Catalog 94/95

Measuring Equipment
New Products

ROHDE&SCHWARZ

We are an independent manufacturer of electronic equipment and systems. Our name is synonymous with innovation, precision and quality. A leading position on the international markets and worldwide presence are the solid basis to our success.

Lasting customer satisfaction is central to our activities. Our market share is maintained through ongoing innovation, high-quality products and effective marketing. For the benefit of our customers, we are continually strengthening our capabilities and expand them by resorting to services and facilities of outside suppliers.

It is one of our principles to find the optimal solution to the customer's needs. Our quality assurance system is in line with the DIN ISO9001 standard.

Quality assurance verification for development and design, production, installation and service (DQS Certificate Reg. No. 10388-01) as well as AQAP 1. The verification system for the measurement equipment used complies with ISO10012-1, AQAP and MIL-STD-45662A.

ROHDE&SCHWARZ

... before you turn to the next page:

New products supplement to Measuring Equipment Catalog 93/94

This supplementary catalog informs you about all new products that have been launched on the market since the publication of our Measuring Equipment Catalog 93/94. Both catalogs will be valid until the publication of the next main Rohde & Schwarz Measuring Equipment Catalog.

You are looking for a suitable solution to your measurement problem?

- Choose the field of application from the Table of Contents (pages 2 and 3) and look for the associated product categories on the right-hand side.
- The page number indicated there will guide you to the table of contents of the individual chapters which are marked by thumb tabs.

You already know the name of the R&S instrument or its type designation?

- In this case, look for the desired instrument in the Type/Data Sheet Index at the end of the catalog, from page 142 onwards.

Specifications

Specifications given in this catalog are in part abridged. For full and binding specifications please refer to the relevant data sheet or system manual which are available on request.

Other Rohde & Schwarz publications

Sound and TV Broadcasting Measurements Catalog

– Excerpt from Measuring Equipment Catalog 93/94, chapter 3

Power Supplies Catalog

– Excerpt from Measuring Equipment Catalog 93/94, chapter 12

Sound and TV Transmitter Systems Catalogs

– Transmitter systems and components
– Antennas, air lines, filters
– Measuring and monitoring systems
– System planning, sound and TV broadcasting standards

Measuring and Monitoring Systems Catalog (sound and TV broadcasting)

– In-service equipment, generators, demodulators, measuring equipment
– Data transmission equipment
– Measuring and monitoring systems

Antennas Catalog (not for sound or TV broadcasting)

– Calculation formulas, diagrams
– Antennas, matching units, rotators, control units, power supplies

User Information for Radiomonitoring

– Receiving systems, components
– DF systems and components
– Radiocommunications equipment
– Antennas
– Standards and regulations
– Applications
– Questionnaires as planning support

Rigs and Recipes for Measurements and Monitoring of FM Sound and TV Broadcasting Systems

– Measurements outside and during transmission times
– Monitoring procedures

Data Sheets

In the Type/Data Sheet Index from page 142 onwards you will find the data sheet reference number (PD 7...) for each instrument. The data sheets come with colour illustrations and a detailed description of instrument features, applications and specifications.

News from Rohde & Schwarz

The Type/Data Sheet Index from page 142 onwards indicates the number of our in-house journal in which you can find an article from the development lab or test hints for a certain instrument. As a regular subscriber to News you will also be kept informed about all newly developed Rohde & Schwarz products. News from Rohde & Schwarz is published in German, English and French three times a year.

Application Notes

Additional technical literature from Rohde & Schwarz such as special publications on current items, refresher topics, compendia, etc. is available for various fields of application. Please contact your local sales engineer or Dept. HW-UKD (Fax +(4989) 4129-3208).

Technical Publications

The index of publications lists all R&S articles that were published in News from Rohde & Schwarz Nos. 132 through 139 and in other technical magazines in 1991 and 1992. We shall be glad to send you a copy of any publications from this index. Please address your requests to Dept. HW-UK (Fax +(4989) 4129-3208).

Request for printed material

Please fill in the reader service cards at the end of the catalog and we will promptly forward you the information requested. For even faster service: just send a fax to our International Sales and Service Division +(4989) 4129-3567.

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Indexes

Contents

Rohde&Schwarz: Competence in Radiocommunications and Measurements

Company Profile

Founded around 60 years ago by Dr. Lothar Rohde and Dr. Hermann Schwarz as a physico-technical development laboratory in Munich, the enterprise was in the beginning engaged in the development and production of high-precision laboratory test equipment. Very soon, the high quality standard of the laboratory became a byword amongst many large companies concerned with radiocommunications, which made the two young entrepreneurs in electronics a major supplier of measuring equipment.

The way from a pioneer for laboratory test equipment to becoming one of the largest European manufacturer of electronic measuring instruments is lined by numerous landmarks in the history of the company.

Today, Rohde&Schwarz is an internationally active company in the fields of radiocommunications and measuring equipment. For the past 60 years the company group has been developing, producing and selling a wide variety of electronic capital goods. The company headquarters are in Munich.

With 4500 employees worldwide and an international network of sales organizations, the Rohde&Schwarz company group attained a turnover of around DM 900 million in the business year 1992/93. The company is to a great extent export-oriented: about 50% of the total turnover is achieved outside Germany, more than half of it outside Europe.

Because of the technological edge of its products, Rohde&Schwarz is a market leader in many of its business fields. A decisive factor for this success is the high qualification of the company's staff. With about 250 trainees and working students per year, Rohde& Schwarz makes an important contribution towards the practical training of the coming generation of engineers.

Rohde&Schwarz is active in altogether seven business fields:

- mobile radio (communications and measurements)
- sound and TV broadcasting (communications and measurements)
- EMC measurements
- general-purpose measurements
- radiomonitoring and signal analysis
- radiocommunications
- service, training and logistics

Mobile Radio Measurements

As a pioneer in the field of mobile radio measurements, the company introduced its first 'intelligent' radio tester as early as 1974. Today, Rohde& Schwarz is a European market leader for mobile radio test equipment with a comprehensive program of measuring instruments and systems for analog and digital mobile radio.

The Munich company played an important role in the development of the European digital mobile radio standard GSM (global system for mobile communications): the test equipment for the approval of GSM mobile telephones and special mobile test systems for determining optimum sites for GSM base stations were supplied by Rohde & Schwarz.

As regards the mobile radio infrastructure, Rohde&Schwarz supplies complete, turnkey trunked radio systems. Most of the CHEKKER networks of the German Telekom have been implemented by Rohde&Schwarz as well as a substantial part of the Cityruf paging system of the Telekom.

Sound and TV Broadcasting

For more than 40 years Rohde& Schwarz has been concerned with sound and TV broadcasting equipment. Today, the company supplies turnkey TV and FM sound broadcasting networks, head stations for CATV networks, monitoring and analyzer systems for TV and sound broadcasting networks as well as a wide range of measuring instruments and systems for audio and video applications. Rohde&Schwarz not only participates in the European research program for HDTV but is also involved in the implementation of the digital audio broadcast system DAB.

Entrance of Rohde&Schwarz R&D center for microelectronics, measuring instruments and systems completed in 1990

EMC Measurements

Rohde&Schwarz is a leader on the world market for EMC measuring instruments and systems. European and worldwide standards have been and continue to be set up in collaboration with the company.

The company supplies high-precision test receivers, spectrum analyzers, signal generators, amplifiers and antennas for measuring EMI and EMS of electric and electronic components in machines, vehicles, etc. Rohde& Schwarz also designed complete turnkey EMC test stations for use in the car industry or in technical services and supplied all required measuring equipment.

General-purpose Measurements

Laboratory and general-purpose test equipment from Rohde&Schwarz reflects the present state of the art in many fields of application: signal generators, spectrum and network analyzers, voltmeters and power meters, AF analyzers, function generators and board testers from Rohde& Schwarz are used worldwide in development laboratories, production plants and service centers in industry and by research institutes and public authorities.

Radiomonitoring, Signal Analysis

Rohde&Schwarz can look back on decades of experience in the development and production of direction finders, receivers and antennas. For instance, the DF system of the new Munich airport has been supplied by Rohde & Schwarz. The company offers complete measuring and monitoring systems which permit authorities like the German PTT to monitor national and international radiocommunications. Mobile coverage measurement systems from Rohde&Schwarz are for instance being used by the German Telekom.

Radiocommunications

In this field, Rohde&Schwarz is one of the leading European manufacturers of VHF/UHF ground and onboard radio systems for air-traffic control. For more than 30 years the company has been developing and producing ATC and airborne radiocommunication systems.

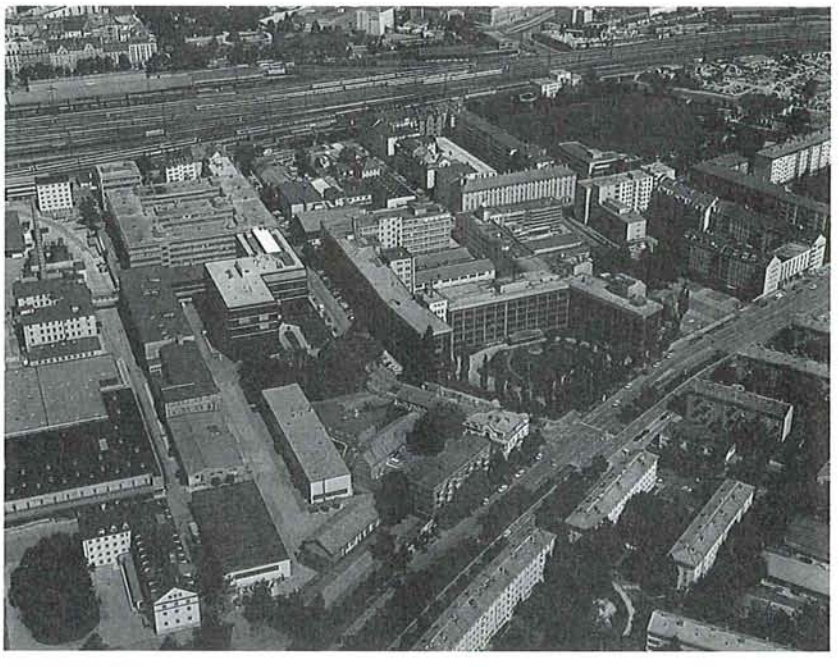
Presently, ATC authorities in more than 70 countries rely on Rohde&Schwarz radiocommunication equipment. The company also develops HF and VHF voice and data transceivers for airborne communication. The shortwave radio network used by the Federal Foreign Office for keeping in touch with German embassies around the world is also a Rohde&Schwarz product.

Training, Support and Service

Optimum service and comprehensive training is rated by Rohde&Schwarz with top priority. Service labs with ultramodern equipment in Munich, Cologne and in many of the international subsidiaries and agencies as well as mobile service centers ensure high availability of the measuring equipment of our customers.

In Cologne, the company maintains Europe's largest logistics center for maintenance and calibration of measuring instruments and radio equipment. At this center the company's own products as well as instruments and systems of other make are serviced, tested and repaired. In its capacity as an approved calibration center, Rohde&Schwarz calibrates measuring instruments for electric parameters.

Rohde&Schwarz provides training on instruments and systems, basic training seminars and retraining courses in line with customer requirements in Munich, Cologne or at the customers worldwide. In addition, Rohde& Schwarz prepares technical documentation for all kinds of products and systems to customer's orders.



Aerial view of Rohde&Schwarz headquarters Munich (1992)

Mobile Station Radiocommunication Test Set CRTP02 provides all simulation and analysis capabilities from measurement of GSM/DCS1800-specific signal parameters through to detailed checking for hidden errors in signalling

Contents of Chapter 1

Mobile Station Testers CMD52, CMD55

Compact testers for digital mobile phones (GSM, PCN) in production and service

SCPI

Uses

The CMD 52 from Rohde & Schwarz is a compact unit for testing GSM mobiles. The CMD 55 is furthermore capable of testing PCN (DCS 1800) mobile phones.

Both models are favourably priced and combine small dimensions with high measurement accuracy and speed. The testers' range of capabilities includes all signalling, generator and measurement functions required for verifying the correct operation of the DUT. Thanks to its fast go/nogo tests and accurate analysis using optional extensions, CMD 52 and CMD 55 are equally well suited for service and production.

Operation

Operation of the CMD is extremely user-friendly and requires no detailed GSM/PCN knowledge. The high-contrast, backlit LCD provided with softkeys on both sides allows convenient callup of test routines under menu control.

Various GSM-specific parameters are preset and permit direct testing without any operator control. In addition, it is of course possible to modify all parameters individually in the configuration menus.

Autotest

The autotest function enables complete measurement routines to be started at a keystroke without any further intervention by the operator being required. The test results in tabular form are displayed on the screen or output on a printer.

Remote control

The CMD is remote-controlled via the RS-232 or IEC/IEEE-bus interface using SCPI-compatible commands. In the remote-control mode the CMD is designed for fast speed to yield high throughputs in production.

Test capabilities

To test mobile phones, the CMD simulates a GSM or PCN base station. Two RF synthesizers, one of which delivers a continuous BCCH signal, are available for this purpose.

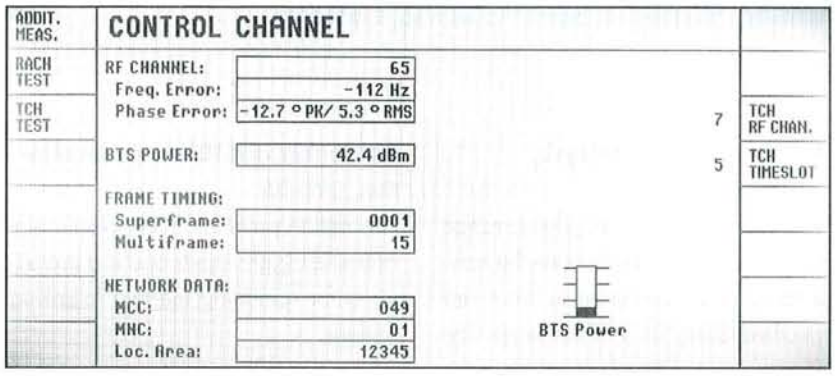
The major test functions are:

- mobile synchronization
- location update
- incoming call setup
- outgoing call setup
- mobile power level control
- handover (channel change, time-slot change)
- peak power measurement
- SACCH measurement (eg RxLev, RxQual, power level)
- echo test
- call clearing by mobile/by CMD
- DC current/voltage measurement
- phase error measurement (option)
- frequency error measurement (option)
- measurement of power ramping as a function of time (option)
- bit-error rate (BER) measurement (option)

Echo test

The echo test allows very rapid go/nogo analysis covering all essential parts of the mobile. A word spoken into the microphone of the mobile is sent to the CMD, stored in buffer memory and sent back to the phone.

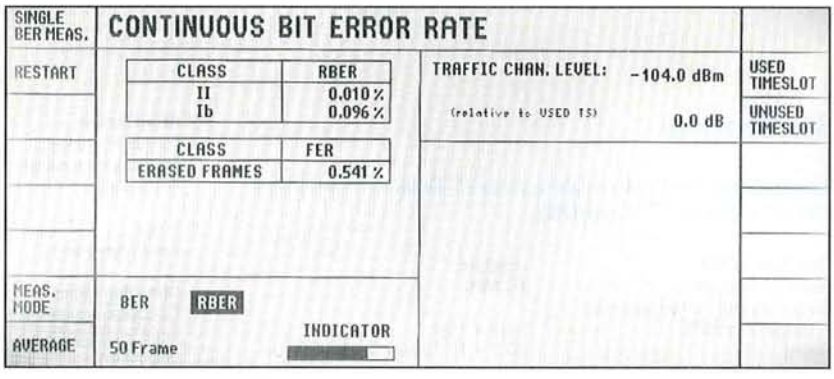
Voltage and power measurements
This measurement immediately shows any atypical behaviour of the DUT. The DC ammeter/voltmeter designed for pulsed signals allows correct measurement of the power consumption of the radiotelephone. To this effect, the CMD simultaneously measures the minimum, peak and average values, the averaging time constant being adapted to the GSM conditions.



Result of RF measurements on CO carrier

Testing handhelds
In addition to the normal RF input/output, the CMD has a high-sensitivity input and a high-level output which enable tests on modules or on handhelds with built-in antenna by using couplers.

Module testing
Fault localization in mobile telephones requires various measurement functions that can also be used without signalling so that defective units can be tested down to modular level. The basic model of CMD already provides some of these functions, other functions being available as optional extensions.



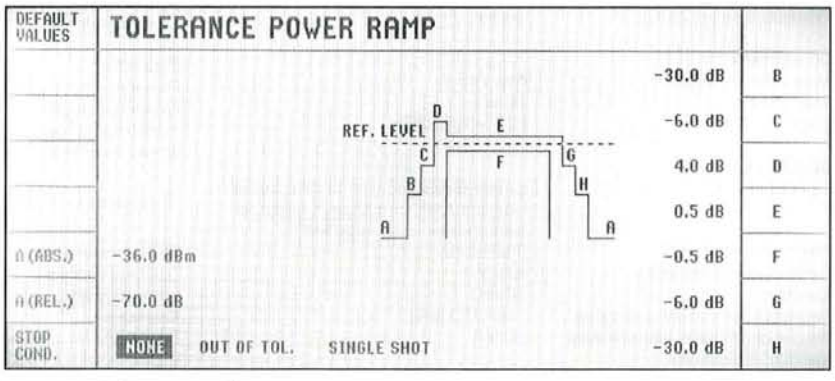
The dependence of the BER on the stimuli can be determined by simply varying the RF level. The BER is continuously measured and indicated.

Options

OCXO Reference Oscillator, CMD-B1
ensures high absolute accuracy, minimum temperature-dependent drifts and especially high long-term stability.

Reference Frequency Inputs/Outputs, CMD-B3
For synchronization of the DUT or CMD to an internal or external frequency of 2.048, 10, 13, 26 or 52 MHz or to the GSM bit clock.

Fast Power Ramp, Phase/Frequency Error and BER Measurement, CMD-B4
This option enables fast testing and numeric/graphic display of power bursts and phase and frequency error as well as various BER, RBER and FER test routines.



Presetting of tolerance mask for power ramp measurement

AF Measurement Unit with Frequency Counter, CMD-B41
For measurements on the audio interface or on modules this option includes an AF generator, a voltmeter, a distortion meter and a frequency counter. CMD-B41 enables measurements up to 60 MHz as are required for LO alignment. Another application is the testing of handsfree equipment.

1

Mobile Station Testers CMD52, CMD55

High Dynamic Burst Analysis, CMD-B42
This option doubles the dynamic range to more than 72 dB and allows the power ramp to be measured in the entire specified GSM/DCS 1800 range. The measurement determines whether the transmitter blanking in the inactive time slot is correct or not.

Bit Interface and TDMA Synchronization, CMD-B6
This option provides GSM-specific signals and trigger inputs and is a prerequisite for operating the two following options:

IEC/IEEE-bus Interface, CMD-B61
In addition to the standard-fitted RS-232-C interface, the CMD can be equipped with this remote-control interface.

Memory Card Interface, CMD-B62
Memory cards are a versatile medium for storing test results and instrument setups.

GSM Test SIM, CRT-Z2
The SIM card is required for most types of radiocom equipment to perform BER measurements in the loop-back mode.

Specifications

These specifications also replace those of Mobile Station Tester CMD 52 (catalog 93/94, page 39).

Time base TCXO	standard
Nominal frequency	10 MHz
Frequency drift in temperature range 0 to 35°C	≤1.5 x 10^{-6}
Aging	≤0.5 x 10^{-6}/year (at 35°C)
Time base OCXO	option CMD-B1
Nominal frequency	10 MHz
Frequency drift in temperature range 0 to 50°C	1 x 10^{-7}
Aging	2 x 10^{-7}/year 5 x 10^{-9}/day after 30 days of operation
Warmup time (at 25°C)	approx. 5 min
DC voltmeter	
Measurement range	0 to ±30 V
Resolution	10 mV
Error	≤2% + resolution
DC ammeter	
Operating modes	current averaging with GSM-adapted time constant, current peak measurement (positive and negative)
Measurement range	0 to ±10 A
Common-mode rejection	±30 V
Resistance	50 mΩ
Resolution for current averaging	1 mA/10 mA
Resolution for peak measurement	10 mA
Residual indication (no current at input)	≤10 mA (at room temperature)
Error	≤2% + residual indication + resolution
AF Measurement Unit	option CMD-B41
AF generator	
Frequency range/resolution	50 Hz to 10 kHz/0.1 Hz
Frequency error	same as time base + half resolution
Level range	10 µV to 5 V
Level resolution	10 µV at a voltage <1 mV 1% at a voltage ≥1 mV
Level error	≤5% at a voltage ≥1 mV
Distortion	≤0.5%
Max. output current	20 mA
Output impedance	<5 Ω
AF voltmeter	
Frequency range	50 Hz to 10 kHz
Measurement range	0.1 mV to 30 V
Resolution	100 µV at a voltage <10 mV 1% at a voltage ≥10 mV
Error	≤5% + resolution
Input impedance	1 MΩ
Distortion meter	
Frequency range	300 Hz to 3 kHz
Input level range	100 mV to 30 V
Resolution	0.1% of THD
Inherent distortion	≤0.5%
Error	≤5% + inherent distortion
Measurement bandwidth	10 kHz
AF counter	
Frequency range/resolution	20 Hz to 10 kHz/≤1 Hz
Frequency error	same as reference + resolution
Input level range	10 mV to 30 V
Input impedance	1 MΩ
IF counter	
Frequency range/resolution	10 kHz to 60 MHz/1 Hz
Frequency error	same as reference + resolution
Input level range	100 mV_{rms} to TTL
Input impedance	approx. 1 MΩ ||100 pF

Specifications of CMD 52 only

RF generator 1	
Frequency range	GSM band: 935.2 to 959.8 MHz
Frequency error	same as time base
Resolution	GSM channel spacing: 200 kHz
Frequency setting time	≤3 ms for phase error <2°
Output level (RF IN/OUT)	–33 to –120 dBm
Output level (RF OUT 2)	+13 to –77 dBm
Resolution	0.1 dB
Level error (RF IN/OUT)	≤1.5 dB (≤1 dB at –104 dBm)
Level error (RF OUT 2)	≤2 dB
Harmonics (RF IN/OUT)	<–30 dBc
Modulation	GMSK, B x T = 0.3
Phase error	≤4° rms, ≤10° peak
RF generator 2	same as RF generator 1, but
Maximum output level (RF IN/OUT)	–35 dBm (RF OUT 2: +11 dBm)
Level error (RF IN/OUT)	≤1.5 dB (RF OUT 2: ≤2 dB)
Peak power meter (RF IN/OUT)	
Frequency range	800 to 1000 MHz
Measurement range/resolution	10 to 47 dBm/0.1 dB

Error in GSM band	
890.2 to 914.8 MHz	≤0.5 dB + resolution (P >13 dBm)
VSWR	≤1.3
GSM phase and frequency error measurement	with option CMD-B4
Frequency range	GSM band: 890.2 to 914.8 MHz
Level range (RF IN/OUT)	10 to 47 dBm (RF IN 2: –60 to 0 dBm)
Inherent phase error	<1.5° rms, <5° peak
Frequency measurement error	<5 Hz + time base
GSM burst power measurement	with option CMD-B4
Frequency range	GSM band: 890.2 to 914.8 MHz
Reference level for full dynamic range (RF IN/OUT)	10 to 47 dBm (RF IN 2: –37 to 0 dBm)
Absolute measurement error of peak power	
RF IN/OUT	see peak power meter
RF IN 2	≤1 dB
Inherent ripple in active part of time slot	0.1 dB
Burst analysis with wide dynamic range	with option CMD-B42
Relative error of individual test sample	≤1.5 dB to 72 dB below peak power
Dynamic range	>72 dB
Measurement limit (RF IN/OUT)	<–36 dBm (RF IN 2: <–83 dBm)

Specifications of CMD 55 only

RF generator 1	like CMD 52, but
Frequency range	GSM band: 935.2 to 959.8 MHz DCS 1800 band: 1805.2 to 1879.8 MHz
Output level (RF IN/OUT)	–35 to –120 dBm
Output level (OUTPUT 2)	+11 to –77 dBm
RF generator 2	same as RF generator 1, but
Maximum output level (RF IN/OUT)	–37 dBm (RF OUT 2: +9 dBm)
Peak power meter (RF IN/OUT)	
Frequency range	800 to 1000 MHz 1700 to 1900 MHz
Measurement range	
GSM band	0 to 47 dBm
DCS 1800 band	0 to 33 dBm
Resolution	0.1 dB
Error in GSM band	≤0.5 dB + resolution (P >10 dBm)
Error in DCS 1800 band	≤0.8 dB + resolution (P>4 dBm)
VSWR	≤1.3
Phase and frequency error measurement	with option CMD-B4
Frequency range	GSM band: 890.2 to 914.8 MHz DCS 1800 band: 1710.2 to 1784.8 MHz
Level range	
RF IN/OUT	GSM band: 0 to 47 dBm DCS 1800 band: 0 to 33 dBm
RF IN 2	–60 to 0 dBm
Inherent phase error	<1.5° rms, <5° peak
Frequency measurement error	<5 Hz + time base
Burst power measurement	with option CMD-B4
Frequency range	GSM band: 890.2 to 914.8 MHz DCS 1800 band: 1717.2 to 1784.8 MHz
Reference level for full dynamic range	
RF IN/OUT	GSM band: 10 to 47 dBm DCS 1800 band: 0 to 33 dBm
RF IN 2	–37 to 0 dBm
Absolute measurement error of peak power	
RF IN/OUT	GSM band: ≤0.5 dB + resolution (P >10 dBm) DCS 1800 band: ≤0.8 dB + resolution (P >4 dBm)
RF IN 2	GSM band: ≤1.3 dB DCS 1800 band: ≤1.5 dB
Inherent ripple in active part of time slot	0.1 dB
Burst analysis with wide dynamic range	with option CMD-B42
Relative error of individual test sample	≤1.5 dB to 72 dB below peak power
Dynamic range	>72 dB
Measurement limit (RF IN/OUT)	GSM band:<–36 dBm DCS 1800 band: <–48 dBm
Measurement limit (RF IN 2)	GSM band:<–83 dBm DCS 1800 band: <–85 dBm

Interfaces

IEC/IEEE-bus interface	option CMD-B61 (option CMD-B6 also required) interface to IEC 625-1/IEEE 488, SCPI-compatible command set
Other interfaces	RS-232-C (9-contact) Centronics (25-contact)
Reference frequency inputs/outputs	option CMD-B3
Synchronization input	
Frequency (selectable)	GSM bit clock (270.8 kHz), 2/4/16 times GSM bit clock, 1 to 13 MHz in 1-MHz steps, 2.048, 26, 39, 52 MHz
Impedance	approx. 100 Ω
Level	0 dBm to TTL
Synchronization output 1	
Frequency	10 MHz with internal reference or frequency at synchronization input with external reference
Level	TTL, R_{out} = 50 Ω
Synchronization output 2	
Frequency (selectable)	GSM bit clock, 2/4/16 times GSM bit clock, 1, 2, 4 or 13 MHz
Level	TTL, R_{out} = 50 Ω

General data

Power supply	100 to 120 V (AC) ±10% 200 to 240 V (AC) ±10%, 50 to 400 Hz ±5%
Power consumption (without options)	CMD 52: approx. 85 W CMD 55: approx. 95 W
Dimensions (W x H x D)	435 mm x 192 mm x 363 mm
Weight (without options)	CMD 52: approx. 13.2 kg CMD 55: approx. 14.0 kg

Ordering information

Mobile Station Tester		
for GSM	CMD 52	1050.9008.52
for DCS 1800 and GSM	CMD 55	1050.9008.55
Extra		
GSM Test SIM	CRT-Z2	1039.9005.02
Options (for both models)		
OCXO Reference Oscillator	CMD-B1	1051.6002.02
Reference Frequency Inputs/ Outputs	CMD-B3	1051.6202.02
Fast Power Ramp, Phase/Frequency Error and BER Measurement	CMD-B4	1051.6654.02
AF Measurement Unit with Frequency Counter (CMD-B4 also required)	CMD-B41	1051.6902.02
High Dynamic Burst Analysis (CMD-B4 also required)	CMD-B42	1051.7150.02
IEC/IEEE-bus Interface (CMD-B6 also required)	CMD-B61	1051.7609.02
Memory Card Interface (CMD-B6 also required)	CMD-B62	1051.8205.02
Support for CMD-B6x Options	CMD-B6	1051.7409.02

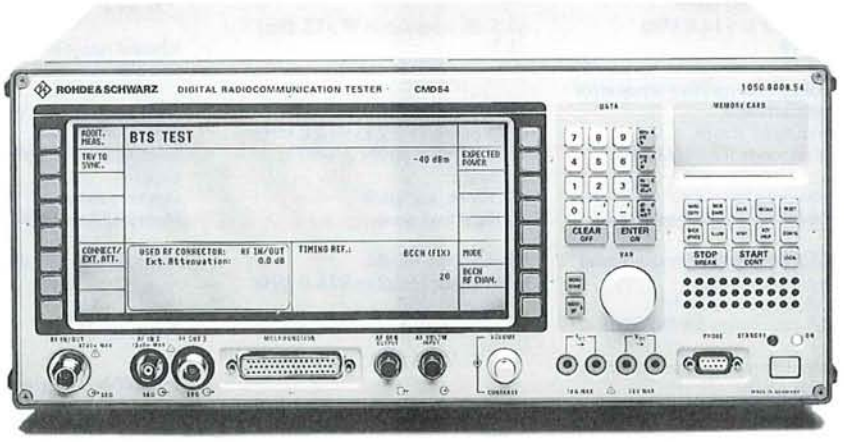
Base Station Testers CMD54, CMD57

Compact digital radiocommunication testers

CMD54: GSM

CMD57: GSM and PCN(DCS1800)

SCPI



Uses

The Base Station Testers CMD54 and CMD57 are especially designed to be used for the installation, service and production of GSM and PCN (DCS1800) base stations. They combine high measurement rates to ensure short testing times with top-class technical specifications for both transmitter and receiver testing. Both instruments belong to a new generation of radiocommunication testers which despite their compact size, low weight and great ease of operation provide a complete range of test and measurement capabilities.

Main features

- Complete range of transmitter and receiver measurements
- Large illuminated LCD display for fast reading of parameters and measured values
- Menu-guided user interface for quick tests as well as for in-depth analysis
- Softkey control with display of all the important parameters enabling operator to work error-free
- Extremely short setting and measuring times both in manual and in remote-control mode via IEEE bus

Operation

A user interface with large illuminated LCD display and softkeys on both sides to select the different menus allows easy operation even without detailed GSM knowledge. Numerical values are input with the hardkeys. Various test-specific parameters are preset and, as well as the measured values, displayed in easy-to-read form. The optional IEEE bus allows fast automated testing. The test results can also be logged on a printer.

Measurement capabilities

Overview

- Synchronization to RF C0 carriers with automatic channel selection
- Optional synchronization via external trigger line
- Display of important network parameters
- Peak power measurement
- Power ramping measurements with full GSM dynamic range
- Phase/frequency error measurement with graphical and numerical display
- Extremely fast measurement of spectrum due to switching/modulation
- Measurement of receiver sensitivity (BER) with different evaluation and connectivities such as:
  - loop-back inside the CMD
  - loop-back in the BTS or
  - transmission of standard test pattern with evaluation via RS-232 or IEEE-bus interface
- Optional A-bis interface for monitoring the bits received by the BTS in order to perform BER measurements
- Echo test
- DC voltage and current measurements especially for pulsed signals
- Optional AF generator and AF measurements with frequency counter

BTS module production

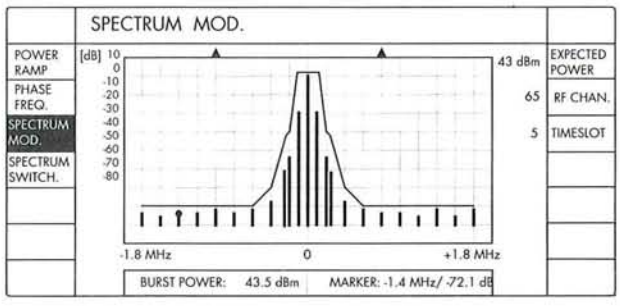
In BTS module production, factory-specific control interfaces, often without signalling possibilities, have to be combined with the test equipment. To solve such problems, the Base Station Testers CMD54 and CMD57 offer specific module test facilities, some of them optionally. For transmitter tests, functions such as direct measurement of power levels, phase/frequency error and power ramping with high dynamic range and accuracy are integrated in the instruments. In addition, very fast measurements of spectrum due to switching/modulation ensure complete testing of the BTS transmitter modules in the shortest possible time. Unmodulated and modulated RF carriers, as well as various ways of per-

forming BER measurements, allow fast sensitivity analysis of receiver modules.

Various trigger capabilities, eg RF and super frame clock, as well as control via RS-232 interface or optionally via IEC/IEEE bus (SCPI standard) ensure easy integration into any production line.

diocommunication tester. The CMD offers two modes for synchronization to C0 carriers:

- BCCH FIX: the CMD synchronizes to the specified channel number
- BCCH SCAN: the CMD searches for the C0 carrier



Spectrum due to switching/modulation

Final test, service and installation of a base station (BTS)

Measurements on base stations have to be performed under operating conditions. Typical GSM-specific channels, such as C0 carrier (broadcast channel/BCCH) and TCH (traffic channel) are available from the BTS and the system transmitter and receiver characteristics have to be measured. CMD54 and CMD57 fully meet these requirements.

External attenuators and/or amplifiers are taken into account for all settings and measurements, regardless of the input/output interfaces used by the ra-

Signalling information such as the Mobile Network Code (MNC) received on the BCCH is shown on the large LCD after synchronization. The results of the RF measurements performed on the C0 carrier, such as frequency and phase error as well as transmitted power, are displayed instantaneously on the screen.

In the TCH measurement menu, power ramping over the full GSM dynamic range or phase and frequency error can be measured and graphically displayed. Due to the use of high-speed DSPs, the CMD can measure the spectrum due to switching/modulation in line with the GSM specifications within less than 100 s, ie on a specific traffic channel and each of its 22 different frequency offsets, 500 bursts are captured and evaluated.

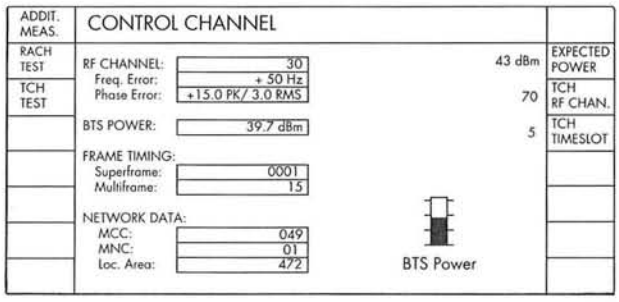
There are different ways of measuring the bit error rate (BER), such as loopback mode inside the CMD, or sending known bit patterns to be looped back or evaluated by the BTS. With the option CMD-B7 the CMD is in addition capable of monitoring the bits received by the BTS and measuring the BER via the A-bis interface.

Options

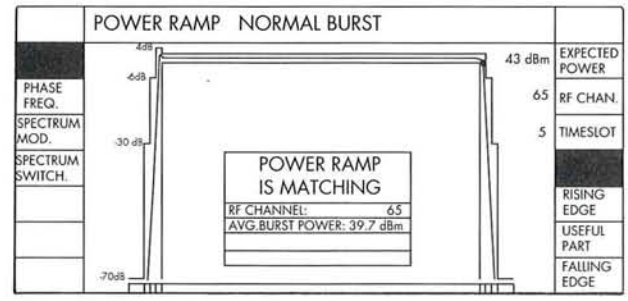
A-bis Interface CMD-B7

A-bis monitoring facilities for performing BER measurements.

All further options, see CMD52 and CMD55 on page 9. The options CMD-B4 and CMD-B42 described there are fitted as standard in the CMD54 and CMD57.



Results of RF measurements performed on C0 carrier



Power ramping with full GSM dynamic range

Base Station Testers CMD54, CMD57

Specifications

Common data for CMD54 and CMD57; data specified below differ from those of Mobile Station Testers CMD52 and CMD55, page 10.

Standard timebase TCXO, timebase OCXO (option CMD-B1), DC voltmeter, DC ammeter, AF measurement unit (option CMD-B41)	same as CMD52/55

Specific data of CMD 54

RF generator 1	
Frequency range	GSM band 890.2 to 914.8 MHz
Frequency error	same as timebase error
Resolution	GSM channel spacing (200 kHz)
Settling time	<3 ms (for phase error <2°)
Output level (RF IN/OUT / OUTPUT 2)	–33 to –120 dBm
Resolution	0.1 dB
Level error (RF IN/OUT / OUTPUT 2, burst with max. level)	1.5 dB (1 dB at –104 dBm)
Harmonics (RF IN/OUT)	<–30 dBc
Modulation	GMSK, B x T = 0.3
Phase error	<4° rms, <10° peak
Peak power meter	same as CMD52
GSM phase and frequency error measurement	
Frequency range	935.2 to 959.8 MHz
Level range (RF IN/OUT)	10 to 47 dBm
Level range (INPUT 2)	–60 to 0 dBm
Residual phase error	≤1.5° rms, ≤5° peak
Error of frequency measurements	≤5 Hz + timebase error
GSM burst power measurement	
Frequency range	935.2 to 959.8 MHz
Reference level range for full dynamic range measurements	
Level range (RF IN/OUT)	10 to 47 dBm
Level range (INPUT 2)	–37 to 0 dBm
Absolute error, peak transmitter power	
RF IN/OUT unsynchronized	same as peak power meter
RF IN/OUT synchronized to C0 carrier	≤1 dB
INPUT 2	≤1 dB
Ripple in active part of time slot	0.1 dB
High-dynamic GSM burst analysis	
Relative error of individual test samples	≤1.5 dB to 72 dB below peak power
Dynamic range	>72 dB
Lower measurement limit RF IN/OUT	<–36 dBm
Lower measurement limit INPUT 2	<–83 dBm
Spectrum due to modulation/switching	
Dynamic range	80 dB
Uncertainty	<±1.5 dB

Specific data of CMD 57

RF generator 1	
Frequency range	
GSM band	890.2 to 914.8 MHz
DCS1800 band	1710.2 to 1784.8 MHz
Frequency error	same as timebase error
Resolution	GSM channel spacing (200 kHz)
Settling time	<3 ms (for phase error < 2°)
Output level (RF IN/OUT / OUTPUT 2)	– 35 to –120 dBm
Resolution	0.1 dB
Level error (RF IN/OUT/OUTPUT 2, burst with max. level)	≤1.5 dB (≤1 dB at –104 dBm)
Harmonics (RF IN/OUT)	< –30 dBc
Modulation	GMSK, B x T = 0.3
Phase error	<4° rms, <10° peak
Peak power meter	same as CMD55
Phase and frequency error measurement	
Frequency range	
GSM band	935.2 to 959.8 MHz
DCS1800 band	1805.2 to 1879.8 MHz
Level range (RF IN/OUT)	
GSM band	0 to 47 dBm
DCS1800 band	0 to 33 dBm
Level range (INPUT 2)	–60 to 0 dBm
Residual phase error	≤1.5° rms, ≤5° peak
Error of frequency measurements	≤5 Hz + timebase error
Burst power measurement	
Frequency range	
GSM band	935.2 to 959.8 MHz
DCS1800 band	1805.2 to 1879.8 MHz
Reference level range for full dynamic range measurements	
Level range (RF IN/OUT)	
GSM band	10 to 47 dBm
DCS1800 band	0 to 33 dBm
Level range (INPUT 2)	–37 to 0 dBm
Absolute error, peak transmitter power	
RF IN/OUT unsynchronized	same as peak power meter
RF IN/OUT synchronized to C0 carrier	
GSM band	≤1.3 dB
DCS1800 band	≤1.5 dB
INPUT 2	
GSM band	≤1.3 dB
DCS1800 band	≤1.5 dB
Ripple in active part of time slot	≤0.1 dB
High-dynamic GSM burst analysis	same as CMD55
Spectrum due to modulation/switching	
Dynamic range	80 dB
Uncertainty	<±1.5 dB

Interfaces

IEC/IEEE Bus Interface	option CMD-B61 (option CMD-B6 also required); interface to IEC 625-1/IEEE 488, SCPI-compatible command set
Other interfaces	RS-232-C (9-pin), Centronics (25-pin)
Reference Frequency Inputs/Outputs	same as CMD52/55 (option CMD-B3)
A-bis Interface	option CMD-B7
Physical (1 RX channel)	75 Ω/high-impedance, unbalanced; 120 Ω/high-impedance, balanced
Logical (traffic/speech)	16 kbit/s, timeslot selectable

General data

same as CMD52/55

Ordering information

Base Station Tester	CMD54	1050.9008.54
	CMD57	1050.9008.57
Options		
OCXO Reference Oscillator	CMD-B1	1051.6002.02
Reference Frequency Inputs/Outputs	CMD-B3	1051.6202.02
AF Measurement Unit	CMD-B41	1051.6902.02
Adapter for Options IEC/IEEE Bus Interface (CMD-B6 also required)	CMD-B61	1051.7609.02
A-bis Interface	CMD-B7	1051.8357.02

Extremely powerful test set, providing all simulation and analysis capabilities from measurement of GSM/DCS1800-specific signal parameters through to detailed checking for hidden errors in signalling

Uses

The Mobile Station Radiocommunication Test Set CRTP02 from Rohde & Schwarz simulates a base station (BTS, cell) in the GSM and PCN (DCS1800) bands.

Development

- Measurements on GMSK-modulated RF signals and receiver testing
- Testing of all signalling functions and validation of data transmission protocols and timing
- Simple generation of customized test procedures

Type approval and quality assurance

- Complete testing for conformance with GSM Recommendations 11.10 and DCS1800 Recommendations with respect to
  - channel coding (OSI layer 1),
  - data link protocols (OSI layer 2),
  - network signalling (OSI layer 3) and
  - all GSM-specific RF parameters
- Automatic measurements and logging using test routines supplied

Chip design

- Thanks to built-in TTL inputs/outputs for the transmit and receive path, CRTP02 is ideal for use in development and validation of integrated circuits and modules

Production

- Fast and reliable testing of modules and of complete mobile stations

Service

- Automatic test routines for reliable evaluation of equipment status
- Comprehensive measurement capabilities for extensive troubleshooting

Characteristics

Main features

- Simulation of a base station with call setup, data transfer and all signalling procedures between CRTP02 and the station under test
- Logging of all signalling activities in OSI layers 1, 2 and 3 for protocol analysis; mnemonic display of message content for protocol troubleshooting
- Checking the error-correction facilities of the mobile station by implanting errors in the data stream
- Measurements on the transmitter signal
  - power ramp and phase trajectory
  - burst delay
  - frequency error
- Measurements on the receive channel
  - bit error rate in realtime
  - receiver sensitivity
- Tests on speech coder and decoder

Mobile Station Radiocommunication Test Set CRTP 02

- Numerical and graphical output of results on screen or printer
- Wide variety of audio measurements with optional CRTP-B1

Signal generation

The analog unit provides two independent RF generator channels. Using these two channels, the test set can simultaneously simulate and test a control channel (BCCH + FCCH + SCH + CCCH) and a traffic channel (TCH + FACCH). For measuring the receiver sensitivity, a fading simulator can be connected into each of the output circuits. Transmission with or without frequency hopping is possible on all channels.

The two signals are GMSK-modulated and are timed as bursts to occupy exactly one or all of the eight GSM/PCN timeslots. The timing of the bursts can be adjusted, the amplitude can be varied dynamically over a 40-dB range.

Signal measurement

A receive channel is allocated to each of the generator channels. It is offset by a duplex spacing of 45 or 95 MHz relative to the generator channel, even under hopping conditions. The digital signal is recovered by a precise GMSK demodulator. In addition, the signal in each of the receive channels is sampled. The phase and amplitude samples are stored and used for computing the signal parameters such as burst delay, phase and frequency error as well as power ramping. A separate input and output are provided for testing the transmitter and receiver unit of a mobile station.

Operation

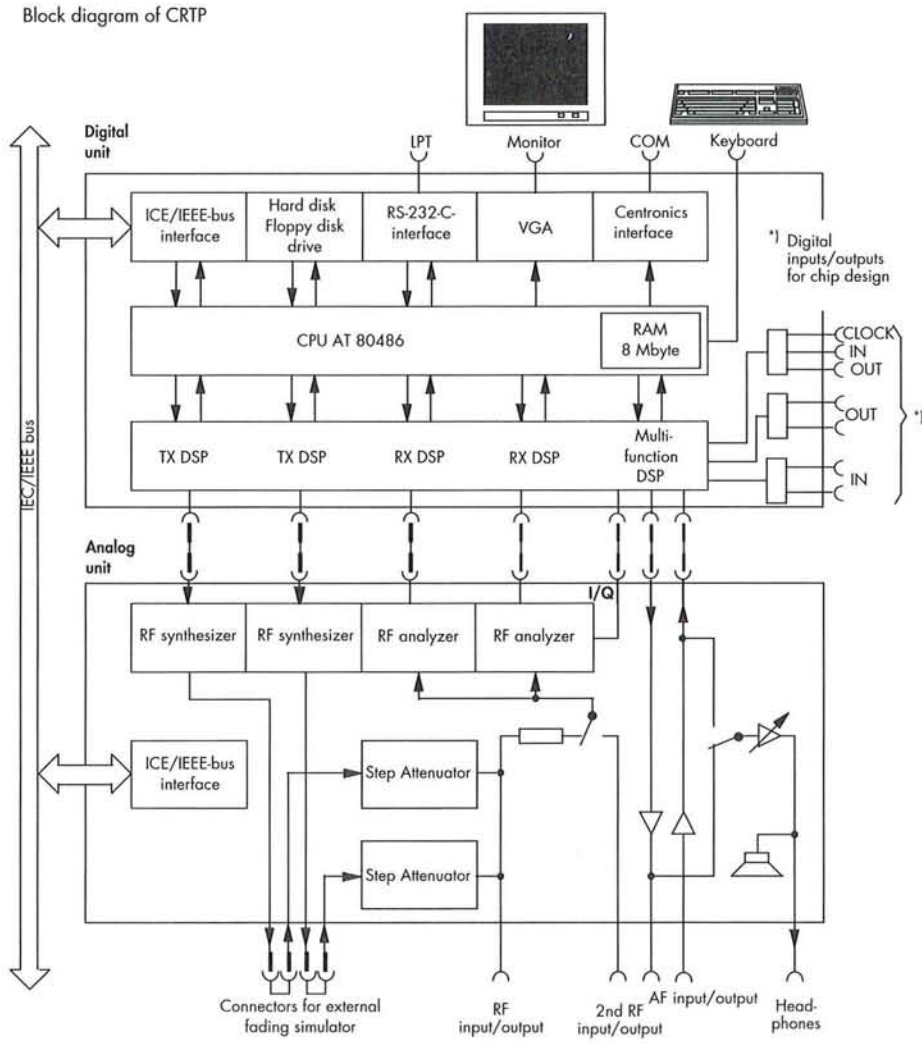
User-friendly software saves time

For development and quality control tasks, full flexibility is given by the possibility of varying procedures, signalling parameters and result display.

For production testing, overview measurements and service tasks, complete test routines supplied with the equipment ensure reliable test results and ease of operation. A menu-driven editor in line with coding rules 4.08 allows convenient entry of messages and system information simply by filling out tables. A comfortable, window-oriented user interface simplifies the generation of user-specific test routines. Test programs are written in Borland C++. The use of such a standard language eliminates the long training periods needed for special test languages and offers the user high flexibility.

The complete software, including message library, control programs and test results, is stored on a hard disk. The built-in floppy drive permits backup to be made and loading of stored data. The digital unit may further be used as an IEC/IEEE controller, allowing extension of the test set by including external instruments. The test sets contain both the IEC/IEEE-bus interface and the necessary software drivers.

Block diagram of CRTP



Measurement capabilities

Standard measurements
CRTP02 is supplied with an extensive test software package. These test programs are available in source code and can also be used as starter programs for generating user-specific programs. The user can either modify the programs supplied or generate his own programs.

The test routines fully comply with specifications
- Receiver sensitivity in speech channel (TCH/FS) and in user-data and control channels
- Receiver input level range
- Layer 2 signalling of mobile station
- Call setup (MS originated and terminated call)
- Absolute delay and timing advance
- Delay measurement function
- Intra-cell power change
- TX power control
- Phase and frequency error
- Power ramp of burst

In addition to this software supplied with the equipment, further programs are available allowing testing and measurements exactly in line with specifications for type-approval testing.

Signalling
CRTP02 accurately simulates for all tests the functions of an ideal base station. For troubleshooting on the station under test, the signalling parameters can also be varied. All layer 1 channel coding as well as layer 2 signalling is automatically performed in realtime. The layer 3 signalling sequence is defined by special test programs.

Protocol analysis
Every transmitted or received layer 2 or layer 3 message and every burst can be marked with a frame number and recorded in the log memory. Depending on whether everything is logged or just selected logical channels, the log can cover a period of up to 15 minutes. The logged messages are displayed in mnemonic form on the screen, using the same basic mask as the message editor.

Burst analysis
After data have been logged, power ramping as well as phase and frequency errors are calculated and displayed as a whole. Detailed analysis is supported by the zoom function.

To check the timing-advance measurement function of a mobile station, CRTP 02 measures the arrival time of the burst and monitors the response of the mobile station to timing advance commands in the generator channels. To permit synchronization of external measuring instruments, eg a spectrum analyzer, CRTP02 has a trigger output for automatically starting measurement at the beginning of a burst.

Testing the receiver sensitivity
In the loop-back mode, bit error rates (BER) can be measured in realtime to test the receiver sensitivity of a mobile station.

Acoustic tests
These tests are supported by the built-in speech codec function of CRTP02.

AF measurements
A wide range of audio measurements can be performed on the AF section of the station under test. The AF generator provides single or double tones. The following measurement functions are implemented:

- AF voltmeter with RMS or peak weighting
- Continuously tunable distortion and SINAD meter
- AF frequency counter
- DC ammeter/voltmeter

Abbreviations used

ACCH:	**A**ssociated **C**ontrol **CH**annel
BCCH:	**B**roadcast **C**ontrol **CH**annel
BFI:	**B**ad **F**rame **I**ndication
CCCH:	**C**ommon **C**ontrol **CH**annel
C0:	Physical channel used for control functions
DAI:	**D**igital **A**udio **I**nterface
EMMI:	**E**lectrical **M**an **M**achine **I**nterface
FACCH:	**F**requency **C**ontrol **CH**annel
GMSK:	**G**aussian **M**inimum **S**hift **K**eying
OSI:	**O**pen **S**ystem **I**nterconnection
SACCH:	**S**low **ACCH**
SAPI:	**S**ervice **A**ccess **P**oint **I**ndicator
SCH:	**S**ynchronization **CH**annel
SDCCH:	**S**tand-alone **D**edicated **C**ontrol **CH**annel
TCH:	**T**raffic **CH**annel
TCH/FS:	**T**raffic **CH**annel/**F**ull **S**peech

Mobile Station Radiocommunication Test Set CRTP02

Specifications

Analog unit

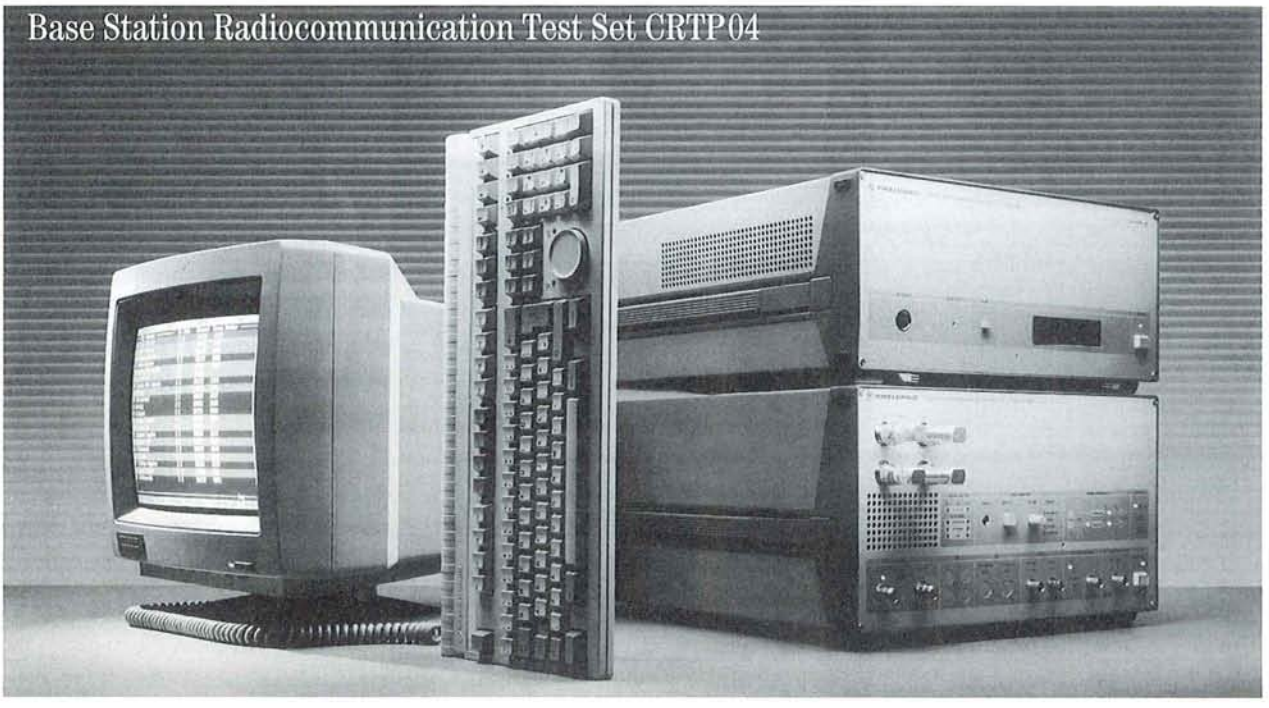
Signal generator		
Frequency range	GSM band	935 to 960 MHz
	DCS1800 band	1805 to 1880 MHz
Hop size		any frequency step within GSM/DCS1800 band
Frequency fine tuning		0 to 60 kHz with about 2 Hz resolution
Frequency setting time		<500 µs (to within <4° of final phase)
Spurious phase modulation		<1° RMS, <4° peak
Aging		$<2x10^{-9}$/day (after 30 days of operation)
Frequency drift		$<2x10^{-9}$/°C
Maximum output level		13 dBm
Static attenuation setting		0 to 135 dB
Resolution		5 dB
Dynamic attenuation		0 to 35 dB (electronic)
Level error		<1.5 dB from –127 to +13 dBm (with dynamic attenuation at 0 dB)
Modulation		GMSK, bit rate 270833 bit/s to GSM Rec. 05.04
Burst delay		–4.6 to +4.6 ms variable in steps of 0.46 µs
Analyzer		
Frequency range	GSM band	890 to 915 MHz
	DCS1800 band	1710 to 1785 MHz
Reference level for full dynamic range		9 to 36 dBm for $RF_{IN/OUT}$, –21 to +6 dBm for RF_{IN2}, adjustable in 3-dB steps
Level error		<2 dB
Sampler		two 12-bit A/D converters for I and Q signals, sampled at 1.083 MHz (4 samples per bit)
Synchronization		10-MHz output, 10-MHz input/output, 52-MHz output, slot sync output
Inputs/outputs		
Fading simulator		2 N female connectors, 50 Ω per channel
Output level		8 to 13 dBm
$RF_{IN/OUT}$ and RF_{IN2}		N female connectors, 50 Ω
Speech coder input		20 mV to 2 V (R_{in} = 100 kΩ), full dynamic range
Speech decoder output		2 V (R_{out} <3 Ω), full dynamic range
Audio monitor		built-in loudspeaker, headphones connector, volume control
Modes		voltmeter, AF generator, speech decoder, speech coder
AF measurement unit		
Signal source		single or dual tone
Frequency range		20 Hz to 20 kHz
Output level (rms)		10 µV to 5 V
Output impedance		<3 Ω
AF voltmeter		
Modes		RMS, +Peak, –Peak
Frequency range		50 Hz to 20 kHz
Level range (rms)		0.1 mV to 30 V
Weighting filters		
CCITT filter		to CCITT 0.41
Programmable highpass filter		107 Hz to 10.6 kHz
Programmable lowpass filter		235 Hz to 21 kHz
Programmable notch filter		100 Hz to 5 kHz (notch frequency)
Distortion and SINAD meter		
Fundamental frequency range		100 Hz to 5 kHz
Measurement range		0 to 50%, 1 to 50 dB
AF frequency counter		
Frequency range		20 Hz to 500 kHz
Resolution		0.1 Hz/1 Hz
Input level (up to 20 kHz)		10 mV to 30 V
DC measurements		
Voltage		0 to ±30 V
Current		0 to ±10 A
I/Q inputs/outputs		
I/Q inputs for up/down converter		adjustable level and level offset
I/Q outputs for up/down converter		fixed level ±1.5 V (peak)

Digital unit

Processor	80486 DX, 33 MHz
RAM	8 Mbyte
Hard disk	200 Mbyte
Floppy disk drive	$3\frac{1}{2}$", 1.44 Mbyte
Graphics	VGA
Interfaces	IEC-625 bus (IEEE 488), RS-232-C, Centronics, keyboard connector on front and rear, CODEC input/output, control interface, DAI/EMMI
Layer 1 functions	
Channels supported	C0 channel with FCCH + SCH + BCCH + CCCH + SDCCH/4 + SACCH/C4; TCH/SDCCH channel with TCH + FACCH + SACCH or SDCCH/8 + SACCH/C8 (TCH is TCH/FS or TCH/F9.6, TCH/F4.8, TCH/F2.4, TCH/H4.8, TCH/H2.4)
Ciphering and frequency hopping	with or without on all channels
Layer 2 functions	
Signalling	all logical channels for SAPI 0 and 3
User data	transparent mode
Layer 3 functions	defined by user programs
Programming language	Borland C++
Starter programs	included for key test runs
GSM-specific measurements	
Bit error rate	measurement of receiver sensitivity in loop-back mode
Phase/frequency error, peak transmitter carrier power, burst delay and simulation of delay in downlink/uplink	to GSM recommendations
Presentation of results	
GSM-specific measurements	graphical or numerical
Messages and signalling (content of log memory)	alphanumeric in mnemonic form
General data	
Power supply	110/220 V ±10%, 47 to 63 Hz, 500 VA
Dimensions (W x H x D); weight	
Analog unit	435 mm x 236 mm x 570 mm;28 kg
Digital unit	435 mm x 192 mm x 570 mm;18 kg
Monitor	357 mm x 304 mm x 397 mm;14 kg
Keyboard	446 mm x 42 mm x 210 mm;1.7 kg

Ordering information

Mobile Station Radiocommunication Test Set	CRTP02	1052.6506.02



Test set for development, validation, quality assurance and production of GSM and PCN (DCS 1800) base stations

Uses

Following the successful introduction of digital mobile-radio networks D1 and D2, network E1 to the new PCN/DCS 1800 standard is being installed in Germany. Manufacturers of base stations and network operators need highly accurate and flexible test equipment, especially in the setup stage of a mobile-radio network.

The Base Station Radiocommunication Test Set CRTP 04 is the optimum solution for all kinds of measurements required for base stations of the Personal Communication Network PCN. It allows design verification at the development and system integration stages, providing an ideal preparation for acceptance tests at the manufacturer's. Moreover, it can be used by network operators, PTTs and test houses to carry out commissioning and maintenance tests on individual items of equipment. CRTP 04 tests the hardware characteristics and signalling software of PCN base stations and that they are interworking correctly.

Main features

- Comprehensive test capabilities
  - Protocol logging
  - Signalling measurements
  - GSM phase 2
  - Transparent/non-transparent data services
  - Short-message service
  - RF measurements
- GMSK modulation and demodulation, TDMA structure and RF measurements and signalling capabilities to GSM and DCS 1800 specifications
- Freely programmable radiocommunication tester for generating test routines or modifying existing programs using the source code supplied
- Test routines for the most important applications such as link setup, RF signal analysis and speech coding/decoding included
- Five digital signal processors for realtime signalling, RF signal analysis and speech coding/decoding
- Two full-duplex RF receive and transmit channels with fast frequency-hopping synthesizers for the entire DCS 1800 and GSM bandwidth
- Excellent signal quality

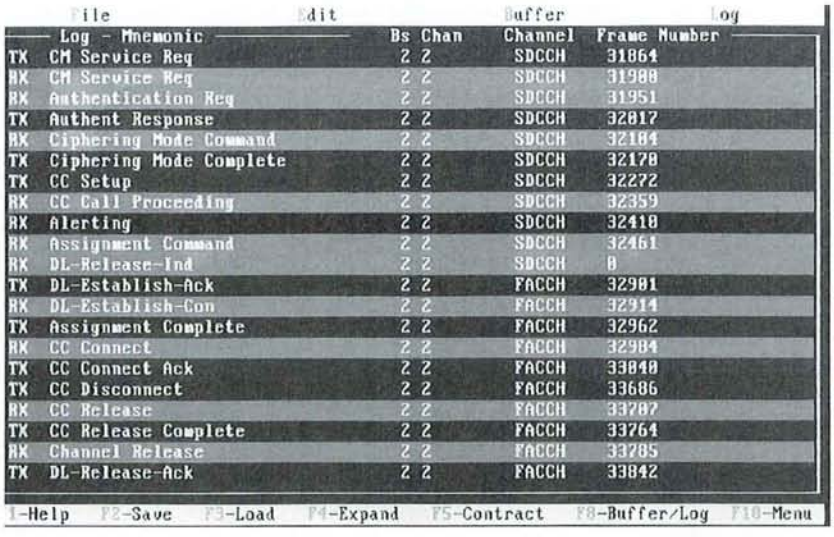
Software concept, operation

Ready-to-use programs (GSM Rec. 11.20)

The CRTP 04 is connected to the radio interface of a base station transceiver (BTS) and simulates mobile station functions.

Dialog programs ask for parameters such as CO carrier channel number, estimated transmitted BTS power, etc. This ensures easy adaptation to every BTS. The values are stored for the next test so that they can either be used again or modified if necessary.

Base Station Radiocommunication Test Set CRTP04



The message editor shows the signalling captured in the log memory

The test programs assume that the base station is connected to a mobile switching center (MSC) so no special A-bis or A interface test equipment is required.

The test programs automatically generate a pass/fail result which in many cases is complemented by additional error messages. The complete signalling sequence is stored in the log memory of the CRTP 04, thus enabling an exact analysis of messages from layer 3 to layer 1 (OSI reference model).

User-specific programming

The ready-to-use test programs are written in C and supplied in source code. They may be used as a basis for the user's own test programs. The user is thus able to modify programs, eg to locate error sources in the base stations. Frequently occurring functions such as location update, mobile originated/mobile terminated calls as well as measurements of BER, phase/frequency error and power time template can be taken from the ready-to-use programs and incorporated into the user's own programs. Support tools such as compiler and message editor are supplied with the instrument.

Evaluation capabilities

The menu-driven message editor (GSM 4.08) permits the entry of layer 3 messages by simply completing tables. Another program allows the data recorded to be displayed in mnemonic form. The output format is identical to the entry mask.

All GSM/DCS 1800 specific test results (phase characteristic, burst delay) are displayed by the CRTP in numerical or graphical form and can be output on a printer.

Design

The CRTP 04 consists of a digital unit, an analog unit, a colour monitor and a keyboard.

Ready-to-use test programs supplied with CRTP 04

2.1.6.1	Static layer 1 functions
2.1.6.2	Modulation, phase error and mean frequency error
2.1.6.3	Mean transmitted RF carrier power
2.1.6.4	Transmitted RF carrier power versus time
2.1.7.1	Static layer 1 receiver functions (nominal error rates)
2.1.8.3.1	BCCH multiframe
2.1.8.3.3	TDMA frame structure
2.1.8.3.4	SACCH multiframe
2.2.2.2.8.1.1	Normal initialisation (contention resolution)
2.2.2.2.8.1.2.1	Repeated SABM (loss of UA frame)
2.2.2.2.8.1.2.2	SABM's with different information fields
2.2.2.2.8.1.3	Normal initialisation (no contention resolution)
5.1.1.1	Location updating procedure
5.1.1.2a	Mobile originated call establishment (SDCCH combined)
5.1.1.2b	Mobile originated call establishment (SDCCH not combined)
5.1.1.3	Mobile terminated call establishment
5.1.3.1	System information
5.1.3.2	Service request in SABM frames
5.1.3.3	Random access by MS and immediate assignment
5.1.3.4	Paging

Digital unit

The core of the digital unit is a 80486 microprocessor. The high speed required for realtime signalling and fast measurements is ensured by five digital signal processors connected to the analog unit via fast interfaces. A 200-MByte hard disk with short access time offers sufficient memory for system software, user programs and measured data.

Analog unit

Extremely high signal quality and low measurement error ensure that the measured data of the base station under test are not impaired by characteristics of the measuring instrument. Each of the full-duplex channels is equipped with a fast frequency-agile synthesizer, a GMSK modulator, an output stage for level generation and a demodulator. A second sensitive RF input enables for instance measurements via a coupler connected to the input. Several LEDs on the front panel indicate essential signal states and instrument setups in realtime. At the transmitter end, fading simulators can be looped into the signal path for realistic radio traffic area simulation.

Specifications

Analog unit

Signal generator	
Frequency range	GSM band 890 to 915 MHz DCS 1800 band 1710 to 1785 MHz
Hop width	any frequency step within the GSM/DCS 1800 band
Frequency tuning	0 to 60 kHz with approx. 2 Hz resolution
Frequency setting time	<500 µs, within <4° from final phase
Spurious phase modulation	<1° rms, <4° peak
Aging	<2 x 10^{-9}/day (after 30 days of operation)
Frequency drift	<2 x 10^{-9}/°C
Maximum output level	13 dBm
Static level attenuation	0 to 135 dB
Resolution	5 dB
Dynamic level attenuation	0 to 35 dB (electronically)
Level error	<1.5 dB from –127 to +13 dBm (dynamic level attenuation 0 dB)
Modulation	GMSK, bit rate 270833 bit/s to GSM Rec. 05.04
Analyzer	
Frequency range	GSM band 935 to 960 MHz DCS 1800 band 1805 to 1880 MHz
Reference level range for full dynamic range	
GSM band	+13 to 47 dBm for $RF_{IN/OUT}$, –17 to +19 dBm for RF_{IN2}
DCS 1800 band	+9 to 36 dBm for $RF_{IN/OUT}$, –21 to +6 dBm for RF_{IN2}
Level error	<2 dB
Spurious phase modulation	<1° rms, <4° peak
Duplex spacing	
GSM	45 MHz
DCS 1800	95 MHz
Sampler	two 12-bit A/D converters for I and Q signals, sampling rate 1.083 MHz (4 samples per bit)
Synchronization	10-MHz output, 10-MHz input/output, 52-MHz output
RF inputs/outputs	
Fading simulator	2 N-type connectors, 50 Ω per channel
Output level	8 to 13 dBm
$RF_{IN/OUT}$ and RF_{IN2}	N connectors, 50 Ω
Speech coder input	
Input voltage for full dynamic range	20 mV to 2 V (R_i = 100 kΩ)
Speech decoder output	
Output voltage at full dynamic range	2 V (R_o <3 Ω)
Audio monitor	built-in loudspeaker, headphone connector, level selectable
Operating modes	voltmeter, AF generator, speech decoder, speech coder

Digital unit

Processor	80486 DX, 33MHz
RAM	8 MByte
Hard disk	200 MByte
Disk drive	3.5", 1.44 MByte
Graphics	VGA
Interfaces	RS-232-C, Centronics, keyboard connector on front and rear panel, input/output for speech coder
Channels supported	CO channels with FCCH + SCH + BCCH + CCCH + CBCH + SDCCH/4 + SACCH; traffic channel (speech and data) TCH + FACCH + SACCH, SDCCH/8 + SACCH

General data

Power supply	110/220 V ±10%, 47 to 63 Hz, max. 500 VA
Dimensions (W x H x D); weight	
Analog unit	435 mm x 236 mm x 570 mm; 27 kg
Digital unit	435 mm x 192 mm x 570 mm; 18 kg
Monitor	357 mm x 304 mm x 397 mm; 14 kg
Keyboard	446 mm x 42 mm x 210 mm; 1.7 kg

Ordering information

Base Station Radiocommunication Test Set	CRTP 04	1052.6506.04

Mobile/Base Station Radiocommunication Test Set CRTP24

Uses, characteristics

The Mobile/Base Station Radiocommunication Test Set CRTP24 from Rohde & Schwarz combines the functions of CRTP02 (page 15) with those of CRTP04.

Specifications

CRTP02 and CRTP04 in one unit

Ordering information

Mobile/Base Station Radiocommunication Test Set	CRTP24	1052.6506.24

Options for CRTP

SIM Card Reader CRTS-B5

SIM Card Reader CRTS-B5

This option allows the CRTP04 to be used even if the base station uses authentication and ciphering.

Some parameters of the signalling messages such as IMSI, SRES and KC must be read from a SIM card into the radiocommunication tester. The card reader is operated on the RS-232 interface. A new library and some sample programs are supplied with the instrument.

Synchronization Unit CMDA-Z1

This option converts the frequency of 52, 39, 26 and 13 MHz used by the base station into the reference frequency of the Base-Station Radiocommunication Test Set CRTP04. See also catalog 93/94, page 53.

Software Packages for CRTP

Testing new GSM services with Radiocommunication Test Sets CRTP and Software Packages CRTS-K28 and CRTS-K48

Uses, characteristics

Non-voice services

In addition to its main task of providing a mobile telephone service, the GSM network now also offers non-voice services which enhance the convenience offered to the subscriber and open up new applications for the mobile telephone. Acceptance of these additional services by the subscriber mainly depends on whether the equipment is free of "teething troubles" when they are launched on the market.

This can only be obtained by thorough testing in development and production. Especially for these new services Rohde & Schwarz developed the software packages CRTS-K28 and CRTS-K48 for the Radiocommunication Test Sets CRTP.

Software CRTS-K48

Data transmission

In addition to facsimile transmission of written documents, remote data transmission to a computer is planned as well. A prerequisite for reliable operation is an error-free data transmission even if the radio channel is impaired. For data protection the GSM system uses redundancy bits and data telegram repetition.

Compared to voice transmission, data transmission requires a greater amount of protection and correction. In the case of transparent data transmission, whenever transmission errors occur that cannot be corrected by means of redundancy bits, the data transmission protocol of the two terminals ensures that lost data telegrams are repeated. For fax transmissions in the transparent mode, this is done by the fax protocol (see also Software CRTS-K48).

Short-message service (SMS)

This non-voice service permits short messages of up to 160 characters to be transmitted and displayed on the mobile unit. There are cell-broadcast SMS and point-to-point SMS. With cell-broadcast SMS, the base station sends a message to all subscribers simultaneously. With point-to-point SMS, messages are sent from one subscriber to another. Testing the SMS function of a mobile station

is described in GSM Rec. 11.10 which defines three test cases:

- Transmission of an SMS message by the mobile
- Reception of an SMS message by the mobile
- Reception of cell-broadcast SMS

In addition to these characteristics, the software also tests special cases. If, for instance, transmission of a short message coincides with the end of a call, the radio link must remain active until the complete short message has been transmitted even though the subscriber has put down the receiver. Simultaneous transmission and reception of short messages is tested as well.

The signalling messages are taken from a message pool. By varying these messages, further test cases can be generated without having to modify the program. This ensures easy testing of the response to false or nonsensical messages in particular.

Rate adaptation

GSM uses specific data rates for channel coding. Other data rates which are not coupled to the GSM clock – as is the case in many modems – are adapted by inserting additional bits (rate adaptation). During rate adaptation, bits are also inserted which describe the status of the flow control lines normally used at the interface between modem and computer. When asynchronous data with start and stop bits are transmitted, start bits are transmitted automatically if no characters are available for transmission. This is likely to occur when characters are entered online via a keyboard. If the transmission rate of the data source is too high, the system sends shorter stop bits.

All these characteristics can be tested using the Radiocommunication Test Sets CRTP. Software CRTS-K48 provides the following standard functions:

- Sending of test telegrams
- Routing of data to external data sources and sinks
- Automatic checking for parity errors
- Display of shortened stop bits

Test programs in source code

For data transmission and SMS, Rohde & Schwarz supplies test programs in source code format. The user is thus able to generate his own tests for more thorough testing. The test programs indicate functional errors by respective messages. Malfunctions can be examined in greater detail using the log memory.

Software CRTS-K28

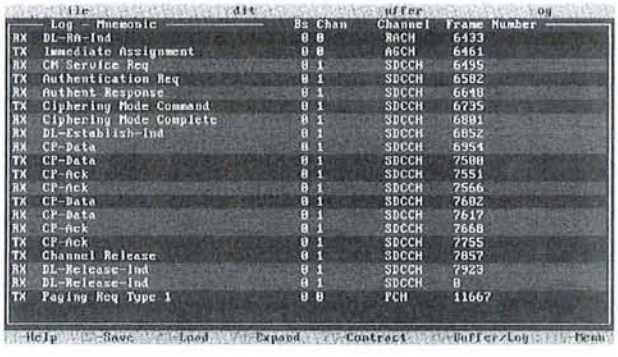
Radio link protocol (RLP)

With non-transparent data transmission, the GSM system itself initiates repeated transmission of incorrectly received data using the RLP. The RLP is described in GSM Rec. 4.22. Like the LAPDm protocol (LAPDm = link access protocol on the Dm channel) the RLP requires extensive tests to ensure implementation in compliance with the standard. In contrast to the LAPDm protocol the RLP however features some special characteristics, eg transmission of a checksum (FCS = frame check sequence).

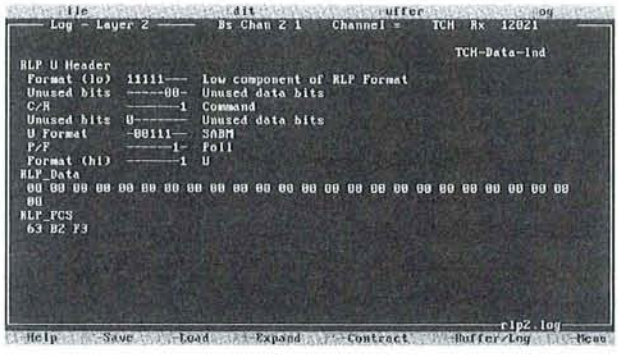
Software CRTS-K28 not only comprises the RLP protocol as provided in the base or mobile stations, but it can furthermore adapt itself to the requirements, eg in order to simulate the loss of data telegrams. C routines supplied with the software control the RLP protocol by changing status variables and counters during program execution. All RLP messages are stored in the log memory of the CRTP and can be displayed in plain text.

Ordering information

Software	CRTS-K28	1034.4405.02
	CRTS-K48	1034.4670.02



Signalling sequence in plain text



Radio-link protocol

Software Packages for Radiocommunication Test Sets CRTP02, CRTP24

Uses

The software packages contain test programs for the type approval of mobile stations (GSM, DCS1800). These test programs are intended to detect and eliminate errors in layers 1, 2 and 3 at an early stage in the laboratory rather than during the type approval of mobiles or when a base station has already been installed and put into operation. This will save both time and cost.

Characteristics

The GSM test cases are based on the programs used in the interim type approval system ITA. These programs have been validated by a group of European test houses and accepted by MoU TAAB as suitable for type approval of GSM mobile stations.

The PCN test cases are also used in the DCS1800 System Simulator supplied by Rohde & Schwarz and intended for the development and type approval preparation of PCN/DCS1800 mobile stations.

These programs have been generated by modifying the code used in the GSM ITA system. Modifications have mainly been made to code sections not affecting the outcome of the result, such as level control routines, which control additional relay matrices in order to combine the signals from various instruments. The signalling sequences and the code generating the test verdict are virtually identical with the software used in the system simulator.

The test programs automatically generate a pass/fail verdict, which in most cases is enhanced by additional error messages. The complete signalling information is captured in a log of the radiocommunication test set, thus allowing detailed analysis of layers 1 to 3.

With the aid of a test environment manager, tests can be selected from a list using the cursor and then started. The manager is able to control more than one test environment, thus allowing easy separation of the original from the user-modified test cases. The user may also bypass the manager and start test cases directly from the DOS command line.

The test programs are written in C or Borland C++ and are supplied in source code format. They can be modified by the experienced C programmer to identify the cause of failures of the hardware under test. All the necessary tools such as compiler and editor are supplied with the radiocommunication test set.

Software	Application	Special features	Order No.
CRTS-K21 CRTS-K22 CRTS-K23 CRTS-K24	Interim type approval of GSM mobile stations to GSM Rec. 11.10, version 3.3.0	For testing authentication and ciphering TEST SIM card to GSM Rec. 11.40 is required (Rohde & Schwarz CRT-Z2)	included 1034.4286.02 1034.4305.02 1034.4328.02
CRTS-K26	5 acoustic tests for interim type approval of GSM mobile stations to GSM Rec. 11.10, version 3.3.0, section II.11	Software is intended for preparation of mobiles for type approval with interim type approval system ITA	1034.4363.02
CRTP-K21 CRTP-K22 CRTP-K23 CRTP-K24	Type approval of PCN (DSC1800) mobile stations to GSM Rec. 11.10-DCS, version 3.3.0	Software is also used in DCS1800 System Simulator supplied by Rohde & Schwarz	included 1053.1050.02 1053.1108.02 1053.1150.02
CRTP-K26	5 acoustic tests for type approval of PCN (DCS1800) mobile stations to GSM Rec. 11.10-DCS, version 3.3.0, section II.11	Software is intended for preparation of mobiles for type approval with interim type approval system ITA	1053.1250.02

Test Programs CRTS-K21, CRTP-K21

II.3.1	**Phase error and frequency error** (CRTS-K21 only)
II.4.2.1	**Reference sensitivity** for TCH/FS-compliance (CRTS-K21 only)*
II.5.2.2.1.1.1	**Normal initialisation****
II.5.2.2.1.1.2.1	**Loss of UA frame****
II.5.2.2.1.1.2.2	**UA frame with different info field****
II.5.2.2.1.1.2.3	**Info frame and supervisory frames** in response to an SABM frame**
II.5.2.2.1.1.3	**Initialisation denial****
II.5.2.2.1.1.4	**Total initialisation failure****
II.5.2.2.2.1	**Sequence counting and I frame acknowledge****
II.5.3.6.1.3	**SDCCH assignment**
II.5.3.6.2.1.<3/9>	**Normal paging request** type 1/procedure 4
II.5.3.9.<2/3>	**MS originating call establishment**; early/late assign.
II.5.3.9.<4/5>	**MS terminating call establishment**; early/late assign.
II.6.1.2.1.<1/2>	**Absolute delay and timing advance** setting RACH/TCH
II.6.1.5.2	**Channel release after unrecoverable errors,** method A

Test Programs CRTS-K22, CRTP-K22

II.1.1	**Tests to verify the implementation of support of services**
II.4.1	**Bad frame indication performance** (only CRTS-K22)
II.5.2.2.1.2.1	**Normal initialisation without contention resolution****
II.5.2.2.1.2.<2/3>	**Initialisation** failure**/denial**
II.5.2.2.1.2.4	**Total initialisation failure****
II.5.2.2.2.2	**Receipt of an I frame in the timer recovery state****
II.5.2.2.2.3	**Segmentation and concatenation*****
II.5.2.2.3	**Normal layer 2 disconnection****
II.5.2.2.4.3	**RR response frame loss** (MS to SS)
II.5.2.2.6.<1/2>	**N (S)/(R) sequence error****
II.5.2.2.7	**Receipt of invalid frames****
II.5.3.2.1.1.<3/4/5>	**Channel request Test1,** case 1/2/3
II.5.3.2.1.2.	**Channel request Test 2**
II.5.3.2.2.	**IMSI detach/attach (basic),**
<3/5/7/9/11/13>	procedure 1/2/3/4/5/6
II.5.3.2.3	**Test of sequenced MM/CC message transfer**
II.5.3.5.2.	**Test of TI error** in RR mangement message/
<1/2/3>	MM message/CC message, procedure 1
II.5.3.5.5.1.<1/2>	**MS reaction to mandatory information element error in RR message,** procedure 1/2
II.5.3.6.1.4	**TCH assignment**
II.5.3.6.1.5.<1/3>	**Extended assignment,** procedure 1/2
II.5.3.6.1.6.<1/3>	**Assignment rejection,** procedure 1/2
II.5.3.6.1.7	**Ignore assignment for another MS**
II.5.3.6.8.3.<1 to 4>	**Ciphering mode setting,** procedure 1/2/3/4
II.5.3.6.12.2.<1 to 4>	**Channel release,** procedure 1/2/3/4
II.5.3.7.1	**TMSI reallocation procedure**
II.5.3.7.<2/3>	**Authentication/Identification elementary procedure**
II.5.3.7.4.1.	**Location updating accepted,** TIMSI is allocated/neit-
<1/2/3>	her TIMSI nor IMSI sent back by network/mess. con-
	tains IMSI
II.5.3.7.4.2.	**Location update rejected,** IMSI unknown in HLR or
<1/2>	illegal MS/PLMN not allowed
II.5.3.7.4.3.1.1	**Random access fails,** procedure 1
II.5.3.7.4.4	**RR connection release after location updating**
II.5.3.7.4.5.2.<2/3>	**Periodic updating,** procedure 2/3
II.5.3.7.5.2.<3/5>	**MM connection establishment successful with cipher mode setting,** procedure 1/2
II.5.3.7.5.3.<3/5>	**MM connection establishment successful with/without cipher mode setting,** procedure 1/2
II.5.3.7.5.4.<3/5>	**MM connection establishment rejected,** procedure 1/2
II.6.1.5.<4/6>	**Channel release after unrecoverable errors,** method B/C

Test Programs CRTS-K23, CRTP-K23

II.5.3.8.1.2.2.1.2	**U0 state,** MNCC_SETUPREQ
II.5.3.8.1.2.2.2.1.	**U0.1 MM connection pending,** MMCC_REL_IND/
<1/2/3>	MMCC_EST_CNF/MMCC_ERR_IND
II.5.3.8.1.2.2.3.	**U1 call initiated,** CALL_PROC rec./REL_COM rec./
<1/2/3/4/5/6/7>	timeout T303/MMCC_ERR_IND/ALERTING receiv-
	ed/CONN received/unknown message received
II.5.3.8.1.2.2.4.	**U3 MS originating call proceeding,**
<1/2/3	ALERT/CONN/PROGRESS received
31/32/34/38/	PROGRESS received cause 1/2/4/8
4/5/6/	DISC received U3→U12/U19/REL received 6
7/8/9/	MNCC_DISC_REQ/MMCC_SYNC_IND/timeout T310
A/B>	MMCC_ERR_IND/unknown message received
II.5.3.8.1.2.2.5	**U4 call delivered**/CONN 1/MNCC_DISC_REQ/DISC
<1/2/4/5/	rec. U4→U12(19)/REL received/MMCC_ERR_IND/
6/7/8/9>	MMCC_SYNC_IND/unknown message received
II.5.3.8.1.2.2.6	**U10 call active**/MNCC_DISC_REQ/REL received/
<1/2/3/4>	DISC received U10→U12/DISC received U10→U19
II.5.3.8.1.2.2.7	**U11 disconnect request**/DISC received/REL received/
<1/2/3/4/5>	timeout 305/MMCC_ERR_IND/unknown mess. rec.
II.5.3.8.1.2.2.8	**U12 disconnect indication**/MNCC_REL_REQ/REL receiv-
<1/2/3/4>	ed/MMCC_ERR_IND/unknown message received
II.5.3.8.1.2.2.9	**U19 release request**/1st timeout T308/2nd timeout
<1/2/3/4/5>	T308/REL receiv./REL_COM receiv./MMCC_ERR_IND
II.5.3.8.1.3.2.1	**U0 null state SETUP received**/U0→U6/send REL_COM/
<1/2/3/4>	U0→U6 table 1 note 5/U0→U6 table 1 note 6
II.5.3.8.1.3.2.2	**U6 call present**/MNCC_CALL_CONF_REQ/DISC
<1/2/3/4/5/6>	rec./REL rec./MMCC_ERR_IND/unknown mess. rec.
II.5.3.8.1.3.2.3	**U9 MS terminating call confirmed**/MMCC_SYNC_
<3/6/7/8/9>	IND/DISC received without prog ind./REL received/
	MMCC_ERR_IND/unknown message received
II.5.3.8.1.3.2.4	**U7 call received**/MNCC_SETUP_RSP/DISC received
<1/3/4/5/6/7/8>	table 1 note 1(2)/REL received/MMCC_ERR_IND/un-
	known message received/MMCC_SYNC_IND
II.5.3.8.1.3.2.5	**U8 connect request**/CONN_ACK/timeout T313/
<1/2/3/4/5/	MNCC_ DISC/REQ/DISC received U8→U12/DISC
6/7/8/9>	received U8→U19/REL rec./MMCC_ERR_IND/
	MMCC_SYNC_IND/unknown message received
II.5.3.8.1.4.1.1	**U10 call active**/MMCC_SYNC_IND table 4 note 1
<8/9/C/E/F>	(note 2, 3)/MODIFY rec. table 1 note 1,2 (5,6/7,8)
II.5.3.8.2.4	Emergency call establishment
<1/3/5/7>	(idle updated) procedure 1/2/3/4
II.5.3.8.2.6	Emergency call establishment
<1/3/5/7>	(idle; no IMSI) procedure 1/2/3/4
II.5.3.8.2.7.<1/3/5>	**Emergency call rejection,** procedure 1/2/3

Test Programs CRTS-K24, CRTP-K24

II.5.2.2.5.1	**I frame with C bit set to zero**
II.5.2.2.5.2	**SABM frame with C bit set to zero**
II.5.2.2.1.1	**Errors in L3 messages** – Wrong protocol discriminator
II.5.2.2.3.1.	**Test of MS reaction** to/non-existing message type/
<1/2/3>	message inconsistent with PD/m. i. with call state
II.5.3.5.5.	**Test of MS reaction to Mandatory Information elements**
<2/3.1/3.2/3.4>	**errors** in/MM message/CC mess. Proc. 1/2/4
II.5.3.6.1.5.5	**Extended assignment,** procedure 3
II.5.3.6.2.2.<1/2>	**Extended paging,** procedure 1/2
II.5.3.6.2.3.<1/2/3>	**Paging reorganisation,** procedure 1/2/3
II.5.3.6.2.4	**No change of page mode**
II.5.3.7.4.2.3	**Location updating rejected »Locat. Area not allowed«**
II.5.3.7.4.2.4.	**Location updating rejected »National Roaming not**
<1/2/3/5>	**allowed«,** Procedure 1/2/3/5
II.5.3.7.4.3.1.2	**The random access fails,** procedure 2
II.5.3.7.4.3.2.	**Attempt counter smaller than 4,** stored LAI different
<1/2/3/4/5/6>	from broadcast LAI, procedure 1/2/3/4/5/6
II.5.3.7.4.3.3.	**Attempt counter greater or equal to 4,** stored LAI dif-
<1/2/3/4/5>	ferent from broadcast LAI, procedure 1/2/3/4/5
II.5.3.7.4.3.4.	**Attempt counter smaller than 4,** stored LAI equal to
<1/2/3/4/5.1/6.2>	broadcast LAI, procedure 1/2/3/4/5 rep. 3/5 rep. 4
II.5.3.7.4.5.2.1	**Test of periodic updating,** procedure 1
II.5.3.8.3.4	**Call present, re-establishment not allowed**
II.5.3.8.<4/4.12>	**DTMF information transfer,** procedure 1 to 11/12
II.8.8	**SIM Tests Access Control**
II.6.1.4.1	**Temporary reception gaps**
II.17.1	**Self testing of the MS**

Test Programs CRTS-K26, CRTP-K26

II.11.1.2	**Sending loudness rating**
II.11.1.4	**Receiving loudness rating**
II.11.1.6	**Acoustic shock**
II.11.1.7.1	**Echo return loss**
II.11.1.7.2	**Stability margin**

* This test deviates from GSM 11.10 (Fading not supported)
** By setting a parameter this test can be performed on either SDCCH or FACCH
*** SDCCH/4 only (CRTS-K22 only)

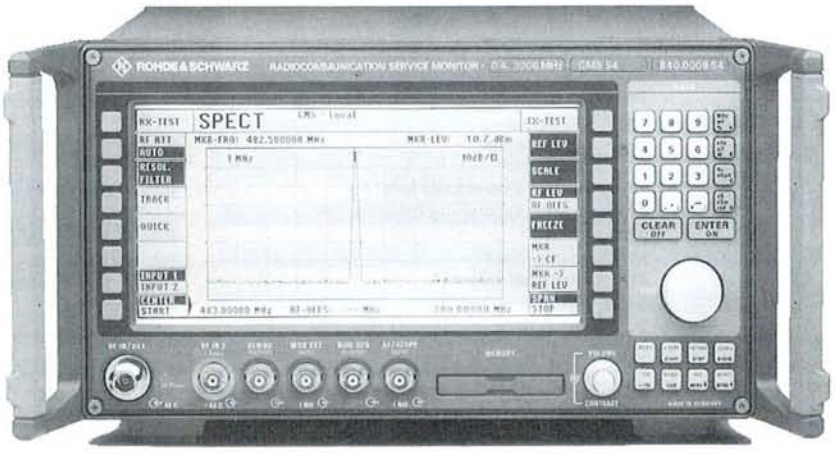
Radiocommunication Service Monitor CMS54

0.4 to 1000 MHz

New measurement functions

for high-end testing in the field

of analog mobile radio



Uses

Radiocommunication Service Monitor CMS54 from Rohde & Schwarz is a new member of the well-known CMS family. It can alone perform transmitter and receiver testing, measurements on antennas, diplexers, filters and frequency-converting modules as well as modulation spectrum analysis. The signalling unit supports all important mobile radio standards.

With its full-feature configuration including enhanced measurement capabilities, this lightweight and compact tester, which is suitable for mobile and stationary use alike, satisfies all requirements of radio measurements:

- High-end service for all fields of radiocommunication
- Base-station testing and monitoring
- Development of RF modules for any application such as
  - radio remote control
  - cordless telephones
  - door-closing systems
- Production and installation of systems with high or low transmitter power, such as
  - high-power transmitters
  - radio telephones, handies
- Measurements to relevant FTZ guidelines and ETSI regulations

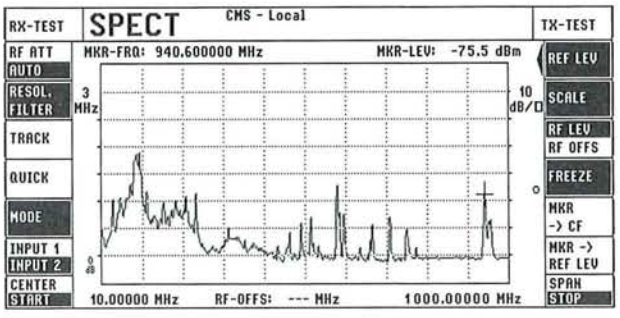
Characteristics

In addition to the RF, AF and signalling tests performed by the other members of the CMS family, the CMS54 provides a number of measurement capabilities allowing even faster checking of radio systems and error elimination.

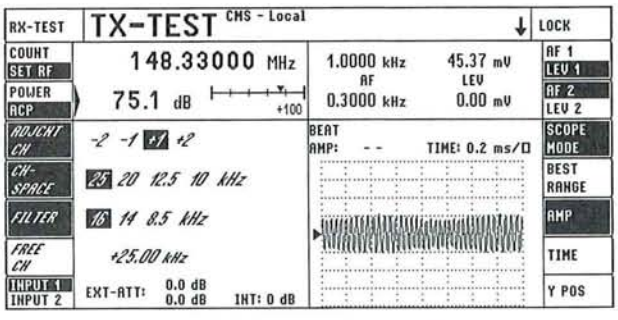
These additional facilities include for instance measurement of the transient response of radio equipment, harmonic measurements as well as measurement of the adjacent-channel power and VSWR. A fast spectrum monitor with a span up to 1 GHz rounds off the configuration of the CMS54.

FULL-SPAN spectrum monitor

- Spectrum monitor from 1 to 1000 MHz with FULL-SPAN display from 10 to 1000 MHz and dynamic range of 80 dB
- Analysis bandwidths from 150 Hz (modulation spectra AM, FM and SSB) to 3 MHz
- Selectable scaling with 2, 5 or 10 dB per division
- RF power display up to 50 W (optionally up to 100 W)



FULL-SPAN display for fast overview measurements



Adjacent-channel power measurements with standard filters to FTZ or ETSI

- Ultra-high sensitivity
- Markers for synthesizer-accurate frequency and selective level measurements
- Tracking generator with selectable level and frequency offset for module testing, filter measurements and checking of antenna systems
- Storage of spectrum displays as well as demodulation of displayed spectral line (FREEZE + LISTEN)
- Quick mode for fast adjustment of RF components

Other features

- Duplex modulation meter with any frequency offset fitted as standard
- Adjacent-channel power meter with standard filters to FTZ and ETSI
- Direct measurement of transmitter harmonic suppression
- Transient frequency and power measurements

Operation

CMS54 uses a large, backlit LCD display with high resolution and graphics capability. It is operated via softkeys at the two sides of the display. A clear menu structure allows fast and direct access to any of the measurement facilities provided in the CMS54. With the optional autorun control and printer interface, automatic test routines can easily be configured and stored via the front-panel keypad. Tolerances can be inserted into these test routines to determine overranging; battery-backed memory cards (extra) can be used as program library. Test reports and program lists can be output on a directly connectible printer.

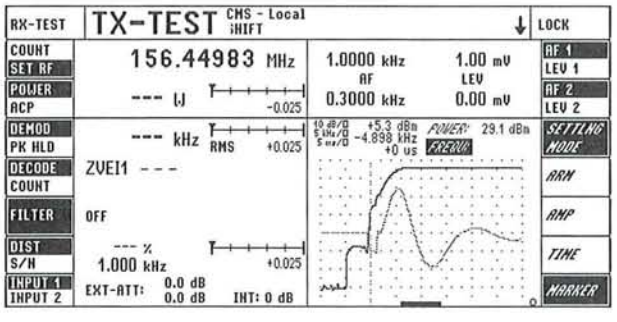
Options

VSWR measurement

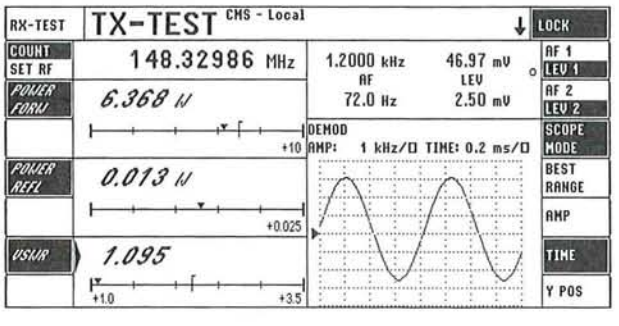
With the Adapter CMS-Z37, VSWR measurements can be performed using the Rohde&Schwarz Insertion Units NAS-Z1, -Z3, -Z5, -Z6 (GSM) and NAS-Z7 (DCS1800). For use of the CMS-Z37, an optional interface CMS-B5 or CMS-B39 must be integrated.

ATIS, CDCSS signalling

With the ATIS/CDCSS Coder (Decoder) CMS-B27, the radio tester can automatically establish a link to radio equipment for this signalling mode. The CMS 54 is fitted with the CDCSS coder as standard. For CDCSS decoding, the Lowpass Filter CMS-B33 is required which has to be integrated into the optional interface CMS-B5 or CMS-B39.



Measurement of power levels upon switching a transmitter on and off or of power ramps (TDMA systems, GSM, data transmission systems)



Incident and reflected power as well as VSWR of a transmitter can be read at a glance

1

Radiocommunication Service Monitor CMS54

Specifications

Only data differing from those of Radiocommunication Service Monitor CMS52 (catalog 93/94, page 17) are specified below.

RF spectrum monitor

Frequency range	1 to 1000 MHz
Span	0 (zero span) to 50 MHz; full span for frequency range 10 to 1000 MHz
Reference level	+47 to –47 dBm (input 1)
Sensitivity	<–110 dBm (for resolution filter ≤6 kHz and reference level ≤37 dBm at input 2, f ≥10 kHz)
Inherent spurious response	<–50 dBc (for reference level >+10 dBm and f >50 MHz)
Display dynamic range	>65 dB (for reference level >–7 dBm at input 1)
Scaling	2, 5, 10 dB/div
Display range	80 dB max.
Resolution filter (3-dB bandwidth)	150 Hz (for modulation analysis) 6, 16, 50, 300 kHz, 1 MHz, 3 MHz for full span, coupled to span
Error	<3 dB + resolution
Resolution	0.4 dB
Transient recorder	measurement of power and frequency as a function of time with graphical display and selectable zoom
Time scale	50 µs/div to 1 s/div, max. recording time 40 s
Frequency transients	
RF measurement range	1 to 1000 MHz
FM dev. measurement range	0 to ±100 kHz
Scaling	0.5 to 50 kHz/div
Triggering	internal, automatic (frequency changes >8 kHz)
Power transients	
RF measurement range	1 to 1000 MHz
Display dynamic range	60 dB for 47 dBm at input 1
Scaling	2, 5, 10, 20 dB/div
Triggering	internal, automatic (power 10%)
Harmonic measurements	display of 1st to 4th harmonic
Max. harmonic frequency	1000 MHz
Dynamic range	>60 dB >90 dB in frequency range 26.965 to 27.0405 MHz (CB radio)

RF frequency counter

Frequency range	0.5 to 1000 MHz (usable from 100 kHz, IF narrow)
Input level range (CW, FM)	
Input 1	0 to +47 dBm
Input 2	–40 to +7 dBm
Transmitter measurement, 2nd RF input	additional internal switch-selectable 24-dB attenuator for measurements with higher level at input 2

Signal generator

Frequency range	0.4 to 1000 MHz (usable from 100 kHz)

Signalling

CDCSS coder	– entry of 3-digit code number of mobile radio – setting the times for turn-off code and RF level drop – setting the data deviation
CDCSS decoder	CMS-B27 with CMS-B5 (model 10 or 12) and CMS-B33 – decoding of 3-digit code number of mobile radio – measurement of data deviation
ATIS coder/decoder	CMS-B27 with CMS-B5 (model 10 or 12)
Coder	– entry of 10-digit ATIS code – sending of ATIS message
Decoder	– decoding and display of 10-digit ATIS code, – measurement of data deviation

Ordering information

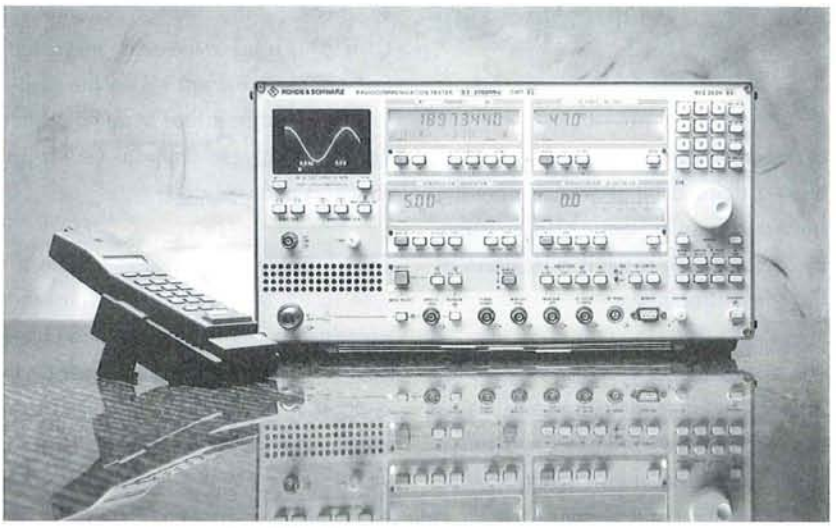
Radiocommunication Service Monitor	CMS54	0840.0009.54
Options	see overview on pages 34, 35	
Extras		
Memory Card 32 Kbyte	CMS-Z1	0841.1609.02
Memory Card 128 Kbyte	CMS-Z2	0841.1509.02
Oscilloscope Probe	SMFS-Z1	0358.0312.02
50-contact Connector for Control Interface CMS-B5	CMS-Z5	0841.1450.02
Sub-D Filter Adapter for Control Interface CMS-B5	CMS-Z6	0841.1409.02
Battery connector for external DC power supply	CMS-Z7	0841.1350.02
600-Ω AF Transformers (ext.)	CMS-Z39	0860.1900.02
Printer Cable (double shielded)	CM-Z5	0835.6919.02
Carrying Strap Set	ZZT-96	0396.9813.00
Transit Case	ZZK-011	1013.9543.00
Service Manual		0840.8616.24
Telescopic antenna with BNC connector		0690.9966.00

Overview of CMS options on pages 34 and 35

DECT Radiocommunication Tester CMT90

0.1 to 2000 MHz

Digital radiocommunication tester for measurements on DECT cordless telephones to TBR 06 – see also DECT Production Test Set CMT90/PSMD, page 31



Uses

In the DECT (Digital European Cordless Telephone) radiocommunication network, a large number of cordless telephones and base stations have to share the scarce resources of frequency, time and space. In general, this can only be realized by observing stringent rules and specifications.

At the same time, the DECT system and above all DECT phones are meant to be low-cost units with clear limitations on their complexity and precision. In face of these conflicting requirements, suitable measurement techniques have to be adopted to ensure that in spite of less sophisticated technology – in comparison with digital cellular systems such as GSM or PCN – the specifications for smoothly functioning communication are met.

DECT Radiocommunication Tester CMT90 from Rohde & Schwarz is a new member of the CMT Radiocommunication Tester family (catalog 93/94, page 24) and a further development of CMT55. It is specially designed for DECT in-channel measurements. In a DECT test system, eg used to monitor the production of cordless telephones, CMT90 also forms the RF interface. As an external unit for analyzing the test results, Process Controller PSMD from Rohde & Schwarz (page 31) can be used, a processor tailored to this application with measurements to TBR 06:

In-channel tests

- Receiver tests
  - sensitivity
  - BER
- Transmitter tests
  - accuracy and stability of RF carriers and timing parameters
  - power ramping
  - transmitted power
  - modulation

Out-of-channel tests

- Receiver tests
  - interference
  - blocking
  - intermodulation
  - spurious emissions
- Transmitter tests
  - adjacent-channel power

Test functions offered by CMT90

Receiver test (BER)

CMT90 generates a DECT-compatible RF signal with high integrity. While an external unit with a bit generator produces the modulation signal, CMT90 carries out GFSK modulation and pulse shaping. The tester provides delay compensation for the two TTL inputs, one a bit input and the other for level control, so that signals simultaneously applied to the inputs do not lag or lead when converted to RF.

As TBR 06 requires the BER test to be carried out with RF loopback, DECT Radiocommunication Tester CMT90 can be used immediately for the looped-back signal: it demodulates the bit stream modulated onto the RF signal so that the external unit can perform bit comparison. For this purpose, a digital bit output and an output indicating the mark/space ratio of the transmitted power pulses are available.

Transmitter test

The frequency/time characteristic of the DECT signal is assessed by means of the DC-coupled FM demodulator of the CMT90. The demodulator can handle pulsed RF signals and is absolutely noise-free during pulse spaces. It delivers a DC signal for calibration purposes which corresponds exactly to the demodulator center frequency.

DECT Radiocommunication Tester CMT90

In a second step, the external unit identifies a defined bit sequence from the burst and takes the mean of the frequency samples. The result is a measure of the carrier frequency.

The above test setup is also suitable for other modulation measurements: using other bit patterns and other evaluation algorithms instead of averaging, the peak deviation and the carrier drift during a pulse are obtained (chapter 11 of TBR 06, "RF Carrier Modulation"). However, CMT90 will display the peak deviation (positive, negative or average) during a burst even if there is no external analysis of the test results.

To measure the timing parameters, CMT90 is used in the same test setup. For this measurement it is not the amplitudes derived from the FM demodulator that are analyzed, but the timing parameters of the signal.

The logarithmic envelope detector with its wide dynamic range makes it possible to carry out the complete power ramping measurement to chapter 9 of TBR 06, "Transmission Burst". The delay compensation provided in the CMT90 ensures that the envelope-detector output and the FM demodulator are in sync.

The test setup described is also suitable for the measurement stipulated in chapter 10 of TBR 06, "Transmission Power". The only difference lies in the analysis of the test results, ie the external unit determines the average power from the active part of the burst. This measurement can also be performed by the CMT90 alone. A built-in pulse power meter indicates the instantaneous power approximately in the middle of the burst on the CMT display.

For further transmitter tests, in particular adjacent-channel and out-of-channel measurements, the DECT signal can be brought out on the CMT and fed, for example, to a spectrum analyzer.

Specifications

Supplementary data for CMT90 in the range <1 to 2 GHz. For data relating to basic functions see CMT54 (catalog 93/94, page 28).

Receiver measurements

Signal generator	
Frequency resolution	<200 Hz
Spectral purity	
Harmonics at $^1/_2$ f, $^3/_2$ f, etc.	typ. –20 dBc
Residual FM (to CCITT)	<24 Hz
Level error (fine setting 0 dB)	<2 dB
Amplitude modulation	same as CMT54, typ. values for f_{in} >1 GHz
Frequency modulation	
Frequency deviation	max. 1600 kHz
Modulation frequency range	
internal	same as CMT54
external	max. 1 MHz (–3 dB)
Error (via MOD EXT, without EXT CAL)	<5% of set frequency + residual FM
Phase modulation	
Phase deviation	max. 160 rad

Transmitter measurements

Power measurements (0% AM)	
Measurement range	5 mW to 50 W
Error (7 dBm <P <20 dBm)	typ. 1 dB (<1 dB for P ≥20 dBm)
VSWR	<1.3 for f ≤1 GHz, <1.5 for f >1 GHz
Burst power measurements (0% AM)	
Frequency range	1.5 MHz to 2 GHz
Level measurement range	10 to 47 dBm
Minimum burst duration	100 µs
Off time	250 µs to 100 ms
Error	<1.2 dB (for P >20 mW)
RF frequency measurements	
Input level range	24 to 47 dBm (2nd input: –16 to +24 dBm)
Error	timebase error + 100 Hz
FM demodulator	same as CMT54
Residual FM (to CCITT)	<24 Hz
FM broadband demodulator	
RF frequency range	40 MHz to 2 GHz
Modulation frequency range	up to 130 kHz
Deviation (selectable range limits)	130/260/520 kHz
Residual FM rms, measured at demodulator output, weighted , 130 kHz bandwidth, deviation limit 130 kHz	
RF <1 GHz	<120 Hz
RF >1 GHz	<200 Hz
Error (peak)	
AF <20 kHz	<3% + residual FM + resolution
AF <100 kHz (w/o 300-Hz HP)	<5% + residual FM + resolution
AF <130 kHz (w/o 300-Hz HP)	<7% + residual FM + resolution
Input level for specified error and residual FM	P >80 mW (V > 20 mV)
FM super broadband demodulator	
Input level range	24 to 47 dBm (2nd input: –16 to +24 dBm)
RF frequency range	60 MHz to 2 GHz
Modulation frequency range	up to 1 MHz (–3 dB)
Deviation	max. ±1 MHz
Residual FM	<3 kHz(rms) (weighted 100 Hz to 1 MHz)
Error	<7% + residual FM + resolution (display) <7% + residual FM + DC offset (demodulator output)
AM meter	same as CMT54, typ. values for f >1 GHz

DECT-specific data

Modulator	
RF frequency range	100 kHz to 2 GHz
Operating mode	external modulation
Nominal FM modulation signal level	TTL
Nominal burst modulation signal level	TTL (minimum duration of H/L signal: 50 µs)
Nominal deviation for DECT GFSK	corresp. to 576 kHz in display
Nominal weighting	Gaussian Frequency Shift Keying
Nominal data input rate	1152 kbit/s (100 Hz AC coupling)
Internal bit clock (9 x bit clock)	648 kHz; 10.368 MHz
External clock	648 kHz; 10.368 MHz (9 x bit clock)
Mark/space ratio (TTL = low)	>30 dB
Demodulator	
RF frequency range	60 MHz to 2 GHz
Input level range	24 to 47 dBm (2nd input: –16 to +24 dBm)
FM operating modes	
Demodulator display	AC-coupled: +PK, –PK, ±PK/2, PK HOLD
Demodulator analog output	DC-coupled, deviation 5 mV/kHz
Digital FM	Rx data (TTL) Rx clock (TTL, negative edge)
Burst operating modes	
Analog envelope output	typ. 40 mV/dB (1.2 to 3.6 V) approx. 3.6 V with 0 dBm at input 2
Digital burst output	TTL level, mark/space display for pulsed signals, threshold approx. –27Bm at input 2

General data

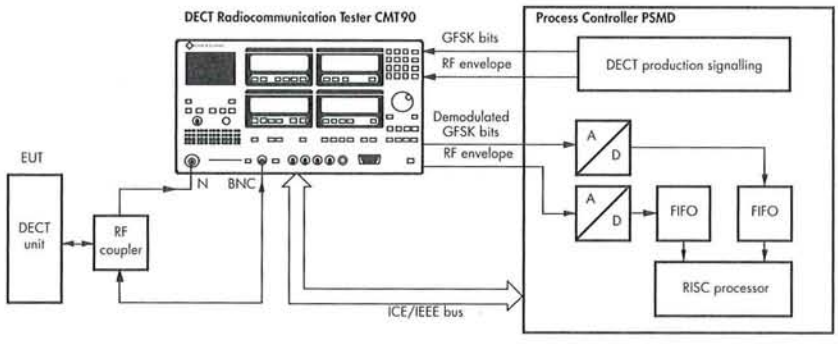
Power supply	same as CMT54
Dimensions	same as CMT54
Weight	approx. 24 kg

Ordering information

DECT Radiocommunication Tester	CMT90	0802.2020.90
Options		
OCXO Reference Oscillator	CMT-B1	0803.8916.02
IEC/IEEE-bus Interface	CM-B4	0803.3914.02
Autorun Control/Printer Interface	CM-B5	0803.3314.02
2nd AF Synthesizer	CMT-B7	0803.2816.02
RF Millivoltmeter	CM-B8	0803.6813.02
Low Rate FM (only factory-fitted)	SCM-U1	0804.1615.02
Extras		
Carrying Bag for CMT90	CMT-Z3	0803.9506.02
150-MHz Highpass Filter	CM-Z11	0835.5012.02
300-MHz Highpass Filter	CM-Z12	0835.5064.02
700-MHz Highpass Filter	CM-Z13	0835.5112.02
Further extras	see catalog 93/94, pages 50, 51	

DECT Production Test Set CMT90/PSMD

DECT Radiocommunication Tester CMT90 (page 29) used with Process Controller PSMD as sampler and analyzer



Test setup with DECT Radiocommunication Tester CMT90 and Process Controller PSMD for test result analysis

Uses, characteristics

The DECT Production Test Set CMT90/PSMD from Rohde & Schwarz is a highly flexible tool. The core of the system is formed by an RF demodulation/modulation unit integrated in the CMT90 and by the DECT-specific sampler and analyzer PSMD. The CMT90 and the PSMD form a test set complying with the TBR 06 test philosophy with respect to the sampling method in general and p0 detection in particular. The PSMD can control further test equipment used in the production line, eg a spectrum analyzer. It can easily be integrated into existing production environments. The modular design allows for future upgrades as well as for customized modifications.

Production

- Fast and reliable testing of DECT mobile stations (MS) and fixed stations (FS)

DECT Production Test Set CMT90/PSMD

- Short measurement times for efficient manufacturing and high throughput
- Simple integration into computer networks (LAN) for production control
- Complete and reliable testing of signalling functions and RF parameters of MS and FS

Service

- Automatic measurement routines for reliable testing of MS and FS
- Universal test capabilities for step-by-step analysis of MS and FS in repair
- Manual and remote-controlled operation

Type testing and quality inspection

- Complete testing for compliance with ETSI Recommendation TBR 06. This recommendation also requires spectrum analysis to be performed in order to determine the radiated interference. For this, a spectrum analyzer is needed (eg FSM from Rohde & Schwarz, catalog 93/94, page 178; also see Test System TS9830, page 126).
- Automatic testing and logging of results with the aid of test routines supplied

Test capabilities

DECT measurements to ETSI Recommendation TBR 06

These measurements for type-approval and in-production testing of DECT cordless telephones are based on the loopback principle and are implemented with the aid of a sampling device. To use the loopback method, the service mode must be activated on the MS and FS. To this end, a force transmit message is sent to the EUT via the air interface containing information on which RF frequency and in which time slot loopback should be performed. It should be noted, however, that force-transmit messages can be used only for MS tests; for FS tests the normal mac-con-req method is used.

The EUT must wait for valid preambles and SYN words to synchronize with the tester. The EUT is then expected to send the respective bits back in the defined loopback fields. For production tests it will normally suffice to check the loopback behaviour for full-slot bursts, which is the standard transmission method, whereas for type testing and quality inspection, both full-slot bursts (P32) and dummy bursts (P00) must be checked. It is therefore indispensable to use a fully DECT-capable signalling device such as the Production Test Set CMT90/PSMD from Rohde & Schwarz.

Standard test parameters to TBR 06

- Transmitter tests
  - modulation deviation
  - RF accuracy
  - power template
  - AF response (microphone sensitivity) with acoustic coupler
- Receiver tests
  - sensitivity (BER)
  - RF level range (BER)
  - AF response with acoustic coupler
- Optional tests (system panel required)
  - low battery function
  - DC current/voltage
  - keypad test (required hardware can be installed)
  - display (required hardware can be installed)

Sampler and analyzer PSMD

The PSMD operates as a sampling device in line with TBR 06. Sampling involves a high volume of measured data which is transmitted to a processor with high computing power for real-time evaluation of essential parameters.

An i80486 processor integrated in the PSMD is used for control of the system devices and output of the results. In addition, an i860 RISC processor is provided which reads the data from the data acquisition card (three A/D converters), stores the data and makes them available for further processing. In addition to frame alignment and data transfer, the RISC processor performs all essential calculations (eg modulation, BER) in real time.

Due to its high computing power, the PSMD is able to acquire data belonging to consecutive bursts. The confidence level thus approaches 99.9%, and compromise solutions such as spot-check sampling of bursts can be avoided.

Main features of Process Controller PSMD

- Excellent price/performance ratio
- 80486/33-MHz CPU with 8-Mbyte RAM (max. 32 Mbyte) and 259-Mbyte hard disk
- IEEE 488.2 standard interface
- Four serial RS-232 interfaces
- Optimized EMC/EMS characteristics
- MS Windows or LabWindows user interface with expansion capability for measurements
- Built-in control panel and keypad
- User-friendly on-line help
- Universal user interface (factory user-port)

- Connector for external monitor
- PCMCIA interface for memory and interface extensions
- Four free 16-bit ISA slots
- Rackable
- 200-W power supply with optional 12-V DC input
- Powerful speed-controlled blower

Performance characteristics of RISC processor

- Parallel architecture providing two floating-point results and an integer result per clock cycle
- Clock frequency up to 40 MHz
- External 64-bit data bus, internal paths up to 128 bits
- 4 Kbyte on-chip instruction cache
- 8-Kbyte on-chip data cache
- Memory management unit
- 120 MIPS (80 MFLOPS + 40 MIPS)
- Up to 4 Gbyte address space

DECT signalling

In addition to the A/D converters and the RISC processor, the PSMD contains a card for user-programmable DECT signalling. This card supplies the DECT baseband signals.

Loopback principle

The loopback principle is apparent from the figure on page 31. The DECT baseband bursts are transmitted from the DECT production signalling card to the GFSK bit input of the CMT90. The radiocommunication tester is set to a specific RF frequency and performs a Gaussian bit conversion as well as bit modulation. For the signal returned by the EUT, the reverse procedure is applied. The CMT90 demodulates the RF signal, samples the baseband signal (equivalent to the vector sum of the I and Q components) by means of 10-MHz A/D converters and transmits it to the RISC processor via FIFO memories.

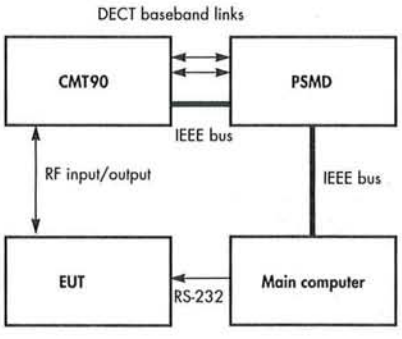
Integration of production test set into a test environment

PSMD as system core

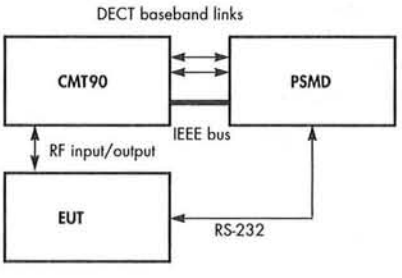
The PSMD controls the DECT Radiocommunication Tester CMT90 via the IEEE bus. The user interface and the user software with all test routines are installed on the PSMD hard disk. The EUT linked to the PSMD via the RS-232 interface is one of several devices that can be controlled in this way. Hence, an interactive and fully automatic testing of an MS or FS can be realized.

Main computer of a production line as system core

In this case the user interface and the user software are installed in the main computer of a production line. The computer addresses the PSMD, which has no control functions in this configuration, via an assigned IEEE-bus address and the CMT90 via a second address. The two instruments can now be controlled independently of each other. The main computer also addresses the EUT via the RS-232 interface. The user is thus provided with a highly flexible hardware and software system for which test routines can be written as required.



Production Test Set CMT90/PSMD remote-controlled by main computer of production line via IEEE bus



PSMD forming the system core as controller, sampler and analyzer

Options for CMS family of radiocommunication testers

Extensions for basic model

	Option	Order No.	Specifications
OCXO Reference Oscillator For high long-term stability	CMS-B1	0840.9406.02	See timebasis Aging 2×10^{-7}/year
OCXO Reference Oscillator For extremely high long-term stability	CMS-B2	1001.6809.02	Specs same as CMS-B1, except for aging $\leq 1 \times 10^{-7}$/year
Duplex Modulation Meter For operation of RF frequency counter and modulation meter independent of RF signal generator (two-port measurements, also on frequency-converting modules)	CMS-B59	1032.0990.02	Specs see basic model, except residual FM ≤10 Hz
Duplex Modulation Meter Same as CMS-B59, plus adjacent-channel power meter for measurements on duplex radio, cellular mobile phones and frequency-converting modules	CMS-B9	0840.9506.02 **(not for CMS50; standard in CMS54**	Specs see basic model Adjacent-channel power meter with ETSI filters Channel spacings 10/12.5/20/25 kHz and freely selectable up to 1 MHz Dynamic range ≥70 dB (channel sp. 25 kHz)
10-MHz Reference Frequency Input/Output External synchronization for measuring systems	CMS-B22	1001.6750.02	Output TTL levels, $Z_{out} \approx 50\ \Omega$, f = 10 MHz Input level >1.5 V_{pp}, $Z_{in} \approx 50\ \Omega$, f = 10 MHz ±500 Hz
Additional RF Input/Output Two-signal measurements and connection of further measuring instruments (eg spectrum analyzer); bidirectional RF connector for additional measuring instruments	CMS-B31	1001.7005.02	Max. input power 20 mW Attenuation between RF_{in} and RF_{out} 32 dB Measurement sensitivity at input 1 for RF counter/transient recorder and demodulation reduced by 6 dB
100-W RF Power Meter Measurement of high RF input power	CMS-B32	1001.7905.02	Max. input power: 100 W for 3 min, then 10 min power off; continuous power: 80 W; max. output level and measurement sensitivity at input 1 reduced by 3 dB; additional error ≤0.15 dB (P >40 mW, AM = 0%)
13-dBm Output	CMS-B34	1032.1350.02	Additional power output for off-air measurements
Autopilot Generator for ILS operation (CMS57)	CMS-B38	1065.5003.02 (for CMS57 only)	Second RF output; not in conjunction with CMS-B31 and -B34
IEC/IEEE Bus Interface	CMS-B54	1032.0748.02 (for CMS50 only)	Use of CMS50 in automatic test systems

Signalling units for models with Duplex Modulation Meter CMS-B9 or CMSB-59

	Option	Order No.	Specifications
Signalling Unit for Cellular Radio NMT 450 (SIS), NMT 450 I, NMT 900 (SIS), E-AMPS, J-TACS, TACS II, R 2000	CMS-B53[1]	1032.0890.02	Simulation of base station for testing cellular mobile phones, eg call setup, call cleardown, channel and power change
Signalling Unit for Cellular Radio Same as CMS-B53, plus C-Net signalling	CMS-B13[1]	0841.1009.02 (not for CMS 50)	Simulation of base station for testing cellular mobile phones, eg call setup, call cleardown, channel and power change
NMT Base Station Test For CMS-B13 in conjunction with CMS-B39	CMS-B25	1032.0490.02 (not for CMS50)	Signalling for setting the base station and RF measurements on air interface
POCSAG, ZVEI/VDEW Digital Signalling For CMS-B13/-B53	CMS-B26	1031.9993.10	Testing of POCSAG radiopaging receivers and ZVEI/VDEW mobile and base stations
MPT 1327/1343 Signalling For CMS-B13/-B53, testing of trunked radio	CMS-B28	1001.7205.02	Additional free programming of signalling sequences via external computer
FMS-BOS Signalling For CMS-B13/-B53	CMS-B29	1032.1550.02	Signalling at AF with CMS-B13 and CMS-B9
Programmable Universal Modem for FFSK Signals (instead of CMS-B13/-B53) Modulation and demodulation of any data	CMS-B21	1001.6509.02	Modulator and demodulator Frequency for logic 0 50 to 3999 Hz Frequency for logic 1 50 to 3999 Hz Bit rate 10 to 2400 Hz
ERMES Coder with Software	CM-Z30	1065.4013.02 (for CMS, CMT, CMTA)	AT-compatible PC required

Extensions in conjunction with control interfaces

	Option	Order No.	Specifications
ATIS Coder/Decoder	**CMS-B27**[2]	**1032.1250.02**	Coder – entry of 10-digit ATIS code – sending of ATIS message Decoder – decoding and display of 10-digit ATIS code – measurement of data deviation
CDCSS Decoder	**CMS-B27 with CMS-B33**		Decoding of 3-digit mobile phone code number, measurement of data deviation; CDCSS coder fitted as standard in basic model
RS-232 Interface For CMS-B5	**CMS-B30**	**1001.6909.02**	Output and reception of any ASCII strings (max. 33 characters)
300-Hz Lowpass Filter For CMS-B5/-B55; fast frequency and deviation measurement of subaudio tones with simultaneous audio modulation	**CMS-B33**	**1032.0290.02**	f_{cutoff} = 200 Hz, attenuation >50 dB for frequencies above 300 Hz
Adapter for VSWR Measurements In conjunction with CMS-B5 or CMS-B39	**CMS-Z37**[3]	**1065.4907.02**	Connection of Insertion Units NAS-Z1, -Z3, -Z5, -Z6 (GSM), -Z7 (DCS1800) with direct reading of VSWR as well as incident and reflected power

Optional Control Interfaces[4]

Order No.	CMS-B5 0841.0502.10	CMS-B5 0841.0502.12	CMS-B55 1032.0790.02	CMS-B20 0841.1209.02	CMS-B39 1032.0090.02	Specifications
DTMF Decoder	•	•	•	•	•	Decoding of DTMF dual tones and VDEW direct dialling
CCITT Filter	•	–	•	•	•	
C-Message Filter	–	•	–	–	–	
Centronics Interface	•	•	•	•	•	
Relays	8	8	–	–	4	Switching relay with max. 1 W switching power, V_{max}=30 V, I_{max}=0.1 A
TTL Input/Output	12	12	–	–	8	Outputs: 25 mA driver power
DC Ammeter/ Voltmeter, floating	–	–	–	•	–	Voltage measurem. Range 0 to ±30 V Resolution 0.1 to 100 mV Error ±1% + resolution Current measurem. Range 0 to ±10 A Resolution 1 to 100 mA Error ≤4% ± 3 mA
600-Ω AF Transformers	–	–	–	–	•	Output impedance of AF generator switchable to 600 Ω ±10% Frequency range: 100 Hz to 6 kHz Output level: 10 µV to 2.5 V Max. output current: 4 mA Input impedance of AF voltmeter switchable to 600 Ω ± 10% Frequency range: 100 Hz to 6 kHz
ATIS Coder/Decoder, CDCSS Decoder	CMS-B27	CMS-B27	–	–	–	see option CMS-B27, CDCSS coder fitted as standard in basic model
RS-232 Interface	CMS-B30	CMS-B30	–	–	–	see option CMS-B30
300-Hz Lowpass Filter	CMS-B33	CMS-B33	CMS-B33	–	–	see option CMS-B33
Adapter for VSWR Measurements	CMS-Z37	CMS-B37	–	–	CMS-Z37	see option CMS-Z37

1) CMS-B9 or CMS-B59 also required, CMS-B13 and CMS-B53 may be used alternatively.
2) CMS-B33 is required for CDCSS.
3) CMS-B5 or CMS-B39 required for Insertion Units NAS-Z1/-Z3/-Z5/-Z6/-Z7.
4) Choice of one option.

• fitted as standard
– not included

1

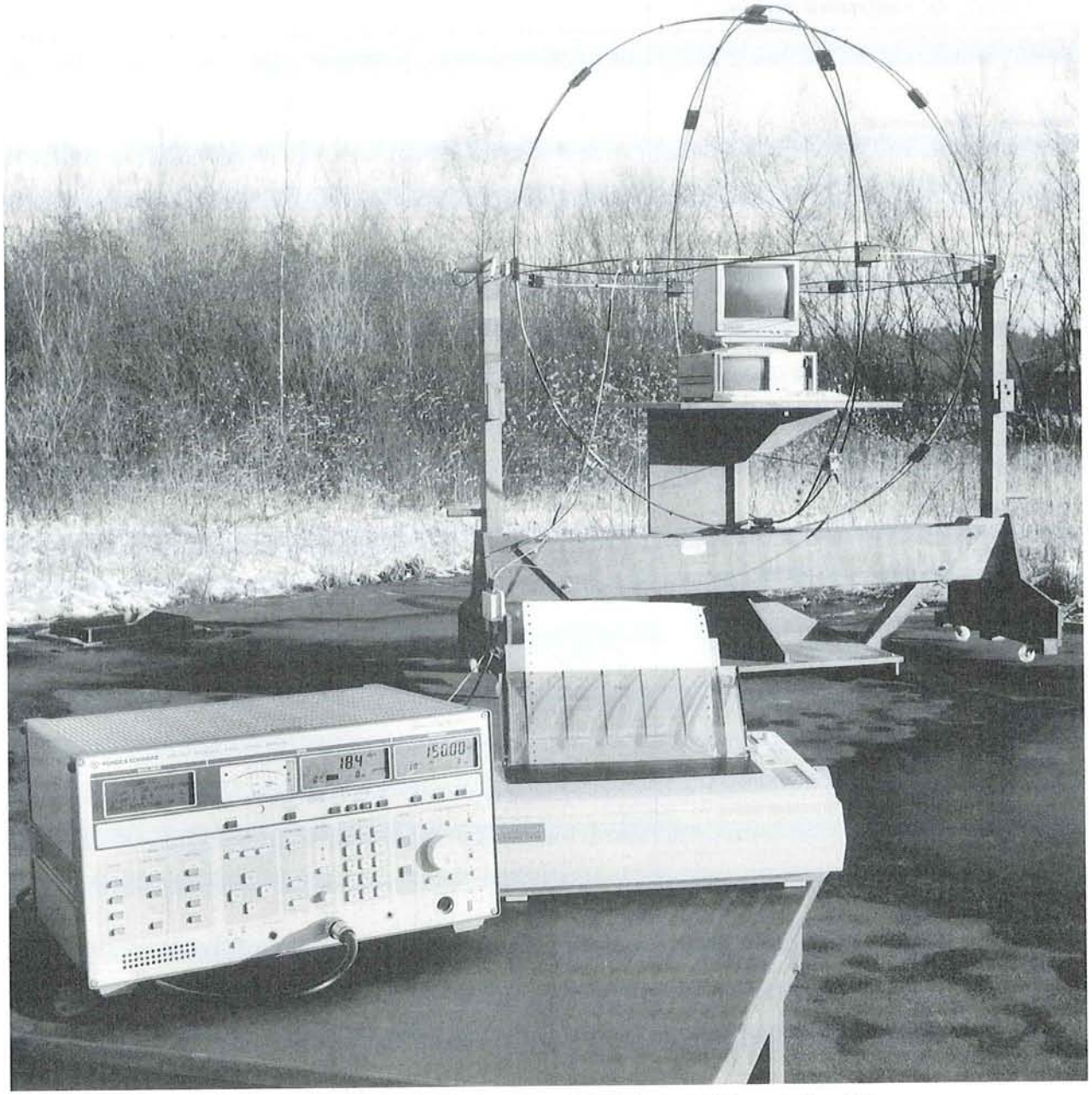
Overview of basic configurations and options for CMS, CMT, CMTA

Configuration features and main differences of analog and analog/digital radiocommunication testers.

Characteristics ● = fitted as standard ○ = with option or accessory		CMS				CMT				CMTA		
Model		50	52	54	57	54	55	84	90	54	84	94
Signal sources												
RF signal generator												
Frequency resolution	25/50/100/200 Hz	–	–	–	–	●	●	●	●	–	–	–
	50 Hz	●	–	–	–	–	–	–	–	–	–	–
	10 Hz	–	●	●	●	–	–	–	–	–	–	–
	1 Hz	–	–	–	–	–	–	–	–	●	●	●
AM (DC), FM (AC), φM		●	●	●	●	●	●	●	●	●	●	●
Low-rate FM		●	●	●	●	○	○	○	○	●	●	●
FM (DC)		–	–	–	–	–	–	–	–	●	●	●
Broadband FM		–	–	–	–	–	●	–	●	–	–	–
Modulation generator 1		●	●	●	●	●	●	●	●	●	●	●
Modulation generator 2		●	●	●	●	○	○	○	○	●	●	●
OCXO reference oscillator		○	○	○	○	○	○	●	○	●	●	●
VOR/ILS generator		–	–	–	●	–	–	–	–	–	–	–
Autopilot		–	–	–	○	–	–	–	–	–	–	–
Measuring facilities												
RF frequency counter		●	●	●	●	●	●	●	●	●	●	●
RF frequency-offset meter		●	●	●	●	●	●	●	●	●	●	●
PEP RF power meter		●	●	●	●	–	–	–	–	–	–	–
RF power meter	50 W	●	●	●	●	●	●	●	●	●	●	●
	100 W	○	○	○	○	–	–	–	–	–	–	–
Adjacent-channel power meter		–	○	●	○	○	○	○	–	○	○	○
Burst RF power meter		–	–	–	–	○	○	○	●	○	○	○
Selective RF level meter		●	●	●	●	○	○	○	–	○	○	○
Broadband RF millivoltmeter		–	–	–	–	○	○	○	○	○	○	○
Modulation meter for AM, FM, φM with												
+PK, –PK, ±PK/2, MAX PK, PK HOLD, RMS rectifiers		●	●	●	●	●	●	●	●	●	●	●
Duplex modulation meter		○	○	●	○	○	○	●	●	○	●	○
Broadband FM demodulator		–	–	–	–	–	●	–	●	–	–	●
DECT broadband modulator/demodulator		–	–	–	–	–	○	–	●	–	–	–
AF voltmeter with RMS, +PK, –PK rectifiers		●	●	●	●	●	●	●	●	●	●	●
Selective modulation and AF level meter		●	●	●	●	–	–	–	–	●	●	●
Highpass filter	300 Hz	●	●	●	●	●	●	●	●	●	●	●
	continously tunable	–	–	–	–	–	–	–	–	●	●	●
Lowpass filter	300 Hz	○	○	○	○	–	–	–	–	●	●	●
	3.4 kHz	●	●	●	●	–	–	–	–	●	●	●
	continuously tunable	–	–	–	–	–	–	–	–	●	●	●
Bandpass filter	continuously tunable	●	●	●	●	–	–	–	–	●	●	●
Notch filter	continuously tunable	●	●	●	●	–	–	–	–	●	●	●
SINAD meter	1 kHz	●	●	●	●	●	●	●	●	●	●	●
	continuously tunable	–	●	●	●	–	–	–	–	●	●	●
CCITT filter		○	○	○	○	●	●	●	●	●	●	●
Distortion meter	1 kHz	●	●	●	●	●	●	●	●	●	●	●
	continuously tunable	●	●	●	●	–	–	–	–	●	●	●
S/N meter		●	●	●	●	●	●	●	●	●	●	●

Characteristics ● = fitted as standard ○ = with option or accessory	CMS				CMT				CMTA		
Model	**50**	**52**	**54**	**57**	**54**	**55**	**84**	**90**	**54**	**84**	**94**
Measuring facilities (continued)											
AF frequency counter	●	●	●	●	●	●	●	●	●	●	●
DC voltmeter	○	○	○	○	○	○	○	●	●	●	●
DC ammeter	○	○	○	○	○	○	○	●	●	●	●
VSWR insertion unit with detached probe	○	○	○	○	○	○	○	○	○	○	○
Analyzer/oscilloscope unit											
Oscilloscope	●	●	●	●	●	●	●	–	●	●	●
Storage oscilloscope	–	–	–	–	–	–	–	–	●	●	●
RF spectrum monitor	●	●	●	●	–	–	–	–	●	●	●
Full span	–	–	●	○	–	–	–	–	–	–	–
RF tracking	○	○	●	○	–	–	–	–	–	–	–
AF spectrum analyzer	–	–	–	–	–	–	–	–	●	●	●
SSB spectrum analyzer (digital display)	–	–	–	–	○	–	–	–	–	–	–
SSB spectrum analyzer (digital and screen display)	●	●	●	●	–	–	–	–	●	●	●
Transient recorder with digital display memory	–	●	●	●	–	–	–	–	●	●	●
Signalling facilities											
Selective-call coder/decoder, all standards, programmable	●	●	●	●	●	●	●	●	●	●	●
DTMF coder	●	●	●	●	○	○	○	○	●	●	●
DTMF decoder	○	○	○	○	○	○	○	○	●	●	●
Cellular-radio simulator for C-Net, Radiocom 2000, NMT 450, NMT 900, AMPS, TACS, E-AMPS, E-/J-TACS, TACS Issue 4	○[1]	○	○	○	–	–	●	–	○	●	○
ERMES coder	○	○	○	○	○	○	○	○	○	○	○
CDCSS coder	●	●	●	●	–	–	–	–	–	–	–
CDCSS decoder	○	○	○	○	–	–	–	–	–	–	–
ATIS coder/decoder	○	○	○	○	–	–	–	–	–	–	–
Coder/decoder for ZVEI/VDEW digital	○	○	○	○	–	–	○	–	○	○	○
Coder for POCSAG (Cityruf)	○	○	○	○	–	–	○	–	○	○	○
Coder/decoder for MPT1327/1343 (trunked radio)	○	○	○	○	–	–	○	–	○	○	○
Coder/decoder for FMS-BOS	○	○	○	○	–	–	–	–	–	–	–
NMT base station test	–	○	○	○	–	–	–	–	–	○	–
Programmable FFSK modem	–	○	○	○	–	–	–	–	○	–	○
Control facilities											
Autorun control	○	●	●	●	○	○	○	○	○	○	○
IEC/IEEE-bus interface	○	●	●	●	○	○	○	●	●	●	●
Relay matrix	○	○	○	○	○	○	○	●	●	●	●
Programmable control lines	○	○	○	○	–	–	–	–	–	–	–
RS-232 interface	○	○	○	○	–	–	–	–	–	–	–
Centronics printer interface	○	○	○	○	○	○	○	○	○	○	○
Other											
AF transformers 600 Ω	○	○	○	○	○	○	○	○	○	○	○
10-MHz reference input and output	○	○	○	○	●	●	●	●	●	●	●
3rd RF input/output	○	○	○	○	●	●	●	●	●	●	●
13-dBm RF output	○	○	○	○	●	●	●	●	●	●	●
Connector for external AF filter	○	○	○	○	–	–	–	–	–	–	–
Battery operation	●	●	●	●	●	●	●	●	–	–	–

[1] Without C-Net



EMC open-area test site with EMI Test Receiver ESHS10 and Triple-Loop Antenna HM020 (catalog 93/94, pages 64 and 96)

Contents of Chapter 2

Microwave Antenna System AC308

Steerable antenna system detects and monitors signals from 1 to 40 GHz

Steerable Microwave Antenna System AC308 with Spectrum Analyzer FSM (catalog 93/94, page 178)

Uses

Antenna System AC308, which is suitable for mobile and semi-mobile applications, is intended for use by postal and other authorities to detect and monitor signals in the frequency range 1 to 40 GHz. The antenna can be remote-controlled in the azimuth (360°) and the elevation (±15°). A control unit allows manual orientation of the antenna and its incorporation into a computer-controlled system. For geostationary satellite reception the elevation range can be extended to 55° (40° ±15°) by manually adjusting the antenna.

The various models integrating external mixers, downconverters or amplifiers provide an application-specific optimum link to the receiving system or analyzer.

Main features

- Fast assembly and disassembly due to the small number of components used
- Lightweight and sturdy design
- Low power consumption

Characteristics

AC308 consists of three parallel antennas covering the frequency ranges 1 to 18, 18 to 26.5 and 26.5 to 40 GHz. The main component of the system is the 1 to 18-GHz antenna comprising a 0.9-m reflector and an active broadband feed operated at the focus. The user may choose from three feeds with different polarizations. They are all equipped with an integral, low-noise broadband amplifier which is protected by a broadband limiter against damage that may be caused by strong radar pulses for instance.

Available feeds

- VE 025 S8 for linear polarization; horizontal/vertical or 45° polarization can be selected manually
- VE 024 S8 for linear polarization; horizontal/vertical polarization can be selected by remote control
- VE 024 S9 for horizontal, vertical, righthand circular or lefthand circular polarization – all selectable by remote control

The two 0.25-m antennas for the K band (18 to 26.5 GHz) and Ka band (26.5 to 40 GHz) are also equipped with low-noise preamplifiers and can be connected to the 0.9-m reflector with quick-release fasteners. The polarization (horizontal, vertical or 45°) is manually selectable.

Model 02 : designed for use with a spectrum analyzer

Rohde & Schwarz Spectrum Analyzer FSM (catalog 93/94, page 178) with its excellent receive characteristics is an ideal instrument for this purpose.

The FSM normally operates without mixers in the frequency range up to 26.5 GHz, but for frequencies from 18 GHz it can be supplied with external mixers for integration into the anten-

na. Customer's own mixers may, of course, also be used.

Model 03 : used in conjunction with the Gigatune receiver set from Rohde & Schwarz

Downconverters incorporated in the antennas for the K and Ka bands extend the frequency range up to 40 GHz. The Gigatune Receiver Set EA 010/ESM 1003 (data sheet PD 756.7194) is a versatile microwave receiver covering the range 1 to 18 GHz and featuring high frequency accuracy and very low phase noise.

Model 04 : to be operated with any microwave equipment

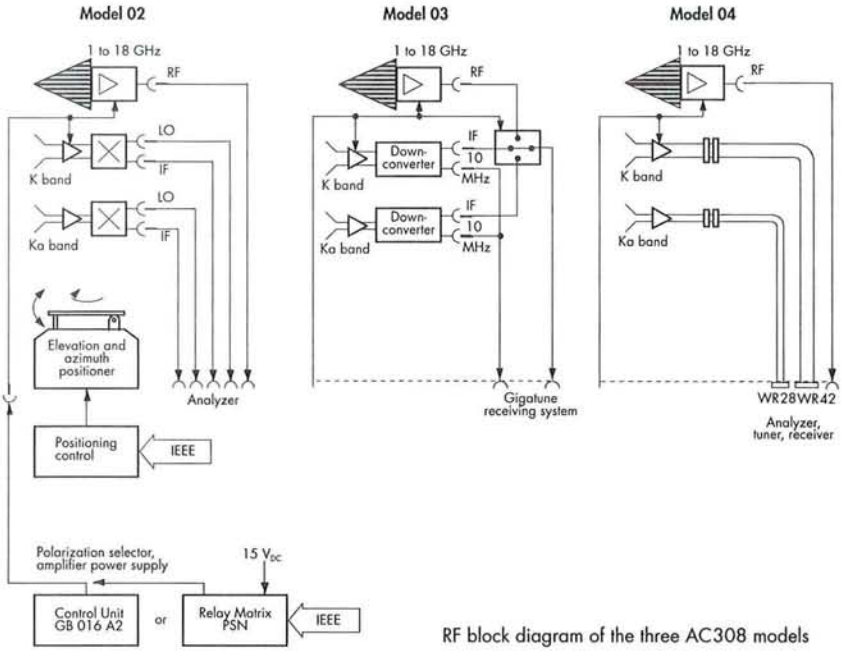
The boosted signals of the K- and Ka-band antennas are available at the antenna connector panel (interfaces: rectangular waveguides WR 42 and WR 28) for low-loss transmission. This universal model allows the connection of an analyzer (with external mixers) or a receiver (with downconverters).

Design

The AC308 is equipped with a well-proven cable twist which accommodates all cables and flexible waveguides and provides a range of rotation (stopped by limit switches) of approximately 365°.

With the AC308, the amount of work required for setting up and taking down a mobile system has been minimized. The easy handling is best demonstrated by the example of disassembly:

- The connectors on the 0.25-m antennas are undone, the antennas are removed from the 0.9-m reflector by opening the quick-release fasteners and stowed away.
- The feed and the cables of the 0.9-m antenna are folded into the dish, secured and the dish is folded upwards.
- The cable twist and the connector panel are placed around the antenna. The quick-release fasteners of the positioning system are released, the antenna is removed and stowed away.



RF block diagram of the three AC308 models

The power supply for the amplifiers as well as the polarization selector is provided by Control Unit GB 016 A2 (without computer interface) or Relay Matrix PSN (with IEC/IEEE-bus interface) and a separate power supply. The cables between the connector panel of the antenna and the remote-control and receiving equipment are tailor-made to customer's requirements.

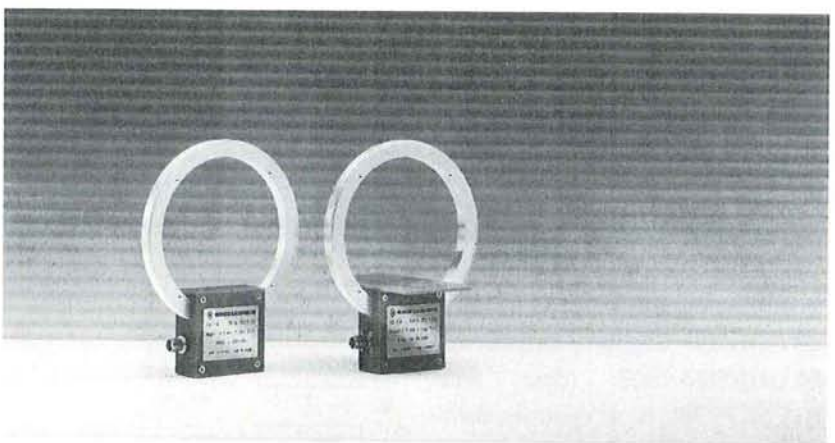
Specifications

	Antenna 1	Antenna 2	Antenna 3
Reflector	900 mm dia.	250 mm dia.	250 mm dia.
Frequency range	1 to 18 GHz	18 to 26.5 GHz	26.5 to 40 GHz
Gain	15 to 39 dBi	29 to 33 dBi	33 to 36 dBi
Half-power width	20 to 1.5°	4.5 to 3°	3 to 2°
Amplifier (at +25°C)			
Noise figure	≤5 dB	≤5.5 dB	≤7 dB
Gain	28 to 32 dB	25 to 31 dB	27 to 33 dB
Positioning system			
Angle of rotation	azimuth 360°; elevation ±15°; extension to 40° ±15° by manual adjustment		
Speed of rotation	azimuth 5°/s; elevation 0.5°/s		
Positioning accuracy	<0.1°		
Control unit			
Angle display	digital		
Control modes	manual control; rotation at constant speed; autotracking		
Controller interface	IEEE 488		

Shielded and Calibrated Magnetic Field Pickup Coil HZ-10

5 Hz to 10 MHz

Measurement of magnetic field-strengths to military standards



HZ-10 with (right) and without (left) spacing plate

Uses

The shielded and individually calibrated Magnetic Field Pickup Coil HZ-10 allows magnetic fieldstrengths in the frequency range from 20 Hz to 200 kHz to be measured in line with MIL-STD-461/462, DEF STAN 59-41, GAM EG 13 and VG standards 95377 Part 13. These standards give limits for the magnetic flux density in the frequency range from 30 Hz to 50 kHz or 200 kHz and prescribe an electrostatically shielded coil with a defined number of turns for measuring the magnetic flux density. The coil comes with a calibration certificate for the range from 5 Hz to 10 MHz.

Characteristics

Main features

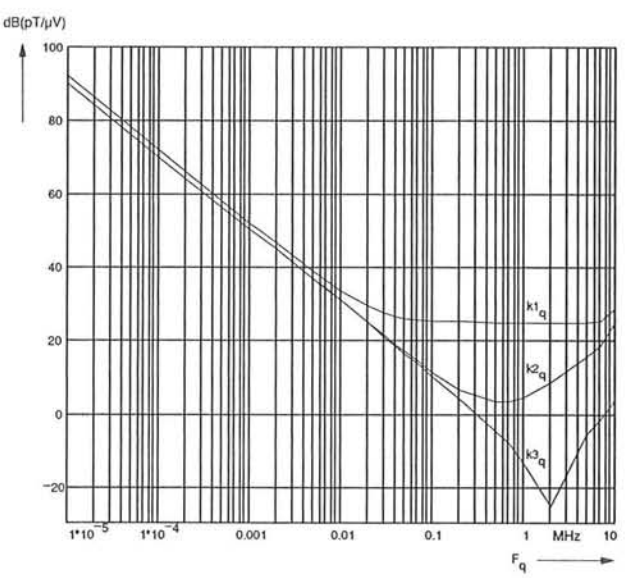
- Frequency range 5 Hz to 10 MHz
- Built to MIL-STD-461A and 462D
- Individually calibrated
- Shielded twin-wire connection
- Spacing plate 7 cm (MIL-STD-461, DEF STAN 59-41) and 5 cm (VG standards)

Design

The coil is covered by an aluminium shielding for high isolation and connected via a shielded twin-wire line to avoid measurement errors caused by galvanic surface currents induced in the shielding.

According to MIL-STD-461/462, DEF STAN 59-41 and GAM EG 13 the magnetic flux density has to be measured at a distance of 7 cm from the EUT and to VG standards at a distance of 5 cm. To ensure that these distances are maintained when searching for the maximum RFI, an asymmetrical spacing plate is provided at the base of the HZ-10. The HZ-10 is provided with a $^1/_4$" thread for mounting on a camera tripod.

Antenna factors in dB (pT/µV) measured and calculated by calibration: antenna factor k1 with 50 Ω, k2 with 600 Ω and k3 with 1 MΩ; k2 and k3 valid up to 100 kHz (above 100 kHz approximate values only)

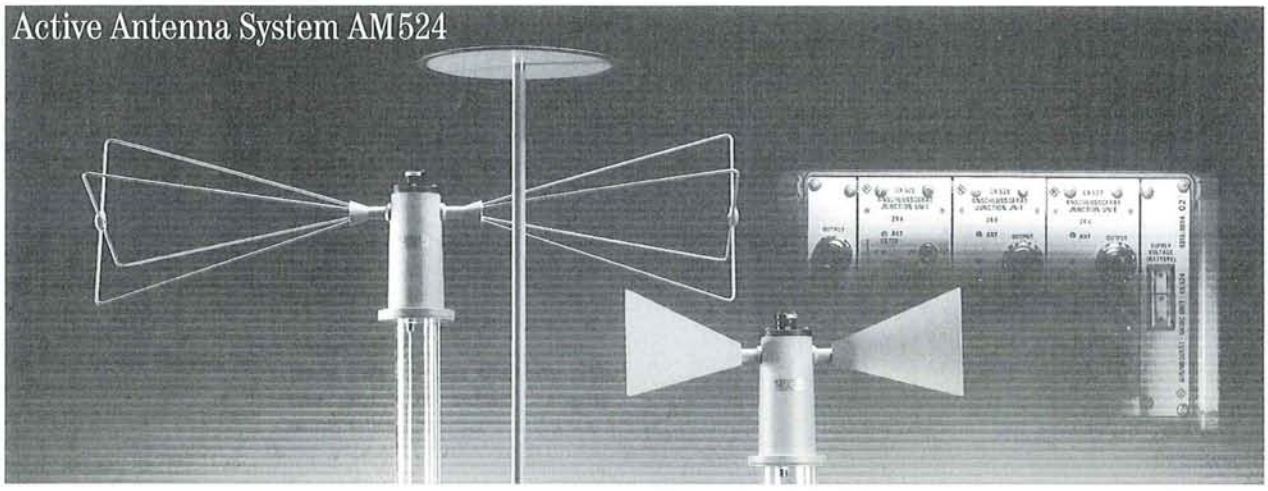


Specifications

Frequency range	5 Hz to 10 MHz
Antenna factor	see diagram (calibration certificate supplied with coil)
Coil	
Diameter	133 mm
Number of turns	36
Type of wire	7-41, litz wire
Resistance	10 Ω
Inductance	415 µH
Connector	Twinax female
Dimensions (W x H x D); weight	142 mm x 178 mm x 29 mm; 260 g

Ordering information

Shielded, Calibrated Magnetic Field Pickup Coil	HZ-10	0816.2511.02
RF connecting cable balanced, 1.5 m, Twinax connector	EZ-15	1052.2500.02
balanced/unbalanced, 0.2 m, Twinax/BNC connector	EZ-19	1052.2630.02



100 Hz to 1 GHz

Antenna system for detection of low-level emissions

Uses

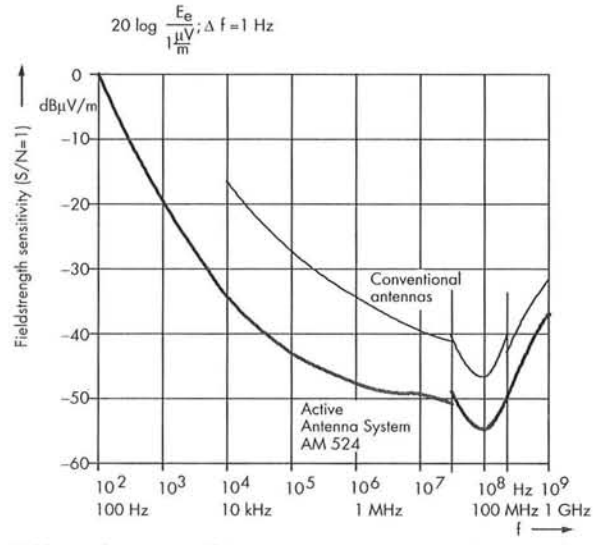
The extremley low-noise Active Antenna System AM524 meets the requirements made on an antenna in a high-sensitivity system for measuring compromising emissions: low-level emissions from EDP peripherals like monitors, printers and data lines can be targeted for eavesdropping and so endanger security. Measures to counteract eavesdropping are therefore essential, but measuring techniques capable of handling spurious emissions just above the noise floor are required to implement them.

Features

- High sensitivity
- High-precision measurements due to individual calibration
- Wide level range
- Compact design for use in small cabins
- Integration into automatic test systems

Specifications

Frequency range	100 Hz to 1000 MHz with three antennas
Sensitivity (Δf = 1 Hz)	0 dBµV/m (100 Hz) –43 dBµV/m (100 kHz) –51 dBµV/m (30 MHz) –54 dBµV/m (100 MHz) –37 dBµ/m (1000 MHz)
Antenna factor (without attenuator/extra amplifier)	approx. 0 dB (100 Hz to 30 MHz) –12 dB (100 MHz) 20 dB (1000 MHz)
Power supply	24-V battery or 110/220-V AC
RF connectors	N female, 50 Ω
Remote control	via fiberoptic cable
Dimensions; weight	
Active Rod Antenna HE525	1500 mm x 600 mm; 5 kg
Active Dipole Antenna HE526	1000 mm x 319 mm; 1.7 kg
Active Dipole Antenna HE527	500 mm x 250 mm; 1.6 kg
Cabinet for junction units (W x H x D)	235 mm x 150 mm x 400 mm
Transit case	660 mm x 545 mm x 245 mm



Fieldstrength sensitivity of Active Antenna System AM 524 compared to values attained with conventional antennas

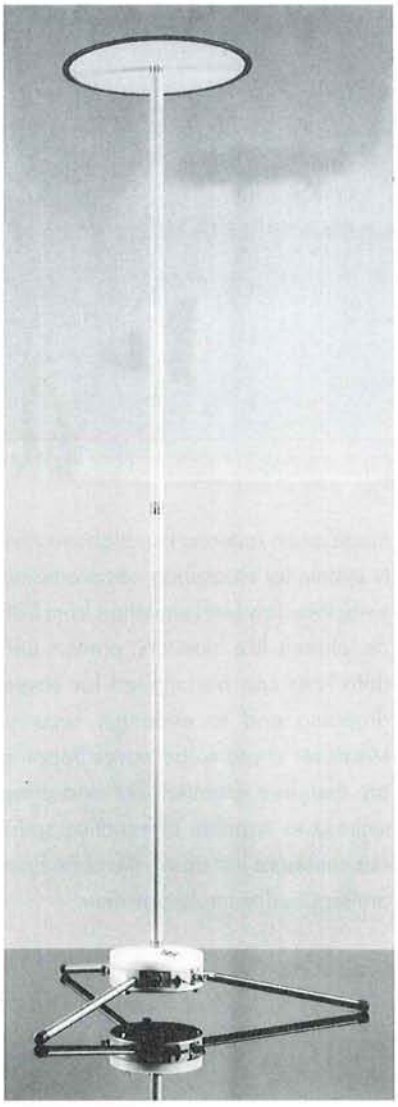
Ordering information

Active Antenna System consisting of	AM524	4015.7001.02
Active Rod Antenna	HE525	4015.7101.02
Active Dipole Antenna	HE526	4015.7501.02
Active Dipole Antenna	HE527	4015.8008.02
Junction Unit for HE525	GX525	4015.9256.02
Junction Unit for HE526	GX526	4015.9504.02
Junction Unit for HE527	GX527	4015.9756.02
Basic Unit with power supply	KK524	4015.9004.02
Transit case	ZR524K	4015.8508.02
Support for HE526 and HE527	AM524-Z1	4036.0502.02

Active Rod Antenna HE525

100 Hz to 30 MHz

Antenna from the Active Antenna System AM524, page 43



Uses, characteristics

The Active Rod Antenna HE525 is an electrically short monopole. The top loading increases the electrical length of the rod, thus making the antenna more sensitive. The signal voltage is coupled out via an extremely high-impedance and low-noise amplifier and taken to the receiver or spectrum analyzer.

In contrast to active antennas for receive tasks in general – where the expected external noise is an essential factor for dimensioning the antenna – the basic criteria for optimizing antennas for use in shielded rooms are their maximum permissible size and large-signal characteristics.

Whilst achieving maximum sensitivity, care has been taken to ensure good large-signal characteristics. For optimum signal matching, the HE525 therefore features a switchable attenuator (approx. 20 dB) at the input of the active antenna section.

In addition a switchable highpass filter is provided for effective suppression of the harmonics of the strong 50-Hz signals. Filter, attenuator and amplifier are controlled from the Junction Unit GX525 (page 48) which is also used as a power supply for the antenna.

Specifications

Frequency range	100 Hz to 30 MHz
Type of antenna	monopole
Antenna factor	see Table
Linearity	1-dB compression point at E >0.5 V/m (without attenuator) E >5 V/m (with attenuator)
Maximum sensitivity (Δf=1 Hz)	
100 Hz	0 dBµV/m
1 kHz	–18 dBµV/m
10 kHz	–35 dBµV/m
100 kHz	–43 dBµV/m
1 MHz	–48 dBµV/m
10 MHz	–49 dBµV/m
30 MHz	–51 dBµV/m
Power supply	18 V ±1 V DC
Current drain	
without attenuator and filter	typ. 0.1 A
with attenuator	typ. 0.13 A
with attenuator and filter	typ. 0.16 A
Connectors	
RF connector	N female, 50 Ω
Power supply, attenuator, filter control	via common round connector (DIN 41524)
Ground	terminal
Dimensions	
Antenna length	1.5 m
Diameter of top loading	0.3 m
Tripod	0.6 m dia.
Weight	approx. 5 kg

Ordering information

Active Rod Antenna	HE 525 4015.7101.02

Antenna factor

f/Hz	k_0	k_F	k_A	k_{AF}
100	0	30	20	30
500	–1	21	19	20
1 k	–1	7	19	19
2 k	–1	2	19	19
10 k	–1	–1	19	19
100 k	–1	–1	19	19
1 M	–1	–1	19	19
10 M	–2	–2	19	19
20 M	–3	–3	20	20
25 M	–4	–4	21	21
30 M	–5	–5	15	15

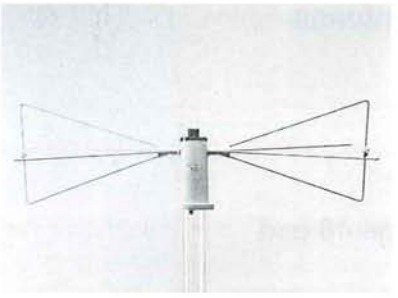
k_0 = antenna factor without filter and attenuator (in dB)
k_F = antenna factor with filter
k_A = antenna factor with attenuator
k_{AF} = antenna factor with attenuator and filter

Active Dipole Antennas HE526, HE527

HE526: 30 to 200 MHz

HE527: 200 to 1000 MHz

Antennas from the Active Antenna System AM524 (page 43)



Left: HE526; right: HE527

Uses, characteristics

Active Dipole Antenna HE526

At low frequencies where the passive antenna operates as an electrically short dipole, an amplifier with high-impedance is required; in the medium and high frequency range the dipole characteristic provides for adequate noise matching of the active section. With the use of state-of-the-art GaAs FETs, this frequency-dependent behaviour can be optimally utilized to achieve a high sensitivity. Any overdrive can quickly be detected and reduced with the aid of the built-in, switchable attenuator. Since the total length of the antenna is 1 m only, it can also be used for measurements in both directions of polarization even where space is at a premium.

Active Dipole Antenna HE527

With its V-shaped dipole and the extremely low-noise active antenna section, this antenna provides for optimum sensitivity while featuring minimum size. The V-shaped passive antenna section with a total width of 0.5 m and a length of only 0.25 m features a directivity which increases with frequency, so that together with the noise-matched amplifier a high sensitivity is obtained.

Since the effective area of the antenna is proportional to the square of the wavelength, lower signal powers occur at higher frequencies. To ensure sufficient system sensitivity, also with receivers which are not particularly of the low-noise type, the HE527 incorporates a switchable 10-dB amplifier built in modern MMIC technology.

Specifications of HE 526

Frequency range	30 to 200 MHz (can be operated from 20 to 300 MHz)
Type of antenna	dipole
Antenna factor (typ.)	

f/MHz	k (without attenuator)	k (with attenuator)
20	–4	13
30	–5	12
50	–5	13
100	–13	14
150	–10	15
200	–10	12

Linearity	1-dB compression point at E >0.2 V/m without attenuator E >2 V/m with attenuator
Maximum sensitivity (Δf = 1 Hz)	
30 MHz	–49 dBµV/m
100 MHz	–54 dBµV/m
200 MHz	–48 dBµV/m
Power supply (via RF cable)	18 V, 0.09 A (attenuator off) 16 V, 0.14 A (attenuator on)
RF connector	N female, 50 Ω
Ground	via outer conductor of RF cable
Dimensions	
Dipole length	1 m
Dipole diameter	0.3 m
Weight	approx. 1.7 kg

Ordering information

Active Dipole Antenna	HE526	4015.7501.02

Specifications of HE 527

Frequency range	200 to 1000 MHz (can be operated from 100 to 1000 MHz)
Type of antenna	V-shaped dipole
Antenna factor (typ.)	

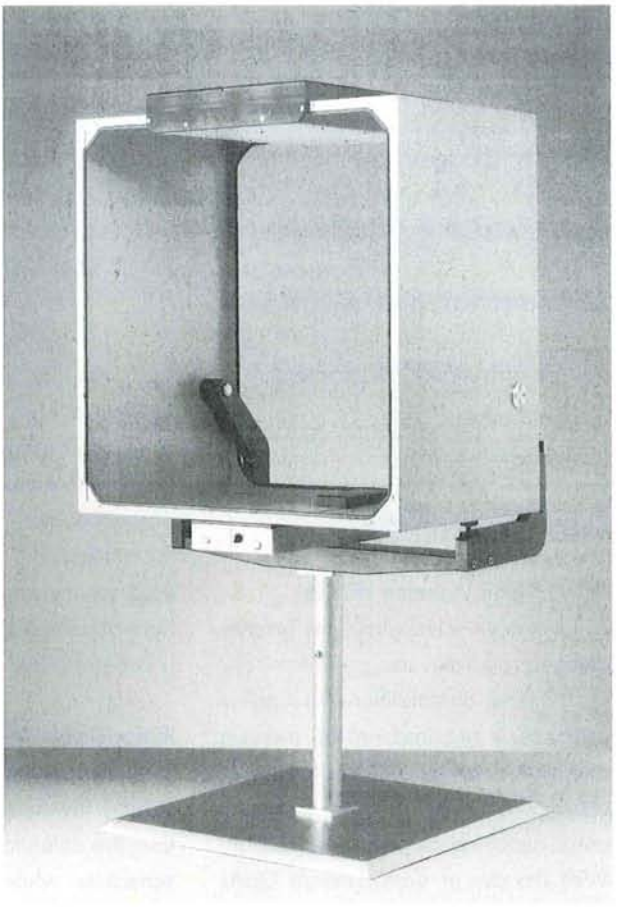
f/MHz	k (without attenuator)	k (with attenuator)
200	–5	–14
300	4	–8
500	10	–1
750	12	2
1000	19	9

Linearity	1-dB compression point at E >0.2 V/m
Maximum sensitivity (Δf = 1 Hz)	
200 MHz	–48 dBµV/m
300 MHz	–45 dBµV/m
400 MHz	–42.5 dBµV/m
500 MHz	–42 dBµV/m
1000 MHz	–37 dBµV/m
Power supply (via RF cable)	18 V, 0.06 A (amplifier off) 16 V, 0.13 A (amplifier on)
RF connector	N female, 50 Ω
Ground	via outer conductor of RF cable
Dimensions (H x W)	approx. 500 mm x 250 mm
Weight	approx. 1.6 kg

Ordering information

Active Dipole Antenna	HE527	4015.8008.02
Support for HE526 and HE527	AM524Z1	4036.0506.02

Active H-Field Measurement Antenna HM525



100 Hz to 30 MHz

See also Junction Unit GX525, page 48 and

Control Unit GS525, page 49

Uses

The Active H-Field Measurement Antenna HM 525 is designed for the defined and reproducible conversion of an alternating magnetic field of amplitude H to a voltage V into 50 Ω. The loop of the antenna can readily be tilted in the three orthogonal directions to enable detection of all magnetic field components.

The antenna factor

$$k_H = 20\log \frac{H \times 1\ \Omega m}{V}$$

determined for each antenna relates the voltage level v (dBµV) indicated on the test receiver with the level h (dBµA) of the magnetic fieldstrength H averaged over the antenna area:

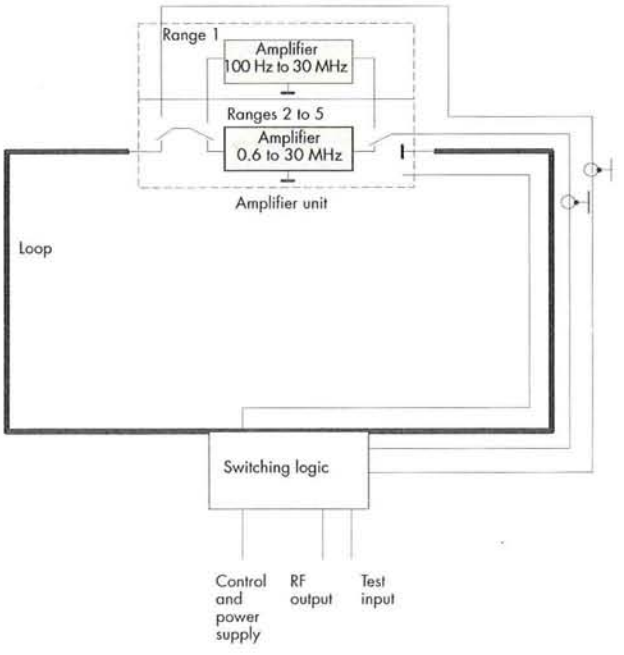
$$H\ (dB\mu A/m) = v\ (dB\mu V) + k_H\ (dB)$$

Characteristics

In addition to the extremely wide bandwidth, the antenna features extremely high sensitivity, wide dynamic range and compact design.

Operating modes

- Broadband operation from 100 Hz to 30 MHz for overview measurements
- Subrange operation for optimum sensitivity: five subranges are available
- Test mode: the antenna can be checked for proper functioning at any time using a test generator with defined output level.



Basic circuit diagram of Active H-Field Measurement Antenna HM525: Voltage induced in the loop is coupled out and matched to the cable impedance of 50 Ω in the amplifier unit

Operation

The range can be selected directly on the antenna, by remote control from the Control Unit GS525 or via the IEC/IEEE bus. The Junction Unit GX525 serves as an interface for the optical cables between antenna and control unit.

Description

To ensure balanced operation of the loop antenna and so avoid coupling in of electric field components, the HM 525 is designed as an EMI loop: the signals are coupled out at the RF symmetry point of the loop where the amplifier is located. The cables are routed along one side of the loop to the "cold" symmetry point where they can be connected without affecting the symmetry.

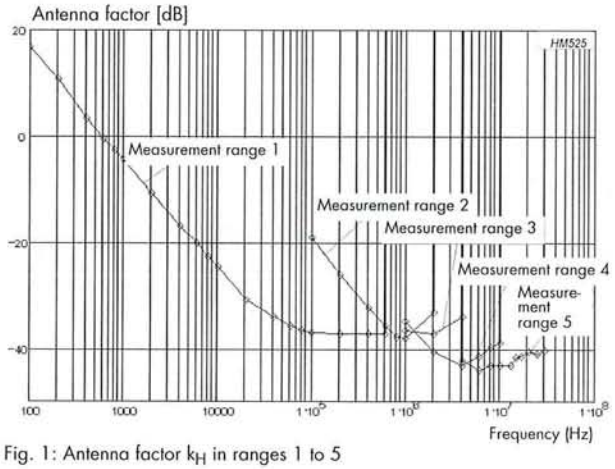


Fig. 1: Antenna factor k_H in ranges 1 to 5

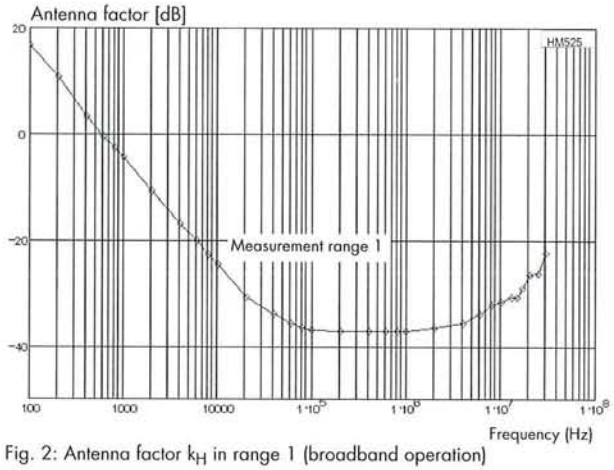


Fig. 2: Antenna factor k_H in range 1 (broadband operation)

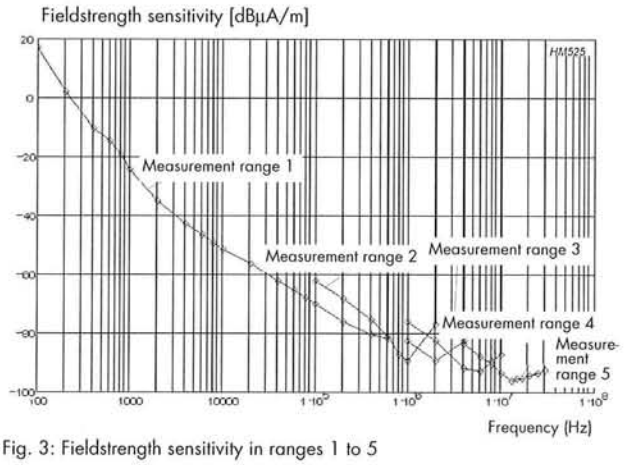


Fig. 3: Fieldstrength sensitivity in ranges 1 to 5

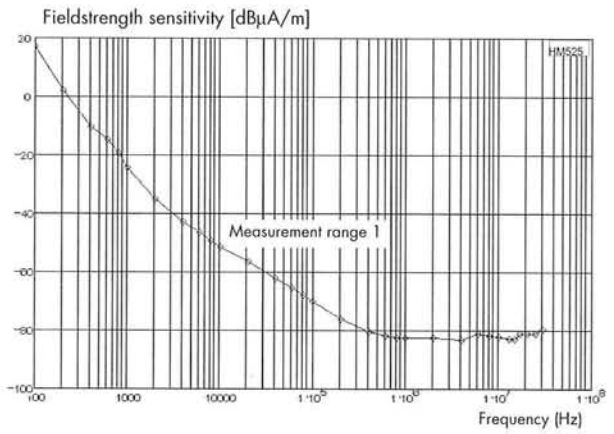


Fig. 4: Fieldstrength sensitivity in broadband operation (range 1)

Specifications

Frequency range	100 Hz to 30 MHz
Type of antenna	loop
Antenna factor	
k_H(dB) = H(dBµA/m) – v_{sens} (dBµV)	see Figs. 1 and 2
Fieldstrength sensitivity	see Figs. 3 and 4
Linearity	1-dB compression point
Range 1 (100 Hz to 30 MHz)	typ. 88 dB/µA/m
Range 2 (600 kHz to 1 MHz)	typ. 80 dB/µA/m
Range 3 (1.2 to 2.6 MHz)	typ. 80 dB/µA/m
Range 4 (2.6 to 8 MHz)	typ. 76 dB/µA/m
Range 5 (8 to 30 MHz)	typ. 79 dB/µA/m
RF connectors	N female, 50 Ω
Power supply	18 ±0.5 V DC, max. 0.7 A, via Junction Unit GX525
Antenna control	via 6-core control line from Junction Unit GX525, via 3 optical cables between GX525 and Control Unit GS525
Dimensions	loop 640 mm x 640 mm x 400 mm
Weight	approx. 10 kg

Ordering information

Active H-Field Measurement Antenna	HM525	4031.0508.02
Extra		
Support for HM525	HM525Z1	4036.1402.02

Junction Units GX525, GX526, GX527 and Basic Unit KK524

Supply and control of antennas

of the Active Antenna System

AM524, page 43

Uses, characteristics

The Junction Units GX525, GX526 and GX527 form the power supply and control unit for the Active Antennas HE52.. in the shielded chamber. The Junction Unit GX525 can also be used for the Active H-Field Measurement Antenna HM525 (page 46). The Basic Unit KK524 consists of a bench cabinet designed to accommodate the Junction Units GX52.. and also contains the power supply unit. The antennas can be remote-controlled via the front-panel controls on the junction units or via optical cables from the Control Unit GS525 (page 49). Test runs can thus fully be automated.

The antenna system can either be supplied from the built-in power supply unit or from external batteries. The use of the latter is of vital importance in view of AC-supply-related spurious. To ensure minimum inherent spurious, techniques like multiplexing or switch-mode power supply have been precluded.

The battery charging state as well as all important status are indicated on the front panels.

Specifications of GX52..

Input voltage	21 to 28 DC
Current drain (without antenna)	typ. 0.06 A (input: 24 V)
Battery connectors	round connectors (DIN41524)
DC feed units	
Insertion loss	<1 dB
RF connectors	N female
Optical cable inputs	
Optical cables	100/140 mm, 50/125 mm, 62.5/125 mm, 85/125 mm and 200 mm (PCS)
Receive wavelength	IP = 820 nm
Max. input level in OFF mode	–40 dBm
Input level range in ON mode	–24 to –12 dBm
Connectors	SMA female
Dimensions (W x H x D)	50 mm x 127 mm x 185 mm
Weight	0.5 kg

Ordering information

Junction Unit		
for HE525 and HM525	GX525	4015.9256.02
for HE526	GX526	4015.9504.02
for HE527	GX527	4015.9756.02

Specifications of KK524

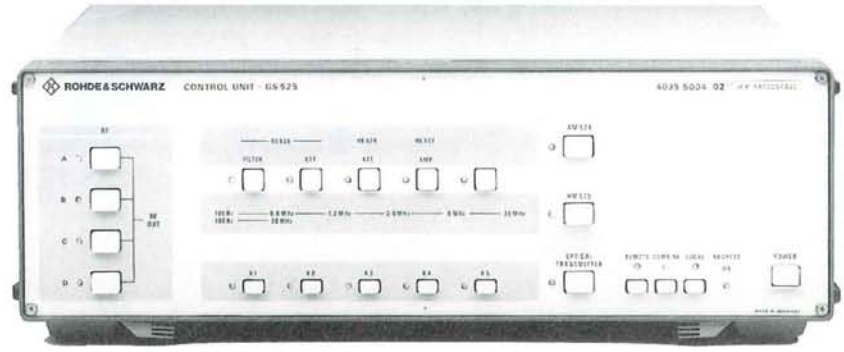
Power supply	battery
Connector	round connector (DIN41524)
Supply voltage	22 to 28 V DC
Current drain (continuous operation)	approx. 0.6 A (24 V) for operation of complete Antenna System AM524
AC supply voltage	100/120/220/240 V, 50 Hz, max. 58 VA
Output voltage	
AC supply operation	22 V
Battery operation	input voltage –1 V
Dimensions (W x H x D)	235 mm x 150 mm x 400 mm
Weight	4 kg

Ordering information

Basic Unit for Junction Units GX52..	KK524	4015.9004.02
Extra		
Transit case for antennas, junction units and basic unit	ZR524K	4015.8508.02

Control Unit GS525

Remote control of Active Antenna System AM524 (page 43) and H-Field Measurement Antenna HM525 (page 46)



Uses, characteristics

The Control Unit GS525 is used for remote control of the Active Antenna System AM524 (page 43) and the H-Field Measurement Antenna HM525 (page 46) with Junction Unit GX525 (page 48).

Front-panel controls as well as an IEC/IEEE-bus interface permit both manual and automatic fieldstrength measurements in processor-controlled systems.

A coaxial selector switch connects one of a maximum of four RF inputs (antennas) to an output (receiver, analyzer, etc). Via five optical transmitters and the Junction Units GX52.. the attenuators, filters and amplifiers of the Active Antennas HE52.. can be remote-controlled and the frequency ranges of the H-Field Measurement Antenna HM525 be selected.

The coaxial selector switch is made up of three coaxial relays which show good RF characteristics up to 1 GHz. The optical transmitters are matched to the Junction Units GX52.. which provide for control and power supply of the active antennas in the shielded chamber.

The GS525 is easy to program. LEDs indicate the current switching status of the system components controlled and permit in automatic mode monitoring of the program run. There are no coded commands to be used in local control; the antennas are simply controlled via front-panel keys. The combine mode, in which the unit responds both to program commands and to manual control, facilitates the generation and testing of programs.

Specifications

RF selector switch	
Connectors	N female, 50 Ω, on rear panel
Frequency range	0 to1 GHz
Insertion loss	<0.8 dB up to 1 GHz (typ. 0.3 dB)
Crosstalk attenuation	>80 dB up to 1 GHz
Life	$>1 \times 10^6$ switching operations
Switching time	<25 ms
Optical transmitter	HFBR-1402
General data	
Programming	IEC/IEEE bus (24-contact Amphenol connector)
Power supply	100/120/220/240 V ±10%, 47 to 63 Hz
Dimensions (W x H x D)	426.7 mm x 132.1 mm x 350 mm
Weight	6.9 kg

Ordering information

Control Unit	GS525	4035.5004.02
Extras		
IEC/IEEE-bus Cable		
0.5 m	PCK	0292.2013.05
1 m	PCK	0292.2013.10
2 m	PCK	0292.2013.20
4 m	PCK	0292.2013.40
Optical cable with SMA connector; Set of 5 cables	GS525K1	4035.5604.02

Active Receiving Dipoles HE202, HE302

Photo left: HE 302; right: HE 202

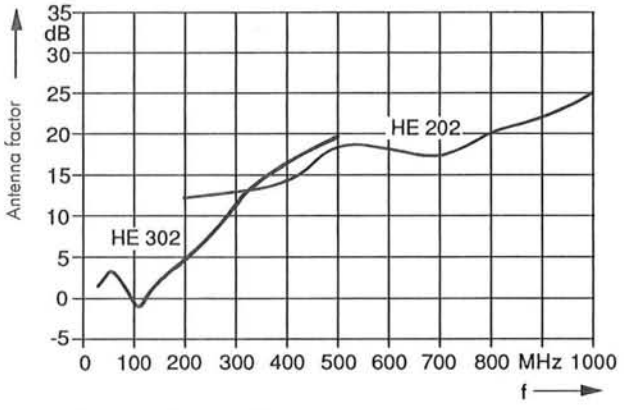
Uses, characteristics

Main features

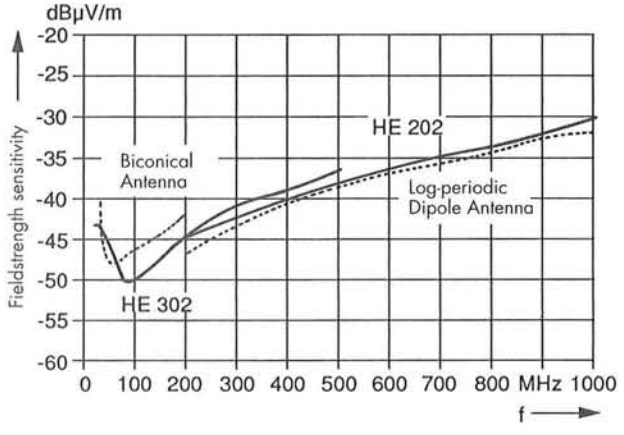
- Extremely small size
- High sensitivity
- Wide frequency range
- High immunity to nonlinear distortion, comparable to passive antennas in conjunction with high-grade preamplifier
- High immunity to nearby lightning strikes
- Shock- and vibration-resistant

Despite their extremely large bandwidth, the Active Antennas HE 202 and HE 302 from Rohde & Schwarz feature a fieldstrength sensitivity that is in the entire frequency range comparable to that of antennas with smaller bandwidth and considerably larger dimensions.

The degree of nonlinear distortion in the test system is important for signal fieldstrength and interference fieldstrength measurements in shielded rooms. With 1-dB compression, for example, the Active Receiving Dipole HE 302 is in the linear range for fieldstrengths up to 5 V/m at 20 MHz and up to 8 V/m at 500 MHz. At frequencies below 20 MHz the maximum fieldstrength increases by 40 dB per decade thanks to the reactive components in the input circuit.



Antenna factor as a function of frequency



Fieldstrength sensitivity of Active Receiving Dipoles HE 202, HE 302 compared to that of passive antennas with a receiver noise figure of 10 dB

Specifications

	HE202	HE302
Frequency range	200 to 1000 MHz	20 to 500 MHz
Polarization	linear	linear
Connector	N female, 50 Ω	N female, 50 Ω
VSWR	<2.5	<2.5
Electronic gain	5 to 9 dB	–11 to +8 dB
Practical gain	7 to 11 dB	–9 to +10 dB
Directivity	2 dB average	2 dB average
Antenna factor	10 to 22 dB	0 to 14 dB
Noise figure	200 MHz: 6 dB 1000 MHz: 7 dB	20 MHz: 28 dB 500 MHz: 9 dB
Fieldstrength sensitivity (Δf = 1 kHz)	200 MHz: –17 dBµV/m 1000 MHz: –2 dBµV/m	20 MHz: –15 dBµV/m 500 MHz: –6 dBµV/M
Intercept point		
2nd order	>55 dBm	>60 dBm
3rd order	>30 dBm	>30 dBm
Power supply (from Power Supply Unit IN 115)	via RF cable 18 to 30 V_{DC} 200 mA	170 mA
Dimensions (L x H)	512 mm x 238 mm	1 m x 240 mm
Weight	2.1 kg	2.5 kg

Ordering information

Active Receiving Dipole	HE202	0630.0310.0x
	HE302	0644.1114.0x

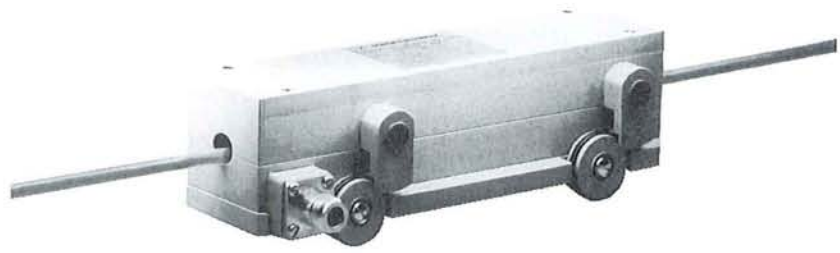
x = 2: for monitoring; x = 3: calibrated to ANSI C63.5

Extras		
Mast Adapter	HE202Z1	0649.7510.02
RF cable	HE202Z2	0649.7785.02
Antenna Adapter	AM524Z2	4036.0658.02

Absorbing Clamp MDS-22

300 to 2500 MHz

RFI power and shielding effectiveness measurements on lines



Uses

The Absorbing Clamp MDS-22 (MDS Clamp) can be used in conjunction with EMI Test Receivers to measure RFI power on lines to prEN 50083-2 and in conjunction with two-port measurement devices to measure the shielding effectiveness of lines to DIN 47250 Part 6, IEC 96-1, prEN 50083-2 and DIN V VDE 0855 Part 10.

RFI power measurement

A ferrite absorber inside the MDS Clamp encircles the power cable and acts as a resistance to the RFI power. The current flowing into the absorber is measured at the absorber input via a current transducer with an EMI test receiver. Since in this test setup there is no matching between interference source, line and absorber, the MDS Clamp is slid along the line for maximum current.

By choosing a suitable absorber and conversion ratio of the current transducer, the dBµV readout of an EMI test receiver is equivalent to a power indication in dBpW. Without calibration curve, the maximum measurement error is ±4 dB and when the calibration curve supplied with the MDS Clamp is used it is ±1 dB.

Measurement of shielding effectiveness

The shielding effectiveness of a cable is defined as the ratio of the RFI power of the surface wave of an unshielded cable to that of the cable shield as measured with the MDS Clamp. The shielded cable is terminated with its nominal impedance. Interfering effects caused by standing waves are reduced by the ferrite absorber of the MDS Clamp.

Characteristics

Main features

- Calibrated to CISPR-Publ. 16
- Ball-bearing rollers for continuous use in automatic measurements
- Can be easily opened to take up the line to be tested
- Maximum line diameter 12 mm

Design

The MDS Clamp is accommodated in a plastic case made up of two hinged parts, each part containing a set of ferrite ring halves. The latter are held in sprung plastic holders to form a channel for the EUT cable to be inserted. By closing the two parts of the case the magnetic loop around the cable is completed. Eccentric catches provide the necessary contact pressure.

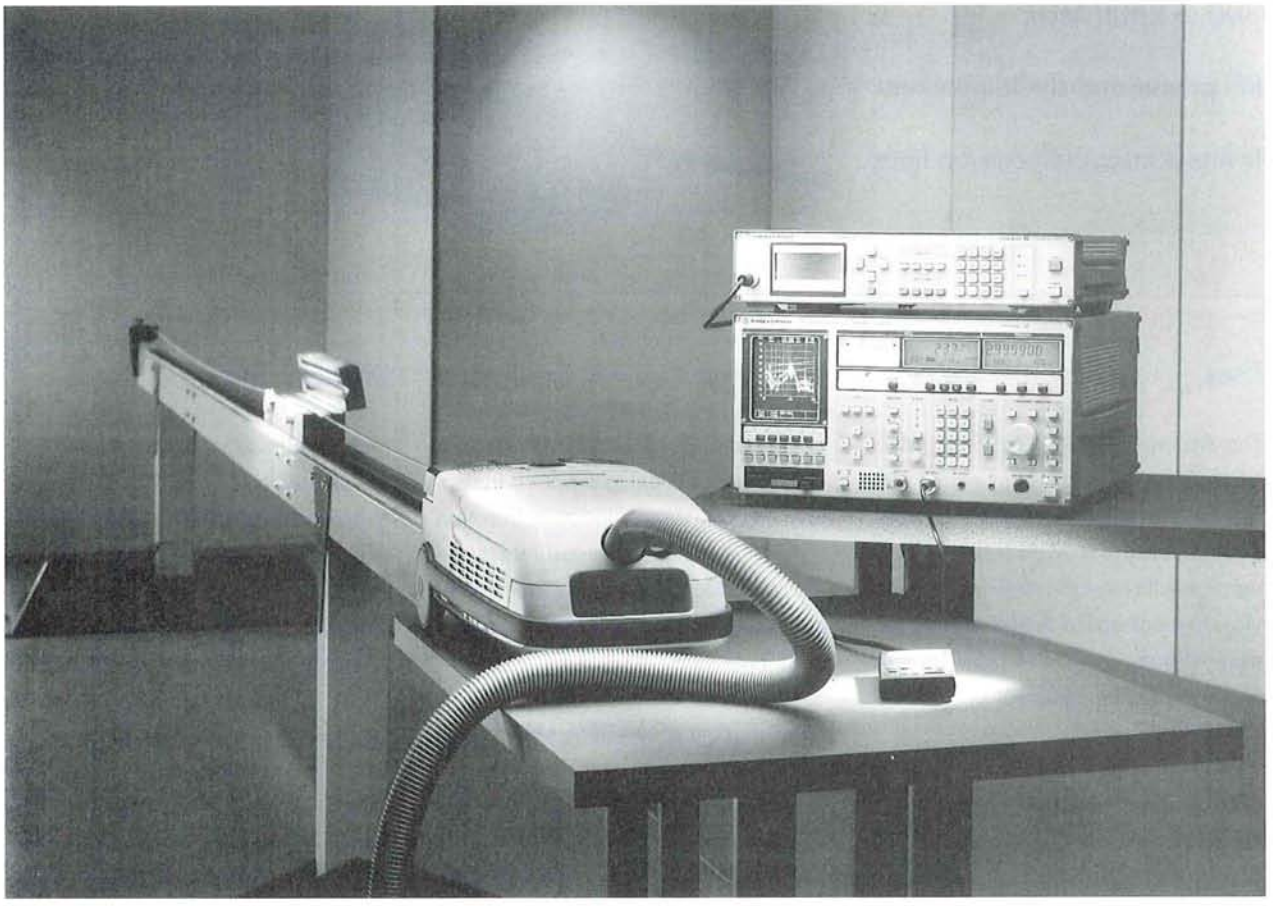
Specifications

Frequency range	300 to 2500 MHz
Insertion loss to CISPR 16 Part 1	17 +4/–2 dB
Connector	N female, 50 Ω
Permissible DC current or peak value of AC current	50 A
Max. permissible RF input power for susceptibility measurement	5 W (core temperature must not exceed 70°C)
Max. cable diameter	12 mm
Rollers	ball bearing, dust-protected
Dimensions (W x H x D); weight	230 mm x 70 mm x 70 mm; 1.25 kg

Ordering information

Absorbing Clamp	MDS-22	1052.3507.02
Extra		
Slideway for MDS Absorbing Clamp	HCA	1008.8420.02

Absorbing Clamp Slideway HCA: new component for Mast and Turntable System HCC, HCM and HCT, see catalog 93/94, page 104



Measurement of RFI power radiated by vacuum cleaner. The power cable is clamped at the ends of Slideway HCA and passes through Absorbing Clamp MDS-21. Right: Test Receiver ESHS30 and Position Controller HCC from Rohde&Schwarz

Automatic guidance of Absorbing Clamps MDS-21, (Catalog 93/94, page 107) and MDS-22 (in this supplementary catalog, page 51) along a cable for measurng the RFI power

Uses

For measuring RFI power, eg on power lines, to CISPR, EN, ANSI, VCCI and VDE an absorbing clamp (MDS Clamp) is used. The ferrite rings of the clamp encircle the line to be measured and the current flowing in the line is measured with a built-in current transducer.

By moving the absorbing clamp along the line by no more than half the wavelength – eg 5 m at 30 MHz – maximum RFI power is picked up. The EUT and the absorbing clamp are placed on a non-metallic surface at a distance of at least 40 cm from the floor and from any metallic objects.

The Absorbing Clamp Slideway HCA from Rohde & Schwarz makes this previously manually performed task redundant. It guides the clamp fully automatically – controlled by the test system – along the cable to be measured at 80 cm from the floor.

Characteristics

Design

The Absorbing Clamp Slideway HCA consists of sturdy glassfiber-reinforced epoxy tubing. A toothed belt is used to position the clamp. The slideway is designed for Absorbing Clamps MDS-21 (30 to 1000 MHz) and MDS-22 (0.3 to 2.5 GHz) from Rohde & Schwarz.

The cable to be measured is fixed by clamping jaws at the beginning and the end of the slideway. Particular care has been taken to move the absorbing clamp as close as possible to the EUT. When using Absorbing Clamp MDS-22, it is possible to reduce the spacing of the clamping jaws to 1.5 m because of the short slideway of the clamp at higher frequencies. The absorbing clamps are well secured so that they cannot drop to the ground.

Fully electronic drive

Like all the components of the Rohde & Schwarz mast and turntable system, the absorbing clamp slideway operates fully electronically. The core of the drive is an electronically commutated permanent-magnet motor. With electronic commutation and control, the sliding speed can be varied in nine steps beween 3 and 40 cm/s and thus optimally matched to all frequencies occurring (= slideways). Startup and braking is smooth and without overshoot.

High positioning accuracy

For RFI emission measurements the high positioning accuracy and in particular the reproducibility of the HCA position are of vital importance. Maximum RFI values measured once may be reliably confirmed.

Hall sensors signal that the clamp has reached an end position on the slideway causing the Controller HCC to stop the movement of the clamp. Like with the mast and the turntable, automatic calibration of the clamp position with respect to a starting point – here the beginning of the slideway – is possible.

Low RFI emission

Great care has been taken to rule out RFI emission: the Absorbing Clamp Slideway HCA does not emit any RFI measurable to CISPR in the frequency range 150 kHz to 1000 MHz. Metal-free fiberoptic cables are used to transmit the control commands and the position messages between the controller and slideway. Therefore, it is possible to avoid all problems associated with reflecting cables in the vicinity of antenna and EUT or with the filtering of control lines if the slideway is used in shielded enclosures or anechoic chambers.

Specifications

Operating range	
Max. slideway with MDS-21	500 cm
Max. slideway with MDS-22	530 cm
Nonlinearity	≤15 mm
Reproducibility error	≤5 mm
Height of slideway above ground	80 cm
Drive	electrical using an electronically commutated permanent-magnet motor with speed control 1:15
Speed	3 to 40 cm/s in nine steps
Transmission	by toothed belt
Materials	
Supporting tube (slideway)	glassfiber-reinforced epoxy tube 110 x 110/5 mm
Toothed belt	polychloroprene with glassfiber tension rope
Connectors	
Remote control	via fiberoptic cables; RS-232 protocol, duplex operation
AC power supply	female connector 3-phase + ground

General data	
Dimensions and weights	
Overall height	910 mm
Overall length	5700 mm
Width (drive)	980 mm
Weight	59 kg
Power supply (AC only)	100/120/230 V +10/–15%, max. 350 VA

Order designation

Absorbing Clamp Slideway incl. fiberoptic control cable, 10 m	HCA	1008.8420.02

Extra

Non-metallic table, adjustable in height (on request)

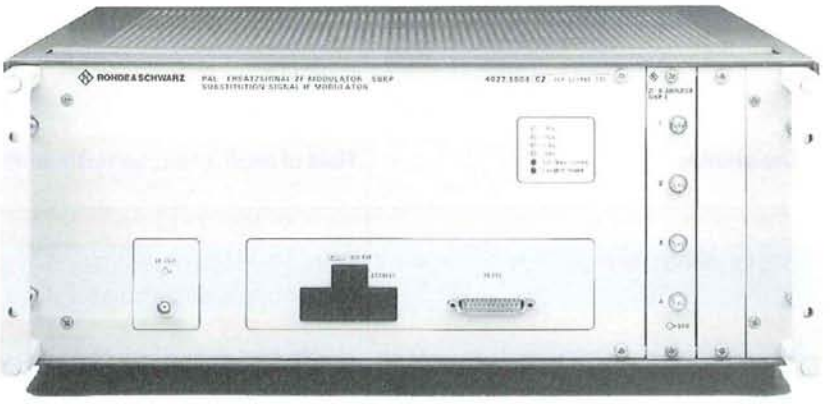
Rohde & Schwarz Video Analyzers and TV Oscilloscopes from the VTA family

Contents of Chapter 3

PAL Substitution Signal IF Modulator SBKP

38.9 MHz

Standard vision and sound signals for CATV systems

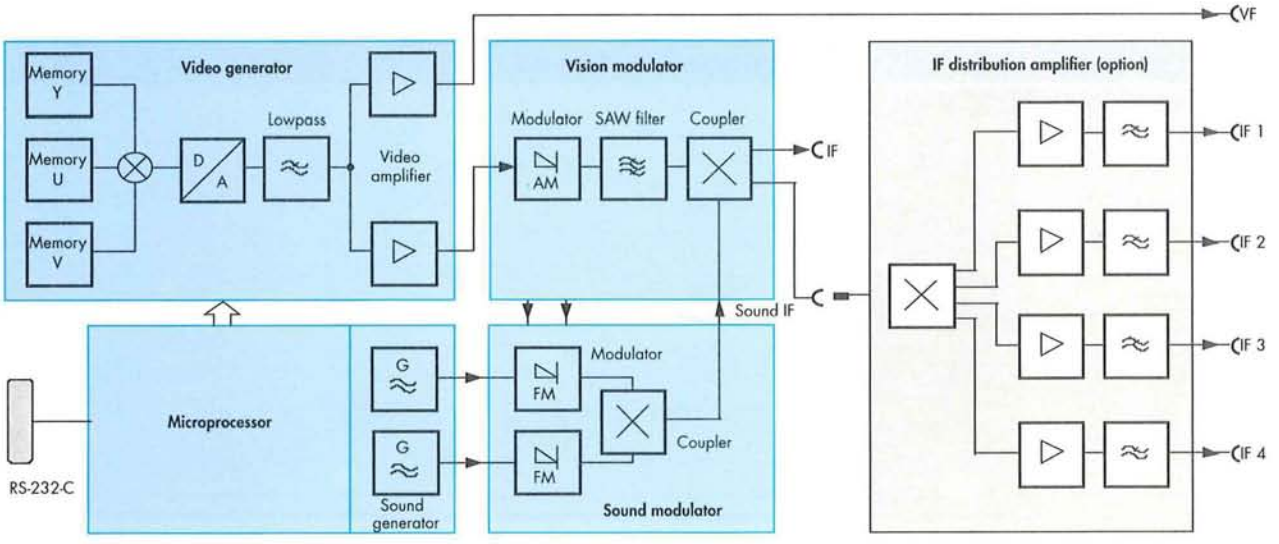


Uses, characteristics

The PAL Substitution Signal IF Modulator SBKP from Rohde & Schwarz supplies a standard vision/sound IF test signal in full compliance with German FuBK specifications. This test pattern is applied as a substitution signal to a CATV channel during program intervals or breakdowns.

An individual text can simply be programmed and inserted via a standard computer interface. For the sound channels, 1-kHz and 5-kHz sinewave signals are produced.

The SBKP can be optionally expanded by adding one or two IF amplifier plug-ins with four outputs each.



Block diagram of SBKP

Specifications

Vision signal

PAL test pattern to FuBK standard with CCIR test lines; luminance signal (including blanking and sync signals) and chrominance signal (including colour burst) are generated digitally with 10 bit resolution each, chrominance modulation at digital end

Clock frequency: 15 MHz, crystal-stabilized (2.5×10^{-6})

D/A conversion: 12 bit

6-MHz lowpass filter: attenuation for f >8.3 MHz: >60 dB

Text insertion: to FuBK specifications, max. 2 lines of 30 characters each, input via PC interface RS-232-C

Video signal output

Connector	75-Ω BNC female on front panel
Return loss	>35 dB
Signal amplitude	1 V_{pp} ±1%
Luminance bar	700 mV ±1%
Sync level	300 mV ±1%

Insertion test signal CCIR 17	baseband signal	demod. IF signal
Tilt	<1%	<1%
2T amplitude	<±1%	<±3%
Line-time nonlinearity	<1%	<3%
2T k-rating	<1%	<1%
Baseline distortion	<1%	<1%
Chrominance/luminance gain (20T pulse)	<1%	<3%

Insertion test signal CCIR 17	baseband signal	demod. IF signal
Chrominance/luminance delay (20T pulse)	<5 ns	<20 ns
Insertion test signal CCIR 18		
Amplitude/frequency response	<2%	<5%
Insertion test signal CCIR 330		
Differential gain	<1%	<3%
Differential phase	<1°	<3°
Noise	–	>70 dB (rms)
Discrete noise	–	>66 dB (rms)
Luminance S/N ratio to CCIR	>78 dB	–
Hum referred to black-to-white transition (rms)	>53 dB	>53dB
Sync level (referred to luminance bar)	–	±2%

Vision IF signal	carrier frequency 38.9 MHz
Modulation mode	C3F (A5C), negative (standard B/G); vestigial sideband AM
Vision carrier frequency (f_{vision})	38.9 MHz (drift <1 x 10^{-5})
Residual carrier	11 ±1%
Receiver delay precorrection	to standard specifications FTZ/ARD, can be bypassed
Outputs; impedance	1, 4 or 8 SMA connectors on front panel; 50 Ω
Output level at sync peak	–4 dBm (without IF amplifier); 6 to 13 dB with 4 and 8 outputs, adjustable in 0.5-dB steps with links and approx. ±0.5 dB with potentiometer for each output
Return loss	>20 dB in range 28 to 41 MHz
IF S/N ratio	referred to sync peak
Spurious emissions	>60 dB
Harmonics	>50 dB
Intermodulation products	>72 dB
Modulated IF vestigial sideband signal, sync level	±5% referred to luminance bar
Sound signal	
Sound 1 / sound 2	1 kHz ±5% / 5 kHz ±5%
Modulation mode	frequency modulation according to dual-sound carrier method
Sound IF1	
Sound subcarrier frequency	33.400 MHz, stabilized by line frequency via PLL
Signal deviation	±10 kHz
Sound subcarrier level	13 dB below sync peak level
Sound IF2	
Sound subcarrier frequency	33.148 MHz, stabilized by line frequency via PLL
Signal deviation	±9.5 kHz (±5 kHz + preemphasis)
Sound subcarrier level	20 dB below sync peak level
Pilot signal	
Pilot frequency	54.6875 kHz = 3.5 x line frequency
Modulation	AM with 274.1228 Hz = 1/57 x line frequency (dual-sound identification)
Modulation depth	50 ±10%
Deviation	2.5 kHz ±10%
Crosstalk sound 1 → sound 2	>80 dB (after demodulation)
Intercarrier S/N ratio	>50 dB
General data	
Power supply	230 V ±10%, 47 to 63 Hz, 80 VA
Dimensions (W x H x D); weight	430 mm x 220 mm x 470 mm; 25 kg

Ordering information

PAL Substitution Signal IF Modulator	SBKP	4027.9504.02
Option		
IF Amplifier with 4 outputs	SBKP-E	4028.1007.02

Digital Video Interface SAF-Z1, SFF-Z1

Option for TV Generators SAF and SFF (see catalog 93/94, page 122)

Uses, characteristics

This option enhances the field of application of TV Generators SAF and SFF for use in digital TV studios: in addition to the analog video signals, a parallel and two serial digital video signals are thus simultaneously available.

With this option fitted, the CCIR 601 menu provides a number of special signals for testing digital 4:2:2 equipment.

19 test signals to CCIR Report 1212

- Flat fields
- Various ramps for testing the correct quantization of D/A converters for each individual component
- Undefined signal transitions for determining frequency responses or transients of the lowpass filters contained in the 4:2:2 decoders
- Digital colour bar for checking level and delay of the components after 4:2:2 decoding

Pathological signals

These stress signals can be used for testing of cable equalizers and PLL circuits, for example.

Non-standard test signals

The signal edit function provided in the basic unit allows video and sync signals to be manipulated also in the digital mode, eg for simulating a transmission error or for testing the response of digital studio equipment under marginal conditions.

The option comes as a plug-in card and can be easily integrated into the basic unit without any alignment.

Specifications

Standard	CCIR Rec. 601/656 (4:2:2)
Systems	625/50 and 525/60
Resolution	10 bit
Level	0.8 V (ECL level)
Signals	in line with CCIR Rep. 1212 and SAF/SFF signals
Parallel output	27 MHz
Connector	25-contact Cannon
Clock shift	±10 ns
Serial output	270 Mbit/s in D1 format
Connector	BNC, 75 Ω

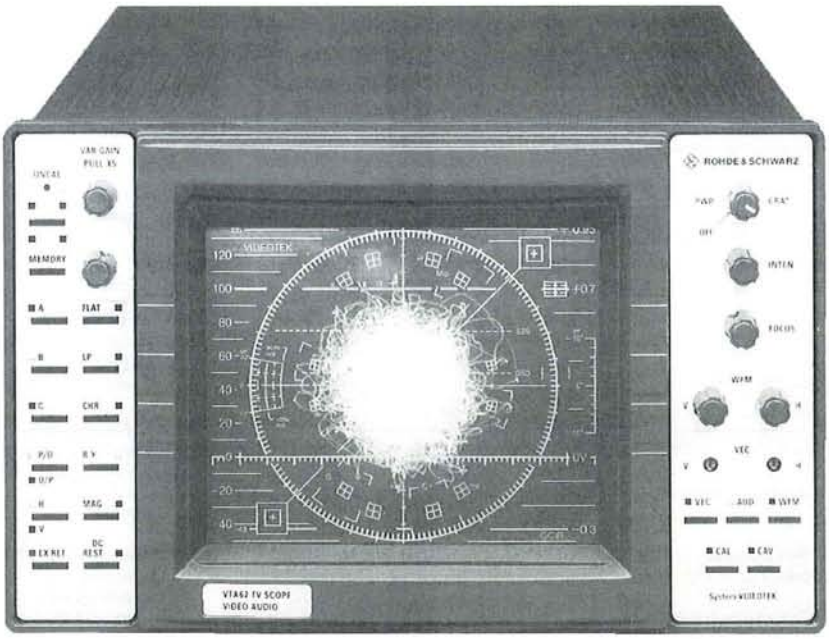
Ordering information

Digital Video Interface		
for SAF	SAF-Z1	2007.1063.02
for SFF	SFF-Z1	2007.1063.03

Video/Audio TV Scope VTA62

25 Hz to 10 MHz

Cost-effective, analog TV oscilloscope/vectorscope for studio applications (PAL)



Uses

The Video/Audio TV Scope VTA62 from Rohde & Schwarz combines three instruments in one unit: oscilloscope, vectorscope and audio monitor. In spite of this versatility, the unit only takes half a 19" rack width and three height units. VTA62 is the ideal instrument for monitoring analog video and audio signals of various formats:

- Video measurements of component and composite signals
- Stereo audio analysis in balanced or unbalanced mode
- Overlay waveforms for timing and amplitude comparison
- Waveform parade to observe multiple inputs
- Overlay vector signals for phase and gain comparison
- Measurement of differential phase

Characteristics

Inputs

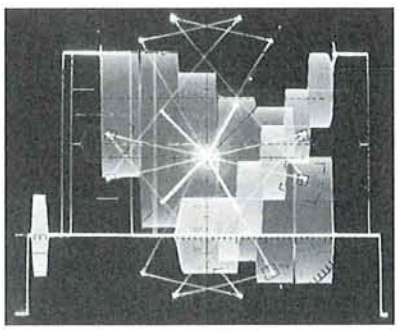
- Three composite loopthrough filters or one CAV (Component Analog Video) loopthrough triplet
- Calibrated X-Y input for Lissajous display of balanced or unbalanced audio signals. Input level is selectable for 0, +4, +8 and +12 dBm

Display modes

- Waveform parade or overlay of three composite inputs and three filters: flat frequency response (FLAT), lowpass filters, chroma filters
- Composite vector overlay of three inputs
- Combination of vectors overlaid and waveforms paraded and/or overlaid simultaneously
- Simultaneous display of up to three different composite functions/filters
- CAV signals to Beta, SMPTE, EBU or MII standards of 75% and 100% equivalent saturation – paraded or overlaid and/or vectors displayed individually or in combination
- R-Y mode (V-axis PAL) with R-Y scale for high resolution of differential phase measurements of composite signals. The R-Y mode displays the demodulated chrominance signal with horizontal deflection
- Display of phase and signal level of audio signals

Further features

- Frequency response 1% up to 10 MHz
- High-brightness CRT, non-glare contrast filter
- Internally etched graticule to eliminate parallax errors
- DC restoration to maintain display stability with varying APL
- Storage and recall of four user-defined device setups
- Built-in diagnostics for fast testing of front-panel controls and LED indicators



Overlay of waveform and vectorscope mode

Specifications

Vertical deflection

Frequency response without filter (FLAT)	
25 Hz to 10 MHz	±1% referred to 50 kHz
Lowpass filter	≥40 dB attenuation at f_{SC}
Luminance frequency response	<1%, in FLAT setting
Chroma	
Level variation at 4.43 MHz	<1% between FLAT and chroma
Transient response	<1% in FLAT mode and using sin^2 pulse-and-bar signal
Pulse-to-bar ratio	0.99:1 to 1.01:1
Tilt with field-rate squarewave or window signal or 25-µs pulse signal	≤1%
Deflection factor for 1-V full scale	±1%, with 1-V input
Maximum absolute input level	±3.5 V (DC + AC peak)
Input impedance	10 kΩ/<25 pF (unterminated)
Return loss, input A/B/C (75 Ω)	>50 dB, DC to 5 MHz
Input voltage range	0.5 to 2 V, adjustable for 1-V display

Horizontal deflection

Vertical rate timebase	equal to x1, x2, or x3 of the field rate of applied video or external reference signal (user-selected parade modes)
Horizontal rate timebase	equal to x1, x2, or x3 of the H line rate of applied video or external reference signal (user-selected parade modes)
Sweep magnification	x10
Timing tolerance in mode	
1 H, HMAG (0.5 µs/div)	<2%
2 H, HMAG (1 µs/div)	<2% of 1 H
3 H, HMAG (1.5 µs/div)	<2% of 1 H
Linearity of complete horizontal position range excluding first and last major division of time axis	≤2%
Display modes	waveform, vector, combination

DC restoration

Clamping	back porch
Blanking level shift due to presence or absence of burst	≤1%
Blanking level shift with APL changing from 50% to either 10 or 90%	≤1%

Calibration

Frequency in waveform display mode	100 ±0.1 kHz; reference signal for sweep and magnifier calibration
Amplitude	1 V ±0.5%
Vector mode (composite only)	display of test circle for sweep linearity check and quadrature alignment

Video output (monitor output)

Frequency response	±2%, DC to 5 MHz
Differential gain	2% at 50% APL at 1 V into 75 Ω
Differential phase	3° at 50% APL at 1 V into 75 Ω
DC level at output	≤±100 mV into 75 Ω
Nominal output impedance	75 Ω
Amplitude	1 V ±3% into 75 Ω for 1-V input
Return loss	>40 dB, DC to 5 MHz

Synchronization

Internal reference	composite video or black burst with sync and burst amplitudes of 300 mV ±6 dB
External reference in waveform mode	150 mV to 4 V sync amplitude will synchronize sweeps
Composite vector mode	composite video or black burst with sync and burst amplitudes of 300 mV ±6 dB

Composite vector mode

Phase control range	≥360°, typ. 400° (vector and R-Y modes)
Vector tolerance	≤1°
Differential gain	≤1%
Differential phase	≤1°
Variable gain range	≥12 dB, typ. –6 to +6 dB with 1-V input
Gain stability error (0 to 50°C)	<2% (for ±5% variation of nominal AC supply voltage)
Subcarrier regenerator	phase-locked to subcarrier with burst signal as reference
Nominal frequency	4.433619 MHz
Pull-in range	±50 Hz of nominal f_{SC}
Phase shift with burst amplitude change	<0.5° per dB change for 6 dB change from nominal burst amplitude
reference switched int./ext. input channel change	≤0.5°
variable gain	≤0.5°/dB in range –6 to +6 dB

Measurement accuracy in multiple display mode

Waveform overlays (HMAG), relative	±100 ns, ±1% of nominal bar amplitude
Vector overlays, relative	±1°, ±1% of nominal bar amplitude

Audio

Input levels	0, +4, +8 or +12 dBm, internally selectable, factory-set to 0 dBm
Type of input	differential, AC-coupled
Input impedance	approx. 20 kΩ
Frequency response	±2%, 50 Hz to 50 kHz
Phase matching	less than a trace width of electron beam at 20 kHz
Input connector	D-type, 15-contact
Displays	audio may be displayed alone or in combination with waveform and/or vector

Microprocessor control system

Microprocessor	65C02, 4 MHz
Storage of instrument settings	typ. 1 year (self-charging battery)
Diagnostics	built-in testing of front-panel keys and LED indicators

CRT

Display size	8 cm x 10 cm
Graticule	internally etched with variable scale illumination; scales provided for waveform, vector and R-Y

General data

Power supply	110/120 V (95 to 132 V) or 230/240 V (195 to 264 V), jumper-selectable, 48 to 66 Hz, 75 VA
Dimensions (W x H x D)	216 mm x 134 mm x 451 mm
Weight	6.1 kg

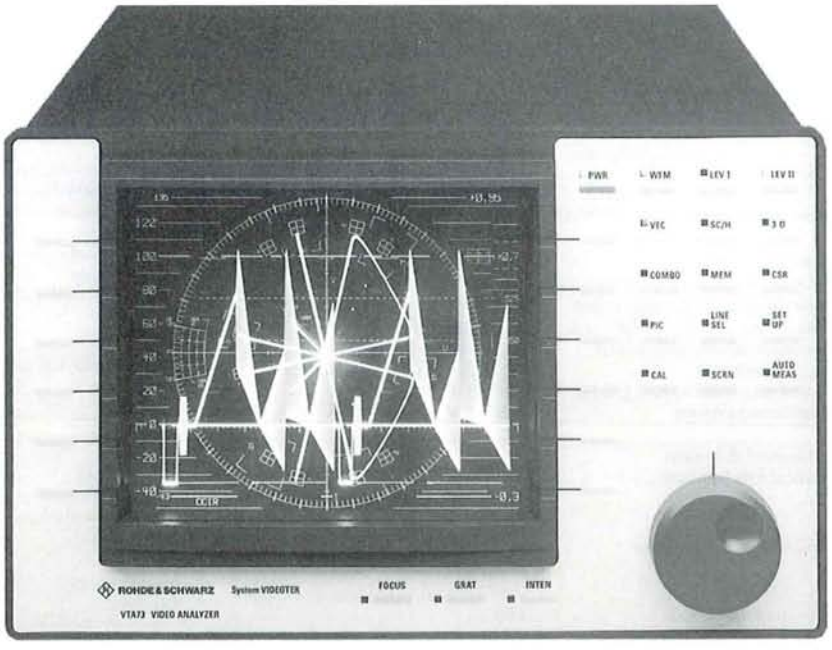
Ordering information

Video/Audio TV Scope (PAL)	VTA 62	1062.4993.02
Accessories supplied	non-glare contrast filter, 75Ω-video termination	
Extras		
Portable case with handle and sunshield	VTA-Z1	1062.5390.00
Double adapter with one blank panel for mounting in 19" racks	VTA-Z2	1062.5419.00

Video Analyzers VTA71, VTA72 and VTA73

25 Hz to 10 MHz

General-purpose video analyzers with oscilloscope and vectorscope function (PAL)



Uses

The Video Analyzers VTA71, VTA72 and VTA73 from Rohde & Schwarz set new standards for the combination of video analyzer, oscilloscope and vectorscope that comes in one compact cabinet $^1/_2$19" wide and 3 units high. They are ideal for all TV applications:

- Monitoring of multiple video signals
- Ideal for studios – eg setting up of TV cameras, measurement and broadcasting vans, monitoring of broadband communications equipment, research and development labs, TV set and video recorder production, service centers
- The VTA 71 is an ideal complement to the Rohde & Schwarz Video Analyzer UAF

A variety of inputs and a large choice of measurement functions provide high monitoring flexibility for
– differential phase
– differential gain
– lowpass and chroma filters

The innovative combination of analog and digital signal processing provides the fidelity of analog resolution with the unequalled accuracy of digital measurements.

Characteristics

Composite Video Analyzer VTA 71

- Four composite loopthrough inputs; any input can be selected as a reference

Component/Composite Video Analyzer VTA 72

- Two CAV (Component Analog Video) input triplets and two composite, or one CAV and five composite, or eight composite inputs, all inputs being designed as loopthrough filters. Any input can be selected as a reference
- Simultaneous measurement of CAV and composite video signals
- Bowtie display for CAV timing measurements

Composite Video Analyzer VTA 73

- Inputs same as VTA 71
- Automatic, fully remote-controlled measurement of test parameters to CCIR 473, 567, 569 and 624 as well as common basic measurements
- RS-232-C/RS-422 interface for direct connection to a printer or PC

Common features

Analog signal display

- Waveform parade or overlay of three inputs and three filters
- Vector overlay of three inputs for phase and gain comparisons
- Combination of vectors overlaid and waveforms paraded and/or overlaid simultaneously for timing and amplitude comparisons
- Up to nine different inputs/filters can be displayed simultaneously

SC/H phase display (patented)

- Simultaneous measurement of up to four inputs
- Drift-free accuracy over a wide temperature range

Digital line selector

- Display of up to any three selectable lines – individually, paraded or overlaid
- VITS monitoring
- Simultaneous monitoring of up to three inputs

- Bright, flicker-free display thanks to waveform memory (8 x f_{SC} with 10 bit resolution)

On-screen digital readouts
- Inputs, filters, line and field numbers, cursor measurement values
- Four cursors: measurement of time, amplitude, phase and saturation in absolute and delta values

Operation

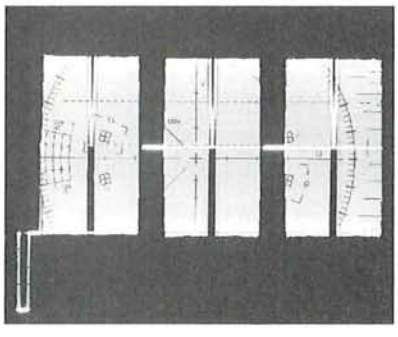
Two operating levels
- Level I for all basic waveform, vector and picture modes
- Level II for line selects, SC/H phase displays, measurement cursors, 3-D display and other complex waveform and vector displays

Great ease of operation
- Easy-to-use hardkeys with subselection via softkeys
- Context-sensitive on-screen menus, all functions are clearly labelled
- On-screen writing completely describes the display on the CRT
- Independent intensity adjustment for waveform, vector, text and picture displays

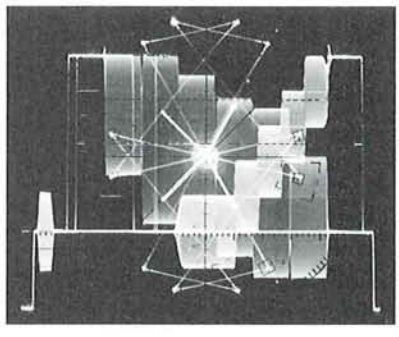
Memory
- Storage and recall of up to 20 user-defined complete instrument settings including graticule intensity, cursor positions and focus
- Upload and download via PC
- Output of stored results for future reference

3-D display (patented)
- Unique adaptation of vector display to include luminance component on Z axis
- Display can be rotated on X, Y and Z axis. All three dimensions of the video signal are shown simultaneously

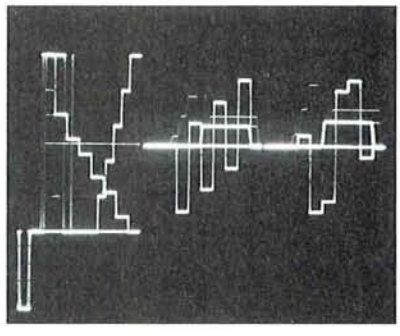
Remote control
- Remote control of all functions via PC (RS-232-C/RS-422)
- Upload, download and recall of all memories of operating level II via RS-232/RS-422 interface



Parade mode YC_BC_R of H sweep 5.8 MHz



Overlay of waveform and vectorscope mode



Parade mode YC_BC_R

Specifications

Vertical deflection

Frequency response	
25 Hz to 10 MHz	±0.1 dB referred to 50 kHz
14 MHz	±1 dB
Lowpass filter (luminance)	<1%, in FLAT setting
Attenuation at f_{SC}	≥40 dB
Line selector bandwidth	9 MHz (-3 dB)
Level variation at 4.43 MHz	max. 1% between FLAT and chroma
Transient response	<1° in FLAT mode and using $\sin^2$ pulse-and-bar signal
Pulse-to-bar-ratio	0.99:1 to 1.01:1
Tilt with field rate squarewave or window signal or 25 µs pulse signal	≤1%
Deflection factor for 1-V full scale	±1% with 1-V input
Maximum absolute input level	±3.5 V (DC + AC peak)
Input impedance	100 kΩ II <10 pF (unterminated)
Return loss (75 Ω)	>40 dB, DC to 6 MHz
Variable gain range	–6 to +14 dB
Voltage cursors	
Resolution	1 mV at 1 V
Tolerance	±0.2%
Differential gain display	
Deflection factor	20% for 0.7 V trace deflection
Tolerance	±0.1%
Differential phase display	
Deflection factor	20° for 0.7 V trace deflection
Tolerance	±0.1°
SC/H phase display	
Displays	1 to 4 inputs simultaneously
Tolerance	±3°, 0 to 50°C

Video Analyzers VTA 71, VTA 72 and VTA 73

3-D display	
Colour phase tolerance	±1°
Colour gain tolerance	±1%
Luminance amplitude tolerance	±1%
Horizontal deflection	
Vertical sweep magnification	x1, x5, x10, x50
Horizontal sweep magnification	x1, x5, x10, x50
Timing tolerance in mode	
1H, HMAG (0.5 µs/div)	<2%
2H, HMAG (1 µs/div)	<2%
3H, HMAG (1.5 µs/div)	<2%H
Linearity of complete horizontal position range excluding first and last major division of time axis	≤2%
Timing cursor tolerance with x1, x5, x10, x50 magnification	±100 ns, ±20 ns, ±10 ns, ±8 ns
Line selects	3 independent, each capable of displaying: any line of any single field, or all odd or even fields, or all fields
DC restoration	
Clamping	back porch
Hum attenuation	
fast DC restoration	>20 dB
slow DC restoration	<1 dB
Blanking level shift due to presence or absence of burst with APL changing from 50% to either 10 or 90% with	≤1%
fast DC restoration	≤1%
slow DC restoration	≤2%
Calibration	
Oscilloscope mode	
Frequency	100 ±0.1 kHz; reference signal for sweep and magnifier calibration
Amplitude	1 V ±0.5%
Vectorscope mode	display of test circle for sweep linearity check and quadrature alignment
Video output (monitor output)	
Frequency response	±3 dB, DC to 10 MHz
Differential gain	2% at 50% APL with 1-V display
Differential phase	3° at 50% APL with 1-V display
Amplitude	1 V ±10% for 1-V input
Return loss	>40 dB, DC to 5 MHz
Synchronization	
Internal reference	composite video or black burst with sync and burst amplitudes of 286 mV ±6 dB
Vector mode	composite video or black burst with sync and burst amplitudes of 286 mV ±6 dB
Input impedance	100 kΩ ‖ <10 pF (unterminated)
Vector mode	
Chrominance bandwidth (3 dB), lower/upper limit frequency	3.88 MHz/4.98 MHz ±150 kHz
Phase control range	infinite
Vector tolerance	≤1°
Differential gain	≤1%
Differential phase	≤1°
Variable gain range	-6 to +14 dB
Gain stability error (0 to 50°C)	<2% (for ±5% variation of nominal AC supply voltage)

Automatic measurement functions (VTA 73 only)

Measurement	Rec.	Nominal value	Measurement range	Error limits	Unit
Bar rise time	473	+0.2	+0.1 to +1 s	±0.02	µs
Bar tilt (end points)	569	0	–20 to +20	±0.5	%
Bar tilt (peak)	567	0	–20 to +20	±0.5	%
Baseline distortion	569	0	–20 to +20	±1	%
Blanking level					
BGDH	624	+75	0 to +80	±0.5	%
I	624	+76	0 to +80	±0.5	%
Burst					
Amplitude					
Differential	basic	0	0 to +25	±2	%
Tolerances	569	0	–50 to +100	±2	%
Cycles	624	+10	+6 to +13	±0.1	n
Duration (time)	624	+2.255	+1.35 to +2.93	±0.025	µs
Level	624	+300	+80 to +600	±5	mV
Quadrature tolerance	basic	+90	±0 to +180	±1.5	°
Amplitude error of chrominance reference	569	0	–50 to +50	±1	%
Chrominance/luminance					
Delay inequality	567	0	–300 to +300	±6	ns
Gain inequality	567	0	–50 to +20	±1	%
Intermodulation	567	0	–20 to +20	±0.5	%
Differential gain	567	0	0 to +100	±0.3	%
Differential phase	567	0	0 to +180	±0.5	°
Equal. pulse duration	624	+3.35	+1.4 to +7	±0.01	µs
Field serration pulses	624	+4.7	+1.4 to +10	±0.01	µs
Front porch duration					
BGDH	624	+1.5	+0.5 to +2	±0.01	µs
I	624	+1.65	+0.5 to +2	±0.01	µs
ICPM	basic	0	0 to +20	±1	°
Line blank duration	624	+12	+9 to +16	±0.01	µs
Line synchronization					
Duration	624	+4.7	+1.4 to +6	±0.01	µs
Fall time					
BGDH	624	+0.2	+0.1 to +0.5	±0.005	µs
I	624	+0.25	+0.1 to +0.5	±0.005	µs
Rise time					
BGDH	624	+0.2	+0.1 to +0.5	±0.005	µs
I	624	+0.25	+0.1 to +0.5	±0.005	µs
Luminance bar amplitude	569	+700	+200 to +900	±3.5	mV
relative	569	0	–70 to +30	±1	%
Luminance nonlinearity	567	0	0 to +50	±0.5	%
Luminance S/N ratio, weighted, 0 to 5 MHz	567	+75	+30 to +75	±2	dB
S/N ratio, unweighted	basic	+75	+30 to +75	±2	dB
Multiburst					
Amplitude (0.5/1/2/4/4.8/5.8 MHz)	567	+100	±10 to +150	±1.5	%
Flag amplitude	567	+420	+200 to +555	±5	mV
Pulse-to-bar ratio	567	+100	+10	+125	±1%
SC/H phase	basic	0	–180	+180	±5°
Sync amplitude (SIS)	569	0	–50 to +100	±1	%
Sync amplitude tolerance	569	0	–50 to +100	±1	%
Sync level	624	+300	+150 to +600	±5	mV
Sync-to-bar					
Ratio (3:7)	basic	+100	+50 to +110	±1	%
Peak-to-peak	basic	+1000	+500 to +1300	±5	mV
Sync-to-burst start	624	+5.6	+4 to +8	±0.02	µs

Subcarrier regenerator	phase-locked to subcarrier with burst signal as reference
Nominal frequency	4.433619 MHz
Pull-in range	±50 Hz of nominal f_{SC}
Phase shift with	
subcarrier frequency change	<0.25° per Hz deviation
burst amplitude change	<0.5° per dB deviation for 6 dB deviation from nominal burst amplitude

Switchover from int. to ext. reference	≤0.5°
Input channel variation	≤0.5°
Variable gain	≤0.5°/dB in range -6 to +6 dB
Measurement accuracy in multiple display mode	
Waveform overlays (x10), relative	±100 ns, 1% of nominal bar amplitude
Vector overlays, relative	±1°, ±1% of nominal bar amplitude
Microprocessor control system	MC 68000, 10 MHz
Storage of instrument settings	typ. 1 year (self-charging battery)
Diagnostics	built-in automatic testing of front-panel keys and LED indicators
CRT	8 cm x 10 cm, internally etched graticule with variable scale illumination: scales provided for waveform and vector display

General data

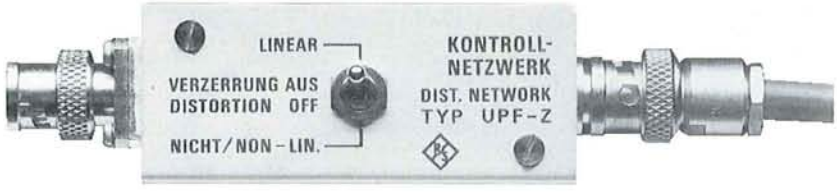
Power supply	110/120 V (90 to 132 V) or 220/230 V (180 to 264 V); jumper-selectable, 48 to 66 Hz, 125 VA
Dimensions (W x H x D); weight	216 mm x 134 mm x 451 mm; 8.2 kg

Ordering information

Video Analyzer (PAL)		
Composite	VTA 71	1062.5090.02
Component/composite	VTA 72	1062.5190.02
Composite with automeasure function	VTA 73	1062.5290.02
Extras		
Portable case with handle and sunshield	VTA-Z1	1062.5390.00
Double adapter with one blank panel for mounting in 19" racks	VTA-Z2	1062.5419.00

3

Distortion Network UPF-Z



Uses

To check the performance of a video analyzer, it is not sufficient to use solely an ideal video signal for testing. It has to be ensured that the video analyzer also provides correct results for distorted signals. The Distortion Network UPF-Z is a suitable tool for this purpose. It is simply connected into the signal path between video signal generator and analyzer and produces either linear or nonlinear distortion.

Specifications

All values measured on CCIR signals 17, 330 and 331 (CCIR Rec. 473-4 Annex I).

Linear distortion

Parameter	Nominal distortion	Guaranteed range
Level	–10%	–9.8 to –10.2%
Tilt	10%	9.8 to 10.2%
Streaking/rounding	10%	9.8 to 10.2%
Baseline distortion	20%	19.6 to 20.4%
2T pulse amplitude (reference point to EBU)	–29.2%	–28.6 to –29.8%
2T pulse amplitude (averaged reference value ±1.5 µs from 2T pulse)	–30.6%	–30.0 to –31.2%
Colour subcarrier amplitude (20T pulse or CCIR 331)	–33.3%	–32.6 to –34.0%
20T group delay	–150 ns	–147 to –153 ns
20T intermodulation	–11%	–10.5 to –11.5%
Burst amplitude	–33.3%	–32.6 to –34.0%

Nonlinear distortion[1)]

Parameter	Nominal distortion
Differential gain $(A_{max} - A_{min})/A_0$	approx. 35%
Differential phase $\varphi_{max} - \varphi_{min}$	approx. 9°
Chrominance/luminance intermodulation (line 331)	approx. –2%
Luminance nonlinearity (with level sampling in middle of staircase)	approx. 11%
Sync pulse amplitude	approx. +10%

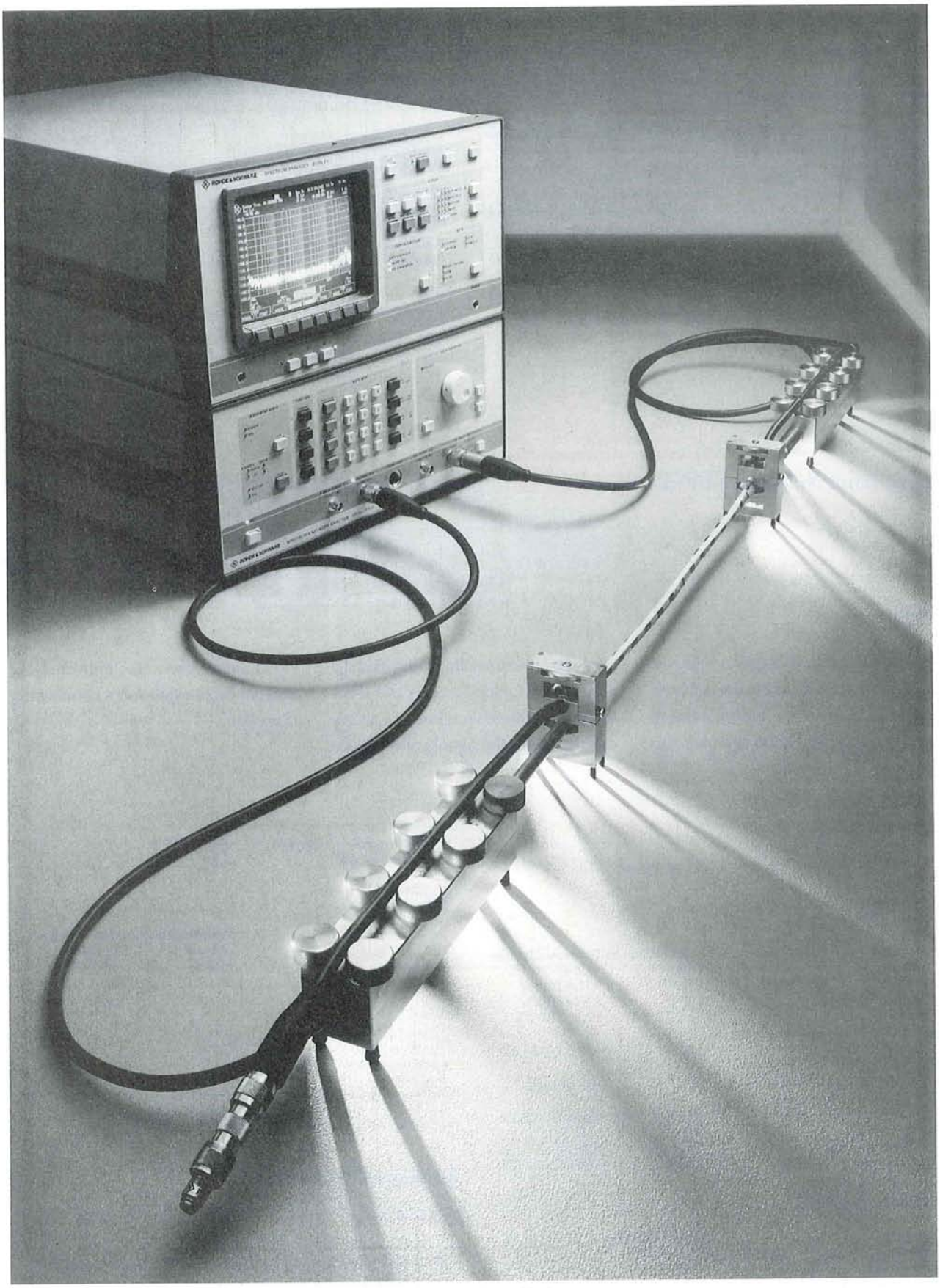
General data

	Without distortion network	With distortion network
Return loss up to 6 MHz	≥34 dB	not defined
Insertion loss up to 6 MHz	≤0.02 dB	frequency- and/or level-dependent
Linear-distortion network		
Attenuator (75 Ω)	0.91 dB	
Time constant of RC network	866 ns	
Max. attenuation of high frequencies	33.3%	
Nonlinear-distortion network	bipolar passive limiting network with level-dependent phase shift	
Overall dimensions (L x W x H)	102 mm x 28 mm x 40 mm	

Ordering information

Distortion Network	UPF-Z	0230.5119.00

1) The specs are typical values; the actual values vary according to the individual distortion network, video level, ambient temperature, contents of ten lines ahead of reference line and/or test line. This is particularly true for differential gain and phase as well as for sync pulse amplitude with reference to luminance bar amplitude.



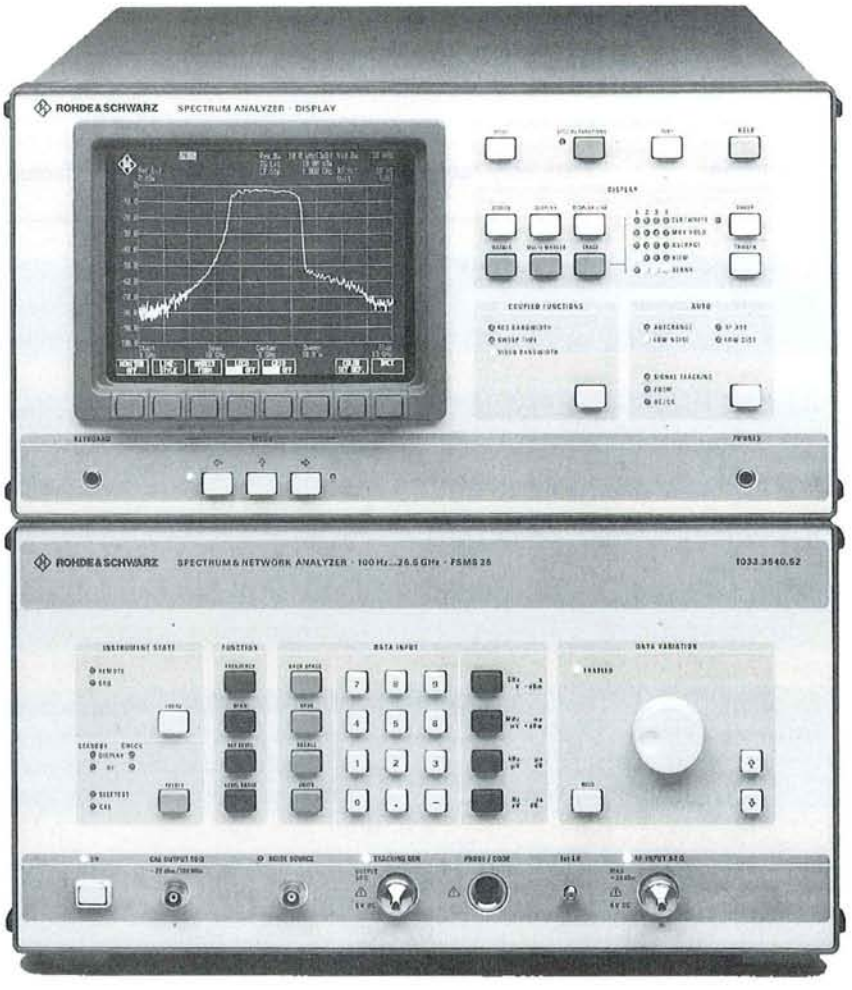
Measurement of shielding effectiveness of coaxial cables requires spectrum analyzer of highest sensitivity

Contents of Chapter 4

Spectrum & Network Analyzer FSMS26

100 Hz to 26.5 GHz

The specialist for testing state-of-the-art communication systems



Uses

The Spectrum & Network Analyzer FSMS26 from Rohde & Schwarz is able to perform a large variety of tasks in satellite communications as well as in microwave module and component testing. Typical fields of application include directional and mobile radio as well as measurements in the submillimeter range which are made with the aid of external mixers (see page 69).

In addition to the excellent characteristics of the FSM basic model (catalog 93/94, page 178), the FSMS26 provides network analysis up to 26.5 GHz. This allows even high losses and gains to be determined, eg in

- satellite communications and directional radio systems
- measurements of shielding effectiveness and
- microwave component testing

Main features

- Continuous receive frequency range
- Selective receive section
- Fundamental mixing
- Tracking generator up to 26.5 GHz; up to 5 GHz with frequency offset ±1 GHz
- Highest frequency accuracy
- Extremely low inherent noise
- Very low phase noise
- Wide dynamic range
- Calibrated AM/FM demodulators
- RF input adapter for N or 3.5-mm PC connectors (male/female)
- Versatile evaluation functions
- Fast sweep rates
- Simple and fast operation
- Large number of interfaces
- Flexible software concept
- Distortion-free switchover between the receiving bands by means of internal diplexer
- Attenuator fitted with calibration inputs

Characteristics

Continuous frequency range

A highly integrated microwave front-end allows continuous sweeps from AF (100 Hz) through to microwave (26.5 GHz):

- Six-stage YIG filter

Software-controlled level matching minimizes spurious products in the dynamic range of the 1st mixer. Measurements with extremely high sensitivity can be made over the entire frequency range.

High frequency accuracy and spectral purity

Frequency spans up to 5 MHz (for receive frequencies ≥12.91 GHz: 10 MHz) are fully synchronized with a high resolution. For spans above this value, the high accuracy is achieved by

synchronizing the start and stop frequencies of the YIG oscillator that features extremely low phase noise.

The excellent spectral purity of the microwave synthesizer enables convenient phase noise measurements even in the microwave range.

The smallest resolution bandwidth is 6 Hz, ensuring detection of line-frequency interference and non-harmonic emissions. The quasi-continuously variable bandwidth allows an optimum compromise to be made between resolution, frequency span and sweep time.

Tracking generator with frequency offset allowing network analysis
Transmission measurements can be made in a dynamic range of 120 dB for losses (resolution bandwidth 1 kHz) and 105 dB for gains throughout the frequency range up to 26.5 GHz. Due to the use of a selective receiver, measurements can also be made on nonlinear devices under test, since the harmonics filtered out do not produce any measurement errors.

The FSMS26 also allows measurements on frequency-converting mixer stages and tuners with built-in local oscillator. A frequency offset of max. ±1 GHz (up to 5 GHz) can be effected without additional signal sources. Short sweep times allow the following parameters to be adjusted under quasi-realtime conditions:

- Conversion loss/gain
- LO feedthrough
- Isolation
- Image-frequency rejection

The FSMS26 supports the versatile capabilities of up/down conversion to both normal and inverted positions.

Operation

Clear operating concept
The analyzer is easy to operate even for complex measurements. A single spinwheel, clear front-panel layout and softkeys along the bottom edge of the screen make for ease of operation, reduce operator errors and speed up measurements. Parameters are entered via the numeric keypad and can be varied using the step keys or the spinwheel.

An LED panel clearly indicates the current status of four trace memories. The status display in the help menu provides a list of the active settings; a hardcopy of this list as well as of the display can be output.

Numerous automatic test routines
- Marker functions with up to eight markers
- Level, frequency and bandwidth corrections
- Selftest
- Adaptation to type of signal
- Selectable operating modes:
  LOW NOISE and
  LOW DISTORTION

Screen display
All important parameters and results can be read directly on a 9" colour screen with high graphics resolution. Relevant data and information such as functions, status line, scaling and command line are logically arranged on the screen without affecting the display of the measurement results.

Enhanced configuration

Remote control, automated measurements
All functions can be remote-controlled via the IEC/IEEE-bus interface. For frequently recurring measurements, the instrument settings can be stored and recalled when required. The computer function (FS-Z4) allows automatic execution of complete test routines as well as storage of BASIC test programs and data.

Data processing via PC
IEC/IEEE-bus programming and numerous built-in evaluation functions speed up the generation of user software. The FSMS26 can be connected to any IEC/IEEE-bus-compatible PC, eg Process Controllers PSM or PSA from Rohde & Schwarz.

Noise Measurement Software FS-K3
Through the use of a separate preamplifier, the FSMS26 is turned into an automatic noise measurement system. An interesting feature is that measurements can be made through to 26.5 GHz without additional conversion.

External keyboard
Keyboard PCA-Z1 provides enhanced user convenience in labelling the screen hardcopy.

Printer/plotter
The FSMS26 allows simple logging of results on a printer, video printer or IEC/IEEE-bus plotter with optimized resolution and display size.

External monitor
An external colour monitor, eg PMC3, PMC4 from Rohde & Schwarz, or a large-display projector can be connected to an RGB output for special workstations or for training and demonstration purposes.

Spectrum & Network Analyzer FSMS26

Specifications

The data specified below differ from those of the basic models FSM and FSA (catalog 93/94, page 184 and 181)

Frequency, spectral purity, filters

same as FSM

Amplitude

same as FSM, however

Immunity to interference

Image-frequency rejection	referred to reference level
f +(2 x 5421.4 MHz)	>80 dB, typ. 90 dB
f ± 442.8 MHz	>80 dB, typ. 100 dB
f ± 221.4 MHz	>80 dB, typ. 100 dB
f + 42.8 MHz	>100 dB, typ. 115 dB
f + 8.388 MHz	>100 dB, typ. 115 dB
IF rejection	referred to reference level
221.4 MHz	>100 dB, typ. 110 dB
21.4 MHz	>100 dB, typ. 110 dB
4.194 MHz	>100 dB, typ. 110 dB

Sweep

same as FSM

Sweep time	
Span >0 Hz	
Setting ranges	**step size**
20 ms to 2 s	20 ms
2 to 20 s	200 ms
20 to 1980 s	2 s
Error	≤±1 x 10^{-3}
Span = 0 Hz	
Setting ranges	**step size**
200 µs to 10 ms	1/2/4/8/10
20 ms to 1980 s	see span >0 Hz
Error	
200 µs to 10 ms	≤±2%
20 ms to 1980 s	≤±1 x 10^{-3}
Sampling rate	1/8.9 µs
Time measurement	with the aid of markers and cursor lines
Resolution	sweep time/900

Sweep mode same as FSM

Scalar network analysis

Frequency range	100 Hz to 26.5 GHz
Frequency span	0 Hz, 10 Hz to 26.5 GHz
Frequency offset (stop frequency <5 GHz)	0 to ±1 GHz
Gain measurement range	105 dB
Loss measurement range, RBW = 1 kHz	
10 MHz ≤f <4.7 GHz	110 dB, typ. >115 dB
4.7 GHz ≤f <18 GHz	>105 dB, typ. >115 dB
18 GHz ≤f ≤26.5 GHz	>100 dB, typ. >105 dB
Inherent frequency response (start frequency >5 x resolution bandwidth in default coupled mode)	
f <4.8 GHz	<2.5 dB, typ. 1.5 dB
4.8 GHz ≤f ≤26.5 GHz	<5 dB, typ. 3 dB
Output level	–75 dBm to 0 dBm (adjustable in 5-dB steps)
Level variation (level of tracking generator –20 dBm at 100 MHz)	≤0.5 dB
Additional error on switching between RF and AF detector	≤0.3 dB
Additional error on switching to f >4.8 GHz	≤1 dB
Frequency response, start frequency >5 x RBW in default coupled mode, referred to level at 100 MHz (RF detector) or 1 MHz (AF detector)	
100 Hz to 4.8 GHz	<2 dB
4.8 GHz to 26.5 GHz	<2.5 dB
Additional error caused by frequency offset	<2 dB
Spurious (frequency offset 0 Hz, 20 to 35°C)	
Harmonics	
3 kHz <f ≤4.8 GHz	>20 dB
4.8 GHz <f ≤13.25 GHz	>7 dB
Subharmonics, f >12.91 GHz	>7 dB
Other (carrier offset >20 kHz)	>30 dB
Residual FM (rms), meas. bandwidth	
30 Hz to 3 kHz	<300 Hz
3 kHz to 20 kHz	<1 kHz
AM modulation	external AF source 10 Hz to 15 kHz, m <30%

Demodulation, VDU

same as FSM

Inputs and outputs

same as FSM, however

Front panel, RF section

Local oscillator	SMA female
Frequency range	5.1 to 13.14 GHz
Output level	>–5 dBm, typ. >0 dBm
VSWR	<2.5 typ.
RF INPUT 50 Ω (100 Hz to 26.5 GHz)	adapter system, N male and female, 3.5 mm male and female

VSWR (3.5-mm female adapter)

RF attenuation	<10 dB	≥10 dB	20 dB
f ≤10 GHz	2.5 typ.	2.0	1.5
10 GHz <f ≤18 GHz	2.5 typ.	2.5	2.0
18 GHz <f ≤26.5 GHz	2.8 typ.	2.8 typ.	2.2

CAL OUTPUT (100 MHz, –20 dBm)	BNC female, 50 Ω
VSWR	<1.1
PROBE/CODE (supply and coding connector, eg for active or passive probes and antennas)	12-contact Tuchel female
Supply voltage	+10 V and –10 V, max. 100 mA
NOISE SOURCE	BNC female, 28 V switchable, max. 50 mA

General data

Power supply	100/120/220/240 V ±10%, 45 to 66 Hz, 500 VA
Dimensions (W x H x D)	435 mm x 472 mm x 590 mm
Weight	62 kg

Ordering information

Spectrum & Network Analyzer	FSMS26	1033.3540.52
Extras	**same as FSM, plus**	
Harmonic Mixer Set (for external frequency mixing from 26.5 to 110 GHz)	FS-Z16	1046.2125.00
DIN-A3 Plotter	DOP3	1009.8352.00
Color Monitor	PMC3	1009.8230.00
Industrial Plotter	PMC4	1034.8000.02

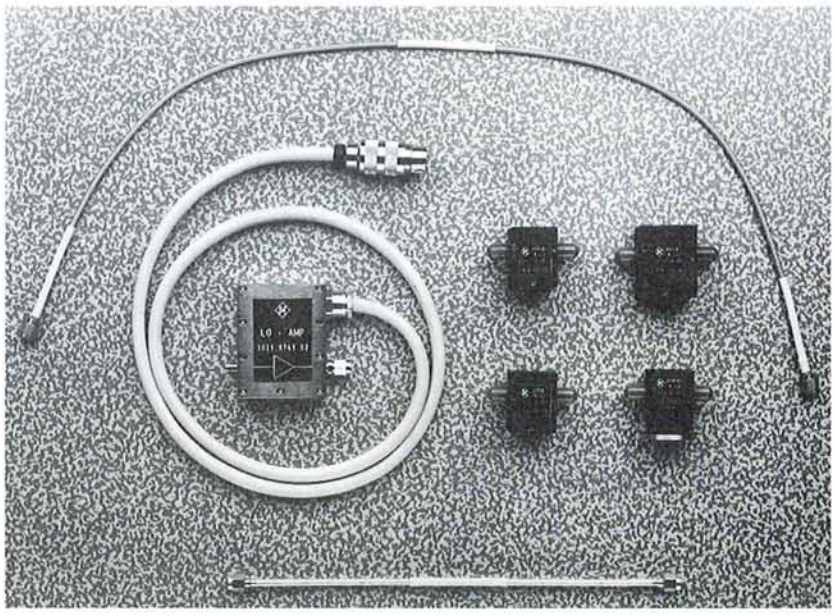
Harmonic Mixer Set FS-Z16

Spectrum analysis up to

110 GHz with

Rohde & Schwarz Spectrum

Analyzers FSM or FSMS



Uses

The Harmonic Mixer Set FS-Z16 enables convenient measurements with the Rohde & Schwarz Spectrum Analyzers FSM and FSMS beyond their upper frequency limit of 26.5 GHz right into the submillimeter range.

Standard waveguide bands

- A-band (FS-Z18): 26.5 to 40 GHz
- U-band (FS-Z19): 40 to 60 GHz
- V-band (FS-Z20): 50 to 75 GHz
- W-band (FS-Z21): 75 to 110 GHz

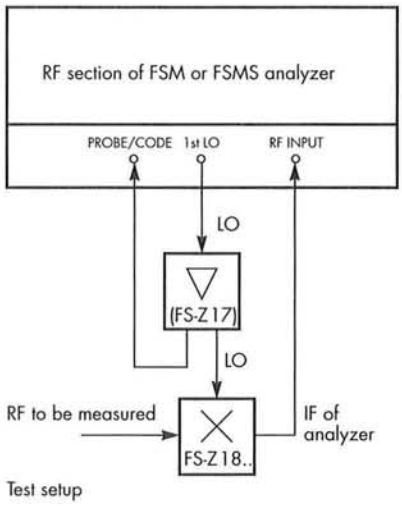
The complete set comprises four external Mixers FS-Z18 to FS-Z21, one LO amplifier as well as a set of cables and transit case (Accessories FS-Z17). The mixers are also available individually, the Accessories FS-Z17 being however required for operation in any case.

Main features

- Intelligent software preselector eliminates all unwanted signals without loss in sensitivity
- High measurement sensitivity (–94 dBm in W-band) due to the use of low-order harmonics
- High level measurement accuracy taking into account frequency-dependent conversion loss of mixers

Operation

The external mixers produce harmonics of the local oscillator of the spectrum analyzer, thus converting the microwave signal to be measured to the IF of the analyzer. The image frequencies generated several times during this process are reliably suppressed by the software preselector. This software function is able to distinguish between the "true" signal and multiple responses: the result shown on the analyzer display corresponds to that of a spectrum measured by a hardware preselector.



Test setup

Specifications

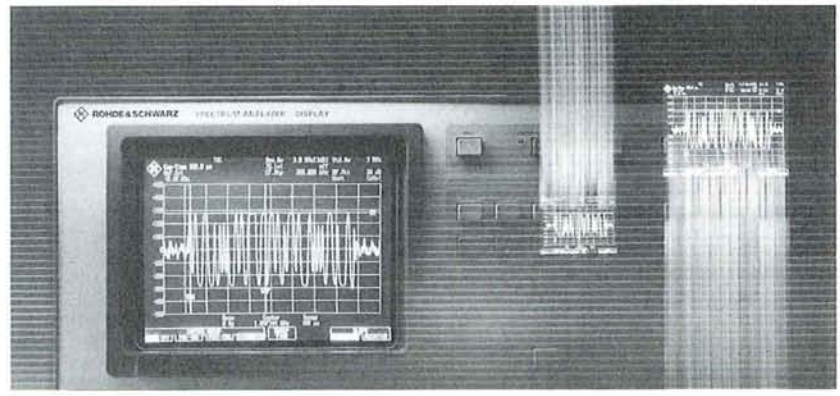
Type	FS-Z18	FS-Z19	FS-Z20	FS-Z21
Frequency range	26.5 to 40 GHz	40 to 60 GHz	50 to 75 GHz	75 to 110 GHz
Sensitivity (RBW = 1 kHz)	–110 dBm	–106 dBm	–98 dBm	–94 dBm
Conversion loss	22 dB	19 dB	28 dB	40 dB

Ordering information

Harmonic Mixer Set		
(including Accessories FS-Z17)	FS-Z16	1046.2090.02
Harmonic Mixer	FS-Z18	1046.2725.02
	FS-Z19	1046.2760.02
	FS-Z20	1046.2825.02
	FS-Z21	1046.2860.02
Accessories, consisting of LO amplifier, set of cables, case	FS-Z17	1046.2660.02

Fast A/D Converter FSA-B7 (Option)

Gate and gap sweep in real-time down to 100 µs



Uses

In conjunction with Rohde & Schwarz spectrum analyzers, the fast A/D Converter FSA-B7 allows realtime display for sweep times down to 100 µs using high sampling rates and new trigger modes. The spectrum analyzers can thus also be used in the fields of digital radiocommunications, TV and of sampled signals.

All Rohde & Schwarz Spectrum Analyzers FS... models .55 are fitted with FSA-B7 and FSA-B8 (page 71) as standard. FS... models .52 as well as the EMI Test Receivers ES...I can be retrofitted.

GSM, PCN and DECT applications

- POWER RAMPING: time characteristic of transmitter power within a time slot
- GAP SWEEP: showing transient response of a time slot by means of the gap sweep mode
- MID AMBLE: showing time invariant part of edge-modulated time slot by averaging

Video applications

- Measurement of CVS with high sampling rate
- GATE SWEEP: display of pulsed-signal carrier in gate sweep mode
- Quasi-analog display: eg measurement of intermodulation products of an IF amplifier

Main features

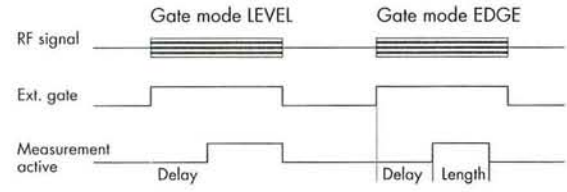
- No interpolation even with short sweep times
- 12-bit resolution with 9-MHz sampling rate
- Video output normal and inverted
- Sample/max. peak, min. peak from 100 µs to 1980 s
- Quasi-analog signal display
- Trigger mode GAP SWEEP in time domain: pre/post-trigger with scaling in time or bit units
- Trigger mode GATE SWEEP in frequency domain: triggering on edge or level

Specifications

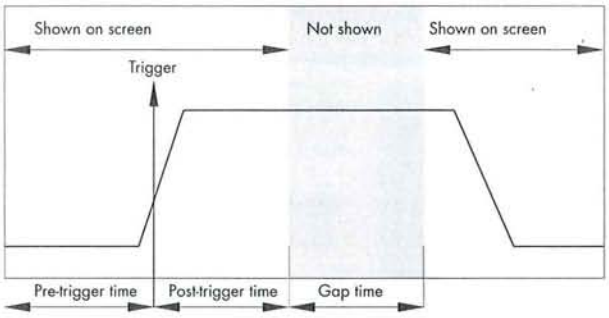
The data specified below concern the differences between models .55 and the basic models .52 (see catalog 93/94, page 182 "Sweep")

Sampling rate	9 MHz
Resolution	12 bit
Level stability	<0.1 dB
Sweep time	step size:
100 µs to 2 ms	100 µs
2 to 20 ms	1 ms
20 ms to 2 s	20 ms
2 to 20 s	200 ms
20 to 1980 s	2 s
Video output	0 to 1 V into 75 Ω (short-circuit-proof), inverted/non-inverted
Trigger	free run/video/network/external
Detector mode	
100 µs to 1980 s	sample/max. peak/min. peak
20 ms to 1980s	auto peak

Sweep mode (trigger menu)
GATE SWEEP (in frequency domain): see timing diagram in next column



Delay	1 µs to 100 s, step size 100 ns
Length	1 µs to 100 s (with edge triggering), step size 100 ns
Level	–5 to +5 V (with level triggering), step size 64 steps
Trigger	
Gate mode LEVEL	triggering on level (positive/negative)
Gate mode EDGE	triggering on edge (positive/negative)
GAP SWEEP (in time domain); Pre-trigger time	see graph next page max. 100 s (70 x sweep time), step size 100 ns



Post-trigger time	0 to 100 s, step size 1 µs
Gap time	0 to 100 s, step size 1 µs
Quasi-analog display (display menu)	display of individual results as pixels and summation with sweeps; display of result spread

Ordering information

Fast A/D Converter (option)	FSA-B7	1046.3750.52

Broadband FM Demodulator FSA-B8 (Option)

Uses, characteristics

Thanks to broadband FM Demodulator FSA-B8, DECT-compatible measurements over the complete modulation range are possible with Rohde & Schwarz spectrum analyzers. Whether it is the precise determination of deviation and carrier frequency drift on DECT signals at the maximum bit rate or measurement of the transient response time of fast synthesizers at a frequency offset of a few Hz, the FM Demodulator masters them equally well. The photo on the first page of this chapter shows transient measurements on a synthesizer.

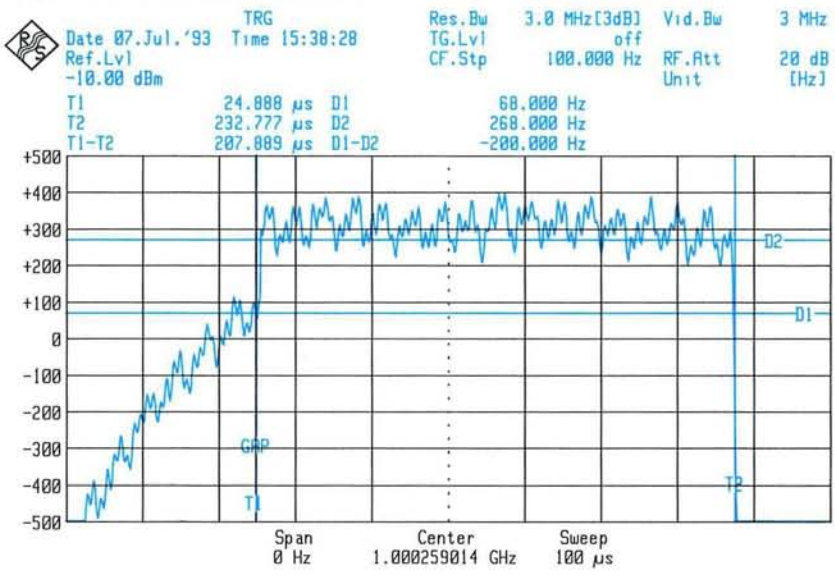
Main features

- 3-dB bandwidth over 1 MHz
- Settling time in burst mode <1 µs
- Deviation measurement range 500 kHz

All Rohde & Schwarz Spectrum Analyzers FS... models .55 are fitted with FSA-B8 and FSA-B7 (page 70) as standard. FS... models .52 as well as the EMI Test Receivers ESxl can be retrofitted.

Applications

Complex procedures can be evaluated, analyzed and documented in the frequency and time domains as well as over the complete modulation range:



- Measurement of center frequency error and deviation error
- Measurement of carrier frequency drift during a single burst
- Accuracy and stability of timing parameters, packet jitter measurements

Specifications

Modulation ranges	500 kHz	50 kHz	5 kHz	500 Hz
Resolution	<0.05% of modulation range			
Modulation frequency range (–3 dB)	DC to 1 MHz	DC to 1 MHz	DC to 500 kHz	DC to 50 kHz
Error of deviation indication (for 1-kHz modulation frequency)	<1%	<2%	<4%	<6%
	(of measured value plus 1% of modulation range)			
DC offset (after calibration)	2% of modulation range ±100 Hz			
Modulation frequency response (referred to 1 kHz)				
Modulation ranges	500 Hz	50 kHz	5 kHz	500 kHz
DC to 20 kHz	–	–	0.2 dB	0.2 dB
DC to 100 kHz	0.2 dB	0.2 dB	–	–
DC to 600 kHz	2 dB	2 dB	–	–
Linearity error	<1% (within modulation range)			
Residual FM, VBW = 10 kHz, rms	<20 Hz			
Settling time in burst mode	<3 µs, including approx. 2 µs burst delay due to filter delay at RBW = 3 MHz and VBW = 3 MHz (departure from stationary value <5%)			
Synchronous FM	typ. <100 Hz (AM 50%, f_{mod} = 1 kHz, VBW = 3 kHz, RBW = 10 kHz)			

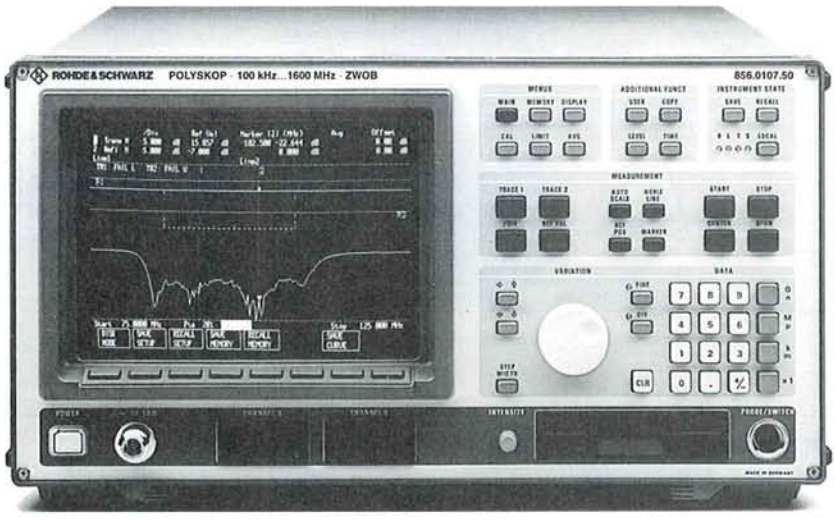
Ordering information

FM Demodulator (Option)	FSA-B8	1046.4005.52

Network Analyzer Polyskop ZWOB

100 kHz to 1.6 (3) GHz

Scalar network analyzer for economical measurements in production, quality control and service



Uses

Network Analyzer Polyskop ZWOB from Rohde & Schwarz is especially designed for the needs in production, quality control and service. Since in these areas it is usually quite sufficient to know the transmission, reflection and group delay characteristics for the evaluation of DUTs, scalar analyzers are the best choice to perform the measurements required. They provide the following advantages:

- Excellent price/performance ratio
- Ease of operation
- Short measurement times due to less complex data processing
- Easy measurements on frequency-converting modules

A large variety of accessories including demodulators, SWR bridges and other facilities rounds off the capabilities of this analyzer.

Characteristics

Generator section

- Wide frequency range and high measurement accuracy
- Generator with counter correction
- High harmonic suppression of typically >35 dB (70 dB with option ZWOB-B4) reduces measurement errors in broadband sweeping to a negligible level. Measurement accuracy is considerably improved, in particular, when filters with high stopband attenuation are tested
- Low spurious FM in the narrowband mode of typically <100 Hz (with option ZWOB-B4) in the lower frequency range allows sharp display even of very steep filter edges

Analyzer section

- Calibrated and temperature-compensated measuring heads available as accessories
- Accurate amplitude measurement ensured by precision amplifiers and 14-bit A/D converter
- High measurement speed thanks to separate processors for signal processing and display, supported by a numeric coprocessor for increased speed
- Seven user-selectable frequency markers

Operation

The ergonomic layout of the front panel and menu-guided operation make it easy for the user to handle the instrument quickly and reliably. The autoscale function, for instance, presents the user with a fast and optimally scaled display at all times. The screen display can be output on a printer, plotter or videoprinter at the push of a button.

Fast automatic measurements are supported by a mask editor which can be used to easily define limit lines. The limit line data together with the relevant test routine and the instrument setups can be stored in the built-in CMOS-RAM or on floppies.

User port

The test result – go or nogo – is available at the built-in user port and can be directly used for triggering messages or actions. The user port also allows setting of switches on DUTs and add-on equipment without requiring an external controller, eg Switch Unit ZZ-52 (catalog 93/94, page 193). This 6-fold test port multiplexer allows for instance fast measurements on multirange antenna amplifiers in one test run without needing to change the cabling.

Computer function (option ZWOB-Z3)

Measurements can be automated in full or in part, this being mainly of interest

for series testing in production and quality control. Apart from saving time and preventing erroneous settings, the operator is guided through the measurements by screen prompts, so that there is no need to have a detailed knowledge of the equipment and measurement procedure.

Measurement capabilities

Level and reflection measurements
Level frequency response, input reflection and bandwidth of an amplifier for instance can be adjusted in one step. Six markers and one delta marker can be set for evaluating individual test points.

Measurements on frequency-converting DUTs
When using a measuring head ZZ-2, ZZ-3 or ZZ-5, the converted signal is taken from the DUT output directly to the frequency counter in the ZWOB. By comparing the generator frequency with the measured frequency, the ZWOB determines the frequency offset, distinguishes between normal and inverted frequencies and provides the appropriate frequency grid and markers.

Group-delay measurements (option ZWOB-B5)
In addition to the transmission and reflection response, the group-delay characteristic within the transmission bandwidth is important for many electronic components especially in the field of communications. The test method uses amplitude modulation to determine the time differences between the zero crossings of the demodulated signals before and after the DUT; it also enables measurements on frequency-converting modules as well as on DUTs with a built-in demodulator.

Accessories

Demodulator ZZ-1
It has a built-in termination (50 or 75 Ω), features excellent VSWR, a dynamic range of more than 76 dB and provides continuous coverage of the frequency range from 100 kHz to 3 GHz.

Active Demodulators ZZ-2, ZZ-3, ZZ-4
For measurements on active DUTs such as cable repeaters, antenna amplifiers and tuners in the frequency range 5 MHz to 1.3 GHz at low input voltages. The wide dynamic range of 96 dB makes the ZZ-2 also ideal for measurements on narrowband filters.

The ZZ-3 is recommended for group-delay measurements at low levels (1 to 100 mV). For measurements on frequency-converting DUTs, an IF signal can be applied to the ZWOB via the RF output of the active demodulators so that IF markers can be displayed.

The Active Demodulator ZZ-4 (+5 to –80 dBm) can be used over a wide frequency range from 1 MHz to 3 GHz. It features very good input VSWR, DC isolation and overload protection.

Insertion Unit ZZ-5
Used to couple out the test signal and apply it eg to the built-in frequency counter of ZWOB for IF marker display.

AF Measuring Head ZZ-6
ZZ-6 can be used if the DUT has its own demodulator. If a high-impedance detector (eg SWOB3-Z) is connected ahead of the AF mesuring head, high-impedance RF measurements can also be performed, eg for troubleshooting on modules.

Precision SWR Bridges ZR...
For VSWR measurements (catalog 93/94, page 200).

Calibration Kit ZCAN
For checking and calibrating the test setup for VSWR measurements (catalog 93/94, page 202).

Type/Option	Order No.	Designation
ZWOB	0857.0107.50	Basic unit up to 1.6 GHz, without attenuator and floppy disk drive
ZWOB-B1	0857.0207.02	Frequency extension to 3 GHz (if retrofitted, guaranteed ZWOB specs up to 2.7 GHz only)
ZWOB-B2	0857.8504.02	Floppy disk drive, required for ZWOB-Z3
ZWOB-Z3	0857.1255.02	Computer function (MS-DOS, R&S BASIC, keyboard)
ZWOB-B4	0857.1455.03	Harmonics filter; especially for high harmonic suppression (60 dB)
ZWOB-B5	0856.9000.02	Group-delay measurements; suitable for measurements on frequency-converting DUTs
ZWOB-B7	0857.1003.02	Step attenuator 0 to 120 dB
ZWOB-B8	0857.1555.02	Frequency counter extension from 400 MHz (standard) to 1.2 GHz

Network Analyzer Polyskop ZWOB

Specifications

Generator section

Frequency

Range	100 kHz to 1.6 GHz
with option ZWOB-B1	100 kHz to 3 GHz
Span	0 to 1599.9 MHz (2999.9 MHz)
Resolution	1 kHz
Error, guaranteed values (23 ±5°C)	span 5[1]/>5[2] MHz)
f ≤3000 MHz	0.003 x span + 50/50 kHz
f ≤1595 MHz	0.003 x span + 25/25 kHz
f ≤400 MHz	0.003 x span + 10/25 kHz
f ≤95 MHz	0.003 x span + 5/25 kHz

Error (without drift), typical values (FAST MODE OFF)

Span	≤5 MHz[3]	>5 MHz	
Sweep time per test point	>12 ms	≥12 ms	>12 ms
f ≤3000 MHz	8 kHz	0.001 x span +20 kHz	0.0001 x span +20 kHz
f ≤1595 MHz	4 kHz	0.0005 x span +20 kHz	0.0001 x span +20 kHz
f ≤400 MHz	2 kHz	0.0005 x span +10 kHz	0.0001 x span +10 kHz
f ≤95 MHz	2 kHz	0.0002 x span +5 kHz	0.0001 x span +5 kHz

Drift (5 to 45°C)	additional error <1 kHz per degree deviation from 23°C
Spurious FM (measurement bandwidth CCIR, quasi peak)	30 Hz to 3 kHz, weighting to <5 kHz (without ZWOB-B4) <3 kHz for f ≤1.6 GHz (w/o ZWOB-B4) <600 Hz for f ≤400 MHz and span ≤5 MHz[3] <150 Hz for f ≤100 MHz and span ≤5 MHz[3]
Harmonic suppression	>30 dB
with Harmonics Filter ZWOB-B4	>60 dB for f >300 MHz >55 dB for f >30 MHz >30 dB for f ≤30 MHz
Nonharmonic suppression	>50 dB (>500 kHz from carrier)

Level

Range	+2 to +16 dBm
with Harmonics Filter ZWOB-B4	+2 to +10 dBm
with Attenuator ZWOB-B7	−104 to +16 dBm
with attenuator + harmonics filter	−110 to +10 dBm
Resolution	1 dB
Deviation	<1.0 dB for f = 100 MHz (<0.5 dB for t_{amb} = 23 ±5°C)
Frequency response	≤±1 dB, referred to 100 MHz (≤±3 dB for f <0.5 MHz)

Output

Connector, impedance	N female, 50 Ω
Return loss	≥15 dB (VSWR ≤1.4)

Analyzer section

Measurement accuracy	up to ±0.1 d B (calibrated)
Test parameters	transmission, reflection (VSWR), group delay (optional), power, voltage
Test channels	A and B
Dynamic range and measurement error	see measuring heads
Voltage slew rate	up to 5 V/ms

VDU

Line frequency/refresh rate	9" screen 29.4 kHz ±2%/50 Hz ±2%
Resolution (X x Y)	1024 x 512 pixels

Display

Display modes	for absolute or relative measurement either linear or logarithmic display of 2 traces can be selected; 2 tolerance curves per channel can be displayed additionally
Frequency markers	7, user-selectable: 1 delta marker and 6 RF markers or 3 RF and 3 IF markers in IF marker mode

Evaluation

Amplitude display	max. resolution 0.001 dB, display range from +100.00 to −100.00 dB
Frequency display	max. resolution 10 Hz
Horizontal lines	1 line or 1 delta line per test trace for direct bandwidth measurement
Markers	up to 6 markers + 1 delta marker per test trace
Auxiliary functions	automatic positioning of marker to minimum or maximum, marker or line amplitude used as reference value
Auto functions	maximum to center frequency; maximum, minimum or marker used as reference value
Calibration memory	2 calibration traces of 501 points each; in case of frequency change within the calibrated range, sample points are interpolated
Reference memory	one per trace for max. 501 points
Averaging (AVG)	digitally over 2 to 256 sweeps
Step width	continuously adjustable for frequency and amplitude

Compensation of spurious signals (error ≤1 dB with test level 50 mV)	
with ZZ-1 or ZZ-5	50 mV
with ZZ-2, ZZ-3 or ZZ-4	5 mV

Sweep times (without using marker, line, limit)
Forward sweep (FAST MODE ON)

Test points	Level, transmission and reflection measurement	Group-delay measurement[4] (split frequency 9.9 kHz)
51	0.03 s	0.09 s
101	0.06 s	0.17 s
201	0.12 s	0.33 s
501	0.30 s	0.85 s

If the sweep time is preset (in FAST MODE OFF only), the maximum number of test points is set automatically. It is however possible to select a smaller number. In FAST MODE ON, the number of test points is always preselected.

Return sweep (51 test points)

Level, transmission, reflection measurement	Group-delay measurement
FAST MODE ON: 0.02 s	0.05 s
FAST MODE OFF*): 0.03 s	0.10 s

*) With built-in optional Harmonics Filter ZWOB-B4, the specified times refer to sweeping within one filter band (see data below). The return sweep time is increased by approx. 6 ms per additional filter band.

Filter bands

0.1 to 22.5 MHz	>205 to 336 MHz
>22.5 to 40 MHz	>336 to 566 MHz
>40 to 69 MHz	>566 to 951 MHz
>69 to 120 MHz	>951 to 1605 MHz
>120 to 205 MHz	>1605 to 3000 MHz

Inputs and outputs

Front panel connectors	
Generator output	N female
Demodulator outputs	two, 12-contact female
FET probe/Switch Unit ZZ-52	12-contact female
Rear panel connectors	
Centronics interface	36-contact female
IEC-bus interface (IEEE 488)	24-contact female
Bus functions	SH1, AH1, T6, L4, SR1, RL1, PP1, DC1, DT1, C1 to C3, E2
USER PORT	D-connector, 25-contact, 8 programmable outputs (TTL), 1 input
External floppy disk	37-contact female
Video output	BNC, 75 Ω
Colour monitor	9-contact female for multisync monitors (PGC analog assignment)

Frequency counter input BNC female, input for IF marker generation

	standard	ZWOB-B8
Frequency range	0.1 to 400 MHz	0.1 to 1200 MHz
Resolution		
in selected range <100 MHz	100 Hz	100 Hz
>20 MHz	400 Hz	1 kHz
Frequency error	see generator section	
Input level range		
in selected range <100 MHz	ca.<1 mV to 1 V	ca.<1 mV to 1 V
>20 MHz	ca.<12 mV to 1 V	ca.<5 mV to 1 V

Input VSWR	<1.9
for f <1000 MHz	<1.5
for f <500 MHz	<1.2

Measuring heads

Demodulator ZZ-1

Frequency range	0.1 to 3000 MHz
Frequency response	
0.5 to 3000 MHz	≤±0.5 dB (referred to 100 MHz)
Dynamic range	≥76 dB
Maximum measurement level	+13 dBm
Noise level	≤–63 dBm
Impedance	50 Ω/75 Ω
VSWR	≤1.1/≤1.15 (f ≤2700 MHz)
	≤1.2 (f >2700 MHz)
Measurement error	
(at 100 MHz and 23 ±2°C)	
+13 to -27 dBm	≤±0.2 dB
–27 to –47 dBm	≤±0.5 dB
Temperature effect	≤±0.2 dB additionally
Max. input voltage (rms)	5 V (AC + DC)
Connector	N male

Active Demodulator ZZ-2

(not suitable for group-delay measurements)	
Frequency range	5 to 1300 MHz
Impedance	50 Ω/75 Ω
Dynamic range 50 Ω/75 Ω	≥96/≥94 dB
Max. measurement level	+13 dBm
Noise level 50 Ω/75 Ω	≤–83/≤–81 dBm
VSWR	≤1.3
Measurement error	
(at 100 MHz and 23 ±2°C)	
+13 to –47 dBm	≤±0.5 dB
–47 to –67 dBm	≤±1 dB
Temperature effect	≤±0.5 dB additionally
Frequency response	
(ref. to 100 MHz)	<2 dB
Max. input voltage (rms)	2.5 V (AC + DC)
Connector	N male

Active Demodulator ZZ-3

Frequency range	5 to 1300 MHz
Impedance	50 Ω/75 Ω
Dynamic range 50 Ω/75 Ω	≥76/≥74 dB
Max. measurement level	–7 dBm
Noise level 50 Ω/75 Ω	≤–83/≤–81 dBm
VSWR	≤1.3
Measurement error	
(at 100 MHz and 23 ±2°C)	
–10 to –47 dBm	≤±0.5 dB
–47 to –67 dBm	≤±1 dB
Temperature effect	≤±0.5 dB additionally
Frequency response	
(ref. to 100 MHz)	<2 dB
Max. input voltage (rms)	2.5 V (AC + DC)
Connector	N male

Active Demodulator ZZ-4

Frequency range	1 to 3000 MHz
Impedance	50 Ω/75 Ω
Dynamic range	85 dB
Max. measurement level	+5 dBm
Noise level	≤–80 dBm
VSWR	≤1.15
Measurement error (at 100 MHz, 23 ±2°C)	
+5 to –44 dBm	≤±0.5 dB
–44 to –64 dBm	≤±1dB
Temperature error	±0.5 dB additionally
Frequency response (ref. to 100 MHz)	≤1.5 dB
Max. input voltage (DC)	30 V
Max. RF input power	0.3 W (1 W over 1 s)

Insertion Unit ZZ-5

Frequency range	0.1 to 3000 MHz
Frequency response 0.5 to 3000 MHz	≤±1 dB (referred to 100 MHz)
Dynamic range	≥69 dB
Max. measurement level	+13 dBm
Noise level	≤–56 dBm
Impedance	50 Ω/75 Ω
VSWR	
≤1000 MHz	≤1.2
≤2000 MHz	≤1.3
≤2500 MHz	≤1.4
>2500 MHz	≤1.6
Measurement error	
(at 100 MHz and 23 ±2°C)	
+13 to –27 dBm	≤±0.2 dB
–27 to –40 dBm	≤±0.5 dB
Temperature effect	≤±0.2 dB additionally
Insertion loss	≤2 dB
≤1000 MHz	≤1 dB
Max. input voltage (rms)	5 V (AC + DC)
Connector	N male and N female

AF Measuring Head ZZ-6

for high-impedance measurements in conjunction with Demodulator Probe SWOB3-Z	
Dynamic range	60 dB (typ.)
Max. test voltage	+1 V (internally switchable to –1 V)
Input impedance	100 kΩ
Max. input voltage	±10 V DC
Connector	BNC female
Data stored in EPROM are either dectector data for SWOB3-Z or for linear mode	
for group-delay measurement (not suitable with SWOB3-Z)	
Input impedance	10 kΩ
All other data	as above

General data

Power supply	100/120/220/240 V ±10% 47 to 63 Hz, max. 200 VA
Dimensions (W x H x D); weight	450 mm x 221 mm x 620 mm; 30 kg

Ordering information

Network Analyzer Polyskop	ZWOB	0857.0107.02
Options		
3-GHz Frequency Extension	ZWOB-B1	0857.0207.02
3½" Floppy Disk Drive	ZWOB-B2	0856.8504.02
Computer Function	ZWOB-Z3	0857.1255.02
Harmonics Filter	ZWOB-B4	0857.1455.02
Group Delay Measurement	ZWOB-B5	0856.9000.02
Step Attenuator	ZWOB-B7	0857.1003.02
Frequency Counter up to 1.2 GHz	ZWOB-B8	0857.1555.02
Measuring heads (model 50/52 = 50 Ω, model 72/75 = 75 Ω)		
Demodulator 0.1 to 3000 MHz	ZZ-1	1010.0000.52
		1010.0000.72
Active Demodulator 5 to 1300 MHz	ZZ-2	1010.0500.52
		1010.0500.72
Active Demodulator 5 to 1300 MHz	ZZ-3	1038.5506.52
		1038.5506.72
Active Demodulator 5 to 3000 MHz	ZZ-4	1068.9500.50
		1068.9500.75
Insertion Unit 0.1 to 3000 MHz	ZZ-5	1010.1006.52
		1010.1006.72
AF Measuring Head		
with correction data for SWOB3-Z	ZZ-6	1010.1506.02
with linear correction data	ZZ-6	1010.1506.03
for group-delay measurement	ZZ-6	1010.1506.05

1) With ZWOB-B4, FAST MODE OFF.
2) Sweep within 0.1 to 20 MHz, >20 to 1595 MHz or >1595 MHz.
3) With optional Harmonics Filter ZWOB-B4.
4) Average values from level and group-delay measurement.

Signal Generator SME can handle all modulation modes required for digital mobile radio

Contents of Chapter 5

Signal Generator SMY

SMY01: 9 kHz to 1040 MHz

SMY02: 9 kHz to 2080 MHz

Ideal for receiver testing and component measurements

Uses

The Signal Generator SMY from Rohde & Schwarz is a cost-effective instrument for testing AM, FM and φM receivers and for component measurements. Designed exclusively for the main applications of signal generators by cutting out the unnecessaries, SMY features an outstanding price/performance ratio. Thanks to its comprehensive basic features and excellent signal characteristics, it is an economical solution for universal use in lab, production and servicing environments.

Main features

- Frequency resolution 1 Hz
- Level range –140 to +13 dBm, overrange up to 19 dBm
- Level accuracy better than 1 dB
- SSB phase noise <–114 dB at 1 GHz, Δf = 20 kHz
- AM, FM, φM and pulse modulation
- Modulation generator 1 Hz to 500 kHz
- Nonvolatile memory for 50 complete front-panel setups
- Remote-control interface IEC 625/IEEE 488
- RF overload protection 30 W (SMY01) or 50 W (SMY02)
- Low RF leakage (<0.1 µV)
- Calibration at 3-year intervals

Characteristics

Cost-saving synthesis concept

Single-loop synthesis is a concept that makes for simple and cost-effective circuit design and does not entail giving up high frequency resolution and short setting time. The fractional-N technique uses a fractional frequency division ratio, ie a frequency resolution of 1 Hz is obtained in spite of the high reference frequency. High reliability and light weight thanks to VLSI components are further advantages of this technique.

Uncomplicated operation

The panel controls are ergonomically arranged. The patented, magnetically locking spinwheel is easy to turn, nevertheless each setting step is felt exactly by the user. Fast tuning and programming of the step width are also possible. Frequently used settings can be stored and recalled any time. The memory saves up to 50 complete front-panel setups.

Reliability of operation, ease of maintenance

The built-in self-test facility monitors continuously the signal generator status. If there are any malfunctions, these are immediately detected and indicated. The user thus has an effective protection against invalid measurements, should the generator ever fail. The SMY requires particularly little maintenance: Aging and drift are compensated for by control loops. Due to the few reference components, which are designed for maximum stability, calibration is required at intervals of 3 years only.

Specifications

Frequency	
Range	9 kHz to 1.04 GHz (SMY01) 9 kHz to 2.08 GHz (SMY02)
Underranging	down to 5 kHz (without specification)
Resolution	1 Hz
Setting time (to within $<1 \times 10^{-7}$ for f >65 MHz or <70 Hz for f <65 MHz)	<60 ms

Reference frequency	**standard**	**option SMY-B1**
Aging (after 30 days of operation)	1×10^{-6}/year	$<1 \times 10^{-9}$/day
Temperature effect (0 to 55°C)	2×10^{-6}	$<5 \times 10^{-8}$
Warmup time	–	10 min
Output for internal reference		
Frequency	10 MHz	
Level (EMF, sinewave)	1 V_{rms}	
Source impedance	50 Ω	
Input for external reference	5 or 10 MHz	
Permissible frequency inaccuracy	5×10^{-6}	
Input level	0.2 to 2 V_{rms}	
Input impedance	200 Ω	

Spectral purity

Spurious	
Harmonics	<–30 dBc for levels <10 dBm
Subharmonics	none (f >1.04 GHz: <–40 dBc)
Nonharmonics at >5 kHz from carrier	<–70 dBc (f >1.04 GHz: <–64 dBc)
Broadband noise with CW, carrier offset >1 MHz, 1 Hz bandwidth, f=1 to 65 MHz	<–135 dBc (f >65 MHz: <–140 dBc)
SSB phase noise at 20 kHz from carrier, 1 Hz bandwidth, CW	
f <65 MHz	<–114 dBc
100 MHz	<–132 dBc
500 MHz	<–120 dBc
1 GHz	<–114 dBc
Residual FM, rms, <1% of maximum deviation, f=1 GHz	
0.3 to 3 kHz (CCITT)	<10 Hz (0.03 to 20 kHz: <20 Hz)
Residual AM, rms (0.03 to 20 kHz)	<0.02%

Level

Range	–140 to +13 dBm
Overranging	up to 19 dBm (without specification)
Resolution	0.1 dB
Total error for levels >–127 dBm	<±1 dB (f >1.04 GHz: <±1.5 dB)
Level flatness at 0 dBm	<1 dB, typ. <0.3 dB
Output impedance	50 Ω
VSWR	<1.5 (f >1.04 GHz: <1.8)
Setting time (IEC/IEEE bus)	<25 ms (<10 ms with electronic level setting)
Non-interrupting level setting	0 to –20 dB

Overload proctection protects the instrument against externally applied (50-Ω source) RF power and DC voltage

Max. permissible RF power	30 W (SMY02: 50 W)
Max. permissible DC voltage	35 V
Max. pulse loading capacity (pulse width <10 µs)	1 mWs or 150 V_p

Simultaneous modulation any combination of AM, FM (φM) and pulse modulation

Amplitude modulation int., ext. AC/DC

Modulation depth	0 to 100%
Resolution	0.1%
Setting error at 1 kHz (m <80%)	<4% of reading ±1%
AM distortion at 1 kHz	
m=30%	<1%
m=80%	<2%
Modulation frequency response flatness (m=60%)	
30 Hz (DC) to 10 kHz	<0.4 dB
10 Hz (DC) to 50 kHz	<3 dB
Incidental φM with AM (30%), AF=1 kHz	<0.2 rad <0.4 rad at f >1.04 GHz (SMY02)
Modulation input (AM EXT)	
Input impedance	100 kΩ; 600 Ω jumper-selected
Input voltage for selected modulation depth	1 V_p (for inaccuracy >3%: high/low indication)

Frequency modulation int., ext. AC/DC

Max. deviation for carrier frequency	
<65 MHz	10 MHz
65 to 130 MHz	1.25 MHz
130 to 260 MHz	2.5 MHz
260 to 520 MHz	5 MHz
520 to 1040 MHz	10 MHz
1040 to 2080 MHz	20 MHz
Resolution	<1%, min. 10 Hz
Setting error at AF=1 kHz	<3% of reading + 20 Hz
FM distortion at AF=1 kHz and 3% of maximum deviation	<0.3%, typ. 0.1%
Modulation frequency response flatness	
10 Hz (DC) to 2 MHz	<3 dB, typ. 1 dB
Incidental AM at AF=1 kHz, f >1 MHz, 40 kHz deviation	<0.1%
Stereo modulation at 40 kHz deviation, AF=1 kHz	
Stereo separation	>50 dB
S/N ratio	
unweighted	>76 dB
weighted	>70 dB
Harmonic distortion	typ. 0.1%
Carrier frequency offset with FM-DC	<1 Hz + 0.1% of deviation
Modulation input	FM/φM EXT
Input impedance	100 kΩ; 600 Ω jumper-selected
Input voltage for selected deviation	1 V_p (for inaccuracy >3%: high/low indication for AF=10 Hz to 100 kHz)

Phase modulation int., ext. AC

Max. deviation for carrier frequency	
<65 MHz	200 rad
65 to 130 MHz	25 rad
130 to 260 MHz	50 rad
260 to 520 MHz	100 rad
520 to 1040 MHz	200 rad
1040 to 2080 MHz	400 rad
Resolution	<1%, min. 0.01 rad
Setting error at AF=1 kHz	<5% of reading + 0.02 rad
FM distortion at AF=1 kHz and half the maximum deviation	<0.5% (typ. 0.2%)
Modulation frequency response flatness	
20 Hz to 20 kHz	<3 dB (typ. 1 dB)
Modulation input	FM/φM EXT
Input impedance	100 kΩ; 600 Ω jumper-selected
Input voltage for selected deviation	1 V_p (for inaccuracy >3%: high/low indication)

Pulse modulation ext.

On/off ratio	>80 dB
Rise/fall time (10/90%)	typ. 4 µs
Pulse delay	typ. 2.5 µs
Modulation input	TTL/HC logic signal, polarity selectable
Input impedance	10 kΩ

Internal modulation generator

Frequency range/resolution	1 Hz to 500 kHz/0.1 Hz
Display	3 digits, floating point
Frequency error	<5 x 10^{-5}
Frequency response flatness up to 50 kHz	<0.2 dB (up to 100 kHz: <0.3 dB)
Harmonic distortion (20 Hz to 100 kHz)	<0.1%
Output voltage	1 V_p ±1% (R_{out} <10 Ω, R_L >200 Ω)
Frequency setting time	<10 ms (after receiving last IEC/IEEE-bus character)

Memory nonvolatile, for 50 front-panel setups

Remote control

System	IEC 625 (IEEE 488)
Connector	Amphenol, 24-contact
IEC/IEEE-bus address	0 to 30
Interface functions	SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT0, C0

General data

Power supply	100 V/230 V (AC) –10 to +15%, 120 V/220 V (AC) –12.5 to +10%, 47 to 440 Hz, max. 120 VA
Dimensions (W x H x D)	
SMY01	435 mm x 147 mm x 350 mm
SMY02	435 mm x 147 mm x 460 mm
Weight	11 kg (SMY01), 12 kg (SMY02)

Ordering information

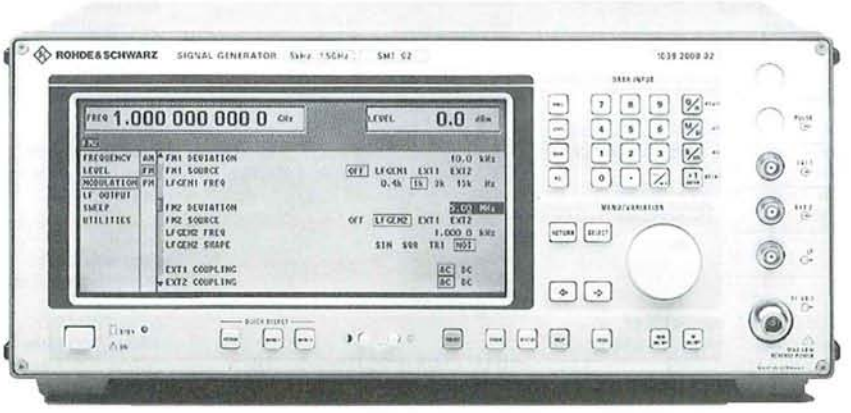
Signal Generator	SMY01	1062.5502.11
	SMY02	1062.5502.12
Options, extras		
Option Reference Oscillator OCXO	SMY-B1	1062.7505.02
Rear-panel Connectors for RF and AF	SMY-B10	1062.8001.02
Service Kit	SMY-Z2	1062.7805.02
Service Manual SMY		1062.5583.24

Signal Generator SMT

5 kHz to 1.5/3 GHz

For receiver and EMS measurements

SCPI



Uses

Signal Generator SMT covers the complete range of conventional analog receiver measurements up to 3 GHz. It provides an exceptionally high signal quality for a generator in this price category, as well as outstanding level accuracy, a wide variety of modulation and signal generation modes, customized configuration, and great ease of operation. Features such as programmable RF, LF and level sweeps as well as the correction of external frequency response make the SMT an ideal source for EMS measurements.

The two models SMT02 (5 kHz to 1.5 GHz) and SMT03 (5 kHz to 3 GHz) only differ in the frequency range, all other features being identical.

Main features

- AM, FM, φM, pulse modulation
- Broadband FM and φM
- Options for signal generation:
  - pulse generator
  - LF generator
  - multifunction generator, eg for stereo and VOR/ILS signals
- Innovative operating concept

Signal characteristics

Spectral purity
For high-accuracy measurements on AM, FM and SSB receivers, the signal source must be superior to the DUT. The low residual FM and SSB phase noise make the SMT suitable for in-channel and blocking measurements even on high-end receivers.

Frequency
With a specified lower frequency limit of 5 kHz (underrange down to 1 kHz), the SMT fully covers the frequency range for EMS measurements stipulated by IEC 801.

Sweep
The digital, step-by-step sweep function with preselectable start and stop frequency, span, step width and step time enables easy investigation of wide frequency ranges. The sweep function can also be used for the RF level and AF frequency.

Level, level correction
The small level error of <1 dB throughout the frequency range allows high-precision sensitivity measurements. To compensate for the frequency response of cables, amplifiers, TEM cells (EMS measurements) etc, level correction values can be entered for up to 100 user-defined frequency points. Correction values for frequencies between these reference points are found by interpolation. The corrections are valid in all operating modes, including sweeps.

Minimum RF leakage
Measurements on highly sensitive receivers such as pagers not only require high signal quality but also extremely high RF shielding of the signal source. Elaborate shielding measures make for extremely low RF leakage of the SMT.

Modulation characteristics

A large variety of modulation modes, user-selectable combination of various types of modulation and a multitude of modulation sources make the SMT a highly flexible instrument for use in development, production and repair of radio equipment.

AM (DC to 100 kHz)
Outstanding AM features of the SMT are its extremely low distortion and flat frequency and phase response – characteristics that play a particularly important role in measurements on VOR/ILS receivers, for example.

Broadband FM (DC to 8 MHz)
In the FM DC mode, high carrier frequency accuracy is ensured through the use of a special control circuit. There is virtually no drift. The SMT can thus generate high-precision FSK signals as required for testing radiopagers. The use of an external Gaussian filter permits GFSK signals to be generated in line with the DECT standard.

Broadband φM (DC to 2 MHz)
This wide span opens up fields of application for which most signal generators do not qualify, for instance tests on phase-sensitive circuits or the generation of PSK modulation with freely selectable phase deviation up to 10 rad.

Pulse modulation (option SM-B3/B8)
Its high-quality pulse modulation, featuring an on/off ratio better than 80 dB and a rise/fall time shorter than 10 ns, make the SMT an ideal choice for radar applications. The optional pulse generator allows pulsed signals to be produced independent of an external source.

Operation

A large LCD display and a well thought-out menu concept make operation extremely easy. All parameters selectable for a specific function are arranged in hierarchical order in a single display. Help texts for the individual functions mean that it is usually unnecessary to consult a manual.

For frequently recurring measurement routines, the memory sequence function is provided which until now was only possible with processor control. Up to 50 instrument settings can be stored in a nonvolatile memory. After programming the sequence of measurements and the step time in a list, the automatic test run can be started.

Options

AM, FM, φM and pulse modulation can be used with various internal and external modulation sources. The SMT can be tailored to suit specific applications by means of optional modules. These can also be retrofitted quickly and easily at a later date.

LF Generator SM-B2
This generator can be fitted in addition to the fixed-frequency LF generator provided as standard. It is a synthesizer up to 500 kHz and supplies in addition to sinewave, squarewave and triangular signals also a noise signal.

If two LF generators are fitted in a unit, multitone signals can be generated internally. The LF generator modulation source also allows call tone sequences in line with all relevant standards and freely definable tone sequences to be generated.

Multifunction Generator SM-B6
This generator produces the same signals as the optional LF generator and, in addition, stereo multiplex and VOR/ILS modulation signals. The multifunction generator option makes the SMT suitable even for highly demanding measurements on FM stereo and navigation receivers.

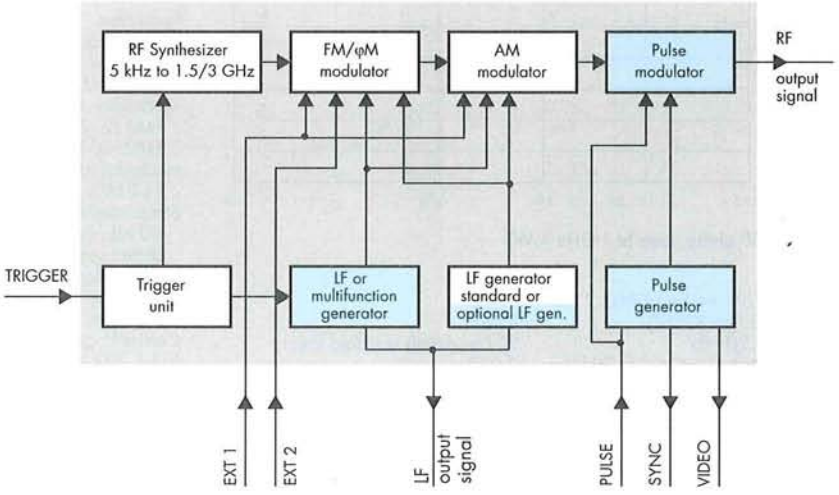
Pulse Generator SM-B4
The pulse generator provides single and double pulses as required for radar receiver testing. The pulse repetition period, pulse width and pulse delay can be set with high accuracy and resolution (Pulse Modulator SM-B3/B8 being required).

Self-diagnostics

The signal generator is continuously monitored with the aid of the built-in test equipment. The SMT indicates malfunctions and deviations from nominal values by means of a message on the display.

Calibration

Calibration of the unit is required every three years at the earliest to ensure frequency and level accuracy to specifications. Calibration values are loaded via the RS-232-C or IEC/IEEE-bus interface. The unit neither needs to be opened, nor need any mechanical adjustments be made.

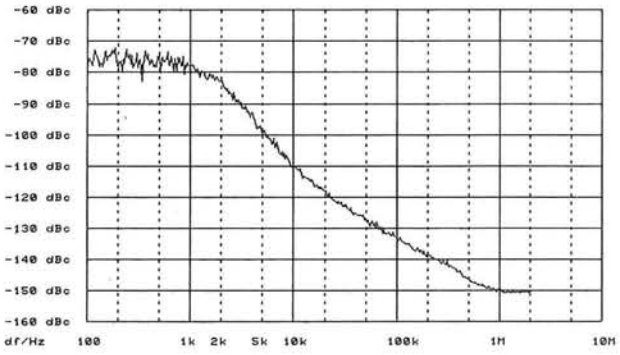


Block diagram of SMT (options shown in blue)

Signal Generators SMT02, SMT03

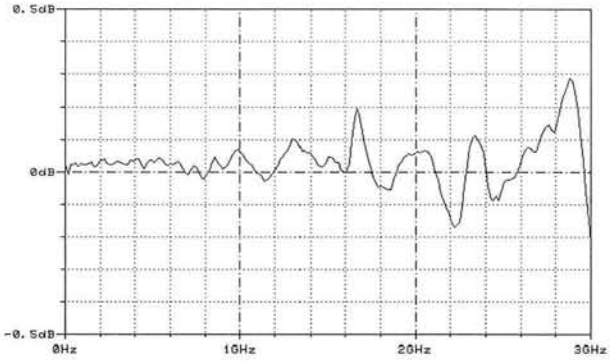
Specifications

Frequency		
Range	5 kHz to 1.5 GHz (SMT02) 5 kHz to 3 GHz (SMT03)	
Underrange		
without guarantee of specs	down to 1 kHz	
Resolution	0.1 Hz	
Setting time (after IEC/IEEE-bus delimiter)	<20 ms	
Phase offset	adjustable in steps of 1°	
Reference frequency	Standard	Option SM-B1
Aging (after 30 days of operation)	1×10^{-6}/year	$<1 \times 10^{-9}$/day
Temperature effect (0 to 55°C)	2×10^{-6}	$<5 \times 10^{-8}$
Warmup time	–	10 min
Output for internal reference	10 MHz	
Level (EMF, sinewave)	1 V_{rms} into 50 Ω	
Input for external reference	1 to 16 MHz in 1-MHz steps	
Permissible frequency error	3×10^{-6}	
Input level	0.1 to 2 V_{rms} into 200 Ω	
Electronic tuning (TUNE)	1×10^{-7}/V	
Input voltage range	0 to ±10 V into 10 kΩ	
Spectral purity		
Spurious signals		
Harmonics	<–30 dBc	
Subharmonics		
f <1.5 GHz	none	
f >1.5 GHz	<–40 dBc	
Nonharmonics at >10 kHz from carrier		
f <1.5 GHz	<–80 dBc	
f >1.5 GHz	<–74 dBc	
Broadband noise for CW, at >2 MHz from carrier, 1-Hz bandwidth	<–140 dBc (typ. <–145 dBc)	
SSB phase noise	see diagram; details see data sheet	



Typical SSB phase noise at 1 GHz (CW)

Residual FM, rms (f = 1 GHz)	
0.3 to 3 kHz (CCITT)	<8 Hz
0.03 to 20 kHz	<20 Hz, details see data sheet
Residual AM, rms (0.03 to 20 kHz)	<0.02%
Level	–144 to +13 dBm
Overrange	up to 16 dBm (without guarantee)
Resolution	0.1 dB
Total error for levels >–127 dBm	
f <1.5 GHz	<±1 dB
f >1.5 GHz	<±1.5 dB
Level frequency response at 0 dBm	<1 dB, typ. <0.3 dB
VSWR	<1.5 for levels ≤0 dBm <2 for levels >0 dBm
Setting time (IEC/IEEE bus)	<25 ms (<10 ms with electronic level setting)
Non-interrupting level setting	0 to 20 dB



Level frequency response at 0 dBm

Overvoltage protection	protects the unit from externally applied RF power (50-Ω source) and DC voltages
Max. RF power/DC voltage	50 W/35 V
Simultaneous modulation	any combination of AM, FM (φM) and pulse modulation
Amplitude modulation	internal, external AC/DC
Modulation depth	0 to 100%
Resolution	0.1%
Setting error at 1 kHz (m <80%)	<(4% of reading ±1%)
AM distortion at 1 kHz	
m = 30%	<1%
m = 80%	<2%
Modulation frequency range	DC to 100 kHz
Modulation frequency response (m = 60%); 20 Hz (DC) to 50 kHz	<1 dB, typ. 0.3 dB
Incidental φM with 30% AM, AF = 1 kHz	<0.1 rad
EXT 1 modulation input	R_{in} >100 kΩ
Input voltage for selected modulation depth	1 V_p (high/low indication for inaccuracy >3%)
Frequency modulation	internal, external AC/DC, two tone with two separate channels FM 1 and FM 2
Max. deviation	depending on carrier frequency: 5 MHz (at f_c <130 MHz) to 20 MHz (at f_c 3 GHz), details see data sheet
Resolution	<1%, min. 10 Hz
Setting error at AF = 1 kHz (FMAC)	<(3% of reading + 20 Hz)
FM distortion at AF = 1 kHz and 50% of max. deviation	<0.2%, typ. 0.1%
Modulation frequency response	
FM1/2: 20 Hz (DC) to 100 kHz	<0.5 dB
FM2: 20 Hz (DC) to 8 MHz	<3 dB
Incidental AM at AF = 1 kHz, f >1 MHz, 40 kHz deviation	<0.1%
Stereo modulation at 40 kHz deviation, AF = 1 kHz,	
Stereo separation	>50 dB
Unweighted S/N ratio	>76 dB
Weighted S/N ratio	>70 dB
Distortion	<0.2%
Carrier frequency offset (FM DC)	<0.1% of deviation
EXT 1, EXT 2 modulation inputs	R_{in} >100 kΩ
Input voltage for selected deviation	1 V_p (high/low indication for inaccuracy >3%) for AF = 10 Hz to 100 kHz
Phase modulation	internal, external AC/DC, two tone with two separate channels broadband φM or narrowband φM (broadband φM only possible with φM2)

Max. deviation (details see data sheet)	depending on carrier frequency
φM range 1: DC to 100 kHz	12.5 to 200 rad
φM range 2: DC to 2 MHz	0.625 to 10 rad
Resolution	<1%, min. 0.001 rad
Setting error at AF = 1 kHz	<(3% of reading + 0.01 rad)
Distortion at AF = 1 kHz (max. dev.)	<0.5%, typ. 0.1%
Modulation frequency response, φM2	
20 Hz (DC) to 1 MHz	<1 dB
EXT 1, EXT 2 modulation inputs	R_{in} >100 kΩ
Input voltage for selected deviation	1 V_p (high/low indication for inaccuracy >3%)
Pulse modulation	with option SM-B3 or SM-B8
Operating modes	external; internal with Pulse Generator Option SM-B4
Frequency range	50 MHz to 1.5 GHz (SM-B3) 50 MHz to 3 GHz (SM-B8)
Max. output level	10 dBm (50 MHz to 1.5 GHz) 9 dBm (1.5 to 3 GHz)
On/off ratio	>80 dB
Rise/fall time (10/90%)	<10 ns
Pulse repetition rate	0 to 10 MHz
Pulse delay	typ. 50 ns
Video feedthrough	<–30 dBc
PULSE modulation input	TTL (HCT) into 50 Ω or 10 kΩ
Internal modulation generator	0.4/1/3/15 kHz ±3%
Level (EMF) at LF socket	1 V_p ±1% (R_{out} = 10 Ω, R_L >200 Ω)
LF generator	option SM-B2
Sinewave, noise	0.1 Hz to 500 kHz
Triangular, squarewave	0.1 Hz to 50 kHz
Resolution/frequency error	0.1 Hz/<1 x 10^{-4}
Frequency response (sinewave)	
up to 100 kHz	<0.3 dB
up to 500 kHz	<0.5 dB
Distortion (20 Hz to 100 kHz)	<0.1% (level >0.5 V)
Level (EMF) at LF socket	1 mV_p to 4 V_p (R_{out} = 10 Ω, R_L >200 Ω)
Resolution/setting error at 1 kHz	1 mV/1% + 1 mV
Frequency setting time	<10 ms (after last character from IEC/IEEE bus)
Multifunction generator	option SM-B6: sinewave, triangular, sawtooth, squarewave, noise, stereo MPX and VOR/ILS modulation signals
Sinewave, noise	0.1 Hz to 1 MHz
Triangular, sawtooth, squarewave	0.1 Hz to 50 kHz
Resolution/frequency error	0.1 Hz/same as reference frequency
Frequency response (sinewave)	
up to 100 kHz	<0.3 dB
up to 1 MHz	<0.5 dB
Distortion (20 Hz to 100 kHz)	<0.1% (level >0.5 V)
Level (EMF) at LF socket	1 mV_p to 4 V_p (R_{out} = 10 Ω, R_L >200 Ω)
Resolution/setting error at 1 kHz	1 mV/1% + 1 mV
Frequency setting time	<10 ms (after last character from IEC/IEEE bus)
Stereo multiplex signal	with multifunction generator
Stereo operating modes	R, L, R=L, R=-L, ARI (pilot tone or MPX signal can be connected to LF socket)
Frequency range of L, R signal	0.1 Hz to 15 kHz
Preemphasis	50 µs, 75 µs
Pilot-tone frequency	19 kHz ±1 Hz
Pilot-tone phase/resolution	0 to 360°/0.1°
Stereo separation	>60 dB
Distortion	<0.1% (L, R = 1 kHz)
Carrier suppression (38 kHz)	>65 dB
Settings for ARI (German traffic information broadcast service)	
Area identification	A, B, C, D, E, F
Announcement identification	on/off
Additional signals (RDS, RDS + ARI)	via EXT 1 input
VOR modulation signal	
Settings	30 Hz (VAR, REF)/ 9.96-kHz FM carrier, FM deviation, COM/ID tone
Phase/phase resolution	0 to 360°/0.01°
Bearing error (RF output, 108 to 118 MHz)	<0.05°
FM error (deviation 480 Hz)	<1 Hz
ILS modulation signal	
Settings	90-Hz, 150-Hz tone, COM/ID tone, marker beacon
DDM setting range/resolution	0 to ±0.8/0.0001
DDM error (RF output)	
Localizer (108 to 112 MHz)	<0.0004 + 2% of DDM reading
Glideslope (329 to 335 MHz)	<0.0008 + 2% of DDM reading
Pulse generator	option SM-B4
Operating modes	single pulse, delayed pulse, double pulse
Active trigger edge	positive or negative
Pulse repetition period	100 ns to 85 s
Resolution	5-digit, min. 20 ns
Error	same as reference frequency
Pulse width	20 ns to 1 s
Resolution	4-digit, min. 20 ns
Error	5% of reading ±5 ns
Pulse delay	40 ns to 1 s
Resolution	4-digit, min. 20 ns
Error	5% of reading –10 to +20 ns
Double pulse	60 ns to 1 s
Resolution	4-digit, min. 20 ns
Error	5% of reading –10 to +20 ns
Trigger delay	typ. 50 ns
PULSE modulation input	TTL (HCT) into 50 Ω or 10 kΩ
Sync output	TTL levels (HCT), 40 ns pulse width
Video output	TTL levels (HCT)
Sweep	digital, in discrete steps
RF sweep, LF sweep	LF sweep with option SM-B2 or -B6
Operating modes	automatic, single-shot, manual or externally triggered, linear or logarithmic
Sweep range and step width lin/log	freely selectable/0.01 to 100%
Level sweep	
Operating modes	automatic, single-shot, manual or externally triggered, logarithmic
Sweep range, step width	0.1 to 20 dB
Step time/resolution	10 ms to 1 s/0.1 ms
Markers	3, freely selectable
MARKER output signal	TTL levels (HCT), selectable polarity
X output	0 to 10 V
BLANK output signal	TTL levels (HCT), selectable polarity
Memory for instrument settings	50
Memory sequence modes	automatic, single-shot, manual or externally triggered
Step time/resolution	50 ms to 60 s/1 ms
Remote control	IEC 625 (IEEE 488)
Instruction set	SCPI 1993.0
General data	
Power supply	90 to 132 V /180 to 265 V , 47 to 440 Hz, autosetting to AC voltage, max. 300 VA
Dimensions (W x H x D); weight	435 mm x 192 mm x 350 mm; 20 kg

Ordering information

Signal Generator	SMT02	1039.2000.02
	SMT03	1039.2000.03
Options		
Reference Oscillator OCXO	SM-B1	1036.7599.02
LF Generator	SM-B2	1036.7947.02
Pulse Modulator for SMT02	SM-B3	1036.6340.02
for SMT03	SM-B8	1036.6805.02
Pulse Generator (only with Option SM-B3 or SM-B8)	SM-B4	1036.9310.02
Multifunction Generator	SM-B6	1036.7760.02
Rear connectors for RF and AF	SMT-B19	1039.4003.02
Extras		
Service Kit	SM-Z2	1039.3520.02
Service Manual	SMT	1039.3359.24

1) A second modulation generator (SM-B2 or SM-B6) cannot be fitted in conjunction with a pulse generator (SM-B3 or SM-B8).

2) To be retrofitted by authorized service centers only.

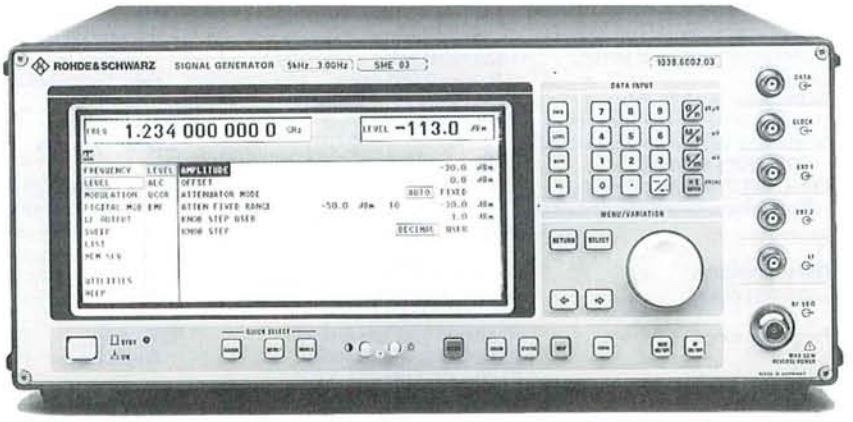
Microwave Signal Generator SMP

SMP02/22: 0.01/2 to 20 GHz

SMP03: 0.01/2 to 27 GHz

SMP04: 0.01/2 to 40 GHz

SCPI



Uses

Microwave Signal Generator SMP is the high-frequency member of the new signal generator family from Rohde&Schwarz. The SMP is able to supply signals for any measurements on radar and communications receivers. A wide range of extensions ensures universal use in research, production, EMC measurements and material testing.

Main features

- Very high spectral purity
- Stable output frequency
- High frequency resolution
- High output level:
  SMP02 SMP22 SMP03 SMP04
  >10 >20 >6 >3 dBm
- Fast settling after a frequency change
- Versatile modulation capabilities
- Large choice of options for user-specific configuration
- Intelligent menu guidance for maximum ease of operation
- User-friendly facilities

Signal characteristics

Spectral purity
The frequency range from 2 to 20 GHz is directly generated by YIG oscillators, so that up to 20 GHz there are no subharmonics which may cause measurement errors. Nonharmonics of <–60 dBc and an SSB phase noise of eg <–86 dBc/Hz at 20 GHz speak for themselves.

Stable output frequency
The crystal reference built-in as standard ensures an accurate and low-drift output frequency. The SMP can also be fitted with an oven-controlled crystal oscillator (option SM-B1, OCXO) to meet the most exacting requirements.

All SMP basic models have a lower frequency limit of 2 GHz which can be optionally extended to 10 MHz (option SMP-B 11), thus qualifying the SMP also for EMC applications.

Frequency resolution 0.1 Hz
A high frequency resolution is required especially for scientific applications and in industrial research, eg for surface measurements of materials using radar equipment.

Frequency hopping (list mode)
The list mode can be used for programming frequency hopping. Up to 2048 pairs of frequency and level values can be stored in lists.

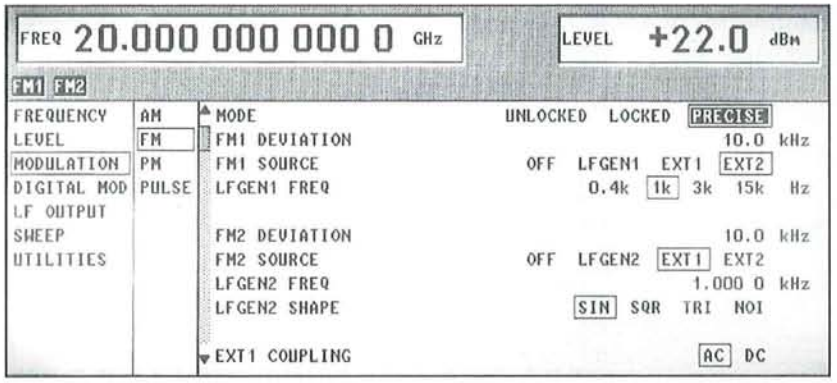
High output level
The SMP02 provides an output level of more than 10 dBm; the SMP22 features a guaranteed level of 20 dBm (without attenuator) and thus sufficient reserves for compensating the attenuation of very long cables as well as the losses of power splitters and directional couplers, etc.

Typical applications requiring a high output level:

- Substitution of local oscillators
- Measurements on nonlinear components such as frequency multipliers or high-level mixers
- Driving of TWTs and other power stages
- Interconnection of several signal generators for intermodulation measurements

Minimum level error
The high accuracy of the levelled and frequency-response-compensated output power is enhanced even further by the built-in precision attenuator (option SMP-B15). High level accuracy is also obtained by external level control using a power meter like the NRVS from Rohde&Schwarz.

Frequency-response compensation
A known frequency response can be compensated by entering level correction values for up to 100 frequency points. The correction values for the frequencies between these points are determined by means of interpolation.



The FM modulation menu shows the clear-cut representation of selectable parameters and current instrument status on the display. Each setting can be made quickly and easily by means of the rotary knob and a few keys.

Sweep
The digital, step-by-step sweep mode with programmable start and stop frequency, span, step size and step time allows easy investigation of wide frequency ranges. The sweep function can also be used for the RF level and the AF frequency.

Minimum RF leakage
Sensitivity measurements on low-noise satellite receivers can only be made with absolutely RF-leakage-proof signal sources. The extensive shielding of the SMP ensures extremely low RF leakage.

Modulation characteristics

Frequency and phase modulation
The SMP is fitted with an FM modulator as standard. In addition, a precision FM/φM modulator (option SM-B5) is available for testing communication receivers and for scientific applications. Thanks to a special frequency control circuit, this precision modulator features an extremely high carrier frequency accuracy and stability in the FMDC mode. Digital frequency shift keying (FSK modulation) is also possible.

The wide frequency range of the phase modulation extending from DC to 100 kHz allows testing of phase-sensitive circuits. In DC-coupled FM or φM mode, the SMP can also be used as a voltage-controlled oscillator (VCO) and integrated into an external frequency control loop.

Pulse modulation
All data specified for pulse modulation are valid throughout the rated frequency range and also at the important intermediate frequencies of 70 and 140 MHz for radar applications. In addition to feeding in external modulation signals, the pulse generator (option SMP-B14) can also be used to generate internal single or double pulses. The pulse generator can also be triggered externally, pulse width and delay being freely selectable in a wide range.

Simultaneous modulation modes
All modulation modes of the SMP can be combined:

- Combined AM and pulse modulation provides the type of signals occurring in pulse radar applications with rotating antenna
- The combination of pulse modulation and FMDC simulates Doppler effects and also chirp signals
- Simultaneous AM and FM can be used to study fading effects of FM receivers

Operation

Easy-to-follow menu guidance
All functions are clearly arranged in menus. Menus and functions as well as parameter settings can be conveniently selected with a spinwheel. Frequently used menu settings can be stored in two memories.

Easy-to-read screen display
All settings associated with a certain function can be seen at a glance on the large-size, high-contrast LCD display.

HELP function
Explanatory remarks can be called up for each individual menu, so there is often no need for looking up functions in a manual.

Automatic measurement functions
The memory sequence function provides convenient execution of standard test routines. Up to 50 complete instrument setups can be stored and are automatically executed after the sequence has been programmed. This function also allows synchronous operation in conjunction with other units to be triggered. Step times can be separately programmed for each step.

Remote control
The IEEE-bus remote control commands are in line with the latest SCPI guidelines. This means, for example, that the user can exchange measuring instruments in an automatic system without having to modify the control software.

Microwave Signal Generator SMP

Specifications

See also specifications of Signal Generator SMT, page 82.

Frequency

Range (Standard)	
SMP02/22	2 to 20 GHz
SMP03	2 to 27 GHz
SMP04	2 to 40 GHz
Range (with option SMP-B11)	
SMP02/22	10 MHz to 20 GHz
SMP03	10 MHz to 27 GHz
SMP04	10 MHz to 40 GHz
	10 MHz to 20 GHz
Resolution	0.1 Hz
Setting time IEEE bus (to within <1 x 10^{-6})	<(11 ms + 1 ms/GHz)
Phase offset	adjustable in 1° steps

Reference frequency	**standard**	**option SM-B1**
Aging (after 30 days of operation)	1 x 10^{-6}/year	<1 x 10^{-9}/day
Temperature effect (0 to 55°C)	2 x 10^{-6}	<5 x 10^{-8}
Warmup time	—	10 min
Output for internal reference	10 MHz	
Level (EMF, sinewave)	1 V_{rms} into 50 Ω	
Input for external reference	1 to 16 MHz in 1-MHz steps	
Permissible frequency error	3 x 10^{-6}	
Input level	0.1 to 2 V_{rms} into 200 Ω	

Spectral purity

Spurious signals	SMP02	SMP22	SMP03	SMP04	
Harmonics					
f <1.8 GHz	<–35	<–25	<–35	<–35	dBc
1.8 to 2.2 GHz	<–45	<–25	<–45	<–45	dBc
f >2.2 to 20 GHz	<–50	<–25	<–50	<–50	dBc
>20 to 27 GHz	–	–	<–40	<–40	dBc
>27 GHz	–	–	–	<–40	dBc
Subharmonics					
f <20 GHz	none	none	none	none	
f >20 GHz	–	–	<–40	<–40	dBc
Nonharmonics at >10 kHz from carrier					
f <2 GHz	<–60	<–60	<–50	<–50	dBc
2 to 20 GHz	<–60	<–60	<–60	<–50	dBc
f >20 GHz	–	–	<–54	<–54	dBc

SSB phase noise, 1 Hz bandwidth, FM off

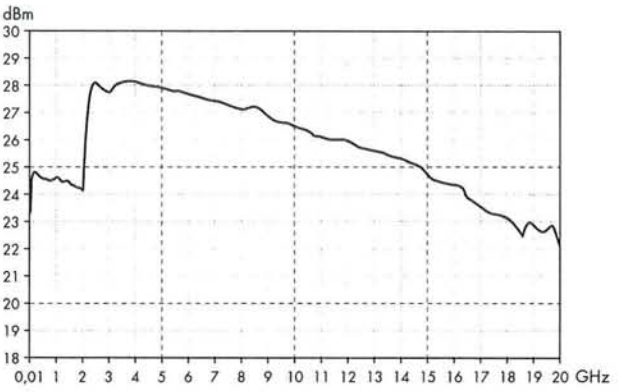
Carrier spacing	0.1	1	10	100	kHz
10 MHz to 2 GHz	<–64	<–77	<–92	<–101	dBc
2 to 10 GHz	<–64	<–77	<–92	<–101	dBc
10 to 20 GHz	<–58	<–71	<–86	<–95	dBc
20 to 27/40 GHz	<–52	<–65	<–80	<–89	dBc

Residual FM, rms, FM off

Weighting bandwidth	300 Hz to 3 kHz	30 Hz to 20 kHz
10 MHz to 2 GHz	<5 Hz	<50 Hz
2 to 10 GHz	<5 Hz	<50 Hz
10 to 20 GHz	<10 Hz	<100 Hz
20 to 27/40 GHz	<20 Hz	<200 Hz

Residual AM, rms, AM off

Weighting bandwidth	300 Hz to 3 kHz	30 Hz to 20 kHz
10 MHz to 2 GHz	<0.1%	<0.2%
2 to 20/27/40 GHz	<0.05%	<0.1%



Maximum level versus frequency (SMP22), typical curve

Level

Range	without option SMP-B15	with option SMP-B15
SMP02	–20 to +10 dBm	–130 to +8,5 dBm
SMP22	–20 to +20 dBm	–130 to +18,5 dBm
SMP03	–20 to +6 dBm	–130 to +4 dBm
	with option SMP-B17	with option SMP-B17
SMP04	–20 to +3 dBm	–130 to +1 dBm

With option SMP-B11, the maximum level of SMP22 available below 2 GHz is reduced by 3 dB. With pulse modulation switched on, the maximum level is at least 13 dBm (SMP02 and SMP22)

Total error (frequency response and temperature effect included)

Frequency range	Level	Error
10 MHz to 2 GHz	>+10 dBm	<±1.2 dB
	>–10 dBm	<±0.6 dB
	>–60 dBm	<±0.9 dB
	≤–60 dBm	<±1.4 dB
2 to 20 GHz	>+10 dBm	<±1.3 dB
	>–10 dBm	<±0.7 dB
	>–60 dBm	<±1.0 dB
	≤–60 dBm	<±1.5 dB
>20 to 27/40 GHz	≤–10 dBm	<±0,9 dB
	≤–60 dBm	<±1,2 dB
	≤–60 dBm	<±1,7 dB

Output impedance	50 Ω
VSWR	
f ≤20 GHz	<2, typ. <1.6
f >20 GHz	<2.2, typ. <1.8
Setting time (IEC/IEEE-bus)	<10 ms
With option SMP-B15, with switching in attenuator set	<25 ms
Non-interrupting level setting	0 to 20 dB
Simultaneous modulation	any combination of AM, FM (φM) and pulse modulation
Amplitude modulation	
Operating modes	internal, external AC/DC
Modulation depth/resolution	0 to 90%/0.1%
Setting error at 1 kHz (m <80%)	<(4% of reading ±1%)
AM distortion 1 kHz (m=60%), f >50 MHz	<1%, typ. <0.5%
Modulation frequency range for frequency response <1 dB, m=30%	DC to 100 kHz
f <2 GHz	DC to 10 kHz
f ≥2 GHz	DC to 50 kHz
Modulation input EXT1	R_{in}=600 Ω or 100 kΩ
Input voltage (peak value) for selected modulation depth	1 V (HIGH/LOW indication for inaccuracy >3%)
Frequency modulation	internal, external AC/DC, locked/unlocked, two-tone with two separate channels FM1 and FM2

Standard frequency modulation	without option SM-B5
Maximum deviation/resolution	
f ≤20 GHz	10 MHz/<1%, min. 10 Hz
f >20 GHz	20 MHz/<1%, min. 20 Hz
Setting error at AF = 100 kHz and 500 kHz deviation	<5% of reading
FM distortion at AF = 50 kHz and 500 kHz deviation	<0.5%, typ. 0.05%
Modulation frequency range	
locked mode	20 kHz to 1 MHz
unlocked mode	DC to 1 MHz
Modulation frequency response	
locked mode, modulation index <10, deviation = 100 kHz	
20 kHz to 1 MHz	<5 dB
unlocked mode, deviation = 10 MHz	
10 Hz (DC) to 50 kHz	<1 dB
50 kHz to 1 MHz	<5 dB
Incidental AM at AF = 50 kHz and 100 kHz deviation	<0.5%
Carrier frequency offset with FM	
locked mode	none
unlocked mode	typ. <10 MHz
FM with option SM-B5	standard FM available
Maximum deviation/resolution	
f ≤20 GHz	1 MHz/<1%, min. 10 Hz
f >20 GHz	2 MHz/<1%, min. 20 Hz
Setting error at AF = 1 kHz and deviation >1 kHz	<2% of reading
FM distortion at AF = 1 kHz and 500 kHz deviation	<0.5%, typ. 0.05%
Modulation frequency range	DC to 1 MHz
Modulation frequency response	
10 Hz (DC) to 50 kHz	<0.5 dB
>50 kHz to 1 MHz	<4 dB
Incidental AM at 1 kHz/40 kHz deviation	<0.5%
Carrier frequency offset with FM	<100 Hz + 1% of deviation
Carrier frequency drift with FMDC	typ. 0.005% of deviation per 1 °C
Modulation inputs EXT1, EXT2	R_{in} = 600 Ω or 100 kΩ
Phase modulation	with option SM-B5
Operating modes	internal, external AC/DC, two-tone with two separate channels φM1 and φM2
Maximum deviation/resolution	
f ≤20 GHz	10 rad/<1%, min. 0.001 rad
f >20 GHz	20 rad/<1%, min. 0.001 rad
Setting error at AF = 1 kHz	<(3% of reading + 0.02 rad)
φM distortion at 1 kHz/5 rad	<1%
Modulation frequency range	DC to 100 kHz
Modulation frequency response	
10 Hz (DC) to 100 kHz	<3 dB
Modulation input EXT1, EXT2	R_{in} = 600 Ω or 100 kΩ
ASK modulation	external
Max. modulation depth/resolution	90%/0.1%
Data rate	0 to 125 kHz
Rise/fall time (10/90%)	<10 µs
Modulation input EXT1	R_{in} = 600 Ω or 100 kΩ TTL/HCT signal, selectable polarity
FSK modulation	external
Maximum shift, standard FM	
f ≤20 GHz	10 MHz
f >20 GHz	20 MHz
With option SM-B5	
f ≤20 GHz	1 MHz
f >20 GHz	2 MHz
Resolution	
f ≤20 GHz	<1%, min. 10 Hz
f >20 GHz	<1%, min. 20 Hz
Data rate (standard FM)	
locked mode	20 to 500 kHz
unlocked mode	0 to 500 kHz
Data rate with option SM-B5	0 to 500 kHz
Modulation input EXT1	R_{in} = 600 Ω or 100 kΩ TTL/HCT signal, selectable polarity
Pulse modulation	external, internal with option SMP-B14
Standard	without options SMP-B12/SMP-B13
Frequency range	2 to 40 GHz
On/off ratio	>50 dB (level >0 dBm)
Rise/fall time (10/90%)	<500 ns
Minimum pulse width	1 µs
Pulse repetition frequency	0 to 500 kHz
Pulse delay	typ. 100 ns
Video feedthrough	<15 mV (peak value)
With options SMP-B12/SMP-B13	
Frequency range	
with option SMP-B13	10 MHz to 2 GHz
with option SMP-B12	2 to 40 GHz
On/off ratio	>80 dB
Rise/fall time (10/90%)	<10 ns
Minimum pulse width	20 ns
Pulse repetition frequency	0 to 10 MHz
Pulse delay	typ. 50 ns
Video feedthrough	<15 mV (peak value)
PULSE modulation input	TTL (HCT) into R_{in} = 50 Ω or 10 kΩ
Internal modulation generator	see SMT
LF generator	option SM-B2, for data see SMT
Pulse generator	option SMP-B14, for data see SMT (option SM-B4)
Second RF output	2 to 20 GHz, 0 dBm
Sweep	see SMT
List mode	
Operating modes	automatic, single-shot, manually or externally triggered
Max. length of list	2048 pairs of frequency and level values
Step time/resolution	1 ms to 1 s/0.1 ms
Level setting range	20 dB
Memory for instrument settings	see SMT
Auxiliary interface	with option SMP-B18
V/GHz output	output voltage proportional to frequency, 0.5 V/GHz or 1 V/GHz selectable
Z output	freely selectable level range between −10 and +10 V
Remote control	
Command set	IEC 625 (IEEE 488); SCPI 1992.0

General data

Power supply	90 to 132 V/180 to 265 V, 47 to 440 Hz, automatic setting to AC voltage, max. 400 VA
Dimensions (W x H x D); Weight	435 mm x 192 mm x 570 mm; 27 kg

Ordering information

Signal Generator	SMP02	1035.5005.02
	SMP22	1035.5005.22
	SMP03	1035.5005.03
	SMP04	1035.5005.04
Options		
Frequency Extension 0.01 to 2 GHz	SMP-B11	1036.6240.02
Pulse Modulator 2 to 40 GHz		
for SMP02/22	SMP-B12	1036.5750.02
for SMP03	SMP-B12	1036.5750.03
for SMP04	SMP-B12	1036.5750.04
Pulse Modulator 0.01 to 2 GHz	SMP-B13	1036.7147.02
Pulse Generator	SMP-B14	1036.7347.02
RF Attenuator 27 GHz	SMP-B15	1036.5250.02
RF Attenuator 40 GHz	SMP-B15	1036.5550.02
Auxiliary Interface	SMP-B18	1036.8920.02
Rear Connectors for RF, AF		
up to 27 GHz	SMP-B19	1036.4303.02
up to 40 GHz	SMP-B19	1036.4503.02
OCXO Reference Oscillator	SM-B1	1036.7599.02
LF Generator	SM-B2	1036.7947.02
FM/φM Modulator	SM-B5	1036.8489.02
Service Kit	SM-Z2	1039.3520.02

Signal Generator SME: new digital modulation standards integrated in DM Coder (SME-B11); new option Memory Extension SME-B12 for DM Coder SME-B11

Uses

Methods are being devised in all places of how to modulate digital data best on an analog carrier for long-distance transmission via cable or air.

The Signal Generator SME from Rohde & Schwarz (catalog 93/94, page 226) is a cost-effective signal source that can handle all modulation modes required in the development, production and quality assurance of such transmission equipment.

A large variety of new modulation standards have been implemented in the DM Coder SME-B11 without any extra cost arising for the customer. The SME is a future-proof instrument that will remain up to date as it allows for the integration of future modulation standards.

Memory Extension SME-B12 for DM Coder (Order No. 1039.4090.02)

This option expands the data memory of DM Coder SME-B11 from 8 kbit to 8 Mbit (data only) or 1 Mbit (data + level attenuation + burst). In addition, an external trigger facility for synchronization has been included.

Applications

- Propagation measurements in GSM and PCN networks. For this purpose, the complete data of a BCCH channel of one of these networks are stored in the SME-B12 option
- ERMES - digital European Radio Message System (supported by user menu of SME)
- Programming of very long data sequences, eg for BER measurements

Possible combinations of SME options

The following options can always be combined:

- SM-B1 Reference Oscillator OCXO
- SM-B5 FM/φM Modulator
- SME-B11 DM Coder
- SME-B19 RF, AF rear connectors

Two slots (A4 and A5) are left for further options to be installed:

Slot A4

- SM-B2 LF Generator or
- SM-B3/-B8 Pulse Modulator for SME 02 and SME 03 or
- SM-B4 Pulse Generator (integrated in option SM-B3/-B8)

Slot A5

- SM-B2 LF Generator or
- SM-B6 Multifunction Gen. or
- SME-B12 Memory Extension (with SME-B11 only)

All digital modulation modes of Signal Generator SME at a glance

Modulation mode	Standard	Designation	Data rate
GMSK	GSM	Groupe Spécial Mobile	270.833 kbit/s
	DCS 1800 (PCN)	Digital Cellular System	270.833 kbit/s
	CDPD	Cellular Digital Packet Data	19.2 kbit/s
	MC9	French communications network	8 kbit/s
	Mobitex-8000	Mobile Data System	8 kbit/s
GFSK	DECT	Digital European Cordless Telephony	1.152 Mbit/s
	CT2	Cordless Telephony	72 kbit/s
	CT3	Cordless Telephony	640 kbit/s
	USER	Test of deviation limits to DECT standard	1.152 Mbit/s
π/4 DQPSK	NADC	North American Digital Cellular	48.6 kbit/s
	PDC	Pacific Digital Cellular (previously JDC)	42 kbit/s
	TFTS	Terrestrial Flight Telephone System	44.2 kbit/s
	TETRA	Trans European Trunked Radio	36 kbit/s
FSK/FFSK	POCSAG	Post Office Code Standardization Advisory Group	512 to 2400 bit/s
	Cityruf	Analog paging system	512 to 2400 bit/s
	USER	User-selectable bit rate	500 bit/s to 100 kbit/s
4FSK	ERMES	European Radio Message System	6.25 kbit/s

Signal Generators SMT and SME with option SM-B6: additional specifications regarding VOR/ILS

VOR modulation signals [1]

Operating modes

NORM	VOR signal + COM/ID tone
COM/ID	COM/ID tone
30 Hz	30-Hz VAR tone
9960 Hz	9.96-kHz carrier, unmodulated
9960 Hz + FM	9.96-kHz carrier, modulated

Modulation tones

Frequency accuracy	same as reference frequency, basic unit
30 Hz (VAR, REF)	
Setting range/resolution	20 to 40 Hz/0.1 Hz [2]
9.96-kHz FM carrier	
Setting range/resolution	5 to 15 kHz/10 Hz
Frequency deviation, 30-Hz reference	0 to 960 Hz
Default	480 Hz
Resolution, deviation	1 Hz
Setting error, deviation	<1 Hz
COM/ID tone (auxiliary audio)	
Default	1020 Hz
Setting range	0.1 Hz to 20 kHz
Frequency resolution	0.1 Hz

Phase (VAR, REF)

Default	0.00°
Setting range	0 to 360°
Resolution	0.01°
Setting error	
Modulation signal	<0.01°
RF signal	<0.05°, typ. 0.01°

Distortion

30 Hz (VAR) tone	<0.1%
9.96-kHz FM carrier	<0.1%
COM/ID tone	<0.1%

Amplitude modulation

Modulation depth [3]	
30 Hz (VAR)	
Range/resolution	0 to 100%/0.1%
Setting error, 30% AM	<2.0% of AM setting
9.96-kHz FM carrier	
Range/resolution	0 to 100%/0.1%
Setting error, 30% AM	<2.0% of AM setting
COM/ID tone	
Range/resolution	0 to 100%/0.1%
Setting error, 10% AM	<2.0% of AM setting

ILS modulation signals [1]

Operating modes

ILS LOC/ILS GS	
NORM	localizer/glideslope signal+ COM/ID tone (can be switched off)
COM/ID	COM/ID tone
90 Hz	90-Hz tone
150 Hz	150-Hz tone

ILS modulation tones

Frequency accuracy	same as reference frequency, basic unit
90-Hz tone	
Setting range/resolution	60 to 120 Hz/0.3 Hz [4]
150-Hz tone	
Setting range/resolution	100 to 200 Hz/0.5 Hz [4]
COM/ID tone (auxiliary audio)	
Setting range/resolution	0.1 Hz to 20 kHz/0.1 Hz

Amplitude modulation [1]

Sum modulation depth of 90-Hz tone and 150-Hz tone [5]	
Range/resolution	0 to 100%/0.1%
Setting error	<2.0% [6]
Default, localizer	40%
Default, glideslope	80%

Difference of depth of modulation (DDM)

Localizer (ILS LOC)	
Setting range	0 to ±0.4 [7]
DDM resolution	0.0001
Error at DDM=0	
Modulation signal	<0.0002, typ. 0.0001
RF signal	<0.0004, typ. 0.0001
Error at DDM=0 to ±0.4	
Modulation signal	<0.005 * DDM + 0.0002
RF signal	<0.02 * DDM + 0.0004
Glideslope (ILS GS)	
Setting range	0 to ±0.8 [7]
DDM resolution	0.0001
Error at DDM=0	
Modulation signal	<0.0002, typ. 0.0001
RF signal	<0.0008, typ. 0.0002
Error at DDM=0 to ±0.4	
Modulation signal	<0.005 * DDM + 0.0002
RF signal	<0.02 * DDM + 0.0008

Phase setting

The phase can be set between the 90-Hz signal and 150-Hz signal. It is measured between adjacent zero crossings (zero phase) of the two signals. The reference is the zero crossing of the 150-Hz signal and the phase is specified in degrees referred to the 150-Hz signal.

Setting range	0 to 120°
Resolution	0.01°
Setting error	
Modulation signal	<0.02°
RF signal	<0.05°

Marker Beacon (MCR BCN)

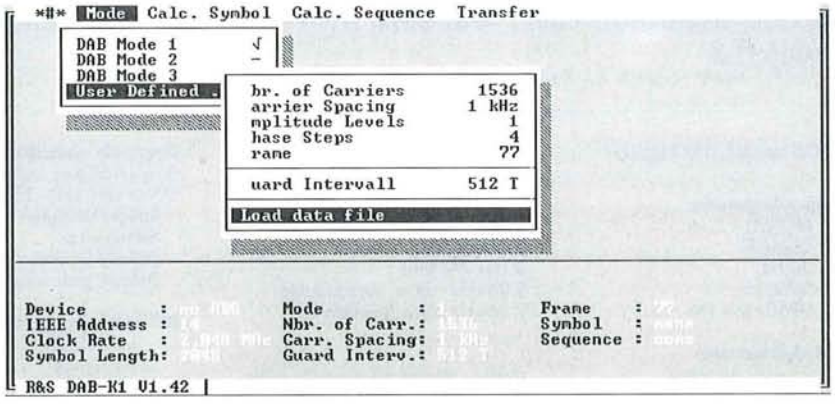
Frequencies	400 Hz, 1300 Hz, 3000 Hz
Frequency accuracy	same as reference frequency, basic unit
Modulation depth	0 to 100% [5]
Setting error (f=74 to 76 MHz)	<4.0% (AM=95%)
COM/ID tone (auxiliary audio)	
Setting range/resolution	0.1 Hz to 20 kHz/0.1 Hz
Modulation depth	0 to 100%

1) These specifications do not apply to non-interrupting level setting (ATTENUATOR MODE: FIXED).
2) The frequencies of the 30-Hz tones are always varied simultaneously.
3) The sum of the modulation depths of the 30-Hz (VAR) signal, 9.96-kHz FM carrier and COM/ID signal must not exceed 100%.
4) If the frequency of the 90-Hz tone is varied, the frequency of the 150-Hz tone is automatically changed in proportion and vice versa.
5) The sum of the modulation depths of all signal components must not exceed 100%.
6) The values apply to the carrier frequency ranges 108 to 118 MHz and 329 to 335 MHz.
7) The maximum DDM value depends on the selected sum modulation depth of the 90-Hz and 150-Hz tone. The specified range corresponds to the default setting range.

COFDM Software DAB-K1

Software for generating COFDM signals in conjunction with Arbitrary Waveform Generator ADS

(catalog 93/94, page 240)



Selection of DAB mode

Uses, characteristics

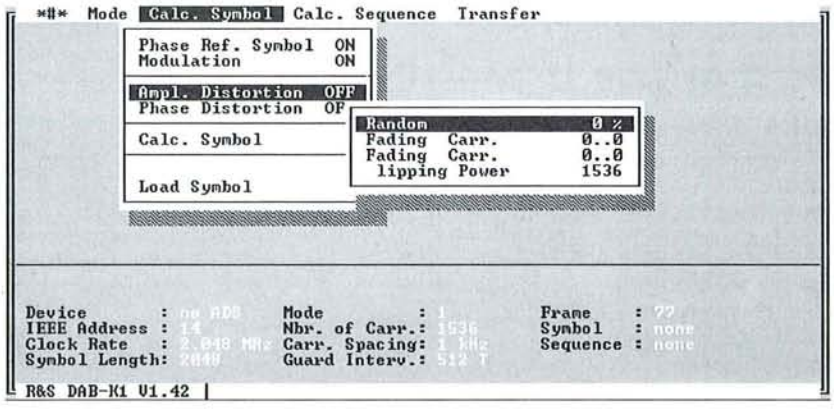
Software DAB-K1 from Rohde&Schwarz is used for the calculation and output of COFDM signals (**C**oded **O**rthogonal **F**requency **D**ivision **M**ultiplex). These signals are used for instance in the new DAB (**D**igital **A**udio **B**roadcasting) transmission methods as well as in other applications. The combination of Software DAB-K1 + Signal Generator SMHU58 + ARB Generator ADS yields a DAB or DVB test signal generator.

COFDM signals can also be generated with QAM (**Q**uadrature **A**mplitude **M**odulation), such as DVB signals (**D**igital **V**ideo **B**roadcasting). Common to all modes is the generation of multicarrier signals in the RF range.

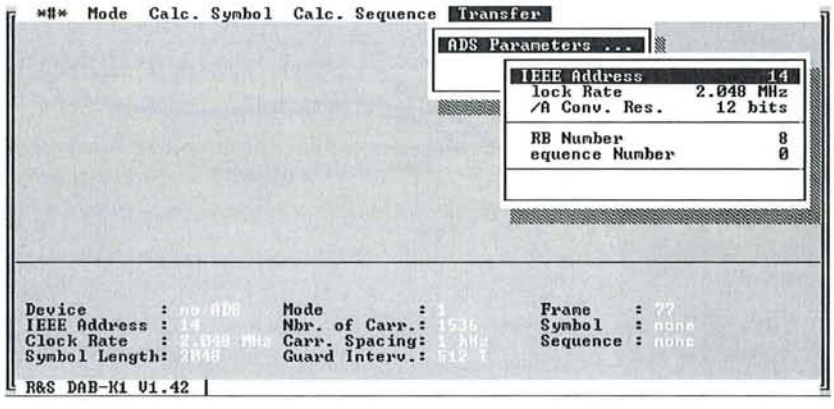
The Software DAB-K1 is an extremely user-friendly tool. Pulldown menus branch into further dialog boxes; all commands can also be directly entered via key combinations. A context-sensitive help system provides explanatory notes for each menu item.

Performance features

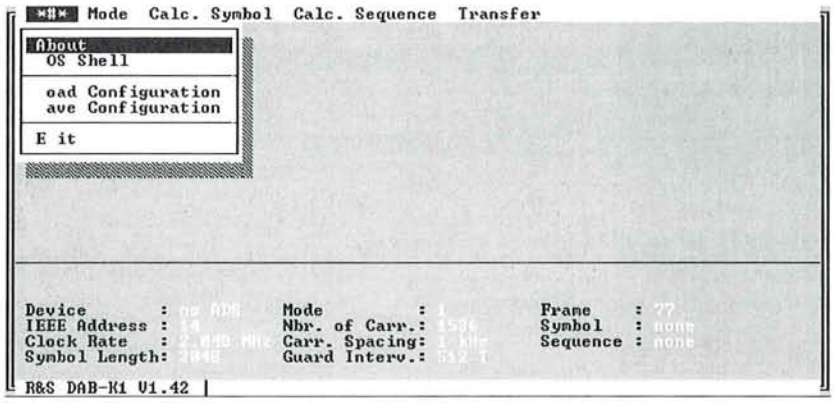
- Simulation of DAB signals with COFDM modulation
- Simulation of other COFDM signals, such as DVB with QAM
- All DAB modes 1, 2 and 3 selectable
- Generation of zero symbols (time reference symbol)
- Generation of phase reference symbol (time frequency_phase reference symbol)
- Inclusion of guard intervals of selectable length
- Repetition of individual symbols with and without guard interval
- Simulation of a DAB frame made up of 77 or 144 symbols; number of symbols also user-selectable
- Calculation of other multicarrier signals with user-selectable number of carriers (up to 8190) and selectable frequency spacing of carriers
- Calculation of signals with random modulation or with selected phase and amplitude modulation of the individual carriers
- Simulation of signal interference such as spurious amplitude and phase
- Simulation of fading
- Calculation of time signals from the amplitudes and phases of the individual carriers
- Saving and loading of calculated symbols and sequences
- Conversion of COFDM-modulated signals into the frequency range of the SMHU58 (5 MHz to 2 GHz)
- Bandwidth of modulated signals 1.5 MHz for DAB modes and up to 20 MHz for user-defined COFDM signals
- Frequency spacing of COFDM carriers according to DAB mode or user-selectable from 1 Hz to 1 MHz
- User-selectable D/A converter resolution from 1 to 12 bit
- Selectable clipping of maximum peak power



Calculation of symbols



Data transfer to ARB Generator ADS



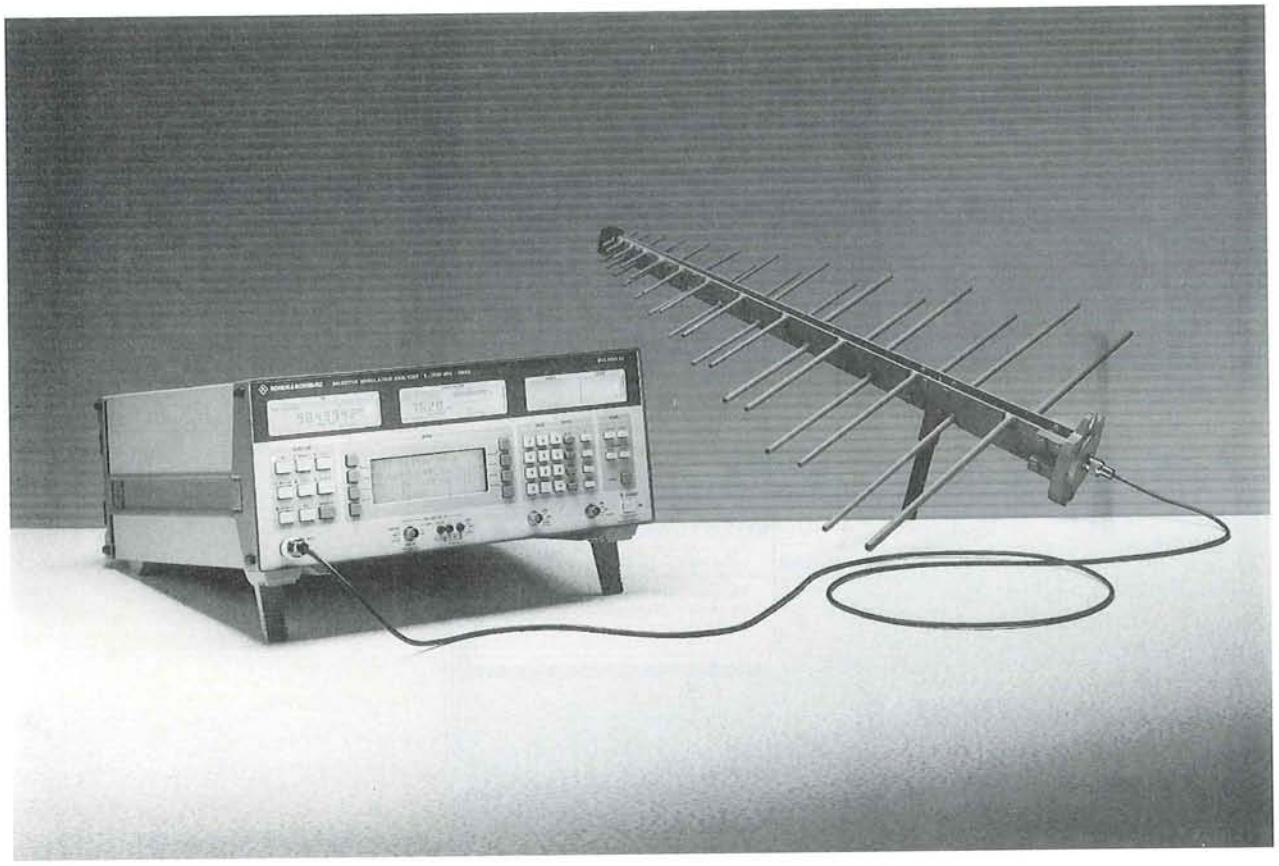
Saving and loading of configurations

Required hardware

Controller	PSA or PSM controller family or AT-compatible to industry standard
Operating systems	MS-DOS 3.3 and higher
Main memory	min. 400-Kbyte RAM
Monitor and graphic card	Hercules graphic card and monochrome monitor, or EGA/VGA with monochrome or colour monitor
IEC-bus card (IEEE 488.1)	Rohde & Schwarz IEC/IEEE-bus card (PAT-B1) or National Instruments PCIIA card
IEC/IEEE-bus driver	Rohde & Schwarz IEC/IEEE-bus driver (PS-K2), National Instruments GPIB-PC software
Mouse	Rohde & Schwarz PS-B11, serial Microsoft mouse or compatibles

Ordering information

Generator		
Signal Generator with I/Q modulator, 1 kHz to 4.32 GHz and	SMHU58	0835.8011.58
ARB Generator, two-channel, programmable	ADS	1012.4002.02
Extra		
Clock Generator	ADS-B1	1013.5748.92
COFDM Software	DAB-K1	1013.1642.02



Selective Modulation Analyzer FMAS: stereo receiver and modulation analyzer all in one unit

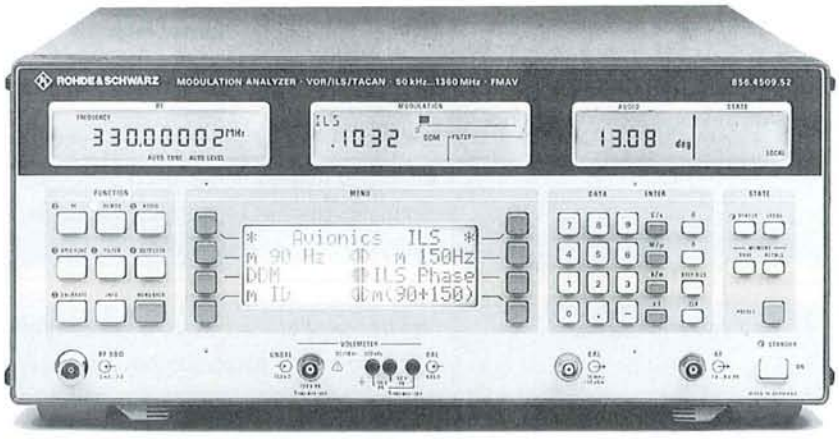
Contents of Chapter 6

Selective Modulation Analyzer FMAS; Options FMA-B9, FMA-B8

5 to 1000 (1360) MHz

FMAS: Stereo receiver and modulation analyzer in one unit

FMAB: Same functions as FMAS by fitting the options FMA-B9 and -B8



Uses

The Selective Modulation Analyzer FMAS from Rohde & Schwarz is the first instrument to combine the characteristics of a universal modulation analyzer with those of an FM stereo/TV dual-sound receiver in the frequency range 5 to 1000 MHz.

Fields of application

- Off-air measurements on VHF broadcasting and TV dual-sound transmitters such as
  - peak deviation monitoring
  - fieldstrength and frequency measurements
  - VHF coverage measurements to ARD/DBP Specification 5 R 4/1.3
- Modulation analysis of TV sound signals
- Modulation analysis
  - in cable networks and headends
  - at VHF transmitter combining networks
  - of TV sound subcarriers in the satellite baseband
- FM stereo relay reception

Main features

- Excellent static and dynamic selectivity
- Level range 10 µV to 7 V
- Outstanding transfer characteristic
- High overload capability to interfering signals
- Selective RF level measurement

Modulation analysis

The FMAS features the same capabilities as the FMAB (catalog 93/94, page 270) plus receiver function and digital AF analysis.

Receiver function (FMA-B9)

RF/IF Selection

The RF/IF Selection FMA-B9 is fitted as standard in the FMAS and can be switched on when required. In normal mode, the standard characteristics of a modulation analyzer are fully maintained in the frequency range 50 kHz to 1360 MHz.

High receive quality

In spite of the high sensitivity of 10 µV, a tunable 4-circuit preselection filter (from 87.5 to 108 MHz and >183 MHz) and a high-level input mixer guarantee high overload capability to interfering signals in the receive mode.

Phase-linear IF filters with an amplitude equalizer at the AF together with a low-noise LO yield excellent static and dynamic selectivity and, at the same time, guarantee a high S/N ratio as well as low linear and nonlinear distortion.

Elaborate temperature compensation

These compensation techniques ensure compliance with specifications over a wide temperature range in the receive mode through

- temperature-responsive tuning of the RF preselector filters by the processor,
- temperature-compensated IF filters,
- computational correction of the selective RF level indication.

The right IF filter for every application
Since a compromise has always to be made between selectivity and low distortion as well as between S/N ratio and immunity to overloading, the user may adapt the FMAS to his particular measurement problem:

Narrow IF filters
With the narrow IF filters FM narrow and TV sound, maximum selectivity can be obtained, with distortion being slightly increased. But also in this mode, the FMAS fully complies with ARD Specification 5/3.5 for stereo relay receivers. Moreover it is ideally suited for all kinds of remote measurements such as VHF peak deviation monitoring and high-precision remote frequency measurement – even under unfavourable receiving conditions.

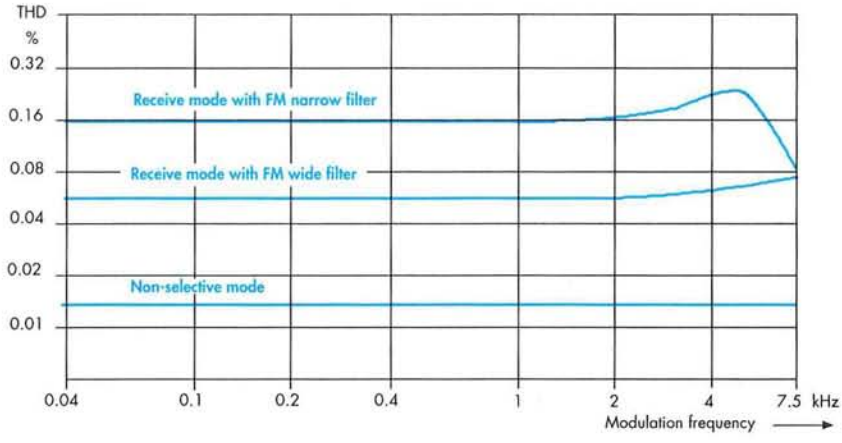
The IF filter TV sound allows modulation analysis of dual-sound carriers in TV transmitters and in cable networks, uninfluenced by vision modulation or adjacent channels. Further applications are remote deviation monitoring as well as level and frequency monitoring of TV sound carriers. The TV-sound filter also permits TV sound subcarriers in the satellite baseband to be analyzed.

Wide IF filter
With the IF filter FM wide, the FMAS complies with ARD Specification 5/3.4 for FM test demodulators. In addition to the required low distortion, high selectivity (see diagram) is obtained with this filter too. The wide IF filter may be used for example at transmitter combining networks whenever at least two adjacent channels are not occupied.

Maximum S/N ratio or minimum RF/IF intermodulation distortion
In the low-noise mode, the preamplifier is permanently on and the mixer level is increased so that the maximum S/N ratio is obtained.

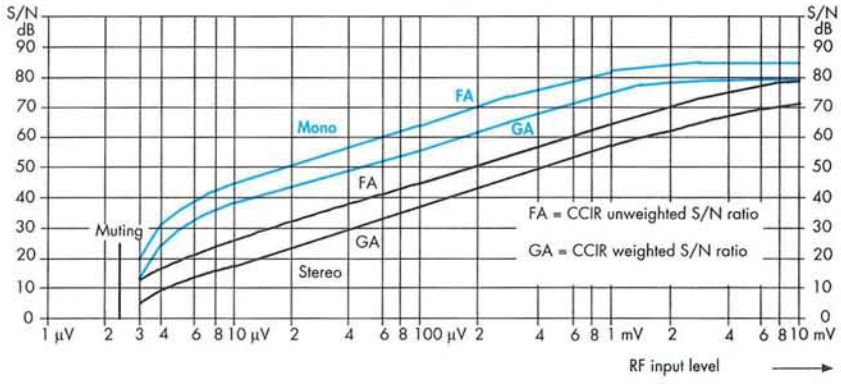
In the low-distortion mode, the mixer level is kept low and the preamplifier is switched off. This mode should be used for measurements on antennas where strong, closely spaced interfering signals cause intermodulation in the receive channel.

Modulation Analyzer FMAV with optional RF/IF Selection FMA-B9.57
A special version of the option FMA-B9 with a frequency range up to 400 MHz turns the FMAV into a highly sensitive and selective receiver for VOR and ILS navigation signals (see page xx).



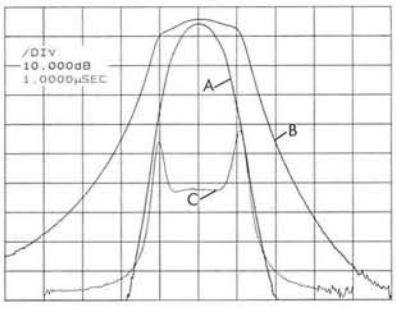
Stereo THD of FMAS at 75 kHz deviation. Due to phase linearity, distortion remains low even with the narrow IF filter.

Considerably lower distortion is obtained with the FM wide filter which is particularly suitable for modulation analysis in cable networks and transmitter combining networks.



S/N ratio of input voltage (referred to 40 kHz deviation). The high sensitivity and selectivity make the FMAS particularly suitable for measurements directly at the antenna.

Selective Modulation Analyzer FMAS; Options FMA-B9, FMA-B8



Characteristic of various IF filters FM narrow (A) and FM wide (B) in the FMAS (frequency axis 200 kHz/div). Very flat group-delay response in the range ±100 kHz about the center frequency (FM wide, C)

Digital AF Analysis (FMA-B8)

The AF Analyzer/DSP Unit FMA-B8 is also fitted as standard in the FMAS and can be retrofitted in all other FM.. models. It makes a previously needed, separate AF (FFT) analyzer superfluous even for complex modulation analysis in the AF range 10 Hz to 150 kHz:

- Selective modulation-depth and AF-level measurements
- Selective harmonic distortion measurement of d_2, d_3, d_n
- True THD measurement, largely unaffected by spurious and noise signals
- Universal measurement of intermodulation products to relevant standards; eg measurement of difference-frequency distortion to German ARD specifications

Complete transmitter test system

With the optional AM/FM Calibrator/AF Generator FMA-B4 (catalog 93/94, page 272), the FM.. is even a complete modulation test system for transmitters and transposers.

- AF Generator FMA-B4 provides precise stimuli signals (single-tone, two-tone, stereo multiplex signals)
- Digital AF Analyzer FMA-B8 features universal analysis capabilities

Highest measurement accuracy

The operating principle is based on digital signal processing. A precision 16-bit A/D converter samples the AF signal. A high-speed signal processor determines the spectrum of the AF signal by means of fast Fourier transform.

Scaled display of AF spectrum

The AF spectrum can be displayed with scaling on a simple, preferably analog oscilloscope in X-Y mode, which can be directly connected to the rear outputs DSP1 and DSP2 of the modulation analyzer to provide the user with overall information at a glance.

Standard functions and options for the individual models

• Standard FMA-B.. Option

Funktionen	FMA	FMAB	FMAS	FMAV	FMB
AM/FM/φM	•	•	•	•	•
Weighting filters to CCITT and CCIR, quasi-peak detector, special filter	FMA-B1	•	•	FMA-B1	FMA-B1
SINAD/distortion meter 10 Hz to 100 kHz	FMA-B2	•	FMA-B2	FMA-B2	FMA-B2
Stereodecoder	FMA-B3	•	•	–	FMA-B3
Calibrator with AF and MPX generator	FMA-B4	FMA-B4	FMA-B4	–	FMA-B4
Calibrator with AF and VOR/ILS generator	–	–	–	FMA-B4	–
VOR/ILS measurements	–	–	–	•	–
ILS distortion meter	–	–	–	•	–
Selective AF analysis up to 45 kHz	–	–	–	•	–
Selective AF analysis up to 150 kHz	FMA-B8	FMA-B8	•	–	FMA-B8
RF/IF selection 5 to 1000 (400) MHz	FMA-B9	FMA-B9	•	(FMA-B9.57)	–
Reference oscillator 1 x 10^{-7}/year	FMA-B10	FMA-B10	FMA-B10	•	FMA-B10
Frequency range up to 5 GHz	FMA-B12	FMA-B12	–	–	•

Specifications

The specifications below apply to the FMAS in receive mode; for the non-selective mode refer to FMAB (catalog 93/94, page 273). Instead of Distortion Meter FMA-B2, the AF Analyzer/DSP Unit FMA-B8 (data sheet 757.0635) is fitted in the FMAS.

RF/IF Selection (FMA-B9)

Frequency

Frequency range	5 to 1000 MHz	
1st IF	158.5 MHz at f_{in} = 87.5 to 108 MHz and 183 to 273 MHz; 208.5 MHz in rest of range	
Image frequencies	f_{in} +317 MHz at 158.5 MHz IF f_{in} +417 MHz at 208.5 MHz IF f_{in} +17 MHz, f_{in} –3 MHz	
IF bandwidths (–3 dB)	FM wide	FM narrow/ TV sound
	350 kHz	150 kHz
Shape factor (–3/–60 dB)	3.4	3.7

RF level

RF input level range	–87 to +30 dBm (10 µV to 7 V)
Overload protection	up to 5 W (15 V_{rms}), max. peak voltage 25 V
VSWR	≤2.7 (without attenuation) ≤1.4 (with ≥10 dB attenuation)
Selective level measurement	(peak measurement)
Measurement error [1]	
5 to 500 MHz	≤±2 dB ±3 µV
500 to 1000 MHz	≤±3 dB ±3 µV
LO feedthrough at f_{in} + IF	
87.5 to 108 MHz	≤20 µV
in rest of range	≤60 µV

FM stereo

Selectivity

Ratio of wanted to unwanted signal for a weighted S/N ratio of ≥54 dB referred to a wanted signal of Δf = 40 kHz, f_{mod} = 500 Hz. Stereo measurements with a 50 µs deemphasis in the stereo decoder. Specifications apply to input levels ≥200 µV (–61 dBm) for mono and ≥2 mV (–41 dBm) for stereo.

Common-mode rejection	Stereo	Mono
Frequency difference 0 to 10 kHz, unwanted signal unmodulated	≤49 dB	≤49 dB
Unwanted signal modulated, f_{mod} = 500 Hz, dev. = ±40 kHz	≤63 dB	≤44 dB

Nearby selectivity, unwanted signal modulated, f_{mod} = 500 Hz, Δf = 75 kHz

	Stereo		Mono	
Frequency difference	FM wide	FM narrow	FM wide	FM narrow
±100 kHz	≤64 dB	≤61 dB	≤7 dB	≤4 dB
±200 kHz	≤25 dB	≤11 dB	≤7 dB	≤0 dB
±300 kHz	≤5 dB	≤–15 dB	≤4 dB	≤–16 dB
±600 kHz	–	–	≤–26 dB	≤–46 dB

Far-off selectivity, unwanted signal modulated, f_{mod} = 500 Hz, Δf = 75 kHz, frequency difference ≥1.2 MHz (except for image frequency and 1st IF)

87.5 to 108 MHz	–	–	≤–54 dB	≤–54 dB
rest of range	–	–	≤–40 dB	≤–40 dB

Image-frequency rejection, unwanted signal modulated, f_{mod} = 500 Hz, FM: Δf = 75 kHz, AM: m = 90% at image frequency ±6 kHz

87.5 to 108 MHz	≤– 10 dB	≤– 30 dB
rest of range	≤+10 dB	≤–10 dB

IF rejection, unwanted signal unmodulated, f_{mod} = 500 Hz, FM: Δf = 75 kHz, AM: m = 90% at IF ±6 kHz

	Stereo	Mono
87.5 to 108 MHz	≤–20 dB	≤–40 dB
5 to <87.5/>108 to 350 MHz	≤+15 dB	≤–5 dB
rest of range	≤–10 dB	≤–30 dB

Linear distortion

Amplitude frequency response, measured at MPX signal output, Δf = 40 kHz, reference frequency = 500 Hz

	FM wide	FM narrow
40 Hz to 43 kHz	≤±0.1 dB	≤±0.1 dB
43 to 53 kHz	≤±0.1 dB	≤±0.3 dB
53 to 61 kHz	≤±0.2 dB	≤±1 dB
61 to 70 kHz	≤±0.5 dB	≤±3 dB
70 to 75 kHz	≤±1.5 dB	≤±5 dB

Stereo crosstalk between L and R channel, measured via stereodecoder, without deemphasis

40 Hz to 5 kHz	≥–50 dB	≥–37 dB
5 to 15 kHz	≥–44 dB	≥–31 dB

Nonlinear distortion

THD measured at MPX signal output (mono)

	Δf=75 kHz		Δf=100 kHz	
FM	wide	narrow	wide	narrow
40 Hz to 5 kHz	–	≤0.5%	–	≤1%
40 Hz to 15 kHz	≤0.25%	–	≤0.5%	–

Measured via stereodecoder

	Stereo		Mono	
FM	wide	narrow	wide	narrow
40 Hz to 5 kHz				
Δf=75 kHz	≤0.3%	≤0.8%	≤0.25%	≤0.5%
Δf=100 kHz	≤0.6%	≤1.6%	≤0.5%	≤1%

Difference-frequency distortion to IEC 268-3, measured at MPX signal output (mono), difference frequency 1 kHz

Δf=75 kHz		FM wide	FM narrow
5 to 15 kHz	d_2	≤0.1%	≤0.25%
	d_3	≤0.15%	≤0.37%
15 to 53 kHz	d_2	≤0.2%	≤0.5%
	d_3	≤0.3%	≤0.75%
Δf=100 kHz			
5 to 15 kHz	d_2	≤0.2%	≤0.5%
	d_3	≤0.3%	≤0.75%
15 to 53 kHz	d_2	≤0.4%	≤1%
	d_3	≤0.6%	≤1.5%

S/N ratio

to CCIR 468-4, deemphasis 50 µs, referred to Δf = 40 kHz
Unweighted S/N ratio, low-noise mode[2]

	Stereo			Mono		
f_{in} (MHz)	5 to 130	130 to 470	470 to 1000	5 to 130	130 to 470	470 to 1000
Input level						
≥200 µV	–	–	–	≥63 dB	≥63 dB	≥63 dB
≥2 mV	≥63 dB	≥63 dB	≥61 dB	≥80 dB	≥80 dB	≥78 dB
≥20 mV	≥75 dB	≥68 dB	≥65 dB	≥80 dB	≥80 dB	≥78 dB

Weighted S/N ratio, low-noise mode[2]

	Stereo			Mono		
f_{in} (MHz)	5 to 130	130 to 470	470 to 1000	5 to 130	130 to 470	470 to 1000
Input level						
≥200 µV	–	–	–	≥58 dB	≥58 dB	≥58 dB
≥2 mV	≥58 dB	≥58 dB	≥56 dB	≥76 dB	≥76 dB	≥74 dB
≥20 mV	≥70 dB	≥63 dB	≥60 dB	≥76 dB	≥76 dB	≥74 dB

TV dual sound

Input signal	TV dual-sound signal, standard B/G, at IF or in bands I, II and IV, V with and without modulated vision carrier
Deviation measurement error 30 Hz to 15 kHz, Δf ≤70 kHz	≤±1% + residual FM

Selective Modulation Analyzer FMAS; Options FMA-B9, FMA-B8

Difference error
with successive deviation meas., sound channel 1/sound channel 2, 30 Hz to 15 kHz ≤±0.3% + residual FM

Nonlinear distortion (THD)	Δf=50 kHz	Δf=70 kHz
f_{mod}=30 Hz to 5 kHz	≤0.3%	0.5%
f_{mod}=5 to 15 kHz	≤0.5%	1%
Difference-frequency distortion (30 Hz to 15 kHz)		
d_2	≤0.2%	≤0.3%
d_3	≤0.3%	≤0.5%

S/N ratio
Quasi-peak measurement to CCIR 468-4, weighted and unweighted. Deemphasis 50 µs, referred to Δf = 30 kHz.

Input level (selective)	unweighted	weighted
≥200 µV	≥53 dB	≥53 dB
2 mV	≥73 dB	≥73 dB

Channel crosstalk
referred to Δf = 30 kHz, selective measurement, deemphasis 50 µs, other sound subcarrier modulated with frequencies from 30 Hz to 15 kHz, Δf = 55 kHz
Level (selective) ≥5 mV ≥80 dB

AF Analyzer/DSP Unit (FMA-B8), selective distortion measurement

Readout in % or dB
Display range 0.001 to 20%, −100 to −14 dB

Measurement of individual distortion d_i (i = 2, 3, ... 10)

Measurement error	10 Hz ≤ f_1 ≤14 kHz f_{di} ≤42 kHz	f_1 ≤50 kHz f_{di} ≤150 kHz
	≤5% of rdg ±0.02% absolute	≤5% of rdg ±0.05% absolute

THD measurement
Measurement of harmonic i = n (n = 2 to 10 selectable)

Measurement error	10 Hz ≤ f_1 ≤14 kHz f_{dn} ≤42 kHz	f_1 ≤50 kHz f_{dn} ≤150kHz
	≤5% of rdg ±0.03% absolute	≤5% of rdg ±0.1% absolute

Intermodulation measurement

Intermodulation distortion d_2, d_3 to IEC268-3
Readout in % or dB
Display range 0.001 to 20%, −100 to −14 dB

Measurement error	$f_2 + 2 \times f_1$ ≤42 kHz, f_1 ≥10 Hz	42 kHz < $f_2 + 2 \times f_1$ ≤150 kHz, f_1 ≥30 Hz
	≤5% of rdg ±0.1% absolute	≤5% of rdg ±0.2% absolute

Difference-frequency distortion d_2, d_3 to IEC268-3
Readout in % or dB
Display range 0.001 to 20 %, −100 to −14 dB

Measurement error (f_2–f_1 ≥30 Hz)

$2 \times f_2 - f_1$ ≤42 kHz	42 kHz < $2 \times f_2 - f_1$ ≤150 kHz
≤5% of rdg ±0.02% absolute	≤5% of rdg ±0.05% absolute

Selective modulation and voltage measurement
in voltmeter, AM, FM and φM mode, using special bandpass filter

Bandwidth (BW_{-3dB}) at center frequency f_c

f_c	10 Hz to ≤1 kHz	1 kHz to ≤20 kHz	20 kHz to ≤150 kHz
BW_{-3dB}	2.3 Hz	6.8 Hz	68 Hz

Shape factor 3 dB/80 dB <4
Ultimate selectivity 80 dB
Display range corresponding to display range of selected operating mode

Measurement error[3]
with deviation of measurement frequency from center frequency <BW_{-3dB}/4

at center frequency f_c	10 Hz to 100 kHz	100 kHz to150 kHz
	≤2%	≤5%

Rear-panel outputs

Deflection for external oscilloscope
DSP1 Y deflection, 0 to 4 V, BNC female
DSP2 X deflection, 0 to 4 V, BNC female

Scale markers
Vertical 13 markers, 10 dB/div
Horizontal 10 markers, scaling can be called up via the information menu

With selective modulation and voltage measurement:

f_c	10 Hz to ≤1 kHz	1 to ≤20 kHz	20 to ≤150 kHz
	49 Hz/div	148 Hz/div	1.5 kHz/div

Ordering information

Selective Modulation Analyzer	FMAS	0856.6001.52
Option for use in FMA or FMAB		
RF/IF Selection 5 to 1000 MHz	FMA-B9	0856.6501.52
Option for use in FMA, FMB or FMAB		
AF Analyzer/DSP Unit	FMA-B8	0855.9007.55
Model for retrofitting in instruments already supplied	FMA-B8	0855.9007.54
Further options	catalog 93/94, page 275	

1) In the range 15 to 35°C; over the full temperature range, the error doubles.
2) In the low-distortion mode, the S/N value may be lower by up to typ. 3 dB.
3) Error of selective measurement in addition to error specified for selected voltmeter, AM, FM or φM mode.

RF/IF Selection FMA-B9.57

5 to 400 MHz

Special option for Modulation Analyzer FMAV: high-precision off-air measurement of VOR/ILS signals directly at the antenna

The RF/IF Selection FMA-B9, model 57, is a highly sensitive and selective receive section that has been developed by Rohde & Schwarz as an option especially for the VOR/ILS Modulation Analyzer FMAV.

With this option, the FMAV becomes a calibrated receiver for VOR and ILS signals. In addition to the modulation measurements (selective modulation depth, VOR phase, ILS, DDM and SDM measurements), it allows off-air frequency measurements and high-precision fieldstrength measurements.

There is no need for additional calibration or a separate receiver that would otherwise be required.

One of the main applications is in flight inspection systems. With the optional AM/FM Calibrator/AF Generator FMA-B4 (catalog 93/94, page 272) being used, the effect of temperature and aging on the specs is also eliminated in the receive mode. The high precision of the FMAV is thus fully maintained in off-air measurements as well.

Specifications

Additional data of FMAV in receive mode with option FMA-B9.57 (basic data see catalog 93/94, page 273).

Frequency

Input frequency range	5 to 400 MHz
1st IF	158.7256 MHz at f_{in} = 107.5 to 118.5 MHz and 183 to 273 MHz; 208.7256 MHz in rest of range

RF level

Input level range	–87 to +30 dBm (10 µV to 7 V)
Overload protection	up to 5 W (15 V_{rms}), max. peak voltage 25 V
VSWR	≤2.7 (without attenuation) ≤1.4 (with ≥10 dB attenuation)

Selective level measurement (peak measurement)

Measurement error[1]	≤±2 dB ±3 µV
LO feedthrough at f_{in} + IF	
in range 107.5 to 118.5 MHz	≤20 µV
in rest of range	≤60 µV

Selectivity

IF bandwidth (–3 dB)	17 kHz
Static selectivity	≤–60 dB in ±50 kHz
Far-off selectivity	≤–60 dB[4]
Intermodulation distortion (d3)	≤–60 dB[4]

VOR/ILS-specific data

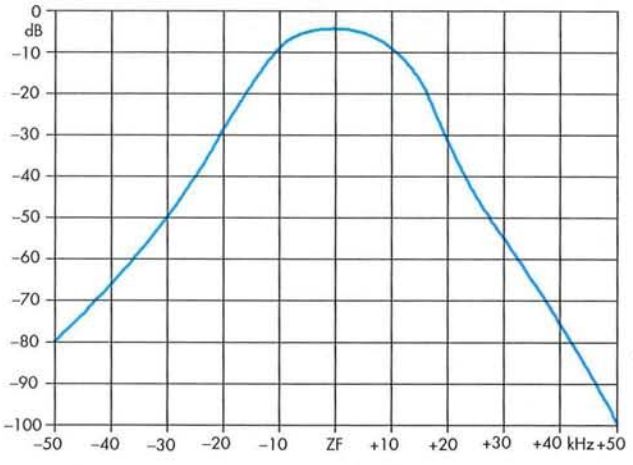
Unless stated otherwise, the specifications of the FMAV are valid. Data differing from the FMAV specs can be calibrated to FMAV accuracy using option FMA-B4.

VOR

Error of amplitude modulation measurement (% of reading)		
f_{mod}	30 Hz ±1%	≤0.8%[2]
	1.02 kHz ±2%	≤2%[2]
	9.96 kHz with Δf = 480 Hz, f_{mod} = 30 Hz (all tolerances ±1%)	≤2%[3]
Error[1] of phase difference measurement at 30 Hz		≤0.05°

ILS

Amplitude modulation measurement		
Measurement error[2] (% of reading)		
at f_{mod}	90 Hz ±2%	≤0.5%
	150 Hz ±2%	≤0.5%
	1.02 kHz ±2%	≤2%



Static selectivity curve: The steep-edged crystal filter makes for excellent adjacent-channel selectivity. Due to the flat group-delay response within the passband (rounded amplitude characteristic), the VOR phase accuracy is only minimally affected

Ordering information

RF/IF Selection for FMAV	FMA-B9	0856.6501.57
Extras		
AM/FM Calibrator/AF Generator	FMA-B4	0855.6008.52
Log-periodic Antennas	HL023A1/	0577.8017.02
	HL023A2	0624.2815.02
High-power Attenuator 20 dB/50 W	RDL 50	1035.1700.52

Further options and extras see catalog 93/94, page 275.

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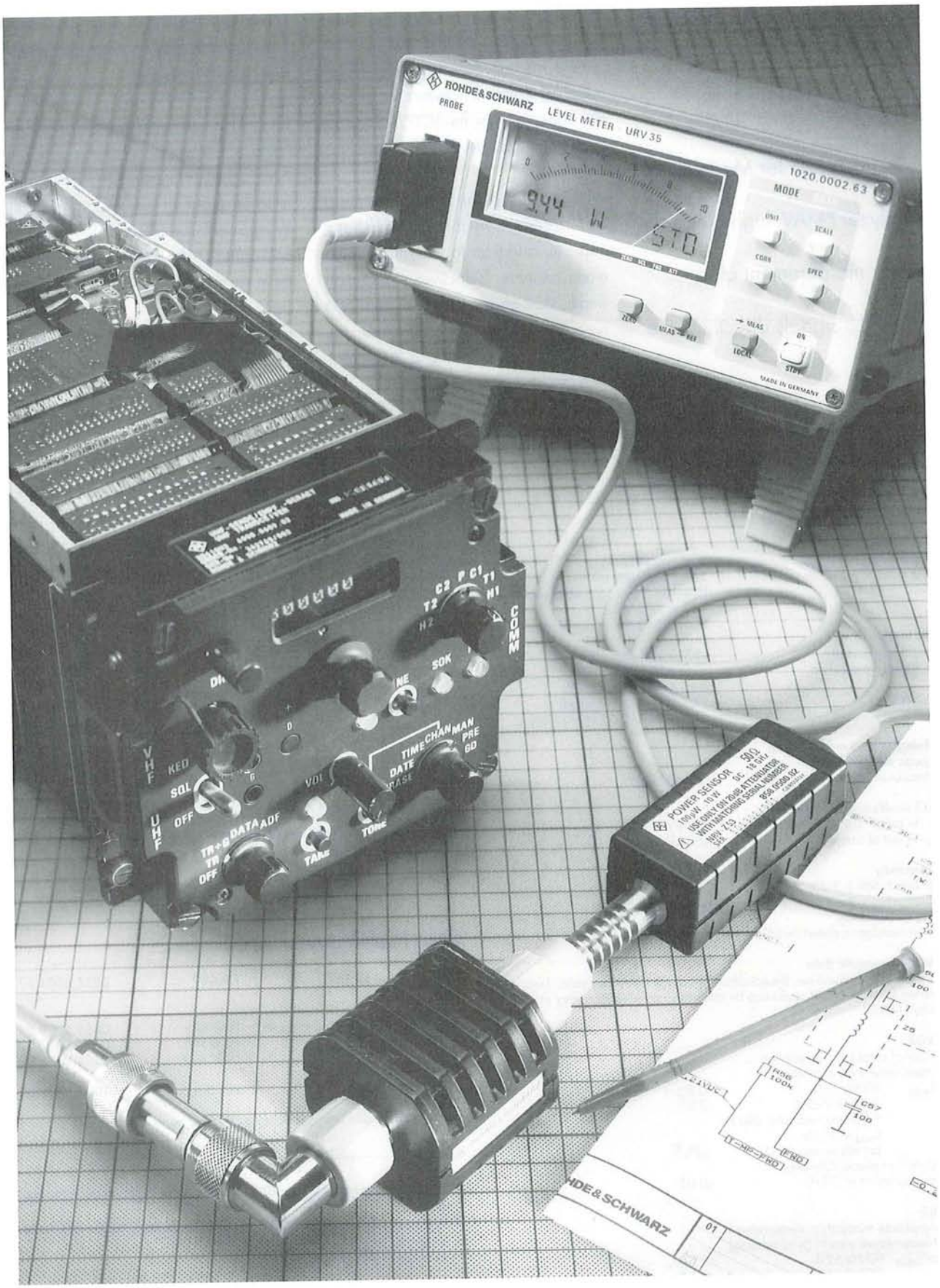
1) In temperature range 20 to 30°C; over full temperature range: error doubles.
2) In temperature range 20 to 30°C; over full temperature range: additional error ±0.3%.
3) In temperature range 20 to 30°C.
4) Guaranteed data for frequencies from 108 to 120 MHz and 328 to 336 MHz, typical values for all other frequencies.



Measuring the output power of a UHF transceiver with NRV-Z53 and URV35

Contents of Chapter 7

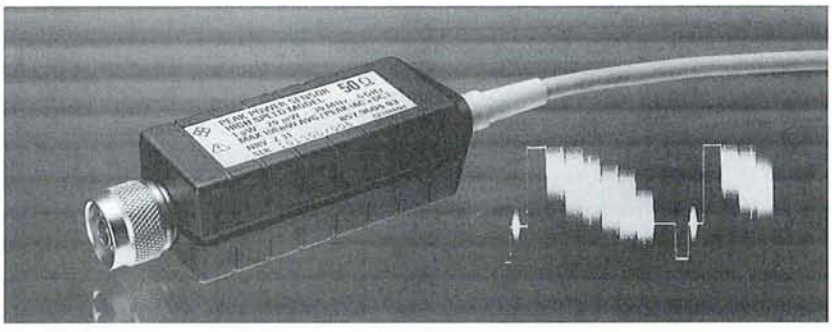
Peak Power Sensor NRV-Z31

30 MHz to 6 GHz

1 µW to 20 mW

50 Ω

User-friendly – budget-priced – versatile



Uses, characteristics

Peak Power Sensor NRV-Z31 measures fast and accurately the peak envelope power (PEP) available into 50 Ω of periodically pulsed or amplitude-modulated signal sources, thus complementing the range of probes and sensors available for NRVD, NRVS, URV35 and URV55 power meters.

The wide frequency range covers all conventional applications as well as measurement tasks to be handled in future communications networks up to 6 GHz. The lower frequency limit of 30 MHz (10 MHz at room temperature) allows measurements at the IF.

Typical applications

- Measurement of transmit power of TDMA radio equipment (GSM, DCS 1800, DECT)
- Sync pulse power measurement of TV signals
- Peak power measurement of EMC test signals
- Peak power measurement of line-frequency modulated signals (microwave ovens, diathermic apparatus)

NRV-Z31 comes in three models

- Model 02 is universally applicable and can handle short RF bursts with a pulse width as small as 2 µs (TV) as well as pulse sequences with a low repetition rate (eg line-frequency modulated signals) from 10 Hz upwards.
- Model 03 can be used for pulse repetition rates from 100 Hz and, again, for pulses as narrow as 2 µs. Providing up to seven settled readouts per second, model 03 is suited for system applications. Like model 02, model 03 is ideal for measuring the sync pulse power of negatively modulated TV signals prescribed by the relevant standards for terrestrial television (NTSC, CCIR, British, and OIRT). The measurements can be made with or without sound carriers. The effect of any sound carrier can be eliminated using tabulated correction factors. The picture contents have no effect on the results of measurement.
- Model 04 is tailored to the requirements of TDMA radio technology (GSM, DCS 1800, DECT). It effectively suppresses envelope overshoots permitted by relevant standards. Model 04 supplies approx. seven readouts per second.

Models 02 and 03 enable peak power measurements on amplitude-modulated signal sources at modulation frequencies up to approx. 100 kHz. The sensors can thus also be used for monitoring modulated EMC test signals as prescribed, for example, by standards IEC801-3 or EN50082-1 (draft).

When Dual-channel Power Meter NRVD is used, NRV-Z31 can be combined with any probe or sensor of the NRV-Z or URV5-Z line. Together with a Thermocouple Sensor NRV-Z51 to -Z54, the modulation of output power stages can be monitored, for example. Correct level matching can be effected by attenuators or directional couplers connected ahead of the sensor.

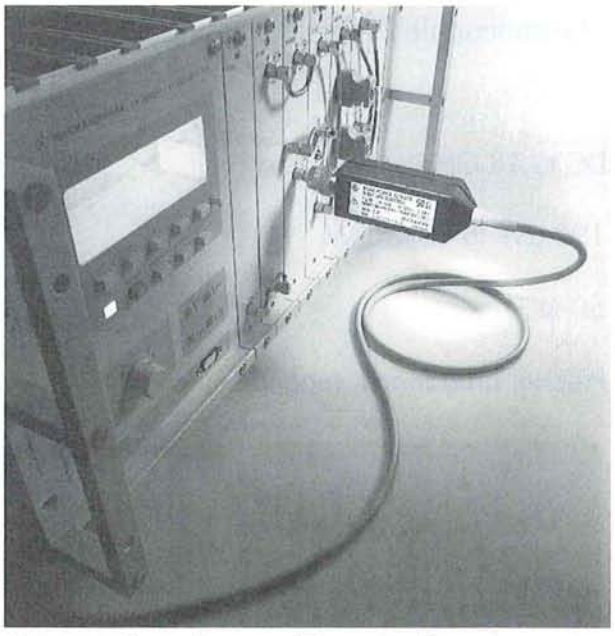
Unmodulated signals can be measured from approx. 100 nW with any NRV-Z31 model. The sensors are individually calibrated, affording the well-known advantages of the NRV line of power sensors.

Specifications

Power measurement range	1 µW to 20 mW
Power handling capacity	100 mW (avg, pk)
Frequency range	30 MHz to 6 GHz[1]
RF connector	N male, 50 Ω
SWR (reflection coefficient)	
30 to 100 MHz	1.05 (0.024)
0.1 to 2 GHz	1.1 (0.048)
2 to 4 GHz	1.2 (0.09)
4 to 6 GHz	1.35 (0.15)
Zero error[2]	30 nW
Display noise 2σ[3]	3 nW
Calibration uncertainties (RSS in %)[4]	
30 to 100 MHz	1.5
0.1 to 2 GHz	1.8
2 to 4 GHz	2.7 (3.4 for 10 to 20 mW)
4 to 6 GHz	3.1 (3.8 for 10 to 20 mW)
Temperature effect in %, referred to indicated power, typical values in parentheses	
22 to 24°C	0[5]
18 to 28°C	1 (0.3)
10 to 40°C	3 (1)
0 to 50°C	7 (2)

	Model 02	Model 03	Model 04
Minimum pulse width	2 µs	2 µs	200 µs
Minimum pulse repetition rate	10 Hz	100 Hz	100 Hz
Minimum pulse duty factor for specified meas. time[6]	5×10^{-4} 2×10^{-3}	10^{-3} 10^{-2}	2×10^{-2} 2×10^{-2}

Max. pulse weighting error (not applicable to CW) in power range 10 µW to 20 mW, pulse width ≥4.5 ms (models 02/03) and ≥200 µs (model 04), pulse repetition rate ≥100 Hz (models 03/04) and ≥50 MHz (model 02), duty factor ≥0.07, 18 to 28°C	1.5 to 2.5%, for detailed information see data sheet PD 757.0841.21



Measurement of sync pulse power of TV transmitter IF stage

General data

Dimensions	120 mm x 37 mm x 31 mm
Weight	0.35 kg
Length of connecting cable	1.3 m (other lengths on request)

Ordering information

Peak Power Sensor		
Standard model	NRV-Z31	0857.9604.02
High-speed model	NRV-Z31	0857.9604.03
TDMA model	NRV-Z31	0857.9604.04

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[1] Lower frequency limit 10 MHz at room temperature (with greater tolerances).
[2] Within 1 h after zeroing, permissible temperature variation 1°C, after 2 h warmup of basic unit and sensor.
[3] Noise specifications (2 standard deviations) refer to filter 11 of NRVS, NRVD and URV55. Noise values for other filters are obtained by multiplication with factors given in the table below.

Filter No.	0	1	2	3	4	5	6	7	8	9	10	11	12
Noise multiplier	51	32	23	16	11.3	8	5.6	4	2.8	2	1.4	1	0.7
Measurement time/s													
Model 02	1.04	1.04	1.05	1.07	1.13	1.24	1.44	1.84	2.7	4.3	7.5	14	27
Models 03/04	0.135	0.14	0.15	0.17	0.23	0.34	0.54	0.94	1.77	3.4	6.6	13	26

In automatic mode, the filters are selected as a function of the measurement range and resolution as shown in the table below:

Measurement range		1 µW	10 µW	100 µW	1 mW	20 mW
		Filter No.				
Resolution	HIGH	9	7	7	7	7
	MEDIUM	7	3	3	3	3
	LOW	3	0	0	0	0

[4] Calibration uncertainty refers to indicated power in W. Sensor nonlinearity is included.
[5] Included in calibration uncertainty.
[6] Models 02/03: if the pulse duty factor is lower than specified, longer settling times are to be expected. In remote-controlled operation, a corresponding delay should be introduced before triggering.

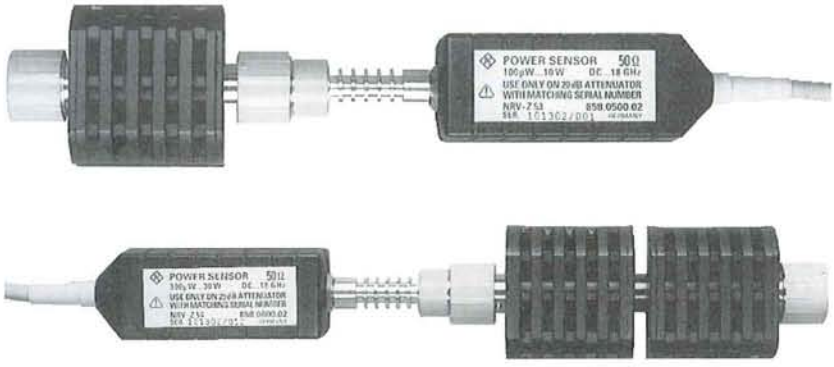
Thermocouple Power Sensors NRV-Z53, NRV-Z54

DC to 18 GHz

100 µW to 10/30 W

50 Ω

Precise, broadband, rugged



Uses, characteristics

For measurements on high-power sources, two new thermocouple sensors are available: NRV-Z53/-Z54 for nominal powers of 10 W and 30 W, respectively.

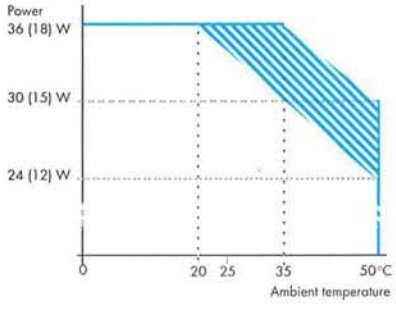
For use in test shops, service, development labs and EMC test rooms

- High-precision power and linearity measurements on amplifiers, transmitter output stages, radio equipment, directional couplers and high-power attenuators
- Calibration of directional power meters and EMC test equipment
- Use as a dummy antenna for compact radio equipment
- Peak power measurements on pulse-modulated RF (with known duty cycle)

The two power sensors stand out for their high precision and measurement speed over a wide power and frequency range. The thermal cell guarantees high measurement reproducibility also in the case of distorted or modulated signals. With DC coupling it is possible to make measurements below 100 kHz, which is important for EMC applications.

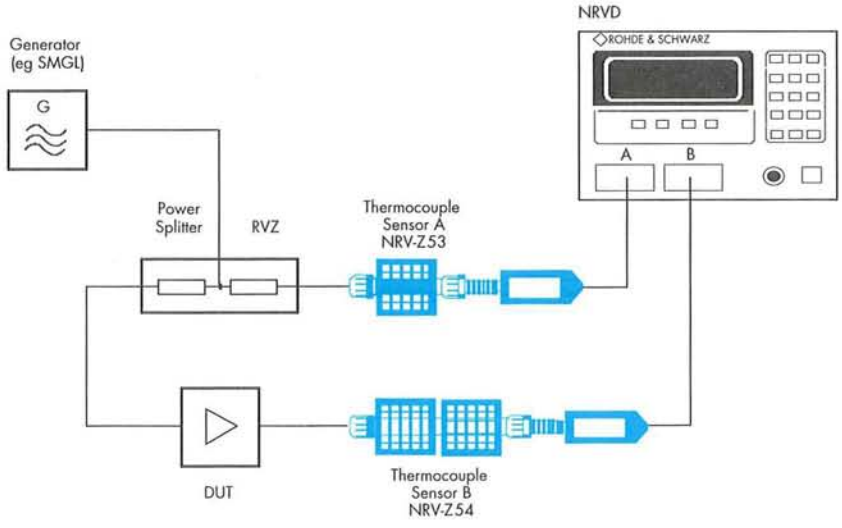
Both sensors are equipped with rugged attenuators designed for long-term stability. All metal parts are protected against direct contact and the sensors are thermally insulated.

NRV-Z53 and NRV-Z54 are individually calibrated and offer the well-known advantages of the NRV family of power sensors (catalog 93/94, page 297).



Load diagram for NRV-Z54 and NRV-Z53 (in parentheses)

Hatched area:
Maximum permissible surface temperatures to IEC 1010-1 are exceeded; provide protection against inadvertent contacting or load sensor only briefly.



Gain measurement on 15-W/20-dB amplifier with NRV-Z53 and NRV-Z54

Specifications

	NRV-Z53	NRV-Z54
Power measurement range	100 µW to 10 W	300 µW to 30 W[1]
Power handling capacity,		
static	see diagram	see diagram
dynamic	1 kW (pk, 1 µs)	1 kW (pk, 3 µs)
Frequency range	DC to 18 GHz	DC to 18 GHz
Impedance	50 Ω	50 Ω
Max. SWR (reflection coefficient)		
DC to 2 GHz	1.11 (0.052)	1.11 (0.052)
2 to 8 GHz	1.22 (0.099)	1.22 (0.099)
8 to 12.4 GHz	1.27 (0.119)	1.27 (0.119)
12.4 to 18 GHz	1.37 (0.157)	1.37 (0.157)
Linearity[2]	±(0.3% + 0.25%/W)	±(0.3% + 0.15%/W)
Zero error[3]	±6 µW	±20 µW
Display noise 2σ[4]	2.2 µW	7 µW
RF connector	N	N
Calibration uncertainties (RSS in %, referred to indicated power)		
0.05 to 2 GHz	1.7	1.7
2 to 8 GHz	2.2	2.2
8 to 12.4 GHz	3.2	3.2
12.4 to 18 GHz	3.8	3.8
Temperature effect (in %, referred to indicated power, typical values in parentheses)		
22 to 24°C	0[5]	0[5]
18 to 28°C	0.8 (0.2)	0.8 (0.2)
10 to 40°C	2.5 (0.7)	2.5 (0.7)
0 to 50°C	4 (1)	4 (1)
Operating temperature range (class 1 to IEC 359, without condensation)	0 to +50°C	0 to +50°C
Storage temperature range	–40 to +70°C	–40 to +70°C
Dimensions	240 mm x 54 mm x 60 mm	298 mm x 54 mm x 60 mm
Length of connecting cable (other lengths on request)	1.3 m	1.3 m
Weight	0.53 kg	0.68 kg

Ordering information

Thermocouple Sensor	NRV-Z53	0858.0500.02
	NRV-Z54	0858.0800.02

[1]) In the temperature range 35 to 50°C, only short-term or reduced loads (see diagram) are permissible if there is no protection against inadvertent contacting.

[2]) Power-dependent linearity error caused by self-heating of attenuator under continuous load. Typical values of ±0.5% for NRV-Z53 and ±1% for NRV-Z54 are not exceeded over the entire power range.

[3]) Within 1 h after zeroing, permissible temperature variation 1°C, after 2 h warmup of basic unit and sensor. Zero error may briefly exceed specified values (by up to 0.5 mW for NRV-Z53 and 2 mW for NRV-Z54 at rated power) after measurement of high power.

[4]) Noise specifications (2 standard deviations) refer to filter 11 of NRVS, NRVD and URV55. Noise values for other filters are obtained by multiplication with the factors given in the table below:

Filter No.	0	1	2	3	4	5	6	7	8	9	10	**11**	12
Noise multiplier	51	32	23	16	11.3	8	5.6	4	2.8	2	1.4	**1.0**	0.7
Measurement time/s	0.115	0.12	0.13	0.15	0.21	0.32	0.52	0.92	1.75	3.4	6.6	**13**	26

In automatic filter mode, the filters are selected as a function of the measurement range and resolution as shown in the table below:

Measurement range	NRV-Z53 NRV-Z54	1 mW 10 mW	10 mW 100 mW	100 mW 1 W	1 W 10 W	10 W 30 W
Resolution	HIGH	Filter 11	Filter 9	Filter 7	Filter 7	Filter 7
	MEDIUM	Filter 9	Filter 7	Filter 3	Filter 3	Filter 3
	LOW	Filter 7	Filter 3	Filter 0	Filter 0	Filter 0

[5]) Included in calibration uncertainty.

PCN Insertion Unit NAS-Z7

Uses, characteristics

The PCN Insertion Unit NAS-Z7 for the Directional Power Meter NAS from Rohde&Schwarz (catalog 93/94, page 301) covers a wider frequency range than the GSM Insertion Unit NAS-Z6 (see NAS) and is thus able to measure both GSM and PCN signals. It is mainly used for measurements on PCN base stations and operates in the same way as Insertion Unit NAS-Z6.

Specifications of NAS-Z7

Frequency range	890 to 960 MHz 1710 to 1880 MHz[1]
Measurement range	0.01 to 30 W[2]
Inaccuracy	±6% of rdg (≤20 W) ±7% of rdg (20 to 30 W)
SWR	<1.15
Directivity	>26 dB
Insertion loss	<0.3 dB
Connector	N female, 50
Dimensions (W x H x D)	55 x 120 x 90 mm[3]
Weight	0.7 kg

Ordering information

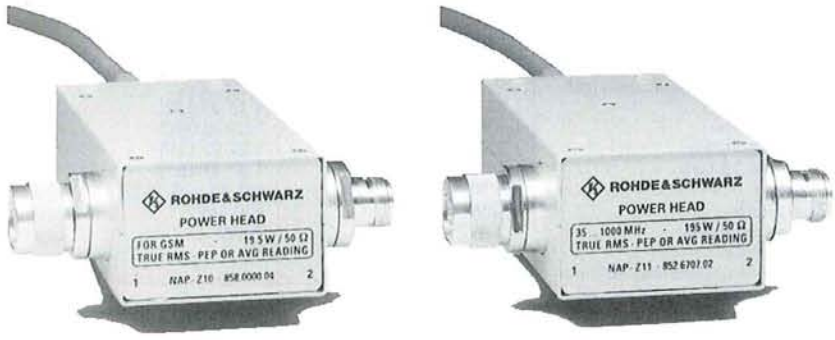
Insertion Unit	NAS-Z7
	0828.6746.02

[1]) Useful frequency range for CW signals: 850 to 2000 MHz, but with higher inaccuracy.

[2]) Up to 100 W with higher inaccuracy.

Peak Power Sensors NAP-Z10/Z11

New sensors for Power Reflection Meter NAP for measurement of TV and GSM signals



Uses, characteristics

Peak Power Sensors NAP-Z10/Z11 for the frequency range up to 1 GHz come in two versions. Model 02 measures short RF bursts with a width from 4.5 µs upwards and is especially suitable for measuring the sync pulse power of TV signals. Model 04 has been designed for the GSM mobile radio network and measures the power of the pulsed TDMA signal with high accuracy.

Measuring the sync pulse power of TV signals with sound subcarrier

Models 02 of the Peak Power Sensors NAP-Z10 and NAP-Z11 are ideal for measuring the sync pulse power of low-power TV transmitters up to 195 W. They detect the short sync pulses of all negatively modulated TV signals to NTSC, CCIR, British and OIRT standards, without the measurement result being affected by the picture content.

The measurement can be made with and without sound subcarrier(s). With the NAP, the power indication that is affected by the sound subcarrier can be corrected. To this end, a correction factor determined by the vision/sound power ratio can be entered manually or via the IEEE bus. In particular small TV transmitters with combined generation of vision and sound subcarriers can be monitored in this way during the ongoing program.

Acceptance testing with mismatched load

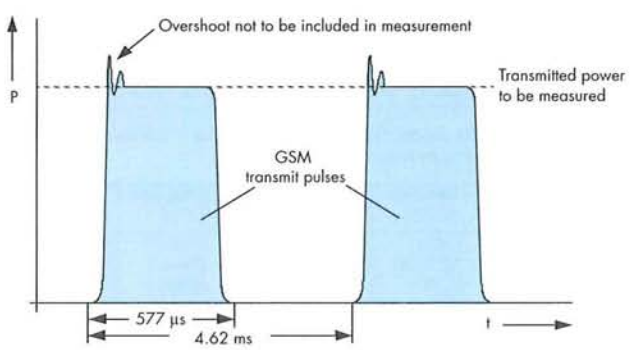
For the acceptance testing of high-power RF transmitters, the manufacturer as a rule has to prove that the specified transmitter power is also ensured in the case of large mismatch of the load. For every percent of measurement error, the manufacturer has to allow for additional RF power to make up for the error. This is where the high directivity of the NAP sensors of at least 30 dB over a large frequency range can be fully used to advantage. With an SWR of 3 of the connected load, this high directivity causes an additional measurement error of maximally 3.2% for the incident power, whereas with a directivity of 20 dB an error of three times this amount has to be expected.

Measuring the TDMA burst without overshoots

The specifications for the digital radio networks to GSM standard allow overshoots of the envelope of up to 4 dB above the pulse top of the TDMA burst. A fast peak power meter may respond to such overshoots, causing measurement errors of more than 100%.

Models 04 of the Power Sensors NAP-Z10/Z11 are especially designed for measuring the TDMA signal to GSM standard and eliminate the unwanted overshoots for the measurement.

Models 04 of Power Sensors NAP-Z10 and -Z11 ensure error-free measurement of the GSM transmit pulses



Specifications

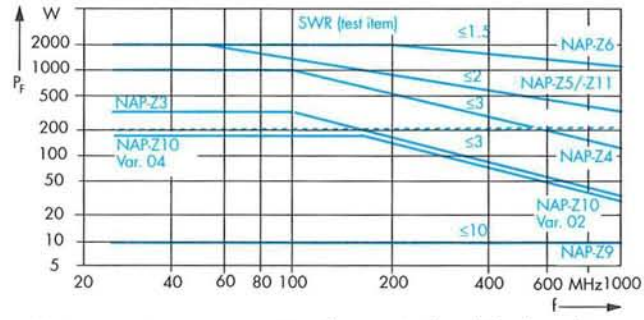
Power Sensor		NAP-Z10	NAP-Z11	NAP-Z10	NAP-Z11
		Models 02		Models 04	
Frequency range	Values in ( ) for PEP measurement	35 MHz to 1 GHz		890 to 960 MHz	
Power measurement range[3]		0.01 (0.05) to 19.5 W	0.1 (0.5) to 195 W	0.01 (0.02) to 19.5 W	0.1 (0.2) to 195 W
Power rating		see diagram			
Parameter measured		average (AVG) and peak envelope power (PEP)			
Modulation frequency range (AM) Pulse width (PM) Pulse repetition rate (PM)	PEP	50 Hz to 100 kHz ≥4.5 µs ≥50 Hz		— 577 µs 216.7 Hz	
Power measurement error[1] at 20 to 25 °C	AVG	≤6.5% + 1 count + 0.01% of P_{max}[2]		≤4.5% + 1 count + 0.01% of P_{max}[2]	
	PEP	same as AVG, plus PEP error (see below)		≤6% + 1 count + 0.02% of P_{max}[2]	
Temperature effect (–10 to +20 °C and +25 to +55 °C)	AVG	≤0.25%/K			
	PEP	same as AVG, plus 0.001% of P_{max}[2]/K			
PEP error		2 [3]% + 0.02% of P_{max}[2] (0.2 to 199 kHz) 3.5 [5]% + 0.02% of P_{max}[2] (100 to 200 Hz) 6.5[8]% + 0.02% of P_{max}[2] (50 to 100 Hz) with pulse modulation as a function of pulse repetition rate, duty cycle 0.05 to 1; values in [ ] for duty cycle 0.005 to 0.05		included in power measurement error (see above)	
Directivity		≥30 dB (40 MHz to 1 GHz)[4] ≥26 dB (35 to 40 MHz)[4]		≥30 dB	
SWR measurement error	SWR ≤1.25	5 (10)% typ. (values in ( ) for PEP)		5% typ.	
	SWR ≤2	8% typ.		8% typ.	
Characteristic impedance		50 Ω			
SWR		≤1.03			
Insertion loss		≤0.10 dB (up to 300 MHz) ≤0.25 dB (up to 500 MHz) ≤0.75 dB (up to 1 GHz)	≤0.08 dB (up to 300 MHz) ≤0.15 dB (up to 500 MHz) ≤0.20 dB (up to 1 GHz)	≤0.2 dB	
Electrical length		140 mm	133 mm		
RF connectors		N male/female			
Dimensions		118 mm x 118 mm x 45 mm			
Weight		0.7 kg			

Ordering information

Power Sensor	NAP-Z10[5]	0858.0000.02
	NAP-Z10[5]	0858.0000.04
	NAP-Z11[6]	0852.6707.02
	NAP-Z11[6]	0852.6707.04

All RF connectors can easily be adapted to other systems with the aid of screw-in assemblies; please order adapters separately (see table below right).

Erratum on page 304 of the Measuring Equipment Catalog 93/94: NAP-Z6 is fitted with a Dezifix B connector and not as stated with an N connector.



Maximum continuous power rating of sensors (with modulated signals: maximum peak envelope power PEP)

Adaptation to	Male	Female	Max. power at 1000 MHz
N	017.7532.00	017.5398.00	0.6 kW
BNC	017.7832.00	017.5730.00	0.4 kW
4.1/9.5	017.9106.00	017.8516.00	0.8 kW
Dezifix B	018.2486.00		1.3 kW

The maximum power at other frequencies can be calculated with P_{max} = P(at 1 GHz)/√f(in GHz)

1) Referred to the power in W flowing out of sensor with autoranging, error limits for AVG mode without modulation.
2) Maximum sensor power (see power measurement range).
3) For modulated signals, the specified upper limits refer to the maximum peak envelope power (PEP).
4) Measured in AVG mode; slightly lower values in PEP mode, depending on envelope of test signal.
5) With firmware version 5.0 or higher only.
6) With firmware version 3.1 or higher only.

Testing with Test Workstation TSA under Windows NT™ on a PC

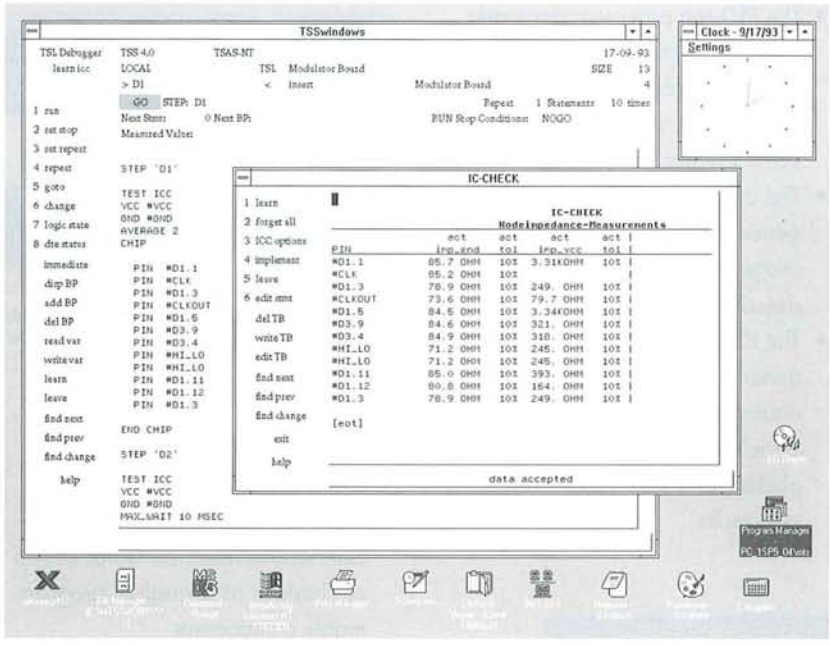
Contents of Chapter 8

Test System Software TSSwindows

MICROSOFT WINDOWS NT

Testing with Test Workstation TSA – under Windows NT™ on PCs

(TSA see catalog 93/94, page 324)



Uses

TSSwindows, a powerful system software for the Rohde & Schwarz Test Workstation TSA, has especially been designed for the future-oriented operating system Windows NT™.

The variety of test modes of the tester family, such as

- hybrid in-circuit tests
- analog and digital functional tests
- power and boundary-scan tests

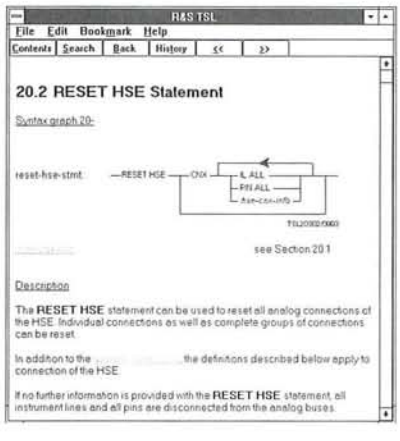
can thus be used – either individually or combined – on PCs.

Characteristics

TSSwindows features a menu-controlled user interface designed for ease-of-use. Since the menus only contain those functions which can really be performed in the particular mode, even the inexperienced user will soon be able to operate the system. The menu options can be selected using softkeys or the mouse, so ensuring fast and error-free operation. Entries can be made on forms containing default data derived from the current operating environment.

Windows help function

The programmer's manual for the test language TSL is contained in the Windows help function. Clear graphics, references displayed at a keystroke, search and index functions help the user get to the sought information quickly and without having to go through the manual.



Convenient help function

Open architecture

Any Windows application can be called up from a test program. This, for example, allows test data to be processed in the spreadsheet program Microsoft® Excel and output on a graphic display. Programs for PC plug-in cards can also be included in the test run.

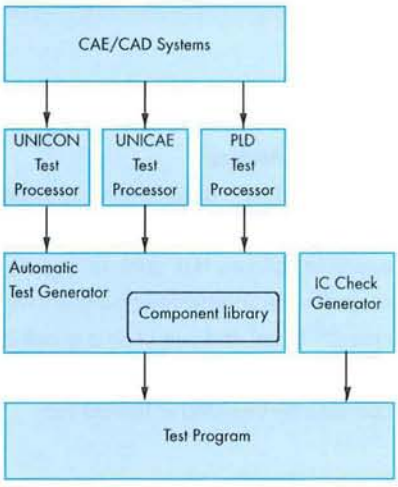
Test methods

Hybrid in-circuit test

- The CAD test processor UNICON converts CAD output lists in ASCII code to the board description format of Test Workstation TSA
- The CAE test processor UNICAE generates component models for the library from tabular CAE output lists in ASCII code. This allows logic simulations, for example from ViewSim (VIEWlogic), to be taken over

Test System Software TSSwindows

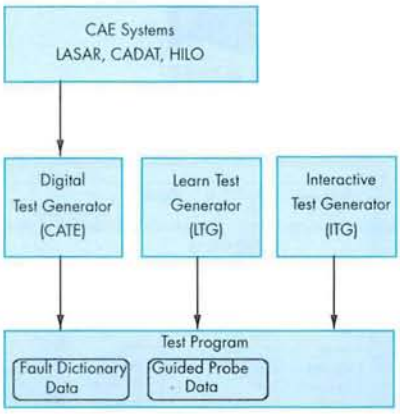
- The PLD test processor generates tests for programmable logic components. Clock, force and disable sequences are generated using the standardized JEDEC format
- The automatic test generator ATG generates an in-circuit/cluster test program on the basis of the board description
- The IC check generator is used to generate tests for ICs by means of analog test facilities. In the case of a fault, an automatic diagnostic algorithm analyzes and evaluates the test results



Automatic in-circuit test generation with CAE/CAD data

Analog and digital functional tests

- The digital test generator CATE converts the simulation results to a functional test program with diagnosis
  - Defective components can be determined easily from the fault dictionary on the basis of the symptoms shown
  - The digital test generator is available for the LASAR (Teradyne), CADAT (RACAL-REDAC) and HILO (GenRad) simulators



Automatic functional test generation with diagnosis from CAE data or from data obtained by the learn test generator

- The learn test generator LTG provides test programs for digital circuits whose response is not known or changes as a result of programmable components
- The interactive test generator ITG generates functional test programs simply by completing device-specific forms

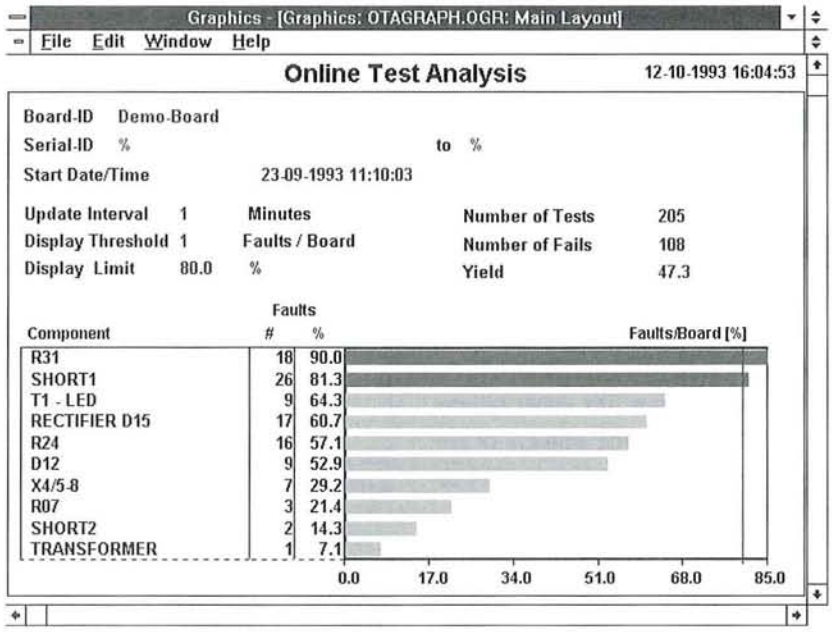
Boundary scan test

The boundary scan method considerably simplifies testing of complex digital boards. A test pattern generator provides test patterns for checking the connections between the individual ICs. The boundary scan test can be combined with the in-circuit and the functional test.

Quality management and paperless repair

Relational database Oracle®

After each test, the relevant data are directly entered into the Oracle database and so are immediately available for repairs and quality reports. An ASCII interface allows test and repair data to be loaded from other systems. The database may also be incorporated in networked computers running under different operating systems (eg UNIX, VMS, OS/2™).



Weak spots immediately detected using the online test analysis

Quality analysis and paperless repair are carried out using the TSA computer or a networked PC with version 3.1 of Microsoft® Windows™.

Quality reports
Online analyses with summary, detailed and trend reports including graphics permit weak spots in the manufacturing process to be analyzed and immediately eradicated. Alarm indications during the production test enable defects to be localized at an early stage and further defects to be avoided. An SQL interface provides access to the data stock.

Paperless repair
The test data of the boards to be repaired can be retrieved from the database in paperless form after the boards have been identified using a barcode reader. For every board unsuccessfully repaired, a test and repair report can be displayed by pressing a key. It is also possible to read the entries of other boards and so benefit from the experience already gained.

Windows NT™ – the modern platform

Windows NT from Microsoft® is a high-end operating system with 32-bit architecture and preemptive multitasking. The user interface, which is basically the same as Windows™ 3.1, is very convenient and easy to get acquainted with.

Compatibility
All applications that have been established for MS-DOS, Windows 3.0 and 3.1 and LAN Manager are binary-compatible and can be run on an Intel processor under Windows NT. Windows NT also supports OS/2 server and POSIX-conformable applications.

Safety
The memory protection provides high system stability. The operating system and the applications have their own address ranges to prevent overwriting. The various user resources (programs, data, memories) are protected by the entry of a name/password.

Multitasking
With preemptive multitasking, the operating system makes for the efficient distribution of computing times to the different applications. So it is possible, for example, to carry out tests on a series in the foreground while evaluating the quality in the background.

MICROSOFT® WINDOWS NT™

Version 3.1

Easy integration into PC network
Windows NT includes a network as standard so that users can resort to the same files and printers as well as exchange messages. The TCP/IP protocol is available for exchanging data with other computers and operating systems.

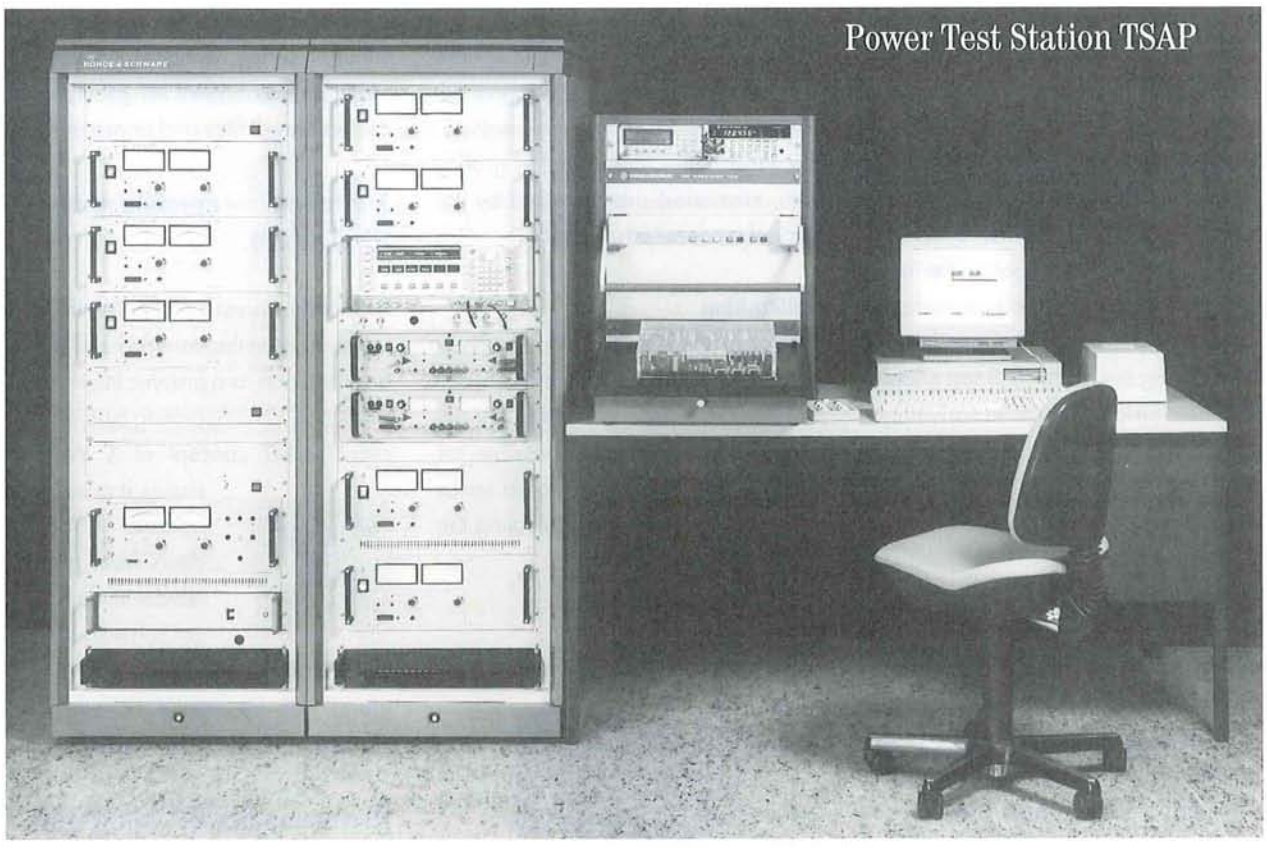
Some network manufacturers offer supplementary products such as Pathworks for Windows NT from Digital Equipment, allowing an NT system to be used in the DECnet as a pathworks client or server. A client product from Novell for Windows NT provides access to Novell files and printer servers.

X Window™ – opening up the UNIX world

TSSwindows uses an OSF/Motif™ interface based on the standardized X Window and acts as a graphic interface for UNIX and VMS operating systems. The client/server concept of X Window makes it possible to operate TSSwindows from any PC fitted with an X-Server software. From the PC of Test Workstation TSA, programs can be started on other networked UNIX or VMS computers.

Recommended PC equipment

Computer with Intel processor
- 80486/33 MHz
- 16-Mbyte main memory
- 250-Mbyte harddisk
- 3½" disk drive
- CD-ROM drive
- 17" colour monitor
- VGA graphics card



Uses

Power Test Station TSAP complements Test System Family TSA/TSAS through the testing of power supplies and other electronic power circuits. As a complete in-circuit and combinational tester the TSAP localizes all defects down to component level with extremely high accuracy, as a complete power tester it measures all data under full load and with all these facilities combined it provides complete fault coverage in a single test run.

Characteristics

Main features

- In-circuit, functional and power-supply tests in one step, hence considerable savings in test costs
- Maximum test depth
- 100% TSA/TSAS-compatible fixtures and programs
- Interactive power test generator
- Measurement of all quality data to ISO 9000 during testing
- Modular system concept ensuring customized solutions for every application

Fixtures

- Combined standard and power interfaces: Pylon (TSA/TSAS-compatible), similar to DIN 41612 for power signals
- Bed-of-nails fixture (vacuum, pneumatic or mechanical systems)
- Two-stage and double-chamber fixtures
- Functional-test fixture or connection via cables

Power test generator

The interactive power test generator cuts down on learning and programming time. With the aid of self-explanatory forms, the user can immediately concentrate on the test problem without having to learn the programming language or handle IEC/IEEE-bus commands. The tests can be carried out and modified interactively and the software generates commands with the correct syntax in the test language.

Power tests

- Output voltage (with and without load)
- Power consumption, load current
- Input power (active/reactive/apparent power), efficiency
- Load regulation, line regulation
- Cross regulation
- Ripple and noise measurement
- Frequency and pulse width of switching regulators
- Load transient recovery time
- Current limiting
- Short-circuit behaviour
- Overvoltage protection, shutdown
- Power-fail function
- Automatic trimming

Specifications

Basic configuration of power option

Rack	19", 32 to 41 HU
TSA basic unit	integrated or accommodated in separate cabinet, 15 HU
Power interface	similar to DIN 41612 (design C96, H15, H7/F24)

Common data of individual units

All units are floating (except function/waveform generator), instruments up to 20 A can be relay-isolated. Sense lines for compensating fixture wiring and connection to scanner are integrated. The following units and modules can be incorporated (instruments with higher ratings on request).

AC and DC sources

AC generator type 1 (1 phase)	
Voltage/current (power)	0 to 280 V (500, 1000, 2000 VA) or 2 to 250 V/10 A (2500 VA)
Frequency	50/60/400 Hz, opt. 40 to 1000 Hz
AC generator type 2 (3 phases)	
Voltage/current (power)	3 x 0 to 280 V (3 x 250 to 2000 VA)
Frequency	16.66 to 1000 Hz
DC source type 1/type 2	max. 10 A/5 A
Voltage/current (power)	0 to 8 V/0 to 10 A (80 W) or 0 to 20 V/0 to 10 A (200 W) or 0 to 70 V/0 to 10 A (350 W) or 0 to 20 V/0 to 5 A (100 W) or 0 to 40 V/0 to 5 A (200 W) or 0 to 100 V/0 to 2 A (200 W)
DC source type 3	
Voltage/current (power)	0 to 40 V/0 to 40 A (600 to 800 W)
High-voltage source	max. 8 A
Voltage/current (power)	0 to 350 V/0 to 5 A (600 to 800 W) or 0 to 300 V/0 to 0.6 A (180 W)
Power supplies up to 7000 W	supplied upon request

DC/AC amplifiers 1 and 2

Voltage/current (power)	±50 V/±2 A (100 W) or ±20 V/±20 A (400 W) or ±100 V/±1 to 4 A (100 to 400 W) amplifier 2: ±200 V/±1 A (200 W)
Bandwidth	DC to 4/20 kHz
Programming	current, voltage, external signal
Operating mode	bipolar, source and sink operation; amplifiers can be used as a dynamic load
Amplifiers up to 1500 W/100 kHz	supplied upon request

Active loads

Type 1	0 to 10 V/0 to 20 A (200 W)
Type 2 (max. 5 x)	3 to 60 V/0 to 5 A (300 W), opt. 10 A (650 W), opt. from 0 V
Type 3	3 to 240 V/0 to 10 A (250 W)
Type 4	3 to 60 V/0 to 60 A (350 W)
Data common to all types of active loads	constant current (sink)/constant resistance operation with automatic switchover, parallel-connected loads, voltage and current readout, internal or external modulation (option)
Loads up to 6000 W	supplied upon request

Measuring equipment

Digital Multimeter UDS 5	see catalog 93/94, page 308
RMS Voltmeter URE 3	see catalog 93/94, page 305
Arbitrary Waveform Generator ADS	see catalog 93/94, page 240
Function generator module FGM	see TSA, catalog 93/94, page 326
Timer/counter module TCM	see TSA, catalog 93/94, page 326
Waveform analyzer	
Number of channels/ storage capacity	2/16 k
Sampling rate	100 MHz
Power meter	
Measurements	current, voltage (rms and peak), impedance, power, apparent power, cos φ/efficiency
Voltage/current	up to 320 V/30 A
Double resistor decade	
Power range	1 Ω to 16 MΩ, resolution 1 Ω (0.5 W, <16 Ω: 1 W), optionally 0.1 Ω to 1.6 MΩ, resolution 0.1 Ω
Accuracy	0.1% + residuals

Matrix

Power switching	all units with force and sense lines up to 20 A
Scanner	for all units and external inputs up to 320 V
Bus	6-wire bus for up to 1088 pins (basic model)
Free relays	see "Utilities" and TSA basic model

Utilities

Discharge circuit	7 x 2.4-W resistor
Shunts	2 x 20 mΩ/5 W, 1 x 100 mΩ/3 W
Power supply for fixtures	+5 V and +12 V, 2 A
Open collector outputs	5 (12 V/500 mA)
Free relays	max. 6, depending on configuration, max. 8 A
Further utilities	IOM, APM, ARM, eg 32-bit I/O ports, 32 relays 100 V/1 A, 4 relays 250 V/8 A
Protection	high- and low-voltage indication, safety shutdown

Software

Interactive power test generator for measuring instruments and scanner, self-documenting power tests, self-test

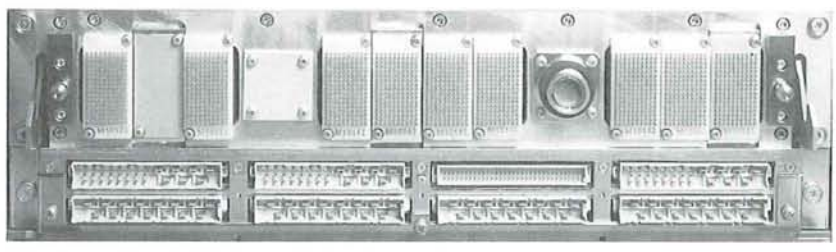
General data

(Dimensions, weights and power supply specs apply to power option only)

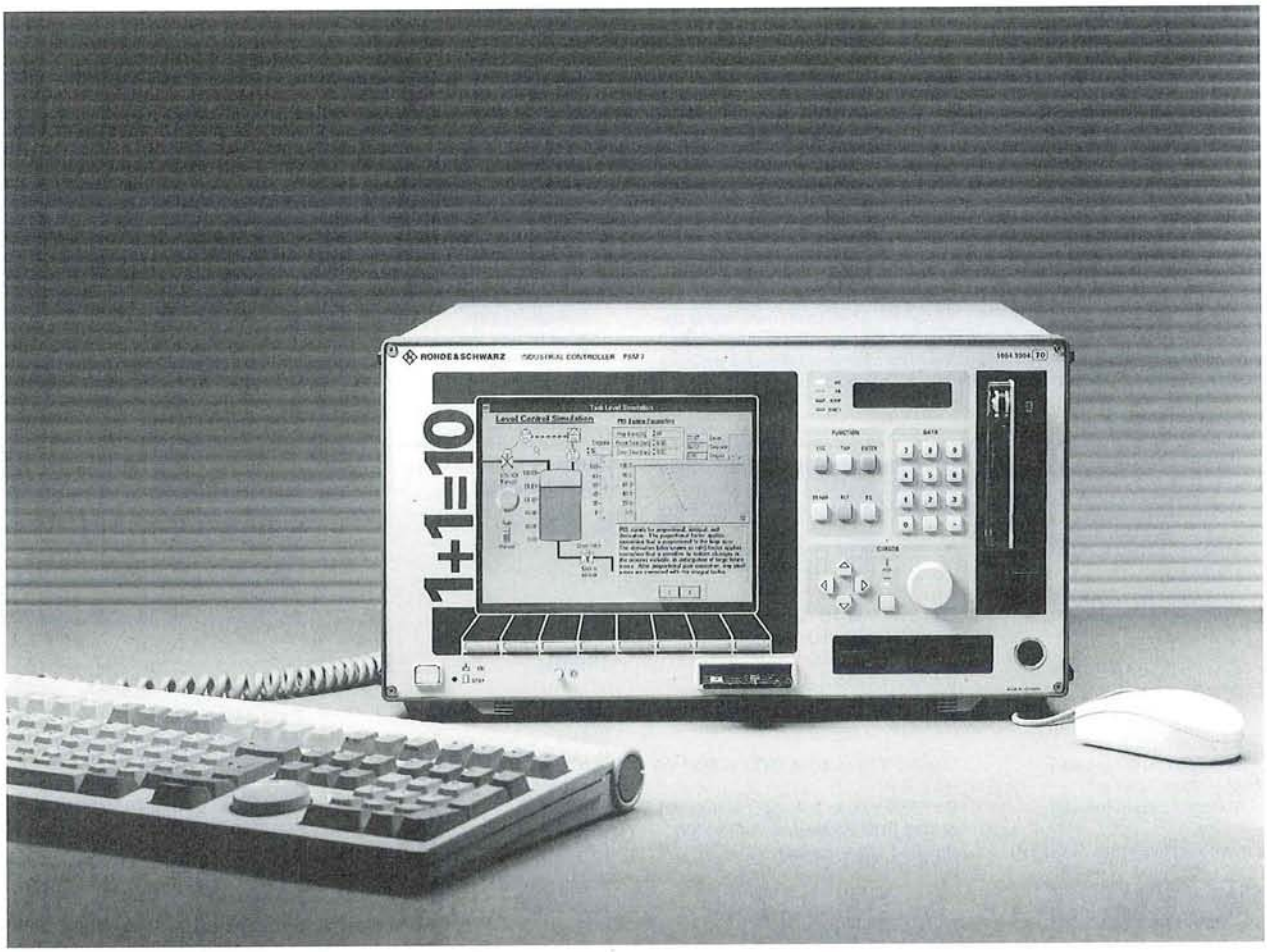
Power supply	230 V ±10% (or 380 V, 3-phase, depending on configuration), 47 to 63 Hz, 2000 to 6000 VA in addition to TSA basic model and computer
Dimensions (W x H x D)	1200 mm x (1600 mm to 2000 mm) x 800 mm
Weight	300 to 600 kg

Ordering information

Power Test Station	TSAP



TSAP fixture interface



Process controllers from Rohde & Schwarz tailor-made for lean production in industry

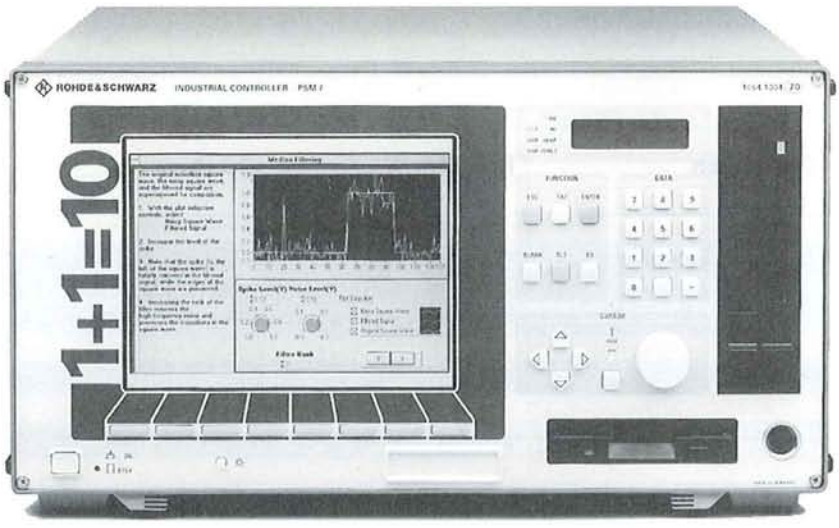
Contents of Chapter 9

Measurement software is described in connection with its specific applications in the individual chapters of the catalog. Page numbers 343 and above refer to the main catalog 93/94.

Industrial Controllers PSM2, 5, 7

Just for the job: industrial controllers for automated test systems in industry and lab.

Turnkey, ready-to-go units



Uses

The Industrial Controllers of the PSM family from Rohde & Schwarz provide a complete solution for automated test systems in industry and lab. Thanks to a perfectly matched hardware and software, the user will be able to implement measurement applications within a minimum time of familiarization.

Lean production is increasingly gaining importance in industry and stands for production with maximum efficiency and minimum expenditure. This is exactly the field of application of the PSM. Being produced on the principles of lean production itself, the PSM is suitable for use wherever automation is the order of the day with the objectives of saving costs and increasing efficiency.

More than a standard PC

In addition to standard features like compatibility with the industry standard, built-in IEEE488.2 interface and optimized EMC/EMI characteristics, these controllers provide special features which a standard PC usually does not offer:

- Microsoft Windows user interface extended for measurement applications
- Colour LCD with excellent display quality
- Also available with monochrome LCD display (PSM5)
- Universal interface (factory user port), tailored to applications in industrial automation
- Parallel connector for external monitors
- PCMCIA interface for memory and interface expansions
- 7 free slots
- Can be rackmounted
- Can be controlled without external keyboard
- Optional DC power supply
- Know-how and support from an experienced T&M equipment manufacturer

Excellent price/performance ratio

The purchase price of the PSM for a well-equipped basic configuration is distinctly lower than that of comparable products. But also the costs for maintenance, update and logistics are low due to the service-friendliness, upgradability and type stability of the PSM. Modules affected by technological developments, such as CPU or graphics, are accommodated on separate plug-in cards to enable easy upgrading.

Extensive basic hardware

- CPU 80486/33 MHz
- 8-Mbyte RAM
- 200-Mbyte hard disk
- $3\frac{1}{2}$" floppy disk drive
- In addition to IEC/IEEE bus, many other interfaces indispensable in automated measurements such as 2 x LPT, 4 x COM, analog I/O, digital I/O, A/D converters, relays, optocouplers for SPS driving and three COM ports
- PCMCIA interface
- Integrated colour or monochrome LCD display with softkeys
- 200-W power supply, two temperature-controlled fans

The only difference between the three models is the screen display: here PSM2 without display

High flexibility

- Language interfaces for operating the versatile interfaces of the PSM via common languages such as MS-C, TurboPascal, Turbo C++
- Open-architecture driver software: interfaces can also be addressed from customer-specific programming interfaces
- 7 free 16-bit ISA slots
- Optional DC input for mobile use of the PSM, eg in cars

Memory

The 8-Mbyte RAM can be expanded to 32 Mbyte. A 200-Mbyte hard disk is installed as standard. Another 540 Mbyte can be added on by integrating the SCSI Host Adapter PS-B27 and the SCSI Hard Disk PSA-B17.

Peripheral SCSI Drive Unit PSDU

Data security

The high degree of data security that the PSM offers is through the use of passwords and exchangeable storage media like memory cards and hard disks.

Powerful software

- MS Windows user interface
- The controllers come with a powerful, self-explanatory software which can be used to control measuring equipment via IEC/IEEE bus immediately after switch-on
- Convenient online help
- Windows drivers are supplied for all PSM interfaces, such as IEEE interface, FUP and front panel, so that user-specific Windows applications can be generated
- The PSM can also be operated under DOS and therefore comes with Rohde&Schwarz BASIC, and optionally with Microsoft QuickBASIC. Programs generated for the PSA controller family can of course also be run on all PSM controllers.
- Optional software extensions such as LabWindows CVI and VisualBASIC are written for the Windows operating system.

Convenient online help

Windows has a powerful online help system. The PSM documentation is fully integrated into the help system. The desired description can be quickly found with the aid of convenient search functions and displayed. For those preferring to work with a hardcopy of the manual, output via a laser printer is possible.

High-resolution, high-speed graphics

A VGA colour or monochrome LCD provides high-quality display of text and graphics, both menu windows and result graphics alike. The only difference between the three models lies in their display facility:

- PSM2 without display
- PSM5 with 9" monochrome LCD display
- PSM7 with 8" colour LCD display

The Peripheral SCSI Drive Unit PSDU, which can be cascaded and, like the PSM, is rackable, allows an almost unlimited expansion of the hard disk capacity in 1-Gbyte steps per PSDU.

The PCMCIA slot provided as standard is particularly suitable for the connection of external interface and memory cards. This interface is a standardized universal bus for which in addition to memory cards and hard disks numerous interface modules such as fax modems or exchangeable hard disks (eg PSM-B1) are also available.

In addition to memory cards and hard disks, numerous interface modules like fax modems or exchangeable hard disks (eg PSM-B1) can also be connected to the PCMCIA slot

Industrial Controllers PSM2, 5, 7

In conjunction with an external monitor, eg PMC3 or PMC4 (page 119) the graphics card of the PSM can also be used in a high-resolution mode with up to 1024 x 786 pixels.

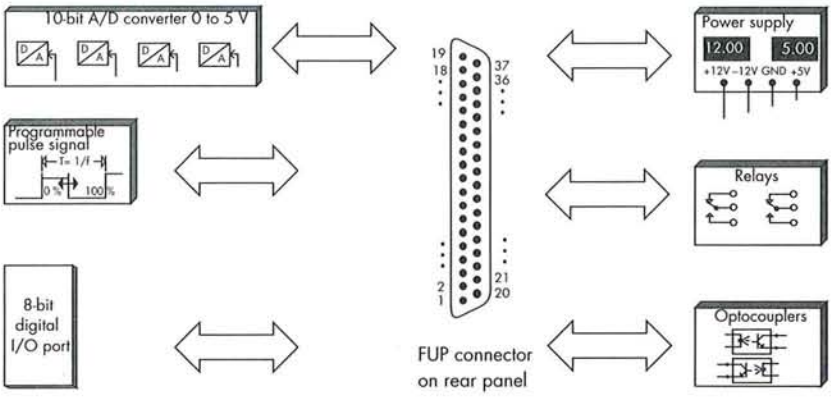
Factory user port: an interface for the job

The factory user port (FUP) provides with a single connection a variety of useful interfaces that are for instance required in automated measurements. The digital I/O interfaces, fully isolated via optocouplers, allow control of external processes or measurement of analog voltages without an external IEC/IEEE-bus voltmeter.

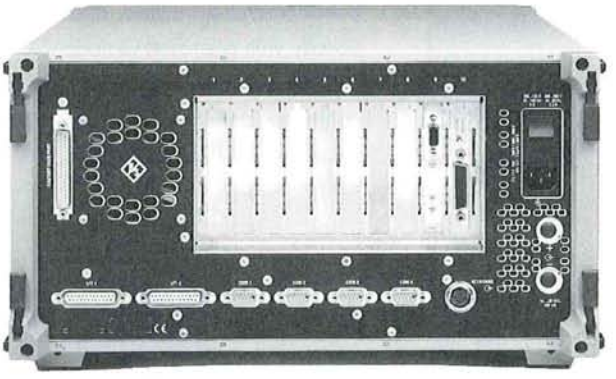
Whether relatively simple or highly complex instrument control tasks have to be performed, the FUP is extremely versatile and the programming steps are cut down to the absolute minimum. Therefore, various high-language drivers for the interfaces are built in so that the user can choose programming the simple way with BASIC under DOS or professionally with C under Windows. All intermediate levels are also supported.

Front-panel control

In the daily routine of industrial automation, external keyboards or use of the mouse are often not very practical. To prevent erroneous settings, Windows application programs can be activated for the PSM directly in the rack without an external keyboard. All keys are provided on the PSM to activate for instance pull-down or pop-up menus, select and start individual menus. Numerical values can be entered via a decimal keypad.



The factory user port (FUP) provides a number of very useful interfaces at a single connector



Numerous interfaces on the rear panel

9

Specifications

Processing unit	
CPU	80486
Clock frequency	33 MHz
RAM	8 Mbyte
Display	
PSM2	none
PSM5	LCD monochrome, 9"
PSM7	LCD colour, 8"
Screen	anti-glare
Mass storage	
Hard disk	200 Mbyte
Disk drive	1.44 Mbyte, $3^1/_2$"
Interfaces	
IEC/IEEE bus	IEEE488.2, compatible with NI NAT
PCMCIA	release 2.0, type III connector
Keyboard	5-pin DIN
Factory user port	8 digital inputs/outputs; 8 x analog input 10 bit, 0 to 5 V; analog output 8 bit, 0 to 5 V via pulse width modulator; optocouplers, 1 input, 1 output; relays: 2 switches, SPS driving
Serial	RS-232-C, for use of front panel: COM1, 2, 3; without use of front panel: COM1, 2, 3, 4
Printer	Centronics LPT1/LPT2 (LPT2 can also be used as a digital input/output)
SPS driving	software drivers: LabWindows (CVI), TurboPascal, MS VisualBASIC
Software	
Operating system	MS Windows from version 3.1 and higher or MS-DOS from version 6.0 and higher
Programming languages	MS QuickBASIC, Rohde & Schwarz BASIC, software drivers for QuickBASIC, MS VisualBASIC, MS-C, TurboPascal

Graphics	
With integrated LCD	VGA standard: 640 x 480 pixels
For external monitors	1024 x 768, 800 x 600, 640 x 480 pixels

General data

Power supply	100 to 120 V ±10%, 47 to 440 Hz, max. 4 A; 220 to 240 V ±10%, 47 to 63 Hz, max. 1.3 A; optionally 10 to 28 V DC
Dimensions (W x H x D)	427 mm x 177 mm x 460 mm
Weight	
PSM2	13.2 kg
PSM5	14.1 kg
PSM7	14.4 kg

Ordering information

Industrial Controller	PSM2	1046.1004.20
	PSM5	1046.1004.50
	PSM7	1046.1004.70
Accessories supplied	mouse	
Interfaces		
2nd IEC/IEEE bus (IEEE488.2)	PS-B4	1006.6207.04
TTL I/O Interface	PS-B11	1006.7303.04
Analog I/O Interface	PS-B13	1006.6859.02
Ethernet Adapter	PS-B21	1028.9009.02
SCSI Host Adapter	PS-B27	1064.5500.02
Memories		
Frame	PSA-B8	1007.4008.03
Exchangeable Hard Disk 250 Mbyte (PSA-B8 required)	PSA-B9	1007.3501.04
PCMCIA Exchangeable Hard Disk 40 Mbyte	PSM-B9	1064.5700.02
$5^1/_4$" Floppy Disk Drive	PSA-B16	1007.4508.03
SCSI Hard Disk 540 Mbyte (only with SCSI Adapter PS-B27)	PSA-B17	1028.9744.02
Memory Expansion 4 x 4 Mbyte[1]	PSM-B2	1064.5880.02
Software		
QuickBASIC (English)	PS-K1	1007.1009.32
VisualBASIC (factory-installed only)	PSM-K1	1064.5000.02
LabWindows CVI (factory-installed only)	PSM-K2	1064.5100.02
Other software	on request	
Keyboards		
Rack-attachable Special Keyboard with rollkey (English)	PSA-Z1	1009.5001.32
Standard Keyboard (English)	PSA-Z2	1007.3001.32
Power Supply		
DC/AC Power Supply (10 to 28 V DC) (factory-installed only)	PSM-B3	1064.6006.02

[1] Total memory with one expansion: 20 Mbyte, total memory with two expansions: 32 Mbyte.

Industrial Monitor PMC4

15" colour monitor, especially for use in vehicles and industry

Main features

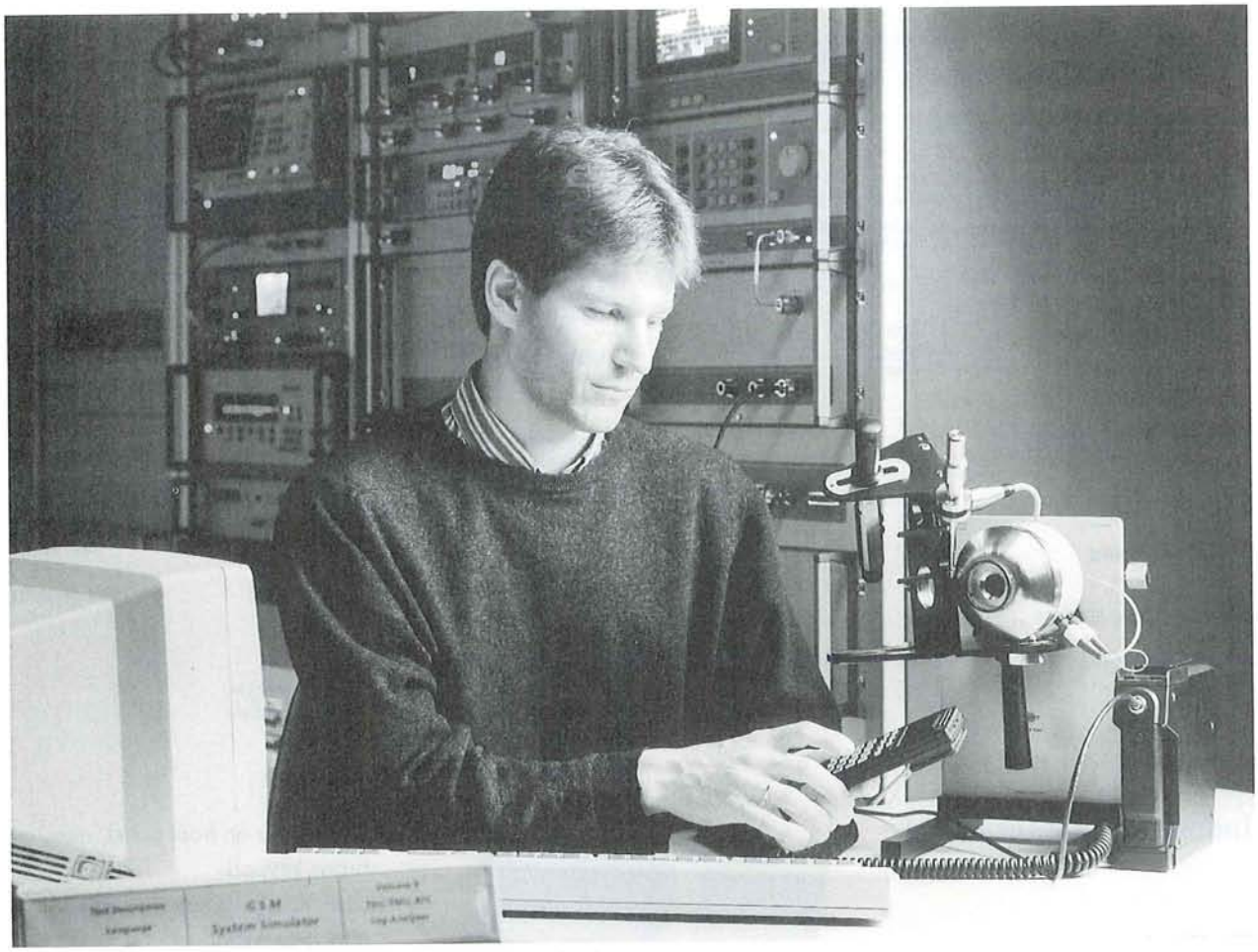
- Multisync technology with automatic adaptation of display resolution
- Sturdy aluminium casing, dust- and splashproof
- All controls on front panel, membrane keypad
- Low emissions, tested to Swedish directives MPRII
- 23 non-volatile memories for picture geometry and positioning
- Demagnetization automatically or manually upon keystroke
- Black-level adjustment via front-panel keys
- 19" adapter for rackmounting

Specifications

CRT	15" flat-face CRT, active display area 262 mm x 196 mm, medium persistence (phosphor P22), anti-glare, antistatic coating, internal implosion protection
Deflection/dot pitch	90°/0.28 mm
Input signal	
Video	composite RGB, analog, positive, 1 V_{pp}, negative sync on green; non-composite RGB, analog, positive, 0.7 V_{pp} with external sync
Impedance	75 Ω
Sync	TTL levels, H/HV positive or negative
Video bandwidth	80 MHz
Synchronization	
Horizontal	30 to 62 kHz (automatic)
Vertical	48 to 100 Hz (automatic)
Resolution (non-interlaced)	640 x 350 to 1024 x 768 pixels
Colours	unlimited number, depending on graphics card
Convergence error	<0.4 mm in center of screen
Geometric distortion	within a 2 mm x 2 mm window
Luminance	≥80 NIT, screen center, full white field
General data	
Power supply	90 to 265 V, 45 to 65 Hz, 0.6 to 1.2 A; 20 to 32 V DC, 2.5 to 5 A
Dimensions (W x H x D)	376 mm x 405 mm x 316 mm
Weight	19.4 kg

Ordering information

15" Industrial Monitor	PMC4	1034.8000.02
Extra		
19" Monitor Adapter	PMC4-Z1	1034.8100.00



Rohde&Schwarz supplies turnkey systems, ie hardware plus all peripheral services

Contents of Chapter 10

GSM/PCN Base Station Test System TS8510

Test system specially designed

for measurements to BAPT

222 ZV6 and MPT 1378

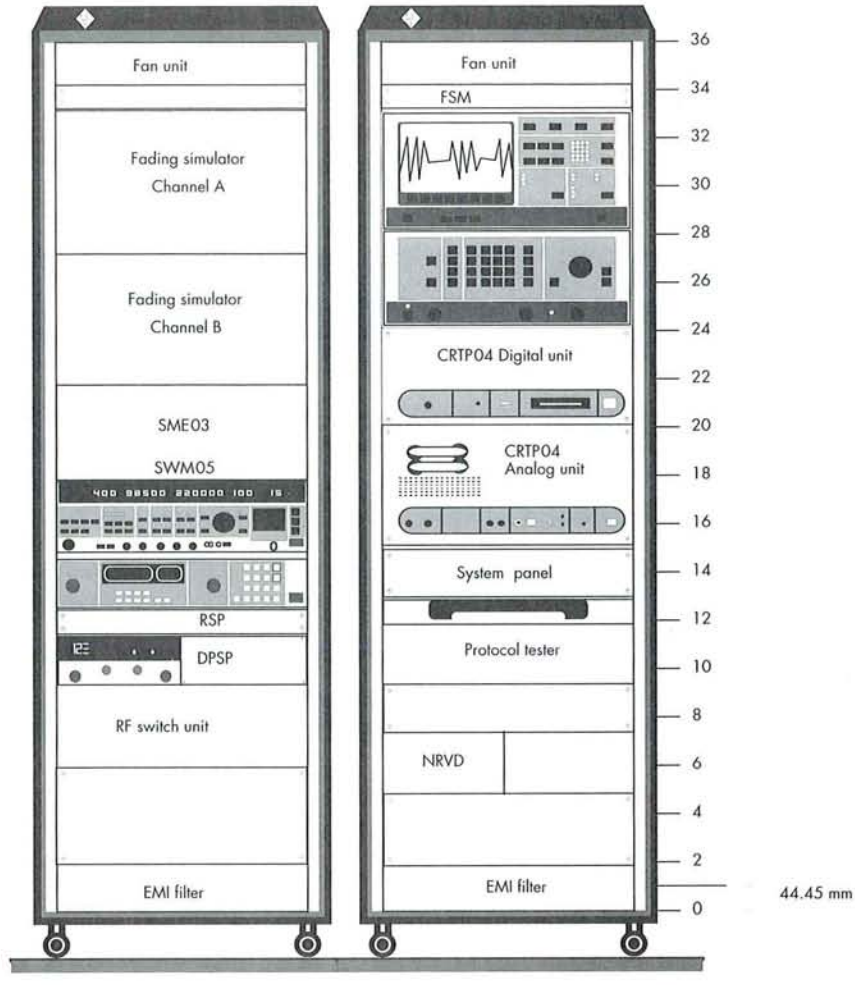
Uses

The GSM/PCN (DCS 1800) Base Station Test System TS8510 from Rohde & Schwarz is an indispensable tool for use in type-approval testing, quality assurance and development at manufacturers of GSM and PCN (DCS 1800) base stations.

With cell structures getting smaller, there is an increasing demand for base stations. In a radio network, thousands of such base stations share the scarce resources of frequency, time and space. Strict adherence to the relevant specifications is therefore a must.

With GSM Specification 11.20, the **E**uropean **T**elecommunications **S**tandard **I**nstitute (ETSI) has set up comprehensive standards for testing GSM and PCN (DCS1800) base stations, specifying more than 1000 test cases on more than five base-station interfaces.

From these standards, national standards were derived, eg BAPT 222 ZV6 for Germany and MPT 1378 for Great Britain. The type-approval specifications in these two national standards only deal with tests on the air interface and the A-bis interface of a base station. The digital A-bis interface (2048 kbit/s) handles up to 120 traffic channels of 16 kbit/s each as well as two signalling channels of 64 kbit/s each.



System configuration

The Test System is accommodated in two castered 19" racks. The Radiocommunication Test Set CRTP04 is the heart of the system, functioning both as a signalling unit and as a process controller. Using two independent signal sources, it simulates the traffic and the broadcast channel. The system's main components are:

- Radicommunication Test Set CRTP04
- Spectrum Analyzer FSM
- Signal Generator SME03
- Sweep Generator SWM05
- Fading simulator
- Protocol tester
- Power Meter NRVD

Measurement capabilities

Transmitter measurements

Following the call setup, the Test System sets the base station to the desired transmit mode via the A-bis interface. RF parameters such as power ramping, frequency accuracy, phase error etc are measured at the air interface.

In addition to the measurements in the GSM and PCN bands, the TS8510 performs further RF tests to determine spurious emissions from the base station in the frequency range 100 kHz to 12.75 GHz. The Spectrum Analyzer FSM used for these tests features an extremely high input sensitivity and an extremely low phase noise.

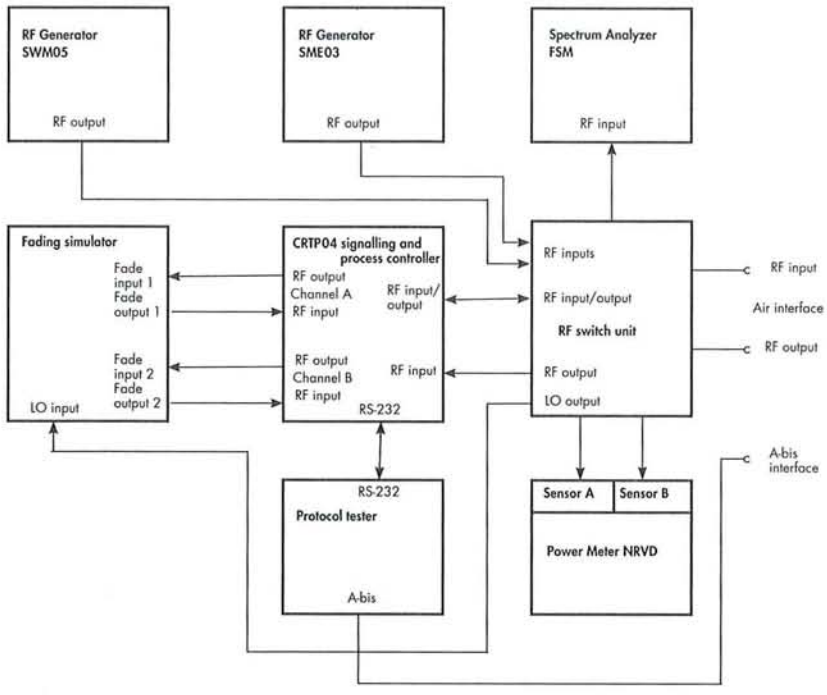
Receiver measurements

Following the call setup, the Test System sends the wanted signal along with defined interfering signals to the base station. The data are received by the protocol tester at the A-bis interface of the base station, converted and sent back to the Test System. By evaluating the bit-error rate, the TS8510 determines the receiving characteristics of the base station.

Further tests are carried out to check the base station's immunity to interference. The Signal Generator SME03 generates complex test signals such as the GMSK-modulated interference signal for testing the intermodulation and interference reference level criteria. The prominent features of the SME03 are its versatile modulation capabilities in conjunction with extremely high spectral purity and frequency hopping. The broadband Sweep Generator SWM05 is available for supplying interference signals in the frequency range up to 12.75 GHz.

A fading simulator degrades the wanted signal to simulate actual conditions in the information channel in the GSM and PCN bands. A total of twelve paths are available for channel simulation – attenuation, delay and Doppler spectrum being individually selectable for each path.

The fading simulator can be operated as a single-channel 12-path simulator or as a dual-channel 6-path simulator. In the dual-channel mode, two uncorrelated fading signals are generated. In addition to all channel models stipulated by GSM Specification 05.05, virtually any type of user-specific channel models can be simulated.



RF block diagram of Base Station Test System TS8510

System software

Convenient user interface

A menu-guided user interface makes for fast familiarization with the test system. Customized test cases guide the user through the highly complex measurements. In addition to the filing data, the test results including all system and specification tolerances are furnished in a detailed test report, allowing fast fault analysis should a DUT fail a particular test.

The standardized programming language C under the MS-DOS operating system is provided for the convenience of the system manager. It facilitates reading and modification of standard test programs as well as writing of user's own test routines. A fast compiler and a variety of debugging facilities serve for an efficient test software generation.

RF path compensation

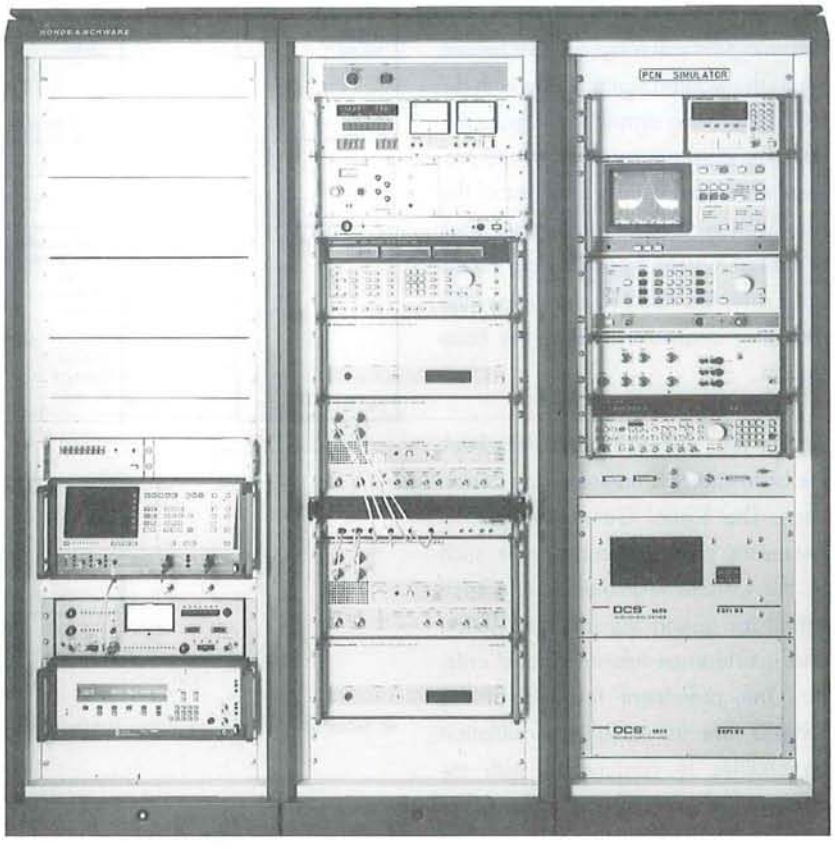
To obtain reliable test results, a high measurement accuracy is required. Therefore, the frequency-dependent attenuation of all RF components in the Test System is taken into account by a complex compensation software. The level settings of the generators as well as the receive signal parameters are corrected depending on the values measured.

System selftest

In a short system test, the IEC/IEEE-bus instruments are checked for addressability and the internal selftest is started. In addition to this routine test, eg after a calibration interval, the frequency and level accuracy as well as the filter curves of the system instruments are checked in an extended system test. Further test parameters include for example the path attenuation of RF switching units.

PCN Simulator TS 8920

Upward-compatible test system for PCN mobile phones from development to type approval



Uses

Rohde & Schwarz is a market leader in type-approval testing technology for mobile radio equipment working in Europe's digital GSM radio networks. With the PCN (DCS1800) Simulator TS 8920, a test system is now also available for PCN (DCS1800) networks, which are intended to handle a greater number of subscribers while providing better service quality. The TS 8920 puts PCN mobiles through their paces – from development through quality assurance to type approval.

The PCN Simulator is of modular design and upward-compatible. Three versions are available to satisfy the various requirements of mobile phone manufacturers and test houses. The versions can be upgraded with special kits stage-by-stage, so the test system can be extended as the complexity of measurement tasks increases. The PCN Simulator is thus suitable for use in

- design verification of PCN mobiles,
- verification of rated performance in quality assurance,
- type-approval testing of PCN mobiles.

System configuration

System core

The PCN Simulator is accommodated in two racks (versions I and II) or three racks (version III). The core of the system is the Mobile Station Test Set CRTP 02 which operates as the master and includes the process controller for the entire system. In versions II and III of the PCN Simulator, a second Test Set CRTP 02 is integrated, which acts as a slave. Each of the two CRTP 02 Test Sets of PCN Simulator versions II and III provides two independent PCN (DCS1800) carriers, which are full physical duplex channels with all the features required for PCN, such as GMSK modulation and demodulation with TDMA (time division multiple access) and frequency hopping.

The test sets perform all signalling tests, measure phase and frequency error and determine power ramping. A fading simulator can be connected to the Tx channels to simulate realistic transmission conditions.

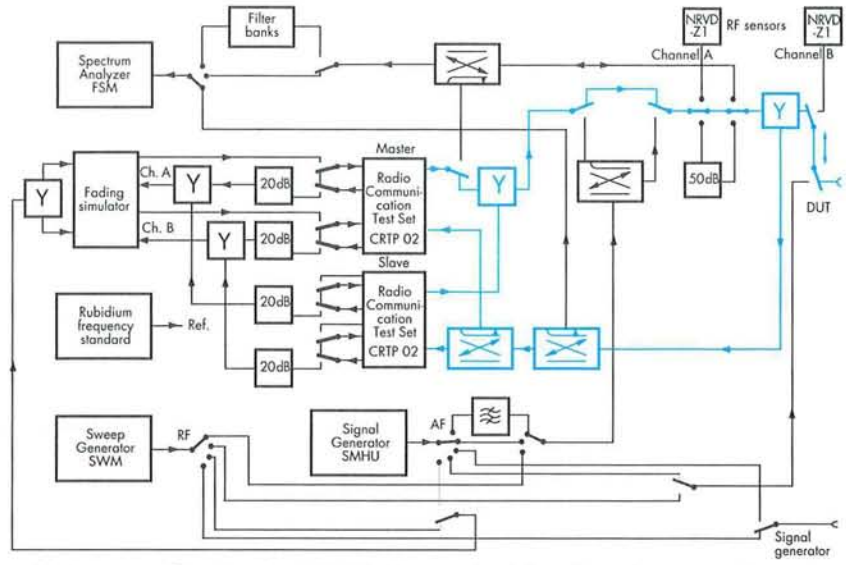
Operation (version III)

The normal signal path for a standard call setup between the PCN Simulator and a PCN mobile is shown in blue in the block diagram: the master CRTP sends a simulated downlink signal to the PCN mobile via a summing unit. The uplink signal sent by the mobile is applied to the receiver section of the CRTP via a power divider and directional coupler.

The signal traffic is displayed on the Spectrum Analyzer FSM. The FSM also measures the output spectrum and the spurious emissions from the mobile phone. For this measurement, the uplink signal is routed through complex filter banks to suppress the wanted signal which would reduce the sensitivity.

The Generators SMHU and SWM are used as local oscillator for the fading

simulator and also as interference sources for immunity and intermodulation tests. Depending on the required frequency, a signal from the SMHU or the SWM is added to the downlink signal and applied to the PCN mobile phone. The PCN Simulator serves the acoustic interface of the PCN mobile with an artificial mouth and an artificial ear; the digital audio interface is connected to a code converter which generates and receives the 104-kbit/s data stream. The Power Meter NRVD monitors the frequency-dependent attenuation of the RF components at critical points in the test system. The level settings of the generators as well as the receive signal parameters are corrected depending on the values measured.



RF block diagram of PCN Simulator TS 8920; blue: signal path for call setup between simulator and PCN mobile phone

Measurement capabilities

Version III of the PCN Simulator TS 8920 provides about 270 test routines referred to as test cases, which cover all measurements on mobile phones required to verify compliance with the rated specifications. These measurements are laid down in the Mobile Station Conformity Specification (DCS 1800) GSM 11.10-DCS and fall into the following categories:

- RF tests on transceivers, transmitters and receivers
- Link management tests
- Signalling tests (layer-2 and layer-3 functions)
- Audio tests
- Supplementary services tests

Transceiver tests

These tests focus on spurious emissions. The PCN mobile should transmit in a defined frequency band at defined times and at the required RF power. Any other emissions are undesirable and should remain below specified thresholds.

Transmitter tests

They check for instance power ramping and the quality of the RF output signal, as well as the mobile phone's ability to synchronize itself to the transmit frequency of the base stations even when reception is poor.

Receiver tests

They check the sensitivity of PCN mobiles and their immunity to spurious signals in the message and adjacent channels or at any other frequency between 100 kHz and 12.75 GHz. The bit error rate, for instance, is a measure of the mobile's ability to decode information correctly, even under adverse conditions.

Link management tests

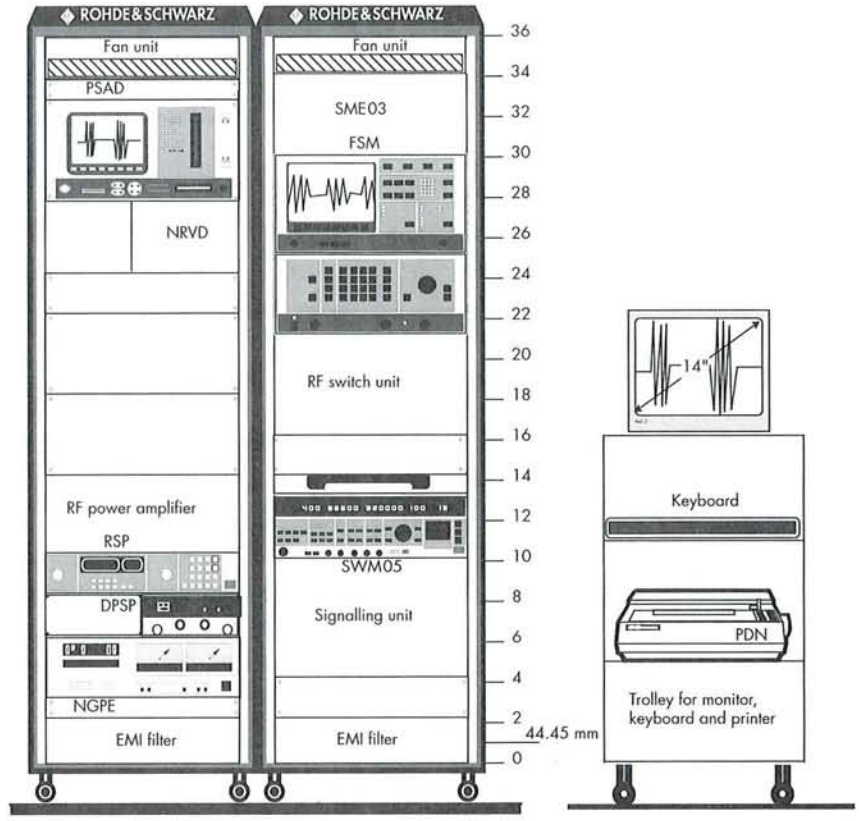
This is essentially a check of the mobile's ability to synchronize itself to the base station. For instance, if two mobile phones communicate with a base station in adjacent time slots at the same frequency, their signals may overlap as a result of different propagation times. This effect is avoided by making the mobile with the longer propagation time transmit earlier by an appropriate interval. In one test case, the PCN Simulator causes the mobile phone to vary its transmit start time within a time slot. The actual time at which transmission occurs is measured by the simulator and checked against the nominal timing.

Signalling tests

For testing the layer-2 functions, the message contents are deliberately modified, data blocks omitted and time limits under- or overranged in order to test the mobile's reaction. The layer-3 tests check the quality of the call setup and the associated messages, handover from one base station to the next, and correct ciphering and emergency-call characteristics.

DECT Type-approval Test System TS8930

Test system for type-approval testing of DECT cordless telephones to TBR06



Uses

The Rohde&Schwarz Test System TS 8930 allows type-approval measurements to ETSI specification TBR06 on cordless telephones of the DECT standard. This test system helps manufacturers of DECT cordless telephones to pass the type-approval test on the first attempt already and thus to gain advantages on the market. For test houses, the TS8930 means a test system which is able to check cordless telephones to a standard that is valid in the whole of Europe.

System configuration

The test system is accommodated in two castered 19" racks. A trolley is provided for the input/output peripherals such as keyboard, monitor and printer. The main system components are:

- DECT signalling unit (partly integrated in Process Controller PSMD)
- Spectrum Analyzer FSM
- Signal Generator SME03
- Sweep Generator SWM05
- Power Meter NRVD
- Process Controller and Sampling Unit PSMD

Measurement capabilities

Transmitter measurements

- Accuracy and stability of RF carriers
- Time jitter
- Referenced time accuracy
- Transmission burst
- Transmitted power
- RF carrier modulation, parts 1 to 4
- Modulation, transients and intermodulation performance
- In-channel spurious emissions

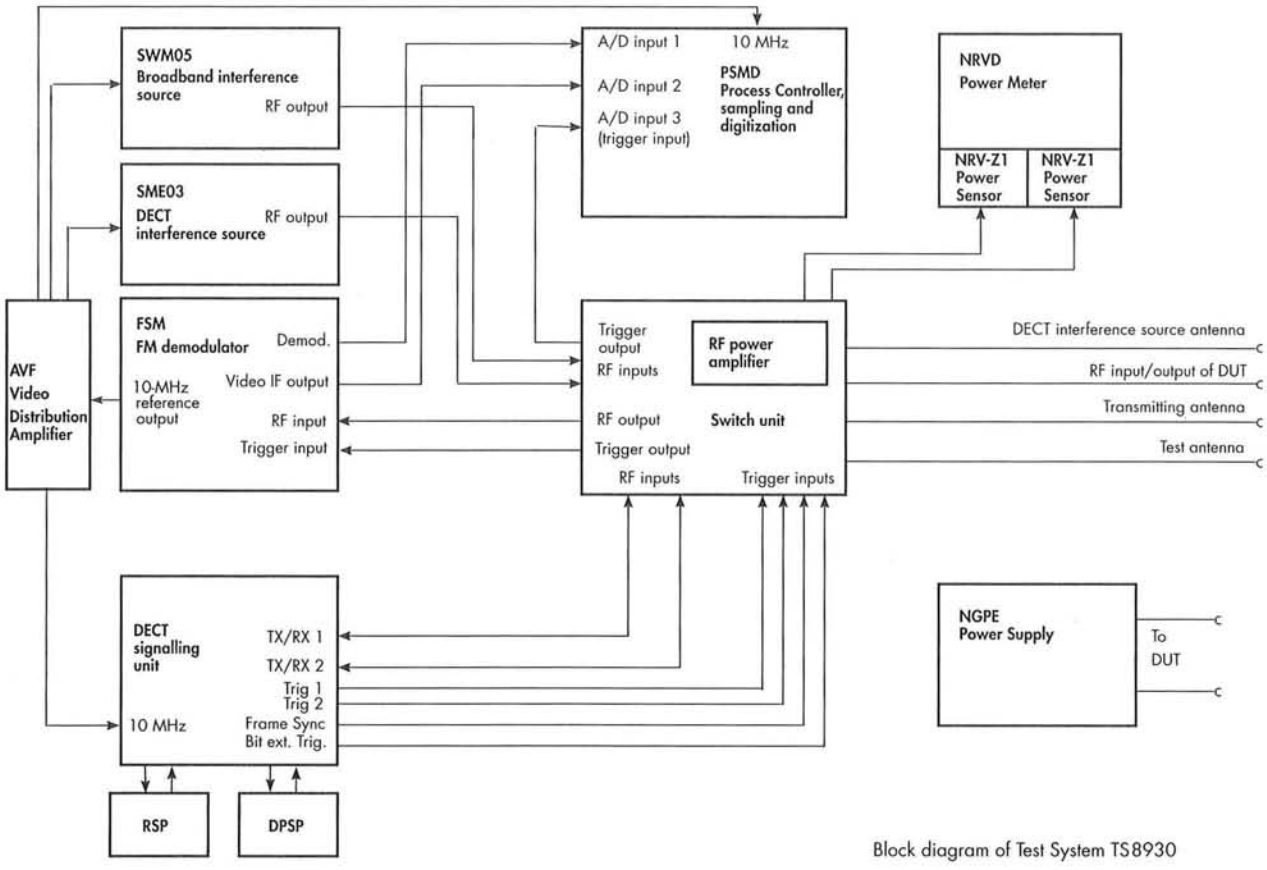
After the call setup with the device under test, the test system sets the DUT to the loopback mode, whereupon the DUT receives data from and sends them back to the test system. These data are evaluated by the TS8930:

- Demodulation by broadband demodulator of the FSM (model 55); the FSM is also used for measuring spurious emissions
- A/D conversion, sampling and digitization as well as computation of the frequency and deviation of the test signal in Process Controller PSMD

An i860-RISC processor makes for the high computing power of the PSMD that is required for realtime evaluation of the test parameters, ie a frequency and deviation measurement is made every 5 ms.

Receiver measurements

- Sensitivity
- Interference performance



Block diagram of Test System TS8930

- Intermodulation performance
- Blocking
- Out-of-channel spurious emissions

After the call has been set up and the DUT switched to the loopback mode, the test system reduces the transmitted power and measures the bit error rate (BER) of the DUT. The Signal Generator SME03 and the Sweep Generator SWM05 generate the interference signals required to measure the BER for determining the interference and intermodulation performance. A 50-W RF amplifier produces the noise level at the receiving site that is required for blocking measurements via the antenna.

System software

Windows 3.1 interface

A menu-guided user interface under Windows 3.1 makes for fast familiarization with the test system. Customized tests guide the user through the highly complex measurements. In addition to the filing data, the test results including all system and specification tolerances are furnished in a detailed test report, allowing fast fault analysis should a DUT fail a particular test.

The standardized high-level programming language is provided for the convenience of the system manager. It facilitates reading and modification of standard test programs as well as writing of user's own test routines. A large variety of debugging facilities support testing.

RF path compensation

To obtain reliable test results, a high measurement accuracy is required. Therefore, the frequency-dependent attenuation of all RF components in the Test System is taken into account by a complex compensation software. The level settings of the generators as well as the receive signal parameters are corrected depending on the values measured.

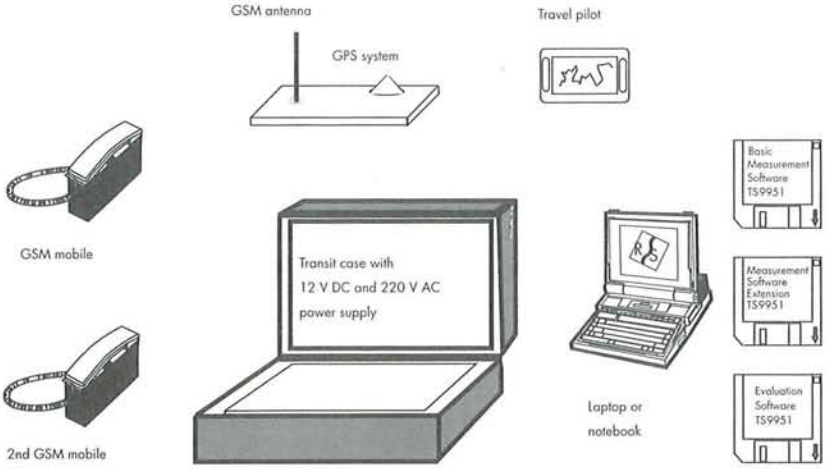
System selftest

In a short system test, the IEC/IEEE-bus instruments are checked for addressability and the internal selftest is started. In addition to this routine test, eg after a calibration interval, the frequency and level accuracy as well as the filter curves of the system instruments are checked in an extended system test. Further test parameters include for example the path attenuation of RF switching units.

Portable GSM Coverage Measurement System TS9951

Only measurements ensure

reliable radio coverage



Uses

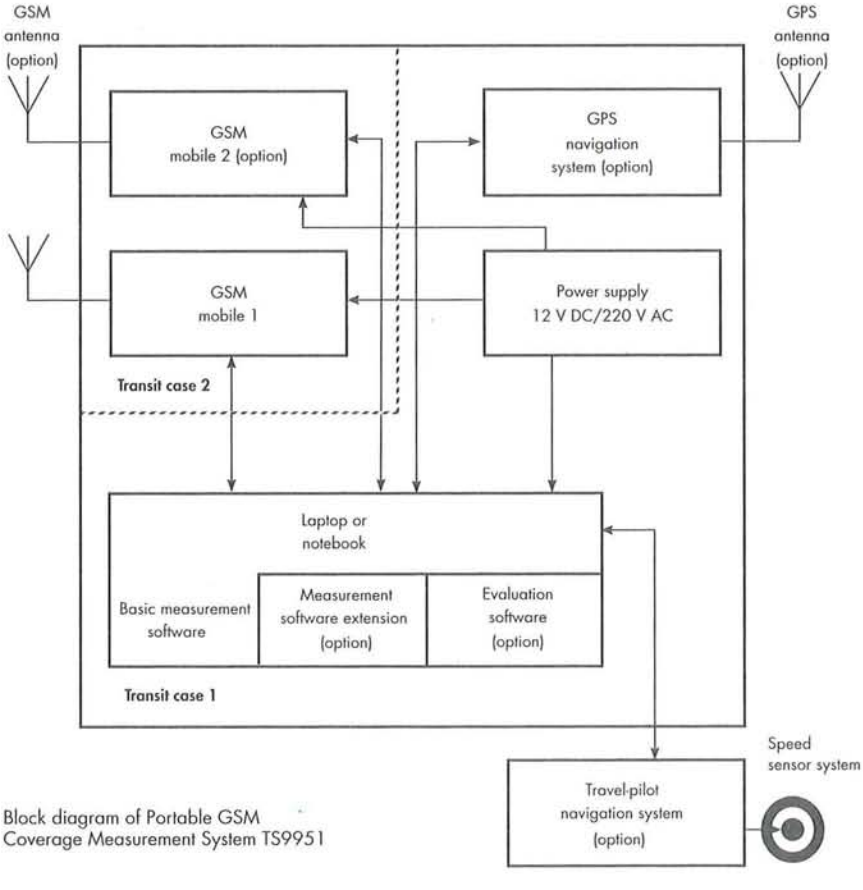
The Portable GSM Coverage Measurement System TS9951 from Rohde & Schwarz has the same functionality as large test systems but it is mobile and extremely compact thanks to the use of a laptop or notebook and a special test mobile.

Applications

- Verification if prediction software alone is not sufficient
- Use as additional portable measurement equipment when there is a lack of test vehicles for the required coverage measurements
- Checking of the actual network situation in the case of service problems and customer complaints
- Upkeep of a permanent network quality thanks to mobile quality assurance

Without radio coverage measurements there is no safe assessment of the actual coverage quality of a mobile radiocommunication network. Although prediction tools can yield the best transmitter sites for ensuring sufficient fieldstrength over the coverage area concerned, pure calculation of the fieldstrength to be expected shows its limitation when dealing with a topology featuring high mountains and deep valleys.

What counts is the real-life situation of the cellular network as the mobile subscriber demands communication without interference under full fieldstrength coverage. However, verification of these crucial criteria requires appropriate coverage measurement equipment. This becomes even more important with higher frequencies (propagation along straight lines and hence stronger fading effects) and smaller radiocells.



Block diagram of Portable GSM Coverage Measurement System TS9951

Moreover, pure fieldstrength calculation is no longer sufficient for digital networks like GSM with its complex digital modulation methods. Effects such as signal reflection due to multipath propagation and problems with protocol processing must be investigated since only an analysis of this type allows the correct measures to be taken for error elimination.

System configuration

- Laptop or notebook
  - Processor 386 or 486
  - 4-Mbyte RAM, 16-kbyte cache memory
  - 80-Mbyte harddisk
  - 3.5" floppy drive
  - Colour TFT display
  - Keyboard, mouse
  - 3 series and 1 parallel interfaces
- GSM test mobile with radio antenna (alternatively test mobiles for DCS 1800, AMPS, TACS, NMT ... on request)
- Rugged transit case with built-in measuring equipment and power supply
- Power supply for connection to 220-V mains or via cigarette lighter
- Software
  - Measurement software with on-line graphics
  - MS-DOS 5.0
  - MS-Windows 3.1

Measuring capabilities

Standard functions

- Recording of GSM signalling together with OSI layers 2 and 3
- Graphic on line display of GSM test report, ie RXLEV and RXQUAL of serving cells and RXLEV of adjacent cells
- On line display of continuous signalling
- Automatic call setup and clearing with telephone number to be dialled and time to be set for call duration and pauses
- Permanent measurement operation with automatic data backup during measurement
- Manual mode with possibility of the user's direct access
- Entry of seven predefined events and one additional event to mark critical measurement situations

Extended functionality in measuring mode (software option)

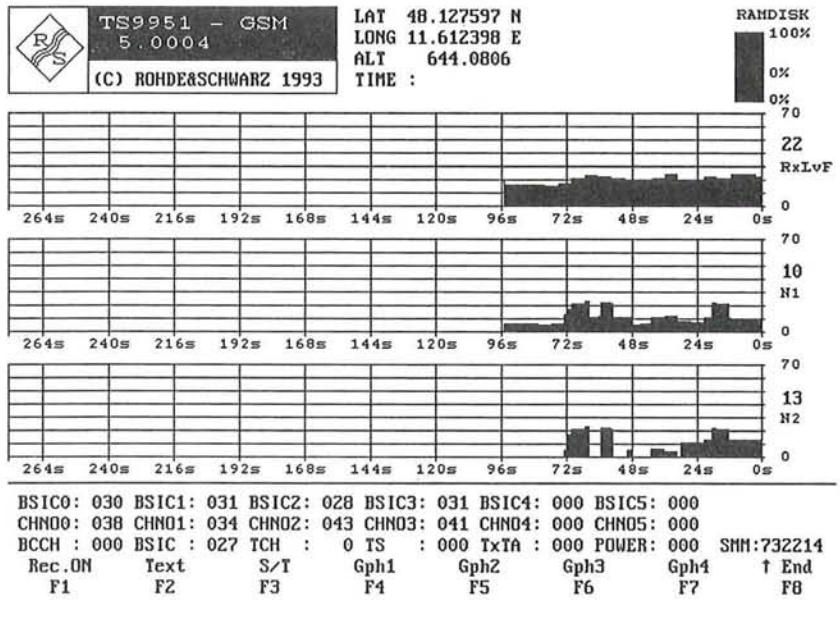
- Blocking of handover to measure cell borders
- Handover activated by user
- Decoding of basic layer-3 messages, eg Sys Type info 1 to 4

Extended functionality in evaluation mode (software option)

- Cartesian representation of test report, ie RXLEV and RXQUAL of serving cell and RXLEV of adjacent cells with marking of
  - handover,
  - cell reselection and
  - call aborts

  indicating in each case BSIC, ARFCN and time slot (before, after) including error cause when failing
- Free selection of scaling with cartographic representation
- Selection of coordinate system with cartographic representation, the following systems being supported:
  - Gauß-Krüger,
  - UTM North,
  - UTM South,
  - AS6 Grad,
  - geographical coordinate net,
  - geographical decimal coordinate net,
  - EOV (Hungary) and
  - Swiss coordinate system

  (others on request)
- Graphic representation of page limits and selection of pages to be plotted
- Output of legend on a separate sheet (plotter or printer)



On line graphics display in measuring mode

Portable GSM Coverage Measurement System TS9951

- Output of several test drives in a cartographic evaluation
- Representation of GSM signalling of OSI layers 2 and 3 with time markers and interlayer primitives in a message monitor
- Decoding of layer-2 and layer-3 messages, partly as text files, the rest always as HEX dumps
- Search function in the message monitor using the following criteria:
  - interlayer primitives
  - layer-2 message
  - layer-3 message
  - message contents
  - time domains
- Output of search results in a separate file or as a printout
- Output of ASCII data with time of day, geographical position (GPS option only) on display or on data carrier
  - layer messages fully decoded or in hexadecimal code
  - RXLEV, RXQUAL
  - events
- Suppression of halt times

Options

GPS navigation system
The satellite navigation system GPS is a stand-alone system for position finding. It consists of 18 (24 when fully implemented) geostationary satellites in orbit which are controlled and operated by the US Department of Defense (DOD), general civil use being permitted.

The receiving system comprises a satellite antenna and a receiver module. The receiver is able to receive the position coordinates of several satellites at the same time. An integral computer determines the exact position of the terrestrial measuring equipment. These data plus the additional time information are transferred to the process controller of the measuring system which relates them to the measurement results of the mobile.

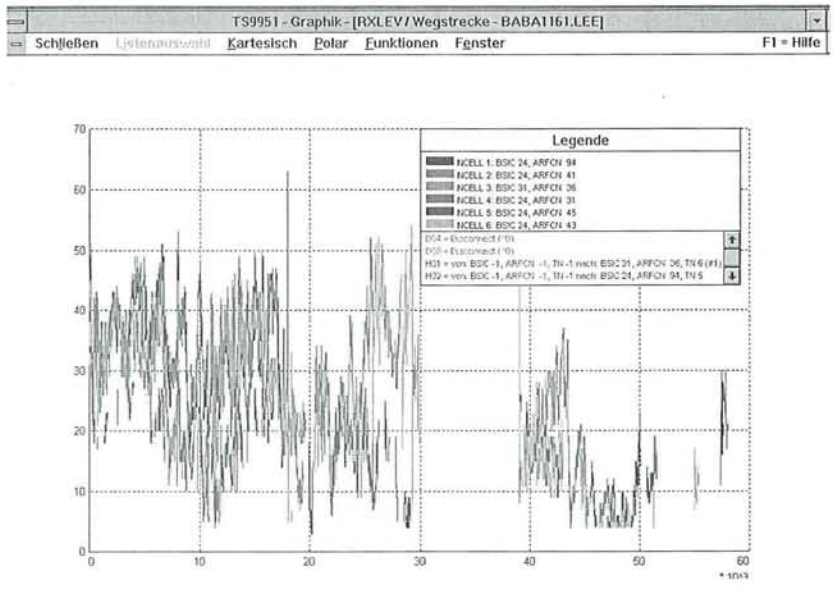
A special installation in the test vehicle is not necessary. The antenna with a magnetic foot is easily mounted on the roof of the vehicle.

The absolute long-term accuracy according to DOD is 107 m. Values of approx. 20 m have been obtained for measurements over a short period of time as they are usually performed.

Travel pilot
Like the GPS system, the travel-pilot system is a navigation system for automatic determination of position coordinates. In contrast to GPS, digitized road maps stored on CD ROMs are used. After entering the start position, the relevant coordinates are output. To determine the displacement vector which controls data access, a sensor system consisting of a compass and a speed sensor is used. This sensor system must be installed in the vehicle by an authorized car workshop.

The advantage of the system is that measurements can also be performed in tunnels or areas obstructed to satellite coverage whereas the disadvantage is that only predefined digitized routes can be represented and used as a backup. User-digitized routes cannot be stored on the CD ROM in addition.

Second GSM test mobile
If a second GSM test mobile is used, comparison measurements of two adjacent cells are possible. Both the measuring and the evaluation software can be extended for this application.



Cartographic representation of measurement results

Training

The complete system software is easy to operate, no programming experience being required at all. Operation is possible even without training just by resorting to the user manual. To afford a fast operation, the measurement software comes in a menu technique with on-line graphics. The evaluation software runs as a Windows application and is operated like any other Windows program.

For faster familiarization with the system and acquiring a deeper knowledge of coverage measurements, Rohde & Schwarz offers a one-day training for the TS9951 system. This training takes place at the Rohde & Schwarz training center but may also be held at the customer's. The customer is trained on the equipment bought, practical measurements being performed under the tuition of Rohde & Schwarz engineers.

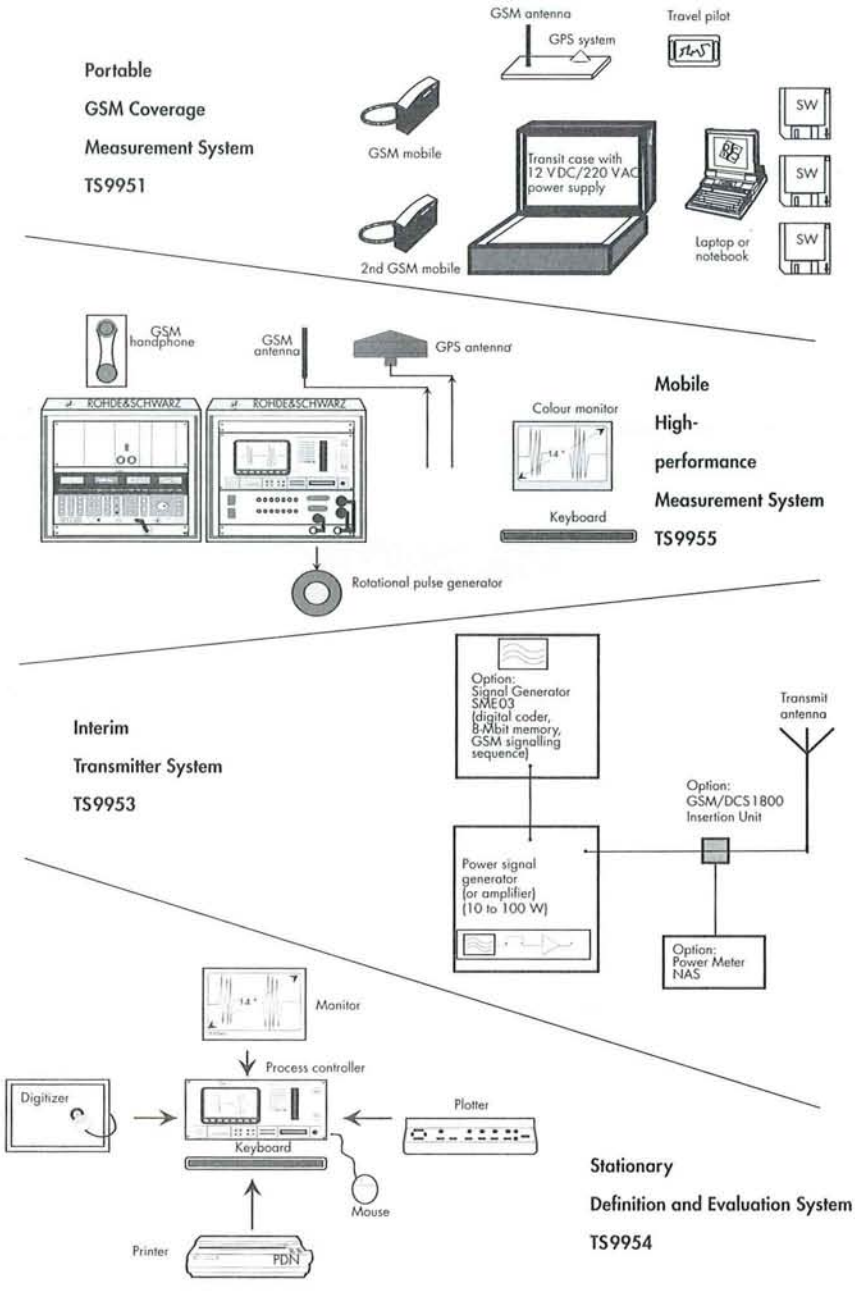
Other coverage measurement systems

Rohde & Schwarz offers a complete system family from the portable coverage measurement equipment through to the high-performance system. Data exchange between the different systems and creation of a common data base are both possible.

For comprehensive data evaluation, the Definition and Evaluation System TS9954 is available (catalog 93/94, page 376). In most cases, it is used in stationary operation; the results are output on a printer and plotter.

The user interface – an easy-to-operate Windows application – is identical for all systems so that changing over to another system requires no supplementary knowledge or training.

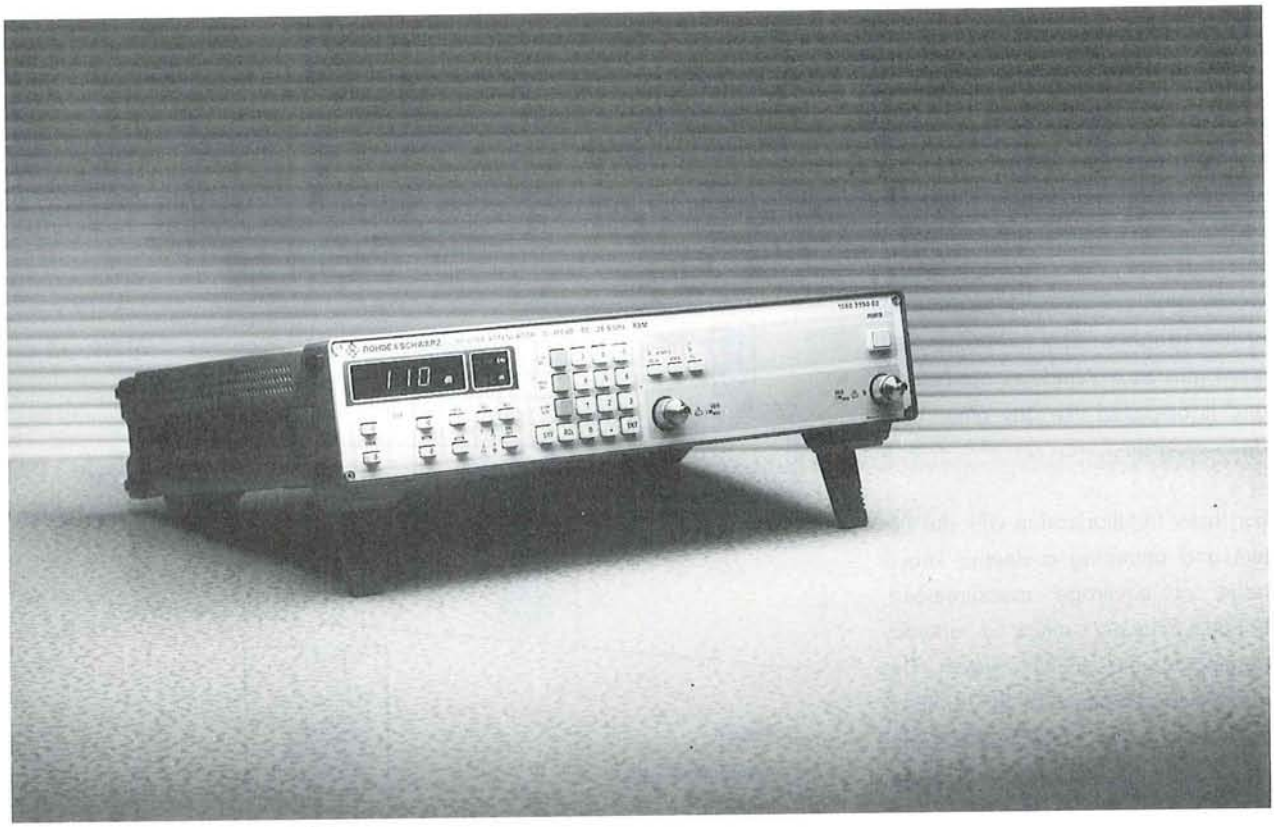
In addition, test transmitter systems (CW and with signalling) are available in particular for the installation phase both for analog and digital nets (eg TS9953, catalog 93/94, page 378).



Coverage measurement systems from Rohde & Schwarz – an overview

For further information on training, support and service

See catalog 93/94, chapter 11.



RF Step Attenuator RSM up to 26.5 GHz

Contents of Chapter 12

Following this chapter, you will find …

Power Supply NGSM 32/10

0 to 18 V/10 A (20 A)

0 to 32 V/5 A (10 A)

Tailored to the needs of car electronics applications in service, laboratory and production

Uses

Power Supply NGSM 32/10 from Rohde & Schwarz is a versatile supply and measuring unit for testing electronic car components by simulating real operating conditions. In addition to a wide field of car electronics, it can also be used in mobile radio and car hifi applications. Due to its compact design, the Power Supply takes up only one half 19" width. A 19" adapter is available for mounting the NGSM into test racks.

Main features

- Excellent RF shielding, accurate standby current measurement – ideal for mobile radio applications
- Trend indication for current measurements
- Car electronics testing by simulating motor startup
- Currents up to 20 A for car hifi applications
- Storage of max. 12 device setups for short tests
- Device under test protected against erroneous settings by ON/OFF output key
- IEC/IEEE bus or RS-232 interface for use in production environments (optional)
- Acoustic signal upon changeover from voltage to current regulation – ideal for long-time testing
- Great ease of operation despite numerous functions

Application-specific characteristics

Car electronics

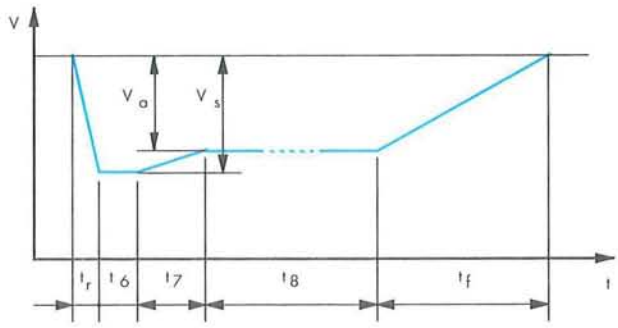
The NGSM is a precise and, thanks to its versatility, an extremely economical tool for use in the production of electronic car components. With the aid of an IEC/IEEE-bus or RS-232 interface (optional) the Power Supply can readily be integrated into in-line production systems. The startup curve in line with DIN 40839 can be adapted to other factory standards by reprogramming it. It is customary for high surge currents to occur in typical applications, such as central locking or ABS, but with a pulse current of up to 30 A, the NGSM is ideally prepared for these applications.

Mobile radio systems

Mobile phones are either operated as handies or from the car supply, thus placing specific requirements on the power supply:

- Ready status should be very long in standby and in transmit/receive mode
- Reliable function, even in case of typical onboard supply fluctuations

The high resolution for current measurements allows the maximum operating time of a handy to be accurately predicted; typical voltage drops during the startup of a car can be simulated. The Power Supply NGSM is insensitive to the RF voltage conducted from



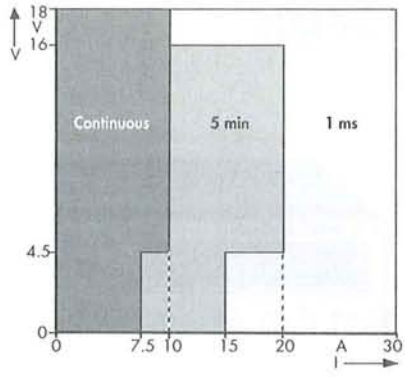
Startup curve to DIN 40839

a device under test or radiated from a nearby antenna.

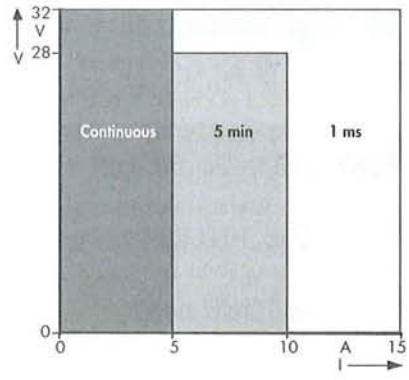
The trend indication of current can be used to check the transmit function of a mobile very simply. The experienced technician will for instance immediately recognize whether a Net-C phone has registered. The peak current measurement allows the achieved transmit power to be indirectly estimated and to detect any malfunctions of the mobile from the ratio of peak current to average value. The high power reserve of the NGSM also covers the current required by additional peripherals.

Car hifi

With a short-term load current of 20 A even boosters can be reliably supplied. Instruments for 12-V and for 24-V onboard supplies can both be operated; peak current measurements allow the power loading of devices to be predicted. Simulation of the startup curve to DIN 40839 is also very useful in car hifi applications, eg to spot problems due to unexpected data loss of theft-proof car radios with security code.



Current loadability in 18-V range



Current loadability in 32-V range

Simple arbitrary generator

The NGSM can also be used as a simple arbitrary generator – but with the high output power of a power supply unit. Up to 60 reference values are available per voltage range which have to be programmed at intervals of 1 ms to 4 s. The NGSM automatically interpolates between two values.

Operation

The Power Supply NGSM features a large-size, extremely easy-to-read display and simple operation despite its versatile functions. It always stores the last instrument setting used. Up to 6 individual settings as well as the data of the arbitrary generator can be stored for each voltage range and recalled whenever required. Faults during operation are immediately displayed and an acoustic alarm is also given; for protection of the DUT in the event of a fault, the user can choose between the constant-current mode or automatic switch-off. The sensing lines are provided with an integrated protection against wrong polarity for added safety.

Specifications

Voltage range	0 to 18 V	0 to 32 V
Characteristics as a constant-voltage source		
Voltage setting	0 to 18.00 V	0 to 32.00 V
Resolution	10 mV	10 mV
Deviation from full scale	<0.4%	<0.2%
with ±10% AC supply var.	<0.01%	<0.01%
between 0 and 45°C	<0.02%/°C	<0.02%/°C
from 10 to 90% load current	0.01%	0.01%
Transient recovery time upon load change	0.1 ms	0.1 ms
PARD, voltage rms	1 mV	1 mV
Characteristics as a constant-current source		
Current setting	0 to 20.0 A	0 to 10.0 A
Resolution	100 mA	100 mA
Deviation from full scale	<0.5%	<0.5%
with ±10% AC supply var.	<0.02%	<0.02%
between 0 and 45°C	<0.05%/°C	<0.05%/°C
from 10 to 90% load current	0.1%	0.1%
PARD, current rms	10 mA	5 mA
Current loadability	see diagrams above	
Continuous current	0 to 10 A	0 to 5 A
Surge current (max. 5 min)	0 to 20 A	0 to 10 A
Pulse current (max. 1 ms)	0 to 30 A	0 to 20 A
Display		
Voltage measurement	0 to 40.00 V	0 to 40.00 V
Resolution	20 mV	20 mV
Deviation from full scale	<0.2%	<0.2%
between 0 and 45°C	<0.02%/°C	<0.02%/°C
Measurement rate	10/s	10/s
Current measurement in mA range	0 to 40.0 mA	0 to 40.0 mA
Resolution	0.1 mA	0.1 mA
Deviation from full scale	<0.5%	<0.5%
between 0 and 45°C	<0.1%/°C	<0.1%/°C
Current measurement in A range	0 to 40.0 A	0 to 40.0 A
Resolution	100 mA	100 mA
Deviation from full scale	<2%	<2%
between 0 and 45°C	<0.2%/°C	<0.2%/°C

General data

Outputs	max. 120 V DC, floating
IEC-625/IEEE-488 interface	optional: listener/talker
19" adapter	optional: 3 HU, 2.8 kg
Voltage compensation	0.5 V per lead (remote sensing)
AC supply	110/120/220/240 V ±10%, 50 to 60 Hz, 690 VA
Dimensions (W x H x D); weight	211 mm x 150 mm x 350 mm; 8 kg

Ordering information

Power Supply	NGSM32/10	0192.0810.31
Options		
IEC-625/IEEE-488 Interface	NGSM-B2	0192.0810.02
RS-232 Interface	NGSM-B1	0192.0810.01
19" Adapter	NGSM-B0	0192.0810.00

RF Step Attenuators RSM, RSN and RSH

RSM: DC to 26.5 GHz

0 to 110 dB

in 10-dB steps

RSN: DC to 18 GHz

0 to 11 dB

in 1-dB steps

RSH:

DC to 5.2 GHz

0 to 139 dB

Uses

Attenuator sets are two-port networks providing adjustable high-precision attenuation and the same constant characteristic impedance at the input and output. They are used for gain, attenuation and linearity measurements. They also generate very small and accurately-known voltages if a precisely determined input voltage is available.

The RF Step Attenuators RSM and RSN can be combined with other IEC/IEEE-bus-compatible measuring instruments to set up fully or semi-automatic test systems which are mainly used in production and test departments.

Main features

- Frequency range up to 26.5 GHz
- Long lifetime (more than 5 x 10^6 switching cycles per section)
- High accuracy
- Excellent matching
- Low residual attenuation
- Fully isolated
- Display of correction values (RSM, RSN)
- Programmable (RSM, RSN)
- Manual operation
- Characteristic impedance 50 Ω
- Continuous power-handling capacity 1 W

Characteristics

The accuracy of the selected attenuation values depends on the accuracy of the resistors used in the attenuator pads; therefore, very close tolerances have been chosen for these resistors. In addition, with high attenuations, ie very low output voltages, a precondition for accurate voltage division is that power should not be coupled directly from the attenuator input to the output. This condition is fulfilled thanks to an effective shielding.

All attenuators are designed for 50-Ω line systems; they can be adapted to 75 Ω with the aid of Matching Pads RAM (catalog 93/94, page 427).

Operation of RSM, RSN

High accuracy

Correction data for the whole frequency range are determined in the factory at 200-MHz intervals (RSN: 100 MHz) and stored in the first of four nonvolatile memories. The three remaining memories may be used for storing user's correction values. This allows attenuators connected ahead or cable losses to be taken into account. Using the integrated memory for correction values, the factory-determined deviation of the actual attenuation from the nominal value is displayed (REL mode). In the ABS mode, the value displayed is the sum of correction value and residual attenuation.

Short setting time

The attenuation settings are made with electromagnetic switches. The setting times are very short and always of the same duration since all attenuator pads necessary for obtaining a specific attenuation are switched at the same time.

Switching on/off

During the switch-on routine, the attenuator is set to a frequency of 0 MHz and an attenuation of 40 dB (RSN to 10 dB), the attenuation being in no case lower than this value. A selftest is then carried out, during which the stored correction values (for maximum values and measurement accuracy of RSM and RSN see tables next page) are determined from their checksum.

Upon switching off, the maximum values of 110 dB and 11 dB, respectively are obtained. The value set before switching off can be recalled at any time. During the switchover between two attenuation values, it is ensured that no lower values are set.

Operation of RSH

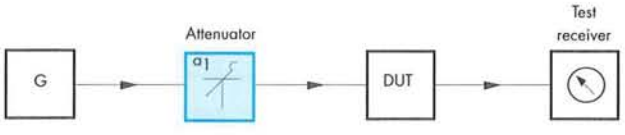
The attenuation value of the RSH can be set manually from 0 to 139 dB in 10-dB and 1-dB steps by means of two rotary switches. Operation of RSH is purely mechanical and the model is fully independent of any power supply.

Construction of RSM, RSN

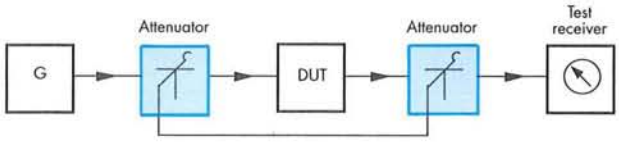
The RF Step Attenuators are accommodated in a compact 19" case suitable for use as a rackmount in test assemblies or as a bench model. The user may refit the connectors from the front to the rear panel of the attenuators, the RF characteristic being not affected. RSM and RSN are equipped with connector interfaces which can be fitted with different connector systems without adapters being required. Since the attenuator module is electrically isolated from the device itself, the attenuator elements themselves have no ground or AC supply connections. Therefore, the RF Step Attenuators can also be used with very small DC voltages and low-frequency AC voltages.

Construction of RSH

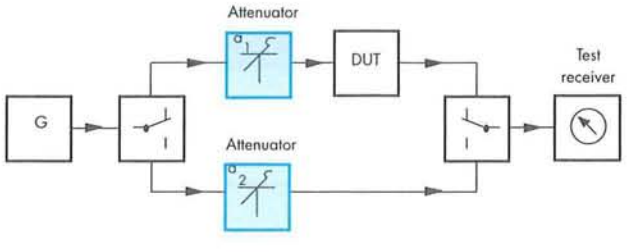
Thanks to the special design of the plastic case, RSH can be operated either upright or lying flat. A test report stating the attenuation values of every attenuation pad as well as the residual attenuation is supplied with each RSH.



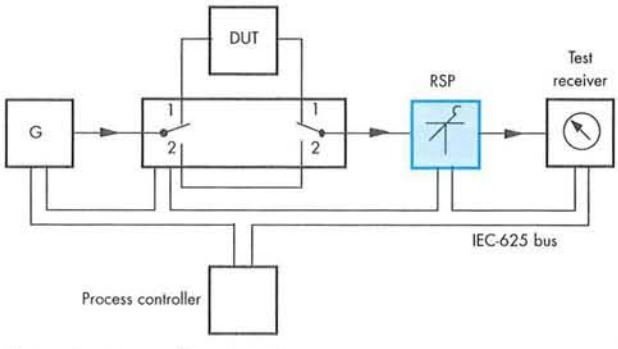
Test setup for gain and attenuation measurements (series configuration)



Test setup for measuring the linearity of two-port networks



Test setup with reference attenuator for high-precision gain and attenuation measurements (parallel configuration)



Automatic test system for gain and attenuation measurements using programmable RF step attenuator

RF Step Attenuators RSM, RSN and RSH

Specifications

	RSM	RSN	RSH
Frequency range	DC to 26.5 GHz	DC to 18 GHz	DC to 5.2 GHz
Attenuation range	0 to 110 dB	0 to 11 dB	0 to 139 dB
Smallest step	10 dB	1 dB	1 dB
Residual attenuation (0-dB position)	≤(0.8 + 0.09 x f) dB [f in GHz]	≤(0.8 + 0.09 x f) dB [f in GHz]	DC ≤0.1 dB ≤1 GHz ≤0.7 dB ≤2.7 GHz ≤1 dB ≤5.2 GHz ≤1.6 dB
Maximum attenuation error (in dB + % of attenuation value)	see 1st table below	see 2nd table below	≤1 GHz ±(0.2 dB + 1%) ≤2.7 GHz ±(0.4 dB + 1%) ≤5.2 GHz ±(0.6 dB + 1.3%)
Correction data stored for each attenuation setting	at 200-MHz intervals (804 values) maximum values and accuracy see 1st table below	at 100-MHz intervals (2172 values) maximum values and accuracy see 2nd table below	–
VSWR (f in GHz)	≤4 GHz ≤1.25 ≤8 GHz ≤1.35 ≤12.4 GHz ≤1.4 ≤20 GHz ≤1.7 ≤26.5 GHz ≤2	≤4 GHz ≤1.3 ≤8 GHz ≤1.4 ≤12.4 GHz ≤1.5 ≤18 GHz ≤1.8	≤3.5 GHz ≤1.1 + 0.2 x f ≤5.2 GHz ≤1.8
Power-handling capacity, continuous	1W	1 W	1 W
pulse	50 W/10 µs, duty cycle 10^{-3}	50 W/10 µs, duty cycle 10^{-3}	200 W/10 µs, max. 150 V
Life	>5 x 10^6 switching cycles *)	>5 x 10^6 switching cycles *)	>1 x 10^6 switching operations
Switching time	≤20 ms	≤20 ms	–
Selftest	checking of correction values	checking of correction values	–
Power supply	100/120/220/230 V ±10%, 47 to 420 Hz	100/120/220/230 V ±10%, 47 to 420 Hz	–
Dimensions (W x H x D)	435 mm x 103 mm x 376 mm	435 mm x 103 mm x 376 mm	248 mm x 135 mm x 76 mm
Weight	5.3 kg	5.3 kg	1.2 kg

Ordering information

RF Step Attenuator (Type: Order No.)		RSM: 1060.3990.02	RSN: 1066.6010.02	RSH: 1060.6518.02
Extras	RSM, RSN, RSH	Microwave cable and adapter set (DC to 26.5 GHz), 1 m, adapter for N male connector	1046.2002.02
		Matching Pad RAM (50/75 Ω)	0358.5414.02
	RSM, RSN	Adapter for 3.5-mm PC connector	1021.0529.00
		Adapter for N male connector	1021.0541.00

RSM: Upper limits and measurement error of correction values

Frequency	Attenuation (referred to 0-dB position)								
	10	20	30	40	50	60	70 to 80	90 to 110	dB
≤8 GHz	±0.3	±0.4	±0.5	±0.5	±0.7	±0.8	±1.0	±1.5	dB
≤12.4 GHz	±0.4	±0.6	±0.7	±0.7	±0.9	±1.2	±1.4	±2.1	dB
≤18 GHz	±0.5	±0.7	±0.9	±0.9	±1.2	±1.4	±1.8	±2.7	dB
≤26.5 GHz	±0.7	±0.9	±1.0	±1.5	±1.8	±2.1	±2.9	±3.7	dB

Frequency	Measurement error of correction values for			
	0 to 40	50 to 80	90 to 110	dB
≤26.5 GHz	±(0.2+0.004 x A)	±(0.4+0.008 x A)	±(0.6+0.013 x A)	dB

RSN: Upper limits and measurement error of correction values

Frequency	Attenuation (referred to 0-dB position)									
	1	2	3	4	5	6	7 to 8	9 to 10	11	dB
≤8 GHz	±0.15	±0.15	±0.2	±0.2	±0.2	±0.25	±0.25	±0.3	±0.3	dB
≤12.4 GHz	±0.2	±0.25	±0.35	±0.35	±0.35	±0.4	±0.45	±0.5	±0.55	dB
≤18 GHz	±0.3	±0.4	±0.45	±0.45	±0.45	±0.5	±0.55	±0.65	±0.7	dB

Frequency	Measurement error of correction values for	
	0 to 11	dB
≤8 GHz	±0.15	dB
≤18 GHz	±0.2	dB

*) A switching cycle is defined as a switchover from one setting to another and back again.

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