# News from Rohde & Schwarz


DECT signalling tests
indispensable in development and service

Standard-conforming fading simulation
in mobile-radio measurements

Operational and test equipment
for digital audio broadcasting

1997/III
155

ROHDE & SCHWARZ

Number 155 1997/III Volume 37

DECT Signalling Test Unit PTW15 met with great interest at CeBIT 97. This unit launched by Rohde & Schwarz is a signalling tester of unrivalled price/performance ratio for development of DECT equipment as well as for installation and servicing of DECT networks. PTW15 impresses not only with its price, but also with its compact size, multitude of functions and convenient operation in the lab or in mobile use (page 4).


## Articles

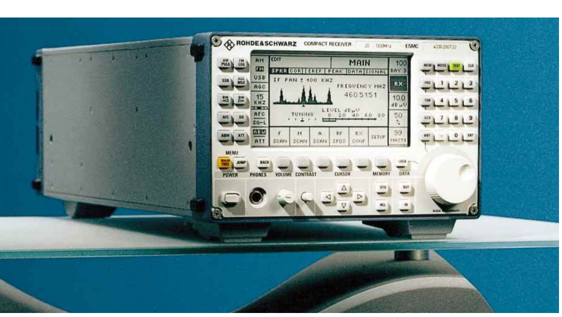


## Application notes



## Software





ESMC-RAMON – a versatile operating software for VHF-UHF Radiomonitoring Receiver ESMC – takes the chore out of tasks connected with reception of emissions, display of frequency spectra and monitoring of frequencies (page 26).

# Refresher topic



# Panorama



# Regular features



# Supplement



Digital Radiocommunication Testers CMD can be found in every mobile-phone production line. And the new models CMD65 and CMD80 make sure that this continues to be true in the future as well. Their multimode and multiband capabilities take into account the breath-taking speed of development on the mobile radio market (page 6).

# Imprint

Published by ROHDE & SCHWARZ GmbH & Co. KG Mühldorfstraße 15 D-81671 Munich Telephone (0 89) 41 29-0 · international (+49 89) 41 29-0 · Editors: H. Wegener and G. Sönnichsen (German) · English translation: Dept. 5CL4 · Photos: S. Huber · Artwork: N. Hofmann · Circulation 100 000 four times a year · ISSN 0028-9108 · Supply free of charge · State company or position · Printed in the Federal Republic of Germany by peschke druck, Munich · Reproduction of extracts permitted if source is stated and copy sent to R & S Munich

## DECT Signalling Test Unit PTW15

# Support in installation and maintenance of DECT networks

**DECT Signalling Test Unit PTW15 provides all test functions required for the installation and maintenance of DECT WLL networks and DECT PABX systems at an unrivalled price. Compact design, front-panel keypad and optional built-in battery modules make this unit suitable for use in the laboratory as well as for mobile applications.**

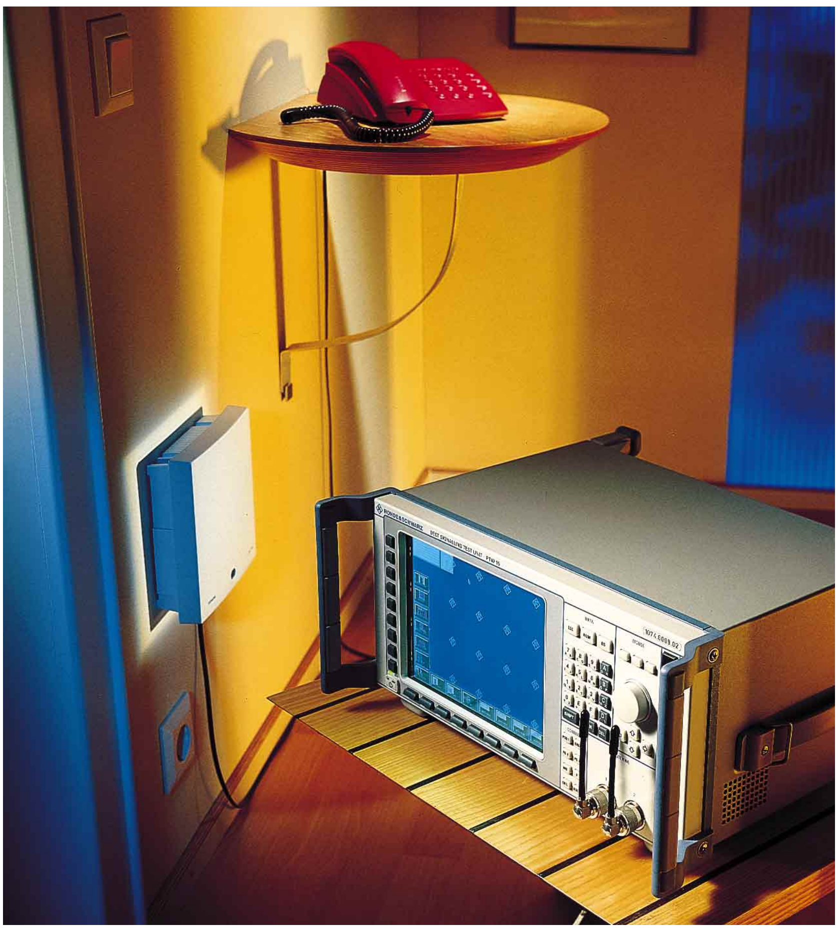


FIG 1 DECT Signalling Test Unit PTW15, compact signalling tester for use in installation of Digital Enhanced Cordless Telecommunications networks and in software development
Photo 42 891

The powerful DECT Protocol Tester TS1220 [1] from Rohde & Schwarz is now seconded by the extremely favourably priced DECT Signalling Test Unit PTW15 (FIG 1). This unit can be used wherever the full functionality of TS1220 is not required: in installation and maintenance of DECT WLL and PABX systems, in DECT audio tests to TBR10 and in the field of DECT software development.

In the installation of DECT WLL networks [2] or test networks, PTW15 produces data about the occupancy of the DECT frequency band including relevant statistics to support antenna positioning and assessment of various parameters of the DECT equipment (eg dynamic channel selection algorithm). Since most tests are carried out on site directly in the network, the unit was designed for mobile use through its compact size and optional battery powering. For DECT audio tests to TBR10, PTW15 can be used as a DECT signalling unit that supports call setup to portable and fixed DECT radio terminations both in normal operation (generic access profile GAP to ETS 300 444) and in test standby mode by providing voice data at an analog and a digital interface. The required DECT reference implementations can also be used for DECT software development.

The DECT Signalling Test Unit comes with channel-occupancy software covering all DECT activities at the air interface as well as with a monitor mode for recording and analyzing selected DECT activities between user-defined fixed radio terminations (FT) and the associated portable terminations (PT).

## System architecture

The unit is based on a 133 MHz AMD K5 processor with 32 Mbyte DRAM, an 8.4-inch colour display and further computer peripherals. The DECT-specific part is accommodated on a separate module, which in addition to the RF section contains the DECT baseband processor and the ADPCM coder/decoder as well as an additional chip developed by Rohde & Schwarz. It is this chip that enables channel-occupancy measurement and operation as a DECT monitor. The entire module is controlled by its own microprocessor.

In addition to two RF connectors, which also allow antenna diversity if PTW15 is operated as a fixed DECT termination, the following **data interfaces** (eg for audio tests) are available for connection to external equipment:

- analog input/output (may also be used to connect an external telephone receiver when simulating a portable termination),
- 64 kbit/s PCM input/output (V.11).

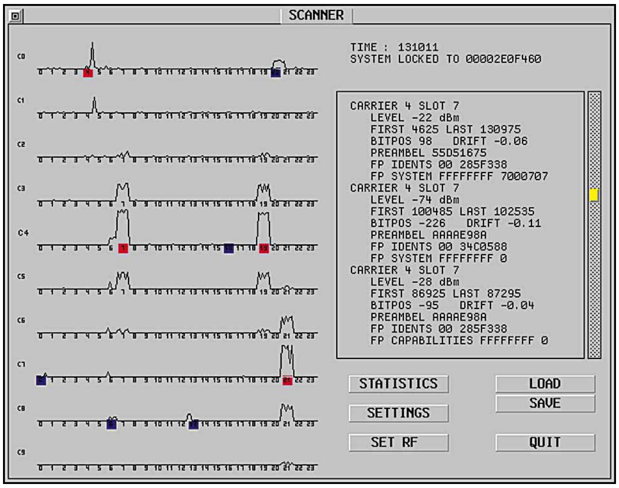



FIG 2 Channel-occupancy measurement providing all essential information at a glance

The unit can be AC- or DC-powered from built-in or external batteries.

The implemented **DECT protocol stack** is mapped on the hardware as follows: the time-critical physical layer (PHL) and medium access control layer (MAC) are implemented in the DECT-specific module. The data received between PHL and MAC at the point of observation are imaged in the processor kernel and displayed. The data link control layer and network layer, used for reference implementations, run as independent processes in the processor kernel. All layers communicate via points of control and observation. The exchanged data are displayed in windows on the graphic user interface.

The processor kernel uses the **realtime Unix operating system LynxOS,** which ensures smooth running of the various processes (DECT layers, display functions, user interface, etc). LynxOS is fully compatible with System V and Posix. The graphic user interface allows convenient operation of the unit via the front-panel keypad supplied as standard or via the external keyboard plus mouse included in the comfort package. All test functions of PTW15 can be activated by hotkey or a mouse click on the matching symbol of the display (FIG 1).

## Measurement examples

**Channel-occupancy measurement** provides a quick and comprehensive overview of all signals received in the DECT frequency band (FIG 2). In addition to the radio signal strength levels for each DECT slot, other information such as identity, signal drift (referred to a user-defined fixed DECT termination) and bit position (referred to the same fixed termination) is displayed. All results can be stored for subsequent evaluation.

In **monitor mode** the unit synchronizes to a user-defined fixed DECT termination and records all data packets exchanged with portable terminations via the air interface, without actively participating in signalling. From the collected data, failed or successful handover and call-setup attempts or the number of actually occupied channels can be determined for instance. All data are available both as visualization of the points of (control and) observation and in a message-sequence chart or as an ASCII file.

**Simulation of fixed and portable terminations** is implemented in line with ETS 300 444 (GAP) and provides the functionality of a fixed or portable DECT termination. The user can set all identities. Each activity after starting simulation is stored in an easy-to-read trace file. The user can also take the points of (control and) observation and the message-sequence chart for analysis and troubleshooting.

Holger Jauch; Peter Riedel

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[1] Gloger, M.; Riedel, P.: DECT Protocol Tester TS1220 – Type approval measurements on DECT fixed parts (FP) and portable parts (PP) to TBR22. News from Rohde & Schwarz (1995) No. 148, pp 9–11

[2] Gloger, M.; Riedel, P.: Optimizing wireless local loop systems. News from Rohde & Schwarz (1996) No. 152, p 35

### Condensed data of DECT Signalling Test Unit PTW15

| | |
|---|---|
| Frequency range | 1881.792 to 1897.344 MHz |
| Transmitter power | 22 dBm ±2 dBm (typ.) |
| Modulation | 288 kHz |
| Carrier frequency | DECT carrier ±30 kHz |
| Receiver sensitivity | –89 dBm (BER <0.001) |
| CPU | AMD K5, 133 MHz |
| RAM | 32 Mbytes |
| Interfaces | 2 x RS-232-C, 1 x Centronics,<br>1 x external keyboard |
| Weight | 8 kg |

**Reader service card 155/01**

### Digital Radiocommunication Testers CMD65 and CMD80

# Multiband and multimode testers for mobile-radio telephones

**Future multimode mobile phones as well as service centers' and manufacturers' demands for cost-effective testing of mobile phones to different network standards call for radio testers supporting several standards all in one unit. Rohde & Schwarz is ready with the solution: Digital Radiocommunication Tester CMD65 measures GSM, PCN, PCS as well as DECT mobile phones, and Digital Radiocommunication Tester CMD80 supports CDMA in several frequency bands as well as analog AMPS.**

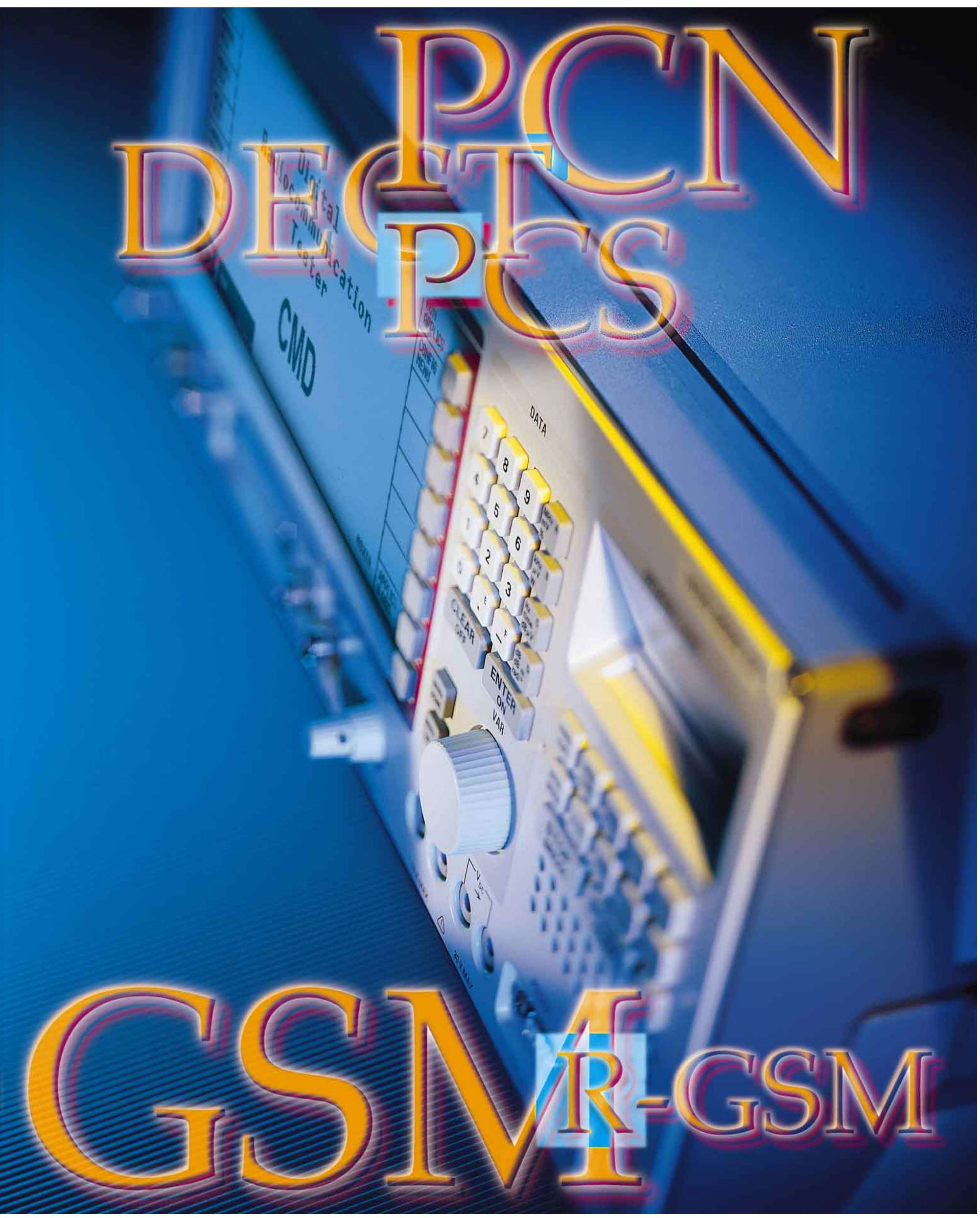


FIG 1 Digital Radiocommunication Tester CMD65 for GSM, PCN, PCS and DECT mobile phones
Photo 42 875/2

## Digital Radiocommunication Tester CMD65

CMD65 (FIG 1) is a specialist for the following **network standards** and the associated frequency bands:

- GSM900: Global System for Mobile Communications (900 MHz band), used in Europe, Australia, etc,
- R-GSM: Railway GSM, ie use of GSM in trains (channels below GSM frequency band),
- PCN (DCS1800): Personal Communications Network in Germany and England in 1800 MHz band (other countries to follow),
- PCS/DCS1900: Personal Communications Service in 1900 MHz band in North America (GSM North America),
- DECT Europe: Digital Enhanced Cordless Telecommunications (channels between 1880 and 1900 MHz),
- DECT Latin America: digital cordless telephones in frequency range above European DECT band.

A modern digital radiocommunication tester is expected to handle several network standards all in one unit, since service centers for instance in Germany must be able to test GSM and PCN mobile phones as well as cordless phones to DECT standard. To save costs and space, it is expedient to use a single tester for all the different kinds of DUTs. On modern production lines, not only GSM mobile phones are manufactured, but usually also mobile phones of the related PCN and PCS standards (GSM with several channels and in a different frequency band). To compensate fluctuating sales figures for different networks, it is an advantage if the manufacturer can use testers on his production lines that are able to measure any type of mobile phone.

Some manufacturers are working at present on **multimode mobile phones,** a combination of GSM mobile and cordless phone. Such a GSM/DECT multimode mobile phone can be used at home to make favourably priced

| | GSM | R-GSM (Railway) | PCN (DCS1800) | GSM North America PCS/DCS1900 | DECT Europe | DECT Latin America |
|---|---|---|---|---|---|---|
| CMD50 | ● | ❍ | ❍ | ❍ | ❍ | ❍ |
| CMD53 | ● | ❍ | ● | ❍ | ❍ | ❍ |
| CMD52 | ● | ❍ | ❍ | ❍ | ❍ | ❍ |
| CMD55 | ● | ❍ | ● | ❍ | ❍ | ❍ |
| CMD60 | ❍ | ❍ | ❍ | ❍ | ● | ❍ |
| CMD65 | ● | ❍ | ● | ❍ | ● | ❍ |

TABLE 1: Overview of CMD models and network standards supported (● standard, ❍ optional)

calls via the fixed DECT termination connected to the public switched telephone network, and beyond DECT coverage via the GSM network. A radiocommunication tester supporting both standards is ideally suited in terms of flexibility, economy, space and speed for checking and measuring the performance features of such phones in production.

PCN (DCS1800) mobile-radio networks are used in Germany and England within Europe so far. Other countries are to follow, but PCN networks will not be available throughout Europe. To ensure European-wide coverage with PCN mobile phones, it is intended – in countries exclusively supporting GSM900 networks – to introduce roaming in the GSM900 network of a foreign operator. This kind of phone is called a **dual-band mobile phone** since it combines GSM900 and DCS1800 (same network technology in different frequency bands) in a single unit. For the production of such dual-band mobiles a GSM radiocommunication tester will be required that also supports the DCS1800 band.

All the above applications fall within the domain of CMD65. It provides the following essential features for use in production: all measurements are performed exactly in line with network specifications. Signalling and measurements as well as remote control of the tester are optimized for high speed. Following switchover to a different network standard, CMD is ready to measure again in less than a second. This is particularly important for use of the tester in the production of multimode and multiband mobile phones to avoid loss of valuable process time.

In addition to performing RF measurements to different mobile-phone standards, CMD65 also checks the audio characteristics of mobiles for all selected networks and operating states. For this purpose CMD65 comes with an AF generator, AF voltmeter with counter, distortion meter and multitone audio analyzer. Up to 14 audio tones can be generated and selectively measured at a time. Frequency response for instance can be measured within two seconds. CMD is able to check the more demanding audio quality of cordless telephones without any further measuring equipment.

Digital Radiocommunication Tester CMD65 basically supports GSM, PCN and DECT standards. R-GSM, PCS and DECT Latin America are optionally available. All GSM and DECT models of the CMD family [1; 2] can be enhanced for further network standards. The possibility of subsequent upgrading ensures maximum versatility and future-proofness as well as low investment for units already available. TABLE 1 gives an overview of the various CMD models and network standards supported by basic equipment or options. Models CMD50/53 are intended for use in qualified service centers, models CMD52/55/60/65 for production lines.

## Digital Radiocommunication Tester CMD80

CMD80 (FIG 2) serves for testing mobile phones operating according to the US mobile-radio system CDMA (code division multiple access). Mobiles of the analog AMPS standard (Advanced Mobile Phone System) can be tested optionally [3]. These mobile-radio systems evolved in the US in recent years as follows. In the North-American countries cellular phones were first operated in the analog AMPS network. Although this network is widespread, it has reached the limits of its subscriber capacity. The successor system CDMA with higher spectral efficiency is used today in the 800 MHz band to supplement and relieve the analog AMPS network. CDMA mobile phones for the 800 MHz band therefore also contain analog AMPS signalling, ie the mobiles operate in dual CDMA and AMPS mode. Even handover between CDMA and AMPS has been defined, ie change of network during a setup call. American operators have also installed networks to CDMA standard in the 1900 MHz band: PCS mobile phones for CDMA. CDMA mobiles supporting both frequency bands (800 and 1900 MHz) are referred to as dual-band CDMA mobiles. Apart from the US, South Korea also uses the CDMA standard, where CDMA mobiles operate in the 1700 MHz band.

CMD80 supports all three CDMA frequency bands mentioned as well as analog AMPS in one unit. Its RF concept provides a continuous frequency range from 800 to 2200 MHz. Transmit and receive frequencies are independent of one another. Signalling and measurement use ultramodern digital signal processing.

All these features make CMD80 ideal for use in **service shops** in the US.

As an all-in-one unit it allows testing of CDMA800 and CDMA1900 mobiles, mobiles of different network operators and multiband mobiles alike. Plus it can be used to check the analog AMPS functions of a dual-mode mobile.

TABLE 2: Network standards and frequency bands covered by Digital Radiocommunication Tester CMD80

| Network standard | Specification | Country/name | Frequency band |
|---|---|---|---|
| CDMA | IS95 | US Cellular | 800 MHz |
| CDMA | J-STD-008 (Upbanded IS95) | US PCS | 1900 MHz |
| CDMA | J-STD-008 | Korea PCS | 1700 MHz |
| AMPS | IS55 | US Cellular | 800 MHz |


FIG 2 Digital Radiocommunication Tester CMD80 incorporating measurement functionality for both digital standard CDMA (800, 1700 and 1900 MHz) and analog AMPS
Photo 42 816/3

CMD80 features the following benefits for use in modern **production:**

- Large mobile-phone manufacturers produce CDMA mobiles for all frequency bands. A multiband tester provides the necessary versatility in case of fluctuating sales figures for single-band mobiles.
- A radiocommunication tester covering both frequency bands provides the most economical solution for the production of dual-band mobiles.
- A radiocommunication tester supporting CDMA and AMPS is the most cost-effective, compact and, in terms of measurement, fastest solution for the production of dual-mode phones.
- Only a multimode tester allows simple testing of CDMA/AMPS handover.

TABLE 2 shows the network standards and frequency bands supported by Digital Radiocommunication Tester CMD80.

Werner Mittermaier

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[2] Maucksch, T.: Digital Radiocommunication Tester CMD60 – A favourably priced compact test set for series production of DECT mobiles. News from Rohde & Schwarz (1995) No. 149, pp 13–15

[3] Maucksch, T.: CMD80: measurements for CDMA and AMPS mobiles. News from Rohde & Schwarz (1997) No. 154, pp 22–23

**Key features of Digital Radiocommunication Testers CMD65 and CMD80**

Measurements to relevant standards
Large graphic LCD
Ease of operation
Extremely fast remote control
DSP technology
Full-featured configuration
Compact design

**Reader service card 155/02**

**Signal Generator SMIQ + SMIQ-B14**

# Fading simulator and signal generator in one unit

**Signal transmission between a transmitter and a receiver, in particular a mobile receiver, is strongly affected by the characteristics of the radio channel. So test signals reflecting the real conditions of mobile-radio reception are used in the development and type approval of receivers. Fading simulators are employed for such tasks. Up to now three instruments were required to generate real-life test signals: signal generator, local oscillator and fading simulator. But when Signal Generator SMIQ and its fading-simulator option are used, the required test signals can be produced in a single unit.**

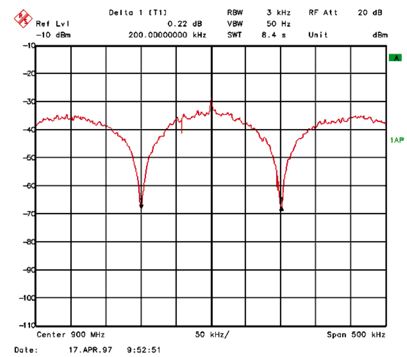


FIG 2 Simulation of multipath propagation: SMIQ set for 2-path simulation, delay difference of active paths being 5 µs. Frequency-dependent notches spaced 200 kHz apart are displayed.

Signal Generator SMIQ (FIG 1) is a universal RF signal source for use in research, development and production in the field of digital mobile radio [1]. The fading-simulator option makes SMIQ even more attractive.

## Degradation during transmission

Propagation conditions between a stationary transmitter and a mobile receiver undergo constant changes. The characteristics of a radio channel vary with time and frequency, which leads to time- and frequency-selective fading. The receive signal is mainly affected by multipath fading, local scattering, Doppler shift and slow signal variations.

**Multipath fading.** The emitted electromagnetic wave is reflected, diffracted and attenuated by obstacles (buildings, terrain, vegetation, clouds) in many ways, so the signal arriving at the receiver is the sum of several single signals. Since these signals travel on different propagation paths, they arrive with different amplitude and delay and consequently with different phase, which may lead to cancellation of signals. The mobile-radio channel thus contains several paths (M paths, M in models up to 12), with great differences in path length. This results in delay differences that are significant referred to the symbol period $T_s$ of digital transmissions ($\tau \geq T_s$, $\tau$ = delay difference of two signals).

One effect of multipath reception, which also occurs in the case of stationary receivers, is narrowband, **frequency-selective fading** showing notches in the bandwidth of the radio channel. The spacing of the notches is $1/\tau$ (FIG 2).

Another effect of multipath reception is the **delay spread** of the received signal, consisting of several components that arrive at different times. With delay differences exceeding one symbol period $T_s$, the signal components of the symbol present at the receiver input may be impaired by components of previously sent symbols. This effect is called intersymbol interference. In the GSM system delay differences of four times the symbol period are expected (FIG 3).


FIG 1 Signal Generator SMIQ with optional Fading Simulator SMIQ-B14 produces real-life signals for testing mobile-radio and sound-broadcast receivers of practically all present-day and future communication systems. Photo 42 890

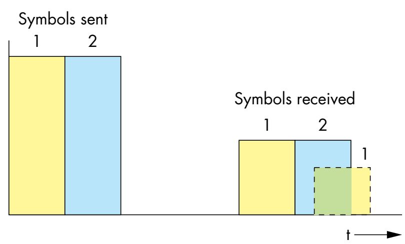


FIG 3 Intersymbol interference in multipath reception caused by delay differences of paths exceeding symbol period

**Local scattering.** Because of diffuse reflection of the signal in the immediate vicinity of the receiver, a large number of waves are produced. Thus a cluster of signals for each path of the multipath propagation scenario will arrive at the receiver. The delay differences of these signals are irrelevant with respect to the symbol period ($\tau << T_s$), but significant with respect to the carrier-frequency period. As the receiver moves, the amplitude and phase of the various echoes change arbitrarily causing **time-selective fading.** This effect, also known as fast fading, produces stochastic signal variations that give rise to notches at a spacing of about one wavelength and at an interval of a few milliseconds – depending on the speed at which the receiver is moving (FIG 4).

**Doppler shift.** As a consequence of receiver movement, shifts of the receive frequency are produced. Due to echoes arriving from different directions with different Doppler shifts, the frequency of the receive signal is spread. This is called **Doppler spread.** The Doppler spectrum is spread around the transmit frequency within the limits $\pm f_{Dmax}$.

**Long-term fading, slow fading.** This effect covers slow field-strength variations as may be caused by shadowing in hilly terrain. In slow fading, variations of path losses extend over distances that correspond to a multiple of the wavelength.

## Fading simulator

Mobile-radio systems are designed so that they are to a large extent not impaired by the anomalies of the radio channel. The techniques developed to compensate for the effects of multipath propagation comprise error-correction methods (FEC), equalization algorithms, data interleaving and frequency-matching circuits. To be able to perform reproducible tests of these techniques, fading simulators are used for the realistic simulation of transmission conditions in the radio channel [2]. The scenarios to be simulated and the mathematical-statistical models used to simulate sporadic fading are laid down in the test specifications of mobile-radio standards.

Up to now fading simulators were available as separate and rather expensive units. With **SMIQ and option SMIQ-B14,** a signal generator and a full-featured fading simulator are integrated in a single unit. Full-featured means that all requirements for fading simulation prescribed by the test specifications of various mobile-radio standards, eg GSM, IS54/IS136, IS95, are met. The SMIQ fading simulator permits the radio channels of all present-day and future communication systems to be simulated irrespective of whether mobile radio, sound broadcasting, flight telephone services, WLL or WLAN systems are concerned.

The fading option for SMIQ may be used in two configurations. With one option fitted, SMIQ is able to simulate 6-path fading, whereas with two options 12-path fading can be performed. The different types of fading, ie Rayleigh, Rice or pure Doppler, may be assigned individually to any signal path.

In the case of **pure Doppler fading** a transmission path with only one direct signal between transmitter and moving receiver is simulated. The signal consists of one component shifted by the Doppler frequency.

With **Rayleigh fading** a radio field is simulated like that produced by local scattering. A great number of waves of different strength arrive evenly distributed from all directions. The received amplitude varies with time. The random variations of a signal as received under real transmission conditions are reproduced realistically in a way that the probability distribution

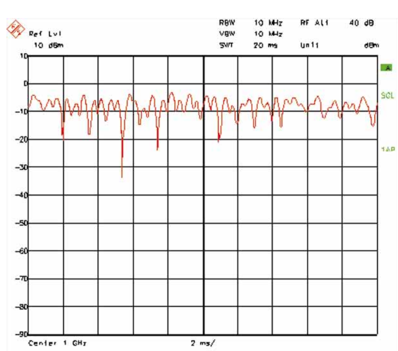

FIG 4 Typical variations of receive signal level caused by time-selective fading

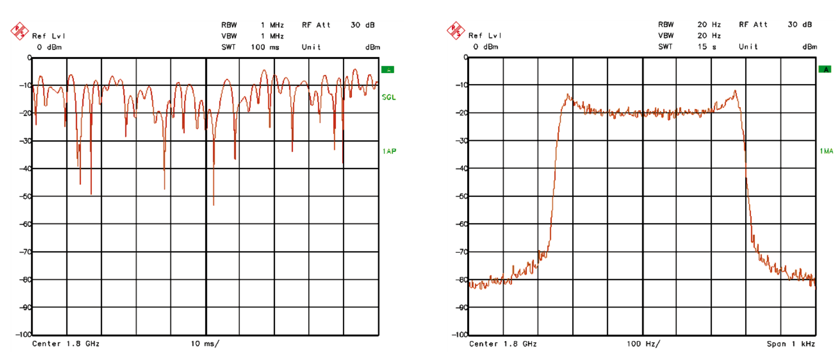

FIG 5 SMIQ output level (left) and spectrum of Rayleigh distribution. Path with Doppler frequency of $f_{Dmax}$ = 250 Hz is active for displayed signal.

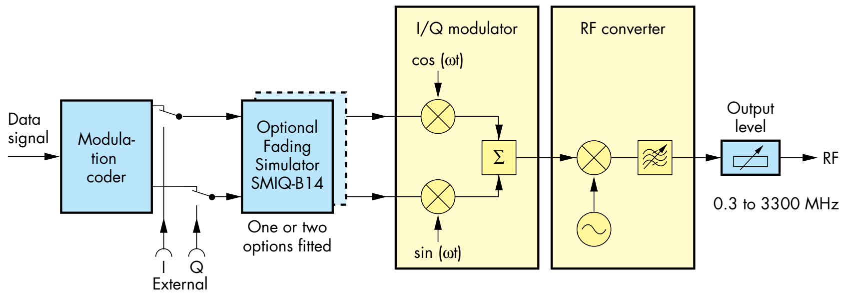


FIG 6 Fading simulator in I/Q signal path of Signal Generator SMIQ, one simulator for 6-path fading, two for 12-path fading

function of the magnitude of the received signal (corresponding to the amplitude produced by the signal generator) follows the Rayleigh distribution. With an unmodulated radio signal the classic Doppler spectrum typical of Rayleigh fading is obtained (FIG 5).

With **Rice fading** a radio field is simulated where a strong direct signal dominates the great number of scattered signals received. The probability distribution function of the magnitude of the received signal is characterized by the Rice distribution. In the fading spectrum of an unmodulated signal a discrete line is superimposed on the classic Doppler spectrum.

In addition to the described types of fading, other parameters may be specified for each path: loss, delay, Doppler frequency or speed, correlation of two paths for 2-channel fading as well as parameters characterizing long-term fading. Long-term fading, also called **log normal fading,** has a multiplicative effect on path loss. In this case the signals are modelled in addition by a log-normally distributed, slow variation of the mean field strength. When log normal fading and Rayleigh fading appear simultaneously, **Suzuki fading** is the result.

With SMIQ plus fading option the user is able to set almost any fading conditions and to call up preprogrammed channel models by a few keystrokes, eg GSM rural area, typical urban or hilly terrain.

## Integration of fading option

The SMIQ fading simulator is integrated into the I/Q baseband of Signal Generator SMIQ (FIG 6). The input and output signals of the simulator are analog I/Q signals. Fading simulation can be performed with internal digital modulation signals (the modulation coder produces I/Q signals from the data signals at its input) or with externally applied I/Q signals. One or two fading simulators for 6-path or 12-path fading may be used.

Two Signal Generators SMIQ are required to simulate 2-channel fading as may be required for instance to test frequency-diversity characteristics. One of the two signal generators is fitted with two fading-simulator options, the second one does not require an option. This permits 6-path fading to be simulated for each channel.

The superiority of this combination of signal generator and fading simulator is obvious when compared to the previously used solutions. Signal Generator SMIQ with integrated fading simulator produces faded signals in the complete frequency range 300 kHz to 3.3 GHz and with any modulation. Previously three instruments were required for the purpose: a signal source to generate the RF signal, a fading simulator and a signal generator used as a local oscillator for frequency conversion. Apart from the price and size of the SMIQ combination, the technical aspects are also convincing: wide level range (–137 to –5 dBm), high level accuracy and spectral purity with regard to spuriae, one user interface and one IEC/IEEE-bus interface for signal generator and fading simulator.

Franz Lüttich

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### Condensed data of Fading Simulator SMIQ-B14

| | |
|---|---|
| RF bandwidth (3 dB) | 14 MHz |
| Channels | 1 or 2 (with second SMIQ) |
| Paths per channel | 12 (1 channel), 6 (2 channels) |
| Path loss | 0 to 50 dB, resolution 0.1 dB |
| Path delay | 0 to 1600 μs, resolution 50 ns |
| Doppler shift | 0 to 1600 Hz |
| Fading profile | Rayleigh, Rice, pure Doppler, log normal |
| Preprogammed channel models | GSM (GSM05.05/GSM11.10), IS54, IS136 (IS55/IS56), IS95 (IS97/IS98) |

**Reader service card 155/03**

## DAB components

# Digital audio broadcasting – all from a single source

**Since 1992 Rohde & Schwarz has taken part in the EUREKA 147 project for the development, testing and specification of digital audio broadcasting. The company is also a member of several working groups of the German DAB platform. These activities laid the foundations for the development of DAB products at Rohde & Schwarz – and today the company is the only supplier worldwide able to offer all essential system components from a single source.**

Besides terrestrial transmitters, a complete DAB system encompasses MUSICAM coders for instance, multiplexers and COFDM modulators as well as special measurement facilities for network planning and operational monitoring. Rohde & Schwarz can supply the entire spectrum (FIG 1).


FIG 1 Rohde & Schwarz has a complete product range for digital audio broadcasting. Photo 42 897

## Components for signal processing

**MUSICAM Codec MUSIC** [1] serves for source coding of audio data and data compression depending on the set data rate in line with ISO-MPEG-11172-3 standard, layer II. Data compression utilizes psychoacoustic effects related to the human ear. Program-associated data (PAD) can also be added. The resulting output signal (including PAD) is fed to the DAB multiplexer (FIG 2).

**DAB Multiplexer DM001** combines all source-coded audio data as well as non-audio data to form a multiplex DAB signal, ie the ensemble transport interface (ETI). This ETI signal is divided up into two layers – ETI(NI = network independent) and ETI(NA = network adapted) – and is taken to the transmitter in one of various ways (via satellite, microwaves or telecommunication lines). There it functions as a control signal for the COFDM (coded orthogonal frequency-division multiplex) modulators. The multiplexer can be conveniently configured on a PC by Windows-based software.

The ETI(NA) output signal of the DAB multiplexer contains additional error control (Reed-Solomon coding) and enables automatic delay compensation. Signal conversion from ETI(NA) to ETI(NI) – the input signal for the COFDM modulators – and dynamic delay compensation up to 1 s are performed by **DAB Network Adapter DY001** located at the transmitter site.

The analog DAB signal is generated from the incoming ETI signal by **COFDM Modulator MCM01** [2] using the COFDM method (ETS 300 401). Depending on the transmission mode used, this signal consists of a multitude of carriers (eg 1536 carriers for VHF band III or 384 carriers for the L-band), each of which is 4PSK-modulated. The output bandwidth of this analog multicarrier signal is 1.5 MHz. Static delay compensation of up to 0.5 s can be set for each input directly at the modulator.

## DAB transmitters

Applied to the terrestrial Transmitters NA5... (band III) and NL5... (L-band), the analog DAB signal from the

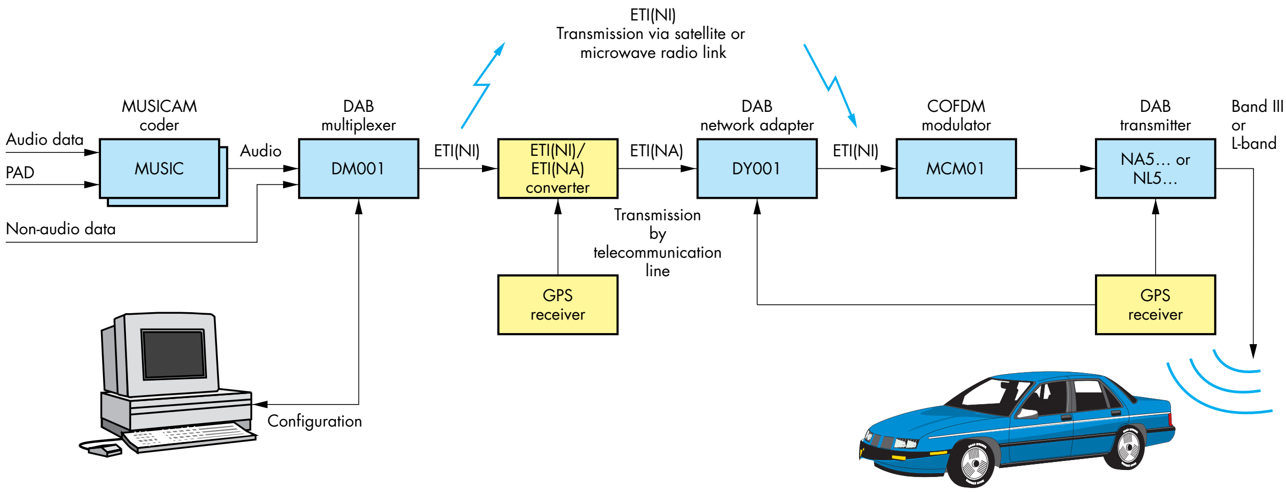


FIG 2 Signal path and equipment used in digital audio broadcasting (options yellow)

COFDM modulator undergoes pre-correction in the exciter and is converted to the transmission frequency [3]. Several power ranges are available for the various frequency bands: 250 W to 1 kW transmitters for the VHF band (174 MHz to 230 MHz) and 100 W to 400 W transmitters for the L-band (1452 MHz to 1492 MHz).

The highly linear amplifiers are fully transistorized and air-cooled. The transmitters are also suitable for single-frequency networks, in which transmitters use a common frequency and are synchronized in time.

Broadcasting the DAB signal without disturbance is made possible by using an RF power bandpass filter following intermodulation attenuation, depending on the requirements to be met. This filter may be installed either in the transmitter rack (L-band) or a separate one. Various filters are available for the different frequency bands.

Additional system components such as GPS receivers for synchronizing DAB transmitters within a single-frequency network, but also DAB transmitting antennas for band III and L-band, are to be found among the products offered by Rohde & Schwarz.

## DAB measurements

For measuring field strength – the most important parameter in the planning of a DAB network – Test Receiver ESVB [4] is used. Its bandwidth matches the DAB channel, so it can monitor the entire COFDM spectrum. Monitoring systems [5] are available to supervise ongoing broadcasts.

Rohde & Schwarz fully utilized its DAB system know-how for the first time in the Bavarian pilot project, in the course of which a turnkey project comprising twelve transmitter stations was implemented in less than eight months. This network, currently the largest worldwide operating with a common frequency, has been on the air since autumn 1995.

Peter H. Frank

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[5] Lehmann, M.; Christiansen, C.: DAB monitoring. In this issue, pp 24–25

### DAB system components

| | |
|---|---|
| Transmitters | |
| Band III | NA5025 (250 W), NA5050 (500 W), NA5100 (1 kW) |
| L-band | NL5010 (100 W), NL5020 (200 W), NL5040 (400 W) |
| Source coding | MUSICAM Codec MUSIC |
| Multiplexing | DAB Multiplexer DM001 |
| Signal conversion | DAB Network Adapter DY001 |
| Modulation | COFDM Modulator MCM01 |
| Measurements | Test Receiver ESVB, monitoring systems |

**Reader service card 155/04**

## Morse Radio Decoder GM094

# New dimensions in Morse decoding

**Morse Radio Decoder GM094 serves for automatic detection of Morse messages under the particular conditions of shortwave propagation and manual keying. It relieves personnel from tedious routine tasks. Its particular advantages are that it can work around the clock without fatigue and that it runs a classification procedure distinguishing Morse from other signals.**

Morse has a long tradition as a reliable shortwave transmission technique and still remains an important medium along with more advanced techniques. This is primarily due to two factors:

1. Compared to other kinds of signal, Morse signals using robust amplitude modulation are affected relatively little by the various types of interference present on the transmission path.

2. Neither transmitter nor receiver are operated automatically but by trained operators. Routine and experience enable them to compensate for interference on the transmission path as well as for any shortcomings by the person they are communicating with.

Morse profits from human capability to adapt to very different transmission errors occurring in a message guided by its context and thus to tolerate errored transmissions. Because Morse continues to be widely used, its monitoring is an important focus. The nature of Morse, however, makes monitoring the signals highly labour-intensive. Morse Radio Decoder GM094 is aimed in particular at cutting down on personnel especially for routine tasks and at extending the range of channels covered, even in unmanned operation. It is implemented as a software module that can be run on the supplied DSP card in a PC and it can be connected to almost any shortwave receiver (FIG 1).

GM094 also achieves excellent decoding results in **real operating conditions,** ie

- if keying is performed with a variable touch-break ratio and is therefore not ideal, as is the case with semiautomatic or manual keying for instance,
- if keying devices and radio equipment are not optimal in terms of frequency stability, AM/FM conversion, level, switch-on/off transients, etc,
- if the transmission path between signals is disturbed by a host of superimposed signals,
- or if the received Morse signal is affected by considerable interference.

Decoder GM094 was designed for tolerance to different types of keying. Varying dot-dash ratios from letter to letter or fluctuations in keying speed are accepted. Frequency and level fluctuations are compensated for by a discrete IF receive unit with matched filters. The real achievement of this new development is its capability to run a continuous classification process during reception, setting the Morse signal apart from

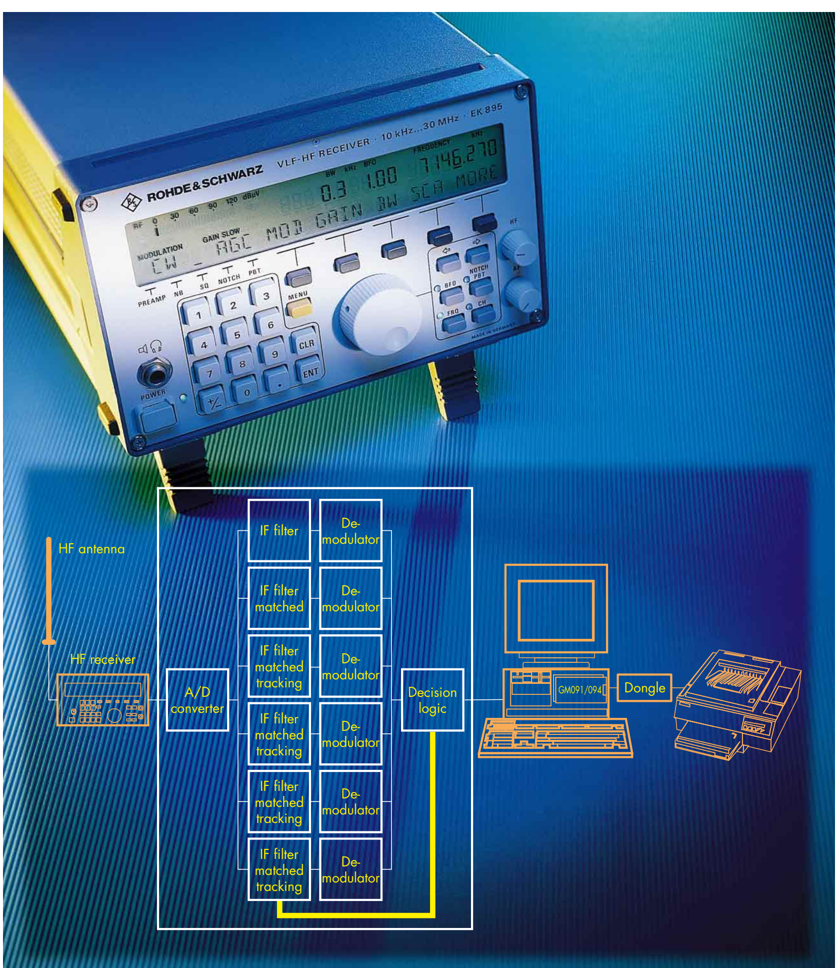


FIG 1 Powerful team: digital VLF-HF Receiver EK895 and Morse Radio Decoder GM094
Photo 42 876/1

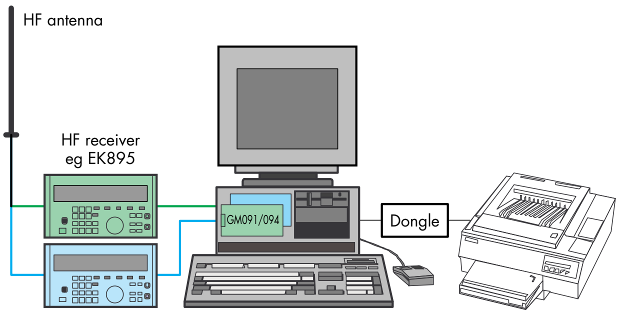


FIG 2
Configuration for simplex (green) and duplex (green plus blue)

other signals. The potential of digital signal processing is fully utilized in GM094 with the aid of modern signal processors. In this way **characteristics** could be implemented in the decoder that were not available in the past and are combined here in a unique way:

- automatic signal search with adjustable capture range,
- frequency-accurate display of signal offset from the receiver center frequency,
- adjustable signal hold time,
- decoding of both manually and automatically keyed signals,
- decoding of short-time signals,
- decoding of duplex traffic.

GM094 also integrates **further features** that proved to be helpful during numerous trials performed by various users. Among these are:

- registration of receive time,
- editable and selectable Morse code,
- editable and selectable radio traffic abbreviations,
- structuring of Morse text,
- marking of call sequences and call signals,
- automatic saving of Morse text,
- fast and easy-to-use text editor.

These features allow optimal adaptation of the decoder to different types of traffic as well as easy editing of decoded text.

Morse Radio Decoder GM094 may be used as a **simplex or duplex device.** The duplex version consists of two simplex versions requiring two DSP cards GM091 and two software packages GM094 (FIG 2). Up to six simplex or three duplex channels may be integrated into a PC. A number of PCs providing several channels each can be connected via a LAN interface to a central monitoring and process controller running under UNIX software.

To obtain uncorrupted input signals the decoder is connected to the **IF of the HF receiver** (2 kHz to 18 kHz and 22 kHz to 38 kHz), which also allows direct connection to a tape recorder. Frequency control is also available for common receivers. The capture range is adjustable between ±5 Hz and ±500 Hz. A certain selectable frequency range is defined as the capture range, within which the decoder periodically searches for the signal with the strongest level at intervals of 0.8 s. The signal is then decoded if it is classified as Morse. The hold time may be selected between 0 and 60 s or as infinite. Once the decoder has detected a Morse signal, it remains at the detected frequency in the pauses between two signals for the hold time selected. If the hold time is 0 s, the decoder again starts searching for the strongest signal within the capture range after maximally 0.8 s. If the hold time set is infinity however, the decoder remains at a Morse signal once it is detected.

**Operation** of the decoder is extremely convenient and user-friendly. The Morse code to be used and radio traffic abbreviations can be freely defined by means of the supplied editor. The signal spectrum received can be displayed to allow checking of receiver settings and signal quality. The maximum error rate is typically less than 0.5 % of characters transmitted at an S/N ratio of 6 dB, receiver bandwidth of 600 Hz and keying speed of 20 Bd. The maximum baud rate is around 60 Bd, which represents approximately 150 letters per minute. If frequency changes by less than 10 Hz/s, the signal is tracked within the set capture range. Keying speeds may vary from one letter to the next by a factor of 3. The dot-dash ratio may change from one letter to the next within the range 1:2 to 1:5. The signal-level variation within one letter may be more than 20 dB.

Once the decoder stops, the decoded text is saved on harddisk as a text file. A special text editor is available to process, print or delete all saved files. Characters that cannot be decoded are logged as dot-dash combinations. The text being decoded is displayed unstructured in a single moving line (FIG 3). The structured text appears in

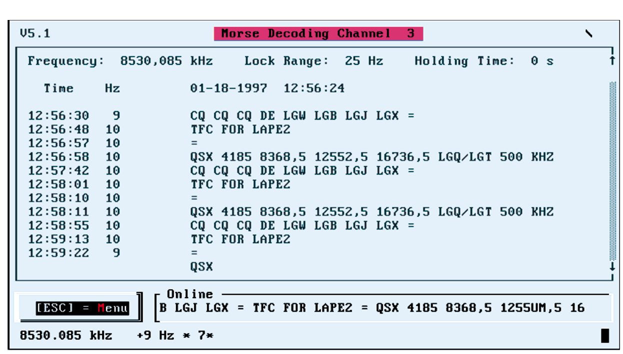


FIG 3
Display of decoded text in simplex operation during reception

18 lines on the screen with time of day and signal offset from IF center frequency given in each line. Structuring of the log can be switched on or off. Identified call sequences are marked line by line with ADDR. Single call signals are marked line by line with R (these must have been identified beforehand in call sequences). Duplex traffic is decoded and logged in a special format. The decoded texts of the two transmitting ends are allocated to different lines and identified by upper- and lower-case letters. In addition a symbol before each line of text indicates which transmitter was the origin.

A modern workstation for HF monitoring can be composed of Morse Radio Decoder GM094, VLF-HF Receiver EK895/896 [1] and Digital IF Spectrum Display EP090 [2].

Dr Klaus Rieskamp

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### Condensed data of Morse Radio Decoder GM094

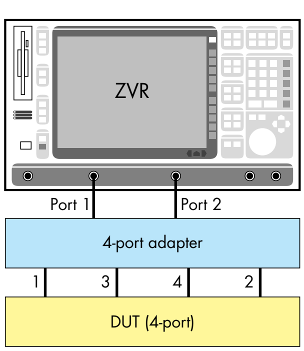
| | |
|---|---|
| Signal Processor Card GM091 | AT (long) |
| A/D converter | 16 bits |
| Analog input bandwidth | 80 kHz |
| Decoder input signal | receiver IF (2 kHz to 18 kHz, 22 kHz to 38 kHz) |
| PC requirements | MS-DOS 5.0 or later, 80486 CPU minimum, harddisk drive ≥30 Mbytes, 1 serial interface for simplex, 2 for duplex |

**Reader service card 155/05**

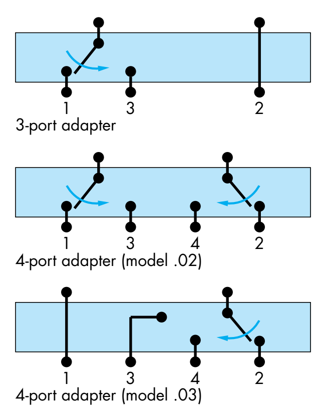
## Test hint

# Fast S-parameter measurements on four-port devices

A two-port device can be connected to test ports 1 and 2 of **Vector Network Analyzer ZVR** for measurement of its S-parameters. If the device has more than two ports however (eg an antenna diplexer with three ports or directional coupler with four ports), it is necessary to change the cabling by hand to be able to measure all the scattering parameters. With the **3-Port Adapter** and new **4-Port Adapters** available as accessories (ZVR-B8 and -B14) this time-consuming procedure can be avoided. Switchover between the different ports is then made with the aid of fast electronic switches.




The **3-port adapter** has an electronic switch at port 1, thus extending it to two ports, while port 2 is directly connected through without switchover. The new **4-port adapters** contain two electronic switches and come in two versions: model .02 has a switch each for extending port 1 and port 2 of the analyzer. It can be used for measurements on 4-port DUTs such as directional couplers. All reflection coefficients as well as most of the transmission parameters of a 4-port DUT can thus be measured without having to reconnect it. Due to the design of the adapter the transmission between ports 1 and 3 and between ports 2 and 4 cannot be measured. If this is required, eg for antenna junction boxes, where the transmission between one input and three outputs has to be measured, use of model .03 is recommended. It has a different internal structure and was specially designed for the above type of 4-port devices under test.




In all cases, the ports that are not through-connected are terminated for low reflection by internal 50 Ω thin-film resistors. The adapters are driven with the aid of an optional rear-panel connector of the analyzer, via which the electronic switches are actuated according to the active display channel of the network analyzer. System-error calibration can be made for each independent display channel to achieve high measurement accuracy. Switchover between channels is so fast that the traditionally high measurement and display speed of the analyzers of the ZVR family is fully maintained.

Dr Olaf Ostwald

Reader service card 155/06

# Single-station location with HF direction finders of DDF01x family

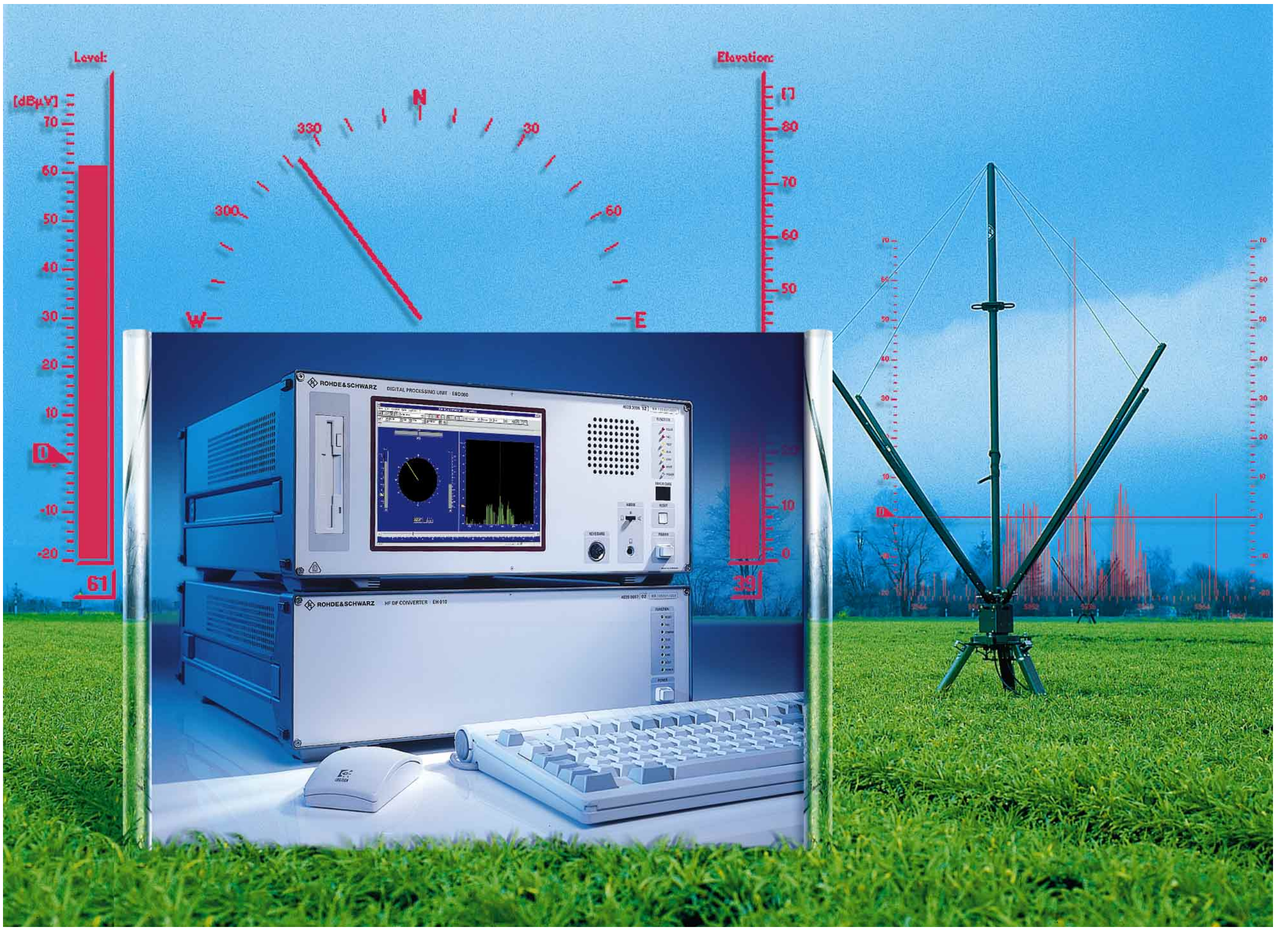



FIG 1 Digital Monitoring Direction Finder DDF01M with circular array interferometer ADD011 Photo 42 880/2

Digital Scanning Direction Finders DDF0xS and Digital Monitoring Direction Finders DDF0xM [1] can make use of the special characteristics of shortwave propagation to locate emitters in a particularly effective way with a single station (FIG 1). The algorithms required for bearing determination by the Watson-Watt or correlative interferometer method are standard in these direction finders. The method used will depend on the specific application and in particular on the available DF antenna system. Adcock or crossed-loop antennas are required for evaluation by the Watson-Watt method. In this configuration the direction finder provides azimuth values only (angles in the horizontal plane). With correlative interferometry the elevation (vertical angle of incidence) is determined in addition. In shortwave direction finding the elevation angle is displayed and output at the data interface.

Direction finding only determines the angle of incidence, so the signal source may be anywhere along a line within the area covered. Emitter **location** in the shortwave range can be performed in two ways, the classic and most accurate method being **triangulation.** Here two or more direction finders are connected via data lines to a location center, where the position of the signal source is computed from the received bearings and normally marked on an electronic map. The second method makes use of the physical characteristics of ionospheric wave propagation: over long distances (> 100 km) shortwaves are propagated as skywaves. On its way to the receiver (direction finder) the emitted wave is reflected once or several times on the ionosphere, the vertical angle of incidence at the receiver being equal to the vertical angle of emission. During the day this reflecting ionospheric layer (E layer) is at an altitude of about 100 km. But at nightfall it disappears and waves are reflected by the F layer, the altitude of which varies between 250 and 400 km. These propagation characteristics can be applied to locate an emitter by means of direction finders that yield azimuth and elevation angles by using the virtual layer height $H_{virt}$ derived from ionospheric parameters (FIG 2). The prerequisite here is that the wave be reflected only once on the ionosphere. This permits fixing of targets up to a distance of 1200 km. Position location with only one shortwave direction finder is called **single-station location** (SSL). SSL is used wherever it is not possible to set up a triangulation system with two or more direction finders, or if the orientation of the involved stations to the target transmitter is so unfavourable that a reliable point of intersection cannot be obtained (direction finder and transmitter on or near the bearing line). With an optimum site selected, triangulation mostly yields more accurate results because with SSL the elevation angles required to determine the distance of the target may greatly vary as a result of frequent instabilities of the ionosphere. So only average values by means of a histogram can be expected.

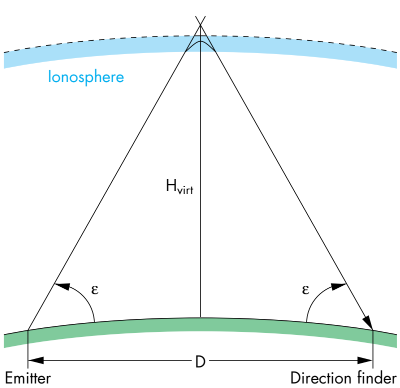



FIG 2 Determination of emitter distance D from signal propagation path via ionosphere

Rohde & Schwarz developed the SSL program for Digital Direction Finders DDF01S and DDF01M based on the **SSL software** for HF Doppler Direction Finder PA010 [2]. Tried and tested operating features were retained and new ones added. So the required ionospheric data need not necessarily be determined each time but may be called up from an ionosphere model with database integrated in the SSL software.

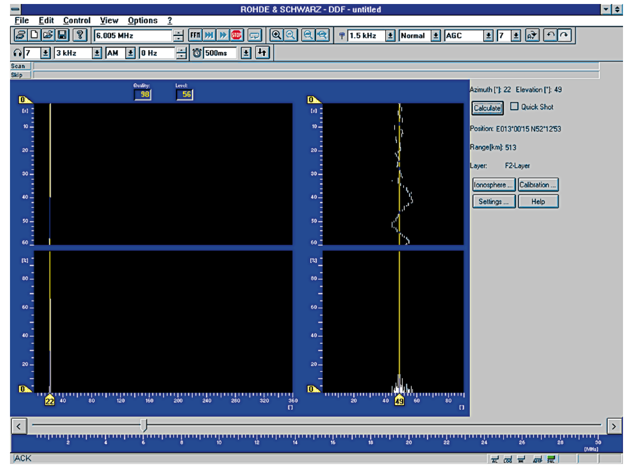



FIG 3 SSL window with histogram and waterfall display

One condition for position location with SSL is accurate measurement of elevation, independent of the azimuth and frequency of the incident wave. **DF Antenna ADD011** used as a correlative interferometer is an optimum solution here in spite of partly contradictory requirements like

- wide aperture for high accuracy,
- good isotropic characteristics for determining elevation angle independent of azimuth,
- widely spaced crossed-loop antennas for low mutual coupling,
- minimum number of crossed-loop antennas affording simple infrastructure.

The whole frequency range from 0.3 to 30 MHz is covered with only nine antennas arranged on a circle of 50 m in diameter. These crossed-loop antennas guarantee high sensitivity and bearing accuracy even for steep-angled skywaves and are virtually unaffected by inhomogeneities of the terrain around the antenna array.

**HF Antenna ADD010** is available for semi-mobile applications and for waves arriving at a less steep angle (up to an elevation angle of 50°). It consists of nine active monopoles, each 2 m high. The elements can be set up and dismantled in a very short time and require extremely little stowage for transportation.

After installation the optional **single-station locator** from Rohde & Schwarz is an **integral part of the direction finder's user interface** and can be called up via the menu bar in fixed-frequency mode. Only a few settings are required to operate the option: position of direction finder and ionospheric data such as critical frequency (MUF) of E layer, virtual height of E layer, critical frequency of F2 layer and M3000 factor. If no relevant ionospheric data (eg from chirp sounders) are available, the single-station locator uses average values to CCIR Rep. 340 [3] from its database, which can be adapted to the actual situation given some additional information, eg the sun-spot number. Adapting data from the database to the actual ionospheric conditions to improve location accuracy is also possible by taking bearings of known transmitters and using the calibration function. It is however essential for the transmitters to be as close as possible to the area of interest at small frequency spacing.

To **perform a measurement,** histogram and waterfall diagrams for azimuth and elevation are displayed in the SSL window of the controller (FIG 3). Two modes are available for result evaluation:

1) Manual selection of bearings with the aid of marker lines in the azimuth and elevation histogram and transfer of these values for position calculation by means of the Calculate key.

2) Automatic assignment of bearing values by pressing the Calculate key in the quick-shot mode.

**Location accuracy** depends on system accuracy, the reliability of ionospheric data and on the integrity of the ionospheric model. Theoretical considerations [4] and measurements have shown that distance determination is typically less accurate by one order of magnitude than azimuth measurement. Furthermore the accuracy of elevation measurement and knowledge of the virtual layer height are of particular importance and a fixing error of 5 to 15 % (rms) of the distance is to be expected under known propagation conditions.

Franz Demmel; Ulrich Unselt

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Reader service card 155/07

# International ALE (automatic link establishment) standard for HF Transceiver XK2000

Because of the dynamic propagation conditions in the shortwave range, setting up a reliable link for this type of communication is anything but a simple task, which in the past could only be performed successfully and within relatively short time by experienced operators. Today this job has been taken over and perfected by automatic-link-establishment techniques. Besides company-specific procedures such as ALIS (automatic link setup) from Rohde & Schwarz [1; 2], which were specially developed and optimized for fast


FIG 1 Modern HF transceiver of XK2000 family with integrated communication processor
Photo 41 251

data transmission via critical HF paths (adaptive response), international standards like FED-STD-1045 and MIL-STD-188-141 have been worked out and widely accepted.

For reasons of interoperability these standardized ALE (automatic link establishment) techniques along with R&S-specific ALIS are supported by the XK2000 HF transceiver family [3] from Rohde & Schwarz and their integrated Data Link Processor GS2200 (FIG 1).

ALE specifies solely the shortwave link setup; subsequent communication (speech, data) is not defined by the standard and may take place in accordance with any other protocol desired. However, brief messages may be conveyed by the setup protocol. Besides the actual link setup protocol, the ALE standard provides several addressing modes for operation in a network as well as means of protection of the link setup against eavesdropping and deception through encrypting the protocol.

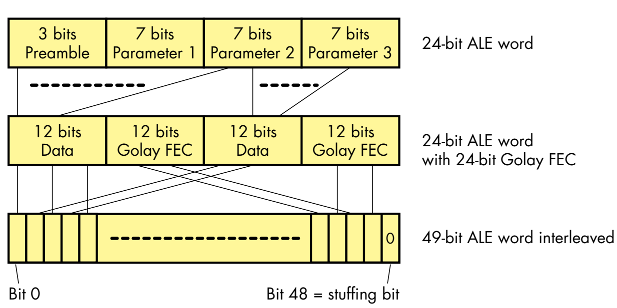


FIG 2 ALE word coding and interleaving

## Technical features of ALE standard

FED-STD-1045 specifies the parameters involved in automatic link setup with HF transceivers. Besides basic parameters like modulation type and transceiver bandwidth, signal type, coding methods and protocol sequence for automatic link setup are also specified. Standard 1045 is supplemented by standards 1046 to 1052. An 8FSK signal with discrete frequencies from 750 Hz to 2500 Hz is used for link setup. This signal type is suitable for transmission via HF transceivers as an SSB (single-sideband) signal with bandwidth of 3 kHz. The tones are transmitted at a symbol rate of 125 per second. An ALE word consists of 24 data bits (3 bits for the preamble and 3 x 7 data bits). To enhance the transmission reliability of ALE words on the HF channel, each one is extended by a 24-bit Golay FEC code (forward error correction), then interleaved and emitted with threefold redundancy. The entire ALE word including error correction consists of 49 tones and is 392 ms long (FIG 2).

Each ALE network is assigned a number of frequencies for establishing links. A station switched to receive mode scans all assigned frequencies at a rate of two or five channels per second, waiting for calls to come in on any of those frequencies. A calling station emits a call whose length is matched to the number of channels available, so the call can be captured by the scanning receive station. If a call is not successful, another call will be performed on the next channel. Several such frequency lists (scan groups) may be stored in an ALE station.

When a link is being set up, ALE words are combined to form an ALE frame. This frame is divided into individual sections, the transitions between which are indicated by preambles contained in the ALE words. A complete ALE link setup is made up of three such frames. First the calling station emits a call frame, which is answered by the called station (response frame). The calling station acknowledges receipt of the response frame by transmitting an appropriate frame to the called station. At this juncture the link setup is completed.

An ALE station is identified by an address with a maximum length of 15 characters consisting of upper-case letters A to Z and numbers 0 to 9. Besides this unequivocal addressing of an individual station (individual call, point-to-point link), further addressing methods for contacting all stations or groups of stations in a network are also possible. All Call serves for addressing all stations of a network (broadcast) and is not acknowledged by the called stations (FIG 3). Selective All Call is used to call stations with the same final character. With Group Call, several stations of a network respond to a call according to a predefined response protocol. Net Call addresses all stations of a network assigned to a network address. Again the called stations respond according to a predefined protocol. Further types of addresses are Any Call for emergencies, which is responded to by all stations receiving this call, and Wild Card addressing, in which case only certain characters of the address are to conform.

ALE allows the link quality of the transmission path to be checked in order to minimize link establishment times. The sequence in which frequencies are called will then be made dependent on actual link quality. This is possible by storing and administering the link quality to each subscriber. The information on link quality is provided by a sounding process that involves calls being emitted at programmable inter-

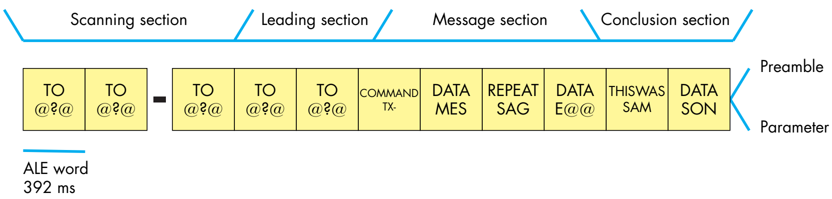


FIG 3 Example of frame for All Call from SAMSON station in automatic message display function with Tx message

vals and determination of their receive quality (link quality analysis, LQA).

Brief messages may already be transmitted during link setup. AMD (automatic message display) enables the calling station to transmit, while calling, a predefined message up to 90 characters long, which is displayed at the called receive station. This feature of the standard is utilized by Transceiver XK2000, among other things for transmitting a phone number to the receive station to allow a telephone network link to be set up via an APP (automatic phone patch). UUF (user-unique function) enables transmission of a manufacturer-specific 14-bit value during link setup, which may for example be used for controlling the subsequent data transmission protocol (in Data Link Processor GS2200). With the aid of DTM (data text message) mode, brief messages can be transmitted without requiring an additional data modem and protocol.

## Encryption of link setup

Linking protection (FED-STD-1049) is one of the ALE functions. It serves to protect the information contained in the protocol such as address and network relation against eavesdropping. This method is also resistant to deception (spoofing) by the enemy through re-cording and retransmitting the emitted information. This function protects the link setup only. For the protection of subsequent speech and data messages, additional cryptographic measures have to be taken at the transmit and receive ends.

The Rohde & Schwarz implementation supports three of five protection levels defined in FED-STD-1049 (AL-0, AL-1 and AL-2). Level AL-2 offers the greatest security (protection interval 2 s), but also means more stringent requirements for network synchronization, while Level AL-1 offers somewhat less security (protection interval 60 s), but network synchronization requirements are not as high either. The protection interval is the time interval within which the input variables of the encryption algorithm are constant.

The 24-bit ALE words for link setup are encrypted with the aid of the Johnson algorithm [4]. Input variables for this algorithm are the crypto key defined by the user, frequency, date and time. The key may be a word up to 63 bits long, which results in a maximum number of keys of $2^{63}$. Because this technique is time-referenced, a time-synchronized network is required. Different procedures are provided to first establish and then maintain synchronization. One station in the network serves as the time master station, supplying the other stations with the exact time via protocols. Time may also be manually entered at each station. For maintaining synchronization, a time-acquisition protocol polling the exact time from the time reference station is started whenever a certain degree of inaccuracy is detected in the system. This protocol is also protected as long as the time deviations are found to be within tolerance by the linking protection process. For stations without any information on date and time or with insufficient time accuracy, an acquisition protocol has been implemented, which however is not protected because of the absence of time information. This option is primarily intended for stations entering the network at a later date.

Günter Wicker; Erich Schippan

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Reader service card 155/08

# Analysis of compressed MPEG2 data stream for digital TV


FIG 1
MPEG2 Generator DVG and MPEG2 Measurement Decoder DVMD, expert duo for generating and analyzing MPEG2 reference transport streams
Photo 42 498/2

Even if TV signals are digitized, compressed according to MPEG2 specifications and transmitted in line with DVB specifications, they are not free of errors and therefore need to be measured in any case. Rohde & Schwarz is worldwide the sole company to supply a complete range of measuring instruments meeting MPEG2 and DVB standards.

The first parameter in the transmission chain to be analyzed is the digitized and compressed MPEG2 data stream. To obtain reproducible results, exactly defined test sequences are required in the form of elementary streams for video, audio and data as well as the relevant tables. With MPEG2 this means generation and multiplexing of moving picture sequences and accompanying audio signals – eg excerpts from concerts – that have been data-compressed according to the conventions (MUSICAM). The data channel contains teletext and other data for any other applications. Tables for PSI (program-specific information) and SI (service information) complete the data stream.

The elementary streams for video, audio and data are organized in packets, the PES (packetized elementary streams), each up to 64 kbytes long. They contain synchronization and identification information. They are subdivided in turn into packets of 188 bytes (transport packets) that contain further information for synchronization and identification. Several programs in the form of transport packets, which may contain video, several audio and data PES, are combined to a transport stream that can be modulated in line with DVB. Since the packing, synchronization and identification procedures are rather complex, reference transport streams are needed for measurements. **MPEG2 Generator DVG** [1; 2] is the solution offered by Rohde & Schwarz. It provides all the conditions required for reproducible measurements in realtime analysis of the MPEG2 transport stream with **MPEG2 Measurement Decoder DVMD** (FIG 1).

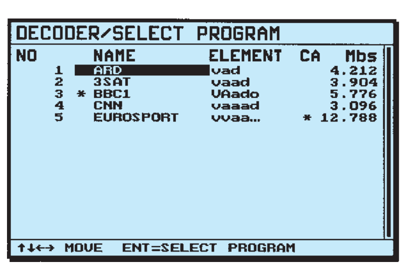


FIG 2 Evaluation of data rates of MPEG2 transport stream

The transport-stream multiplex signal containing several programs can be measured on line. No error, however slight, may go unnoticed. First the data rate of the whole transport stream, which is decisive for utilization of the DVB transmission channel, is determined. Once the number of programs in the data stream is known, the data rate of the individual programs and then the data rate of the program elements – PES for video, audio, data, etc – are measured to obtain the volume of data transmitted for each program (FIG 2). The volume of data transmitted per PES determines the picture and sound quality of the compressed programs. Continuous evaluation of data rates is therefore essential when signal quality is monitored.

With the aid of the **MPEG2 decoding process** in MPEG2 Measurement Decoder DVMD all other items of the (protocol) analysis can be checked:

- The decoder searches for the beginning of the transport-stream packets, which is identified by the sync byte. A sync byte is sent every 188 bytes. The analyzer checks the length and content of these bytes.
- When the sync byte is found, the decoder stores and checks the data content of the transport-stream packets. In a next step it searches for the transport-stream tables, the most important of which is the PAT (program-association table). It is assigned the identification number 00hex (packet identification, PID) and describes all programs in the transport stream. If DVMD does not find a PID with the value 00hex, it signals this error but nevertheless searches for decodable data.

- PAT is the list of programs. The individual programs are described in subdirectories, the PMTs (program map tables). The program to be decoded is specified by selecting a PMT, the PIDs of which must all be listed in the PAT. The specifications exactly define the minimum and maximum repetition rate of the tables. For data protection, PAT and PMTs are transmitted together with the CRC sum (cyclic redundancy check). Both the repetition rate and CRC are continuously monitored by DVMD.
- The decoder selects a program, ie a PMT in the PAT, to check whether the PAT really contains the PID of the PMT or, vice versa, whether all PMTs identified by the PAT are contained in the transport stream.
- Not only the program but also the program content is selected. To this end all files with their PIDs for video, audio and data elementary streams are listed in the PMT subdirectories. PIDs are again analyzed, and missing or unreferenced PIDs are indicated.
- If applicable, the program is next descrambled. Scrambled programs and their PIDs are listed in a separate table, the CAT (conditional access table) with PID 01hex. MPEG2 Measurement Decoder DVMD compares the information on scrambling with the information in the CAT, measures the repetition rate and compares the CRC sum calculated in the decoder with the CRC transmitted in the transport stream.
- The decoder is at this stage not synchronous with the video and audio data in the transport stream. The system clock of the transport-stream demultiplexer is to be synchronized. To achieve this the decoder searches for the PCR (program-clock reference) in the specially marked transport-stream packets. DVMD also measures the repetition rate of all PCRs, which is at least 10 Hz. To allow jitter-free decoding, the PCRs of the program selected via the PMT must be transmitted in a time window with an accuracy of ±500 ns.

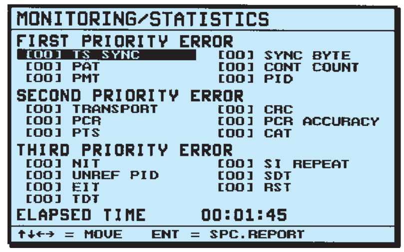


FIG 3 Evaluation of events of first, second and third error class to DVB measurement guidelines

- To enable the decoder to detect at all times whether all transport streams are available in the right order for decoding, the status of the continuity counter is monitored. Counter data are transmitted in the transport-stream packets so that the correct order of the video and audio data packets can be checked. A discontinuity in the count shows that elementary stream data are missing, which would cause the reproduced vision and sound signals to flicker. DVMD signals an error when discontinuities are detected in the count.
- Transport-stream data for video and audio arrive at the decoder in time multiplex. The decoder is informed by DTS (decoding time stamps) at what time it should provide particular data in decoded form. PTS (presentation time stamps) decide when the decoded data are to be forwarded to the display or the loudspeaker. The decoder determines the frequency of the two time stamps and indicates deviations from the standard.
- For transmitting the transport-stream packets via cable, satellite or terrestrial links, an error-correction code is added to the transport-stream packet (Reed and Solomon, named after its creators). If this forward error correction is not able to correct the errors incurred, a bit is set in the header of the transport stream. The decoder evaluates this bit and signals a transport error. The respective packet is then no longer used for error analysis.

Errors in the PAT and PMT tables containing program-specific information, in the associated PIDs as well as the sync bytes and the continuity counter are put in the highest category in the DVB measurement guidelines (FIG 3). Transport errors, CRC, PTS and the two PCR errors as well as errors in the CAT are assigned to the second category. This latter contains events which lead to incorrect reproduction of the signal but still allow data to be processed. The third group contains errors in the service information tables. These tables are read from the transport stream at the end of the described decoding process and then analyzed in DVMD. The repetition rate of the tables is used as a measurement criterion. Although these errors do not impair reproduction of audio and video data, the service information tables are important because they convey all important information on the transmission media (eg channel bandwidth, transponder, network information table or a complete program journal) to the TV set or measurement decoder.

Sigmar Grunwald

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Reader service card 155/09 for further information on DVG and DVMD

# DAB monitoring

The world's largest digital audio broadcasting (DAB) pilot project has been on the air in Bavaria since the autumn of 1995, providing the whole region with a wide selection of stereophonic sound programs in CD quality [1]. Rohde & Schwarz is the principal DAB equipment supplier, from modulation feed to power transmitters including associated antennas [2]. The project has yielded a wealth of experience with DAB. To guarantee high availability of the transmitter network, Rohde & Schwarz developed a DAB monitoring concept to detect and prevent failures in the transmission chain [3]. Monitoring systems of this type are already being used at a number of selected terrestrial sites within the Bavarian pilot project and during the current phase serve to provide information about satellite transmission quality (FIG 1). A study by Bayerischer Rundfunk (Bavarian broadcasting corporation) showed that any transmitter in a single-frequency network that is not exactly synchronized to the other transmitters, be it because it gives off a wrong type of modulation or does not operate at exactly the same frequency or does not emit simultaneously with the other transmitters, will interfere with other DAB transmitters throughout the network. The interfering transmitter generally cannot be identified by touring the coverage area and conducting measurements. It is therefore essential that the operator should have information on the state of all DAB transmitters in the network at all times [4].

## Monitoring concept

Various types of disturbance may occur in the DAB transmission chain, anything from light interference to complete transmission breakdown. The newly developed monitoring concept from Rohde & Schwarz enables the operator to choose to what extent monitoring for the DAB network is necessary (FIG 2).

The **uplink of the satellite transmission path** (including the multiplexer) is the most critical point in the DAB chain because here several programs are combined in a multiplexer to form a DAB ensemble, which is then transmitted to the satellite (eg DFS Kopernikus). If the multiplexer fails or an error occurs in the ETI (ensemble transport interface) signal of the multiplexer, the whole network will be affected and possibly even break down. To avoid such failures, which may result in considerable costs for the operator, a DAB transport-frame decoder is used to continuously monitor the ETI signal output by the multiplexer and to switch to a second multiplexer whenever necessary. This guarantees an errorfree ETI signal at the output of the uplink to the satellite. In addition, a spectrum analyzer may be used to monitor the RF signal on the uplink.

Located at the **downlink stations** are the DAB transmitters, which serve for terrestrial broadcasting to DAB receivers. Here the satellite signal received via the downlink and the terrestrial signal broadcast by the DAB power transmitter are to be monitored. The transmission quality of the satellite link can be determined through a variety of parameters provided by the satellite receiver used for demodulating and decoding the incoming signal. The signal output by the terrestrial transmitter is continuously monitored by a DAB monitoring receiver, which enables comprehensive analysis of the DAB signal. Any error occurring within the DAB transmission chain will be detected by the monitoring receiver and localized with the aid of further monitoring components. The monitoring receiver is suited for mobile use as well as for use directly at the transmitter site. A further component for monitoring the transmission chain is the COFDM (code orthogonal frequency-division multiplex) modulator, which provides status information. The terrestrial DAB transmitter may also be controlled and polled from a PC connected via a remote-control interface.

The DAB monitoring components can be used as stand-alone units or integrated into a monitoring system at the transmitter site. The monitoring system (slave) can be connected to a control center (master), which makes automatic monitoring and control of unattended stations possible.

## Monitoring components

**DAB Transport Frame Decoder DAB-FD** serves for monitoring ETI signals such as the output signal of the DAB transport multiplexer as well as the signal transmission components between

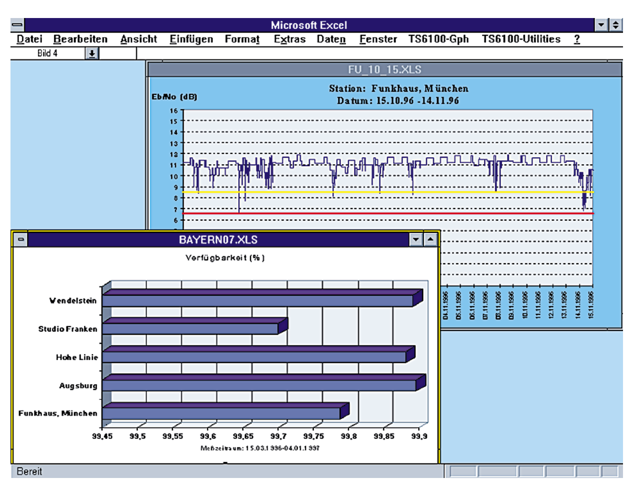


FIG 1
Example showing availability of DAB transmitter sites in %

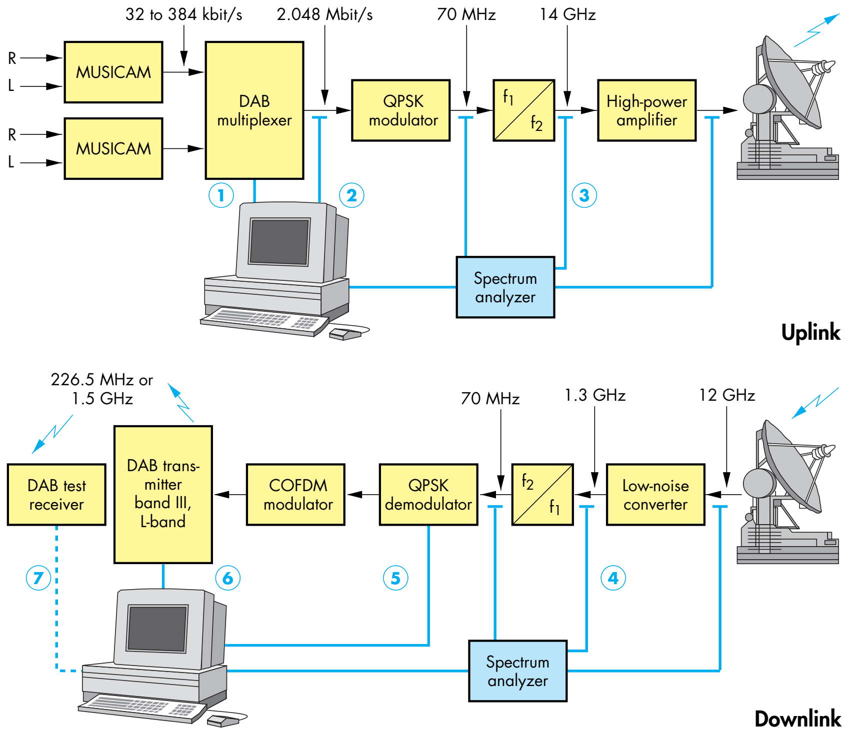


FIG 2 Principle of DAB network monitoring. Following functions are monitored: multiplexer configuration (1), ETI signal (2), RF signal on uplink (3) and downlink (4), S/N ratio $E_b/N_0$ (5), DAB transmitter data (6) and broadcast DAB signal (7).

multiplexer and COFDM modulator. The decoder is also capable of demultiplexing a channel of a transport frame and displaying selected parameters. The following functions can be monitored by the decoder:

- correct change of frame sync symbol,
- incrementing of frame counter and frame phase,
- cyclic redundancy check of header, mainstream and individual information channels,
- consistency of frame length with individual stream lengths and of stream start addresses,
- presence of signalled audio streams,
- audio bit rate.

The DAB transport-frame decoder is a PC card and runs using a Windows application program. It may be used with portable and stationary PCs alike.

**DAB Monitoring Receiver DAB-TR** is for the continuous checking of DAB programs and allows easy and intuitive operation (hypertext markup language, HTML). DAB data services are also transmitted as HTML pages, so the receiver can check them for correctness. The receiver's DAB test screen displays information such as ensemble designation and identification number, designation of audio and data service including their identification as well as signal strength and frequency of occurrence of errors. Signal strength and error rate are continuously monitored and compared with an adjustable tolerance threshold. If the threshold is exceeded, an acoustic alarm may be generated. The opening screen of the DAB monitoring receiver shows the name of the audio service, the designation of the program received, the ensembles available and the HTML pages transmitted. Switching back and forth between various ensembles or audio services is possible. The DAB monitoring receiver has an RF input for band III and L-band, outputs for the connection of audio analyzers and loudspeakers and an RS-232-C data interface with over 30 commands allowing connection to a PC for integration into a monitoring system.

Besides the equipment explicitly designed for monitoring purposes, the components involved in data transmission also provide important information. **Satellite Receiver CM701,** for instance, reveals information on S/N ratio, clock and offset at its input and on automatic gain control. **COFDM Modulator MCM01** signals whenever a clock is missing at its input or if the signal frame structure is invalid or the input signal or the modulator itself is faulty. Seen together, all these parameters give a clear view of the current status of the whole DAB network.

Michael Lehmann; Christian Christiansen

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# ESMC-RAMON – entry into computer-aided radiomonitoring

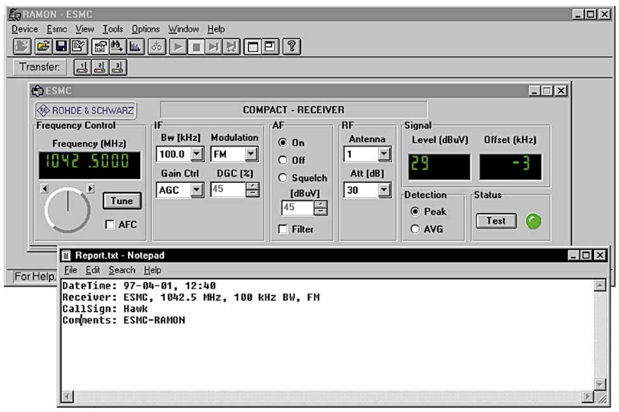


FIG 1 ESMC-RAMON for simultaneous receiver operation and preparation of reports

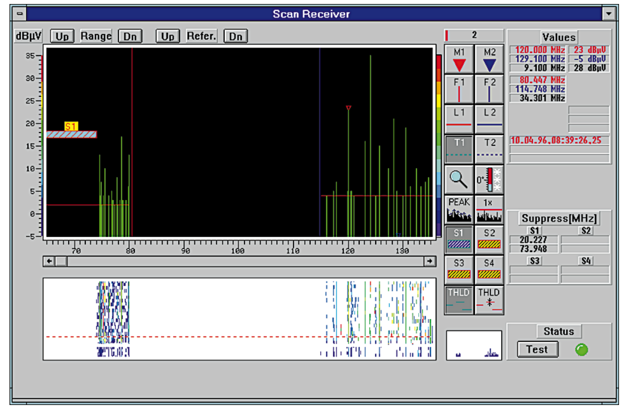


FIG 2 Overview window of ESMC-RAMON in search mode

The ESMC-RAMON program package offers an attractively priced entry into computer-aided radiomonitoring. The universal operating software is a new option for Compact Receiver ESMC [1; 2]. Derived from Radiomonitoring System RAMON® [3; 4], it combines the two names to ESMC-RAMON thus indicating its origin. This program package is the solution for newcomers to computer-aided radiomonitoring. Its graphics interface and the standardized Windows operating concept make the user feel familiar right from the startup of the program. The scope of functions is reduced to the essential, operation is simple and the benefits of ESMC-RAMON will show after a very short period of use.

The favourable price is not only easy on the budget but also a spur to try and test, particularly when customized solutions are to be developed. This especially applies to the complex field of instrument control, where the outlay required for software development rapidly exceeds the price of ESMC-RAMON. This software is proof that instrument control too is a Rohde & Schwarz domain. Despite data exchange with the receiver, other programs may also be active. The user can monitor signals with ESMC and prepare reports at the same time (FIG 1). Another example of optimized instrument control are the two possibilities for operation. ESMC can be set from the controller, or settings can be made on the receiver without any switchover being required. Settings made on the one are automatically updated on the other. The user thus benefits from direct instrument control and from computer control at the same time.

Resolution, colours and the memory of the controller open up new dimensions for radiomonitoring with ESMC. This is emphasized by the integrated overview window (FIG 2), where all signal levels of a search run are displayed. Discrete signals can be selected by means of colour markers and lines and their parameters measured. Search parameters are taken from files on the harddisk. These capabilities and the use of ESMC-RAMON give access to computer-aided radiomonitoring.

ESMC-RAMON is not only capable of controlling a single ESMC. With the aid of the "Transfer" software option it can also allocate signal parameters to other units (FIG 3). Since not only other ESMCs but even VHF-UHF Receivers ESM500 can be set, users of ESM500

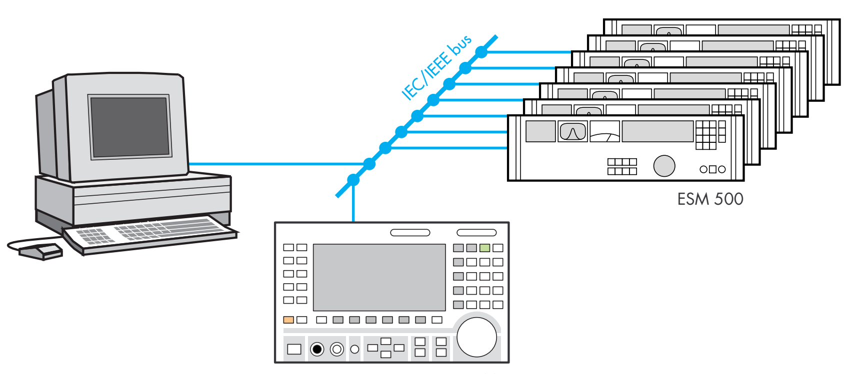


FIG 3 ESMC-RAMON software combining VHF-UHF Receivers ESMC and ESM500 into one system

will also be able to enhance the effectiveness of their units. Signals from the ESMC overview window can be directly transferred to the receivers for monitoring and evaluation. The time between signal detection and monitoring is thus reduced to a mouse click.

Search data can be recorded using the "Evaluate" software option. Recorded results may be recalled and then analyzed. ESMC-RAMON makes stepping up to Radiomonitoring System RAMON® easy. ESMC setups can be transferred to RAMON without any modifications, reducing the outlay for the change to a minimum. Operation of the two systems is identical, so know-how acquired with ESMC-RAMON can immediately be put to use on RAMON.

Günther Klenner

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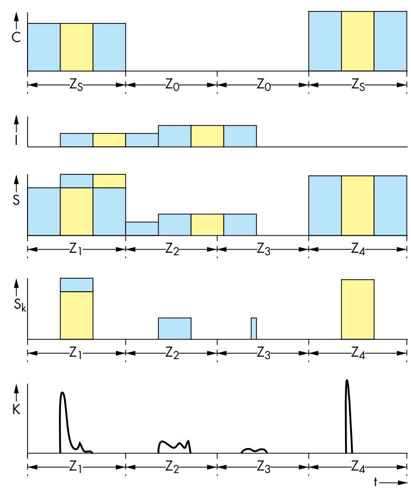
# Patent

## Power measurement in mobile-radio channel

In mobile-radio networks where carrier signals are transmitted from several transmitters to different receivers, interfering signals may be present at the receiver input that are superimposed on the carrier signal intended for the specific receiver. Such signals come from transmitters in the network or from other signal sources. Measuring the power of interfering signals is vitally important for network operation. The technique described in the patent utilizes the fact that if the carrier signals are transmitted with unused time slots between the time slots occupied by the signal, the power of a superimposed signal can be measured by selecting the time slots not containing a carrier signal from the sum signal in the receiver. This can be done by means of pulse compression and the patented technique. In a GSM signal, for instance, pulse compression can be performed on the training sequence of the signal. In the case of an indoor DECT network the sync sequence of the signal can be used for compression. The average power of the successive time slots of the sum signal may be measured over the total width of the time slot or in part of it. Likewise the average power of the compressed signal section can be measured or calculated in a section of the pulse obtained by compression, in the total pulse or over a predefined width of the compressed signal. This depends on signal bandwidth, sync quality and, if any, on propagation delays in the radio channel. The interfering signal power in the selected carrier-free time slot can be calculated from the digital data of the time slot as an average value measured either over the whole time slot or in a section of it. Spectral power evaluation is also possible.




The diagram illustrates the relationship between the carrier signal C consisting of occupied time slots $Z_S$ and empty time slots $Z_0$ in between, the interfering signal I, resulting sum signal S at the receiver input, signal sections $S_k$ used for pulse compression and signal section K compressed for each time slot, the GSM network being used as an example. The sum signal arriving at the receiver is digitized, and the sequence of the samples of time slots $Z_1$ to $Z_n$ of the sum signal are stored. When an IF signal is scanned, a sequence of real numbers is obtained, and for the I/Q signal a sequence of complex numbers. Time synchronization can then be derived from the stored signal data between the frame structure of the carrier signal and the values of the sum signal already scanned or still to be scanned. Then the average RF power is first calculated from the digital samples of the successive time slots. At the same time a selected, network-specific section of the carrier signal, which is in a time slot between the signalling or data sections of the time slot, is subjected to pulse compression and the average power of the pulse obtained by compression in the compressed signal K is calculated. The ratio of these two average powers is then compared with a preset limit. If the power is below the limit, the time slot does not contain a carrier signal but an interfering signal to be evaluated. The stored digital data of this time slot may then be used to measure the interfering signal power (average interference power, maximum interference power or interference power versus time). In the simplest case the power calculated for the time slots $Z_0$ may be taken as the average interference power. Another useful method for evaluating the interfering signal power is calculation of spectral power density.

Extract from patent specification
DE 44 30 349 C2
Patent applied for by Rohde & Schwarz
on 26 Aug 1994
Issue of patent published on 28 Nov 1996
Inventor: Otmar Wanierke

Used in Digital Radio Analyzer PCSD

Reader service card 155/12 for further information on PCSD

# Digital modulation and mobile radio (VI)

### 3.2.3 Bandwidth reduction by baseband filtering

The power-density spectrum of unfiltered MSK can be described analytically by the function

$$\Phi_{vv(MSK)} = \frac{16\,A^2\,T_{bit}}{\pi^2}\left[\frac{\cos 2\pi f T_{bit}}{1-16\,f^2\,T_{bit}^2}\right]^2 \quad (27)$$

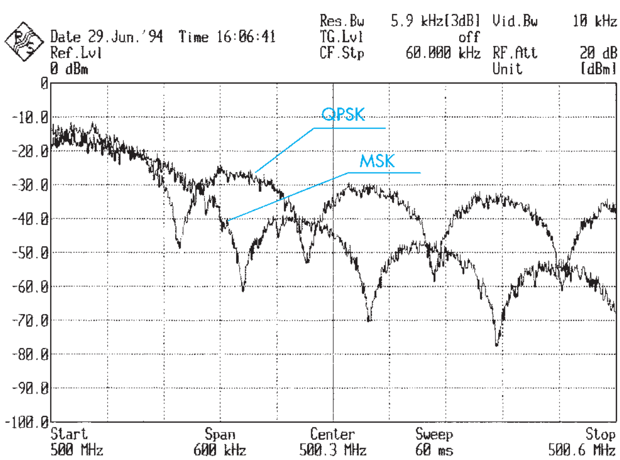



FIG 14 Spectra for QPSK and MSK

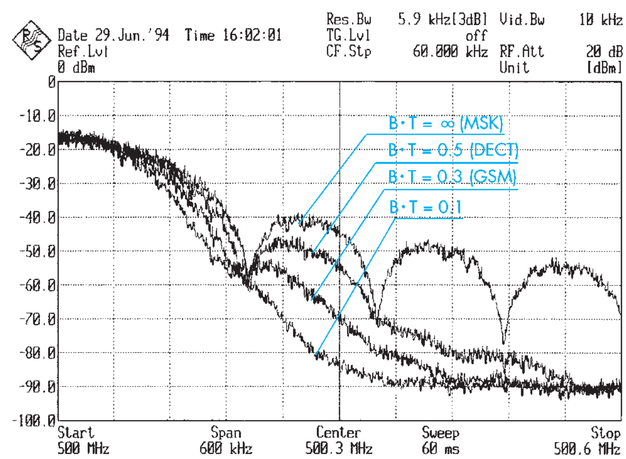



FIG 16 GMSK spectra for various values of bandwidth · bit duration

In FIG 14 it is compared with the QPSK power-density spectrum function. The diagrams show that the main lobe of the MSK spectrum is considerably wider and that there are no spectrum zeroes at $f_c$ +/– $f_{bit}$. On the other hand, the MSK spectrum's tail-off, which is proportional to $f^{-4}$, is considerably steeper than that of the QPSK spectrum. In both cases the spectrum can be improved by baseband filtering, but with one big difference – in the case of QPSK it is the modulating signals $c_I(t)$ and $c_Q(t)$ that are filtered, but with MSK the data function is filtered before the modulating signals $c_I(t)$ and $c_Q(t)$ are calculated from it by means of a non-linear operation.

For the time being it will be convenient to think of the I/Q modulator as a frequency modulator (VCO) as far as the processing of the modulating signals is concerned, because this simplifies the description of filtering. Simply imagine the filter connected to the input of the frequency modulator (FIG 15). GSM specifications stipulate that the data signal should be passed through a Gaussian filter, hence the designation Gaussian minimum-shift keying (GMSK) for this type of bandlimited modulation. This filter can be described in terms of its impulse response

$$h(t) = \frac{1}{\sigma T_{bit}\sqrt{2\pi}}\, e^{\frac{t^2}{2(\sigma T_{bit})^2}} \quad (28)$$

or by its transfer function

$$H(f) = e^{-\frac{\ln 2}{2B^2}f^2} = e^{-\frac{\ln 2}{2(B\cdot T_{bit})^2}(T_{bit}\,f)^2} \quad (29)$$

where $\sigma = \frac{\sqrt{\ln 2}}{B\cdot T_{bit}}$ and B = 3 dB bandwidth of filter. These expressions contain the new term $B\cdot T_{bit}$, which normalizes the filter bandwidth to the bit frequency $f_{bit}$ and which is used instead of the actual bandwidth of the Gaussian filter to describe the efficiency of the filtering process. $B\cdot T_{bit} = \infty$ means that MSK is being implemented, while smaller values of $B\cdot T_{bit}$ indicate GMSK with a correspondingly smaller bandwidth. FIG 16 shows the effect on the RF spectrum.

GSM networks use $B\cdot T_{bit}$ = 0.3. This means that the 3 dB bandwidth of the baseband signal is 81.25 kHz (TABLE 4).

Apart from the wanted effect of bandlimiting that is obtained by filtering the data function, there is also an unwanted effect referred to as intersymbol interference. Theoretically, when a rectangular pulse $p_c(t) = \mathrm{rect}(t/T_{bit})$ of duration $T_{bit}$ is filtered, its duration t satisfies the inequality $-\infty < t < +\infty$. To estimate the interference, the ap-

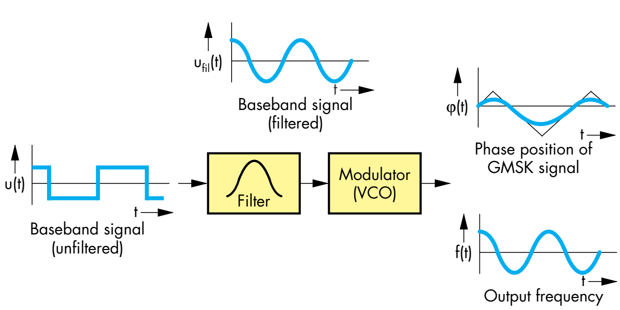



FIG 15 Generation of GMSK

| Bit duration $T_{bit}$ | Bit frequency $f_{bit}$ | Bandwidth · bit duration $B \cdot T_{bit}$ | 3 dB bandwidth |
|---|---|---|---|
| 3.69 µs | 270.833 kHz | 0.3 | 81.25 kHz |

TABLE 4  GMSK parameters for GSM

proximate response of the filter to this pulse can be obtained from convolution with the impulse response of the filter. The convolution of $p_c(t) * h(t)$ gives rise to integrals of the form

$$\int_A^B \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}} dx,$$ which do not have closed-form solutions but can be calculated from the Gaussian error function erf(x) using the methods of numerical analysis (FIG 17).

In practice, when $B \cdot T_{bit} = 0.3$, only an interval from $t = -3T_{bit}$ to $t = +3T_{bit}$, the duration of 6 bits, needs be considered; outside this time interval the filter response can be assumed to be zero. A delay of at least $3T_{bit}$ must be introduced to prevent causality from being violated. Due to pulse spreading and the conservation of energy, the maximum value of the filtered pulse drops to about 0.7 times the amplitude of the stimulus.

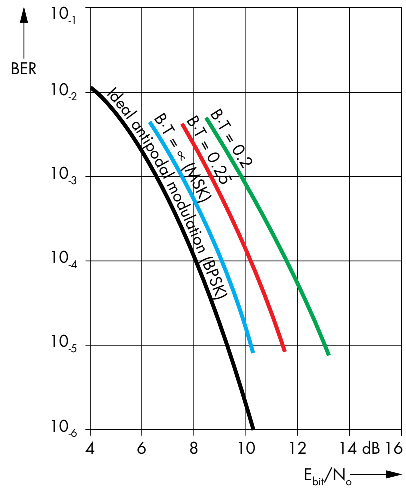



FIG 20  Bit error rate, BER, as function of $E_{bit}/N_0$ with $B \cdot T$ as parameter

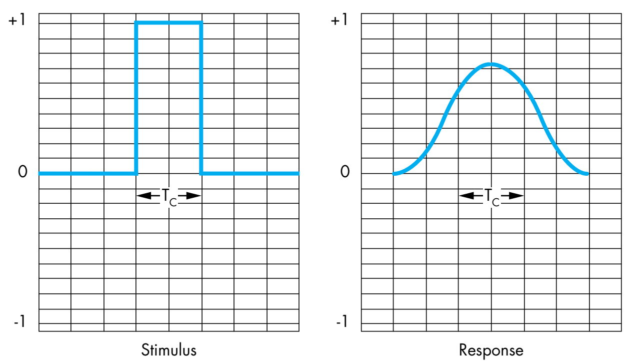



FIG 17
Shaping rectangular pulse with Gaussian filter

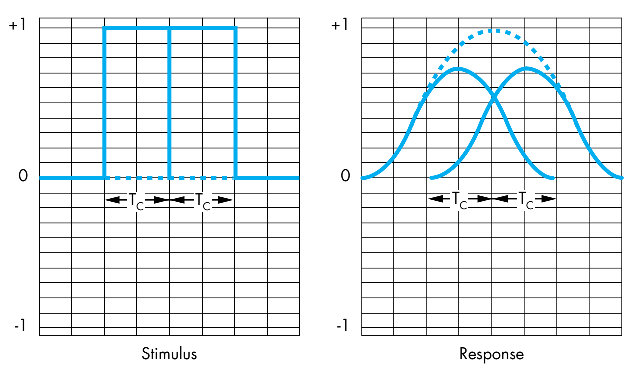



FIG 18
Reinforcement of two neighbouring rectangular pulses with same polarity (resulting output function shown by dashes)

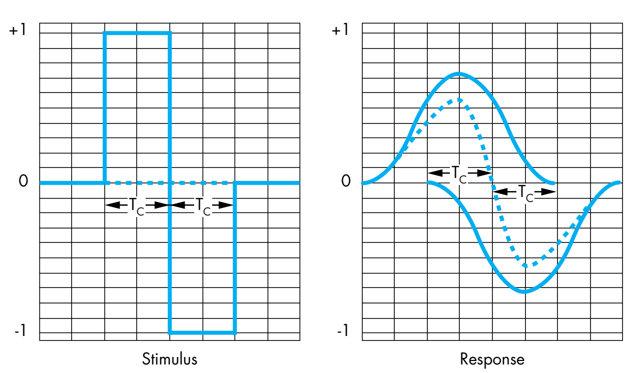



FIG 19
Cancellation of two neighbouring rectangular pulses with opposite polarity (resulting output function shown by dashes)

The responses of the Gaussian filter to neighbouring rectangular pulses reinforce and cancel each other out. Reinforcement occurs if neighbouring pulses have the same polarity (FIG 18) and cancellation, ie the maximum amplitude of the current pulse is reduced even further to about 0.5 times the value of the original pulse, if neighbouring pulses have opposite polarities (FIG 19).

Because of filtering, the function $c_{fil}(t)$, which is proportional to the instantaneous output frequency, is continuous at the modulator input and the phase function $\varphi_{fil}(t)$ loses its breakpoints. This in turn smooths the modulating functions $c_I(t)$ and $c_Q(t)$ and, as a result, there is an improvement in the spectrum that is a function of $B \cdot T$; this is shown in FIG 16.

However, because of intersymbol interference, the improvement in the spectrum has to be traded off against an error rate that increases as $B \cdot T$ decreases, the ratio $E_{bit}/N_0$ remaining constant (FIG 20).

To be concluded.  Peter Hatzold

# Digital Radiocommunication Test Set CRTC02 growing with GSM standard

FIG 1 Digital Radiocommunication Test Set CRTC02, specialist for development and type-approval testing of GSM, DCS1800 and DCS1900 mobile phones Photo 42 777

The high innovation rate on the mobile-radio market with new products appearing year after year forces manufacturers to make considerable efforts in development. The GSM standard is in a state of flux, with new functions and improvements continually being added. The resulting necessary modifications in the complex mobile-phone software may lead to unexpected delays in type approval if a manufacturer fails to test his mobiles to sufficient depth.

Digital Radiocommunication Test Set CRTC02 (FIG 1) and the associated software products can make a decisive contribution towards avoiding such undesired delays and ensuring the product's market introduction in time*.

Through continuous further development CRTC is always able to check the latest GSM features. It is one of the two stand-alone testers approved in Europe and is used for type-approval measurements in test houses. The validated software used is now available as an option for CRTC and allows optimum preparation for the type-approval test. CRTC is at present worldwide the only measuring instrument for which validated tests for all three networks (GSM900, DCS1800 and GSM North America) are available. The unrivalled diagnostic functions of CRTC – down to bit level of a burst – not only permit careful documentation of the test results but also minimize troubleshooting times should the mobile phone not pass a test right away.

The **new test software** was configured so that only minor modifications are required for a fully automatic regression test. In this case the device under test is no longer manually operated but remotely controlled by manufacturer-specific commands via an RS-232-C interface. A sequencer controlling test-program selection and providing for storage of results and signalling logs comes with the software (FIG 2). New software releases can thus be tested with little effort at short notice and unexpected side effects of software modifications detected at an early stage.

In addition to the main application of a GSM mobile phone, ie voice transmission, data and short message services are being used more and more. Due to the increasing use of E-mail and Internet in wire-line networks, these functions are now also called for in mobile radio. Therefore, manufacturers already supply special PCMCIA modules designed for radio data transmission for use with laptops or small organizers with integrated mobile phone. This is the reason why, in addition to the basic data service functions available for some time, appropriate **test suites in line with GSM 11.10** are now offered for CRTC02. These ready-to-run test programs not only check the basic function under ideal conditions but also the response of the mobile if part of the information is lost by interference in the radio channel or if mobile and base station have first to "agree" on transmission parameters and protocols.

The increasing number of mobile-radio subscribers causes bottlenecks during

* Steffen, R.: Digital Radiocommunication Test Set CRTC02 – Universal tester for GSM and DCS mobile phones. News from Rohde & Schwarz (1995) No. 149, pp 10–12

peak periods. Apart from the usual remedies like installation of microcells and allocation of additional frequencies, the use of **half-rate speech coding** is another efficient means of increasing capacity. Here two mobiles share a time slot and use the individual bursts alternately. Powerful hardware in the mobile phone in conjunction with an elaborate algorithm ensures approximately the same speech quality although only half the number of bits are transmitted. In addition to the required basic functions such as half-rate speech and channel coding, the signalling software must be considerably enhanced so that the network is informed that the mobile phone supports the half-rate mode and wants to make use of the benefits of a half-rate connection, which include lower charges for instance. Thanks to new software options, also available for testers already supplied, CRTC02 is able to perform all the necessary tests.

Through further development of speech coders, speech quality can be improved in **full-rate mode** using the same number of bits. CRTC02 is now able to test these new enhanced full-rate speech coders with the associated signalling.

CRTC02 also has functionality for checking **multiband mobile phones.** These phones can be operated both in the GSM900 and the DCS1800 band. DCS1800 mobiles can thus use the 900 MHz band for roaming in countries where no DCS1800 network yet exists. This means that DCS1800 network subscribers can now be called worldwide.

In some countries a network operator may use both bands – GSM900 and DCS1800. In these cases long-range GSM frequencies can be used to cover large areas while the short-range DCS1800 frequencies are more suitable in cities where, for reasons of capacity, microcells are employed anyway. The required **handover functions between GSM900 and DCS1800** are defined in GSM specifications. CRTC02 provides two RF carriers that can be operated independently of each other both in the GSM900 and the DCS1800 band. The tester is thus able to perform even these extremely elaborate and complex tests.

Frank Körber; Roland Steffen

Reader service card 155/13

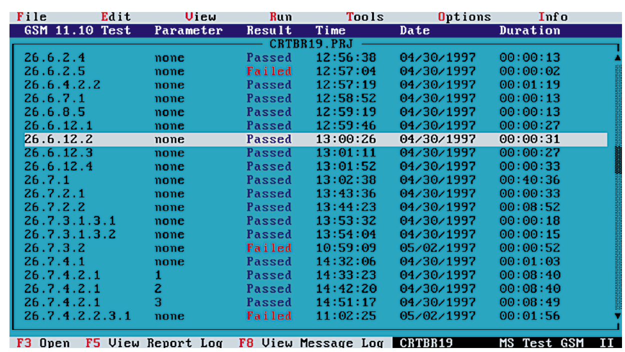



FIG 2
Automatic test run with sequencer

# DVB-T, the new terrestrial TV standard

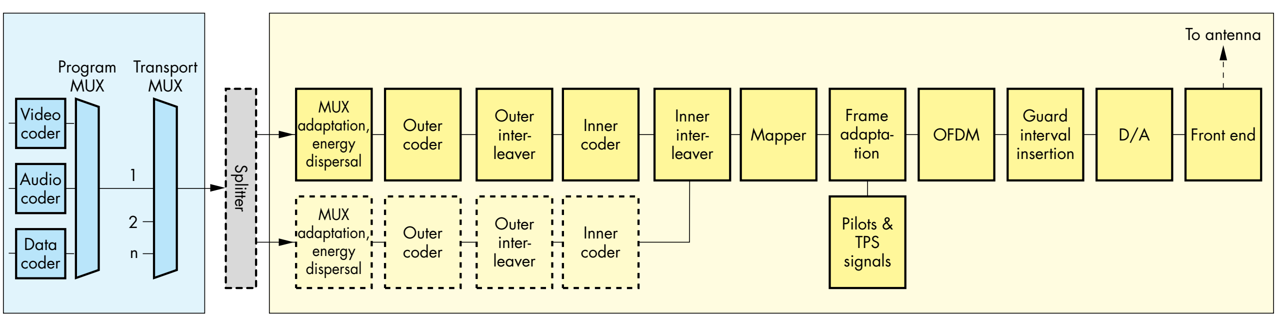
In February 1997 the voting procedure for the new terrestrial European Telecommunications Standard ETS 300 744 (in short DVB-T) ended with a unanimous vote*. Thus, within about two years, a basis has been created for the terrestrial television of the future. This new standard will be applied in Europe first, and is expected to be taken up in other parts of the world too.

The basic technical specifications were prepared by the European DVB Project and in particular by its Technical Module, in which Rohde & Schwarz is taking an active part. Like all other DVB specifications, the terrestrial broadcasting standard is based on the requirements of potential users.

* ETS 300 744: Digital broadcasting systems for television, sound and data services; Framing structure, channel coding and modulation for digital terrestrial television. March 1997

The **DVB-T standard** is envisaged to fulfill the following **requirements:**

- Trade-off between transmission capacity and coverage range should be possible.
- The implementation of large-area and local single-frequency networks should be possible.
- The system should allow transmission of data containers irrespective of their actual contents (eg compressed video or audio data).
- The system should be robust and allow adjacent-channel operation of analog and digital TV signals in a densely occupied frequency band.
- The transmission standard should be available well in time to enable network operators wishing to adopt the standard to start operation still in 1997.
- Multiplex adaptation and energy dispersal: multiplex adaptation through appropriately standardized inter–faces, inversion of every eighth sync byte, energy dispersal for even power distribution in the transmission channel.
- Outer coder: coder with shortened Reed-Solomon code (204,188, t = 8), capable of correcting up to eight errored bytes in an MPEG2 transport-stream packet.
- Outer interleaver: interleaver with a depth of I = 12 for dispersal of burst errors to different packets so that higher probability of successful error correction is achieved.
- Inner coder: punctured convolutional code with code rates of 1/2, 2/3, 3/4, 5/6 and 7/8.
- Pilot and TPS signals (transmission parameter signalling): insertion of pilot carriers, some of which carry the transmission parameters in coded form as modulation signals.
- OFDM (orthogonal frequency-division multiplex): calculation of IFFT with 2048 or 8192 carriers, with 1705 or 6817 of which containing data or transmission parameters, 1512 or 6048 being exclusively reserved for payload data.
- Guard interval insertion: insertion of a guard interval for the OFDM signal, permissible intervals are 1/4, 1/8, 1/16 or 1/32 of symbol duration.
- Digital /analog conversion: conversion of digital into an analog signal.
- Front end: conversion to output channel, usually in UHF range.




Functional block diagram of system (terrestrial channel adapter)

The DVB-T standard contains elements of the standards for satellite and cable transmission. The input signal, for instance, is defined in all cases as an MPEG2 transport stream. For error protection too, well-proven techniques have been resorted to. In contrast to other systems, a multicarrier transmission method was chosen for adaptation to the terrestrial transmission channel with its multipath propagation. **Channel coder** and **modulator** contain the following functional blocks (FIG):

- Inner interleaver: combination of bit interleaving and symbol interleaving.
- Mapper: allocation of information to the individual carriers and constellation points; permissible modes are QPSK (quadrature phase-shift keying), 16QAM and 64QAM (quadrature amplitude modulation), Gray mapping.
- Frame adaptation: providing synchronization to frame structure of the signal.

For the socalled hierarchical modulation, two sets of the forward error-correction blocks are required and the MPEG2 transport stream is split up accordingly.

Rohde & Schwarz pre-series DVB-T modulators successfully passed their first interoperability tests and are at present being used in laboratory and field tests in cooperation with customers.

Dr Jürgen Lauterjung

# New measurement functions in Digital Radio Tester CTS55

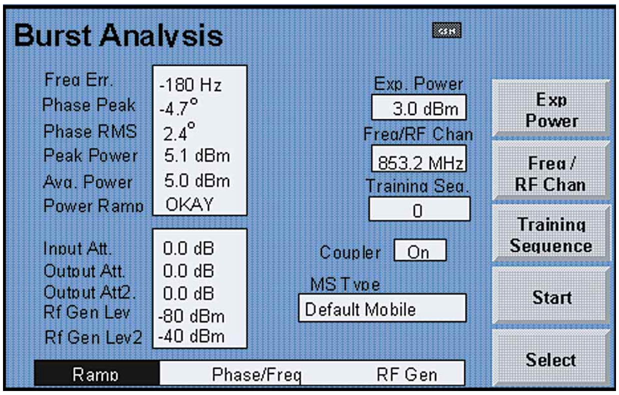



FIG 1 Result of signal analysis in module test

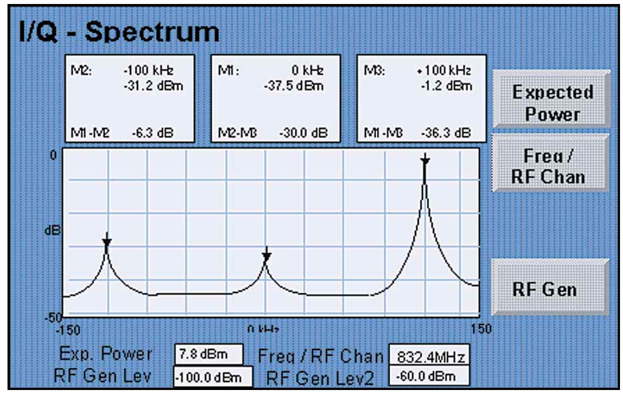



FIG 2 I/Q spectrum analysis with Digital Radio Tester CTS55

Digital Radio Tester CTS55 is a compact unit for testing GSM, DCS1800 and PCS1900 mobile phones in qualified service [1]. Rohde & Schwarz has now enhanced measurement and control functions, making this successful tester suitable for new fields of applications.

The **BER search routine** offers an interesting application. Here CTS55 performs successive bit-error-rate measurements in the course of which the signal level is continuously reduced relative to a selectable start value until the BER limit, which can also be adjusted, is reached. With this function the sensitivity of a mobile phone can be determined in an extremely easy way and with high accuracy.

Another function of modern mobile phones – the **short message service** – can also be tested conveniently with CTS55. Without explicit call setup, either a text message is sent from the tester to the mobile phone or a message received from the mobile phone. If an error occurs in transmission, eg if the text memory of the mobile is full, the tester will output a corresponding error message.

The **module test** mode (option CTS-B7) allows measurements and adjustments of individual modules of mobile phones or operation in the service mode. For this purpose CTS55 contains an RF synthesizer that, in addition to GSM, DCS1800 and PCS1900 bands, also covers the 900 to 995 MHz and 1800 to 1990 MHz bands. The level can be adjusted at two outputs in the range –10 to –110 dBm with or without burst shaping. Available modulation modes are "dummy burst modulation" with selectable midamble (training sequence) and "unmodulated". After entry of the expected frequency, ie channel number, and power, the RF signal generator can synchronize to GSM signals (FIG 1). Measurement is triggered by pulsed signals on the received burst and by CW signals on a midamble. CTS55 then measures peak power, average power, power ramp versus time as well as frequency and phase error.

The **I/Q spectrum** measurement function allows simple checking or adjustment of an I/Q modulator module. Graphical display of the spectrum close to the carrier provides a quick overview of carrier and sideband suppression, while the delta marker functions allow qualitative assessment (FIG 2).

The **remote-control function** of CTS55 (option CTS-K6) opens up further possibilities. The tester can be fully controlled via an RS-232-C interface for setting parameters, conducting measurements and reading out results. With few exceptions, the remote-control commands are identical to those for the GSM testers of the CMD series [2]. So automatic test routines, as used for CMD testers on repair lines in production for instance, can also be implemented with CTS55. This means an interesting variety of applications for the customer, such as automatic product-specific test routines, test-result documentation, central evaluation or statistical analyses.

Gottfried Holzmann

REFERENCES

[1] Vohrer, M.: Digital Radio Tester CTS55 – All-in-one service tester for GSM, PCN and PCS mobile telephones. News from Rohde & Schwarz (1996) No. 152, pp 4–6

[2] Mittermaier, W.: Module test with Digital Radiocommunication Tester CMD52/55. News from Rohde & Schwarz (1995) No. 149, pp 36–37

Reader service card 155/14

# T&M technology from Rohde & Schwarz for EMC mobile of TÜV Rheinland Japan


FIG 1
EMC mobile of TÜV Rheinland Japan in the field

TÜV Rheinland (Technical Inspectorate Rhineland) is based in Germany and has more than 50 overseas offices in over 30 countries. It is a private organization with international activities that can look back on 125 years of experience in the field of testing and certifying technical installations and products. The organization also acts as an advisor to government and industry on technology and safety matters. Of all the German safety standards authorities, TÜV Rheinland is one of the largest and internationally most widely known. The spectrum of items tested and inspected by TÜV Rheinland is striking: everything from an electric hair drier to a power station, from a toy train to a chemical plant.

TÜV Rheinland has been active in Asia since 1978 and after a period of remarkable growth now employs over 170 specialists from Germany and other European countries plus a host of local professionals, currently totalling over 400 staff at 21 locations. TÜV Rheinland Group Asia covers the entire Far East from fully fledged offices in Japan, Hong Kong, China, Taiwan, South Korea, Singapore, Indonesia, Thailand, the Philippines and India.

**TÜV Rheinland in Asia** offers the **following services:**

- quality control and consulting,
- safety and EMC testing for all kinds of products from household appliances to industrial equipment and medical apparatus,
- testing in TÜV's own laboratories,
- certification of quality and environmental management systems according to ISO9000, QS9000 and ISO14000 by TÜV-CERT,
- testing of vehicles, their parts and accessories as well as certification of their compliance with international standards,
- testing of children's toys,
- educational services by the TÜV Academy,
- support for companies who wish to enter Asian markets through FEMAC (Far East Market Access GmbH).

Because of the mandatory implementation of a European EMC directive early in 1996, industry in Japan like in other countries has undertaken great efforts to comply with the new legislation. The general scarcity of EMC test facilities meant serious problems in particular for manufacturers of large equipment such as industrial or medical goods. EMC inspection is usually carried out at a test house, requiring the manufacturer to pack the product and transport it to the test site. For large machinery, however, this means disassembling, loading, transporting and reassembling the machine at the test house – a time-consuming and expensive process. And once testing is completed, the whole process has to be reversed to return the machine to the factory.

To meet testing needs for large machinery or machinery requiring a special operating environment, the TÜV Rheinland Japan office in Osaka devised an EMC mobile, a custom-built Mercedes Benz van equipped with a miniature office and the latest in EMC test equipment (FIG 1). The van drives to the customer's site, so time delays and expenses normally associated with transporting a machine to and from a test house are eliminated. And because testing is performed at the customer's factory, many resources like construction plans, special tools and equipment as well as personnel are readily available. Customers also appreciate the fact that they can continue machine testing and assembly at their factory while EMC testing is in progress. Together these benefits add up to major savings in time and increased flexibility for the manufacturer.

When confronted with the difficult task of choosing **equipment for the EMC mobile,** TÜV Rheinland defined the following key **criteria,** in addition to requiring full compliance with relevant test standards:

- After-sales service: the equipment manufacturer was to have local Japanese facilities offering instant and reliable service in case of trouble. The provider of such service must be aware that any equipment downtime makes the customer dissatisfied because he may not be able to keep to schedule.
- When used for testing at factories or being transported throughout the country, the measurement equipment is subject to an unusual amount of stress and strain. Extreme temperature changes, vibration, frequent setting up and disassembly are just some of the factors to consider. The manufacturer was therefore to have a reputation for high-quality products.
- To ensure testing efficiency, the measurement equipment should be easy to use, but still flexible enough to adapt to testing situations that can differ from day to day.

As a result of these considerations, the following **tests and products** were chosen for the initial phase:

- measurement of radiated and conducted emission by LISNs, high-impedance probes and Receiver ESS, all from Rohde & Schwarz (FIG 2), as well as a bi-log antenna from Schwarzbeck,
- measurement of electrostatic discharge, fast transient noise and surge by generators and networks from Schaffner,
- measurement of conducted susceptibility, again by equipment from Rohde & Schwarz, in this case signal generators and power meters.

After more than a year of service, these choices have proven to be right. Although the equipment has been subjected to a great deal of stress, no problems occurred. Neither repairs nor adjustments were needed after calibrations, frequently performed to evaluate the impact of environmental factors. The services offered by TÜV Rheinland have met with an extremely positive response from Japanese companies. The list of big-name firms already utilizing the services includes Shimadzu, Mori Seiki, Nissin High Voltage, Sumitomo Precision Products, Meiki, Ube Industries, Yutani Heavy Industries and Kubota.

Michael Borgmann
(TÜV Rheinland Japan)


FIG 2 EMC Test Receiver ESS from Rohde & Schwarz in action at TÜV Rheinland Japan
Photos: TÜV Rheinland Japan

Reader service card 155/15 for further information on EMC T&M technology

# New from Cologne: telescopic masts with universal control unit


Rotor Control Unit HSRG for local or remote control of telescopic masts of MxEA series
Photo: R&S Cologne

For many years Rohde & Schwarz Cologne has been fitting out vehicles for radiated emission testing, field-strength or coverage measurements, and not only with the required instrumentation but also with telescopic masts for the antenna systems. The Cologne plant has now developed Rotor Control Unit HSRG (FIG) for telescopic masts. HSRG features high reliability, simple manual operation via the front-panel keypad as well as effective remote control via an RS-232-C interface. Of course it can be adapted to different types of rotors.

The desired extension height can be adjusted manually or automatically. For rotating the antenna, an azimuth and an elevation rotator can be controlled independently of each other (1° resolution of rotation angle). To ensure smooth startup of the rotors, the rotating speed is kept low at first. The control unit shows its strengths particularly in computer-controlled use in test vehicles: automatic extension and retraction of the mast with monitoring of the programmable mast configuration and indication of height and rotating angle on separate displays. Thanks to the integrated monitoring functions any faults are immediately detected and automatically signalled to the user, so incorrect handling that may cause antenna damage is excluded. All essential parameters such as minimum and maximum extended height, minimum working and transport height and the parking position required by the antenna design are stored in an EEPROM.

The control unit comes as a bench model or 19-inch rackmount. Plug-in PC cards are provided for different conditions of use. The basic model is equipped for control of an azimuth rotor. Retrofittable optional PC cards are available for polarization rotor (elevation) and mast control. Depending on the application, power modules for 230 V AC and 12 or 24 V DC are available. The rotors can be driven with 12 or 24 V DC or 230 V AC. The connectors are rated for startup currents of up to 50 A.

The electrically extendible telescopic masts of the MxEA series are an ideal match for Rotor Control Unit HSRG. They meet the stringent requirements in terms of reliability, stability and freedom from maintenance. The main mechanical features such as little wear and tear, high carrying capacity and horizontal top load show their benefits especially in mobile use. The mast sections are made of ALU F22, other parts of stainless steel. The mast is driven by a 12/24 V DC motor in a weatherproof enclosure. Masts are available with extension heights of 4600 up to 9150 mm, as well as suitable rotors and accessories such as roof feedthroughs for different types of vehicles and special mast feet. Rohde & Schwarz Cologne also offers complete integration as a service package: everything from a single source.

Helmar Scherpe

Reader service card 155/16

**Software SME-K2** runs under Windows and sets Signal Generator SME to signals to GSM, DCS1800, DCS1900, IS136 DECT or PDC standards.

Data sheet PD 757.3092.21 enter 155/17

**Spectrum Analyzers FSE** (20 Hz to 40 GHz) 40 GHz models FSEK20 and FSEK30 are now covered by the data sheet.

Data sheet PD 757.1519.24 enter 155/18

**Security System ComSaveBox** from **SIT** (Gesellschaft für Systeme der Informationstechnik mbH) encrypts serial data transmission (also available in form of a PCB as Security System ComSave).

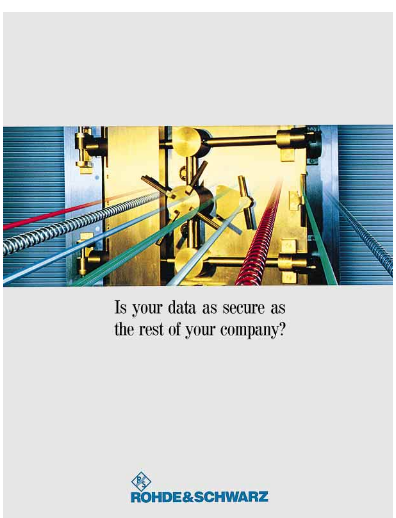
Data sheet PD 757.3392.21 enter 155/19

**LaserVision TS-LV1, TS-LV2** for optical component testing are available as a complementary system (LV1) for parameters not covered by electrical tests and as a complete stand-alone system (LV2); numerous options.

Data sheet PD 757.3311.21 enter 155/20

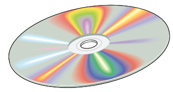
**EMI Test Receiver ESCS30** (9 kHz to 2.75 GHz) is compact, compliant to standard (CISPR 16-1) and has a 6.5-inch colour screen; level measurement range from −38 to +137 dBµV, measurement error <0.5 dB (typ.), integrated preselection, macro functions; IF spectrum analysis, tracking generator and OCXO reference oscillator available as options, internal/external battery operation.

Data sheet PD 757.3186.22 enter 155/21




**Is your data as secure as the rest of your company?** asks **SIT** (Gesellschaft für Systeme der Informationstechnik mbH) in its new brochure, thus offering the services of Rohde & Schwarz also in matters of security.

Info PD 757.3328.21 enter 155/22



**Catalogs "Test & Measurement Products" and "Sound and TV Broadcasting" now for the first time on CD-ROM**

This CD, which will be available free of charge from all Rohde & Schwarz representatives as of August this year, gives an overview of products and services provided by Rohde & Schwarz in the fields of T&M, sound and TV broadcasting. The CD comprises the contents of the printed catalog plus the new equipment from Rohde & Schwarz launched before May 97. It can be run on any 486 or higher standard PC. Finding any product is made easy by comprehensive instructions, navigation aids and a full-text search function.

In addition, the completely revised Sound and TV Broadcasting Catalog is now available in print. It presents, among other equipment, new DVB and DAB transmitters including all equipment needed for building up DVB/DAB systems, the TV Test and Monitoring System Family TS6100, Audio Data Transmission System ADAS/AMON, Program Input Rack PI6200, new broadband-communication system components and signal generators for digital signals as well as Receiver Family EFA and Audio Analyzer UPL.

Catalog PD 756.7294.23 enter 155/23


**TV Test Transmitter SFQ** (0.3 MHz to 3.3 GHz) provides standardized and also variable digital (4PSK, DVB-S, QAM, DVB-C) and analog satellite signals (depending on model used); FM or ADR sound subcarriers as well as noise signals (options); optional ASI input.

Data sheet PD 757.3334.21 enter 155/24

**MPEG2 Measurement Generator DVG** provides digital TV test signals to 525- and 625-line standard (moving/still video, audio, data) at a keystroke; infinite sequence length, selectable PID; various interfaces.

Data sheet PD 757.2738.21 enter 155/25

**MPEG2 Measurement Decoder DVMD** monitors, analyzes and decodes 19 DVB signals at a time; two-line LC display, OSD on external screen; various interfaces.

Data sheet PD 757.2744.21 enter 155/26

**Radiomonitoring System RAMON** (10 kHz to 40 GHz) is a modular system that can be anything from a portable receiver to a nationwide network for monitoring, location and analysis, depending on the individual application.

Info PD 757.3234.21 enter 155/27

**Message Handling Software PostMan** serves for the integration of shortwave and VHF-UHF radio links into international communications networks under WindowsNT.

Data sheet PD 757.3163.21 enter 155/28

**VHF Manpack Radio XV3088** (30 MHz to 89.975 MHz; 0.2 W or 5 W) Modular transceiver system for mobile/stationary use; simplex/half-duplex, selective/group call, voice scrambler, sub-audio squelch; numerous options (among others for 25 and 50 W).

Data sheet PD 757.3228.21 enter 155/29

**VHF/UHF Airborne Transceiver Family 610** The data sheet has been revised and now appears in the new design (new order number).

Data sheet PD 757.3257.21 enter 155/30

**Digital IF Spectrum Display EP090** Besides some modifications, the frequency specifications for the AF input (30 Hz to 20 kHz), IF input (30 kHz and above 50 kHz) and sweep (to 1 MHz/s) have been newly defined.

Data sheet PD 757.1554.22 enter 155/31

**New application notes**

Limit Checking with Audio Analyzers UPL or UPD
Appl. 1GA33_1E enter 155/32

Measurements on Frequency-Converting DUTs using Vector Network Analyzer ZVR
Appl. 1EZ31_E enter 155/33

Schz

## Fully automated EMC test facility opens at Panasonic in Wales

One of the biggest and most up-to-date EMC test facilities in the UK has been opened at Panasonic's European Television Division in South Wales. It enables the company to reduce their testing time by a factor of ten. The recent inauguration ceremony (photo above) marked the completion of two years of work involving Rohde & Schwarz, who supplied the fully automated turnkey solution, and Hemford Communications, supplier of the anechoic chamber. Together Charles Toda (front center), Managing Director of Panasonic European Television Division, and Dr Wolfgang Winter (front right), Managing Director of Rohde & Schwarz UK, cut the ribbon at the entrance to the anechoic chamber. Rohde & Schwarz has been supplying transmission and test equipment to Panasonic for more than 17 years, so it came as no surprise when the company was awarded the contract for designing the EMC test facility. The facility includes two TS9980 systems for immunity testing, two ESBI receivers for emission measurements up to 5 GHz, and a complete set of products for the anechoic chamber. Testing is conducted to EN55013 and EN55020.

This new completely automated facility will be used almost entirely for batch testing, enabling Panasonic to conform to the 80/80 rule (80% of units pass the test with a confidence level of 80%). The present production rate of more than 4000 TV sets per day makes that absolutely essential. According to Phil Josty, responsible for the project at the Panasonic end: "With a scheme as huge as this we had to award the contract to a capable and well established organization. Rohde & Schwarz was the only company who could meet our criteria". This latest delivery brings the total value of Rohde & Schwarz EMC test equipment in use at Panasonic to around one million pounds. This includes equipment used purely for design and development.

T. Stephens

## Reference test engineering from Munich for booming US mobile-radio market

Type testing of mobile stations to PCS (Personal Communications Service) standard for the North-American market has been obligatory as of the beginning of June 1997 as part of CTIA (Cordless Telephone Industry Association) type certification. By agreement with the PCS network operators represented in the PCS1900 Type Certification Review Board (PTCRB), the internationally known German test house and service enterprise CETECOM was selected for the type-certification tests. CETECOM will be using Rohde & Schwarz equipment throughout for its tests on the air interface. Thus Rohde & Schwarz extends its worldwide leadership in test engineering for type certification.

In the general-purpose Test System TS8915B (photo below), based on Radiocommunication Test Set CRTC02 (see page 30 in this issue), Rohde & Schwarz has already implemented more than 200 test cases – of 283 – for the PCS1900 band. To guarantee conformance of the tests with standards, CETECOM and Rohde & Schwarz have decided to cooperate with the objective of ensuring timely test-case validation. So, for example, all RF tests from phase II of European GSM type testing are already available for PCS1900 certification. Virtually all the signalling procedures needed – some 150 – can be performed with both the CRTC02 tester and the TS8915B system.

PI

## Rohde & Schwarz and Tektronix extend their marketing cooperation

Rohde & Schwarz and Tektronix Inc. of Wilsonville, Oregon/US, announced extension of their global marketing agreement at the beginning of April this year, with the aim of providing customers worldwide with a complete range of test and measurement equipment for digital television. Under the terms of the agreement Tektronix will market Rohde & Schwarz developed MPEG and DVB test and measurement equipment in North and South America, Pacific Rim and Asia, while Rohde & Schwarz will be responsible for marketing in Europe and Japan as well as the Middle East. The two companies are thus intensifying their successful cooperation, begun in August 1993, and which has already seen joint development projects like test and measurement equipment for the North-American mobile-radio network (CDMA) and achievement of an excellent position on the market.

"This agreement builds on the successful partnership we have established over the past several years and significantly leverages the resources both companies bring to our customers in the television and broadcast markets", explained Dan Terpack, President of Tektronix' Measurement Business Division. "With this new chapter in our relationship we will be working together closely to bring an even stronger set of tools and solutions to a marketplace undergoing dramatic changes as it moves to digital". According to Reinhard Bruckner, President and COO of Rohde & Schwarz, this expansion of relationships gives customers worldwide ready access to the broadest and most capable family of digital television test and measurement equipment currently available on the market.

PI

### Rohde & Schwarz faculty prize in Jena


Photo: Müller

The faculty prize for outstanding scientific achievement, donated by Rohde & Schwarz, was awarded at the beginning of the year during a special colloquium convened by the dean of the physics and astronomy faculty, Professor Dr Roland Sauerbrey, of Friedrich Schiller University in Jena. The prize for the best dissertation in 1996 was presented by engineer Karl-Otto Müller, responsible for university contacts at Rohde & Schwarz, to Dr Jörg Gehler of Fraunhofer Institute for applied optics and precision mechanics. The prize for the best graduate thesis went to physicist Sandor Nietzsche.

Dr Gehler's work "Experimental investigation of new kinds of photon components based on resonant waveguides in SiON and $KTiOPO_4$" attracted a lot of international interest and resulted in an invitation to Japan. There he is continuing his research at Kanagawa University for Science and Technology in Kawasaki. In his lecture Dr Gehler (left in the photo above, right Prof. Sauerbrey) explained and illustrated the new principle. Its economic significance stems from the possible multiple use of optical fibers in wavelength multiplexing. The thesis submitted by Sandor Nietzsche "Design and testing of basic configurations for position detectors with SQID" is of importance for basic research in physics, allowing the space between two closely adjacent bodies to be measured more precisely by several orders of magnitude than was previously possible. This means that examination of the equivalence principle of the equality of gravitational and inert mass can be performed much more accurately.

In the awarding of the prize for 1996 Rohde & Schwarz continued a tradition that goes back six years. The recipients of the prizes are chosen by the university. In this way Rohde & Schwarz demonstrates its interest in excellence in science education. AS

### Security for modem links with ComSaveBox

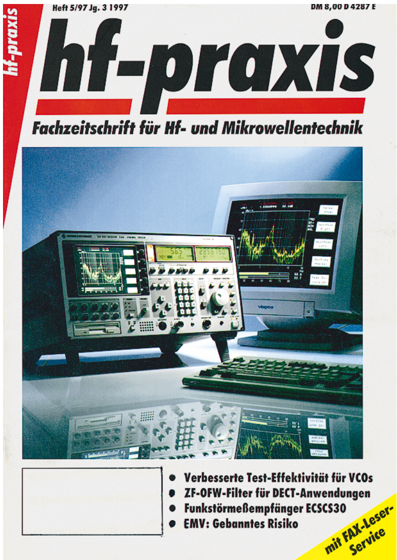
SIT, an affiliate of Rohde & Schwarz engaged in systems for information security, is offering ComSaveBox (large photo below) for online encryption of a modem link. The compact unit with its RS-232-C interface is connected between PC and modem and encrypts data up to 115 kbaud. Transmission rates up to 110 kbaud are achieved in the use of ISDN modems with B-channel trunking. Applications for ComSaveBox are secure data transmission in telejobs, mailboxes, remote maintenance and network linking. Initialization of ComSaveBox and code entry are possible by PC software. A secure, symmetrical block algorithm is used for encryption. It has a code length of 128 bits and is an insuperable barrier even for the latest methods of cryptoanalysis. SIT is also offering the ComSave plug-in card for PCs (small photo), compatible with ComSaveBox and providing the same functionality (reader service card 155/19).

F. Bergmann


### Shortwave experts from Rohde & Schwarz help stage course by Carl Cranz Society

Although today's telecommunication links are cable, fiber optic or by satellite for the most part, the shortwave band – 1.5 through 30 MHz – is enjoying increased popularity. It is especially interesting for administrations, embassies, armed forces and in amateur radio. Data transmission by shortwave has also taken on greater significance in recent years. Data rates of 4.8 kbit/s or even 5.4 kbit/s can be achieved through the use of modern digital transmitting and receiving techniques.

The Carl Cranz Society showed its interest in this development by including a course "Radio transmission by shortwave" in its 1997 program. The course was held in Oberpfaffenhofen in April, staged by Prof. Dr Friedrich Jondral of Karlsruhe University and a team of shortwave experts from Rohde & Schwarz – Dr Günter Greiner, Johann Hackl, Peter Iselt, Dr Christof Rohner and Bernhard Wolf. The course began with an introduction to the fundamentals (physical features of shortwave, modulation and transmission security, transmission and reception techniques, MIL-STD-188-110A) and moved on in the second part to equipment and systems engineering (shortwave antennas, transceivers, modems and radio processors, interfaces with the user, network structures and station design). To round off the course there were demonstrations of modern shortwave transmission systems at Rohde & Schwarz in Munich. The course was attended by 28 persons from industry, administrations and the armed forces, and the consensus was that the event had been a success worth repeating. PI/CC




**The RF and microwave magazine "hf-praxis" put EMI Test Receiver ESCS30 from Rohde & Schwarz into just the right perspective on the cover of its 5/97 edition. But it is not only attractiveness that counts – the instrument also excels through its 6.5-inch VGA TFT colour display, sophisticated specifications, lean dimensions and favourable price.**

**To mark the launch of the European issue of the American electronics magazine "EDN", the European editor Brian Kerridge (photo) introduced himself to readers in an informative brochure. As his platform he chose a photo from Rohde & Schwarz, showing Digital Radio Tester CTS55.**

## Module test systems from Rohde & Schwarz for automobile industry

**The monthly "Automobil Industrie", published in Würzburg, which looks at every kind of automobile topic, described in its 4/97 issue the problems of sensitivity to an electromagnetic environment resulting from the increased use of different kinds of controllers in car design. But it also showed the solution – the new Automotive Production Test System APTS from Rohde & Schwarz:**

At the end of 1996 Rohde & Schwarz presented the new Automotive Production Test System APTS from the family of TSUx systems. It is primarily intended for performance testing of all kinds of automotive electronic circuitry. What is special about it is a modular plug-in called the automotive load system (ALS). This can hold up to 24 modules for simulating the special loads and signal sources in automotive electronics. ... A number of modules for the major applications like ABS, airbag, motor management and chassis control are already available.

## The world's first, compact multimode radiocom tester for GSM, DCS1800, DCS1900 and DECT

**is how the British electronics magazine "Compliance Engineering" presented Digital Radiocommunication Tester CMD65 in edition 3-4/97:**

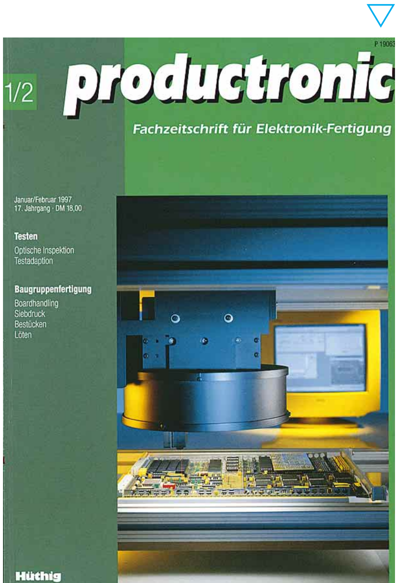
In Digital Radiocommunication Tester CMD65 Rohde & Schwarz has brought out the only instrument uniting GSM, DCS1800/1900 and DECT testing capability in a single unit. CMD65 is the latest model from the successful CMD platform, supporting GSM, DCS, DECT, PCD and CDMA tests on mobiles and base stations. In both volume and weight it is the smallest and lightest tester of its kind. (See also article on page 6 in this issue.)

## PostMan knocks on e:mail door

**"CommsMEA", a magazine appearing in the Middle East and Africa, reported in its 3/97 issue on Rohde & Schwarz's PostMan software:**

The PostMan message-handling software is one of the first solutions for the proven and cost-attractive shortwave medium that offers access to worldwide communication networks. PostMan opens up the whole world of international communication – formerly the reserve of cable networks – covering islands, deserts and the polar regions.

**Edition 1-2/97 of "productronic" showed a part view of the LaserVision II optical test system from Rohde & Schwarz on its title page and went on inside to tell of the benefits of this modern system for optical testing of populated boards.**




**The Austrian electronics magazine "Elektronikschau" showed a composition as the title spread of its 1-2/97 edition on the subject of electromagnetic compatibility, centering on Software Package EMS-K1 from Rohde & Schwarz.**


**The editors of the British magazine "What's new in Electronics" awarded TV Test Receiver EFA from Rohde & Schwarz a preferred positioning on the cover of their April 1997 issue.**

# Fast and secure data transmission on shortwave – result of intensive research

FIG 1 HF Transceiver XK2100 with integrated ALIS Processor GP2000 and HF Modem GM2100
Photo 42 878

The sophistication of Rohde & Schwarz's ALIS processor for automatic link setup and shortwave-link adaptability is the result of technical advances and continuous experimentation and trials [1]. By variation of the system parameters frame length, redundancy, type of modulation and frequency, the HF transceivers of the XK2000 family (FIG 1) [2] show high capability in adapting to time-variant channel quality and can achieve data rates up to 3.6 kbit/s using Modem GM2100 (max. 5.4 kbit/s) and the RSX.25 protocol.

## Measuring quality of shortwave channels

To obtain typical values for variations of channel quality with time and for the availability of shortwave channels, Rohde & Schwarz carried out trials with prototypes of the ALIS processor on a radio link between Hamburg and Munich at the beginning of 1985 [3]. After link setup, data blocks were sent continuously for periods of one hour at a rate of 100 bit/s, with transmitter output of 100 W, 2FSK modulation deviation of ±42.5 Hz and filter bandwidth of 150 Hz. BER (bit error rate) was continuously determined and recorded. FIG 2 shows typical BER over a period of one hour on a channel of good quality. For the most part it is below 1%. FIG 3 illustrates deterioration of the originally good channel quality after about 20 min and an increase of BER from less then 1% to figures between 10 and 50%.

Relative outages of the tested channels are presented in FIG 4 (mean values over two weeks). BER above 10% was considered a channel failure. Four outage spans were defined: 0 to 12.5 s/12.5 to 30 s/30 to 60 s/60 s to 1 h. The following results were obtained. Failures in the three groups below 60 s occur with approximately the same frequency, but this is considerably less than that for failures between 60 s and 1 h. In other words, if BER exceeds a threshold of 10%, the probability of the failure lasting longer than 1 min is significantly higher than the channel recovering after a short period. This leads to the conclusion that a change of channel is the best reaction for restoring quality once outage has reached 1 min.

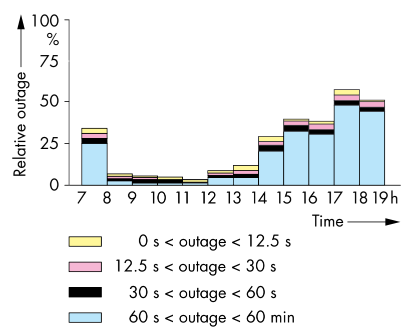



FIG 4 Relative outage of shortwave channels (FSK, 150 Hz bandwidth, 100 bit/s, 100 W)

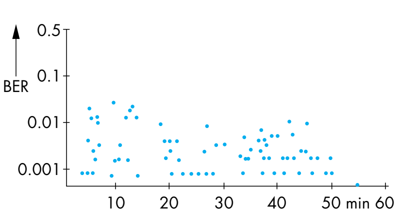



FIG 2 BER for shortwave channel between 9:00 and 10:00 h (7.512 MHz, FSK, 150 Hz bandwidth, 100 bit/s, 100 W)

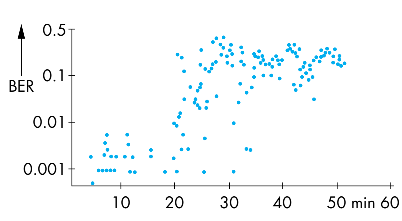



FIG 3 BER for channel between 15:00 and 16:00 h (8.165 MHz, FSK, 150 Hz bandwidth, 100 bit/s, 100 W)

## Automatic adaptation of system parameters to channel quality

The above trials showed that channel quality in Europe varies strongly and rapidly. For this reason the ALIS concept attaches great importance to adaptive matching of radio parameters to momentary channel quality. Based

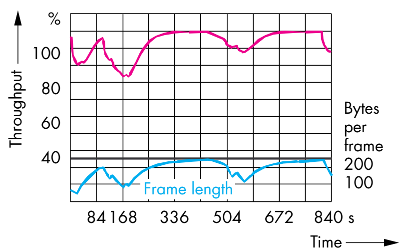



FIG 5 Throughput and frame length on good shortwave channels; low variation of channel quality and thus frame length

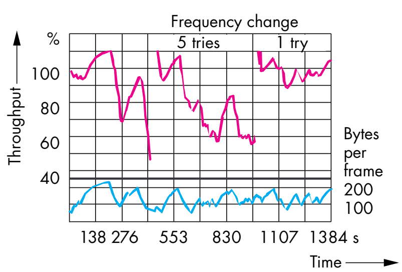



FIG 6 Throughput and frame length on medium-quality shortwave channels. Two adaptive frequency changes can be seen in center. In first case suitable frequency was found after five tries, in second case one try was sufficient.

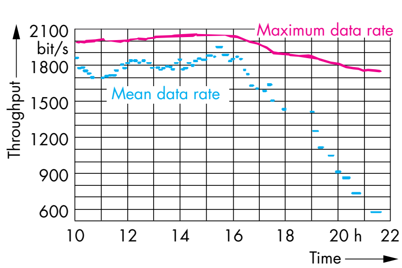



FIG 7 Mean throughput on channel during daytime (RSX.25, 8PSK); at about 16:00 h throughput starts to fall off.

on measurements of current channel quality, the system is provided with all the information needed for selecting or changing frequency when a link is set up and during data transmission. When a suitable frequency for link setup is selected, the levels last measured in the channels (passive channel analysis) plus a forecast analysis are taken as criteria for channel availability. Various parameters can be used to measure channel quality during transmission, ie active channel analysis. The efficiency of the data-transmission method is a highly indicative parameter, easy to obtain and adequate for deciding what measures to take. The following parameters can be varied to maintain an established link: transmitter output power, (frame) length of data packets, redundancy for detecting and correcting transmission errors, bandwidth, type of modulation (parameters directly affecting data rate) and frequency.

When the ALIS system was first implemented with a conventional FSK modem, the transmission channel was changed in the presence of persistent interference. With HF Modems GM857C4 and GM2000 [4] and the RSX.25 protocol, specially created for this purpose, it became possible to adapt several parameters – frame length, number of frames per packet and frequency – to channel quality. Plus there was the use of narrowband 2FSK modulation. RF power is not adapted because transmission is usually at full level and this would produce no improvement. The RSX.25 protocol used with the new modem generation is a modified AX.25 packet radio protocol. The advantages compared to earlier shortwave communication protocols are: use of a common channel in a network, routing and relay function, bidirectional communication and greater flexibility of frame structure due to asynchronous transmission. With 8PSK the net data rate of the serial modem with adaptive echo cancellation is 5400 bit/s. Errors are at first corrected by FEC (forward error correction, convolutional code, 1/2 code rate, Viterbi

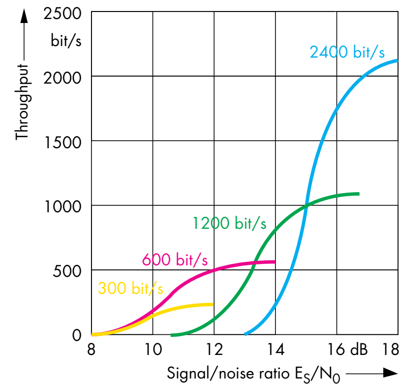



FIG 8 Adaptability of modem speed, throughput in bit/s versus S/N ratio $E_S/N_0$

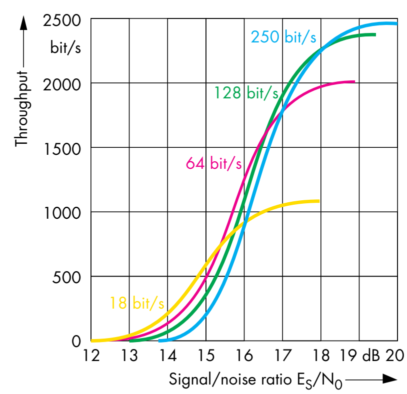



FIG 9 Adaptability of frame length (bytes/frame), throughput versus S/N ratio

decoding), which reduces net data rate to 2700 bit/s. Errors escaping FEC are eliminated by the ARQ (automatic repeat request) procedure of the RSX.25 protocol.

FIGs 5 and 6 show the results from field trials with HF Transceivers XK2000 on channels of good and medium quality. These trials were carried out in early 1993 on a link between Bonn and Munich. The upper trace represents the efficiency of the RSX.25 transmission protocol, while the lower one shows how frame length varies between 16 and 250 bytes. FIG 7 illustrates average throughput between 10:00 and 21:00 h on a particular day.

## Further improvement of RSX.25 transmission protocol

To investigate possibilities for improving the RSX.25 protocol, Rohde & Schwarz compared it by computer simulation with the STC protocol developed by and named after the Shape Technical Centre [5]. Major features of this STC protocol are the adaptive data rate of the modem, which matches type of modulation (8-, 4-, 2PSK) and redundancy, and selective repeat ARQ. The maximum data rate of the modem is 2.4 kbit/s, yielding a maximum data rate of the ARQ protocol of around 2 kbit/s. The RSX.25 protocol adapts frame length in the memory-go-back N-ARQ. The modem, otherwise identical, achieves a data rate of 2.7 kbit/s because of a different ratio of test to data bits. Thus a maximum data rate of 2.5 kbit/s is obtained for the RSX.25 protocol. However, even in the diagram normalized to the same modem rate and at higher S/N ratios, the transmission rate of the RSX.25 protocol is somewhat higher than that of the STC protocol because of the slightly lower overhead.

The advantages of an adaptive modem rate can be seen from FIG 8, those of the adaptive frame length from FIG 9, where the data-rate improvement is shown as a function of S/N ratio ($E_S/N_0$). The greater robustness of the modulation at lower modem rates is attained by increasing the phase angle of the mPSK modulation and the redundancy in the coder of the modem, while shortening frame length reduces the probability of bit errors in the frame and thus the need for data repetition.

The two protocols are compared in FIG 10. At low S/N ratios the adaptation of modulation method and redundancy has a greater effect, and here the STC protocol produces higher throughput. Above an S/N ratio of 17 dB, the throughput of the RSX.25 protocol is higher even in the normalized display because of the lower overhead, particularly when long frames

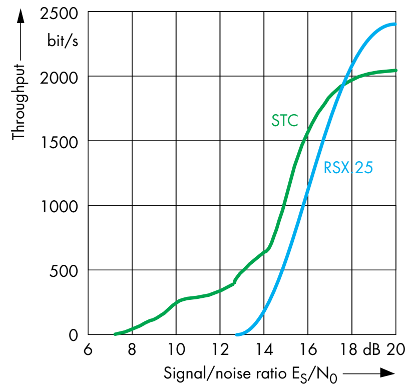



FIG 10 Comparison of STC and RSX.25 protocols, throughput versus S/N ratio

are transmitted. FIG 11 compares the RSX.25 protocol and an optimized form of it called RSop2. The latter uses an adaptive modem data rate, adaptive frame length and selective repeat ARQ. Throughput improves in the whole S/N range.

As a result of what was learnt from the comparative simulation, Rohde & Schwarz developed HF Modem GM2100 [6] for HF Transceivers XK2000. This offers different types of modulation (2-, 4-, 8PSK) and redundancy (1/2, 1/3, 5/6, 1/1 code rates) and features maximum data rate of 5400 bit/s. The modem was integrated in an optimized RSX.25 protocol that controls modulation and redundancy adaptation. With the aid of this protocol, data rates of 3600 bit/s can be achieved on undisturbed links, ie considerably more than the 2 to 3 kbit/s of conventional shortwave links.

Dr Günter Greiner

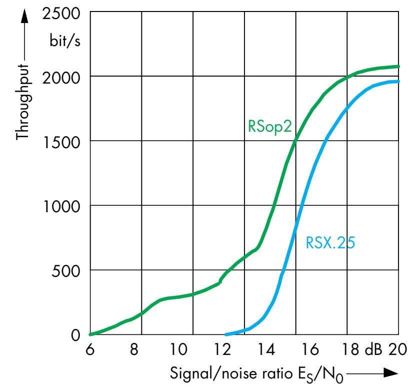



FIG 11 Comparison of RSop2 (RSX.25 + selective repeat ARQ + adaptive modem speed) and RSX.25 protocols

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