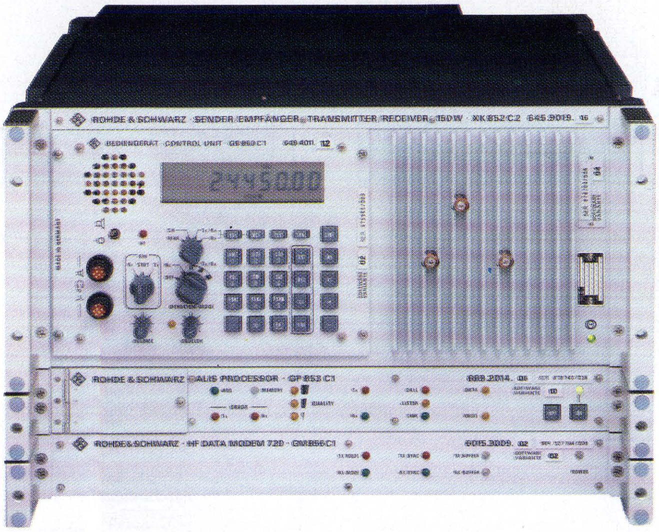


FIG 3 ALIS processor with 150-W transmitter/receiver and HF data modem **Photo 38 809**

The first thing in automated radiocommunication is **frequency selection,** something that has never been easy for the shortwave operator because of the many parameters that have to be considered, like time of day, season of the year, distance to the station at the receiving end and sun-spot activity. But the ALIS processor with its built-in intelligence analyzes all parameters by itself and automatically sets up the equipment accordingly. The following phase of **automatic link setup** is performed using an address and a reliable, redundant code. During link setup the receiving station is informed of the required mode of communication and likewise set up automatically. After this the ARQ process ensures **errorfree transmission.** The residual error rate, which is already further reduced anyway, tends towards zero because of an entirely new kind of coding. If transmission quality degrades, there is an **adaptive reaction** with automatic selection of another operating frequency.

Integrated radio and office communication

Information technology is naturally appearing on an increasing scale in the everyday work of the Foreign Office too, so it was essential that the method of radiocommunication be able to transmit data in 7-bit and 8-bit ASCII code as well as telex messages in 5-bit Baudot code. Now the Foreign Office is able to transmit **computer data and Word documents** from workstation computers securely and reliably on its official radio links – a technical first that is also ready for integration into the future MHSAV (message-handling server of foreign embassies and consulates) system.

When it comes to **transmission speed,** another breakthrough has been made through the use of microprocessor technology from which data transmission in particular benefits. Two data rates can be selected for transmission, ie a conventional subscriber rate of approx. **100 Bd** and, with a special HF data modem, a rate of about **370 Bd.**

MERLIN system processor

And the developments continue. The kind of things made possible by technology today border on wizardry. So it is no wonder that a piece of equipment which has revolutionized shortwave radio (FIG 4) was named after Merlin, the famed magician from the legend of King Arthur.

The constantly growing volume of communications means that more and more messages have to be handled in increasingly tight time frames. In radio-relay stations the increased communications traffic can be mastered without having to employ extra staff, ie by using electronic and automatic handling systems.

At the beginning of 1989 the Foreign Office tried out for the first time, between its center and the embassy in Addis Abeba, a **message-handling system** for automatic shortwave radiocommunication. At the start of 1990 a MERLIN system processor was then installed and put into operation. MERLIN stands for **me**ssage-handling and radio-**lin**k management [4; 5]. This processor works as an **automatic relay station,** linking different radio circuits with one another, routing and transmitting messages on command.

MERLIN simplifies quite considerably what used to be a very complicated procedure. Messages can now be entered into the system for processing continuously and simultaneously – even when radio operations are shut down – on very different channels like radio, computer, teletype or keyboard. They are stored and managed like the files of a word-processing system under

FIG 4 MERLIN system processor for message handling **Photo 37 707/2**

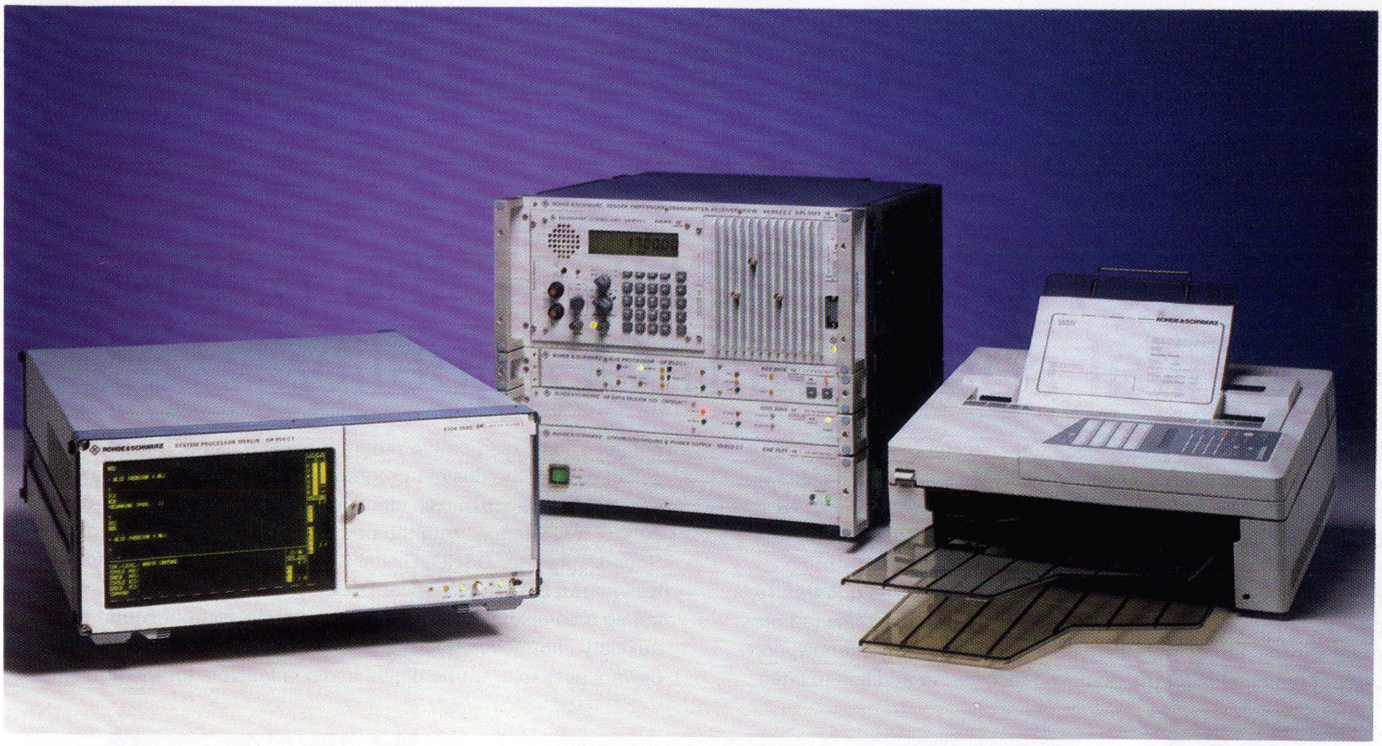


FIG 5 ALIS radio processor and MERLIN system processor for automatically controlling and supervising shortwave radiocommunication links
Photo 39 605

automatically assigned names. The messages are also automatically queued, ie sorted by destination and priority, and then routed and transmitted. A record is kept of every telex that comes in or goes out.

In conjunction with the ALIS radio processor, MERLIN **automatically controls and supervises transmitting and receiving systems** (FIG 5). Intelligent communication interfaces enable it to be matched to very different data rates, input/output devices and network structures [6] as well as various networks like X.400, fax and ISDN.

Summary and prospects

The ALIS processor virtually does away with all the previous problems of shortwave communication. It is now possible, and without specially trained operators, to set up radiocommunication links for the transmission of telex messages and data. Link setup, frequency selection as well as the safeguarding of transmission quality are all handled in the background by the ALIS processor. The MERLIN system processor is responsible for automatic message handling in the system. It works with a multitasking operating system, so that transmission, reception, processing, etc all run more or less simultaneously. One point of interest is that the increase in communications between Ankara and Bonn during the Gulf War could not have been mastered if it had not been for the implementation of this new technology. MERLIN and ALIS will soon be going into operation in other communications stations of the Foreign Office's network. The future-oriented system concept permits extension with HF modems for even faster data rates.

Karl H. Ofer

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CONDENSED DATA SHORTWAVE RADIO NETWORK

Transmitting power	150/1000 W
Data rate	100/370 Bd
Error correction	ARQ and FEC
Equipment used	
Transmitter/receiver	XK 859 (1 kW)
	XK 852 (150 W)
Radio processor	ALIS GP 853
System processor	MERLIN GR 856
HF data modem	GM 856
Log-periodic antennas	AK 451 (5 to 30 MHz)
	AK 471 (7 to 30 MHz)

READER SERVICE CARD 135/05

In DSR Modulator SFP, Digital Sound Converter DSRU and Digital Sound Receiver DSRE, Rohde & Schwarz presents a complete digital sound-transmission system to DSR standard. Thanks to its flexibility and high quality, the system covers the whole range of operational and test requirements for digital satellite radio.

SFP, DSRU and DSRE – the pleasure of digital sound with CD quality

Digital satellite radio (DSR) distributes 16 stereo sound-broadcast programs with compact-disk quality via satellite and cable networks. The sound signals are digitized with resolution of 16 bits, the sampling frequency being 32 kHz. The complete information of 16 stereo programs is transmitted using a 16/14-bit floating-point technique at a rate of 20.48 Mbit/s and quadrature phase-shift keying (QPSK) [1]. Auxiliary information items (eg program service name, program type, speech/music) yield new, convenient tuning aids for the domestic receiver: in addition to channel selection based on the program service name, it is possible to select directly the desired program type (eg light music, news, sport). The speech/music identification permits separate volume control for instance. With the new DSR Modulator SFP, Digital Sound Converter DSRU, Digital Sound Receiver DSRE and the well-known DS1 Audio Coder DCA [2], Rohde & Schwarz is marketing a complete system for digital transmission of sound and auxiliary information (FIG 1). Thus – with suitable domestic receivers available – true digital audio is feasible for the first time.

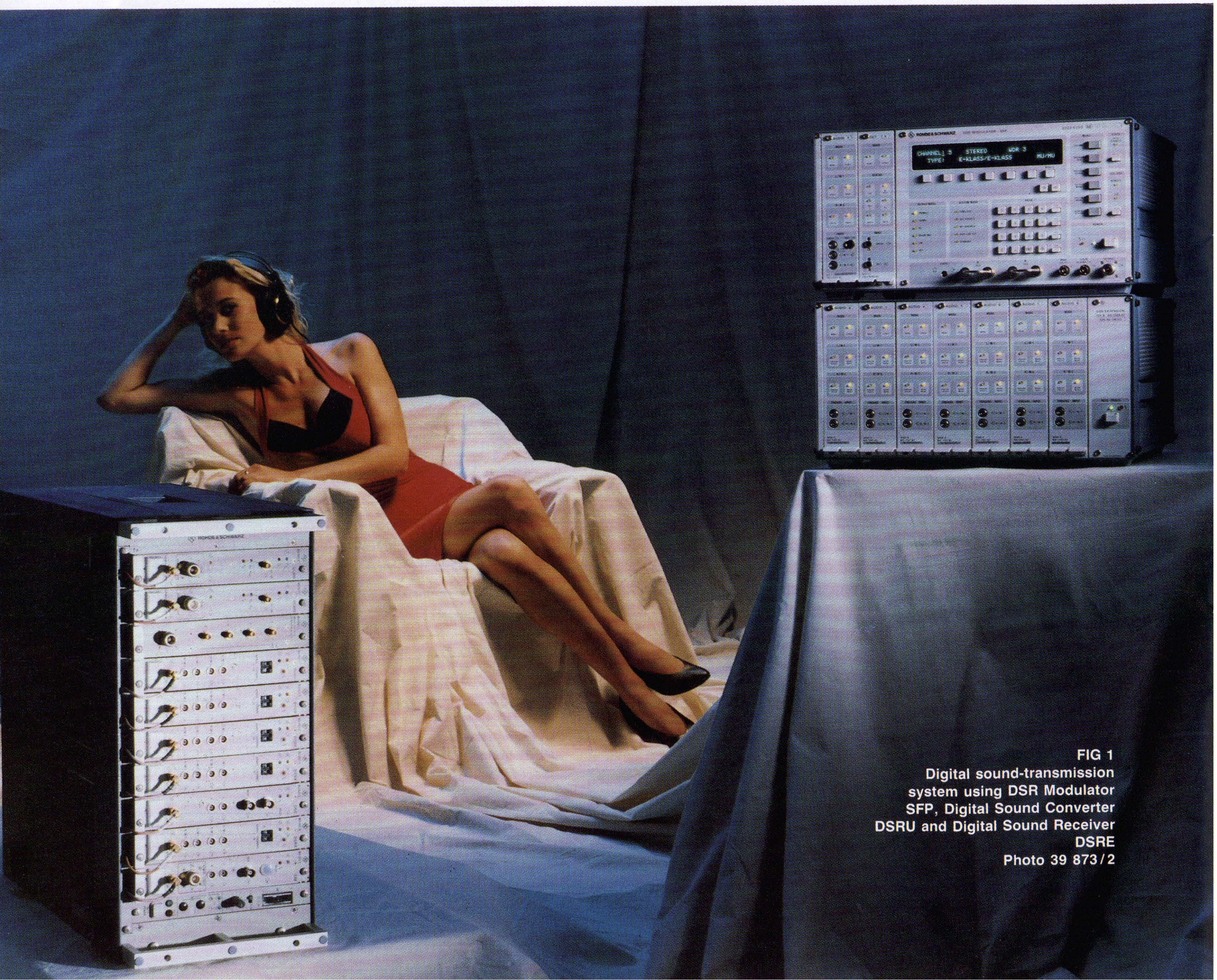

FIG 1
Digital sound-transmission system using DSR Modulator SFP, Digital Sound Converter DSRU and Digital Sound Receiver DSRE
Photo 39 873/2

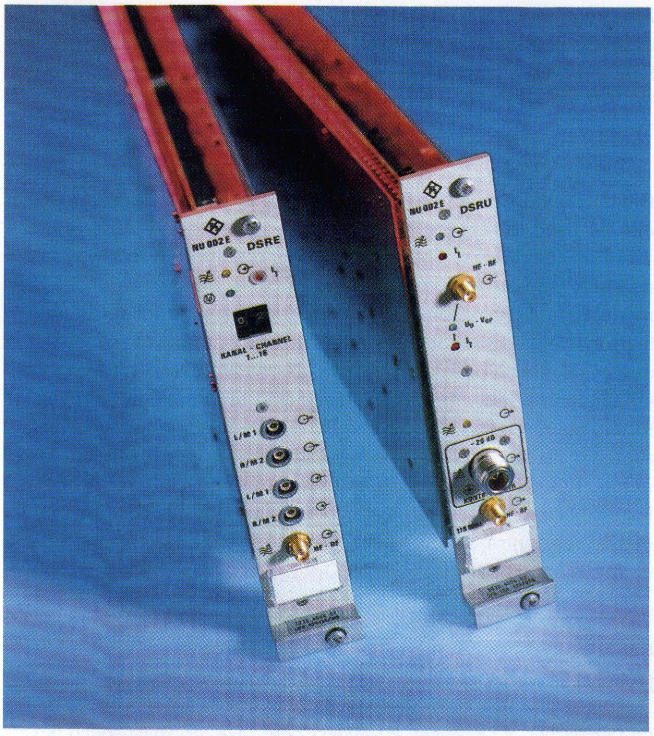

FIG 2 Digital Sound Receiver DSRE and Digital Sound Converter DSRU Photo 39 883

DSR Modulator SFP

DSR Modulator SFP with its DS1 Plug-in SFP-E1, Audio Plug-in SFP-E2 and DSR Extension SFP-X is a state-of-the-art DSR transmitter producing a 118/70-MHz QPSK carrier signal which is in line with the DSR specifications of ARD and ZDF [3] and can be modulated with 16 stereo channels.

The most important **features of SFP** are:

- standard 118/70-MHz QPSK signal which can be modulated with up to 16 stereo or 32 mono channels,
- audio-signal inputs, DS1 signal inputs as required,
- external synchronization,
- bit-error-rate (BER) measurement possible in both main frames,
- user-friendly hard/softkey operation,
- remote control via IEC/IEEE bus.

DSR Modulator SFP is the basic unit for the DSR transmitting system. It accepts one or two channel plug-ins each handling a complete stereo program and delivering the digital AF data. The internal digital interface is accessible on the rear panel and permits connection of **DSR Extension SFP-X,** which allows seven additional channels to be fitted. Thus, with two DSR Extensions SFP-X, all 16 channels of a DSR signal can be used. After the relevant plug-in has been selected, it is possible to set the complete operating state of the channel on the front panel of the basic unit. User-friendly hardkey and softkey control allows rapid and problemfree entries. In the basic unit the digital audio signals and auxiliary information are combined in two main frames A and B and applied to the QPSK modulator with 118-MHz carrier frequency. Thanks to the integrated 70-MHz converter, a 118-MHz or 70-MHz carrier signal is available.

The **channel plug-ins** (SFP-E1 and SFP-E2) are designed for different tasks. **DS1 Plug-in SFP-E1** constitutes the DS1 digital line end; it decodes the 1-Mbit data stream which arrives in HDB3 code. The decoded AF with 16-bit resolution and 32-kHz sampling frequency as well as the program-related data are fed to the basic unit where they are integrated into the DSR signal. The auxiliary information items of the DS1 signal are read out in plain text on the alphanumeric display. In addition, aural monitoring is possible at the headphones output of the basic unit after D/A conversion of the sound signal. In conjunction with the basic unit, the DS1 decoder (SFP-E1) thus also operates as a DS1 monitoring receiver.

Audio Plug-in SFP-E2 is used for analog-signal modulation. It converts an AF stereo or two mono signals into digital data streams which – as with the DS1 decoder – are applied to the basic unit. In this way the two types of plug-in can be combined as required. The auxiliary information associated with the corresponding channel is entered from the basic unit under menu control or via the IEC/IEEE bus if an audio plug-in is fitted.

Digital sound receiving units DSRU and DSRE

With Digital Sound Converter DSRU and Digital Sound Receiver DSRE (FIG 2) R&S has extended its modular NU 002 sound-processing system [4]. Both devices are of the plug-in type and can be used together with the NU 002 VHF-FM units, ie Demodulator/Stereodecoder DDC (substitution-signal source) and Stereocoder/Modulator CM (FM modulator).

The most important **characteristics** of the digital sound-receiving equipment are:

- excellent transmission quality on 16 stereo or 32 mono channels,
- passive standby with two DRSUs without modification,
- switchover to substitution signal based on internal BER measurement,
- auxiliary-information output via serial interface,
- control and monitoring with internal microcontroller,
- system compatibility due to I^2C bus control (I^2C = inter-IC bus).

Digital Sound Converter DSRU uses PLL-based carrier recovery to convert the first satellite IF to 118 MHz. This conversion related to the QPSK signal is absolutely necessary for demodulation since the frequency errors of all free-running local oscillators along the transmission path must be corrected. In addition to the operating output, which is muted when there is a failure, DRSU is fitted with a permanently through-connected test output. Built-in tuning aids facilitate level alignment and frequency adjustment.

Digital Sound Receiver DSRE processes the 118-MHz QPSK-modulated signal. After demodulation and decoding the selected program is transmitted to a fourfold-oversampling digital filter. A 16-bit stereo D/A converter converts the signal back into analog form. The subsequent, steep-skirt audio lowpass filter eliminates all aliasing components which might cause audible interference in the case of further modulation. DSRE is fitted with an AF substitution-signal input; an integral BER meter controls switch-over to the substitution signal. The switchover threshold is set to a BER of approximately 5×10^{-4} since, with DSR transmission, audible errors occur only above a BER of about 3×10^{-3}. Moreover the receiver monitors the auxiliary information associated with the selected channel. If the message "No program" is sent, switchover to the substitution signal also takes place.

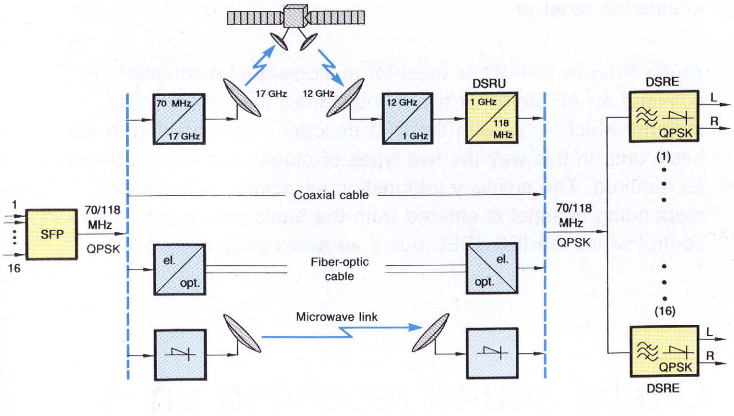

FIG 3 Use of digital sound units in broadband communication networks

Uses

DSR Modulator SFP is ideal for **quality measurements** during the development, production and servicing of receivers, converters and transmission links. The standard transmission frames allow complete testing of satellite-radio receivers. This covers measurement of AF quality data through to checking the decoding of the data streams. Another important application is determination of the BER of transmission links and converters. For this purpose noise is superimposed on the QPSK signal. The bit error rates caused are determined as a function of the carrier/noise ratio [5].

In earth stations a **modulator** is required for the **satellite uplink;** this modulator accepts 16 different program sources producing a DSR signal. In this case DSR Modulator SFP fitted with two DSR Extensions SFP-X to provide 16 channels can be used. Normally program transfer to the earth station is purely digital using the DS1 method, as broadcasters operate at a different site.

There are several ways (FIG 3) of **feeding digital sound programs into broadband communication networks** and for using the digital sound units. A DSR signal received by Digital Sound Converter DSRU via satellite and subjected to conversion with PLL-based carrier recovery is transmitted without being modified. Reliability of operation can be increased using a second converter and a second satellite antenna if required. Switchover between the two converters is performed automatically by the system I²C bus. Thanks to its modular design, DSR Modulator SFP also allows a DSR signal to be obtained by combining local and regional programs as well as those received by satellite for distribution in broadband communication networks. In this case, both digital and analog plug-ins are fitted to SFP depending on the program feed. If Digital Sound Receivers DSRE are used as the AF signal source for transferring individual programs from the DSR satellite channel, the auxiliary information available is routed to SFP via an I²C bus that connects equipment outside the system.

Digital Sound Converter DSRU and Digital Sound Receiver DSRE can be used to **replace relay receiving systems, sound links and FM converters.** The audio signals obtained in this way are used for high-quality program feed to cable head-ends or for modulating signals from FM transmitters installed for terrestrial broadcasting. DSRE delivers one of the 16 programs with CD quality. It is also possible to apply alternative signal paths to the substitution-signal input of DSRE so that automatic switchover to this source takes place if the DSR transmission link is interrupted. The auxiliary-information items (eg program service name, stereo/mono, speech/music, program type) are available for further processing. It is possible to use and process this information for control and for new coding, for instance for the radio data system (RDS).

Albert Dietl; Gregor Kleine

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CONDENSED DATA
DSR SOUND-TRANSMISSION EQUIPMENT

DSR Modulator SFP	
Modulation	QPSK
Centre frequency	118/70 MHz
Bandwidth of output signal	±7 MHz
Output level	0 to −48 dBm
Spectral shaping	SQRT (50% cosine rolloff)
Transmission rate	20.48 Mbit/s
Remote control	IEC 625-2 (IEEE 488.2)
Digital Sound Converter DSRU	
Input-frequency range	950 to 1750 MHz
Input-level range	−55 to −25 dBm
Output centre frequency	118 MHz (±50 kHz)
Output-level range	−20 to +10 dBm
LNC supply	15 V, <200 mA, shortcircuit-proof
Digital Sound Receiver DSRE	
Input frequency	118 MHz (70 MHz on request)
Input level	−25 to +10 dBm
Switchover to substitution signal	BER threshold approx. 5×10^{-4}
AF output level	6 to 9 dBm into 600 Ω, balanced to ground
AF frequency-response flatness	±0.5 dB (20 Hz to 15 kHz)
AF harmonic distortion	<0.1% (20 Hz to 15 kHz)
Unweighted S/N ratio	≥ 80 dB
AF crosstalk	down 80 dB

READER SERVICE CARD 135/06

application

AMS and ADS – applications for state-of-the-art ARB generators

With Arbitrary Waveform Generator AMS and Dual Arbitrary Waveform Generator ADS [1] a virtually unlimited variety of waveforms can be generated (FIG 1) so that the range of applications of these generators, in some cases, goes far beyond that of conventional ARB generators.

Video applications

The ARB sequence mode opens up application areas for AMS and ADS that are normally closed to other ARB generators. An example is the **generation of video test patterns.**

Representing a test pattern made up of 625 lines as an ARB waveform is not usually possible since even for simple patterns of only a few video lines more than 640,000 points have to be stored when normal ARB synthesis is employed. A memory requirement of this size rules out such an application. The ARB sequence mode of AMS/ADS cuts down substantially the memory required for the generation of simple test patterns. In this mode different waveforms may be called up from main memory in any sequence.

A repetition factor between 1 and 65,535 can be specified for each waveform. This eliminates the need for storing identical and consecutive waveform sections over and over again. It is also possible to generate waveforms within an ARB sequence at a reduced output rate. This technique allows sections of constant amplitude to be stored with just a fraction of the number of points required when the clock frequency is not reduced. The colour-bar test pattern shown in FIG 1 can be stored using as few as 8032 points through optimum utilization of the ARB sequence mode.

The synthesizer clock must have high frequency resolution for **generating colour test patterns.** Without the high frequency resolution, the frequency of the colour burst cannot be produced with the accuracy required for correct demodulation in the receiver. The AMS/ADS option Clock Generator ADS-B1 with 10 ps resolution for the synthesizer clock creates the necessary prerequisites.

The internal 320-Kbyte memory can be used to store a large number of test patterns and generate them at a keystroke. With the use of the optional memory card, the number of test patterns can be increased as required. The excellent broadband AM characteristics of Signal Generator SMHU 58 [2] enable the user to convert the CCVS signal of AMS/ADS to a carrier frequency between 10 MHz and 1.9 GHz.

In contrast to the proven R&S Video-signal Generators SPF 2 and SVDF for standard video test signals, AMS and ADS offer the means to **generate virtually any type of non-standard video signal.** All parameters such as line number, horizontal resolution, line- and field-repetition frequency, picture format or colour-subcarrier frequency can be freely selected. AMS and ADS thus allow measurements to be made on video systems that deviate from existing standards or testing of new systems during the development phase.

FIG 1 **Arbitrary Waveform Generator ADS as signal source for generating colour-bar test patterns** Photo 39 721

Generation of complex modulation signals

Arbitrary Waveform Generator AMS can generate flexibly and precisely complex signals which up to now were the domain of special application-oriented generators. The versatility of this generator will usually make it a more economical proposition than special-purpose generators. A further benefit lies in the fact that all the parameters that determine the quality of modulation signals can be varied independently. In addition to ideal modulation signals, signals deviating from the ideal characteristics can be generated allowing precise predictions about the real behaviour of DUTs.

A typical example of a complex modulation signal is the **stereo multiplex signal** used in VHF sound broadcasting. An MPX signal consists of the sum signal (L + R) of the two stereo channels, a double-sideband AM signal representing the difference of the stereo signals (L – R) modulated onto a suppressed 38-kHz carrier and a 19-kHz pilot tone which is phase-locked to the 38-kHz carrier (FIG 2). The separation of the L and R

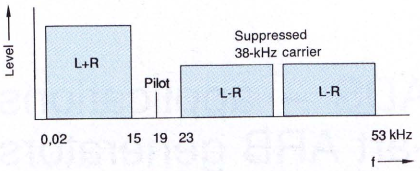

FIG 2 Spectrum of stereo MPX signal

signals takes place in the receiver following FM demodulation by forming the sum and difference of the (L + R) signal and the (L – R) signal which is synchronously demodulated with the aid of the pilot tone. The AF bandwidth of each channel is between 20 Hz and 15 kHz. The prerequisites for clean separation of the lefthand and righthand channel signals in the receiver are high phase linearity and flat amplitude/frequency response of the modules involved in synthesis of the MPX signal in a frequency range up to 53 kHz.

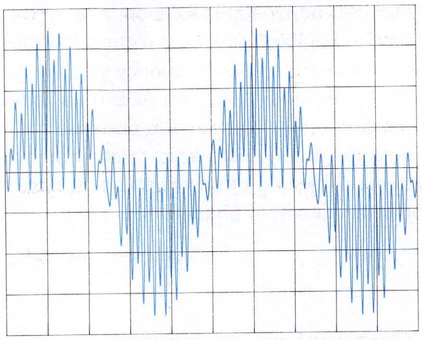

FIG 3 Stereo multiplex signal generated by AMS

Thanks to its precise signal synthesis, Arbitrary Waveform Generator AMS is ideal for generating high-quality stereo multiplex signals (FIG 3). Stereo multiplex signals can simply be calculated using **Application Software AWD-K1** and transferred to AMS via the IEC/IEEE bus. However, the calculation must take into account that, as a result of the periodic readout of waveforms, the ARB waveform should contain complete cycles of all signal components. The number of cycles to be stored depends on the required frequency resolution for the AF components of the lefthand and righthand stereo channels. Resolution of 1 kHz for the AF signals contained in the multiplex signal yields a minimum ARB period of 1/1 kHz = 1 ms, at 100 Hz resolution a period of 10 ms.

With a view to filtering, the number of points for representing the multiplex signal should at any rate be chosen large to obtain maximum separation between the synthesizer clock frequency and the MPX signal spectrum. Using the AWD program shown in the blue box, any stereo multiplex signal with 1 kHz resolution for the AF components can be calculated. If the selected number of points is 12,500, the synthesizer clock period to be set is

$$\Delta T = 1/1000\ \text{Hz}/12{,}500 = 80\ \text{ns}$$

The performance data obtained with AMS are 60 dB down for channel crosstalk, typically 70 dB for the total harmonic distortion of demodulated AF signals and better than 80 dB for unweighted and weighted S/N ratios.

Apart from generating standard stereo test signals (L, R, L = R, L = – R), practically **any combination of AF signals** can be generated including two-tone signals for intermodulation measurements.

Modulation sources for air-navigation signals

VOR (VHF omnidirectional radiorange) and ILS (instrument landing system) are amongst the most important navigation techniques used in civil aviation. Both techniques are based on the evaluation of complex AM modulation signals. ARB generators AMS and ADS are ideally suited for producing these modulation signals. Together with Signal Generator SMX [3], AMS or ADS forms a convenient and yet inexpensive test system for air-navigation receivers.

The VOR modulation signal is a combination of a 30-Hz signal and a 9.960-kHz carrier modulated by another 30-Hz signal. The navigation receiver onboard the aircraft provides the required bearing information by evaluating the phase of the two 30-Hz phase-locked signals. **Dual Arbitrary Waveform Generator ADS** is an ideal source for **VOR signals** since the phase of its two channels can be set very accurately. By assigning the two VOR signal components separately to the ARB synthesizer channels, the phase between the 30-Hz FM reference signal and the 30-Hz bearing signal can be conveniently set with resolution of 0.02° in the range between – 180° and + 180° by means of the rotary control on ADS. The frequency-modulated 9.96-kHz carrier in channel 1 generated as an ARB waveform is superimposed onto the 30-Hz bearing signal of channel 2 to yield the VOR modulation signal at the output of channel 1.

```
!AWD-Programm zur Berechnung eines Stereo-Multiplex-Signals

! Einstellung AMS/ADS : dT = 80 ns, 12500 Punkte

    X : 0 : 2*PI*(1-1/12500) : 12500;
    Y : -1 : +1 ;

! Parameter

    N= 40  ;    ! Nutzhub  [kHz]
    P= 6.72;    ! Pilothub [kHz]
    L= 1   ;    ! Frequenz, linker Kanal  [kHz]
    R= 0   ;    ! Frequenz, rechter Kanal [kHz]
    PH=0   ;    ! Pilotphase [rad]

    A=N/(N+P);
    B=P/(N+P);
    M=0.5*SIN(L*X)+0.5*SIN(R*X);
    S=0.5*SIN(L*X)-0.5*SIN(R*X);

    Y=A*(M+S*SIN(38*X))+B*SIN(19*X+PH);
```

The FM component of the VOR signal can be simply calculated as an ARB waveform using AWD (Arbitrary Waveform Designer) software (see red box) and transmitted to the Dual Arbitrary Waveform Generator ADS via the IEC bus. When calculating the FM component, a constant phase offset of the two VOR components arising from the different clock frequencies during synchronization has to be taken into account. This phase offset can be eliminated by introducing a correction factor K in the formula used to calculate the FM component. If the convenient phase-setting technique is not desired, the VOR signal can be calculated completely as an ARB waveform and generated by AMS.

The AF signal demodulated by the ILS receiver during approach to land is made up of two sinewaves at 90 and 150 Hz, the strength of which depends on the deviation of the aircraft from the ideal landing course. High resolution, accurate setting of the output amplitude and the internal combination of the two synthesizer channels make **Dual Arbitrary Waveform Generator ADS** an ideal modulation source for **ILS signals.**

The decisive factor in determining the accuracy of an ILS signal is the level difference between the two signals when set to the same level, ie DDM (difference in depth of modulation) error. A simple calibration routine in ADS allows the level difference of the two modulation

```
! AWD-Programm zur Berechnung des FM-Anteils eines VOR-Signals

! Einstellung des Clock-Synthesizers mit Hilfe der Spezial-
! funktion "dTARB"        :  S-FRQ = 24,960 MHz
!                            DIV   = 52
! Punkteanzahl            :  16.000
! Phasenkorrekturfaktor   :  0,0042

X : 0 : 2*PI*(1-1/16000):16000;
Y : -1 : +1;

Y = SIN ( 332*X + 16*SIN (X+K) );
```

signals to be minimized. The calibration itself uses two 90-Hz signals with a phase difference of 180°. Residual amplitude of the internally superimposed 90-Hz signals caused by tolerances in the internal level settings and the adding network can be minimized by manually adjusting the D/A converters used for the fine amplitude setting in the two channels.

Given sensitivity of 0.1% AM per mV of AF amplitude at the signal generator's AM input, a nominal amplitude (V_{pp}) of 800 mV is obtained for the modulation signal of the approach-to-land transmitter, taking into account that the amplitudes are halved when the two signals are added together. The amplitude setting resolution is 625 mV/2048 = 305 µV in this level range. At this resolution, a level difference of around 150 µV is obtained through calibration assuming a flat amplitude/frequency response between 90 and 150 Hz. This corresponds to a DDM error of approximately 0.00004.

In addition to ILS modulation signals, ADS can also generate **marker signals** that are used as range-identification labels.

Driving I/Q modulators

Digital modulation methods are increasingly gaining ground in communication applications because they have better spectral efficiency than analog methods. The classic digital modulation methods are based on phase, amplitude or combined phase and amplitude shift keying of the carrier frequency. The digital information is transmitted as discrete phase and amplitude states of the carrier. Depending on the number of possible states (FIG 4), seven bits of information can be assigned to each state.

By appropriate driving of the I/Q modulation inputs of Signal Generator SMHU 58 [2], **any type of phase and amplitude shift keying** can be produced in the RF carrier range of 10 MHz to 1.9 GHz. Dual Arbitrary Waveform Generator ADS is eminently suitable for driving the I/Q modulator of SMHU 58. It can generate control signals for up to 16,384 arbitrarily selected carrier states at a symbol rate of up to 33 MHz. The clock-generator option allows the symbol rate to be set at high resolution. Hard phase keying that generates interference lines is avoided by filtering the control signals. ADS can generate control signals with any type of filtering (FIG 5) thanks to its high amplitude resolution and large memory. The calculation of the filtered signals can be performed automatically by software and varied in any way.

While modulation methods based on keying the carrier phase and amplitude are mainly found in satellite communications and terrestrial radio links, another class of modulation based on digital FM is gaining in importance especially in the field of mobile radio. An example of this is **Gaussian minimum shift keying (GMSK)** specified by Groupe Spécial Mobile (GSM) for the pan-European mobile-radio network. GMSK modulation offers a good compromise between spectral efficiency and a satisfactory S/N ratio, both of which are especially significant for mobile radio. In GMSK the bit stream is first filtered by means of a Gaussian lowpass with a bandwidth B = 0.3/T (T = bit duration) and then transmitted as an FM signal with a modulation index of 0.5. The maximum phase deviation per bit is thus 0.5 radian.

Dual Arbitrary Waveform Generator ADS is a high-precision signal source for driving I/Q modulators used for GMSK modulation (FIG 6). The advantage of ADS over special coders that are made for particular modulation types is that all the modulation parameters – especially filter parameters – can be varied by

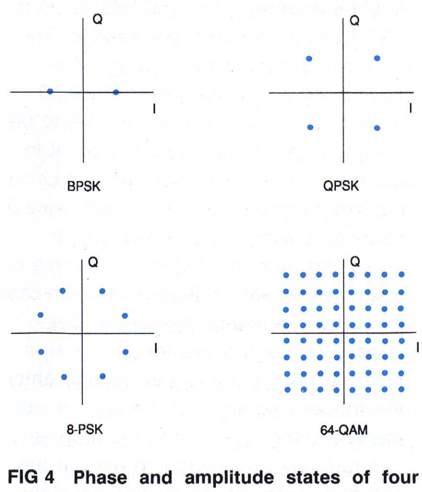

FIG 4 Phase and amplitude states of four common digital modulation types defined by end points of carrier vectors in I/Q diagram

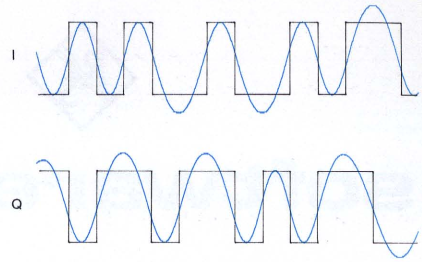

FIG 5 Typical I/Q driving-signal curves output by ADS for generating QPSK (black: without filtering; blue: cos² rolloff filtering, rolloff factor 0.5)

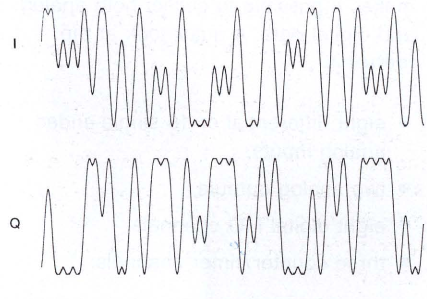

FIG 6 Driving signals produced for GMSK modulation by ADS

software. This capability offers simple ways of investigating the behaviour of communication systems based on digital modulation.

Hans-Günter Titze

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Reader service card 135/07

Data acquisition with Analog I/O Interface PS-B13

The Analog I/O Interface option PS-B13 for the PSA range of Process Controllers makes it possible to collect both analog and digital data. A quick look at the **features:**

- eight differential or 16 single-ended analog inputs,
- two analog outputs,
- eight digital I/O channels,
- three counter/timer channels.

As this board has so many functions, a **completely menu-driven application program** was written to demonstrate to the user practically the entire range of functions. The program was written in QuickBasic version 4.5 and uses a "toolbox" to generate pulldown menus. The actual programming of PS-B13 is done using the PSLIB function library, which is supplied with any unit in the PSA range as well as with the analog I/O option. This application program is not only an excellent demo program, but also an ideal example of the use of toolboxes and utility routines using the QuickBasic language, and shows how QuickBasic supports a modular, top-down programming style. It also shows how to integrate analog I/O interfaces into modern programming languages and how easy it is to write software for them. Previously you had to program in C or Pascal to use them. FIG 1 shows the initialize screen for the PS-B13 hardware.

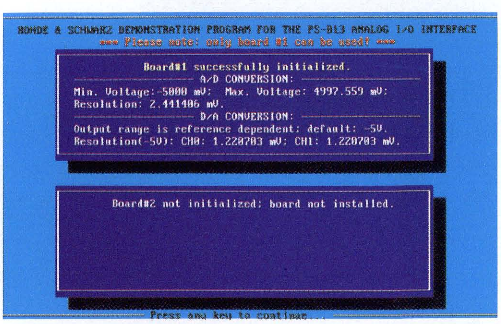


FIG 1 Initialize display of demo program for Analog I/O Interface option PS-B13 for PSA family of controllers from R&S

The **PSLIB function library** contains 25 functions to drive the analog I/O interface; 20 of them are used in the application program. Only the following functions are left out: digital input ANG.DIG.IN() and output ANG.DIG.OUT(), the timer-input function ANG.TMR.IN() and the functions for simultaneous block input and output operations, ANG.BLIO.INIT() and ANG.BLIO(). If at runtime a problem occurs in communication with PS-B13, an error code from the ANGIO error-code table is output.

This program can handle **input voltages** of ±5 V on channels 0 through 15; higher voltages are limited at ±5 V (maximum input voltage is ±10 V, independently of the gain set).

The **output-voltage range** depends on the reference voltage used. Normally this is supplied by the onboard −5-V reference to the two reference inputs D/A 0 REF IN and D/A 1 REF IN. This allows output voltages in the range 0 to +5 V. If a voltage other than the internal reference voltage is used, then you should bear in mind that the voltage readings produced by the program no longer correspond to the actual voltages at the output.

For DMA-driven **analog input** the maximum **sampling rate** is 50 kHz, ie up to 50,000 measurements per second. This represents the maximum trigger frequency which can be set on the A/D converter. If multiple channels are to be sampled, the sampling rate is equal to the trigger rate divided by the number of (active) channels to be sampled, since a channel is sampled on every trigger pulse and then the multiplexer moves on to the next channel. This is also the case if you use an external trigger signal instead of the onboard trigger (using a timer IC). In that case you need to enter the trigger frequency at the appropriate place in the menu so that the program can properly scale the time axis on the graphic display. If the trigger signal is aperiodic, you should enter −1. The sample number from 1 to 500 is then plotted along the X axis of the display instead of time. Memory constraints set the maximum number of samples at 8000.

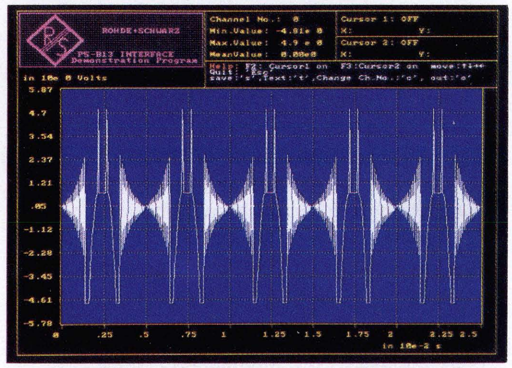


FIG 2 Readings displayed in graphic mode

For **block output** of analog data to the DA 0 and DA 1 outputs, the analog I/O interface is operated in interrupt mode, so the **maximum analog output rate** is **20 kHz.** All the outputs which can be generated with this program (both standard functions and user-definable functions) consist of 100 samples. Therefore the maximum output frequency for a function is 200 Hz. If the data to be output via the analog output channel have previously been stored via an analog input channel, only the first 100 samples are used for the output.

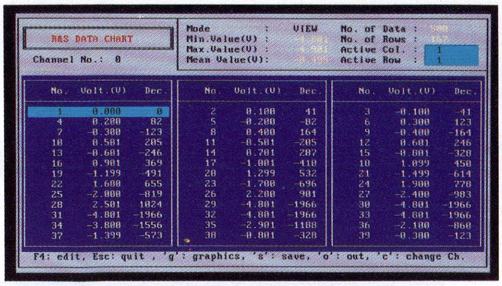
It is generally true that **single-conversion input and output** is slower than block I/O. Therefore the application program presents various choices for optimum results in the two basic modes:

1. When you press Enter, a single analog reading is taken from the input channel and displayed in bar-graph format.
2. To output slow pulses, a pulse output generator is provided.

Using the **timer-output function,** squarewave signals can be output with TTL levels (0 and +5 V) up to a frequency of 50 kHz. This function is handy when the maximum output frequency of the analog output channels DA 0 and DA 1, ie 200 Hz, is not sufficient.

The **pulse-counter function** of the analog I/O interface uses the trigger routine in the PS-B13 library. The resolution is 1.4 ms. Any of the 16 analog input channels can be used as the counter channel. A menu is provided for entering trigger level, trigger polarity and count time. If no pulse is detected within one hour, the function is aborted. This time-out period can also be changed from the menu.

In the **graphic display mode** the measured analog input data are output as an XY graph (FIG 2). The display always comes up showing the first 500 samples. If more than 500 samples per channel were taken, you can press the PgDn key to access the next 500. Pressing PgUp brings back the previous 500



R&S DATA CHART

Channel No.: 0

Mode : VIEW No. of Data :
Min.Value(V) : No. of Rows :
Max.Value(V) : Active Col. : 1
Mean Value(V): Active Row : 1

No.	Volt.(V)	Dec.	No.	Volt.(V)	Dec.	No.	Volt.(V)	Dec.
1	0.000	0	2	0.100	41	3	-0.100	-41
4	0.200	82	5	-0.200	-82	6	0.300	123
7	-0.300	-123	8	0.400	164	9	-0.400	-164
10	0.501	205	11	-0.501	-205	12	0.601	246
13	-0.601	-246	14	0.701	287	15	-0.801	-328
16	0.901	369	17	-1.001	-410	18	1.099	450
19	-1.199	-491	20	1.299	532	21	-1.499	-614
22	1.600	655	23	-1.700	-696	24	1.900	778
25	-2.000	-819	26	2.200	901	27	-2.400	-983
28	2.501	1024	29	-4.801	-1966	30	-4.801	-1966
31	-4.801	-1966	32	-4.801	-1966	33	-4.801	-1966
34	-3.800	-1556	35	-2.901	-1188	36	-2.100	-860
37	-1.399	-573	38	-0.801	-328	39	-0.300	-123

F4: edit, Esc: quit , 'g': graphics, 's': save, 'o': out, 'c': change Ch.

FIG 3 Readings displayed in text mode

samples. In addition, the minimum, maximum and mean for the channel are displayed.

The display also provides two graphic cursors. The F2 key is used to move the lefthand one, and F4 the righthand one. The cursors are used to read off time intervals and amplitude differences. A zoom function is also provided. If more than one channel was sampled, you can press C to switch the display to another channel. Pressing S saves the sampled data in a file, and pressing T switches the display to text mode.

In **text mode** the sampled data are displayed as columns of numbers (FIG 3). A total of 39 samples are displayed, with three columns for each sample: the lefthand column shows the sample number, the second the measured voltage, and the third the 12-bit integer reading from the A/D converter (between 0 and 4095). As in the graphic mode, the minimum, maximum and mean values are displayed. Using the cursor keys and PgUp/PgDn you can move anywhere in the samples. F4 can be used to edit any reading. When a new reading has been keyed in, it can be entered with F9, or by pressing F10 you can leave the edit mode without changing the reading. Pressing G gets you back to the graphic mode. All the readings which were changed manually are then immediately used to update the graphic display.

Achim Gerstner

Reader service card 135/08

test hint

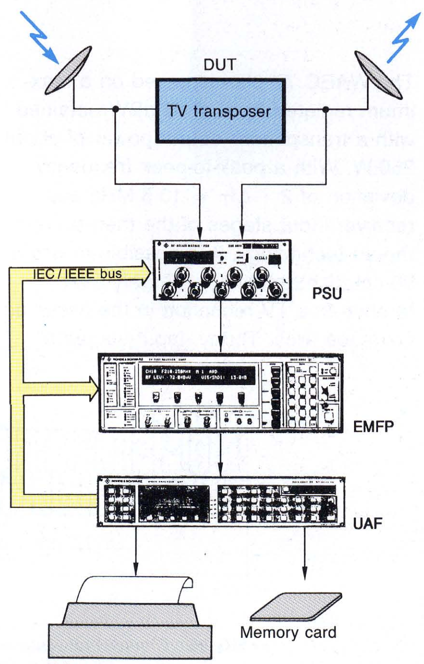
Automatic testing of TV transposers

Distorted signals at the input of a TV transposer are inevitable. These distortions have to be taken into account when evaluating the output signal if the quality of the transposer is to be determined. Such time-consuming measurements can be simplified considerably by the use of the **CATV test system made up of Video Analyzer UAF and TV Test Receiver EMFT or EMFP.**

Provided with an AUTORUN function and IEC/IEEE-bus controller capability, UAF controls the test receiver and switches over the test signal by means of the remotely controllable **RF Relay Matrix PSU.** During the short measuring time the input signal is automatically disconnected from the transposer. The output signal is passed through the directional coupler incorporated in the transposer. Within a few seconds the system measures all 25 video parameters at the transposer input and output and provides full information on the transposer's quality by subtracting the results of the measured values. The test results can be logged directly or temporarily stored on the memory card for subsequent evaluation. Depending on the application, the AUTORUN program can be modified in such a manner that the test sequence is performed once or repeated at defined intervals.

Harald Ibl

Reader service card 135/09



refresher topic

Television technology (XII)

10 Satellite TV broadcasting

10.3 Direct-broadcast satellites

Direct-broadcast satellites (DBS) are intended to ensure comprehensive TV coverage with different programs, later – on the European level – possibly also with multilingual accompanying sound. Following the agreements reached by the World Administration Radio Conference 1977 (WARC 77), the frequency range from 11.7 to 12.5 GHz was subdivided for different satellite positions into 40 channels with a bandwidth of 27 MHz which are spaced 19.18 MHz apart and overlap alternatingly with righthand and lefthand circular polarization. FIG 85 shows the assignment of the 40 channels to satellite position 19° west with five channels each for the central European states, ie Germany (D), France (F), Austria (AUT), Luxemburg (LUX), Belgium (B), Netherlands (HOL), Switzerland (SUI) and Italy (I).

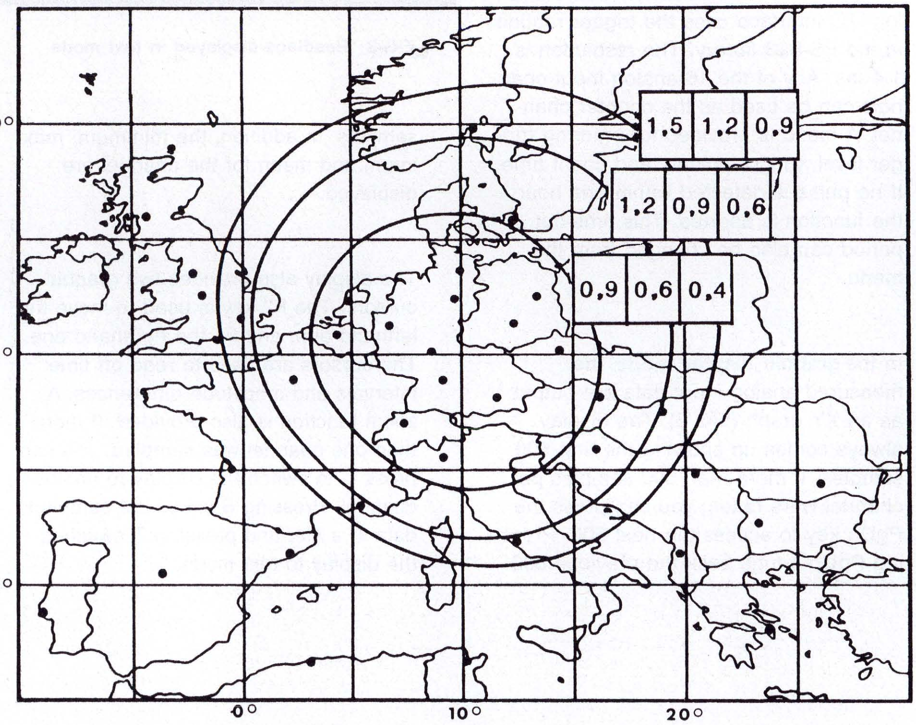


FIG 86 Coverage area of TV-SAT 2 and development of receiving-antenna diameters (in m) from 1977 to 1990

The WARC 77 plan is based on a maximum radiated level of 65 dBW obtained with a transponder output power of about 250 W. With a peak-to-peak frequency deviation of $2 \cdot \Delta f_T = 13.5$ MHz and receiver input stages of the then-state-of-the-art technology, it is possible to use a 90-cm dish antenna for largely interference-free TV reception in the assumed coverage area. Today, input stages of higher sensitivity permit the antenna diameter to be reduced to 40 cm in this range (FIG 86) [21].

The ASTRA satellite from SES (Société européenne des satellites) in Luxemburg introduced a new generation of direct-broadcast satellites. This is a medium-power satellite with a radiated power level of about 50 dBW; it has 16 transponders and is able to cater for 16 TV transmission channels in central Europe (FIG 87) [25]. State-of-the-art, low-noise input stages permit dish antennas of less than 90 cm in diameter to be used for reproducing a noise-free TV picture under good atmospheric conditions. The DBS ASTRA does not operate in the frequency band specified by WARC 77 but in the range from 11.2 to 11.45 GHz allocated to telecommunication satellites. The channels are radiated alternately with horizontal and vertical polarization [26].

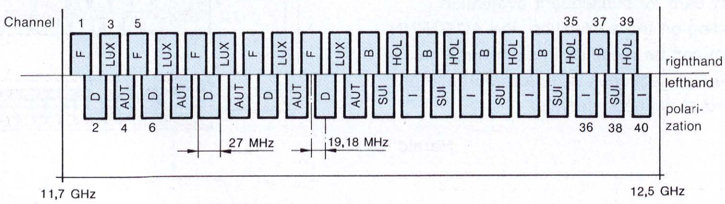


FIG 85 Channel allocation for satellite position 19° WL of direct-broadcast satellites to WARC 77 plan

The German television satellite DFS KOPERNIKUS launched in June 1989 also belongs to the category of medium-power satellites. The transponder channels in the range 11.45 to 11.70 GHz and 12.50 to 12.75 GHz in the downlink are mostly occupied by TV program signals. The effective radiated power level is about 54 dBW in the centre of the footprint and 49.5 dBW for "half-transponder operation" in the frequency range 11.45 to 11.70 GHz, where one transponder of 90-MHz bandwidth is operated with two

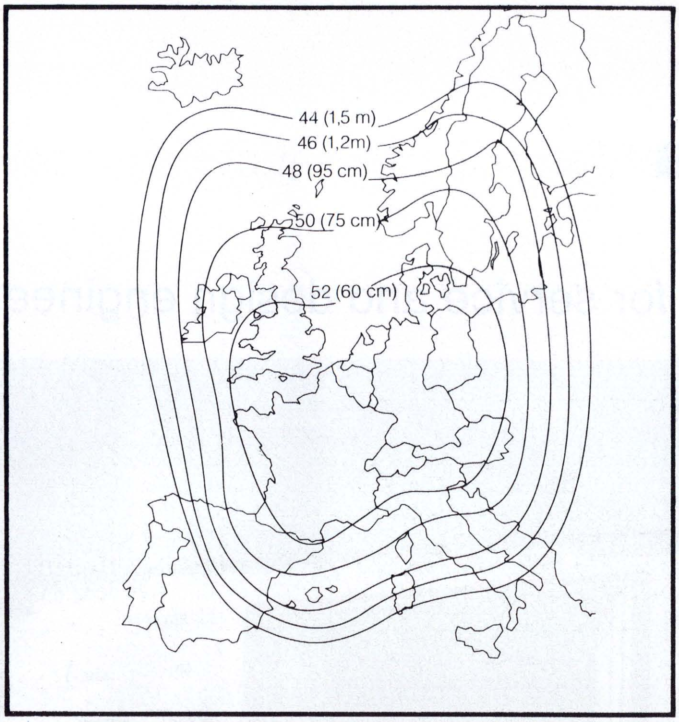


FIG 87 Effective radiated power level in dBW of ASTRA satellite and typical receiving-antenna diameters

program carriers. The maximum output power of the travelling-wave tubes used in these transponders is about 20 W. The radiation is strongly concentrated on central Europe, orbit position 23.5° east longitude [27].

Future broadcast satellites of the second generation with their effective radiated power level of about 56 dBW will belong to a class between the high-power and the medium-power range as "optimum-power satellites".

The most important telecommunication and (direct) broadcast satellites operating in Europe at the beginning of 1990 are listed below:

EUTELSAT ECS I-F1	Position 13° EL, west and east spot beams
EUTELSAT ECS I-F2	Position 7° EL
INTELSAT V-F1	Position 60° EL
INTELSAT V-F2	Position 60° EL
ASTRA	Position 19.2° EL
DFS KOPERNIKUS	Position 23.5° EL
TDF-1, TV-SAT 2	Position 19.0° WL

10.4 Reception

For TV picture-signal transmission by frequency modulation via satellite, additional equipment is required at the receiver end, starting with the outdoor unit, ie the microwave dish antenna with the polarization filter followed by one or two mixers which convert the DBS frequency band from 11.7 to 12.5 GHz into the first intermediate frequency of 950 to 1750 MHz (FIG 88). It is with this frequency that the signals are applied to the actual satellite receiver. As, at least in the near future, the 800-MHz frequency band will not be fully occupied, the signals of carriers with righthand and lefthand circular polarization may be converted sequentially also at the IF and routed to the receiver only via one line. Here a second mixer converts the signal to the second IF, which is normally about 480 MHz. The actual channel selection and FM demodulation is performed at this frequency. For further distribution and reproduction on a conventional TV receiver, the signal is added to a channel carrier in the VHF or UHF range by vestigial-sideband amplitude modulation if the TV receiver does not have a connector for the composite colour video signal.

For TV vision and sound transmission via the German DBS TV-SAT and the French TDF of identical construction, the D2-MAC system requiring a decoder after the FM demodulator is used.

Rudolf Mäusl

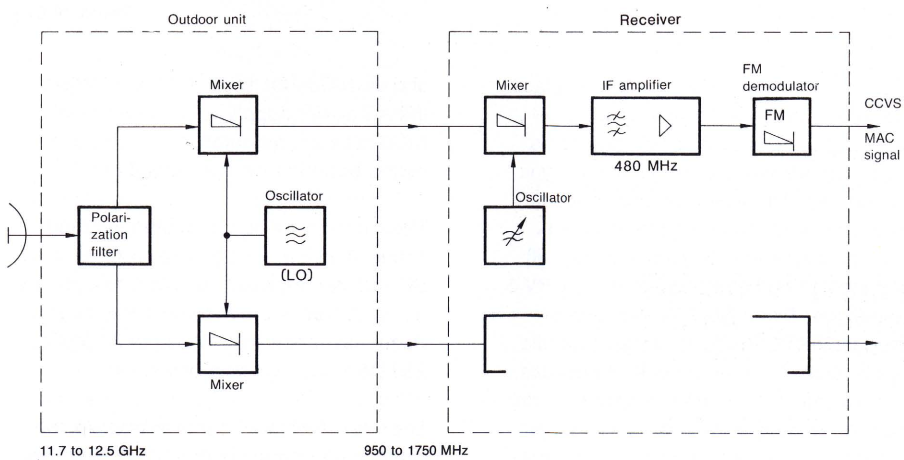


FIG 88 Receiving system for satellite TV signals

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Extracts from the following book were used for the above refresher topic:
Mäusl, R.: Fernsehtechnik – Von der Kamera bis zum Bildschirm. Hüthig Buch Verlag, Heidelberg 1990

brief items

Level Meter URV 35 – a precision instrument for service and design engineers

FIG 1 Level Meter URV 35 with RF Probe URV 5-Z7 **Photo 39 813**

Level Meter URV 35 (FIG 1) from Rohde & Schwarz combines the high precision of RF Millivoltmeter URV 5 [1] with the best features of a service instrument for voltage and power measurements. With its unique synthesis of ruggedness and portability plus the high precision expected of a laboratory instrument, URV 35 can handle anything from field measurements where a degree of mobility is required, to precision measurements in RF and microwave labs. The built-in RS-232-C interface also makes it suitable for production tests and final tests on transmitters, radio equipment, etc.

Thus Level Meter URV 35 takes its place between the inexpensive Millivoltmeter URV 3 [2] and URV 5, which continues to set the standard as far as accuracy is concerned. The new level meter needs high-precision measuring heads for its high-precision results. Conveniently, all the measuring heads designed for URV 5 and Power Meter NRV [3] can also be plugged into URV 35. It can also handle applications covered by URV 3 because, like the latter, it can be powered from dry cells or rechargeable batteries or via an external AC adapter. A version with built-in adapter is also available. URV 35 will run on dry cells for around 140 hours, and on NiCds for about 60 hours. When the AC power supply is connected the NiCd cells are automatically recharged, ie even when the unit is switched off.

Thanks to the wide range of measuring heads available for URV 5 and NRV, URV 35 can **measure levels from 200 µV to 1000 V or 400 pW to 500 mW** over a frequency range from 9 kHz to 26.5 GHz and DC.

The **user interface** is interesting. All the settings are made via menus. One of the advantages of this is that all the special functions are fully described in onscreen text prompts, instead of your having to work with code numbers which are devoid of meaning and easily forgotten. It also allows you to make all the settings needed with just eight keys without having to refer to the shortform operating manual which other units have to provide to explain basic operations.

However, the most novel thing about URV 35 is its display. This has just about an ideal combination of features for both service engineers (easy-to-read pointer) and design engineers (precise digital display). This new **"combo" display** has a real built-in moving-coil needle but the old-type scale has been replaced by an LCD behind the needle (FIG 2). This arrangement makes it possible to provide a wide range of scale modes which could not be imagined with old-fashioned pointer-type meters:

- **Auto** This mode selects the optimum scale automatically.
- **Fix** In this mode the selected scale is not changed even if the input goes out of range, avoiding scale changes when not desired. This also keeps the calibration of the DC voltage output constant.
- **Limit** In this mode the values represented by either end of the scale can be selected as desired. This means that you can zoom in on the range of interest.

If you ever find that the simultaneous double display gets in your way, this is no problem. You can select the following **display modes**:

- Meter needle only plus scale and unit of measurement.
- Digital readout only plus unit of measurement. To make the digital display easier to read, the needle is parked hard right.
- Combined display with digital readout as well as needle.

Thanks to the built-in backlighting the display of URV 35 is easy to read even when the ambient light is poor.

The wide range of tasks that URV 35 can handle means that its display has to meet a variety of different requirements. For instance, the unit can change the **resolution** (3½ or 4½ digits) to suit the measurement. Also, an automatic filter function is built into URV 35, ie the number of results used for averaging

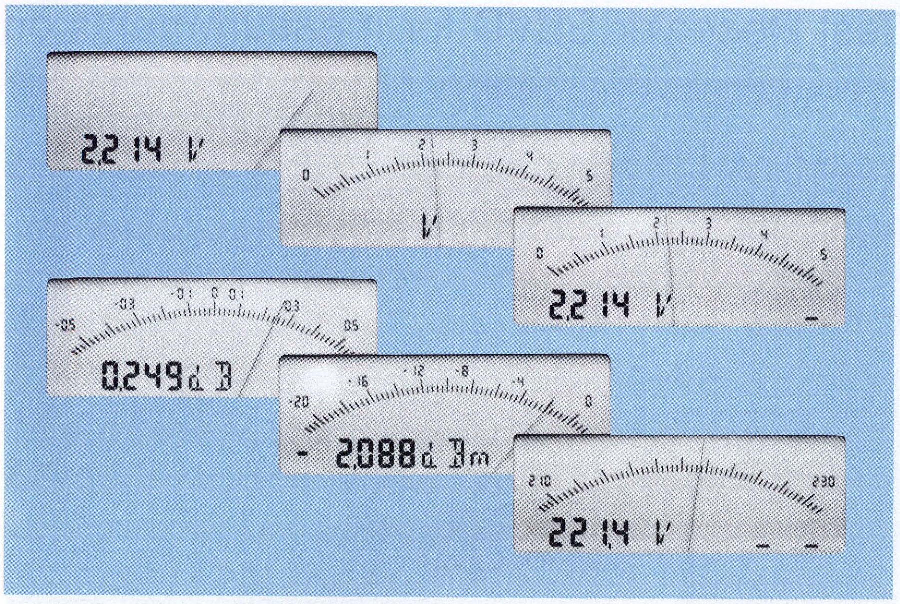

FIG 2 Some of URV 35's new "combo" display modes

depends on the signal level. Another feature is that URV 35 includes a new kind of **autoranging** system which speeds up the selection of the optimum range. The ranges are chosen so that accurate voltage and power readings can be made over the full range of the head. The reading itself can be displayed in V, W, dBm or dB. The relative display mode is especially useful for reflection-coefficient measurements using directional couplers or VSWR bridge circuits and attenuation measurements.

One of the new level meter's special features is a DC-FREQ input. This gives the user **tracking frequency-response correction** as well as the normal calibration at a fixed frequency. Many of the sweep generators used for frequency-response measurements have a voltage output which provides a DC voltage proportional to the frequency generated. By entering the necessary scaling factors, ie the upper and lower voltage and related frequency values (two pairs), URV 35 can be set to self-correct over the entire frequency range.

A DC voltage output for connecting a YT plotter is provided on the rear panel of URV 35. This continuously outputs a voltage between 0 and +3 V which is proportional to the deflection of the needle. As expected with an instrument in this class, URV 35 can store and recall up to ten complete setups. Another feature is that by connecting it up to a PC and a DC calibrator, it can be completely calibrated in a few minutes, as it needs no manual settings or alignment.

In the design of the new level meter, great effort was put into the **RF shielding** of the entire unit, so that even in the near field of antennas the readings are not affected. For this reason the case of URV 35 is made of solid metal.

Thanks to its wide range of applications, the options of battery or AC power, the remote-control interface and the impressive selection of accessories for operation up to microwave frequencies, URV 35 is *the* portable level meter of the future.

Burkhard Küfner

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Reader service card 135/10

Test Receiver ESVD for measurements on digital mobile-radio networks

Test Receiver ESVD for digital mobile-radio networks Photo 39 801

As with any other radio system, the transmission medium, which can be thought of as a four-terminal network, is of great importance in digital mobile-radio networks too. Generally the characteristics of a radio path are determined by loss, which is a function of frequency and local conditions, and by extraneous interference. For determining these factors, the **wanted-signal and RFI field strength** of a specific transmitter output power is measured at the receiver site. Depending on transmission bandwidth, type of modulation and the error-control method used, the propagation characteristics for the radio path and the relationship between wanted-signal and RFI field strength have to meet specific values to yield a defined transmission quality.

In Test Receiver ESVD for digital mobile-radio networks (FIG) Rohde & Schwarz offers an instrument which – together with test antennas or special, calibrated vehicle antennas – is intended to measure all essential parameters of this most modern type of mobile communication. ESVD covers the **frequency range from 20 to 1000 MHz** and, when retrofitted with an appropriate **option, up to 2000 MHz** for measurements on future mini-cell systems. Especially for use in digital transmission networks it is equipped with an **I/Q modulator,** the output voltage of which is evaluated and decoded by a computer for determining the quality parameters of the transmission channel.

ESVD's ability to change the receive frequency in the 900-MHz GSM band in less then 3 ms and to measure field strength at the new frequency also enables it to meet other practical test requirements. This feature permits quasi-simultaneous recording of field strengths of several base stations. Not only the field-strength profile of the next transmitter but also that of transmitters in neighbouring cells can be measured during a single trip. Thus the number of tours to be made with **Test System TS 9955,** which includes ESVD, can be reduced considerably. [1]. To perform an analysis according to Lee, which requires four field-strength values to be determined within a distance of three wavelengths, the measured values of four different base stations can be recorded with the vehicle moving at 100 km/h. Measurements can be made on a greater number of stations at a suitably reduced speed.

Of course, bandwidth and frequency accuracy of ESVD meet GSM requirements. The test receiver is powered either from an AC supply, from a vehicle electrical system (11 and 33 V) or from internal batteries. As ESVD, like ESHS and ESVS [2], belongs to the latest generation of R&S EMI test receivers, there is a useful bonus: **weighted EMI measurements to CISPR 16 and VDE 0876** can be carried out too. Consequently the influence of classic RFI on transmission quality in mobile-radio networks can be determined. However, this deals with only one source of RFI. For a comprehensive analysis of RFI sources in mobile radio, I/Q signals have to be evaluated by means of a process controller.

Karl-Otto Müller

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Reader service card 135/11

Enhanced Network Analysis System ZPM

The era of microwave measurements began at Rohde & Schwarz with the introduction of Scalar Network Analysis System ZPM (10 MHz to 18 GHz)*. Compared with competitive products, ZPM features excellent level and frequency accuracy, flexible analyzer functions, convenient calibration functions and power-measurement capability. To enhance the system's application range even further, R&S has developed some new functions and options for ZPM (FIG 1).

It is now possible to enlarge the built-in setup and calibration memory with a **disk-storage function.** Instrument parameters and settings can be conveniently stored on floppy disks and are portable

* Leischnig, J.; Loll, G.: Scalar network analysis up to 18 GHz using Network Analysis System ZPM. News from Rohde & Schwarz (1989) No. 127, pp 12 – 15

without any data errors to further ZPM systems, for instance in production and test departments. Test results can also be saved on floppy disks and processed at a later date by a DOS-compatible computer. 5¼-inch HD disks with storage capacity of 1.2 Mbytes are used. Up to 288 instrument settings and over 100 test results can thus be stored per disk. Subdirectories are an efficient way of organizing the disk contents. The disk-storage function is available from firmware version 1.3 of ZPM; EPROMs for upgrading older firmware versions can be obtained from R&S representative offices. To use the storage function, Floppy Disk Station PZ-11 and Floppy Disk Drive PCA-B6 are required.

FIG 2 SWR Bridge ZRMD for 10 MHz to 18 GHz Photo 38 541

ZPM can be fitted with an **optional computer function** compatible with Process Controllers PCA and PSA. With this computer function it is possible to use DOS programs like Edlin or R&S BASIC while measurements are being performed. The multitasking operating system used in ZPM allows priority of application (measurement and/or computer function) to be selected. When fitted with this option and using suitable application software, the network analysis system is upgraded to an automatic test system for complex measurements. The computer function opens up new fields of application like postprocessing stored test results, dialog mode for programming and editing test routines or measurement control via IEC/IEEE bus with relay matrix. Connection of an external colour monitor gives the convenience of better evaluation and display of test results and routines. The optional computer function includes a keyboard with rollkey, MS-DOS 3.1 and the R&S BASIC interpreter. Floppy Disk Station PZ-11 (with two 5¼-inch drives), which is required for the computer function, can also be used for the disk-storage function.

With the **group-delay option** ZPM can make broadband measurements on twoports. Especially measurements on frequency-converting twoports like tuners, mixers or low-noise converters are much easier than with vector network analyzers, so that this option will mainly be used in satellite communications. The group-delay option is able to measure delays of up to 50 µs with resolution of 10 ns or 1 ns and a typical error that is below 10 ns. The split-frequency method with a split frequency of 9.9 kHz is employed.

For reflection measurements in the RF and microwave range, **SWR Bridge ZRMD** was developed which, compared with other SWR bridges, features better matching at the test port and a built-in demodulator. Measurement precision can thus be improved considerably. SWR Bridge ZRMD is available with standard or precision N-male and N-female or PC-7 test-port connectors. The test output has an indicator cable and R&S connector mating with Network Analyzers ZAM, ZAS and ZWOB. The diode characteristic stored in ZRMD enables ZPM to use correction methods to improve its test results.

Maximilian Janker; Johannes Leischnig

FIG 1 Network Analysis System ZPM with optional computer function and external colour monitor Photo 39 184

Reader service card 135/12

AES/EBU interface with sampling-rate converter for Audio Coder DCA and Audio Decoder DDA

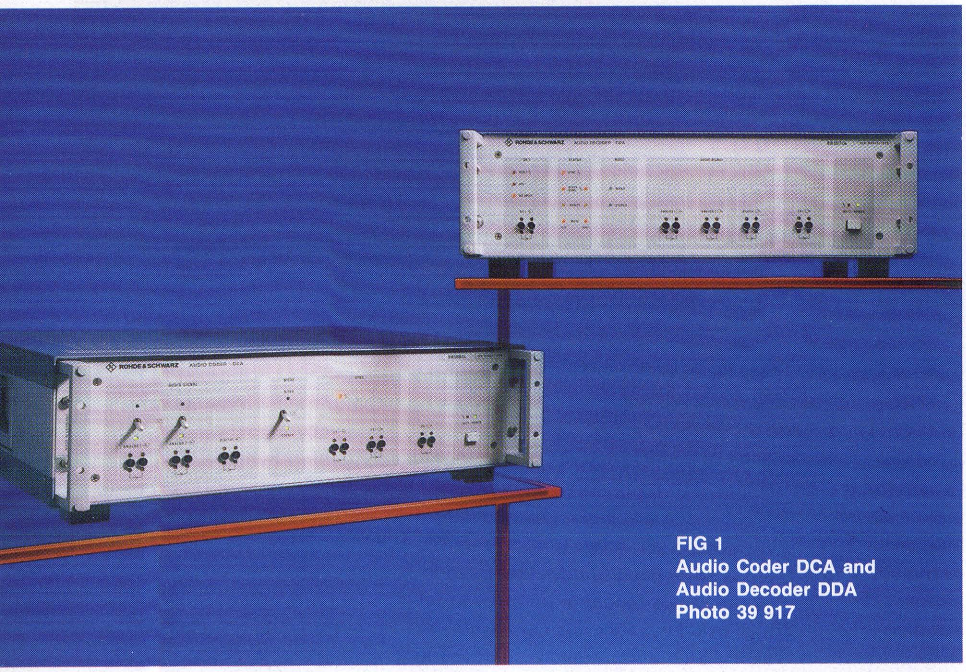

FIG 1
Audio Coder DCA and Audio Decoder DDA
Photo 39 917

Audio Coder DCA and Audio Decoder DDA (FIG 1) for digital, two-channel sound transmission using the DS1 technique [1] (DS1 = Digital Sound 1 Mbit/s) have so far been supplied with an analog or a digital sound signal with a sampling rate of 32 kHz [2–4]. Broadcasting studios use a sampling rate of 48 kHz for digital audio signals, with a resolution of 16 to 24 bits per sample. The audio signals are transmitted in AES/EBU format (3.072 Mbit/s, AES = Audio Engineering Society, EBU = European Broadcasting Union) [5]. Since the DS1 system operates with a 32-kHz sampling rate, conversion of the sampling rate from 48 kHz to 32 kHz or vice versa is required in order to link digital studio equipment with DS1 equipment.

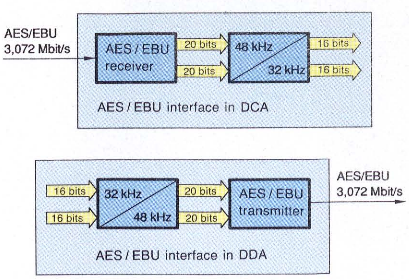

FIG 2 AES/EBU interfaces in DCA and DDA

Using state-of-the-art equipment this conversion can be performed digitally, especially if the sampling rates involved are integer multiples of each other (in this case 3:2).

The AES/EBU interface modules for DCA and DDA comprise an **AES/EBU interface** and a **sampling-rate converter** (FIG 2). The serial data stream coded to AES/EBU standard is decoded by the AES/EBU receiver of DCA and taken to the sampling-rate converter. In DDA the reverse procedure takes place: conversion to a sampling rate of 48 kHz and generation of the serial data stream by the AES/EBU transmitter.

The **AES/EBU data stream** is generated by repeating the subframe shown in FIG 3. Each subframe starts with a preamble (time slots 0 to 3), which is used for synchronization and tells the receiver which channel the bits of the subframe are assigned to. Time slots 4 to 27 carry the audio sample word, which may consist of max. 24 bits. Time slots 28 to 31 carry the validity flag (V), a user bit (U), a channel status bit (C) and the parity bit (P). The validity flag indicates whether the audio sample word is valid or not. The user bit and the channel status bit are not necessarily used in the application described here. Controlled by the preambles, these bits are combined to form blocks of 192 bits to carry a multitude of information on the audio signal as well as a CRC character (cyclic redundancy check). The parity bit is chosen to complement the number of ones carried by time slots 4 to 31 to obtain an even number of ones. The bits of time slots 4 to 31 are encoded in biphase-mark to avoid any DC components on the transmission line and to make the interface insensitive to the polarity of connections. The preambles, which are carried by time slots 0 to 3, are DC-free. The bit rate of the transmitted data stream is obtained as follows: 2 (channels) x 48 kHz (sampling rate) x 32 bits (per channel) = 3.072 Mbit/s.

The AES/EBU receiver is implemented by a finite state machine (FSM), which decodes the biphase-mark-coded data stream, synchronizes itself to the preambles received, performs a parity check and outputs the audio sample words (20 MSBs) and the V, U and C bits to the signal processors.

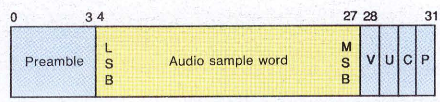

FIG 3 Subframe of AES/EBU data stream: LSB = least significant bit, MSB = most significant bit, V = validity flag, U = user bit, C = channel status bit, P = parity bit

Sampling-rate conversion in DCA is based on a digital FIR filter (finite impulse response) and implemented by means of one signal processor per audio channel. Conversion of the sampling rate is performed in three steps:

- The sampling rate is increased from 48 to 96 kHz by sampling the input-frequency band at a rate of 96 kHz. This corresponds to inserting a zero between every two audio sample words.
- The signal is passed through a 96-kHz lowpass filter.
- The sampling rate is decreased from 96 to 32 kHz by using only every third sample.

The audio sample words (16 bits) thus obtained are output via an internal interface to the DCA signal processors, which also evaluate the validity flags. Channels carrying invalid audio sample words are muted. The same will apply in the case of parity errors. Error signalling is provided on an optional LED display or at relay outputs.

The **DDA sampling-rate converter** too is based on a digital FIR filter, and conversion is performed in three steps:

- The sampling rate is increased from 32 to 96 kHz by sampling the input-frequency band at a rate of 96 kHz. This corresponds to inserting two zeroes between every two audio sample words.
- The signal is passed through a 96-kHz lowpass filter.
- The sampling rate is decreased from 96 to 48 kHz by using only every second sample.

The AES/EBU transmitter is also implemented using a finite state machine. It reconverts the output data from the sampling-rate converter (20 bits) into a biphase-mark-coded serial data stream. A CRC character included in the channel status bits gives the receiver information on the quality of the transmission link.

The interfaces are provided with 110-Ω and 75-Ω inputs and outputs and are thus compatible with existing line networks. The interfaces can be retrofitted to each DCA or DDA. The transmission characteristics of the sampling-rate converters correspond to the IRT specification [1]. The filters used in the two interfaces have identical characteristics.

Peter Schmidt

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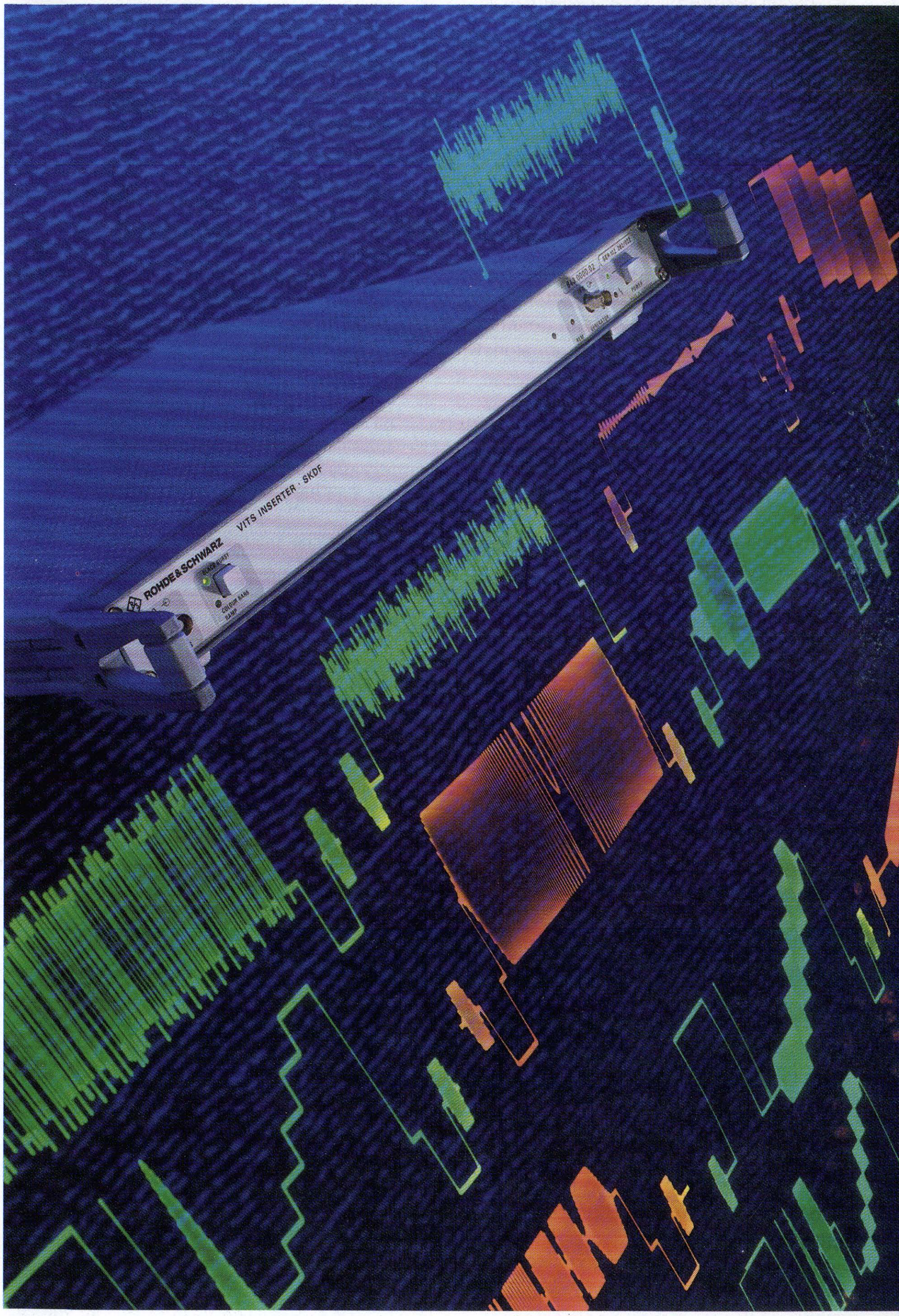
Reader service card 135/13

SKDF – a versatile VITS inserter

Today insertion-test-signal measurements are standard for quality-assurance applications and for monitoring video-transmission equipment. Rohde & Schwarz offers a number of video measuring instruments [1; 2] for this purpose. In VITS Inserter SKDF a favourably priced test-signal source is added to this line. Thanks to state-of-the-art digital technology such as VLSI memories and gate arrays, SKDF comes as a 19-inch model only one unit high (FIG).

Fully **digital signal generation** ensures excellent signal stability. A comprehensive set of test signals is stored in the SKDF memories (blue box) covering different versions of the well-known CCIR



VITS Inserter SKDF and some of its test signals **Photo 39 875**

test signals, additional signals such as the sin x/x signal, sweep signal and coring signals, through to the test signals used and planned for the UK. The teletext test lines are of special interest.

Coding of test lines, ie selection of the test signal and the line into which the signal is inserted, is user-friendly thanks to DIL switches. SKDF has three memories for test-line coding, thus enabling the user to configure three test-line blocks for different measurement tasks. A special feature of SKDF is the PAL 8-field sequence identification pulse which can be inserted in line 7. In studio applications this pulse is used to mark the beginning of the first field in the sequence. Moreover, SKDF permits the configuration of test-line sequences such as alternating teletext test lines or a pseudo-random noise signal for calibrating noise-voltage meters. In addition to the internally produced test signals, external signals, eg a teletext or a data-line signal from an appropriate generator, can be inserted into the program signal.

If there is no program signal, SKDF delivers a substitution signal. **Three different substitution signals** can be selected: black burst, colour-bar or ramp signal. These signals are also available at the generator output. The SKDF functions are controlled by a microprocessor.

SKDF test signals

CCIR 17	Colour-bar signal
CCIR 18/1	Red-area signal
CCIR 18/2	Ramp
CCIR 330/4	Modulated ramp
CCIR 330/5	Grey staircase
CCIR 331/1	Pulse-and-bar signal
CCIR 331/2	2T-20T pluge signal
UK ITS 1	15-kHz squarewave
UK ITS 2	250-kHz squarewave
IBA test line	Noise 1
BT composite waveform	Noise 2
BBC test line	Noise 3
2T pulse	Noise 4
2T pulse train	Coring signal
Teletext test line 1	0% black signal
Teletext test line 2	10% grey signal
H sweep 1	50% grey signal
H sweep 2	80% grey signal
H sweep 3	90% grey signal
H sweep 4	100% white signal
sin x/x signal	Blanking signal
Multipulse	

Full remote control is possible via the IEC/IEEE bus. This includes selection of the substitution signal and test-line memory as well as entry of the different wait times for switchover from the program to the substitution signal and vice versa. It is possible to interrogate the device setup and the genlock state via the IEC/IEEE bus.

SKDF is available as a bench model or as a 19-inch rackmount. For rack integration a junction panel is available as an extra. To ensure that the program path is not interrupted when SKDF is withdrawn or switched off, the junction panel is fitted with a bypass circuit which can also be remotely controlled.

Thanks to the large number of insertion-test signals, suitable for the most diversified measurement tasks, and to the possibility of inserting the 8-field sequence identification pulse, SKDF is the ideal VITS inserter for studio applications. This is enhanced further by its small dimensions, also making it highly suitable for use in broadband cable systems.

Helmut Hagl

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Reader service card 135/14

Insertion-test-signal measurements with Video Analyzer UAF for standard M/NTSC

The compact Video Analyzer UAF [1] introduced in 1989 has met with wide interest in Europe, where customers use it to solve a variety of measuring and monitoring problems on PAL video signals, appreciating the extras fitted as standard, ie remote control, memory card and printer output. But UAF is also used in non-PAL countries such as France, where the standard CCIR test lines are measured in SECAM video signals. The new **M-standard UAF** (FIG 1) was developed with a view to the requirements of the market in North America, Japan and Korea. In conjunction with TV Generator SGMF [2], an M/NTSC insertion-test-signal measuring system is thus available offering high precision, extremely high measuring speed and reliability even in mobile operation as well as user friendliness, all at an unrivalled, attractive price.

Features:

- 25 video and test-line parameters,
- high test speed (1 s to calculate all 25 parameters simultaneously),
- eight user-definable sampling modes,
- visual and acoustic out-of-tolerance messages,
- testpoint selector with three inputs,
- difference and reference measurement,
- memory card,
- IEC 625-2/IEEE 488-2 bus,
- printer output (Centronics).

UAF handles all linear and nonlinear distortions in the luminance and chrominance components of the test signal by continuously making parallel calculations of all parameters. Noise-voltage analysis is frequency-selective and meets CCIR recommendation 569.

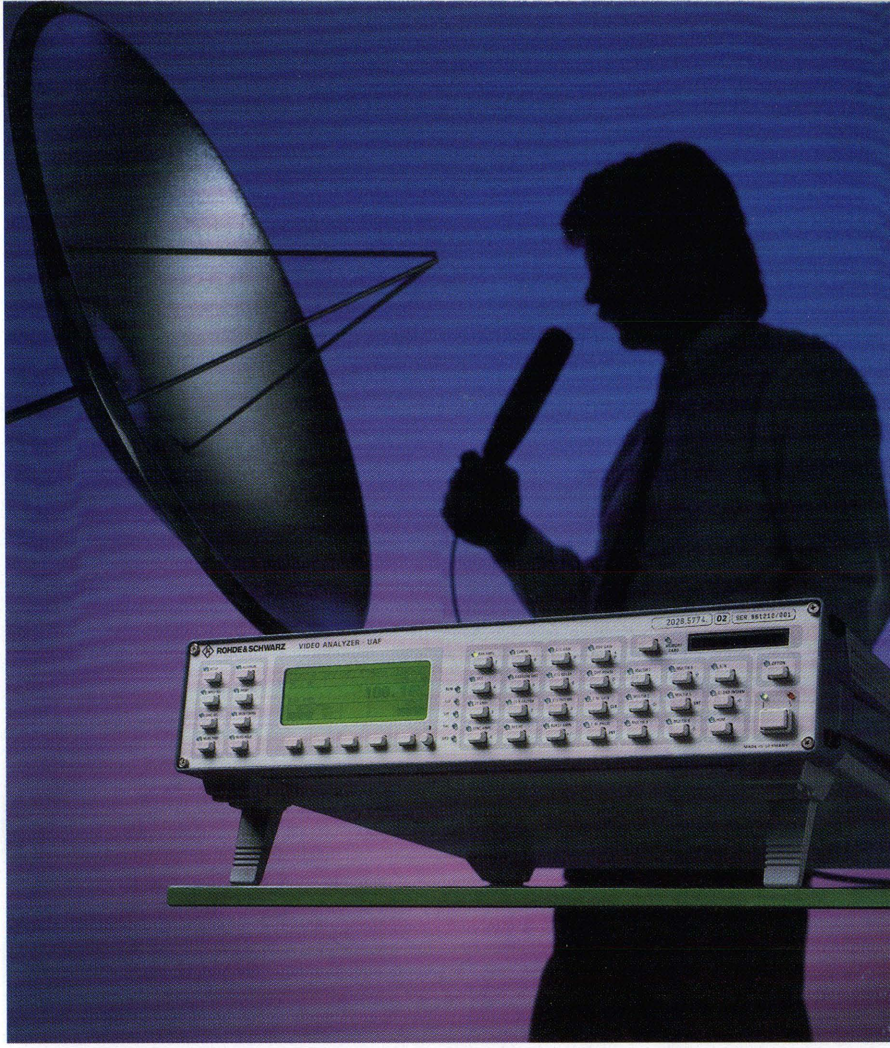

FIG 1 For NTSC countries: M-standard Video Analyzer UAF Photo 39 908/1

Luminance parameters: luminance-bar amplitude, bar tilt, black-level distortion, sync-pulse amplitude, luminance nonlinearity, residual picture carrier, 2T pulse amplitude, 2T K factor, multiburst amplitude.

Chrominance parameters: colour-subcarrier gain 12.5T, chrominance/luminance intermodulation, chrominance/luminance delay inequality, burst amplitude, differential phase, differential gain, nonlinearity of colour-subcarrier gain, nonlinearity of colour-subcarrier phase.

Noise parameters: luminance signal/noise ratio, intermodulation between colour subcarrier and sound carrier, hum.

For standard M, UAF measures all signal amplitudes in IRE units, ie scale units (FIG 2), in contrast to Europe where measurements are made in percent. This scale dates back to the specification of oscilloscope level measurements in the 50s by the Institute of Radio Engineers, which became the Institute of Electrical and Electronics Engineers (IEEE) in 1963. Level scales are defined in accordance with IEEE 205.

For signal analysis it is of no importance where the test signals are inserted in the test-line region of the picture, as UAF is able to handle user-defined test lines. All measurements can be performed during the ongoing program. For parameter assessment only two test lines are required with standard M. UAF is able to process test signals to NTC 7, FCC and NE-TV (a TV station in Nebraska).

Signal	IRE units	Level
Zero reference pulse	120	857 mV
Reference: white level	100	714 mV
Blanking level	0	0 mV
Sync level	– 40	– 286 mV

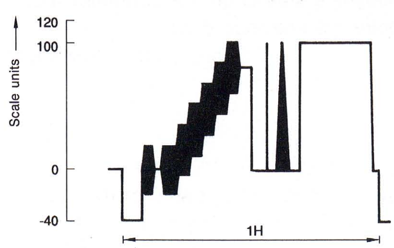

FIG 2 Amplitude measurement in IRE units

Thanks to its compact design, UAF is suitable not only for **stationary operation,** for example quality assurance and production monitoring of video equipment, but also for **mobile use,** eg checking signals in cable networks or transmitting systems. Automatic quality assessment is also possible in unattended stations or at remote locations; here data logging is first made on the memory card. Later a printout can be obtained in the central station to assess the results.

To handle specific monitoring tasks such as measurements on all channels in a cable-TV system, UAF features the **"Autorun"** mode which allows the user to write her/his own schedule for measurement and data-logging cycles. With this setup it is possible to operate a test receiver, eg EMFT or EMFP [3], via the IEC/IEEE bus without an additional controller. For this application R&S offers the combination of UAF and EMFT (or EMFP) plus accessories as a complete test system under the designation CATV. Within a minute the system is able to check out a cable network comprising more than 30 channels. Since M-standard video signals are also transmitted via transcontinental satellite links, UAF has been used in earth stations outside NTSC countries to permit rapid quality assessment when live transmissions are being exchanged or standard conversion is necessary.

Manfred Krohne, Peter Wolf

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Reader service card 135/15

Three 40-kW TV containers for Finnish Broadcasting Company

The Finnish Broadcasting Company FYR placed an order with Rohde & Schwarz for three containers, each holding a UHF-TV transmitter with high video output power of 40 kW. With these three containers FYR will advance the completion of the transmitter chain for its 3rd program (FIG 1).

The **40-kW TV Transmitter NT 444 A9** is accommodated in five racks. The water-cooled klystron amplifiers for vision and sound and the TV diplexer are installed at the front of the first rack row. Exciters and the HV power supply, which is able to compensate AC supply variations of ±10%, are accommodated at the front of the opposite row (FIG 2). The remaining space is used for storage.

FIG 1 40-kW TV container at site in Finland. Dimensions without external fittings (L × W × H): 7 m × 2.5 m × 2.7 m **Photo: Kath**

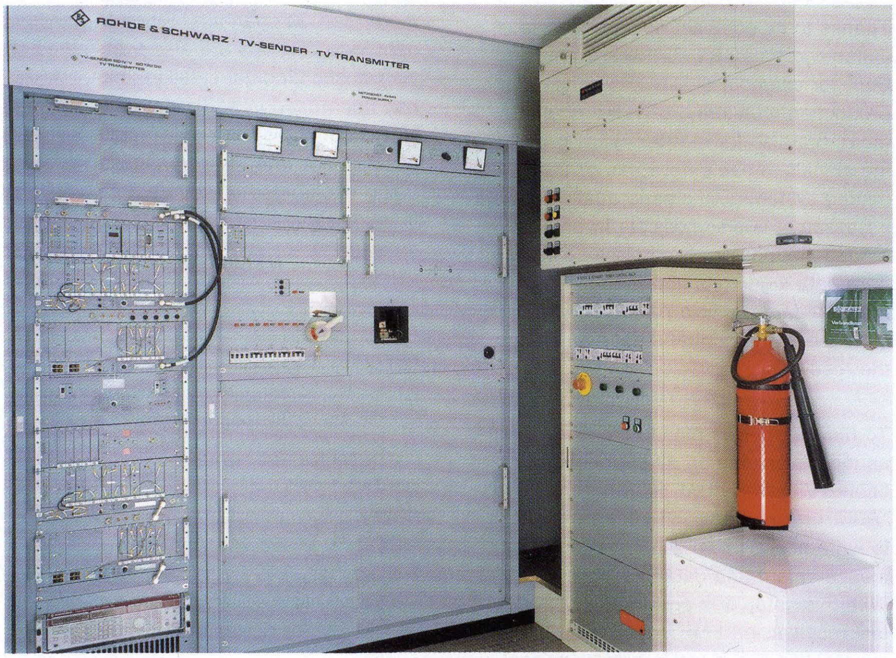


FIG 2 Interior of TV container; view of exciter rack, power supply, air-conditioning system and power rack **Photo 39422/1**

To ensure optimum reliability, TV exciters and amplifiers are duplicated with one set being in passive standby mode. The **Central Control Unit GB 222** was developed especially for this system: it is processor-controlled and, after reprogramming, it may also be used for other transmitters. The control unit comprises an analog and a digital section. The analog section applies the modulated signals to the exciters, monitors the amplifiers and switches the optical cable for ABC operation of the klystron amplifier. The AF distribution amplifier and the RF monitor are also suitable for NICAM. The digital section receives commands from the switch-on control unit and applies them to the exciters. If a fault occurs, the central control unit determines the source of the fault, triggers a switchover, if required, and indicates the fault.

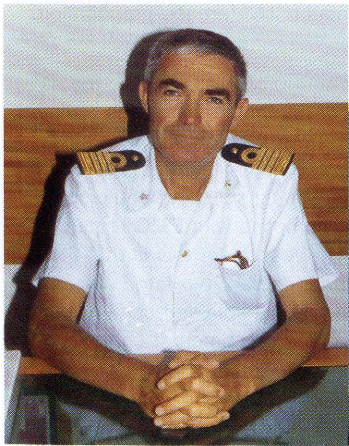
The **transmitter cooling system** ensures operation at an ambient temperature of between −35 and +30° C as requested by the customer. Klystrons and the dummy antenna in the TV diplexer are cooled by means of a water/glycol mixture. The water/air heat exchanger is installed on the container roof. Power supply, exciters and output racks are air-cooled. The space behind the racks serves as air-mixing chambers. All air inlets and outlets of the container have been fitted with shutters and coarse filters. A separate air-conditioning system is provided in the transmitter room.

Due to the space-saving arrangement of the equipment in the container, all externally installed equipment (eg heat-exchanger system) and the klystrons, which are packed during transport, can be stored inside the container. To facilitate lifting the klystrons on and off their trolleys, a collapsible crane with pulley is installed on the container roof above the entrance door.

Franz Harrer; Erich Kath

Reader service card 135/16

Activities of Mariteleradar of the Italian Navy in shipboard EMC



Captain Michele De Palo, director of Mariteleradar, lectures on telecommunication systems and related EMC problems at the Naval Academy in Livorno.

FIG 1 Mariteleradar, the Institute for Telecommunications and Electronics of the Italian Navy, was established in Livorno in 1916 by Admiral G. Vallauri. The institute is involved in technical and scientific activities, mainly in the following fields: EMC, antenna systems, telecommunications, radar, electronic warfare, infrared. The first Italian radar system was developed by Mariteleradar.

The constantly growing number of electronic devices onboard modern ships makes it increasingly difficult to ensure electromagnetic compatibility (EMC) between all the components. So all necessary preventive measures have to be considered during the planning of a vessel.

The activities of Mariteleradar, the Institute for Telecommunications and Electronics of the Italian Navy in Livorno (FIG 1), include responsibility for dealing with all EMC problems of electronic instrumentation and installations onboard ships. The institute conducts EMC tests for both military and civil projects and issues certification of the equipment tested.

In the **planning of a vessel** the work of Mariteleradar commences with an investigation of the preliminary EMC design, followed by examination of the EMC characteristics of the equipment that is to be installed, and finally tests are carried out onboard before completion of the ship, these being repeated periodically when it is in service.

For its **EMC tests of shipboard equipment** Mariteleradar has an **anechoic chamber** for EMC tests (the first one built in Italy in 1977). EMC characteristics are tested in compliance with MIL-STD 461 A/B/C and STANAG 4374, the new NATO standard which Mariteleradar, like similar institutes of the other member nations, helped to elaborate. Mariteleradar uses **high-grade instrumentation** for its compatibility tests, including an EP-6 EMI Test System from Rohde & Schwarz (FIG 2).

"In order to correctly understand the EMC problems onboard vessels, a basic

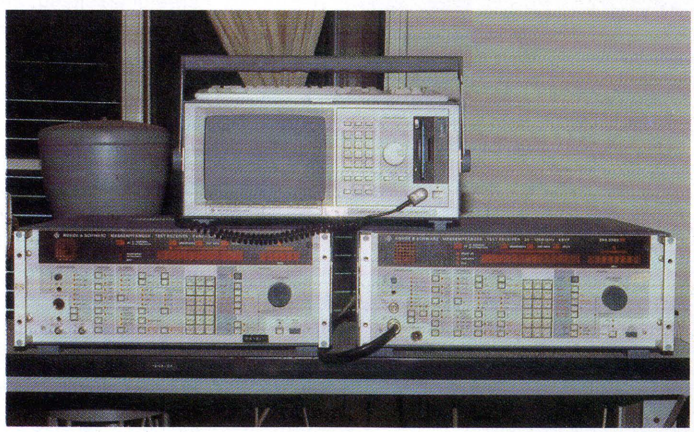


FIG 2 Rohde & Schwarz EMI Test System EP-6 as used by Mariteleradar

distinction has to be made between metal and nonmetal ships", explains **Captain Michele De Palo, director of Mariteleradar.** "With metal ships you then make two further distinctions: between equipment above deck and equipment below deck."

The coexistence of receiving (active and passive) antennas and transmitting antennas, both omnidirectional and directional (these have very high radiated power), in a limited area **on the deck of a metal vessel** (FIG 3) can cause serious EMI and RADHAZ problems. So it is essential to reduce the number of omnidirectional antennas and select, for instance, broadband transmitting antennas with multicouplers, time-sharing modes of operation and automatic antenna switching matrices.

A metal hull acts like an electromagnetic screen, so the interference signals which are detected **below deck** can be caused by lack of maintenance of the shielding, by insufficient filtering of power supplies, or even by equipment with non-compliant EMC characteristics. So the only remedy is the use of EMC-tested equipment and careful shielding, filtering and grounding by skilled technicians.

The hulls of **non-metal ships** provide no shielding and cannot be taken as a grounded surface. So transmitting apparatus radiates power both above and below deck. Another risk encountered on vessels of this kind is the fact that equipment located below deck is not protected against lightning strikes in the proximity of a vessel. The most common solutions consist of using an artificial grounded surface, shielded rooms for the most sensitive equipment, and of reducing the radiated power. Special attention has to be paid to air ducts; lengthy ones have an antenna effect and must be segmented to reduce interference propagation.

When it comes to **submarines,** the number of antennas and so the radiated power is lower than on surface ships. Almost all compatibility problems can be solved by simply selecting equipment that fully complies with EMC requirements. The reason for this is that the hull of a submarine can to a large extent be compared with a shielded chamber, protecting all the equipment it contains from external electromagnetic fields.

To ensure good compatibility of all the radiating systems installed onboard a ship, the arrangement of the various antennas has to be optimized. For this purpose Mariteleradar carries out **measurements on scale models of ships** and performs computer simulations.

"Although great efforts have been made in recent years in the simulation by computer of the electromagnetic fields existing onboard a vessel, measurements using scale models are still extremely important", says Captain De Palo.

Such measurements are made on a ship's model of copper, a perfect replica of the original on a 1:50 scale. Tests are performed on a zinc-coated concrete ground plane, which simulates the surface conductivity of the sea on the same

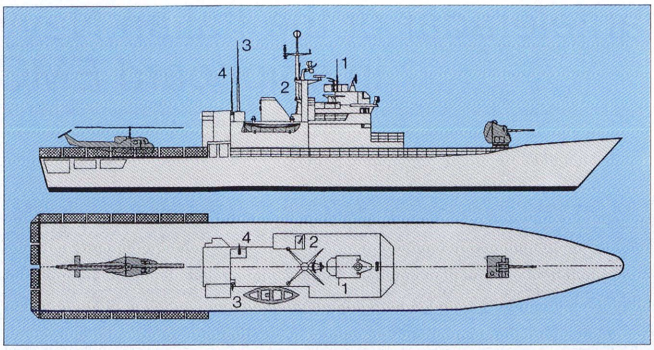


FIG 3 Antenna configuration on vessel of Italian Navy

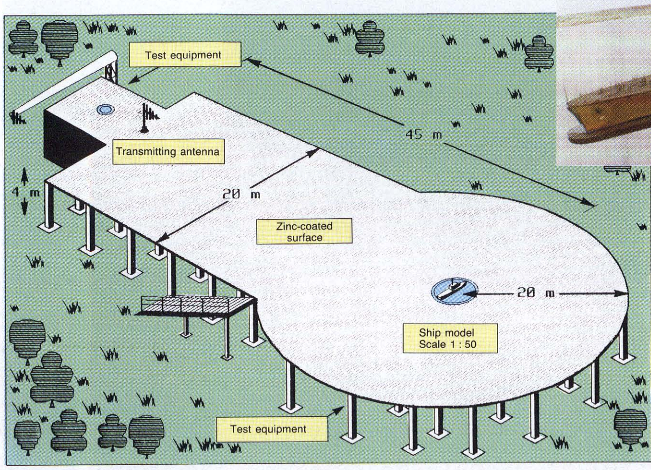


FIG 4 Setup for measurements on 1:50-scale model ships and copper model of cruiser

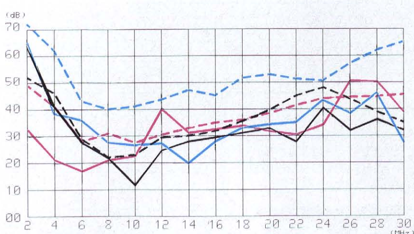


FIG 5 Interference measurement on receiving antenna 1 coupled to transmitting antennas 2 (black), 3 (red) and 4 (blue) (antenna configuration of figure 3). Comparison between computer simulation (solid line) and test results (dashed line)

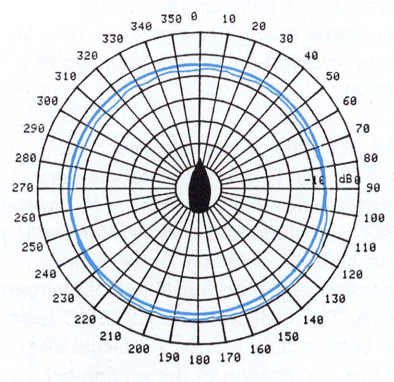


FIG 6 Radiation pattern of whip antenna onboard ship at 2.586 MHz, recorded at range of 4.4 nautical miles; transmitting power 270 W; normalized mean received field strength 8.97 mV/m. Almost the same pattern was obtained in the planning phase of the ship through measurements on a scale model.

scale (FIG 4). This ground plane is approx. 76 m in length and is located a few meters above the terrain to avoid any interference through reflections from objects nearby. Models with a length of up to 4 m can be tested.

The model is irradiated with a frequency 50 times higher than in real conditions by means of an antenna placed at the other end of the testing surface; this compensates for scaling down the antennas on the model by 1/50. The signals received by the various model antennas are then measured (FIG 5). The ship's model is gradually rotated through 360° to obtain the horizontal radiation patterns of all the antennas onboard. The same method is used to measure vertical radiation patterns and detect incorrect antenna coupling and matching conditions. In the HF range the results differ by 10% at the most from those of the measurements on the full-scale ship (FIG 6).

Once a vessel has been completed, a comprehensive series of measurements is performed in situ before it goes into service. Checks are made to see if there is any interference, and corrective action is taken as necessary. For the **real-life testing of antennas onboard ships,** Mariteleradar has devised an automatic system (FIG 7). This is based on Rohde & Schwarz instrumentation – including the ESH 3 and ESVP Test Receivers – and permits exhaustive testing of the compatibility of the various transmitting and receiving antennas onboard.

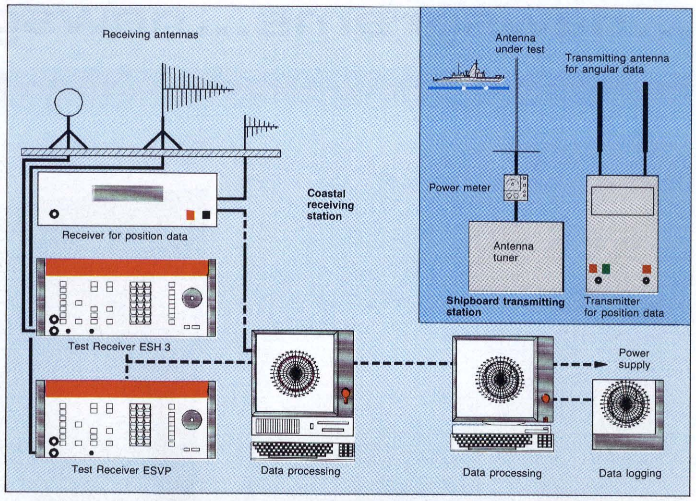


Fig 7 Setup for measuring radiation patterns of shipboard transmitting antennas under real conditions

The successful work of Mariteleradar is due not only to the institute's excellent technical equipment and the expertise of its staff but also to superb cooperation with other military and civil organizations as well as with private companies since, as Captain De Palo concludes: "Full compatibility of all the equipment installed onboard ships can only be achieved when all the decision-makers interact and take all the necessary steps to prevent interference. It is during the engineering phase that most of the problems must be found and solved, because once ships have been built, any corrective action is far more difficult and is more expensive."

Marco Brusati; Volker Janssen

Enter 135/17 for further information on EMC testing

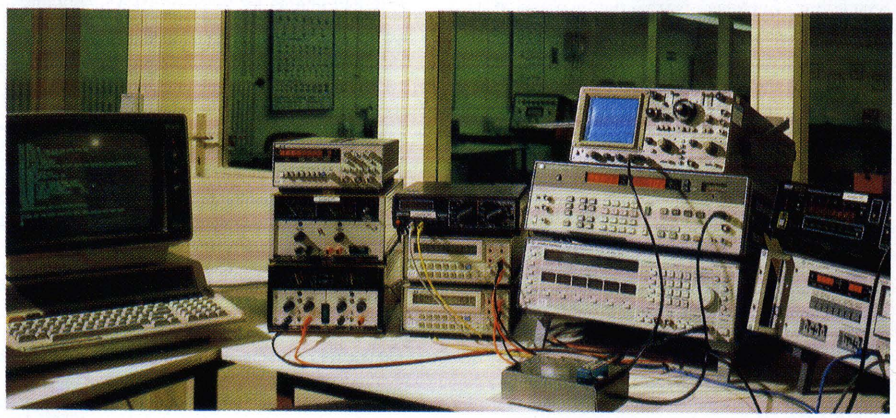
references

Measurements on customized thickfilm hybrid circuits

As early as the 70s, Deutsche Vitrohm GmbH & Co. KG in Pinneberg laid the foundation for the manufacture of this type of circuit. Due to the availability of favourably priced surface-mounted devices (SMDS) and application-specific ICs (ASICs) a variety of applications have opened up for thickfilm hybrid technology in professional electronic engineering.

In Vitrohm's QA department the test parameters agreed upon with the customer are transferred to computer-controlled test systems (the picture shows such a system including an allround R&S signal source – Function Generator AFG for 10 mHz to 20 MHz). The logging of all measured data guarantees a 100% test; the log can be handed over to the customer.

The picture and text are from an extremely informative 12-page Vitrohm brochure giving a general idea of Vitrohm's production process and test philosophy and including a useful questionnaire to facilitate the work of manufacturer and prospective buyers. Stw



Address:
IHZ Berlin
Rohde & Schwarz Werk Köln
Ausbildungsstätte Berlin
Georgenstraße 35
O-1086 Berlin
Tel.: (0 30) 26 43-25 77

Berlin training center Against a background of social and technical change in Germany, Rohde & Schwarz Werk Köln opened up a new training center in the heart of Berlin. This new location was made necessary by the large demand for further education in the five new German states and the distance from Cologne, where R&S has conducted training for more than 25 years (see NEWS 130). The choice went to the trade & industry center (IHZ) in Georgenstrasse (photo above) because of its good traffic connections and excellent technical infrastructure. R&S can make use of all the facilities of the IHZ, where there are ready equipped rooms for seminars and presentations plus an organization for managing all the procedures of registration and the like.

Training in Berlin started off with four parallel courses, each attended by 25 participants. The goal is the examination set by the chamber of trade & industry for telecom technicians specializing in information technology. Passing this examination means that you are qualified to manufacture, test, maintain and repair data equipment and systems. The new German states have some catching up to do, so there are excellent professional opportunities for the telecom technicians of the future with emphasis on information technology in the following fields:

- information and data technology,
- repair of data equipment,
- installation and servicing of communication units and systems,
- maintenance of units and systems,
- quality assurance.

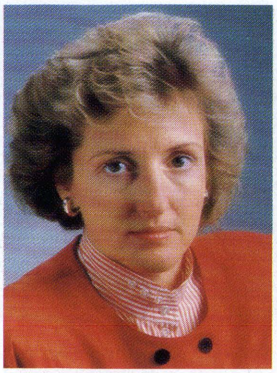
The training offered by Rohde & Schwarz Werk Köln is sponsored by the German Department of Labor, courses last two and a half years and the qualifications are matched to the demands of the market. The simultaneous startup of four courses requires the presence of Cologne training staff to familiarize the newly engaged teachers from East Berlin. Further education goes on continuously in Cologne to make sure the new staff is appropriately qualified. R&S's training standards are high, so the rooms where the courses are held are excellently furnished and fitted with all the necessary aids and instruments for teaching both theory and practice.

Because of the popularity of the courses in Berlin, further training facilities are planned. A search is currently going on for suitable premises in the business and industrial centers of Saxony, Thuringia, Brandenburg, Mecklenburg-West Pomerania and Saxony Anhalt. 20 engineering graduates from the new states are presently attending a six-month course in Cologne to qualify them as teachers for various professions in electronic engineering.

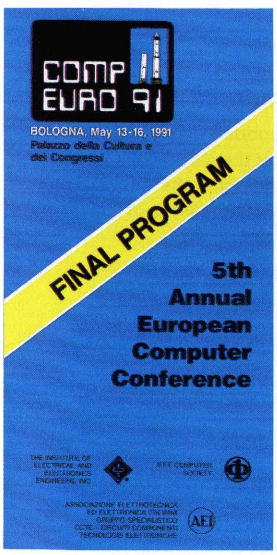
5 DCA/Ba

R&S measuring instruments on the road
Since the spring of 1991 a new Rohde & Schwarz presentation bus has been on tour, bringing solutions to the many applications in RF and AF test engineering right to the user. There is space of 16 m^2 in the bus to demonstrate computer-controlled setups for testing radiophones, for measuring EMC, for network, spectrum, audio and modulation analysis, for video and television measurements and tests on circuit boards. The bus is extremely well fitted and air-conditioned. Besides the demonstration area there is a conference room plus a kitchen for preparing refreshments, and a video system adds to the attractiveness of the presentations. At the stops along the demonstration routes, which take the bus all over Europe, visitors are looked after by sales engineers from the local R&S organization. P/Sö

Corporate communication As of 1 August 1991 Dr Doris Larmann-März (37) became manager of the newly created department for corporate communication at Rohde & Schwarz. Dr Larmann-März was previously with the central association of the electrical and electronic engineering industry (ZVEI) in Frankfurt/Main, where she headed the press and PR department.



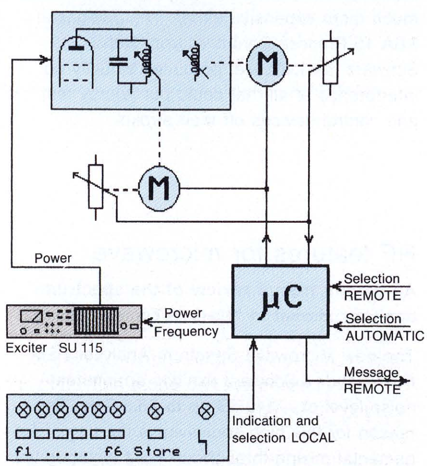
In this role she was responsible for presentation of the association as a whole and its 29 subassociations to the press and the public. The activities of the former advertising department together with the press office are integrated into this new department. Dr Larmann-März will report directly to the board. HW



5th Annual European Computer Conference In May 1991 the fifth European Computer Conference was held in Bologna, Italy. At the invitation of the organizer, the IEEE Computer Society, Dr Uwe Ullrich, head of the R&S department for software development, presented a lecture on the subject of "Development of Modern Computer-based Measuring Systems" that had been prepared in cooperation with Henning Krieghoff. Dr Ullrich dealt with modern methods of software design and development, explaining the theory with reference to the new standard VHF-UHF radiomonitoring system from Rohde & Schwarz (see NEWS 132). Following the lecture, conference participants took the opportunity to discuss with the speaker their experience in the use of relational databases, windows and other standard software together with the Ada programming language. 3 PS/UI

10-kW tubed FM standby transmitter In (n+1) backup concepts it was common until now to use a broadband, solid-state transmitter with switch-selected frequency and of lower output power as a reserve for tubed, narrow-band program transmitters. R&S is now offering an attractively priced alternative in the automatically tuned, tubed 10-kW Preset Transmitter NR 410 M1, which only differs from the normal Transmitter NR 410 R in a few details. Because of the broadband neutralization and grid matching, only the anode circuit and output coupling had to be fitted with processor-controlled stepping motors (diagram below).

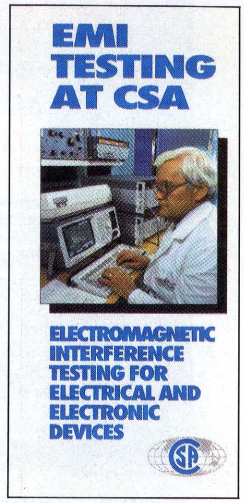
The two tuning values are given by precision potentiometers and are compared to presettings stored in an EEPROM. So, when there is a command to change frequency, the motors are only driven long enough for the values to correspond. The time taken to tune is about 10 s (87 to 108 MHz) and so is about the same as the warmup time of the standby transmitter. Once the backup has taken over operation from the primary transmitter, this preset transmitter acts like a conventional tubed transmitter.



Every local tuning of the transmitter on the antenna can be transferred to EEPROM and updated at any time. A change of frequency is possible remotely, locally or by a privileged automatic switchover unit. The switchover can work with six primary transmitters of different frequency and output power (3 to 10 kW). Even without being automated, the transmitter can operate autonomously and with selectable frequency. The motor control is in the form of an add-on set so that an existing, tubed FM transmitter can easily be converted. Its rugged design ensures a long and maintenance-free service life. In tests in the laboratory, for instance, more than 1000 tuning cycles were performed without any error. 2 ARD/St; Qu

Reader service card 135/18 for NR 410 M1

CSA banks on EMC test systems from R&S The Canadian Standards Association (CSA) has been offering a new service since April 1991: all manufacturers of electronic equipment who submit their products to the CSA for the purpose of obtaining certification of conformance to Canadian or US standards can have EMC testing performed beforehand. If any EMC problems are detected, the CSA advises the producer on suitable filtering measures. These EMC tests mainly concern devices with clock frequencies of more than 9 kHz (USA) or 10 kHz (Canada). For the service that it offers the CSA chose R&S systems consisting of Test Receivers ESH 3 and ESVP plus Spectrum Monitor EZM (photo). The systems are installed at CSA's six centers in Canada. The type of equipment tested includes processors, disk and tape drives, terminals, keyboards and printers, monitors, audio and video devices, CD players, electronic games and PSUs. 5 ZWA/Ar



Canadian prize for R&S signal generator The Canadian High Technology Show is held every two years in Montreal and is the country's biggest electronics event, drawing 35,000 visitors and more than 500 exhibitors. During the show a selected group of representatives of industry judges all new test equipment and makes awards for the best items. In 1991 a prize went to Signal Generator SMHU 58 from Rohde & Schwarz.

This high-performance signal source betters everything that has gone before it in terms of modulation capability (including I/Q and broadband FM) and, with its complex signals over an unmatched frequency range of 100 kHz through 4.32 GHz, is excellent for testing modern communication and radar systems and for measurements where frequency hopping is involved. Philip L. McDouall, sales director of Rohde & Schwarz Canada Inc., accepted the award. RSC/RUS

Press Comments

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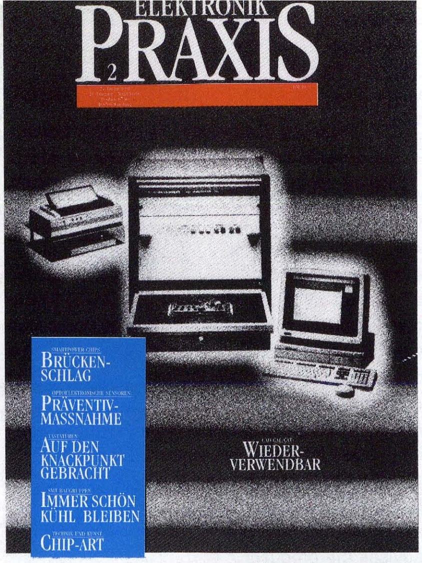


Admittedly, electronic test instruments no longer look very different from one another on the outside, but do they have to be "alienated" as was done here with the new and powerful TSA Board Tester from R&S? Still, at least the pictures and text by R&S product manager Bernd Stockmeyer on the inside of "Elektronikpraxis" 2/91 were interesting, on the subject of re-using the CAD data record for board testing.

Total EMC testing

Jürgen Höfling of "Elektronik Journal" spoke to R&S engineers Wolf Schreyer and Jochen Wolle. Here are some major points from the interview, which appeared in the 3/91 issue:

We've built a compact set, EMI Test Receiver model ESAI, that combines all the characteristics you want for EMC measurements. Using a 20-dB preamplifier we achieve a noise figure of 6 dB in ESAI, which is close to the physical limit. With what is, in effect, a spectrum analyzer with the features of a test receiver, a user can carry out the measurements that are necessary for an overview of the situation during design – measurements that are only possible with a spectrum analyzer – and then, when he's getting near the end of his design effort, he can concentrate on any weak points, where he benefits from ESAI's high sensitivity and wide dynamic range. We've given the instrument a sizeable portion of built-in intelligence. You can enter the limit curves from the standards on the display for instance, and then you see immediately if they are met. And it can set itself up on certain test bandwidths for different frequency bands.

PCs in production

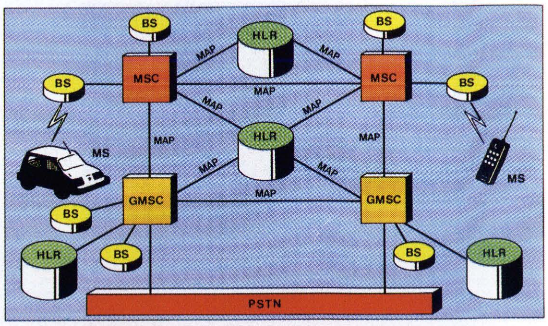
"impulse" 2/91 presented the best computers for heat, dust and damp:

Your normal personal computer will pack up if it is used near vibrating machinery, if water gets splashed around or there are strong electromagnetic fields. Nowadays there are special industrial computers and they are not all that much more expensive either. The 386-based PSA 15 Process Controller from Rohde & Schwarz, for instance, produces virtually no interference at all that could put nearby test and control devices off their stroke.

RF features for microwave

An extract from a review of the spectrum-analyzer market in "Markt & Technik" 14/91:

The new Microwave Spectrum Analyzer FSM from Rohde & Schwarz exhibits an inherent noise level of —140 dB up to 26.5 GHz. The reason for this high sensitivity is the use of fundamental mixing throughout. FSM incorporates two RF input stages: one with a high first IF for frequencies from 100 Hz to 5 GHz, and the actual microwave stage of 5 to 26.5 GHz, which down-mixes to a low first IF of 221.4 MHz and achieves its selectivity through tracking preselection (YIG filter).



Rohde & Schwarz stole the show as the first producer of a system for type-approval testing of GSM mobile stations, wrote "PNE Public Network Europe" in its 4/91 issue, which showed the above signaling scheme for GSM networks: BS base station, GMSC gateway mobile switching center, HLR home location register, MAP mobile application port, MS mobile station, PSTN public switched telephone network.

There was international focus in March 1991 on Spectrum Analyzer FSM for 100 Hz to 26.5 GHz ("Microwave Journal") and Video Analyzer UAF for insertion test signals ("Broadcast electronic" of Portugal).

Video cameras compared

"Medien Bulletin" 6/91 reported about an interesting investigation by the Video Plus company in Hamburg, concerning the different systems and price/performance of professional video cameras:

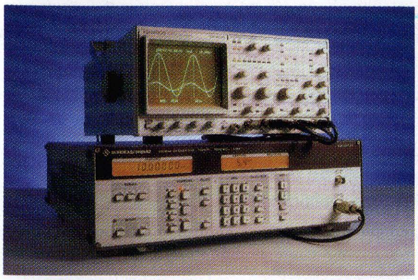
If anyone was interested in getting hard facts on the adjustment of a camera's internal sync generator, well, there was something from test-instrument producer Rohde & Schwarz that came up with a report for the individual cameras. R&S's multistandard Video Timing Analyzer TIF provided a neutral reference after the motto: if you don't believe your own eyes, at least you can believe the test instrument.

Focus on shortwave

Christian Rockrohr started off his test report on the VLF-HF Receiver EK 890 in "funk" 1/91 with the following words:

While Far-Eastern suppliers of receivers for amateurs are continuously striving upwards in price, a Munich producer of professional communications equipment is taking the opposite tack: Rohde & Schwarz is offering its brand-new VLF-HF Receiver EK 890 in the basic version for less than 12,000 DM.

ts



14 analog oscilloscopes for up to 60 MHz were tested by "ELRAD" 2/91 with the aid of R&S Signal Generator SMX (100 kHz to 1000 MHz with 10 to 100 Hz resolution).

Personal communication networks (PCNs) are an ideal and individual telecom service that is becoming increasingly popular, said Unitel director Peter Ramsdale in "IEE Review" 2/91, photographed above with a setup for propagation measurements comprising a signal generator and spectrum analyzer from Rohde & Schwarz.

Nils Schiffhauer tried out an AMTOR amateur shortwave terminal and, in issue 3/91 of the same magazine, cast some thoughts on the subject of error correction on shortwave:

The professionals have developed ARQ further. The ALIS system from Rohde & Schwarz for instance, which recently became a CCIR standard, works with automatic repeat request and its users include the German diplomatic service.

For its video yearbook 1991 "Foto Populär Spezial" carefully tested and objectively judged the best camcorders. R&S Video Noise Meter UPSF 2 helped out.

Trunked radio . . .

In trunking the available channels can easily make utilization four times better than in a system with firmly assigned channels (Claus Reuber in "VDI nachrichten" of 12 April 91):

Rohde & Schwarz is involved in trunked-radio technology, supplying equipment for base stations, and received the first contract from DBP Telekom for the new German states. After barely three months the project was completed, with eight channels for Dresden and a second networked cell for the Meissen area.

. . . and Cityruf

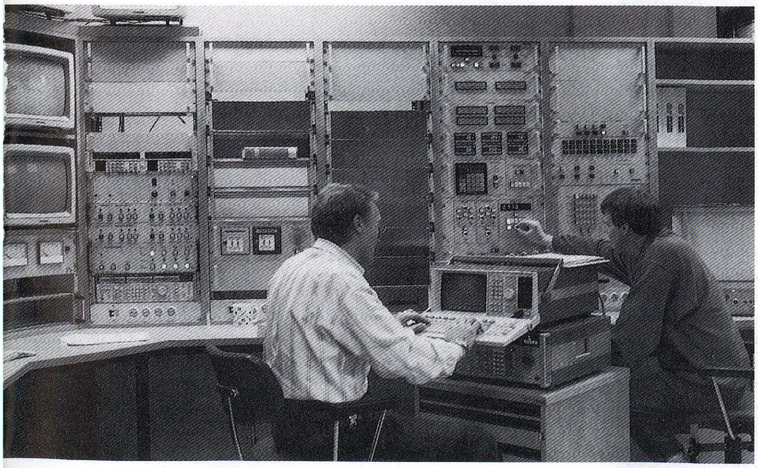
"MOBILCOM" 1/91 listed all ongoing DBP Telekom activities:

Cityruf will also be available in all conurbations with more than 30,000 inhabitants by mid-1991. The contracts for this are being split between ANT and Rohde & Schwarz.

Mobile environmental protection

For applications in clean-air preservation the Rohde & Schwarz plant in Cologne devised a mobile and modular environmental test lab ("umwelt & technik" 4/91):

This lab can take samples, reliably analyze the results and transport the data. Here are some examples of what it incorporates: meteorological test station for wind speed and direction (with north alignment), temperature, relative humidity and barometric pressure with sensors on a maintenance-free telescopic mast; UV photometer for ozone; chemiluminescence analyzer for NO, NO_2 and NO_x; UV fluorescence analyzer for SO_2; IR gas-filter correlation analyzer for CO; FID for hydrocarbons; dust-measuring system for micrometric weighing and mass spectrometer.



EMC is here to stay and technology for measuring it is a prime objective of R&S's specialists:

R&S EMC test station in Volkswagen's test center (left, from "EMV-ESD" 1/91) and test receiver with spectrum monitor for 20 Hz to 1.3 GHz plus the new EMI Test Receiver ESHS 10 for 9 kHz to 30 MHz (right, title shots of "Elektronik Journal" 3/91 and "Design & Elektronik" 5/91).

...information in print...information in print..

TV Test Receiver EMFP (7 to 910 MHz) is a monitoring and test receiver (for broadband-cable and transposer installations, labs and test stations), demodulator and relay receiver; hardkey and softkey operation, various modes of channel setting (4-character station code can be assigned to each channel), memory for ten device setups, IEC-bus interface; suitable for use in mobile units.

Data sheet PD 756.9480.21 enter 135/19

VITS Inserter SKDF (standard B/G; PAL/SECAM) produces 40 test signals (including teletext and PAL-8 field-sequence pulse), three VITS insertion codings can be programmed; IEC-bus interface.

Data sheet PD 756.9445.21 enter 135/14

NICAM Modulator SNM (standard B/G; I) works with the clock signal of the data stream and can be preset to interrupt it in three states; intercarrier, IF and SOV output according to model.

Data sheet PD 756.3153.21 enter 135/20

DSR Modulator SFP generates a standard 4-PSK signal that can be modulated with two stereo or four mono channels; the basic model can be fitted with max. two audio plug-ins, DS1 decoders or AF generators; expandable to 16 (32) channels.

Data sheet PD 756.3199.21 enter 135/06

Modular Sound-broadcast Receiving/Transmitting System NU 002 for unmanned relay stations with the VHF/FM cassettes demodulator/decoder, amplifier (100 W), demodulator/modulator and coder/modulator that are mentioned here can also be equipped for applications in AM radio relay and satellite audio broadcasting.

Data sheet PD 756.3160.21 enter 135/21

Video Analyzer UAF is now also available in an NTSC version.

Data sheet PD 756.9516.21 enter 135/15

Transmitter Control Unit GS 125 handles all settings on TV transmitters, reports faults and displays operating status; keyboard and softkeys (menus in different languages), graphics display, IEC 625-1 and V.24 interfaces.

Data sheet PD 756.3130.21 enter 135/22

10-kW TV Transmitter NT 413 S (standard B, band III) is the first element of the new TV-transmission system 2100 (see below); PAL, NTSC or SECAM, dual sound to IRT or NICAM; picture and sound amplifiers with active, input stages with passive standby, air cooling; total width 1300 nm with integrated picture/sound combiner.

Data sheet PD 756.3124.21 enter 135/23

TV Broadcasting Engineering TV-transmission system 2100 is a new generation of solid-state, modular VHF and (to follow) UHF transmitters with air cooling (despite compact size). The information brochure also details R&S's wealth of experience in TV transmission and measurement engineering for projects: from orientation and planning through to station startup, accompanied by personnel training and on-the-job instruction plus service throughout the lifetime of equipment.

Info PD 756.3147.21 enter 135/24

Cable-TV Measurement System CATV consisting of TV Test Receiver EMFP (or EMFT), Video Analyzer UAF, software and accessories plus (optionally) NICAM Demodulator NDZ is a highly precise and automatic test setup for cable transmissions and terrestrial broadcasting.

Info PD 756.9239.21 enter 135/25

RDS Radio Data Wonderland The information brochure presents the enormous variety of data that can be transmitted in the radio-data system (RDS) using FM Data Coder DMC and FM Data Decoder DMDC.

Info PD 756.8955.21 enter 135/26

Power Sensor NRV-Z6 (50 MHz to 26.5 GHz, 50 Ω) measures from 1 nW to 20 mW with a mean square calibration-factor error (RSS) of 1.3% (up to 200 MHz), power handling 100 mW.

Data sheet PD 756.9416.21 enter 135/27

High-power Attenuator RDL 50 (0 to 6 GHz) can handle 50 W up to 30°C (pulsed 2 kW); attenuation 20 dB, N connectors.

Data sheet PD 756.3247.21 enter 135/28

Spectrum Analyzer FSB (100 Hz to 5(5.2) GHz) is now available with a maximum frequency sweep of 2 GHz.

Data sheet PD 756.8384.22 enter 135/29

D for Digital The entire range of instrumentation for European mobile-radio networks to GSM standards is already available from R&S: for production, certification, operation and service.

Info PD 756.5756.21 enter 135/30

Airport Communication In this information brochure R&S offers air-traffic-control radio networks from planning through to turnkey handover, including systems for transmission and reception, DF navigation, VCS and trunked radio.

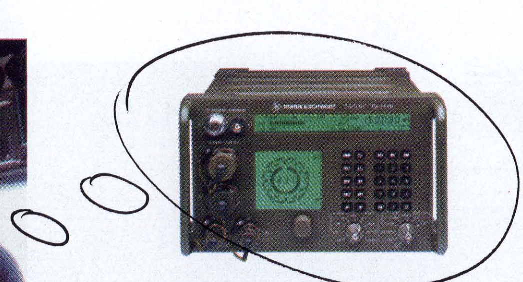
Info PD 756.3101.21 enter 135/31

Schz

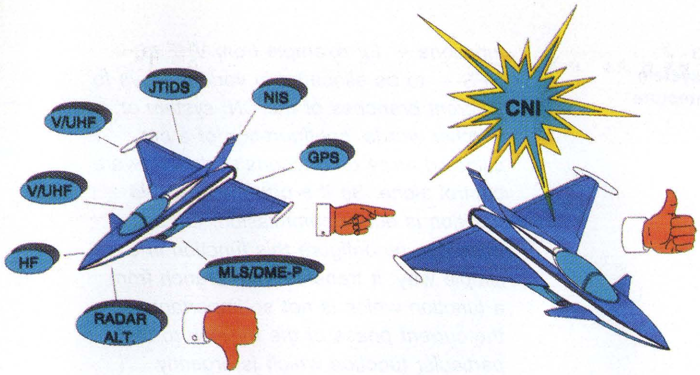
feed back

Dr Michele Dolci of Croce Rossa Italiana was kind enough to send us this photo of her nostalgic radio station with **R&S Receiver ESU + ESUP** – proof that equipment from Rohde & Schwarz is still up and going after a quarter of a century. In Dr Dolci's words:

"I have a very high opinion of your equipment, so I'm sending you this photo of the interior of a mobile radio unit of the Italian Red Cross showing the Monitoring Receiver ESU + ESUP. After reading about your **Tacloc PA 1100,** I think it must be the dream of every operator. All the best and thank you for sending NEWS FROM R&S."



Note: Tacloc PA 1100 is a modern and highly mobile, also remotely controllable VHF-UHF direction finder and locating system, and at the same time the smallest R&S system using the doppler principle (see NEWS 129 or enter 135/32 on the reader service card).



Modular CNI avionics systems

"Redundancy lets you live longer" – this observation has nothing to do with unemployment but comes from aircraft designers, who want to make aircraft more reliable and economical. The key is systems made up of multifunction modules, and currently various international authorities like ISO, DIN and ARINC in the AEEC are engaged in efforts to standardize them.

Today's aircraft contain a multitude of different radio functions for communications, navigation and identification. The individual radio functions, like VHF/UHF, JTIDS/MIDS, GPS or NIS, are each handled by an individual item of equipment. In the absence of built-in redundancy, the failure of a single avionics item can lead to the failure of the overall system. In future, therefore, the individual radio functions need to be integrated in a modular total system, the modular CNI system (communication/navigation/identification).

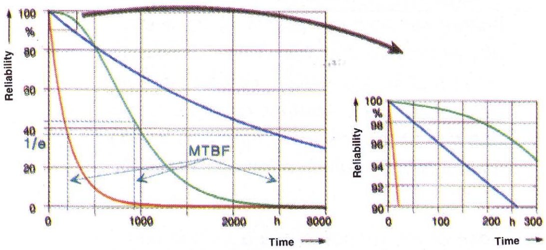


FIG 1 Typical reliability curves for individual unit (blue), conventional system (red) and modular system (green)

Reliability and reconfigurability

With a conventional system consisting, say, of twelve radio units with a mean time between failures (MTBF) of 2500 h each, the survival time for the operation of the total system is just 2.1 h, assuming a required reliability of 99%. If, instead, a system is chosen which consists of twelve multifunction units (each also having an MTBF of 2500 h), of which no more than nine can be used simultaneously, then, again for reliability of 99%, the system will continue operating for 120 h. In other words, the survival time for the operation of the total system has improved by a factor of 57.

The way such a system is used in flight is divided into various phases in which the different CNI functions have different priorities. For example, in the run-in phase for a fighter-bomber the VHF and MLS/DME functions are not used at all, and HF has very low priority. Now, if a high-priority CNI subsystem (like UHF) fails, the modular CNI system has a certain potential supply of modules which are either not currently in use or in use for low-priority tasks and which can be used to take over the function that suffered the fault. This allows the main radio functions to be reconfigured if there is a fault. This dynamic redundancy leads to a major improvement in system MTBF.

FIG 1 shows typical reliability functions of a single unit, of a state-of-the-art CNI system and of a modular CNI system as in the above example. While the reliability function of conventional systems decreases exponentially at t = 0, that for systems with redundancy is almost flat. For our example this means that the reliability function of a modular system does not fall below 99% until 120 h have elapsed, whereas this happens for a conventional system after 2.1 h.

System architecture

When designing a modular CNI system, there are several basic architectures which could be chosen. The reconfiguration of failed modules or groups of modules can be achieved using multiplexers of various complexity to switch the signal paths between the modules. The reliability of the multiplexers thus largely determines the reliability of the overall system, and complex multiplexers are tougher to evaluate than simple ones which might have only two inputs and outputs.

As part of the New Avionics Structures study, the CNI Team (R&S, Siemens, Standard Elektrik Lorenz), under the leadership of R&S, together designed a modular CNI system architecture and identified and defined the individual modules of the system. The basic modularization of the radio functions (FIG 2) was carried out using a functional top-down division of the transmit and

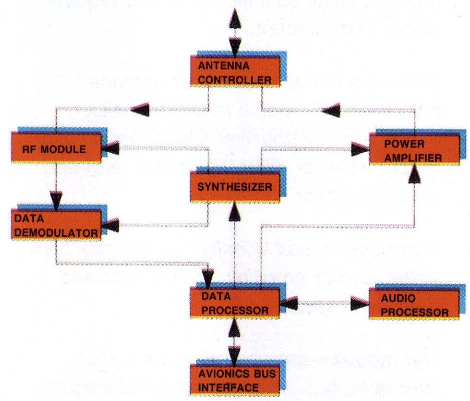


FIG 2 Basic structure of radio functions in modular CNI system

Abbreviations used in text

AEEC Airlines Electronic Engineering Committee
ARINC Aeronautical Radio Incorporated
CNI communication/navigation/identification
COMSEC communications security
DME distance measuring equipment
DME-P distance measuring equipment, precision
ECCM electronic counter-countermeasures
GPS global positioning system
ISO International Organization for Standardization
JTIDS joint tactical information distribution system
MLS microwave landing system
MIDS multifunctional information distribution system
NIS Nato identification system

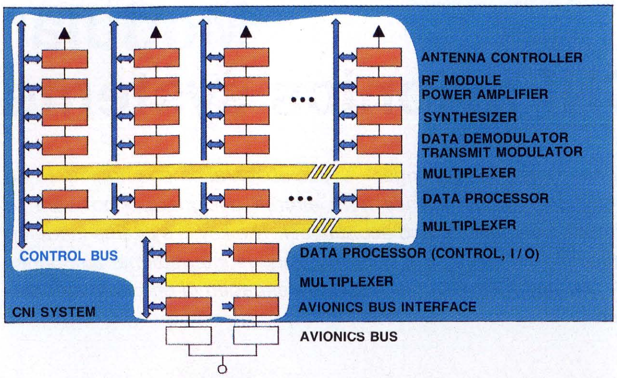


FIG 3 CNI system architecture

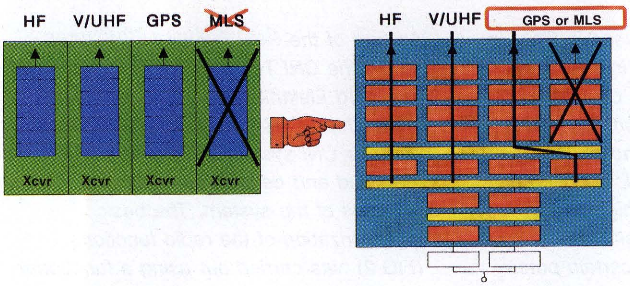


FIG 4 In conventional system (left), fault in a function means loss of that function. Modular CNI system (right) maintains functionality by reconfiguring faulty function.

receive circuitry, it being necessary to take technical specifications and requirements into account.

A receive circuit consists of antenna controller RF module (filter, amplifier, mixer, etc), synthesizer, data demodulator (A/D converter, filter, correlator, etc) and data processor.

A transmit circuit consists of antenna controller, power amplifier, synthesizer and data processor.

The modules are controlled via a fast fiber-optic bus. Thus CNI radio functions can be built up from just eight module types, including the audio processor and the avionics bus interface. This architecture makes it possible to configure the following radio functions: HF, VHF/UHF, GPS, MLS and DME-P. More complex systems for VHF/UHF with ECCM and COMSEC, MIDS/JTIDS or NIS require additional mdoules; however the basic structure does not need to be changed.

From the above considerations, the CNI system architecture shown in FIG 3 resulted. This architecture was based on technology which is available today, or will be in the immediate future. For example, multiplexers for analog RF signals are extremely difficult, whereas digital multiplexers are available even for very fast signals. The fiber-optic bus controlling the system as well as the connection to the avionics bus are designed with dual redundancy.

The system in practice

The system architecture described above permits a multitude of configurations for radio functions which are currently handled by specialized individual units. The various modules are supplied with setup data via the control bus and are thus set for a particular function. This allows a defined, preselected array of functions – for example from VHF to GPS – to be allocated in various ways to different branches of the CNI system or, in other words, configuration of a preselected array of functions under software control alone. So if a currently needed function is out of commission, the software can reconfigure this function in a simple way: it transfers one branch from a function which is not so important in the current phase of the mission to the particular function which is urgently needed and has failed (FIG 4). This quite obviously provides a considerable improvement in reliability and availability of the total system, without forcing the aircraft to carry dead-weight redundancy.

The implementation of a modular CNI system appears more complex than previously discussed. To ensure the complete range of functions, we need different module types: in addition to the eight modules needed for receive and transmit paths, we need a data correlator, a transmit modulator and a control-bus interface. These eleven types also have a number of subtypes which are tailored to the technical and functional requirements of each CNI function. Thus it seems neither sensible nor practical, for example, to provide a power amplifier which could handle the entire frequency range from HF to EHF. Another example is certain complex correlation functions needed for the NATO identification system (NIS).

Each of the modules has a built-in test (BIT) feature as well as a nonvolatile memory for storing BIT results for later analysis. For simple and fast identification of faulty modules by maintenance crews, each module is provided with a go/nogo indicator. Integrated EMC features plus the fiber-optic inputs and outputs make the system a "green island" in the polluted avionics environment. The number of different modules is limited; identifying faulty modules is easy; also,

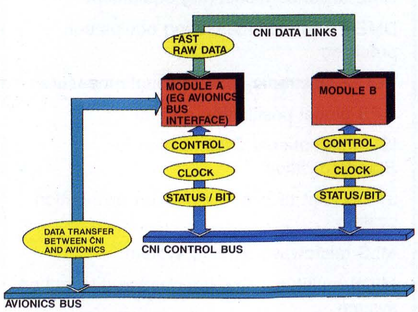


FIG 5 Data transfer within CNI system, and between CNI system and rest of avionics

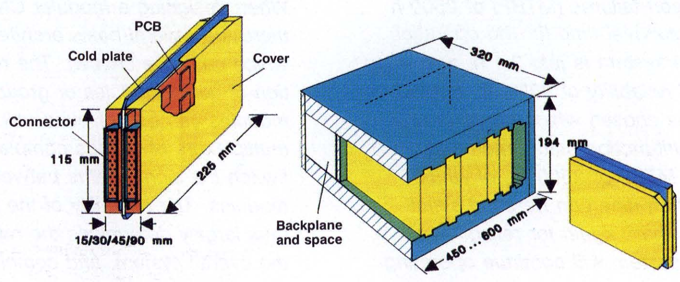


FIG 6 Mechanical design of CNI system: line replaceable module (left) and rack with several LRMs (right)

they are easy to replace right in the flight-line area – all of which means benefits in terms of spares handling and maintenance planning, and thus reduces life-cycle costs.

The data transfer between the modules (FIG 5) is carried out via the CNI control bus (clock, settings data, BIT) and special point-to-point data links (fast raw data). The total data transfer runs, as far as possible, via fiber-optic links to cut EMC problems both between the CNI system units and externally (eg EMP). The control bus is distributed via star couplers in the rear of the rack. The CNI system is connected to the rest of the avionics system via the avionics bus, which only has to carry a small amount of data since all the internal CNI data transfers are handled separately.

Mechanically, the design is based on the line-replaceable-module (LRM) concept, which may have various widths to hold the hardware (FIG 6). Special cold plates conduct the dissipated heat to the ventilation channels in the top and bottom of the rack. The racks come in various widths for the space available and the functions required. The modules are fully connectorized using plug-in connectors at the rear of the rack to make it easier to replace them.

Summary

The better performance of modular CNI systems is due to higher system efficiency and reliability. A modular CNI system has growth potential: it allows the introduction of new technologies, or adapting the system to new functional requirements, in a simple and inexpensive manner. Thanks to the low maintenance and spares-handling costs, lifecycle costs are reduced drastically. The modular design of the CNI system makes it possible to use it in a multitude of avionics systems. Resource sharing and dynamic redundancy, ie the ability to reconfigure faulty functions, make a big improvement in reliability, availability and survivability of the system.

Peter Reitberger; Michael Köpf

Reader service card 135/33

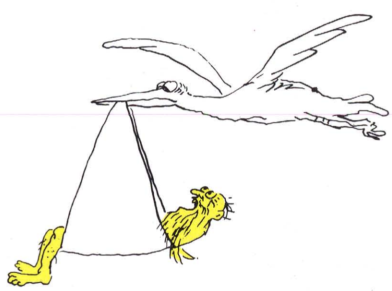
peripherals

INSIDE LOOKING OUT Even after 40 years of television, there are still people who believe that the person on the tube can look into their living room. The father of a family wrote to broadcaster ARD: "Dear Mr Wieben, Don't be surprised next time you're on, because we've got new wallpaper." rtv

PLUS AND MINUS "I'd like to marry my divorced wife again, but she says I'm only after my money." stern

OUTSIDE LOOKING ON The woman owner of a pit bull terrier became involved in an incident with another woman walking her dog in Churchfield Road, Weybridge, last Friday. The two dogs watched while their owners are claimed to have hit and bitten each other. One owner was treated for black eyes and abrasions. Woking News and Mail

POLITICAL WISDOM Each German member of parliament is entitled to three computer workstations. The Augsburger Allgemeine Zeitung inquired in Bonn about how often they get a new computer. The answer from the house administration: "A PC is replaced every four years, because by then the hard disk is usually full."



"Why don't you admit that you've lost your way." Cartoon commentary to our final article on avionics from "Das Buch Otto – von und mit Otto Waalkes" (published by Hoffmann und Campe).

PRESS RELEASE from an insurance company encouraging cyclists to wear helmets: "Turtles have survived for billions of years – and not least because they wear a helmet."

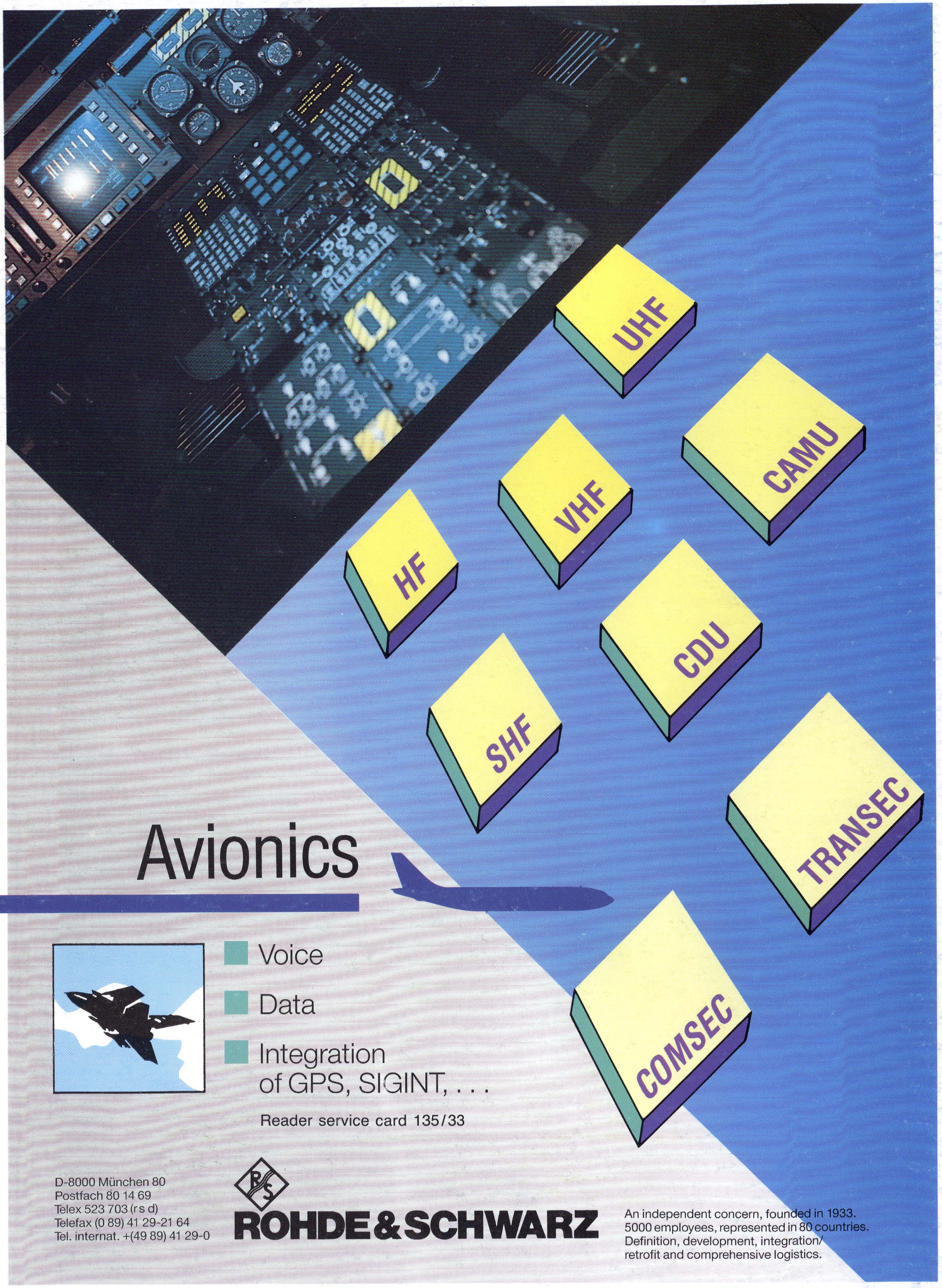
CREATIVE WEDLOCK "I'd like to know how Chambers managed to write his first dictionary." – "He probably quarrelled with his wife and one word led to another." Calendar joke

PLANS FOR THE FUTURE "You're retiring next week. What are you going to do with your time?" – "Well, for the first four weeks I'm just going to sit in a rocking chair." – "And then?" – "Then I'm slowly going to start rocking." Münchner Merkur

miniquiz

DO YOU KNOW which is the oldest German parliament, when the first tram took to the rails in Berlin and when there were more electric cars in the city than petrol ones, where the scoring in tennis originated, and what virtual reality (VR) produces?

Answers to miniquiz: the Bavarian Landtag (since 1311); 1881 and in the 1920s; in money bets in the 14th century with the French gold coin called sou, which was worth 60 deniers, and when a game at that time already went to at least four points, so that the scoring was 15, 30, 45 deniers (later shortened to 40): computer-controlled perfect illusions.



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