Catalog Contents

Competence in Test and Measurement, Radiocommunications and Broadcasting

From our principles

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

Who we are and what we do

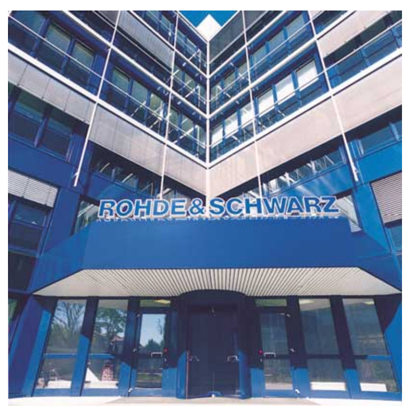
Rohde & Schwarz is an internationally active company in the fields of radiocommunications and test and measurement. For more than 60 years the company group has been developing, producing and marketing a wide range of electronic products for the capital goods sector. The company is headquartered in Munich. With 5000 employees worldwide and subsidiaries and representatives in over 70 countries around the world, the Rohde & Schwarz group achieves an annual turnover in excess of 1.6 billion DM. The company is highly export-oriented: More than 70% of the total turnover is achieved outside Germany. Due to the comprehensive know-how and the innovative strength of its employees, Rohde & Schwarz is among the technological leaders in all of its business fields.

Today the Rohde & Schwarz group of companies is active in the following fields:

- Test and measurement
- Radiocommunications systems
- Mobile radio
- Broadcasting
- Radiomonitoring and radiolocation
- IT security
- Services

The quality and environmental management system of Rohde & Schwarz has been certified to DIN EN ISO 9001 and 14001 and complies with the standards of AQAP 110 and 150. The company has approval for the development, production, installation and servicing of avionic communication equipment and is the first German transmitter manufacturer authorized to carry out BZT (Federal Approvals Office for Telecommunications) approval testing for radio transmitter systems.

Our business fields and products



Test and Measurement

Rohde & Schwarz is the largest manufacturer of electronic test and measurement equipment in Europe. Our T&M instruments and systems are setting standards worldwide in research, development, production and service. We are the key partner for the industry and network operators as far as all measurement tasks in the field of digital communications are concerned.

Mobile radio measurements

- Complete range of measuring instruments, test sets and systems for mobile and base stations of analog and digital mobile communication networks
- Radiocommunication testers for use in service, production and development
- Go/NoGo testers
- Signal generators and analyzers as well as power meters
- Coverage and interference measurement systems
- Type-approval test systems

EMC measurements

- Complete EMC test centers
- Turnkey systems for measurement of electromagnetic interference (EMI) and electromagnetic susceptibility (EMS)
- Test receivers and EMI spectrum analyzers for compliance and precompliance measurements
- Full range of accessories:
  - Artificial mains networks
  - Antennas and masts
  - Field probes
  - Transducers
- Software

General-purpose and RF measurements

- RF and microwave signal generators
- ARB generators
- Spectrum and network analyzers
- Audio and modulation analyzers
- Voltmeters and power meters
- Field-strength test receivers
- Process controllers
- Power supply units

Automatic test systems

- Type-approval and certification test systems
- Production test systems for communication terminal equipment
- Coverage measurement systems for all modern radio networks
- EMC test systems and test centers
- Board test systems (in-circuit and functional testers)

- Monitoring, coverage and transmitter test systems for both analog and digital sound and TV broadcasting

Radiocommunications Systems

Rohde&Schwarz is one of the leading international suppliers of professional HF, VHF and UHF radio systems for use in stationary and mobile ground stations, on ships and in airplanes. Embassies, governmental authorities and armed forces worldwide use our radio equipment for voice, data and image transmission. We support our customers by providing product-related consulting, logistics concepts and services.

ATC systems

- VHF and UHF radio systems for ground-air communications
- Radio direction finding systems
- Remote monitoring and control of ATC systems
- Mobile ATC towers

Air defence systems

- VHF/UHF radio systems for voice and data transmission
- Integrated methods for secure and protected transmission
- Network management including remote control and remote monitoring

Avionics

- HF, VHF, UHF airborne transceivers for secure and protected voice and data transmission

Naval communication systems

- Systems for internal and external communications
- Integrated control and message handling systems
- HF broadband systems

Army communications and IT systems

- Tactical multiband radio equipment
- HF transmitting /receiving systems or stationary and mobile use
- Network integration and interfacing
- Frequency and key management

Mobile radio

Rohde &Schwarz ranks among the leading suppliers of MPT-1327 and TETRA mobile radio systems for the professional user.Worldwide installations at Ministries of the Interior, commuter traffic enterprises,at railway stations and airports as well as or public network operators speak or the effectiveness of our solutions.

Trunked radio systems

- Network engineering
- Switching systems
- Base stations
- Network management and applications
- Turnkey installation

Broadcasting

For 50 years sound and TV broadcasting has been one of the key activities of Rohde&Schwarz. We are the only supplier of a complete range of transmission, monitoring and measurement equipment in the world. We are international leaders as regards equipment and T&M systems and instruments for the new digital transmission methods DAB, DVB and MPEG2.

Sound and TV broadcast transmitters

- VHF FM sound broadcast transmitter systems from 20 W to 20 kW
- Analog TV transmitter systems from 20 W to 40 kW
- Digital audio broadcast (DAB) systems from 50 W to 1 kW
- Digital video broadcast (DVB-T, ATSC) systems from 250 W to 5 kW

Measurement and monitoring systems

- Monitoring systems for terrestrial transmitter stations
- Measurement systems for development, production and maintenance of transmitters

Video and broadcast measurements

- Generators and analyzers for MPEG2, DVB and ATSC transport streams, for use in development, production and monitoring
- Picture quality analyzers
- Analog baseband generators and analyzers
- Signal generators and test receivers, modulators and demodulators for analog sound and TV broadcasting standards as well as for DVB-C/S, DVB/T and DTV-ATSC
- TV network analyzers
- Studio measurement equipment

Radiomonitoring and Radiolocation

Rohde&Schwarz is worldwide a leading manufacturer of equipment and systems for detection, location and analysis of radiocommunication signals in the following fields of application:

- Internal and external security
- National and international radiomonitoring by postal authorities
- Frequency management

We are leading in the design and implementation of full-coverage automatic radiomonitoring and frequency management systems. Many years of experience and ultramodern technology are the sound basis of our receivers, direction finders, signal analyzers and antennas:

Receivers

- Fast search receivers
- Stationary and portable monitoring receivers
- Computer-controlled receiving systems

Direction finders

- Extremely fast, broadband, digital radiomonitoring direction finders for stationary and mobile/portable use
- Automatic radiolocation networks using direction finders

Signal analyzers

- Versatile signal analyzers for flexible use
- Automatic signal classifiers
- Signal decoders, demodulators

Antennas

- Receiving and transmitting antennas
- Test antennas
- Complex antenna systems

IT security

Rohde &Schwarz SIT GmbH meets the customers' demand or secure and reliable utilization of information and communication technology.Key activities are in the development of crypto products and systems or the protection of information in modern data processing and communication systems as well as consulting and IT security analyses or industry and government authorities.

- Hardware and software crypto products
- Customized crypto systems
- Consulting and IT security analyses

Services

Rohde&Schwarz maintains at its Cologne Plant one of Europe's largest service centers for T&M and communications equipment.

Our training centers in Cologne and Munich offer a comprehensive choice of courses on T&M and communications topics, which on request can also be held at the customer's.

- Calibration, service and maintenance
- Planning, development, system integration
- Seminars and training courses
- Development of customer-specific systems
- Technical documentation and logistics
- Electronic information systems, multimedia applications

Technical Milestones

1938 World's first portable crystal clock
1948 Europe's first VHF sound broadcast transmitter
1964 Europe's first air-traffic-noise monitoring system
1967 Europe's first automatic IC test system
1974 First microprocessor-controlled radio measurement system
1975 World's first quality monitoring system for TV signals
1980 Europe's first stereo/dual-sound TV transmission system
1984 First processor for automatic setup of shortwave links
1986 Introduction of radio data system RDS for sound broadcasting in Germany
1990 First compact test set for GSM transmitters and receivers
1992 Exclusive supplier of reference test equipment for type-approval testing of GSM mobile phones
1992 World's fastest digital radiomonitoring system
1995 Technical equipment for world's largest pilot project for digital audio broadcasting (DAB)
1996 First integrated HF voice/data radio for use in commercial aircraft for fully automatic worldwide transmission of flight data
1997 Reference test equipment for first mobile radio standard for satellite- and ground-based communications
1997 Order for nationwide DVB-T transmitter network in Great Britain (largest DVB project worldwide)
1999 World's first operational universal software radios for use on military platforms

Plants

Munich

Company headquarters in Munich house the R&D departments, systems engineering and assembly, training and service center, central divisions and administration.

Cologne

Rohde&Schwarz Cologne Plant is one of Europe's largest service centers for electronic T&M and communications equipment. Services include maintenance and repair, training, technical documentation and logistics (also in conjunction with multimedia applications), system integration and adaption as well as services for information and communications technology projects. The Cologne Plant is an accredited calibration laboratory of the German Calibration Service.

Memmingen

The plant in Memmingen is responsible for the final production and delivery of all Rohde& Schwarz equipment.

Teisnach

The Rohde&Schwarz plant in northern Bavaria produces the mechanical and electrical parts for the equipment production in Memmingen.

Subsidiaries

ROHDE&SCHWARZ Vertriebs-GmbH (RSV)

Founded in Berlin in 1946 and relocated to Munich in 1961, RSV is responsible for domestic sales of Rohde&Schwarz products as well as products of other make marketed on behalf of RSE. RSV has a marketing network throughout Germany.

ROHDE&SCHWARZ International GmbH (RUSIS)

Since the end of 1993, RUSIS has been responsible for sales of Rohde&Schwarz products outside Europe. The company coordinates agencies, representatives and other business partners in the Asia-Pacific region, Middle East, Africa, North and Latin America.

ROHDE&SCHWARZ Engineering and Sales GmbH (RSE)

Founded as a subsidiary in 1972 and headquartered in Munich, RSE is primarily involved in marketing complementary products from other manufacturers. The objective of RSE is a vertical completion of the Rohde&Schwarz product line in close cooperation with headquarters and the representatives abroad. The numerous companies represented by RSE include renowned manufacturers such as the Rohde&Schwarz cooperation partner Advantest from Japan.

ROHDE&SCHWARZ BICK Mobilfunk GmbH

R&S BICK Mobilfunk GmbH with headquarters in Bad Münder specializes in the development and implementation of professional mobile radio systems.In particular,the company supplies TETRA and MPT-1327 mobile radio networks and applications.

ROHDE&SCHWARZ FTK GmbH

ROHDE &SCHWARZ FTK GmbH with headquarters in Berlin develops and supplies products and systems in the field of analog and digital audio broadcasting as well as solutions or the transmission of ancillary data via digital broadcast channels (datacasting).The variety of services offered by ROHDE &SCHWARZ FTK includes software development.

ROHDE&SCHWARZ SIT Gesellschaft für Systeme der Informationstechnik mbH

ROHDE&SCHWARZ SIT GmbH provides solutions or security in information technologies. Key activities are in the development of crypto products and systems or the protection of information in modern data processing and communication systems as well as consulting and IT security analyses or industry and government authorities.

Our Partners

To secure a complete market presence in the technological key regions North America and Japan, we are cooperating with successful local partners who guarantee customer-oriented consultation and competent servicing - Tektronix in North America and Advantest in Japan.

Tektronix

The company was founded in 1946 and with its headquarters in Beaverton/Oregon is now fully devoted to test and measurement products after selling its line of printers and video/network equipment in 1999. With 3600 employees worldwide, Tektronix achieved with its test and measurement products a turnover of US$ 845 million in the fiscal year 1999. In North America, the Tektronix product range is enhanced by almost the full range of T&M products from Rohde&Schwarz. The two companies also cooperate in the development of test and measurement instruments for special applications.

Advantest

Advantest, a Tokyo-based company founded in 1954, is the world's leading supplier of semiconductor test systems. The second most important business field is test and measurement equipment. In the fiscal year 1998, Advantest had a total turnover of Yen 141.7 billion. Advantest and Rohde& Schwarz have concluded a mutual sales agreement for T&M products: Advantest sells Rohde&Schwarz equipment in Japan and Rohde&Schwarz markets Advantest test and measurement instruments in Europe, the Middle East, in Brazil, Australia, South Africa and other countries. The two companies also cooperate in the development of T&M equipment for the Japanese market.

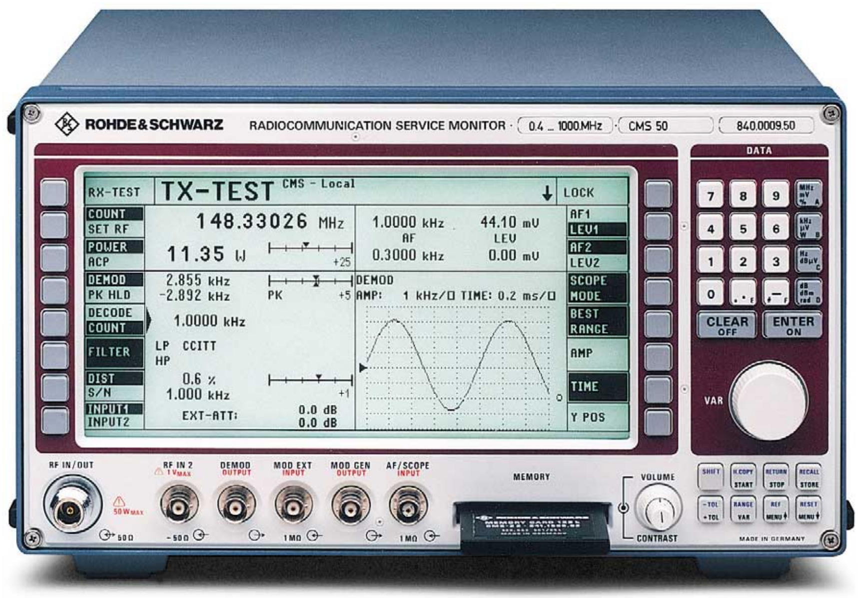
THE tester for current and future Mobile Radio Networks with scalable multimode functionality (photo 43 238-11)

Contents of Chapter 1

Radiocommunication Service Monitors of CMS Family

0.4 MHz to 1000 MHz

Radio testers for service, production and development



CMS50 (photo 40081)

Brief description

The family of Radiocommunication Service Monitors CMS comprises four models. These radio testers allow transmitter, receiver and duplex measurements to be performed on mobile radios, base stations or RF modules. The CMS family monitors are ideal radio testers for service, maintenance and test departments.

CMS – a test set replacing many individual measuring instruments

Due to the comprehensive standard configuration of the individual models and the optional extensions tailored to specific applications, external measuring instruments in addition to the CMS are not required.

Main features

- AM, FM or φM and SSB
- Analog and digital signalling
- Large, high-contrast LCD
- Operation via softkeys
- Clear menu structure
- Simultaneous and easy-to-read display of settings and results
- Manual and automatic measurements
- Tracking generator
- Cable fault test
- Spectrum monitor
- Optional extensions to cover measurements in related fields
- Stationary and mobile use
- Low weight, compact size

Overview of models

CMS50 – the budget-priced model for service applications

- Transmitter and receiver testing
- Spectrum monitor
- Fully automatic testing
- SSB test
- ERMES coder

CMS54 – the high-end tester for demanding requirements (see page 12)

- Radio measurements and optional extensions same as CMS50

Basic model additionally with:

- Full-span tracking generator from 0.4 MHz to 1000 MHz
- Adjacent-channel power meter with standard ETSI filters
- Duplex modulation meter
- Automatic harmonic measurement
- Cable fault test

CMS57 – the specialist for avionics (see page 14)

- Radio measurements and optional extensions same as CMS50

Basic model additionally with:

- VOR/ILS signal generator

Overview of configurations (model-dependent or optional)

Signal sources

- RF synthesizer from 0.4 MHz to 1000 MHz, resolution 10 Hz, with AM, FM, φM and multitone modulation capabilities
- Two independent modulation generators, from 20 Hz to 30 kHz each, resolution 0.1 Hz

Radiocommunication Service Monitors of CMS Family

- Selective-call encoder to all standards (also user-programmable)
- CDCSS coder
- ERMES coder
- DTMF coder
- 10 MHz reference frequency input/output
- VOR/ILS signal generator
- Signalling units for all main radio networks

Measuring facilities

- RF frequency counter, RF frequency-offset counter
- Power meter from 5 mW to 100 W
- Selective RF power meter down to –100 dBm
- RF spectrum monitor with wide dynamic range and filters which also allow modulation analysis (AM, FM, SSB)
- Tracking generator in frequency range from 400 kHz to 1000 MHz
- Adjacent-channel power meter with standard ETSI filters
- Modulation meter for AM, FM and φM; weighting: +PK, –PK, PK HOLD, ±PK/2, RMS, RMS √2
- Duplex modulation meter for duplex spacings of any size
- AF voltmeter with peak and true RMS weighting
- SINAD meter with variable test frequency
- S/N meter
- Distortion meter with variable test frequency
- AF frequency counter with period and gate-time counting
- Selective-call decoder for all standards (also user-programmable)
- DTMF decoder
- CDCSS decoder
- Oscilloscope
- DC ammeter/voltmeter
- Transient recorder for analysis of power and frequency transients
- Cable fault test

Filters

- CCITT or C-message filters for weighting to relevant standards
- Continuously tunable bandpass filter from 50 Hz to 5 kHz with high skirt selectivity for selective modulation and AF measurement
- Continuously tunable notch filter from 100 Hz to 5 kHz for signal suppression
- Highpass and lowpass filters for band limiting and measurement of subaudio tones

Other facilities

- Second RF input with high sensitivity for off-air measurements, can be used independently for module testing
- Built-in 600 Ω AF transformers for modulation generator and AF voltmeter
- Connector for battery (11 V to 32 V)
- 13 dBm RF output for off-air measurements
- Memory for storing complete instrument setups

Signalling

The CMS features built-in signalling units combining signalling measurements and receiver/transmitter tests on mobile stations as well as partly on base stations. The signalling units support all main radio networks including their country-specific versions:

- Selective call to all international standards
- POCSAG/Cityruf/Euromessage
- ZVEI digital, VDEW digital
- ERMES pager test
- ATIS coder/decoder (Rheinfunk)

The following signalling routines are available for cellular networks:

- C Net
- NMT 450 (SIS), NMT 450 I
- NMT 900 (SIS)
- AMPS, E-AMPS, N-AMPS
- TACS, E-TACS, N-TACS, TACS II
- Radiocom 2000
- NMT base station test

No external equipment is required for testing. All signalling routines are permanently available (no loading or reloading of software is required).

Operation

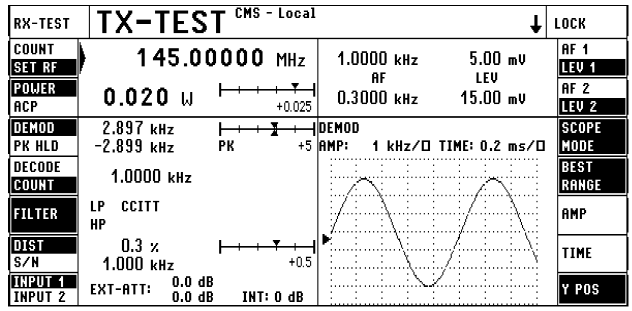
- All functions are clearly displayed; 16 softkeys allow direct access to individual parameters
- The large, backlit LCD screen provides clear and simultaneous readout of all test results, entries and functions
- Hardcopy of screen display, entry of tolerance and reference values are made at a keystroke
- Settings can be varied in selectable steps using the spinwheel
- Programs, instrument settings and test results can be stored on memory cards
- Additional inputs and outputs allow independent and versatile use of signal sources and test facilities

Automatic tests

Automatic test routines are indispensable for high throughput and reproducible results in service and production: in the learn mode, the Radiocommunication Service Monitor CMS stores all manual settings and measurements and produces from them ready-to-start automatic test routines. The user need not have any programming knowledge or learn equipment-specific command sets.

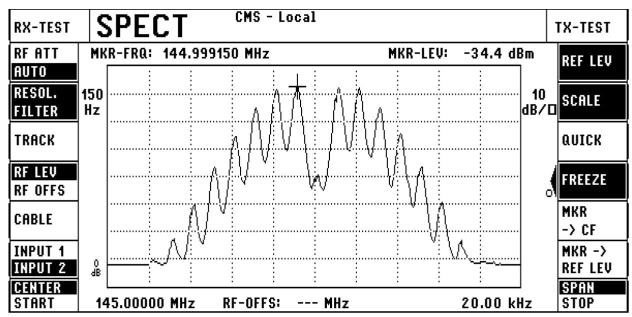
Radiocommunication Service Monitors of CMS Family

Tolerances, comments and conditions (loops, jumps, queries and control commands) can additionally be inserted into the test routines. Programs can also be activated directly from the memory card. The test report format may be user-specified and can be clearly structured by transferring control characters to the printer, such as blank line, paragraph and bold-face.



CMS user prompting – all settings and test parameters at a glance

RF measurements, evaluation of demodulated signals and setting of modulation generators



150 Hz filter allowing direct modulation analysis for AM, FM and SSB

Specifications in brief (all CMS models)

Bold-faced values in brackets refer to CMS54 (page 12) and CMS57 (page 14).

Timebase

Standard

Temperature effect 0 to 35°C	≤1 x 10^{-6}
Aging	≤2 x 10^{-6}/year

Options CMS-B1 and CMS-B2

Temperature effect 0 to 50°C	≤1 x 10^{-7}
Aging	≤2 x 10^{-7}/year (CMS-B2: ≤1 x 10^{-7})

Receiver measurements

Signal generator

Frequency range	0.4 MHz to 1000 MHz
Frequency resolution	50 Hz **(10 Hz)**
Level	
FM, φM, CW	–134 dBm to 0 dBm
AM	–134 dBm to –3 dBm
Level resolution	0.1 dB
Accuracy	±2 dB
Harmonics	≤–20 dBc **(≤–25 dBc)**
Nonharmonics	≤–50 dBc
Phase noise	≤–110 dBc (20 kHz from carrier, referred to 1 Hz test bandwidth)

Modulation

Frequency range	2 MHz to 500 MHz **(0.4 MHz to 1000 MHz)**
AM depth	0 to 99%
Mod. frequency range	DC to 20 kHz
FM deviation	0 to 100 kHz (50 Hz to 50 kHz)
Resolution	1 Hz
Mod. frequency range	20 Hz to 20 kHz
Mod. distortion	≤1%
φM deviation(internal)/resolution	0 to 10 rad/1 mrad
Mod. frequency range	100 Hz to 6 kHz
Mod. distortion	≤1%

AF voltmeter

Frequency range	50 Hz to 20 kHz
Measurement range/resolution	0.1 mV to 30 V/100 µV
Input impedance	approx. 1 MΩ

Transmitter measurements

RF power meter

Frequency range	1.5 MHz to 1000 MHz (2 MHz to 1000 MHz)
Measurement range	5 mW to 50 W (100 W optional)
Accuracy (P >20 mW, AM=0%)	0.4 dB + resolution
Selective level measurement	in frequency range 1 MHz to 1000 MHz
Level range	–60 dBm to +47 dBm without weighting filter, –80 dBm to +47 dBm with 2 kHz resonance filter

RF frequency counter

Frequency range	0.5 MHz to 1000 MHz

Frequency deviation meter

Operating modes	+PK, –PK, ±PK/2, PK HOLD, RMS, RMS√2
Measurement range	0 Hz to 50 kHz **(0 Hz to 100 kHz)**
AF frequency range	20 Hz to 15 kHz **(20 Hz to 20 kHz)** (DC-coupled at demodulator output)
Resolution	1 Hz

Radiocommunication Service Monitors of CMS Family

Phase deviation meter

Operating modes	+PK, –PK, ±PK/2, RMS, RMS√2
Measurement range/resolution	0.001 rad to 5 rad/0.001 rad
AF frequency range	300 Hz to 6 kHz

AM depth meter

Operating modes	+PK, –PK, ±PK/2, RMS, RMS√2
Measurement range/resolution	0.01% to 99%/0.01%
AF frequency range	50 Hz to 10 kHz **(50 Hz to 20 kHz)**

RF spectrum monitor	1 MHz to 1000 MHz
Display dynamic range	>60 dB
Span	0 (zero span) to 50 MHz
Filter (3 dB bandwidth)	150 Hz, 6/16/50/300 kHz, 1/3 MHz (coupled to span)

Tracking generator (with CMS-B59/-B9)

Frequency range	400 kHz to 1000 MHz
Reference level	–67 dBm to –27 dBm
Display dynamic range	50 dB
Span	0 to 50 MHz (full span for CMS52, CMS54 and CMS57)
Output level	–128 dBm to 0 dBm
Frequency offset	0 to –999 MHz (depending on span and center frequency)

Transmitter measurements at 2nd RF input

Measurement of RF frequency, modulation (AM, FM, φM), modulation frequency and RF spectrum (level) of small RF signals, eg in off-air or module measurements, for input levels from approximately

RF frequency counter	30 µV (selective frequency counter with presetting)
Modulation meter	5 µV (IF narrow) 1 µV (IF narrow, selective meas.)
Selective level measurement	–75 dBm to –35 dBm without weighting filter, –100 dBm to –35 dBm with 2 kHz resonance filter

Transmitter and receiver measurements

Modulation generator I and II

Frequency range	0.1 Hz
Output voltage range	10 µV to 5 V
Output impedance	≤4 Ω

Distortion meter

Frequency	100 Hz to 5 kHz (100 Hz to 3 kHz)
Measurement range	0.1% to 50%
SINAD meter	
Frequency	100 Hz to 5 kHz (1 kHz ±10Hz)
Measurement range	1 dB to 46 dB

AF frequency counter

Operating modes	demodulation, AF, beat (frequency offset)
Frequency range	20 Hz to 500 kHz (20 Hz to 20 kHz) (superimposed RF)
Resolution	1 Hz/0.1 Hz

Oscilloscope

Bandwidth	
DC	DC to 20 kHz
AC	10 Hz to 20 kHz
Horizontal deflection	20 to 0.1 ms/div
Vertical deflection	scaled in kHz (FM), rad (φM), % (AM), mV/V (AF)
Input voltage range	0 to 40 V (Vp)
Input impedance	approx. 1 MΩ

AF filters

Highpass	f_{cutoff}=300 Hz
Lowpass	f_{cutoff}=3.4 Hz
Bandpass	
broadband	highpass + lowpass
narrowband	100 Hz to 3 kHz **(50 Hz to 5 kHz)**
Notch filter	100 Hz to 3 kHz **(100 Hz to 5 kHz)**
CCITT filter	see option CMS-B5 or CMS-B20

Selective-call coder/decoder	
Tone sequences	ZVEI1/ZVEI2/CCIR/EIA/EEA/EURO/NATEL/CCITT/VDEW/DTMF/VDEW direct dialling/user-defined sequences (DTMF decoding see Control Interfaces CMS-B5 and CMS-B55); CDCSS decoder and ATIS see option CMS-B27
CDCSS coder	entry of 3-digit code number of mobile radio, setting times for turn-off code and RF level drop, setting the data deviation
Audio monitor (loudspeaker)	demodulated signal, AF signal, beat (frequency offset)

General data

Power supply AC	100/120/220/240 V ±10%, 47 Hz to 420 Hz (50 VA)
DC	11 V to 32 V
Dimensions (W x H x D)	320 mm x 175 mm x 375 mm
Weight without options	13 kg
with options	15 kg

Ordering information

Radiocommunication Service Monitor	CMS50	0840.0009.50
	CMS54	0840.0009.54
	CMS57	0840.0009.57

Radiocommunication Service Monitor CMS54

0.4 MHz to 1000 MHz

New measurement functions for high-end testing in the field of analog mobile ratio

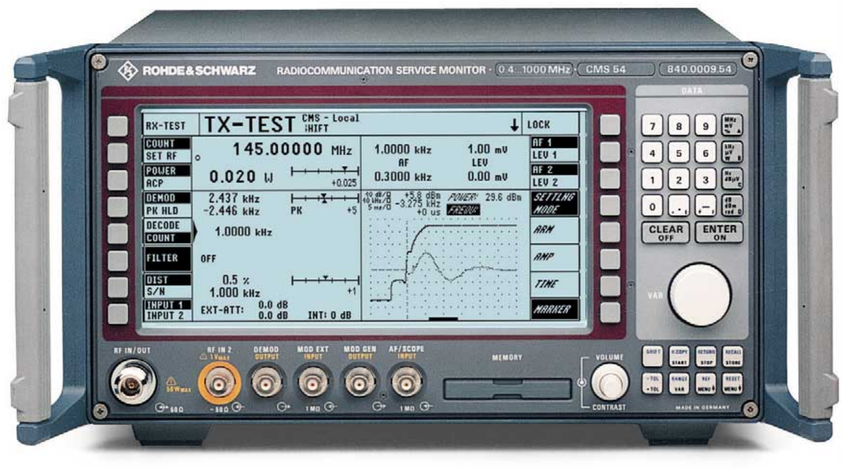


Photo 41410

Brief description

The Radiocommunication Service Monitor CMS 54 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.

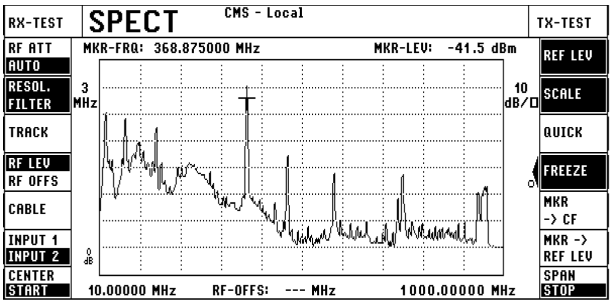
With its full-feature configuration offering enhanced measurement capabilities, this lightweight and compact tester, which is suitable for mobile and stationary use alike, satisfies all requirements of radio measurements:

- 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, mobile phones
- Measurement of the harmonic suppression of transmitters

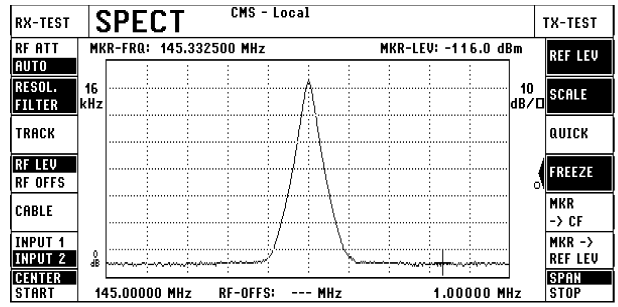
Main features

- Full-span spectrum monitor
  - Display of whole spectrum from 10 MHz to 1000 MHz
  - Dynamic range 80 dB
  - Analysis bandwidths from 150 Hz (modulation spectra AM/FM/SSB) to 3 MHz
  - Ultra-high sensitivity of up to –110 dBm
  - Markers for synthesizer-accurate frequency determination and selective level measurements
  - Storage of spectrum displays as well as demodulation of displayed spectral lines (FREEZE & LISTEN)
  - Built-in tracking generator with selectable level and frequency offset for measurements on filters, modules and antenna systems
  - Quick mode for fast adjustment of RF components
  - Reference markers for determining level and frequency offsets
- Transient frequency and power measurements
  - Display of frequency response when radios are switched on/off or switched over
  - Combined display of power and frequency response
  - Recording of power variations during transmitter switch on and off or of power ramp (TDMA system, data transmission system)
- Adjacent-channel power measurements
  - Direct measurement of adjacent-channel power without external filters being required
  - Filters required for measurements to ETSI are implemented in the CMS
- Harmonics measurements
  - Harmonics up to 1 GHz are measured at a keystroke and results displayed in digital and analog form
- Duplex modulation meter with any frequency offset

Radiocommunication Service Monitor CMS54



Full-span display for fast overview measurements



Display range 80 dB

Special data of CMS54

Basic specifications see page 8

RF spectrum monitor (also CMS57)

Frequency range	1 to 1000 MHz, usable from 100 kHz
Span	0 (zero span) to 50 MHz; full span for frequency range 10 to 1000 MHz
Reference level	+47 dBm to –47 dBm (input 1)
Sensitivity	<–110 dBm (for resolution filter 6 kHz and reference level ≤–37 dBm at input 2, f ≥10 MHz)
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
Resolution filter (3 dB bandwidth)	150 Hz (for modulation analysis), 6/16/50/300 kHz/1/3 MHz (for full span), coupled to span
Error	<3 dB + resolution
Resolution	0.4 dB

Transient recorder (also CMS57)

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, maximum recording time 40 s
Frequency transients	
RF frequency range	1 MHz to 1000 MHz
Measurement range (FM dev.)	0 to ±100 kHz
Scaling	0.5 kHz to 50 kHz/div
Triggering	internal, automatic (frequency changes >8 kHz)
Power transients	
RF frequency range	1 MHz 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%)

RF frequency counter (also CMS57)

Frequency range	0.5 MHz to 1000 MHz (usable from 100 kHz, IF narrow)
Input level range (CW, FM)	
Input 1	0 to +47 dBm
Input 2	–40 dBm to +7 dBm

Transmitter measurements at 2nd RF input

Additional, internally switchable 0/24 dB attenuator pad, for high-level measurements at input 2

Harmonic measurements (also CMS57 with CMS-B9)

Display of 1st to 4th harmonic

Max. harmonic frequency	1000 MHz
Dynamic range	>60 dB >90 dB in frequency range 26.965 to 27.405 MHz (CB radio)

Signal generator

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

Ordering information

see CMS..., page 11

Radiocommunication Service Monitor CMS57

The avionics specialist

Photo 39832

Brief description

Radiocommunication Service Monitor CMS57 is the ideal radio tester for service and maintenance in the field of avionics. A built-in VOR/ILS signal generator delivers all test signals for

- **VOR** (VHF Omnidirectional Range)
- **ILS** (Instrument Landing System)
- **MB** (Marker Beacon)
- Autopilot

CMS57 features the same characteristics and optional extension facilities as the CMS52 (see page 8).

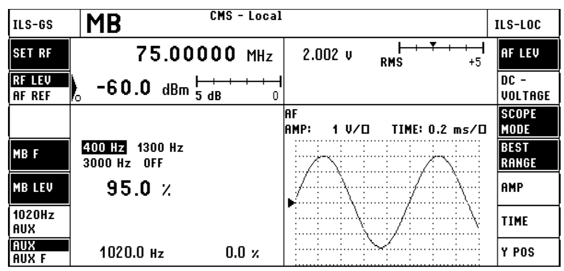
CMS57 combines conventional radiocommunication and radionavigation measurement facilities in a single unit covering avionics measurements.

Small size, low weight and battery operation enable the CMS57 to be used in the cockpit or for fast Go/NoGo testing based on off-air measurements (RAMP test).

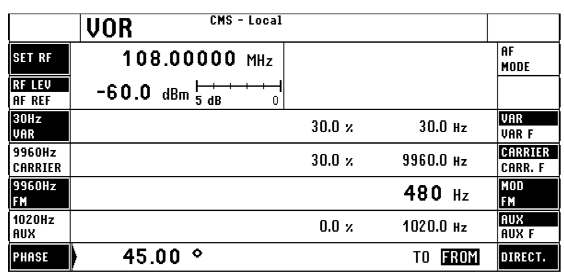
Main features

The VOR/ILS generator allows for

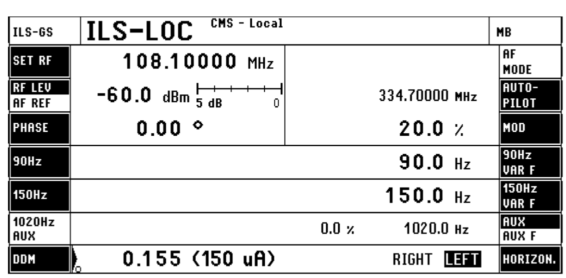
- Generation of highly accurate signals, ie high measurement accuracy, thanks to digital signal processing
- High resolution of parameters
- High long-term stability and reliability
- Independence from operating temperatures due to automatic self-adjustment



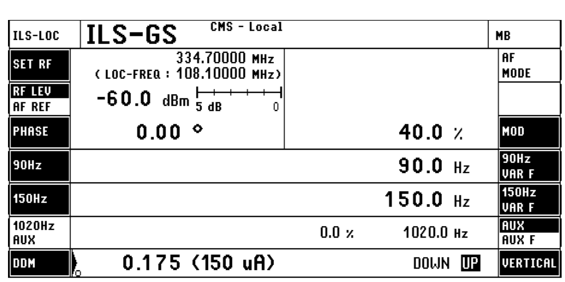
A clear menu is also available for the generation of marker beacons



Frequency and deviation adjustable over a wide range allows receiver testing in line with standard



Fine variation of the DDM value in steps of 0.001 DDM for ILS and of the phase in steps of 0.01° for VOR ensure accurate adjustment of the onboard monitor



Radiocommunication Service Monitor CMS57

Operation

The operating concept of the CMS57 allows with only a few settings all characteristics of the VOR/ILS receivers to be measured. Signal parameters are defined either by

- direct keyboard entry
- fine variation via spinwheel or recall of preset standard RF frequencies
- fixed coupling of ILS glideslope and localizer frequencies according to specification
- recall of preset test parameters like phase or DDM (Difference in Depth of Modulation)
- recall of standard settings to ARINC 578, 579

Ordering information

see CMS, page 11

Specific data of CMS57

Basic specifications see page 10 [1)]

	Range	Resolution	Accuracy
VOR			
Phase RF output	0 to 360°	0.01°	typ. 0.05°
AF output	0 to 360°	0.01°	0.04°
9960 Hz carrier			
Modulation frequency	7.9 kHz to 12 kHz		
Amplitude modulation			
–128 dBm to –9 dBm	0 to 100%	0.1% AM	typ. 2% at 30% AM
–85 dBm to –45 dBm	0 to 100%	0.1% AM	2% at 30% AM
FM deviation	384 Hz to 576 Hz	1 Hz	1 Hz
30 Hz VAR			
Modulation frequency	24 Hz to 36 Hz		
Amplitude modulation			
–128 dBm to –9 dBm	0 to 100%	0.1% AM	typ. 2% at 30% AM
–85 dBm to –45 dBm	0 to 100%	0.1% AM	2% at 30% AM
1020-Hz AUX			
Modulation frequency	50 Hz to 20 kHz		
Amplitude modulation	0 to 100%	0.1% AM	3%, at 1020 Hz and 10 to 20% AM
ILS			
90 Hz and 150 Hz phase	0 to 180°, referred to 150 Hz	0.01°	1°
90 Hz tone			
Modulation frequency	72 Hz to 108 Hz		
150 Hz tone			
Modulation frequency	120 Hz to 180 Hz		
1020 Hz tone (AUX)			
Modulation frequency	50 Hz to 20 kHz		
Amplitude modulation	0 to 100%	0.1% AM	3%, at 1020 Hz and 10 to 20% AM
ILS localizer			
Amplitude modulation			
–128 dBm to –9 dBm	0 to 50%	0.1% AM	typ. 2% at 20% AM
–85 dBm to –45 dBm	0 to 50%	0.1% AM	2% at 20% AM
DDM[2)] RF output	±0 to 0.4 DDM at 20% AM	0.001 DDM	
On-course error, –128 dBm to –9 dBm			0.0004 DDM
Off-course error, –128 dBm to –9 dBm			2% + 0.0004 DDM at |DDM| ≤0.2
DDM AF output	±0 to 0.4 DDM at 20% AM	0.001 DDM	3% + 0.0002 DDM at |DDM| 0.4, AF level 0.5 to 5 V
ILS glideslope			
Amplitude modulation			
–128 dBm to –9 dBm	0 to 50%	0.1% AM	typ. 2% at 40% AM
–85 dBm to –45 dBm	0 to 50%	0.1% AM	2% at 40% AM
DDM RF output	±0 to 0.8 DDM at 40% AM	0.001 DDM	
On-course error, –128 dBm to –9 dBm			0.001 DDM
Off-course error, –128 dBm to –9 dBm			2% + 0.001 DDM at |DDM| ≤0.4
DDM AF output	±0 to 0.8 DDM at 40% AM	0.001 DDM	3% + 0.0002 DDM at |DDM| 0.4, AF level 0.5 to 5 V
Marker beacon (MB)			
Modulation frequency	400, 1300, 3000 Hz		
Amplitude modulation	0 to 100%	0.1% AM	5% at 95% AM
1020 Hz tone (AUX)			
Modulation frequency	50 Hz to 20 kHz		
Amplitude modulation	0 to 100%	0.1% AM	same as CMS52

1) Data of VOR/ILS/MB signals in the RF level range (–128 dBm to –9 dBm, fine variation 0 dB) are specified for discrete RF frequencies and for the following continuous ranges:
VOR: 108 MHz to 118 MHz;
ILS localizer: 108 MHz to 112 MHz,
ILS glideslope: 329 MHz to 335 MHz;
Marker beacon: 74 MHz to 76 MHz.

2) Difference in Depth of Modulation; describes the modulation depth difference between 90 Hz and 150 Hz tone; |DDM| = |(90 Hz modulation in % – 150 Hz modulation in %)|/100%.

Options for radio testers of the CMS family

Extensions for basic model	Option	Order No.	Specifications	
OCXO Reference Oscillator For long-term stability	CMS-B1	0840.9406.02	See timebase Aging	 2 x 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	 ≤1 x 10^{-7}/year
Duplex Modulation Meter For operation of RF frequency counter and modulation meter independent of RF generator (two-port measurements, also on frequency-converting modules)	CMS-B59	1032.0990.02 (not for CMS54)	Specs same as 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 same as basic model Adjacent-channel power meter with ETSI filters Channel spacings Dynamic range	 10/12.5/20/25 kHz and user-selectable up to 1 MHz ≥70 dB (chan. spacing 25 kHz)
10 MHz Reference Frequency Input/Output External synchronization for measuring systems	CMS-B22	1001.6750.02	Output Input	TTL signal, Z_{out}≈50 Ω, f=10 MHz level >1.5 V (V_{pp}), Z_{in}≈50 Ω, 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 (not for CMS57)	Maximum input power 20 mW Attenuation betw. RF_{in} → 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	Maximum 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; level approx. –50 dBm	
IEEE/IEC 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 CMS-B59				
	Option	**Order No.**	**Specifications**	
Signalling Unit for Cellular Radio NMT 450 (SIS), NMT 450, NMT 900 (SIS), E-AMPS, E-TACS, 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 CMS50)	Simulation of base station for testing cellular mobile phones, eg call setup, call cleardown, channel and power change	
Extensions in conjunction with control interfaces	**Option**	**Order No.**	**Specifications**	
CDCSS Decoder (for CMS-B5)	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-C Interface for CMS-B5	CMS-B30	1001.6909.02	Output and reception of any ASCII strings (max. 33 characters)	

Options for radio testers of the CMS family

Extensions in conjunction with control interfaces	Option	Order No.	Specifications
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
VSWR Meter in conjunction with CMS-B5 or -B39	CMS-Z37 3)	1065.4907.02	Connection of Insertion Units NAS-Z1, -Z3, -Z5, -Z6 (GSM900), -Z7 (GSM 1800) with direct reading of VSWR as well as forward 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	With max. 1 W switching power, V_{max} = 30 V, I_{max} = 0.1 A	
TTL Input/Output	12	12	-	-	8	Outputs: 25 mA	
DC Ammeter/ Voltmeter, floating	–	–	–	•	–	Voltage measurement Range Resolution Error Current measurement Range Resolution Error	 0 to ±30 V 0.1 mV to 100 mV ±1% + resolution 0 to ±10 A 1 mA to 100 mA ≤4% ± 3 mA
600 Ω AF Transformers	–	–	–	–	•	Output impedance of AF generator Frequency range Output voltage Max. output current Input impedance of AF voltmeter Frequency range	switchable to 600 Ω ±10% 100 Hz to 6 kHz 10 µV to 2.5 V 4 mA switchable t 600 Ω ± 10% 100 Hz to 6 kHz
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	
VSWR Measurements	CMS-Z37	CMS-Z37	–	–	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 also required for CDCSS.

3) CMS-B5 or -B39 required for Insertion Units NAS-Z1/-Z3/-Z5/-Z6/-Z7.

4) Choice of one option.

• included

– not included

Universal Radio Communication Tester CMU200

THE tester for current and future Mobile Radio Networks with scalable multimode functionality

Photo 43238

Brief description

Radio Communication Tester CMU200 brings premium cost effectiveness with a set of features where extremely fast measurement speed plus very high accuracy are the two most important ones. Complementing these, the secondary remote addressing of the unit's modular architecture makes for intelligent and autonomous processing of complete measurement tasks and fast control program design.

Whether the application is in production, service or development, it calls for different tests and measurements to be performed, and the flexible concept of the CMU 200 provides the user with a tailored solution. CMU200 functionality extends from basic RF signal generation, frequency, power and spectrum analyzer measurements for alignment of modules in production or development applications, to an instrument simulating a base station for testing that requires the support of standard-specific signalling in either of the above-mentioned bands, as well as module tests on frequencies anywhere in the range of 10 MHz to 2.7 GHz.

The flat menu structure enables fast and efficient entry in dedicated measurement menus directly after a call setup, as well as an easy and quick change between the different measurement menus, in signalling and non-signalling mode alike.

Applications

- RF development
- Module design
- Module test in production
- Adjustment of mobiles
- Final test in production
- Functional test
- Feature test
- High-end service
- Quality inspections
- Basis for test systems
- Base station simulation

Main features

- Multi-protocol support
- Extremely high speed testing
- Highly accurate measurements
- Modular future-proof design
- Comprehensive spectrum analyzer
- Easy migration to 3rd generation technologies

Prepared for tomorrow's networks

- Testing of 1st, 2nd and 3rd generation mobile radio possible in a single unit
- Standard-specific software packages available for tests in accordance with present and future standards
- Platform with multimode modular design
- Network-independent non-signalling test for the development of new or existing standards
- Flexible input/output structure
- Wide frequency range from 10 MHz to 2.7 GHz suitable for all mobile radio standards
- Simultaneous RX/TX measurements
- Time domain analyzer built in
- Simple operation either manual or via IEEE/IEC bus
- Benchmark-breaking IEEE/IEC bus speed due to parallel measurements, secondary addressing, optimized processing power
- Bright high-resolution TFT colour display
- Unrivalled repeatability
- Realtime automatic temperature correction for best accuracy
- Low power consumption
- Low heat dissipation
- Optimized cooling concept for higher reliability and decreased production down time
- Worldwide service network
- Standardized calibration system for the instrument
- Compact level verification test system available
- Easy 19" rackmounting, compact box of only 4 rack units height

Universal Radio Communication Tester CMU200

GSM measurements

The applications of the GSM system are numerous and are currently:

- GSM400
- GSM900 including
  - P-GSM (primary GSM)
  - E-GSM (extended GSM)
  - R-GSM (railway GSM)
- GSM1800 (DCS)
- GSM1900 (PCS)

GSM Evolution – 2.5G

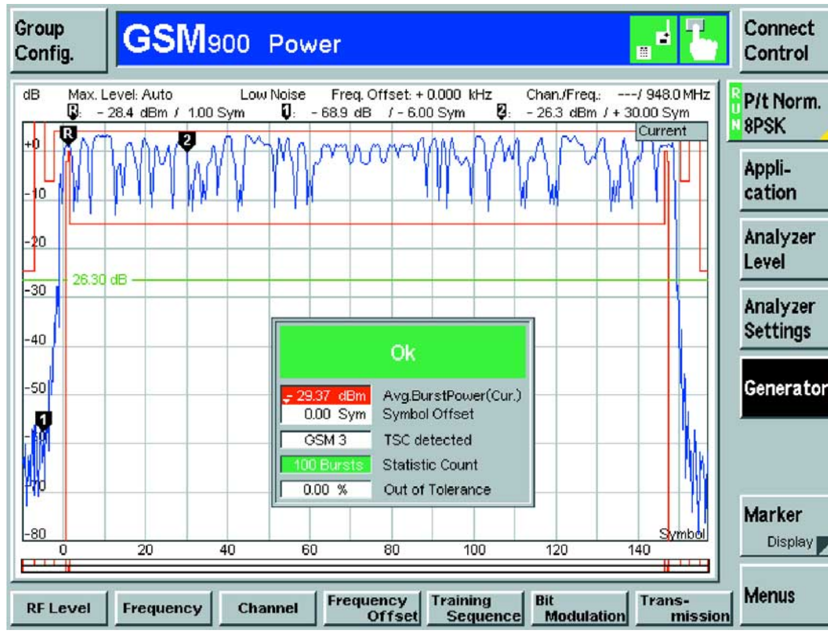
The amount of data transfer in GSM networks is growing rapidly. Quite simply, the current data transfer capacity of GSM will not be sufficient in the future. Multislot applications such as HSCSD or GPRS together with the innovative 8 PSK modulation scheme EDGE are needed to cater for the evolving data traffic. The CMU200 platform is not only able to meet today's standards and systems but is also designed for the needs of tomorrow. Tests in both circuit switched and packet oriented connections are implemented in the CMU200 GSM function groups, EDGE signals can already be generated and analyzed.

Signalling mode

The options required to support GSM signalling are based on the versatile signalling unit CMU-B21 and one or more of the software options CMU-K20, -K21, -K22 and -K23. The CMU200 simulates a GSM base station RF interface with the signalling flexibility necessary to test the behaviour of the mobile under the influence of different signalling parameters.

Reduced signalling synchronized mode

The CMU200 provides the same functionality as in the Signalling mode, but discards any signalling reaction from the mobile connected. This mode of operation enables both testing of modules that only have layer 1 operation and very fast RF testing in production environments. It can also skip the location update procedure in order to save time.



In the GSM non signalling function groups the possibility to switch between GMSK and 8PSK (EDGE) is already implemented. Thus EDGE bursts as shown here can easily be analyzed

Non-signalling mode

This mode serves for generating a signal with GSM-specific midambles and modulation in the entire frequency range from 10 MHz to 2.7 GHz. The analyzer offers high flexibility for GSM-specific measurements.

GSM highlights

Base station simulation including

- BS_AG_BLK_RES, BS_PA_MFRMS, DTX, cell access, MCC, MNC, NCC, BCC, location area, BA list, hopping, radio link timeout for mobile/base station, AOC

More features

- Location update (display of IMEI and IMSI)
- Call to/from mobile
- Call termination from mobile /network
- Channel, timeslot, PCL band handover
- BCCH, SACCH, SDCCH, FACCH, TCH, PDCH

GMSK/8PSK Measurements

- Phase/frequency error, EVM, magnitude error, origin offset, I/Q imbalance for I/Q modulator tuning
- Power vs time normal/access
- Peak power/average, power vs frame, power vs slot
- General spectrum measurements
- Timing error
- BER/DBLER, RBER/FER, FastBER
- Power vs PCL (on 3 or 7 channels)

Universal Radio Communication Tester CMU200

TDMA (IS-136) measurements

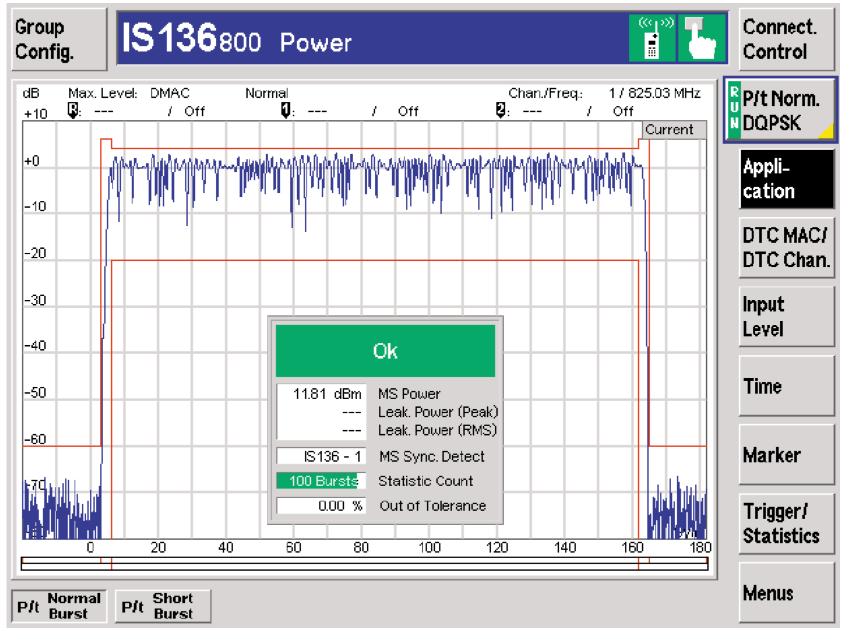
The wide acceptance of TDMA (IS-136) is based on a very flexible and powerful technology as well as on its compatibility with AMPS, which is widespread and one of the major wireless communication standards. Derived from analog AMPS, the TDMA standard is now ready for a step-by-step evolution into the third generation of mobile technology.

For TDMA (IS-136) signalling functionality, the CMU200 requires the versatile signalling unit (CMU-B21) as well as the software option CMU-K27 for the cellular band or CMU-K28 for the PCS band.

Signalling mode
The CMU 200 simulates a TDMA base-station RF interface including the signalling protocol so that a mobile can be tested with regard to different signalling parameters. All necessary network and base-station parameters can be set, such as control and traffic channel configuration, neighbouring channels setup etc. A MAHO report can also be generated.

Non-signalling mode
The non-signalling mode is for generating and analyzing TDMA (IS-136) signals within the frequency range from 10 MHz to 2.7 GHz.

Handoffs
Handoffs are part of the IS-136 specification. Handoffs between PCS and cellular bands as well as from and to AMPS are defined and have to be tested. CMU 200 supports handoffs from IS-136 800 MHz to 1900 MHz (inter-band handoff) and vice versa. Handoffs from 1900 MHz or 800 MHz to AMPS and back are also possible (inter-mode handoff) with CMU 200.



In the power menu, the mobile output power of the short burst or the normal burst is displayed. CMU also enables leakage power measurements which inform on the mobile power output in unused time slots

Switching standards
The flexibility of CMU 200 makes for quick and simple switching between two different standards. This is very important for IS-136, which is a dual-mode standard containing a digital (TDMA) and an analog mode (AMPS). The handoff between TDMA and AMPS can be achieved by simply pressing a button. This results in a very versatile test concept to improve the flexibility and throughput of your production line.

Basic features
- Call to/from mobile
- Handoff to AMPS
- Dual-band handoff

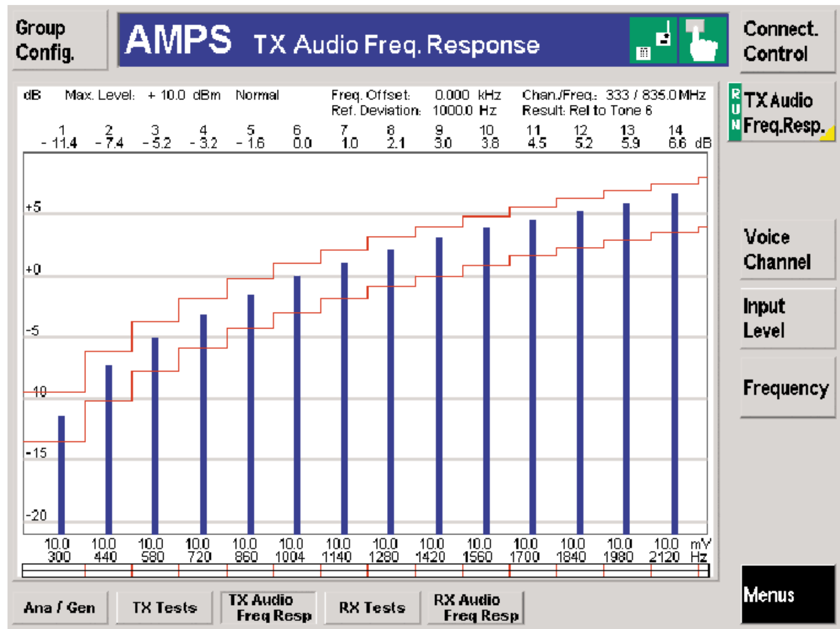
Signalling measurements
- MAHO report
- Power versus time
  – Short burst
  – Normal burst
- Modulation
  – Phase error
  – Magnitude error
  – EVM/EVM10
  – Overview of phase / magnitude and EVM simultaneously
- Spectrum
  – Adjacent channel power due to switching/due to modulation
- Overview
  – Signalling information

Non-signalling measurements
- Modulation
- Spectrum
- Power versus time
- BER

Universal Radio Communication Tester CMU200

AMPS measurements

Although AMPS is a 1st generation analog standard, a great demand for mobile radio testers covering this standard will continue to exist in the future. Especially in the United States, dual-mode CDMA/AMPS and TDMA/AMPS phones are very common. By combining the digital standards with analog AMPS, the network operators offer their customers the advantages of the digital standards and ensure nearly 100% coverage in North America. As a consequence, Rohde&Schwarz is extending the range of CMU200 options by introducing analog AMPS in addition to the digital standards TDMA and CDMA. These options add analog AMPS functionality to the CMU200 base unit:



TX audio frequency response measurement. The pre-emphasis characteristic of the mobile transmitter is verified by a single-shot measurement

- CMU-B21 (versatile link handler)
- CMU-B41 (audio generator/analyzer)
- CMU-K29 (AMPS test software)

The hardware options CMU-B21 (versatile link handler) and CMU-B41 (audio generator/analyzer) are suited for other standards as well. As for other standards, there are two categories of AMPS measurements:

- Transmitter tests for assessing the transmit part of a mobile
- Receiver tests for assessing the receive part of a mobile
- AF Level Search routine
- Sensitivity Search routine

The AF Level Search routine in the TX test menu allows the user to set the desired frequency deviation of the mobile transmitter at a keystroke, the level of the CMU200 modulation generator is automatically corrected.

The Sensitivity Search routine in the RX test menu automatically searches the receiver input level at which a selectable SINAD of the demodulated signal can still be attained. The following list provides an overview of the most important tests implemented in option CMU-K29.

Transmitter measurements

- Carrier power
- Carrier frequency error
- SAT frequency error/peak deviation
- ST frequency error/peak deviation
- Modulation noise and distortion
- Hum and noise
- Electrical audio frequency response
- Modulation distortion
- Residual AM

Receiver measurements

- Sensitivity
- Hum and noise
- SINAD
- Distortion
- AF voltage
- Electrical audio frequency response
- Residual AM
- Audio deviation

Audio frequency response measurements

All the filters required for the measurements are of course preconfigured in line with specifications, but their settings can be modified for individual measurements. The RX and TX electrical audio frequency response measurements in AMPS are usually defined as frequency sweep versus AF frequency range. The CMU200 offers a much faster and more modern alternative. Using the TX and RX audio frequency response menus of CMU200, the AF frequency response is measured simultaneously at 20 test points with user-programmable level and frequency and then checked against specified tolerances (see screenshot above).

Universal Radio Communication Tester CMU200

CDMA measurements

All supported CDMA standards

- US Cellular (800 MHz)
  - TIA/EIA-IS-95
- Japan Cellular
  - ARIB-T53/IS-95
- China Cellular
  - TIA/EIA-IS-95
- US PCS (1900 MHz)
  - ANSI-J-STD008, UB-IS-95
- Korea PCS (1800 MHz)
  - J-STD008, UB-IS-95

Instead of using frequencies or timeslots as traditional technologies like TDMA and AMPS do, CDMA uses mathematical codes to transmit and distinguish between multiple wireless conversations. Depending on the level of mobility, CDMA provides 8 to 10 times the capacity of AMPS and 4 to 5 times the capacity of TDMA systems. CDMA can efficiently utilize the spectrum and serve many subscribers without requiring extensive frequency planning.

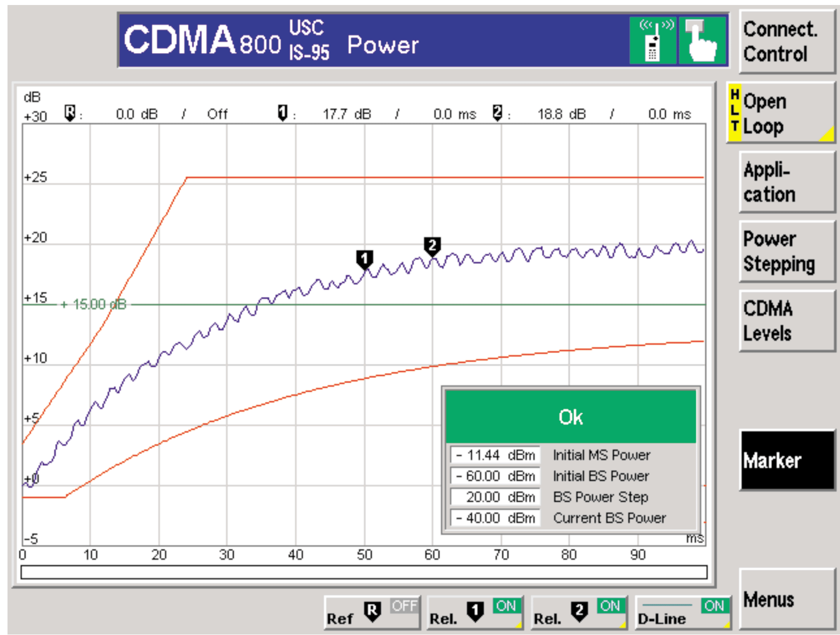
CDMA options

The following options make the CMU200 a compact radio communication tester for all TIA/EIA-95-based CDMA mobile phones:

- CMU-B81 (CDMA link handler)
- CMU-K81 (CDMA, cellular)
- CMU-K82 (CDMA, PCS)

CDMA functionality

The tester emulates a code division multiple access base station, makes a call to the mobile, and tests all essential parameters of a CDMA mobile station. The tester can measure the following key parameters among other tests:



Open-loop time response: The open-loop power control test shows the response of the mobile station to an increase or decrease in base-station total power. The default increase or decrease for this test is 20 dB. Power stepping and CDMA levels are user-definable

- Power control measurements:
  - Open-loop time response
  - Gated output power
  - Minimum output power
  - Maximum output power
- Receiver quality measurements:
  - Frame error rate (FER)
  - With additional AWGN generator to simulate noise caused by other CDMA calls at the same frequency
- Transmitter quality measurements:
  - Waveform quality
  - Error vector magnitude
  - Phase error
  - Magnitude error
  - Carrier feedthrough and I/Q imbalance
  - Frequency accuracy

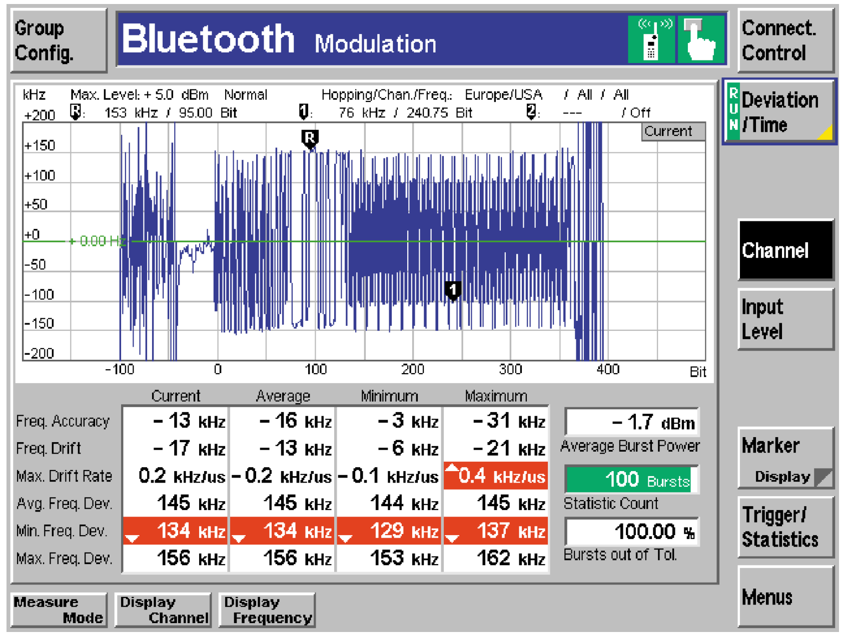
CDMA-related features

- Voice loopback and comprehensive testing of mobiles
- Powerful signalling capabilities
- Built-in AWGN generator for simulating noise generated by other CDMA calls
- Base station simulation
- Mobile or base station originated call connect/disconnect
- Short measurement time ensuring high throughput
- Combined measurements (RX/TX in parallel)
- Benchmark-breaking IEEE/IEC bus speed (see GSM highlights)
- Simple interactive operation, standardized MMI
- No specialized network knowledge required
- Various handoffs supported (e.g. CDMA to analog AMPS)
- Dual-band/dual-mode testing

Universal Radio Communication Tester CMU 200

Bluetooth[TM] measurements

The CMU 200 is compliant with the *Bluetooth* core specification Ver. 1.0 B (Core specification Ver 1.1 in preparation). The *Bluetooth* Test Mode (Core Spec. Part I:1) is implemented with all commands needed to perform the TX/RX measurements. All measurements can be performed in hopping, reduced hopping or non-hopping mode. The CMU 200 supports measurements using DH1, DH3 and DH5 packets.



The graphical display of the modulation results may be spread between 1/1 and 1/8 of a burst for in-depth analysis. The "Max. Freq. Dev." and "Min Freq. Dev." results allow the highest and lowest values for 10 bit long fractions of a payload to be evaluated individually

TX measurements

The current measurement values for each parameter are displayed on the CMU 200 screen. Additionally average, maximum and minimum values are displayed as a result of a statistical evaluation of a settable number of *Bluetooth* packets (bursts).

- Power measurements
  - Nominal power (measured as the part of the burst starting at the detected 1st bit of the preamble (bit 0) to the last bit of the burst)
  - Leakage power (measured within defined areas before and after the burst)
  - Peak power (shows the highest power level within a burst)
- Timing measurements
  - Packet alignment (distance between ideal master receiver slot and detected bit 0 of the received burst)
- Modulation measurements
  - Frequency accuracy (difference between measured frequency and intended transmitted frequency, measured in the preamble at the beginning of a packet)
  - Frequency drift (difference between the frequency at the start of the packet and the frequency in the payload)
  - Maximum drift rate (maximum drift rate anywhere within the packet payload)
  - Average, maximum and minimum frequency deviation (calculated over the packet payload)

RX measurements

For RX measurements, the built-in signal generator generates a selectable bit sequence, which is looped back in the DUT and demodulated and processed by the CMU 200 again. The TX level of the CMU 200 can be adjusted for this measurement. The BER application supports defining up to five test programs. Each program can independently set settings such as control parameters, limits, repetition or statistical cycles.

- Sensitivity
  - BER (percentage of bit errors that have occurred within the current statistical cycle)
  - PER (percentage of packet errors that have occurred within the current statistical cycle, where an errored packet is a packet with a header which cannot be corrected)

Universal Radio Communication Tester CMU200

Options overview

The base unit without any options installed, may be used for testing general parameters of 1st, 2nd or 3rd generation mobile phones. The CMU200 base unit is the ideal solution for trimming tasks at module level, i.e. in early production stages of all cellular standards. Constituent parts of the CMU200 base unit are the RF generator (100 kHz to 2.7 GHz) and analyzer which are complemented by a versatile network-independent analyzer/generator menu and a comprehensive spectrum analyzer.

Key advantages for the customer

- Single measurement up to 10 times faster than the previous generation of instruments
- Three times more accurate than the previous generation of instruments with excellent repeatability
- Modular hardware and software concept provides easy extension to further functionality
- Low component count, low power consumption, and effective heat conduction result in unparalleled reliability
- Easy migration to future standards

Type/Option	Description	Order number
CMU200	Base unit with following accessories: power cord, operating manual, service manual instrument	1100.0008.02
CMU-B11[1])	Reference OCXO, aging 2 x 10^{-7}/year. Ensures high absolute accuracy, minimum temperature-dependent drift and especially high long-term stability. Used for measurements with exacting frequency stability requirements	1100.5000.02
CMU-B12[1])	High-stability OCXO, aging 3.5 x 10^{-8}/year. Oven crystal with highest long-term stability. Ensures compliance with tolerances specified by GSM. Used for highly demanding frequency stability requirements to GSM 11.20	1100.5100.02
CMU-B21	Versatile signalling unit. Provides multistandard signalling hardware	1100.5200.02
CMU-B41	Audio generator and analyzer. Includes audio frequency (AF) generator, voltmeter, distortion meter	1100.5300.02
CMU-B52[2])	Internal versatile multimode speech coder/decoder. This option converts digital speech signals into analog signals and vice versa. The option allows separate uplink and downlink audio application measurements on GSM phones.	1100.5400.02
CMU-B53[2])[6])	Bluetooth extension, factory installation only	1100.5700.02
CMU-B81	CDMA signalling unit.	1100.6506.02
CMU-U53[2])[7])	Bluetooth upgrade kit for CMU	1115.5000.02
CMU-U61	Modification kit: floppy disk drive 3 ½“ instead of PCMCIA	1100.5500.02
CMU-K20[2])	GSM400 mobile station signalling/non-signalling test	1115.5900.02
CMU-K21[2])	GSM900, R-GSM and E-GSM mobile station signalling/non-signalling test	1115.6007.02
CMU-K22[2])	GSM1800 (DCS) MS signalling/non-signalling test	1115.6107.02
CMU-K23[2])	GSM1900 (PCS) MS signalling/non-signalling test	1115.6207.02
CMU-K24[2])	GSM850 MS signalling/non-signalling test	1115.6307.02
CMU-K27[2])	IS-136/Cellular (800 MHz band) mobile station signalling/non-signalling test	1115.6607.02
CMU-K28[2])	IS-136/Cellular (1900 MHz band) mobile station signalling/non-signalling test	1115.6707.02
CMU-K29[3])	AMPS mobile station signalling/non-signalling test	1115.6807.02
CMU-K53[2])[5])	Software Bluetooth (CMU-B21 and CMU-B53 required)	1100.7302.02
CMU-K81[4])	CDMA 800 mobile station signalling/non-signalling test	1115.5500.02
CMU-K82[4])	CDMA 1700/1900 mobile station signalling/non-signalling test	1115.5600.02
CMU-DCV	Documentation of calibration values	0240.2193.08
CRT-Z2	Test SIM to enable loopback mode as required for BER and other applications	1039.9005.02
CMU-Z1	30 MB memory card for use with PCMCIA interface	1100.7490.02
CMU-Z3	Service Kit for CMU200	11007690.02
PSM-B9	PCMCIA Type 3, 520 MB hard disk	1064.5700.02
ZAA-411	19“ rack adapter	1096.3283.00

1) CMU-B11 or CMU-B12 possible. One of two OCXOs should be installed to ensure high frequency accuracy or external frequency reference may be used, if available.

2) CMU-B21 necessary.

3) CMU-B21 and CMU-B41 necessary.

4) CMU-B81 necessary.

5) CMU-B53 necessary.

6) CMU-K53 necessary.

7) Includes CMU-B53 and CMU-K53.

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Radio Communication Tester CMU200

Specifications in brief

Timebase TCXO

Max. frequency drift	± 1 x 10^{-6} (+5°C to +45°C)
Max. aging	± 1 x 10^{-6}/year

Timebase OCXO option CMU-B11

Max. frequency drift	± 1 x 10^{-7} (+5°C to +45°C)
Max. aging	± 2 x 10^{-7}/year

Timebase OCXO option CMU-B12

Max. frequency drift (+5°C to +45°C)	± 5 x 10^{-9}, referred to +25°C
Max. aging	± 3.5 x 10^{-8}/year

Reference frequency inputs/outputs

Synchronization input	BNC, 0.5 V to 2 V rms, 50 Ω
Frequency sinewave	1 MHz to 52 MHz, step 1 kHz
Frequency squarewave (TTL level)	10 kHz to 52 MHz, step 1 kHz
Max. frequency variation	± 5 x 10^{-6}
Synchronization output 1	BNC, >1.0 V pp, 50 Ω
Frequency	10 MHz from internal reference or frequency at synchronization input
Synchronization output 2	BNC, >1.4 V pp, 50 Ω
Frequency	net-specific frequencies in the range 100 kHz to 40 MHz

RF generator

Frequency range	100 kHz to 2700 MHz
Frequency resolution	0.1 Hz
Frequency settling time	<400 µs to Δf <1 kHz

Output level range

RF1	100 kHz to 2200 MHz	– 130 dBm to – 27 dBm
	2200 MHz to 2700 MHz	– 130 dBm to – 33 dBm
RF2	100 kHz to 2200 MHz	– 130 dBm to – 10 dBm
	2200 MHz to 2700 MHz	– 130 dBm to – 16 dBm
RF3OUT	100 kHz to 2200 MHz	– 90 dBm to +13 dBm
	2200 MHz to 2700 MHz	– 90 dBm to +5 dBm

Output level uncertainty (+23°C to +35°C)

RF1, RF2	>–106 dBm	>–117 dBm	–117 to –130 dBm
10 MHz to 450 MHz	<0.6 dB	<0.6 dB	
450 MHz to 2200 MHz	<0.6 dB	<0.6 dB [2]	<1.5 dB [1) 2)]
2200 MHz to 2700 MHz	<0.6 dB	<0.8 dB [2]	<1.5 dB [1) 2)]

RF3OUT	10 MHz to 450 MHz	<0.8 dB P=– 80 dBm to +10 dBm
	450 MHz to 2200 MHz	<0.8 dB P=– 90 dBm to +10 dBm
	2200 MHz to 2700 MHz	<1.0 dB P=– 90 dBm to +5 dBm

Level settling time	<4 µs
Resolution	0.1 dB

VSWR

RF1	10 MHz to 2000 MHz	<1.2
	2000 MHz to 2200 MHz	<1.3
	2200 MHz to 2700 MHz	<1.6
RF2	10 MHz to 2200 MHz	<1.2
	2200 MHz to 2700 MHz	<1.6
RF3OUT	10 MHz to 2200 MHz	<1.5
	2200 MHz to 2700 MHz	<1.7

Attenuation of harmonics (f_0 = 10 MHz to 2200 MHz, up to 7 GHz)

RF1, RF2	>30 dB
RF3OUT	>20 dB

Attenuation of nonharmonics

10 MHz to 2200 MHz	>40 dB at >5 kHz from carrier

Spectral purity

Phase noise (single sideband, f <2.2 GHz)	
Carrier offset	
20 kHz to 250 kHz	<– 100 dBc
≥250 kHz	<– 110 dBc
Residual FM	
30 Hz to 20 kHz	<50 Hz (rms), <200 Hz (peak)
CCITT	<5 Hz (rms)
Residual AM (CCITT)	<0.02% (rms)

IQ modulation

Data for frequency offset range 0 kHz to ± 135 kHz	
Carrier suppression	> 40 dB

RF analyzer

VSWR

RF1	10 MHz ... 2000 MHz	<1.2
	2000 MHz ... 2200 MHz	<1.3
	2200 MHz ... 2700 MHz	<1.6
RF2	10 MHz ... 2200 MHz	<1.2
	2200 MHz ... 2700 MHz	<1.6
RF4IN	10 MHz ... 2200 MHz	<1.5
	2200 MHz ... 2700 MHz	<1.6

Power meter (wideband)

Frequency range	100 kHz to 2700 MHz
Level range	
RF1 (continuous power [3])	
100 kHz to 2200 MHz	+6 dBm to +47 dBm (50 W)
2200 MHz to 2700 MHz	+10 dBm to +47 dBm (50 W)
max. peak power [6] (PEP)	+53 dBm (200 W)
RF2 (continuous power)	
100 kHz to 2200 MHz	– 8 dBm to +33 dBm (2 W)
2200 MHz to 2700 MHz	– 4 dBm to +33 dBm
max. peak power [6] (PEP)	+39 dBm (8 W)
RF4IN (continuous power and PEP)	
100 kHz to 2200 MHz	– 33 dBm to 0 dBm
2200 MHz to 2700 MHz	– 29 dBm to 0 dBm

Level uncertainty		
RF1	10 to 20 dBm	20 to 47 dBm
10 MHz to 2700 MHz	<1.0 dB [5]	<0.5 dB [4) 5)]
RF2	– 4 to +6 dBm	+6 to +33 dBm
10 MHz to 2700 MHz	<1.0 dB [5]	<0.5 dB [5]
RF4IN	– 29 to –19 dBm	– 19 to 0 dBm
10 MHz to 2700 MHz	<1.5 dB	<0.8 dB
Resolution	0.1 dB	

Power meter (frequency-selective)

Frequency range/resolution	10 MHz to 2700 MHz/0.1 Hz
Resolution bandwidths	10 Hz to 1 MHz in 1/2/3/5 steps
Level range for rated data	
RF1 (continuous power[3])	
10 MHz to 2200 MHz	– 40 dBm to +47 dBm (50 W)
2200 MHz to 2700 MHz	– 34 dBm to +47 dBm (50 W)
max. peak power[6] (PEP)	+53 dBm (200 W)
RF2 (continuous power[3])	
10 MHz to 2200 MHz	– 54 dBm to +33 dBm (2 W)
2200 MHz to 2700 MHz	– 48 dBm to +33 dBm
max. peak power[6] (PEP)	+39 dBm (8 W)
RF4IN (continuous power and PEP)	
10 MHz to 2200 MHz	– 80 dBm to 0 dBm
2200 MHz to 2700 MHz	– 74 dBm to 0 dBm
Level uncertainty (+23°C to +35°C)	
RF1, RF2 10 MHz to 2200 MHz	<0.5 dB
2200 MHz to 2700 MHz	<0.7 dB
RF4IN 10 MHz to 2200 MHz	<0.7 dB
2200 MHz to 2700 MHz	<0.9 dB
Resolution	0.1 dB

Demodulation (data of hardware paths) Spectral purity

Phase noise (single sideband, f <2.2 GHz)	
Carrier offset 20 kHz to 250 kHz	<– 100 dBc
250 kHz to 400 kHz	<– 110 dBc
≥400 kHz	<– 118 dBc

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Residual FM	30 Hz to 20 kHz	<50 Hz (rms), <200 Hz (peak)
	CCITT	<5 Hz (rms)
Residual AM (CCITT)		<0.02% (rms)

Spectrum analyzer

Frequency range	10 MHz to 2.7 GHz
Span	zero span to full span
Frequency resolution	0.1 Hz
Resolution bandwidths	10 Hz to 1 MHz in 1/2/3/5 steps
Sweep time	≥ 100 ms, depending on RBW
Display	560 dots, horizontal
Marker	up to 3, absolute/relative
Display line	1
Display scale	10/20/30/50/80/100 dB

Level range

RF1	continuous power[3]	up to +47 dBm (50 W)
	max. peak power[6] (PEP)	up to +53 dBm (200 W)
RF2	continuous power	up to +33 dBm (2 W)
	max. peak power[6] (PEP)	up to +39 dBm (8 W)
RF4IN continuous power and PEP		up to 0 dBm

Level uncertainty

RF1, RF2, RF4IN (+23 °C to +35 °C)	
10 MHz to 2200 MHz	0.5 dB
2200 MHz to 2700 MHz	0.7 dB

Reference level for full dynamic range

Logarithmic level display	
RF1	+10 dBm to +47 dBm
RF2	– 4 dBm to +33 dBm
RF4IN	– 22 dBm to 0 dBm

Displayed average noise level (RBW 1 kHz)

RF1/RF2/RF4IN	
10 MHz to 2200 MHz	<– 100 dBc
2200 MHz to 2700 MHz	<– 95 dBc
Inherent spurious response	<– 50 dB

Low distortion mode, f >20 MHz, except 1816.115 MHz

Inherent harmonics

(f_0 = 10 MHz to 2200 MHz, up to 7 GHz)

RF1, RF2	> 30 dB
RF4IN	> 20 dB

Audio option CMU-B41

Audio generator

Output impedance	<4 Ω
Maximum output current	20 mA

AF sine generator

Frequency range	20 Hz to 20 kHz
Frequency resolution	0.1 Hz
Level range	10 µV to 5 V

Audio analyzer

Input impedance	1 MΩ ǀǀ 100 pF

AF voltmeter

Frequency range	50 Hz to 20 kHz
Level range	50 µV to 30 V
Level resolution	1 µV at level <1 mV
	0.1% at level ≥1 mV

THD+N meter

Measurement bandwidth	21 kHz
Frequency range	100 Hz to 10 kHz
Level range	10 mV to 30 V
Resolution	0.01% THD+N

GSM specifications

RF generator GSM

Frequency range	GSM900 band	925 MHz to 960 MHz
	GSM1800 band	1805 MHz to 1880 MHz
	GSM1900 band	1930 MHz to 1990 MHz
Frequency resolution		
GSM channel spacing		200 kHz
Frequency settling time		<500 µs to res. phase of 4°
Attenuation of inband spurious emissions		> 50 dB
Modulation		GMSK, BxT = 0.3
Inherent phase error		≤ 1°, rms,≤ 4°, peak

RF analyzer GSM

Frequency range	GSM900 band	880 MHz to 915 MHz
	GSM1800 band	1710 MHz to 1785 MHz
	GSM1900 band	1850 MHz to 1910 MHz
Frequency resolution		200 kHz (GSM channel spacing)
Measurement bandwidth		500 kHz (in measurement menus)

Power meter GSM

Level range for rated data		
RF1	continuous power[3]	– 40 dBm to +47 dBm (50 W)
	max. peak power[6] (PEP)	+53 dBm (200 W)
RF2	continuous power	– 54 dBm to +33 dBm (2 W)
	max. peak power[6] (PEP)	+39 dBm (8 W)
RF4IN (continuous power and PEP)		– 80 dBm to 0 dBm

Phase and frequency error measurement GSM

Level range (PEP)	RF1	– 6 dBm to +53 dBm
	RF2	– 20 dBm to +39 dBm
	RF4IN	– 60 dBm to 0 dBm

Burst power measurement GSM

Reference level for full dynamic range	
RF1	+10 dBm to +53 dBm
RF2	– 4 dBm to +39 dBm
RF3IN	– 22 dBm to 0 dBm
Dynamic range	> 72 dB, rms

TDMA specifications

RF generator

Frequency range	
US Cellular	869 MHz to 894 MHz
PCS (US)	1930 MHz to 1990 MHz

Modulation

π/4 DQPSK or unmodulated (non-signalling mode)

Carrier suppression	>40 dB

RF analyzer

Modulation analyzer	
EVM, rms (residual)	<2%
EVM, peak (residual)	<4%
I/Q offset (residual)	<–50 dB (0.3%)
I/Q imbalance (residual)	<–50 dB (0.3%)
Frequency measurement range	–2 kHz to +2 kHz
Frequency measurement error	≤5 Hz + drift of timebase
Reference level for full dynamic range (low noise mode)	
RF1	+4 dBm to +47 dBm
RF2	–10 dBm to +33 dBm
RF4IN	–28 dBm to –6 dBm
Dynamic range	>74 dB (BW=100 kHz, rms)

Relative measurement uncertainty

Result >–40 dB	<0.1 dB
–60 dB≤ Result ≤–40 dB	<0.5 dB

Radio Communication Tester CMU200

Adjacent channel power measurement

Dynamic range	
1st adjacent channel	>45 dB
2nd and 3rd adjacent channel	>55 dB

AMPS specifications

Modulation

FM deviation range	100 Hz to 20 kHz
AF range	100 Hz to 15.999 kHz

FM distortion

(SINAD; dev. 8 kHz, AF 1 kHz, BW 30 Hz to 15 kHz)	≥40 dB
Residual FM (rms, BW 300 Hz to 3 kHz)	≤10 Hz
Deviation uncertainty at 1 kHz AF, 8 kHz dev. (measurement bandwidth 30 Hz to 15 kHz)	<2 % of setting + residual FM

RF analyzer

Power meter (frequency-selective)		
Reference level range	RF1	0 dBm to +53 dBm
	RF2	–14 dBm to +39 dBm
	RF4IN	–37 dBm to 0 dBm
FM measurement		
AF range		100 Hz to 18 kHz
Residual FM		
BW 300 Hz to 3 kHz, rms		≤5 Hz
BW 6 Hz to 20 kHz, rms		≤18 Hz
Uncertainty (BW 6 Hz to 20 kHz)		<1% of reading + residual FM
Carrier frequency error		
Measurement range		–47 kHz to +47 kHz
Measurement uncertainty		≤2 kHz + drift of timebase

CDMA specifications

Standards

CDMA standards	TIA/EIA-95, J-STD-008, ARIB T53
Korean, Chinese CDMA test standards	TIA/EIA-98, J-STD-018

RF generator

Modulation	
QPSK, multiple QPSK	1.2288 Mcps
Carrier suppression	>35 dB
Waveform quality factor (ρ)	>0.966; >0.995 typ.
AWGN generator	
Selectable bandwidth	1.23 MHz or 1.8 MHz

RF analyzer

Measurement filter	according to standard (1.23 MHz BW)
Frequency resolution	channel spacing according to standard
Level range (O-QPSK signal)	
RF1	–40 dBm to +47 dBm
RF2	–54 dBm to +33 dBm
RF4IN	–80 dBm to –6 dBm
Power meter (frequency-selective)	
Level uncertainty RF1, RF2, RF4IN	
in temp. range +23° to +35°C	<0.5 dB
in temp. range +5° to +45°C	<0.7 dB

Modulation analyzer

Measurement uncertainty (for 0.9 to 1)	<0.003
Frequency measurement range	–3 kHz to +3 kHz
Frequency measurement uncertainty	≤30 Hz + drift of timebase
Timing measurement uncertainty	<60 ns

Bluetooth specifications

RF generator

Frequency range	
Europe (except Spain and France), USA and Japan	2.4000 GHz to 2.4835 GHz
France	2.4465 GHz to 2.4835 GHz
Spain	2.4450 GHz to 2.475 GHz
Frequency resolution	channel spacing 1 MHz according to std.

Modulation

GFSK	1 Mbps, B x T = 0.5

RF analyzer

Frequency range	same as RF generator

Power meter (frequency-selective) and power versus time

Reference level for full dynamic range (GFSK signal)	RF1	0 dBm to +41 dBm
	RF2	–14 dBm to +33 dBm
	RF4IN	–32 dBm to 0 dBm

Modulation analyzer (RBW = 3 MHz)

Level range (GFSK signal)	
RF1, RF2, RF4IN	from full-scale setting down to –25 dB
Frequency deviation error	<±4 kHz
Frequency measurement range	–250 kHz to +250 kHz
Timing measurement	
Range	±20 µs
Uncertainty	≤0.25 µs

General data

Rated temperature range	+5 °C to +45 °C
Storage temperature range	–25 °C to +60 °C
Power supply	100 V to 240 V ± 10% (AC), 3.1 A to 1.3 A, 50 Hz to 400 Hz, – 5% to +10% power factor correction
Power consumption	
Base unit	130 W
with typical options	180 W
Dimensions (W x H x D)	465 mm x 193 mm x 517 mm (19"; 4 height units)
Weight	
Base unit	14 kg
with typical options	18 kg

Ordering informations

see table "Instruments options and ordering information"

1) Valid for RF1 only.

2) Not valid at frequencies of netclock harmonics.

3) 50 W in the temperature range +5 °C to +30 °C, linear degradation down to 25 W at 45 °C.

4) Calibrated for P>33 dBm only in frequency range 800 MHz to 2000 MHz.

5) Temperature range +5° C to +23 °C or +35 °C to +45 °C and f>2200 MHz: additional uncertainty of 0.2 dB.

6) Mean value of power vs time must be equal or less than allowed continuous power.

Universal Radio Communication Tester CMU300

Base station tester for developmet, production, system test, installation and service

Photo 43641-6

Brief description

Universal Radio Communication Tester CMU300 is designed for testing the U_M air interface of base stations in line with GSM Specification 11.21 (ETSI TS 101 087). It is suitable for transmitter tests (power measurement, modulation analysis, spectrum measurements) and receiver tests (BER measurements).

CMU300 also features all highlights of a modern tester: top measurement accuracy and speed combined with extremely high reliability and reproducibility. The CMU300 from Rohde&Schwarz is a versatile platform for all applications in base station testing: development, production, system test, installation and service. It keeps up with the evolution of modern digital mobile radio. At present the tester supports GSM (2G) and EDGE (2.5G), with upgrading for 3rd generation testing being planned already.

Main features

- Wide frequency range from 10 MHz to 2.7 GHz
- Simple operation (manual, IEEE bus)
- Simultaneous transmitter/receiver measurements
- Spectrum analyzer function
- Bright, high-resolution TFT colour display
- Network-independent non-signalling tests for the development of new or existing standards facilitated by power versus time, RF analyzer/generator and spectrum analyzer measurements
- Measurements
  - Modulation analysis
  - Power versus time
  - Power versus slot
  - Peak/average power
  - BER, RBER/FER, NER
  - General spectrum measurements
- Benchmark-breaking IEEE/IEC bus speed due to parallel measurements, secondary addressing and optimized processing power
- Low power consumption
- Low heat dissipation
- Easy 19" rackmounting
- Compact box of only 4 height units

Further characteristics

Bit error rate measurements in real time

Here the CMU300 shows all the benefits of a compact test set (generator/analyzer functions in a single unit). Generating and decoding various channels in realtime is the main prerequisite for continuous bit error rate measurements, e.g. for automatic search for the sensitivity limit, and for signalling at higher layers, e.g. for simulation of MS functions.

Compatibility with various test environments

The CMU300 supports various test paths from the PN generator via the device under test (DUT) to the BER analysis. The test path may be taken via various loops within the BTS (with or without channel coding) or via the A_{bis} interface. On the other hand the CMU300 itself may be used as an RF loop (with or without channel coding).

RF input/output switching panel

The base station is connected to the CMU300 frontend via its antenna or test inputs and outputs. For optimum adaptation to the RF test environment the tester features an RF switching unit with 4 configurable inputs and outputs. Two of the inputs/outputs have duplex capability, one being designed for connection to a high-power base station with max. +47 dBm output power, and the second for micro base stations with max. +33 dBm output power. In addition, the CMU300 features a sensitive input and a high-power output.

Base Station Tester CMU300

Options

The base unit already provides the functionality of two general-purpose instruments: signal generator and spectrum analyzer. By installing a Signalling Unit CMU-B21 and at least one of the five available GSM Software Options CMU-K30 to K34, the base unit becomes a radiocommunication tester (transmitter and receiver measurements for GMSK modulation).

The GSM functionalities can be enhanced to EDGE with the aid of Software Option CMU-K41. Software Option CMU-K39 enables call setup via standard signalling such as MOC/MTC which is required whenever the signalling software of the base station is to be tested too and measurement reports from the base station are requested.

A high-stability OCXO (CMU-B12) and an Abis board (CMU-B71) are available as hardware options. The Abis board is required for the BER test if internal loopback of the bit pattern sent by the CMU300 is not possible in the base station. The CMU300 then recovers the bit pattern via the Abis connection between BTS and BSC.

The CMU300 comes standard with two PCMCIA slots. On request it may also be supplied with a disk drive (CMU-U61).

Specifications in brief

Base unit

Timebase TCXO

Max. frequency drift (+5°C to +45°C)	$\pm1 \times 10^{-6}$
Max. aging	$\pm1 \times 10^{-6}$/year

Timebase OCXO – option CMU-B12

Max. frequency drift (+5°C to +45°C)	$\pm5 \times 10^{-9}$, referred to +25°C
Max. aging	$\pm3.5 \times 10^{-8}$/year, $\pm5 \times 10^{-10}$/day after 30 days of operation

Reference frequency inputs/outputs

Synchronization input	BNC connector REFIN
Frequency	
Sinewave	1 MHz to 52 MHz, step 1 kHz
Squarewave (TTL level)	10 kHz to 52 MHz, step 1 kHz
Max. frequency variation	$\pm5 \times 10^{-6}$
Input voltage range, impedance	0.5 V to 2 V, rms, 50 Ω
Synchronization output 1	BNC connector REFOUT1
Frequency	10 MHz from internal reference or frequency at synchronization input
Output voltage, impedance	>1.4 V, peak-peak, 50 Ω
Synchronization output 2	BNC connector REFOUT2
Frequency	net-specific (100 kHz to 40 MHz)
Output voltage (f ≤13 MHz), imp.	>1.0 V, peak-peak, 50 Ω

RF generator

Frequency range	100 kHz to 2700 MHz
Frequency resolution	0.1 Hz
Frequency uncertainty	same as timebase + resolution
Frequency settling time	<400 µs to Δf <1 kHz
Output level range (RF1)	
RF1 100 kHz to 2200 MHz	–130 dBm to –27 dBm
2200 MHz to 2700 MHz	–130 dBm to –33 dBm
RF2 100 kHz to 2200 MHz	–130 dBm to –10 dBm
2200 MHz to 2700 MHz	–130 dBm to –16 dBm
$RF3_{OUT}$ 100 kHz to 2200 MHz	–90 dBm to +13 dBm
2200 MHz to 2700 MHz	–90 dBm to +5 dBm

Output level uncertainty

RF1, RF2 (+23°C to +35°C)	≥–106 dBm	>–117 dBm	–117 to –130 dBm
10 MHz to 450 MHz	<0.6 dB		
450 MHz to 2200 MHz	<0.6 dB	<0.6 dB[2)]	<1.5 dB[1) 2)]
2200 MHz to 2700 MHz	<0.8 dB	<0.8 dB[2)]	<1.5 dB[1) 2)]
RF3OUT (+23°C to +35°C)			
10 MHz to 450 MHz	<0.8 dB P=–80 dBm to +10 dBm		
450 MHz to 2200 MHz	<0.8 dB P=–90 dBm to +10 dBm		
2200 MHz to 2700 MHz	<1.0 dB P=–90 dBm to +5 dBm		

Output level settling time	<4 ms
Output level resolution	0.1 dB
Generator RF level repeatability (RF1, RF2, RF3OUT, typical values after 1 h warm-up)	
Output ≥–80 dBm	<0.01 dB
Output <–80 dBm	<0.1 dB
VSWR (RF1) 10 MHz to 2000 MHz	<1.2
2000 MHz to 2200 MHz	<1.3
2200 MHz to 2700 MHz	<1.6
Attenuation of harmonics (f_0 = 10 MHz to 2200 MHz, up to 7 GHz)	
RF1, RF2	>30 dB
RF3OUT (P≤ +10 dBm)	>20 dB
Attenuation of nonharmonics	
10 MHz to 2200 MHz	>40 dB at >5 kHz from carrier
Spectral purity	
Phase noise (single sideband, f < 2.2 GHz)	
Carrier offset	
20 kHz to 250 kHz	<–100 dBc(1 Hz)
≥250 kHz	<–110 dBc(1 Hz)
Residual FM	
30 Hz to 15 kHz	<50 Hz (rms), <200 Hz (peak)
CCITT	<5 Hz (rms)
Residual AM, CCITT	<0.02% (rms)
IQ modulation	
Data for frequency offset range 0 kHz to ±135 kHz	
Carrier suppression	>40 dB

RF analyzer

VSWR (RF1)	
10 MHz to 2000 MHz	<1.2
2000 MHz to 2200 MHz	<1.3
2200 MHz to 2700 MHz	<1.6

Radio Communication Tester CMU300

Power meter (wideband)	100 kHz to 2700 MHz
Level range	
RF1, continuous power [3]	
100 kHz to 2200 MHz	+6 dBm to +47 dBm (50 W)
2200 MHz to 2700 MHz	+10 dBm to +47 dBm (50 W)
Peak envelope power [4] (PEP)	+53 dBm (200 W)
RF2, continuous power	
100 kHz to 2200 MHz	–8 dBm to +33 dBm (2 W)
2200 MHz to 2700 MHz	–4 dBm to +33 dBm
Peak envelope power [4] (PEP)	+39 dBm (8 W)
RF4IN (continuous power and PEP)	
100 kHz to 2200 MHz	–33 dBm to 0 dBm
2200 MHz to 2700 MHz	–29 dBm to 0 dBm

Level uncertainty		
RF1	10 dBm to 20 dBm	20 dBm to 47 dBm
50 MHz to 2700 MHz	<1.0 dB [6]	<0.5 dB [5] [6]
RF2	–4 dBm to +6 dBm	+6 dBm to +33 dBm
50 MHz to 2700 MHz	<1.0 dB [6]	<0.5 dB [6]
RF4IN	–29 dBm to –19 dBm	–19 dBm to 0 dBm
50 MHz to 2700 MHz	<1.5 dB	<0.8 dB
Level resolution	0.1 dB	

Power meter (frequency-selective)	
Frequency range	10 MHz to 2700 MHz
Frequency resolution	0.1 Hz
Resolution bandwidths	10 Hz to 1 MHz in 1/2/3/5 steps
Level range	
RF1, continuous power [3]	
10 MHz to 2200 MHz	–40 dBm to +47 dBm (50 W)
2200 MHz to 2700 MHz	–34 dBm to +47 dBm (50 W)
Peak envelope power [4] (PEP)	+53 dBm (200 W)
RF2, continuous power	
10 MHz to 2200 MHz	–54 dBm to +33 dBm (2 W)
2200 MHz to 2700 MHz	–48 dBm to +33 dBm
Peak envelope power [4] (PEP)	+39 dBm (8 W)
RF4IN (continuous power and PEP)	
10 MHz to 2200 MHz	–80 dBm to 0 dBm
2200 MHz to 2700 MHz	–74 dBm to 0 dBm
Level uncertainty	
RF1, RF2 (+23 °C to +35 °C)	
50 MHz to 2200 MHz	<0.5 dB
2200 MHz to 2700 MHz	<0.7 dB
RF4IN (+23 °C to +35 °C)	
50 MHz to 2200 MHz	<0.7 dB
2200 MHz to 2700 MHz	<0.9 dB
RF level measurement repeatability (RF1, RF2, RF4IN, typical values after 1 h warm-up)	
Input ≥–40 dBm	<0.01 dB
Input <–40 dBm	<0.03 dB
Level resolution	0.1 dB

Demodulation (data of hardware paths)	
Spectral purity	
Phase noise (single sideband, f <2.2 GHz)	
Carrier offset	
20 kHz to 250 kHz	<–100 dBc(1 Hz)
250 kHz to 400 kHz	<–110 dBc(1 Hz)
≥400 kHz	<–118 dBc(1 Hz)
Residual FM	
30 Hz to 15 kHz	<50 Hz (rms), <200 Hz (peak)
CCITT	<5 Hz (rms)
Residual AM, CCITT	<0.02% (rms)

Spectrum analyzer

Frequency range	10 MHz to 2.7 GHz
Span	zero span to full span
Frequency resolution	0.1 Hz
Resolution bandwidths	10 Hz to 1 MHz in 1/2/3/5 steps
Sweep time	≥100 ms, depending on RBW
Display	560 dots, horizontal
Marker	up to 3, absolute/relative
Display line; scale	1; 10/20/30/50/80/100 dB
Level range	
RF1, continuous power [3]	up to +47 dBm (50 W)
RF1, peak envelope power [4] (PEP)	up to +53 dBm (200 W)
RF2, continuous power	up to +33 dBm (2 W)
RF2, peak envelope power [4] (PEP)	up to +39 dBm (8 W)
RF4IN (continuous power and PEP)	up to 0 dBm
Level uncertainty	
RF1, RF2 (+23 °C to +35 °C)	
50 MHz to 2200 MHz	<0.5 dB
2200 MHz to 2700 MHz	<0.7 dB
RF4IN (+23 °C to +35 °C)	
50 MHz to 2200 MHz	<0.7 dB
2200 MHz to 2700 MHz	<0.9 dB
Reference level for full dynamic range (low noise mode)	
Logarithmic level display	
RF1	+10 dBm to +47 dBm
RF2	–4 dBm to +33 dBm
RF4IN	–22 dBm to 0 dBm
Displayed average noise level (RBW 1 kHz, low noise mode)	
RF1/RF2/RF4IN	
10 MHz to 2200 MHz	<–100 dBc
2200 MHz to 2700 MHz	<–95 dBc
Inherent spurious response, low distortion mode, 20 MHz to 2200 MHz, except 1816.115 MHz	<–50 dB
Inherent harmonics (f_0 = 50 MHz to 2200 MHz, up to 7 GHz)	
RF1, RF2	<–30 dB
RF4IN	<–20 dB

GSM specifications – base station test

RF generator	
Modulation	GMSK, B x T = 0.3, 8PSK [7]
Frequency range	
GSM 400 band	450 MHz to 458 MHz/478 MHz to 486 MHz
GSM 850 band	824 MHz to 849 MHz
GSM 900 band	876 MHz to 915 MHz
GSM 1800 band	1710 MHz to 1785 MHz
GSM 1900 band	1850 MHz to 1910 MHz
Att. of inband spurious emissions	>50 dB
Inherent phase error (GMSK)	<1°, rms, <4°, peak
Inherent EVM (8PSK)	<2%, rms
Frequency settling time	<500 µs to res. phase of 4°
Output level range (GMSK)	
RF1	–130 dBm to –27 dBm
RF2	–130 dBm to –10 dBm
RF3OUT	–90 dBm to +13 dBm
Output level range (8PSK)	
RF1	–130 dBm to –31 dBm
RF2	–130 dBm to –14 dBm
RF3OUT	–90 dBm to +9 dBm
Output level resolution	0.1 dB
Level uncertainty, RF1, RF2, P >–117 dBm (+23 °C to +35 °C)	<0.5 dB
RF3OUT (+23 °C to +35 °C)	
P >–90 dBm to +10 dBm (GMSK)	
P >–90 dBm to +6 dBm (8PSK)	<0.7 dB

RF analyzer

Frequency range	
GSM 400 band	460 MHz to 468 MHz/488 MHz to 496 MHz
GSM 850 band	869 MHz to 894 MHz
GSM 900 band	921 MHz to 960 MHz
GSM 1800 band	1805 MHz to 1880 MHz
GSM 1900 band	1930 MHz to 1990 MHz
Measurement bandwidth in measurement menus	500 kHz

Radiocommunication Tester CMU300

Power meter

Level range	
RF1, continuous power [3]	–40 dBm to +47 dBm (50 W)
Peak envelope power [4] (PEP)	+53 dBm (200 W)
RF2, continuous power	–54 dBm to +33 dBm (2 W)
Peak envelope power [4] (PEP)	+39 dBm (8 W)
RF4IN (continuous power and PEP)	–80 dBm to 0 dBm
Level uncertainty	
RF1, RF2, RF4IN (+23 °C to +35 °C)	<0.5 dB
Level resolution	0.1 dB (0.01 dB via remote control)

Modulation analysis

Level range (PEP)	
RF1	–6 dBm to +53 dBm
RF2	–20 dBm to +39 dBm
RF4IN	–60 dBm to 0 dBm
Inherent phase error (GMSK)	<0.6°, rms; <2°, peak
Inherent EVM (8PSK)	<1,0%, rms
Frequency measurement uncertainty	≤10 Hz + drift of time base

Burst power measurement

Reference level for full dynamic range (GMSK, low noise mode)	
RF1	+10 dBm to +53 dBm
RF2	–4 dBm to +39 dBm
RF4IN	–22 dBm to 0 dBm
Dynamic range (GMSK)	>72 dB (BW= 500 kHz, rms)
Reference level for full dynamic range (8PSK, low noise mode)	
RF1	+6 dBm to +49 dBm
RF2	–8 dBm to +35 dBm
RF4IN	–26 dBm to –4 dBm
Dynamic range	>69 dB (BW= 500 kHz, rms)
Relative measurement uncertainty	
Result >–40 dB	<0.1 dB
–60 dB ≤ result ≤–40 dB	<0.5 dB
Resolution	0.1 dB in active part of burst

Spectrum due to modulation [8]

Level range for full dynamic range	
RF1	+10 dBm to +47 dBm
RF2	–4 dBm to +33 dBm
RF4IN	–22 dBm to 0 dBm
Test method	relative measurement, averaging
Filter bandwidth	30 kHz resolution filter (5 pole)
Measurement at an offset of	100, 200, 250, 400, 600, 800, 1000, 1200, 1400, 1600, 1800 kHz
Dynamic range (noise correction mode) with offset ≥ 1200 kHz	>80 dB

Spectrum due to switching [8]

Level range for full dynamic range	
RF1	+10 dBm to +47 dBm
RF2	–4 dBm to +33 dBm
RF4IN	–22 dBm to 0 dBm
Test method	relative measurement, max hold over several measurements
Filter bandwidth	30 kHz resolution filter (5 pole)
Measurement at an offset of	400, 600, 1200, 1800 kHz
Dynamic range (noise correction mode) with offset ≥ 1200 kHz	>80 dB

General data

Rated temperature range	+5 °C to +45 °C
Storage temperature range	–25 °C to +60 °C
Display	21 cm TFT colour display (8.4")
Resolution	640 x 480 pixels (VGA resolution)
Power supply	100 V to 240 V ± 10% (AC), 3.1 A to 1.3 A, 50 Hz to 400 Hz –5% to +10% power factor correction, EN61000-3-2
Power consumption	
Base unit	130 W
With typical options	180 W
Dimensions (W x H x D)	465 mm x 193 mm x 517 mm (19"; 4 height units)
Weight	
Base unit	14 kg
With typical options	18 kg

Ordering information

Radio Communication Tester	CMU300	1100.0008.03
Accessories supplied	power cord, operating manual, service manual instrument	
Options		
High-stability OCXO	CMU-B12	1100.5100.02
Additional RF and IF connectors	CMU-B15	1100.6006.02
Versatile signalling unit; provides multistandard signalling hardware	CMU-B21	1100.5200.02
Modification kit: floppy disk drive 3 ½" instead of PCMCIA	CMU-U61	1100.5500.02
GSM400 base station signalling/ non-signalling test	CMU-K30 [9]	1115.4004.02
GSM900 and E-GSM base station signalling/non-signalling test	CMU-K31 [9]	1115.4104.02
GSM1800 (DCS) base station signalling/non-signalling test	CMU-K32 [9]	1115.4204.02
GSM1900 (PCS) base station signalling/non-signalling test	CMU-K33 [9]	1115.4304.02
GSM850 base station signalling/ non-signalling test	CMU-K34 [9]	1115.4404.02
MOC/MTC GSM Signalling Software	CMU-K39 [9]	1115.4791.02
8PSK-extension for all CMU-K3X packets	CMU-K41 [9]	1115.4604.02
Documentation of calibration values	CMU-DCV	0240.2193.08
30 MB memory card for use with PCMCIA interface	CMU-Z1	1100.7490.02
PCMCIA Type 3, 520 MB hard disk	PSM-B9	1064.5700.02
19" rack adapter	ZAA-411	1096.3283.00

1) Valid for RF1 only.
2) Not valid at frequencies of netclock harmonics.
3) 50 W in temp. range +5 °C to +30 °C, linear degradation down to 25 W at 45 °C.
4) Mean value of power vs time must be equal or less than allowed continuous power.
5) Calibrated for P>33 dBm only in frequency range 800 MHz to 2000 MHz.
6) Temperature range +5°C to +23°C or 35°C to 45°C and f>2200 MHz: add 0.2 dB.
7) With option CMU-K41.
8) The specifications apply to all cases, in which interfering carriers (up to the same level as the measured carrier) are more than 50 GSM channels away.
9) CMU-B21 necessary.

DECT Signalling Test Unit PTW15

Support in installation and maintenance of DECT networks

Photo 42907-2

Brief description

The powerful DECT Protocol Tester TS1220 from Rohde&Schwarz is seconded by the extremely favourably priced DECT Signalling Test Unit PTW15. This unit can be used wherever the full functionality of TS1220 is not required: in installation and maintenance of DECT WLL and PABX systems, in DECT audio tests according to CTR10 and in the field of DECT soft-ware development.

In the installation of DECT WLL net-works or test networks, PTW15 produces data about the occupancy of the DECT frequency band including relevant statistics to support antenna positioning and assessment of various parameters of the DECT equipment (eg dynamic channel selection algorithm). Since most tests are carried out on site directly in the network, the unit was designed for mobile use through its compact size and optional battery powering. For DECT audio tests to CTR10, PTW15 can be used as a DECT signalling unit that supports call setup to portable and fixed DECT radio terminations both in normal operation (generic access profile GAP according to EN 300 444) and in test standby mode by providing voice data at an analog and a digital interface. The required DECT reference implementations can also be used for DECT software development.

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

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

All layers communicate via points of control and observation (PO/PCO).

Main features

Main applications

- DECT coverage measurement (installation and test)
- DECT network control (maintenance and optimization of WLL networks and PABX systems)
- DECT software and hardware development
- Signalling unit for DECT audio tests according to CTR 10
- Designed for mobile and stationary operation

Main functions

- Channel occupancy measurement: scanning and visualization of the air interface in the DECT frequency ranges Europe, China, South and Latin America; analysis of the scanned data by scanner postprocessing
- Built-in PT and FT reference implementation according to EN 300 444 (Generic Access Profile)

Protocol monitoring and analysis between the DECT layers according to EN 300 444.

Brief specifications

Basic instrument

CPU	AMD K5 (586), 133 MHz
RAM	32 MB
Display	8,4" TFT colour display
Surface	non-reflecting
Graphics built-in display	VGA standard: 640 x 480 pixels
Graphics for external monitors	max. 1024 x 768 pixels
Hard disk	>500 MB
Floppy disk drive	1.44 MB, 3½"
Interfaces	4 x 16 bits, dimensions (L x H): 2 x ISA 330 mm x 140 mm 2 x ISA 312 mm x 140 mm
Serial	2 x RS-232-C
Parallel	1 x LPT (Centronix) for printer
Keyboard	DIN and PS/2 for keyboard incl. trackball
Operating system	LynxOS
User interface	MGR
Rated temperature range	+15 °C to +35 °C
Operating temperature range	0 °C to + 40 °C
Power supply	100 V to 120 V ±10%, 50 Hz to 400 Hz ±5%, 1 A (max. 120 W) and 220 V to 240 V ±10%, 50 Hz to 60 Hz ±5%, 0.5 A (max. 120 W)
DC	10 V to 32 V
Dimensions (W x H x D)	412 mm x 198 mm x 380 mm
Weight	8 kg

RF Parameters

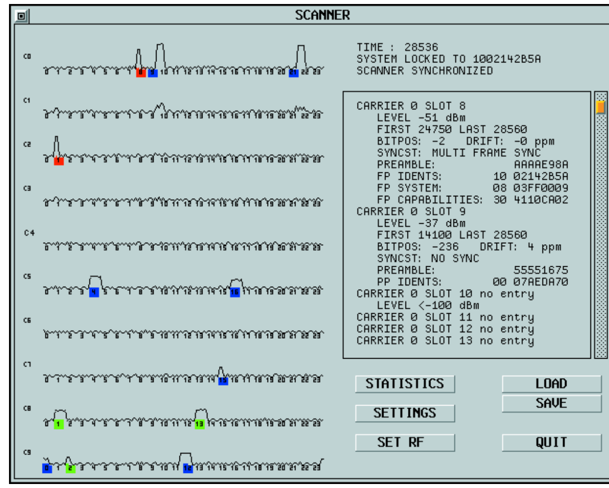
Operating frequency Europe	1881.792 MHz to 1897.344 MHz
Optional (exclusive options)	
China	1902.528 MHz to 1918.080 MHz
South America	1911.168 MHz to 1926.720 MHz
Latin America	1912.896 MHz to 1928.448 MHz
Carrier spacing	1.728 MHz
Carrier multiplex	TDMA
Duplexing	TDD
Bit rate	1152 kbps
Modulation method	GFSK (B x T = 0.5)

TX specifications	
Normal transmitter power:	21 dBm ± 2 dBm
Nominal peak deviation (modulation)	288 kHz (acc. to CTR 06)
carrier frequency	DECT carrier frequency ± 30 kHz (acc. to CTR 06)
Synthesizer	transmitter burst acc. to CTR06 (slow synthesizer => 'blind slots'); hardware signalling (PTW15 DECT Sig. Board)

RX Specifications	
Sensitivity	–73 dBm for BER <0.00001 (acc. to CTR 06)
RSSI	–33 dBm to –93 dBm
Maximum level (without damage)	25 dBm
Maximum level (for measurements)	0 dBm

Channel occupancy measurement

RSSI (permanent)	
Resolution time	<14 ms
Resolution level	1 dB
Range	0 dBm to –93 dBm
Data indication	graphically online, update rate 1/s
Scanning rate	min. 3 RSSI scanning loops covering all DECT channels per second.



For channel monitoring purposes the activities on all DECT channels / slots are indicated numerically and graphically including information on fieldstrength, identities, drift, offset etc; the information is automatically stored in a database

Database
Continuous recording of data packages
Classification: locked, coordinated, uncoordinated, not classified

Permanent scan, simultaneous for fixed (FT)
and portable radio termination (PT)

Contents of database record: time of recordings, number of recordings, preamble, level, bit position, drift, identities, system parameters, etc

Assignment of database records to the graphical RSSI indication under consideration of system identities, coordinated and uncoordinated fixed radio terminations

Statistics
Channel occupancy statistics
Graphical indication (coloured)
Statistics referring to EN 300 175 Common Interface 'Channel selection algorithm'

GPS data
NMEA 0183 Interface Standard can be connected to the serial interface;
GPS data will be displayed and included in the database file

Ordering information

DECT Signalling Test Unit		
Europe	PTW15	1074.6009.02
China	PTW15	1074.6009.03
South and Latin America[1)]	PTW15	1074.6009.05
Options		
Comfort package (ext. keyboard + adapter)	PTW-B1	1074.6509.02
Battery module for mobile operation	PSP-B3	1091.3740.02
Frequency range China (replaces module Europe)	PTW-B3	1115.2501.02
Frequency range South and Latin America (replaces module Europe)	PTW-B4	1115.2701.02

1) Frequency channel difference between adjustable in the software.

Protocol Tester PTW60 for Bluetooth™ Solutions

Platform for signalling tests in Bluetooth environments

Photo 43471-1

Brief description

The Protocol Tester PTW60 for *Bluetooth Solutions* is designed for protocol and profile compliance testing of *Bluetooth* products. The tester is both a verified tool for *Bluetooth* protocol/profile qualification and an ideal R&D test and measurement instrument at all stages of product development. The core of PTW60 is the realtime signalling unit that can simulate a *Bluetooth* piconet. The PTW60 runs the LynxOS (realtime UNIX) operating system which is also used by other protocol testers from Rohde&Schwarz. MGR is the graphical user interface.

Main features

Main applications

- Protocol tests for the development of basic layers and profiles
- Protocol qualification (compliance testing) of layers and profiles by execution of TTCN test cases
- Reference implementation of baseband, LM and L2CAP in master and slave mode
- Test mode signalling (master) implemented
- Fully controlled by graphical user interface

Main functions

- Simulation of one (optionally two) *Bluetooth* piconets (baseband, LM and L2CAP)
- Automatic generation of ETCs from the official SIG (Bluetooth Special Interest Group) ATSs by TTCN and C compiler
- Platform for the execution of all SIG protocol/profile tests for baseband, LM, L2CAP, GAP, SPP and SDAP
- Open programming interface with multiple possibilities for defining scenarios
- Message editor for easy generation of messages
- Connection of external layers via TCP/IP socket
- Extensive possibilities for analyzing incoming and outgoing messages

Hardware

Hardware components at a glance

- *Bluetooth* RTSU for simulating a *Bluetooth* piconet
- Wide variety of external interfaces which can also be operated as Bluetooth TCI:
  – USB
  – RS232/UART
  – Ethernet

Software

Basic applications

- Rohde&Schwarz TTCN toolbox comprises TTCN compiler, TTCN test case manager and PIXIT editor. *Bluetooth* simulator libraries for the automatic generation of executable test cases are being developed for the following Bluetooth TTCN test suites:
  – Baseband
  – Link manager
  – L2CAP
  – GAP
  – SPP
  – SDAP
- Scenario manager: simulation scenarios can be run step by step. A sequence of messages can thus be fed into a SAP and sent. All required development options for simulation scenarios have been implemented in the PTW60
- Message editor: *Bluetooth* messages can be compiled using the message editor. These messages are then fed into the different SAPs and sent

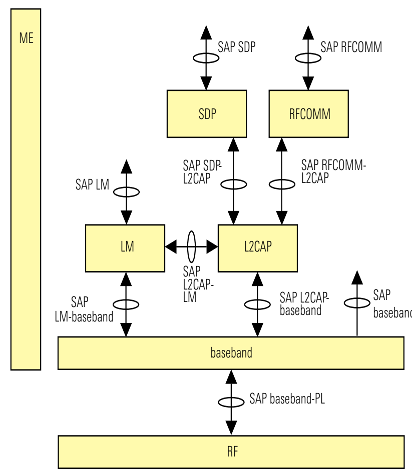
Protocol Tester PTW60 for Bluetooth™ Solutions

PTW60 *Bluetooth* protocol stack

The logical protocol data flow of the PTW60 *Bluetooth* protocol stack can be displayed as shown in the illustration. The baseband, LM and L2CAP layers are available on the PTW60 as reference implementations. They can be started and stopped selectively and provide the SAPs for feeding data from the basic applications.

Protocol analysis tools

The PTW60 features various protocol analysis tools such as PCOs , MSCs and TTCN trace analysis. All ASPs exchanged between the layers via SAPs can be displayed and analyzed in PCOs. Each ASP is treated as a separate data packet and displayed in a line.



PTW60 protocol data flow

Abbreviations

AM_ADDR	Active Member Address
ASP	Abstract Service Primitive
ATS	Abstract Test Suite
BD_ADDR	*Bluetooth* Device Address
ETC	Executable Test Case
GAP	Generic Access Profile
L2CAP	Logical Link Control and Adaptation Protocol
LC	Link Control
LM	Link Manager
ME	Management Entity
MMI	Man Machine Interface
MSC	Message Sequence Chart
PCO	Point of Control and Observation
PDU	Protocol Data Unit
PIXIT	Protocol Implementation Extra Information for Testing
PL	Physical Layer
RFCOMM	Serial Cable Emulation Based on ETSI TS07.10
RSSI	Received Signal Strength Indication
RTSU	Realtime Signalling Unit
SAP	Service Access Point
SDAP	Service Discovery Application Profile
SDP	Service Discovery Protocol
SIG	Special Interest Group
SPP	Serial Port Profile
TCI	Test Controller Interface
TTCN	Tree and Tabular Combined Notation

Specifications in brief

RF data

TX frequency range	2.402 GHz to 2.480 GHz
TX power range, impedance	–20 dBm to +18 dBm +/– 3 dB, 50 Ω
RX frequency range	2.402 GHz to 2.480 GHz
RX input power range, impedance	–70 dBm to –20 dBm, 50 Ω
Modulation	GFSK with BxT = 0.5
Carrier spacing, bit rate	1 MHz, 1 Mbps

Processor architecture

CPU	AMD-K6, 233 MHz
Hard disk	4.3 GB IDE
RAM	64 MB, can be upgraded to 128 MB
Display	8.4" TFT colour LC (640 x 480 dots)
Others	3.5" floppy disk, 3 PCI slots, 3 ISA slots
Operating system	LynxOS v3.0.1
Graphical user interface	MGR v2.20b

Interfaces

Split RF connectors for RX and TX path	N connectors at front panel
External reference inputs/outputs	BNC connectors at rear panel
Printer port	Centronics
COM 1	RS-232-C
COM 2	RS-232-C (600...19200 baud) or TTL (5 V), selectable by means of microswitch
USB	dual-port connector
External monitor	VGA connector

General data

Rated temperature range	+15 °C to +35 °C
Operating temperature range	+5 °C to +40 °C
Power supply input range, current	100 V to 240 V AC, 1.3 A to 3.1 A
Power supply frequency range	50 Hz to 400 Hz
Dimensions (W x H x D), weight	412 mm x 197 mm x 417 mm, 10 kg

Ordering information

Protocol Tester Basic System	PTW60	1133.3006.02
Libraries for Compilation and Execution of Test Case Packages		
Baseband	PTW60BB	1133.3741.02
Generic Access Profile	PTW60GA	1133.4148.02
Link Manager	PTW60LM	1133.3841.02
Logical Link Control and Adaptation Protocol	PTW60L2	1133.3793.02
Service Discovery Application Profile	PTW60SD	1133.4048.02
Serial Port Profile	PTW60SP	1133.4090.02
Packages: Basic System and libraries		
BB, LM, L2CAP	PTW60P1	1133.3893.02
GAP, SPP, SDAP	PTW60P2	1133.3941.02
BB, LM, L2CAP, GAP, SPP, SDAP	PTW60P3	1133.3993.02
Extras		
Encryption key length 128 bit (export licence required!)	PTW60EK	1133.4190.02
US keyboard with trackball	PSP-Z2	1091.4100.02

Digital Radiocommunication Testers CMD53/55, CMD65

Multimode compact testers for digital mobile phones to GSM900/1800/1900 and DECT standard

CMD65 (photo 40882-1)

Brief description

CMD 53/55 is a compact unit for testing GSM mobiles according to GSM900/1800 standard, optional GSM1900 standard. The CMD65 combines the functionality of CMD55 and that of CMD60 (see page 45). CMD53/55 can optional be extended to include the DECT standard. All models can optionally be extended to include the GSM1900 standard.

All models 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 their fast Go/NoGo tests and accurate analysis using optional extensions, CMD53 is suited for use in service and production. CMD55 is additionally suited for use in development.

Main differences of CMD53 to CMD55

- Remote control via RS-232-C only (no IEEE/IEC bus)
- No multifunction connector on front panel
- Speech coder/decoder cannot be integrated
- Optional ammeter and voltmeter
- High-sensitivity 2nd RF input available as an option

Operation

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

Remote control

- CMD controlled via RS-232-C or IEEE/IEC bus interface uses SCPI-compatible commands
- Designed for fast speed to yield high throughputs in production

Autotest

The autotest function enables complete measurement routines to be started at a keystroke.

Test capabilities

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

- mobile-to-base station synchronization
- location update
- incoming call setup
- outgoing call setup
- mobile power level control
- handover (channel change, time-slot change)
- dual-band handover
- peak power measurement
- SACCH measurement (eg RxLev, RxQual, power level)
- echo test
- call clearing by mobile
- call clearing by network
- DC current/voltage measurement
- phase and frequency error measurement (option CMD-B4)
- measurement of power ramp as a function of time (option CMD-B4)
- bit-error rate (BER) measurement (option CMD-B4)

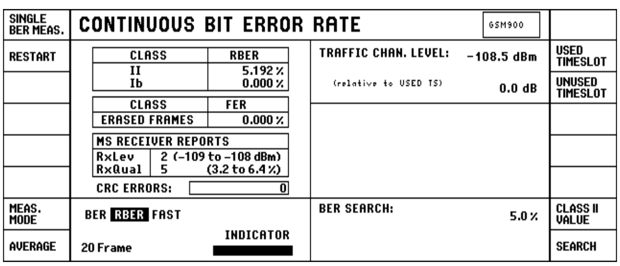
Digital Radiocommunication Testers CMD53/55, CMD65

Echo test
The echo test allows very rapid Go/NoGo analysis covering all essential parts of the mobile including microphone and loudspeaker.

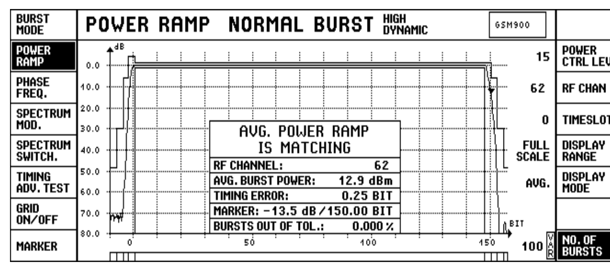
Voltage and power measurements
The DC ammeter/voltmeter designed for pulsed signals allows correct measurement of the power consumption of the mobile phone.

Module test
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 module level. The basic model of CMD already provides some of these functions, other functions are available as optional extensions:

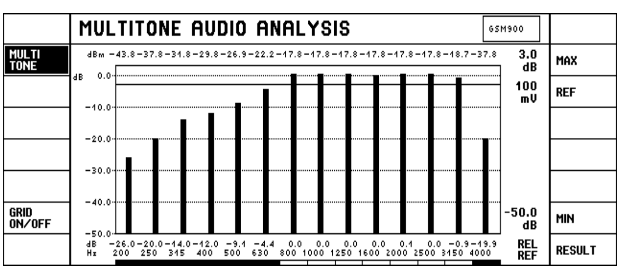
- power measurement
- signal generation
- phase and frequency error measurement
- measurement of power ramp



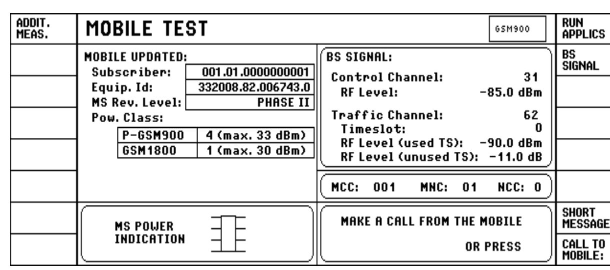
The BER search function allows the absolute sensitivity of a mobile to be determined



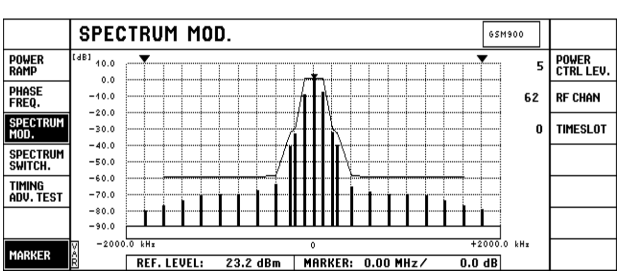
The full dynamic range (>72 dB) of a GSM normal and access burst can be verified with the CMD-B42 option



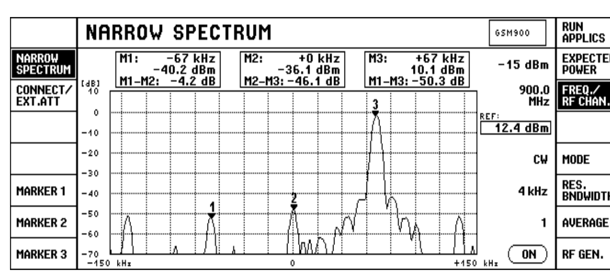
The audio measurement option CMD-B44 is capable of generating and analyzing up to 14 freely configurable tones in about 1 second. Measurements in absolute and relative mode are possible



After location update, it is indicated whether a mobile is a dual-band version. For realistic simulation of the real networks, the CMD offers the option to have the BCCH present in either band during dual-band simulation



Option CMD-B43 provides measurements of spectrum due to modulation and switching according to GSM recommendations



The narrowband spectrum analyzer option CMD-K43 is used to determine the I/Q modulator balance by measuring the suppressed carrier and sidebands

Digital Radiocommunication Testers CMD53/55, CMD65

Overview of applications and options

	GSM900	GSM1800	GSM1900	DECT	RS232	IEEE-bus	V/I meas.	Service	Production
CMD53	•	•	CMD-B19	CMD-U56	•	–	CMD-B20	•	–
CMD55	•	•	CMD-B19	CMD-U56	•	•	•	•	•
CMD65	•	•	CMD-B19	•	•	•	•	•	•

Designation, functions	Option	Order No.
OCXO Reference Oscillator: frequency drift $\leq 1 \times 10^{-7}$	CMD-B1	1059.6002.02
Reference Frequency Inputs/Outputs: synchronization to internal or external frequency (2.048, 10, 13.26, 52 MHz) or GSM bit clock (270.8 kHz) 1 to 13 MHz, input signal min. 0 dBm, max. TTL signal	CMD-B3	1051.6202.02
Fast Power Ramp, Phase/Frequency Error and BER Measurement: numeric/graphic display, various BER, RBER, FER test routines; required for fitting CMD-B41 and CMD-B42	CMD-B4	1051.6654.02
GSM1900 mobile station test	CMD-B19	1059.6201.02
AF Measurement Unit with Frequency Counter: comprises AF generator, voltmeter, distortion meter and frequency counter, measurements up to 60 MHz	CMD-B41	1051.6902.02
High-Dynamic Burst Analysis: dynamic range >72 dB (CMD-B4 required)	CMD-B42	1051.7150.02
GSM900/1800/1900-Specific Measurement of spectra due to switching/modulation (CMD-B4 and CMD-B42 required)	CMD-B43	1059.6001.02
Multitone Generator and Analyzer for CMD5x and CMD6x: comprehensive audio tests up to 8460 Hz (CMD-B4 and CMD-B41 required)	CMD-B44	1099.3203.02
Realtime Speech Encoder/Decoder	CMD-B5	1051.8657.02
TDMA Signals and Adapter for CMD-B6x Options: required for fitting CMD-B61 and CMD-B62	CMD-B6	1051.7409.02
IEEE/IEC bus Interface: alternative for RS-232-C interface (standard, CMD-B6 required)	CMD-B61	1051.7609.02
Memory Card Interface: archiving of results, etc. (CMD-B6 required)	CMD-B62	1051.8205.02
I/Q Demodulator Output and Trigger Input (BNC connector on the rear panel)	CMD-U5	1059.6901.02
I/Q Demodulator Output and Trigger Input for Fading Simulation	CMD-B17	1099.3003.02
DECT Extension for CMD53/55	CMD-U56	1051.8004.02
Narrowband RF Spectrum Analyzer (CMD-B4 required)	CMD-K43	1082.4830.02

Specifications in brief

For CMD65 see also CMD60, page 45

Timebase TCXO standard, 10 MHz

Frequency drift (0 to +35°C)	$\leq 1.5 \times 10^{-6}$
Aging	$\leq 0.5 \times 10^{-6}$/year (at 35 °C)
Timebase OCXO	with option CMD-B1, 10 MHz
Nominal frequency	10 MHz
Frequency drift (0 to +50°C)	$\leq 1 \times 10^{-7}$
Aging	$\leq 2 \times 10^{-7}$/year
DC voltmeter	0 to ±30 V
Resolution/accuracy	10 mV/2%
DC ammeter	current averaging with GSM-adapted time constant, current peak measurement (positive and negative)
Measurement range	0 to ±10 A
Resolution/accuracy	10 mA/2%

Specific data of CMD 55

RF generator 1	same as CMD52, but	
Frequency range	GSM900 band	935.2 to 959.8 MHz
	GSM1800 band	1805.2 to 1879.8 MHz
	GSM1900 band	1930.2 to 1989.8 MHz
Output level	RF IN/OUT	–35 to –120 dBm
	OUT2	+11 to –77 dBm

Digital Radiocommunication Testers CMD53/55, CMD65

RF generator 2	same as RF generator 1, but	
Max. 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/resolution	GSM900 band	0 to 47 dBm/0.1 dB
	GSM1800/1900	0 to 33 dBm/0.1 dB
VSWR	≤1.3	

Phase and frequency error

Measurement	with option CMD-B4	
Frequency range	GSM900 band	890.2 to 914.8 MHz
	GSM1800 band	1710.2 to 1784.8 MHz
	GSM1900 band	1850.2 to 1909.8 MHz
Level range		
RF IN/OUT	GSM900 band	0 to 47 dBm
	GSM1800/1900	0 to 33 dBm
RF IN 2		–60 to 0 dBm
Burst power measurement	with option CMD-B4	
Frequency range	GSM900 band	890.2 to 914.8 MHz
Frequency range	GSM1800 band	1717.2 to 1784.8 MHz
	GSM1900 band	1850.2 to 1909.8 MHz
Reference level range		
RF IN/OUT	GSM900 band	10 to 47 dBm
	GSM1800/1900	0 to 33 dBm
RF IN 2		–37 to 0 dBm
High-dynamic burst analysis	with option CMD-B42	
Dynamic range	>72 dB	
Measurement limit		
RF IN/OUT)	GSM900 band	<–36 dBm
	GSM1800/1900	<–48 dBm
RF IN 2	GSM900 band	<–83 dBm
	GSM1800/1900	<–85 dBm

AF Measurement Unit

option CMD-B41

AF generator

Frequency range/resolution	50 Hz to 10 kHz/0.1 Hz
Frequency drift	same as timebase + half resolution
Voltage range/resolution	10 µV to 5 V/10 µV (1%)
Distortion	≤0.5%

AF voltmeter

Frequency range	50 Hz to 10 kHz
Measurement range/resolution	0.1 mV to 30 V/100 µV (1%)

Distortion meter

Frequency range	300 Hz to 3 kHz
Input voltage range/resolution	100 mV to 30 V/0.1%
Inherent distortion	≤0.5%

AF counter

Frequency range/resolution	20 Hz to 10 kHz/≤1 Hz
Input voltage range	10 mV to 30 V

IF counter

Frequency range/resolution	10 kHz to 60 MHz/1 Hz
Input signal	min.: 100 mV; max.: TTL signal

Interfaces

IEEE/IEC bus Interface	option CMD-B61 IEC625-1 (IEEE 488), SCPI-compatible
Other interfaces	RS-232-C, Centronics
Reference Frequency Inputs/Outputs	option CMD-B3
Synchronization input	
Frequency (selectable)	GSM bit clock (270.8 kHz), 2xGSM bit clock, 4xGSM bit clock, 16xGSM bit clock, 1 to 13 MHz in 1 MHz steps, 2.048 MHz, 26, 39, 52 MHz
Input signal	min.: 0 dBm; max.: TTL signal
Synchronization output 1	
Frequency	10 MHz with internal reference or frequency at synchronization input with external frequency
Input signal	TTL signal, Z_{out} = 50 Ω
Synchronization output 2	
Frequency (selectable)	GSM bit clock, 2x, 4 x, 16x GSM bit clock, 1, 2, 4 or 13 MHz
Input signal	TTL signal, Z_{out} = 50 Ω

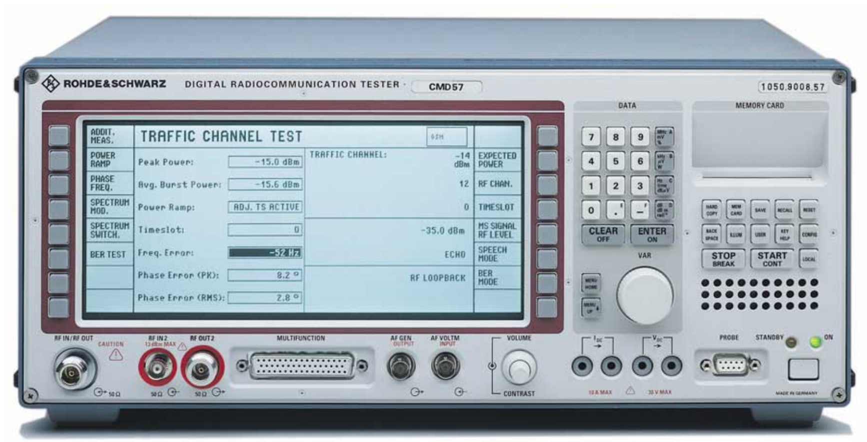
Ordering information

Mobile Station Tester

GSM900 and GSM1800	CMD 53	1050.9008.53
GSM900 and GSM1800	CMD 55	1050.9008.55
GSM900, GSM1800 and DECT	CMD65	1050.9008.65
For all models GSM1900 optional	CMD-B19	1059.6201.02

Digital Radiocommunication Tester CMD57

For production, installation and service of GSM900/1800/1900 base stations



CMD57 (photo 42367)

Brief description

Digital Radiocommunication Tester CMD57 is advanced top-class instrument for measurements on base stations (BTS) and BTS modules.

CMD57 is designed for measurements in line with:

- GSM900
- GSM1800
- GSM1900 optionally
- E-GSM
- UIC – European train radiotelephony

The main applications are:

- Module testing in production
- Final testing with A_{bis} control
- Installation with A_{bis} control
- Service with test mobile functionality

CMD is the first compact radiocommunication tester worldwide allowing measurements on transmitters and receivers of base stations without affecting telephone calls in progress.

These testers combine compact size with high measurement accuracy and speed. They are suitable both for stationary and mobile use and feature great ease of operation and high reliability.

Operation is extremely easy and requires no detailed GSM knowledge. The high-contrast LCD display with softkeys on both sides allows menu- guided convenient callup of test routines.

The key features at a glance

Characteristic/function	Benefit/application
Transmitter measurements	
Dynamic range >72 dB	Checking the power ramps and output spectrum of the BTS transmitter for compliance with the dynamic range specified by GSM
Measurement of power ramps	Checking the switching characteristics of the BTS transmitter
Phase and frequency error	Testing the modulation characteristics of the BTS transmitter including statistical function
Extremely fast measurement of spectrum due to modulation or switching	Detecting interference to the BTS transmitter at adjacent frequencies, due to modulation or switching
Receiver measurements	
Measurement of bit error rate (BER) via A_{bis}/IEEE bus/ RS-232-C interface, BTS loopback or CMD loopback	Testing the BTS receiver characteristics by adaptation to specific implementation in the BTS
Measurement of adjacent timeslot rejection with up to 50 dB higher level	Measuring the automatic gain control (AGC) of the BTS with high level difference between used and adjacent timeslot; simulation of different BTS receive levels
Level error <1dB at –104 dBm	Reproducible and conclusive measurements even at low output levels especially at the sensitivity limits of the receiver

Digital Radiocommunication Tester CMD57

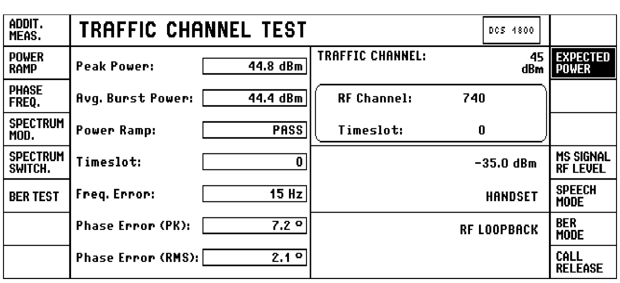
Characteristic/function	Benefit/application
Other measurements	
Echo test	Subjective test of speech quality with call established
Module test	Complete transmitter measurements even without signalling or time synchronization
Multifunction RF generator	Ideal for alignment of receiver modules
DC current and voltage measurement	Optimized for pulsed signals; replaces external measuring instruments
AF measurement facilities and 60-MHz frequency counter (optional)	Replaces external frequency counter; ideal for measuring reference frequencies
RF monitor with bandwidths of 30 kHz, 100 kHz	Replaces external spectrum analyzer
Simulation of fading effects	On request
Flexible use	
Various BTS synchronization facilities as to time and frequency	Easy integration of measuring instrument into operational environment and problem-free adaptation to the specific synchronization signals of a BTS
Remote control via RS-232-C and IEEE/IEC bus	SCPI-compatible for easy generation of user-specific control programs
Low cost of ownership	
Software update via interface	No need to open the instrument; simple download of the latest software version via the RS-232-C interface
3 years of warranty	The optional warranty allows the instruments to be utilized at calculable costs

Overview of options and extras

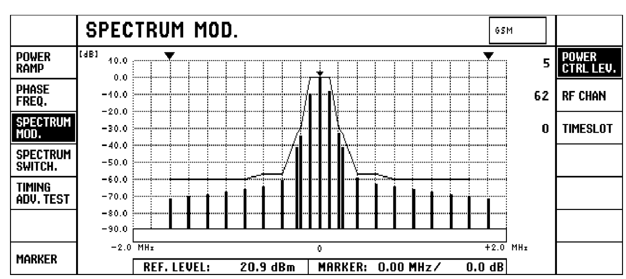
Designation	Brief description, recommendation	Option	Order No.
IQ Modulator Output	For BER measurement on BTS receivers under conditions of fading (application note 1MA04_0E available on request). Generator/fading simulator SMIQ can be connected. Not useable with CMD-B8 **and** CMD-B2 together, but with CMD-B8 **or** CMD-B2 (only CMD59)	**CMD-B17**	1099.3003.02
GSM1900 Base Station Test	For testing GSM1900 base stations	**CMD-B19**	1059.6201.02
OCXO Reference Oscillator	For highly demanding requirements on frequency stability. Oven crystal with highest long-term stability. Aging $3.5 \cdot 10^{-8}$	**CMD-B2**	1059.8604.02
Reference Frequency Inputs/Outputs	For synchronizing DUT and measuring instrument with internal or external frequencies	**CMD-B3**	1051.6202.02
AF Measurement Unit with Frequency Counter	This option includes an AF generator, a voltmeter, a distortion meter and a frequency counter for measurements on the audio interface or on modules. CMD-B41 permits measurements up to 60 MHz as are required for LO alignment	**CMD-B41**	1051.6902.02
Realtime Speech Coder/ Decoder	This option converts digital speech signals into analog signals (and vice versa) (in conjunction with CMD-K1x, CMD-K30 or CMD-B8)	**CMD-B52**	1115.8800.02
Adapter for CMD-B6x Options	Required for operating the options CMD-B61 and CMD-B62	**CMD-B6**	1051.7409.02
IEEE/IEC bus Interface	Alternative to standard RS-232-C interface for remote control of CMD	**CMD-B61**	1051.7609.02
Memory Card Interface	Memory cards are a versatile medium for storing instrument settings	**CMD-B62**	1051.8205.02

Digital Radiocommunication Tester CMD57

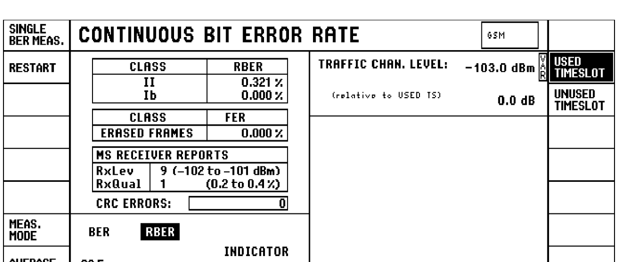
Designation	Brief description, recommendation	Option	Order No.
A_{bis} Interface	For sensitivity measurments; required for A_{bis} control. A_{bis} card for BER measurements at this interface	**CMD-B71**	1115.8500.02
Test Mobile Functionality	Adds signalling software, SIM card reader and selective filter to the basic model (CMD-B6 required, not usable with CMD-B2 and CMD-B17)	**CMD-B8**	1059.8204.02
Ciphering Software	Allows encryption according to ETSI Rec. (A5-1/A5-2) (in conjunction with CMD-B8)	**CMD-K51** **CMD-K52**	1082.3540.02 1082.3640.02
Modification Kit High-Level 2nd RF Output (9 dBm or 11 dBm)	For off-air measurements. The standard output level range of the second output is approx. –35 dBm to –120 dBm; the level range +9 dBm/+11 dBm to –60 dBm is offered alternatively (not usable with CMD-U13)	**CMD-U3**	1059.6501.02
Trigger Inputs/Outputs	The time synchronization signals can additionally be applied to BNC connectors on the rear panel. For monitoring purposes the demodulated I/Q signals are brought out at BNC sockets (rear panel)	**CMD-U5**	1059.6901.02
Modification of RF IN/OUT	Test of micro BTS. Peak power meter measurement range –10 dBm to 37 dBm alternatively to standard range 0 dBm to 47 dBm (not usable with CMD-U3)	**CMD-U13**	1059.4009.02
Memory Card	Formatted PCMCIA-compatible memory card for storing instrument settings (CMD-B62 required)	**CMD-Z1**	1059.4809.02
Rucksack	Multifunction carrying bag for the instrument	**CMD-Z40**	1059.7808.02
Handset	Together with CMD-B8 + CMD-B5 allows to talk using CMD in the same way as a mobile	**CMD-Z50**	1059.4250.02
Transit Case	Robust case for transport CMD with Rucksack CMD-Z40	**ZZK-014**	1013.9595.00



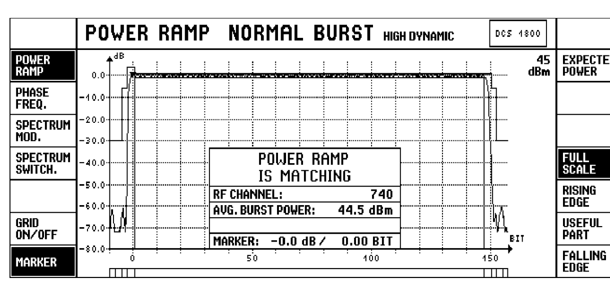
After synchronization to the base station and setting up of a traffic channel, all relevant RF parameters are immediately measured and displayed; this menu also allows a quick change of channel, power and timeslot as well as setting of CMD transmission parameters



The spectrum due to modulation and switching can be measured in line with GSM specifications within a minimum of time and graphically displayed; the built-in marker function allows the digital value of each individual spectral line to be called up



Sensitivity of a transceiver module of the base station is verified by means of a bit error rate (BER) test in RF loopback mode



CMD 57 allows the power ramp to be measured with high dynamic range; with graphic display, the zoom function enables application-oriented resolution of parts of the displayed curve

Digital Radiocommunication Tester CMD57

Specifications in brief

Timebase TCXO	standard
Nominal frequency	10 MHz
Frequency drift (0 to 35°C)	$\leq 1.5 \times 10^{-6}$
Aging	$\leq 0.5 \times 10^{-6}$/year (at 35°C)
Timebase OCXO	Option CMD-B2
Nominal frequency	10 MHz
Frequency drift (0 to 50°C) (referred to 25°C)	$\leq 5 \times 10^{-9}$
Aging after 30 days of operation and under constant operat. conditions	$\leq 3.5 \times 10^{-8}$/year; $\leq 5 \times 10^{-10}$/day
Warm-up time (at 25°C)	approx. 10 min
RF generator	
Frequency range	GSM900: 890.2 to 914.8 MHz E-GSM900: 880.2 to 890.0 MHz GSM1800: 1710.2 to 1784.8 MHz GSM1900[1]: 1850.2 to 1909.8 MHz
Frequency accuracy	same as timebase
Resolution	GSM channel spacing 200 kHz
Settling time	<3 ms for phase error <2°
Output level (RF IN/OUT)/(OUTPUT 2)	–35(–37[1]) to –120 dBm
Modulation	GMSK, B x T = 0.3
Phase error	<4° rms, <10° peak
Peak power meter (RF IN/OUT)	
Frequency range	800 to 1000/1700 to 1900 MHz
Measurement range	0 to 47 dBm
Maximum RF power	47 dBm pulsed, 45 dBm CW 47 dBm CW at room temperature
VSWR	≤1.3
Phase and frequency error measurement	
Frequency range	GSM900: 935.2 to 959.8 MHz E-GSM900: 925.2 to 935.0 MHz GSM1800: 1805.2 to 1879.8 MHz GSM1900[1]: 1930.2 to 1989.8 MHz
Level range	
RF IN/OUT	0 to 47 dBm
RF IN 2	–57(–51[1]) to 0 dBm
Burst power measurement	
Frequency range	GSM900: 935.2 to 959.8 MHz E-GSM900: 925.2 to 935.0 MHz GSM1800: 1805.2 to 1879.8 MHz GSM1900[1]: 1930.2 to 1989.8 MHz
Reference level for full dynamic range	
RF IN/OUT	GSM900: 10 to 47 dBm GSM1800/1900: 0 to 47 dBm
RF IN 2	–37(–31[1]) to 0 dBm
High-dynamic burst analysis	
Relative error of individual test samples	≤1.5 dB to 72 dB below peak power
Dynamic range	>72 dB
Measurement limit RF IN/OUT	GSM900: <–36 dBm GSM1800: <–48 dBm GSM1900: <–42 dBm
Measurement limit RF IN 2	GSM: <–83 dBm GSM1800: <–85 dBm GSM1900: <–79 dBm

GSM-specific measurements	
Spectrum due to modulation	
Test method	relative measurement, averaging
Resolution filter bandwidth	30 kHz
Measurement at an offset of	100/200/250/400/600/800/1000/1200/1400/1600 and 1800 kHz
Dynamic range	better than specified by GSM
for offset >400 kHz	max. 80 dB
Error	<±1.5 dB
Spectrum due to switching	
Test method	relative measurement, Max Hold over several measurements
Resolution filter bandwidth	30 kHz
Measurement at an offset of	400/600/1200 and 1800 kHz
Dynamic range	better than specified by GSM
for offset >400 kHz	max. 80 dB, with SW correction max. 76 dB, without SW correction
Error	≤1.5 dB (dynamic range <50 dBc) ≤2.5 dB (dynamic range 50 to 80 dBc)
Multi-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, 2.048/16.384/26/39/52 MHz
Impedance	approx. 100 W
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
A_{bis} Interface	Option CMD-B7
Receive channel (traffic/speech)	75 Ω/high-impedance, unbalanced; 120 Ω/high-impedance, balanced; 16 kbit/s, timeslot selectable
Interfaces	RS-232-C (9-pin), Centronics (25-pin)
DC voltmeter	0 to ±30 V
DC ammeter	current averaging with GSM-adapted time constant, current peak measurement (maximum and minimum)
Measurement range	0 to ±10 A
Common-mode rejection	±30 V
Resistance	50 mΩ
AF Measurement Unit	Option CMD-B41
AF generator	
Frequency range	50 Hz to 10 kHz
Level range	10 µV to 5 V
Output impedance	<5 Ω
AF voltmeter	
Frequency range	50 Hz to 10 kHz
Measurement range	0.1 mV to 30 V
Input impedance	1 MΩ
Distortion meter	
Frequency range	300 Hz to 3 kHz
Input level range	100 mV to 30 V

Digital Radiocommunication Tester CMD57

AF counter

Frequency range	20 Hz to 10 kHz
Input level range	10 mV to 30 V
Resolution	≤1 Hz

IF counter

Frequency range	10 kHz to 60 MHz
Input level range	100 mV rms to TTL
Resolution	1 Hz

Multicarrier mode (Option CMD-B8)

The specifications apply to all cases, in which interfering carriers (up to 30 dB above useful level) are more than 30 GSM channels away. If there are interfering signals close to the useful carrier, an additional IF filter is switched in (multicarrier mode).

Typical filter characteristics in multicarrier mode

Offset from useful channel (kHz)	Filter suppression (dB)
0	0 (reference)
200	<3
400	>20
600	>33
800	>41
1000	>48

This filter increases the measurement error for phase and power measurements.

Phase and frequency error measurement

Inherent phase error	≤2° (rms), ≤7.5° (peak)

Measurement of peak power/burst power

Level error	≤1.5 dB

GSM-specific spectrum measurements

The dynamic range specified for the basic model refers to the sum of all input voltage components. The additional GSM carriers appear as strong spurious emissions in the spectrum measurement and have to be taken into account accordingly when evaluating the tolerances.

Typical effects of an interferer on power and modulation measurement results

(see diagrams on the right). The characteristics of an interferer close to the carrier have the following effect on the measurement error:

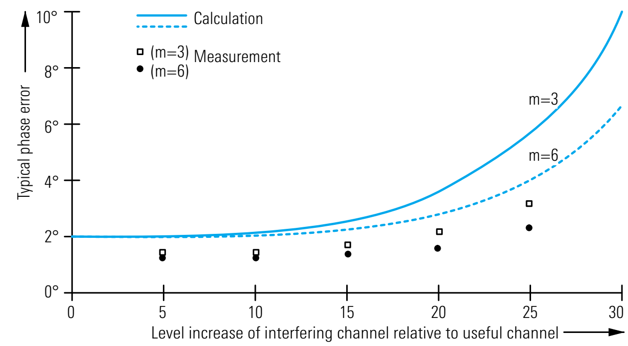
– Power: the lower the power of the interferer, the smaller the measurement error.
– Frequency offset: the larger the frequency offset of the interferer, the smaller the measurement error. In the diagrams on the right an interferer with an offset of m=3 or m=6 GSM channels has been assumed.
– Spectral purity: the narrower the modulation spectrum of the interferer, the smaller the measurement error. In the diagrams on the right the modulation spectrum to GSM 05.05 with linear interpolation (in the dB/Hz coordinates) has been used (worst case spectrum).
– Number of carriers: the fewer the carriers, the smaller the measurement error. In the example, 1 interferer has been assumed.

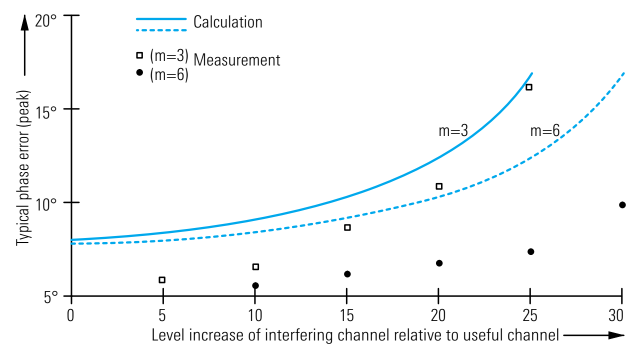
The curves shown in the diagrams have been **calculated** assuming the worst case spectrum as interferer, the guaranteed CMD-B8 specifications for phase and power measurement and a typical IF filter characteristic.

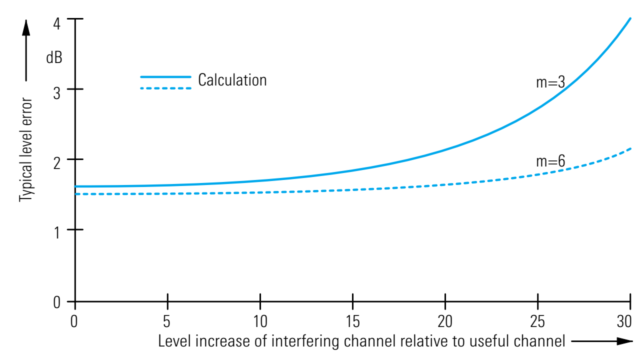
The **measured values** are based on a real GSM spectrum, typical CMD-B8 specifications and typical filter characteristic.

General data

Rated temperature range	0 to +45°C to DIN IEC 68-2-1/2
Storage temperature range	–40 to +60°C







Phase and level error as a function of adjacent-channel power and adjacent-channel frequency offset

Power supply	100 to 120 V AC ±10% 200 to 240 V AC ±10% 50 to 400 Hz ±5%
Power consumption (without options)	approx. 85 W
Dimensions (W x H x D)	435 mm x 192 mm x 363 mm
Weight (without options)	approx. 14 kg

Ordering information

Digital Radiocommunication Tester	CMD57	1050.9008.57
Accessories supplied	power cable, operating manual, fuses	
Options	see overview of options on page 41	

1) In GSM 1900 mode with option CMD-B19 fitted.

Digital Radiocommunication Tester CMD60/CMD65

Speedy and cost-effective measurements on DECT communications devices; can be retrofitted for GSM900, 1800 and 1900 measurements

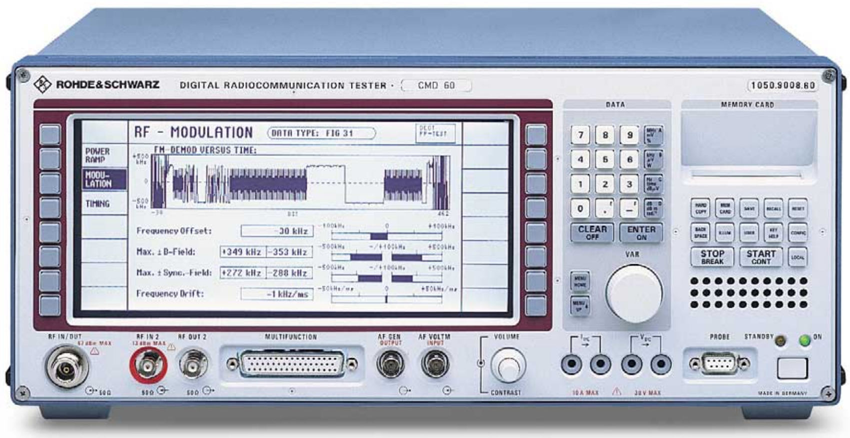


Photo 42198

Brief description

Reliability, measurement speed and cost effectiveness are the characteristics a test equipment must have to succeed in the field of the widely used DECT communication devices.

In a radiocommunication network such as DECT (Digital European Cordless Telephone) numerous cordless telephones and fixed stations have to share the scarce resources of frequency, time and space. This can only be done by observing stringent rules and specifications.
On the other hand, the DECT system in particular and associated phones are expected to be low-cost units whose complexity and precision are limited. Given these conflicting requirements, it is measurement engineering which has to ensure that the specifications for smoothly working communication are met in spite of less sophisticated technology (compared with other digital cellular systems). The great experience gained with preceding DECT measurement instruments such as signal generators, analyzers, communication testers and DECT type-approval systems as well as cooperative development work with several key end-users have contributed towards creating a well-balanced tester for production and service according to all aspects.

Benefits at a glance

Production

- The CMD60 can be remote controlled via the RS-232-C or IEEE/IEC bus interface using SCPI-compatible commands. In the remote-control mode CMD60 is designed for fast speed to yield high throughputs in production
- High production output at low investment for test equipment
- Comprehensive test capabilities implemented in one single unit

Development

- Comprehensive in-depth measurements under a convenient user interface
- A lot of complex test setups with conventional equipment become redundant with the use of this special DECT tester
- Automatic regression and stress tests
- The tester supplies a great number of DECT-specific signals such as bit clock, TX/RX enable, to control the module under test

Servicing

- Relaxed manual operation due to a large bright LCD in conjunction with an extremely simple user interface (requires no DECT-specific knowledge) strictly separated from the expert user interface for configurations
- Integrated tools such as a scope display for power and FM demodulation versus time ease troubleshooting

Application overview

	GSM900	GSM1800	GSM1900	DECT	RS232	IEEE-bus	V/I meas.	Service	Production
CMD60	CMD-U65	CMD-U65	CMD-U65 CMD-B19	•	•	•	•	•	•
CMD65	•	•	CMD-B19	•	•	•	•	•	•

Digital Radiocommunication Tester CMD60/CMD65

Main features

- For production, service and development
- RF measurements to CTR06
- Comprehensive audio tests
- Extremely fast measurements for high production throughput
- Ergonomic user interface for service applications
- Selfcontained, lightweight, compact tester
- Can be retrofitted for GSM, GSM1800 and GSM1900 measurements

Menu structure

The power ramp measurement permits in-depth analysis of the burst power transmitted by the FP or PP. The measurement is synchronized to bit P0, thus giving precise information not only about the power transmitted but also about timing parameters.

The RF modulation measurement menu presents the demodulated signal in a scope display for easy and quick recognition of typical data forms, and accurate measurement results as numbers and bargraphs for further analysis.

Timing parameters such as the absolute timing accuracy as well as the jitter between two bursts are measured and displayed in an easy-to-read format.

User-defined tolerances for parameters like BER, modulation, timing, power and power ramp (burst) as are shown here can easily be entered via the configuration menu. If any of the set limits are exceeded, the measurement will be shown in inverse video for easy identification.

The module test offers RF signal generator and RF burst analyzer features for testing DECT modules without signalling, ie when troubleshooting or adjustments are required.

Interface description

CMD 60 transmitter part
In a very busy DECT environment most DECT frequencies may be in use for communication and therefore influence the measurement in production and development. Besides the channels 0 to 9 the CMD60 enables the use of an extended frequency range for testing. Channels –3, –2, –1 and 10, 11, 12 are outside the normal DECT specification and therefore free for testing.

The DECT standard requires two levels: –83 and –73 dBm. The CMD60 provides an extra level range of up to 30 dB to overcome external coupler and cable attenuation.

The CMD60 provides 1 up to 12 consecutive TDMA slots for rapid BER measurements for PP tests (2 slots for FP test). The measuring time in production can be considerably cut down if more than one timeslot is used for BER measurements.

Modulation is GFSK with $B \times T = 0.5$ according to DECT specifications. In addition, constant envelope, signals with or without modulation or DECT bursts with various bit patterns for module test are possible.

These bit patterns can easily be recognized while testing receiver and demodulator modules.

CMD 60 receiver part
It is similar to the transmitter part above: there are 10 DECT frequency channels No. 0 to 9. Additionally, 6 extended DECT frequency channels No. –3, –2, –1 and 10, 11, 12 in DECT channel spacing are provided.

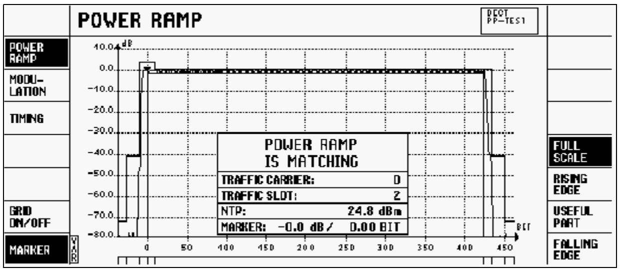
Should the standard DECT output level of 24 dBm be attenuated due to couplers and cable attenuation, the CMD60 provides more than 30 dB measurement range.

There are two independent receive paths: For DECT signalling and BER a signalling path is incorporated in the CMD60. For TX tests the CMD60 provides a measurement path. The FM and envelope detector are both taken to external connectors and post-processed for power ramp and modulation measurements. The FM and envelope detector output permits monitoring of the DUT transmit signal.

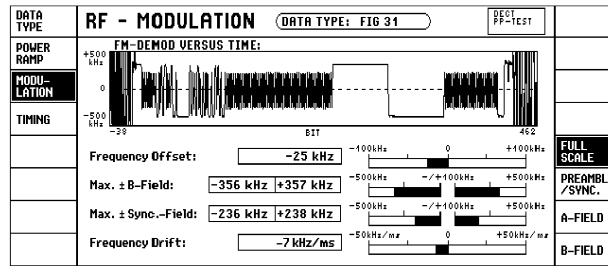
RF input/output
The CMD60 transmitter and receiver are connected to a bidirectional N connector (RF in/out). All mentioned specifications are valid for this connector. Moreover, there is a high-level output for the CMD transmitter (level range like N connector + approx. 40 dB) as well as a high-sensitivity input for the CMD receiver on the front panel.

Demodulator interface
CMD60 provides a linear, analog FM demodulator output (DC-coupled) and a logarithmic analog RF envelope demodulator output (DC-coupled).

Digital Radiocommunication Tester CMD 60



Power ramp measurement



RF modulation measurement

Wideband input/output

The second wideband input/output (100 MHz to 2.5 GHz) is on the rear panel. The input signal from the front connector is provided at this connector with an attenuation of 12 dB. It can be monitored with a spectrum analyzer for spurious measurements. Furthermore, this connector can be used to introduce an interferer into the RF connection without reconnecting the test setup for the in-channel tests.

CMD 60 audio part

In addition to the DECT RF interface on the CMD 60 front panel, there is an analog DECT voice interface for a speaker and the appropriate microphone (analog ADPCM interface). Alternatively it can be connected to the AF Measurement Unit CMD-B41.

Overview of options

Designation, functions	Option	Order No.
OCXO Reference Oscillator: this option improves aging and frequency drift of the internal reference source	CMD-B1	1051.6002.02
Reference Frequency Input/Output, Frequency Syncronization: CMD provides a 10 MHz interface as a common frequency reference.	CMD-B3	1051.6202.02
DSP/Adapter for CMD-B4x options: DSP system carrying out applications for GSM RF and audio tests as well as DECT audio tests. In contrast to GSM, this option is not required for DECT BER measurements	CMD-B4	1051.6654.02
AF Measurement Unit with Frequency Counter (CMD-B4 needed): this option provides an audio measurement unit with AF generator and AF analyzer. The parameters measured are level (peak and rms), frequency, and distortion on selectable frequencies. In addition, the option CMD-B41 incorporates a 60-MHz TTL counter to verify the DUT’s reference frequency	CMD-B41	1051.6902.02
Multitone Generator and Analyzer for CMD5x and CMD6x: comprehensive audio tests up to 8460 Hz (CMD-B4 and CMD-B41 required)	CMD-B44	1099.3203.02
IEEE/IEC bus Interface: in addition to the standard RS-232-C interface, the CMD can be fitted with this remote-control interface (CMD-B6 required)	CMD-B61	1051.7609.02
Adapter for CMD-B6x options	CMD-B6	1051.7409.02
Frequency Extension DECT CH +12 to -22 for Latin America and other countries	CMD-K61	1082.3840.02
Extension for GSM 900 and GSM 1800	CMD-U65	1059.8104.02

Digital Radiocommunication Tester CMD60/CMD65

Specifications in brief

For CMD60/65 see also CMD53/55 on page 36

Time and frequency reference	
TCXO	standard
Nominal frequency	10 MHz
Temperature effect (0 to 35°C)	$<1.5 \times 10^{-6}$
Aging	$<0.5 \times 10^{-6}$/year
OCXO	option CMD-B1
Nominal frequency	10 MHz
Temperature effect (0 to 50°C	1×10^{-7}
Aging	$<5 \times 10^{-9}$/day or $<2 \times 10^{-7}$/year
DECT signal generator	specifications valid for N connector
Frequency	10 DECT channels 0 to 9
Additional DECT channels	–3 to –1, 10 to 12 and half channels
Level range	–100 dBm to –40 dBm
Burst switch-off	>30 dB
Modulation	GFSK (B x T = 0.5)
DECT analyzer	specifications valid for N connector
Frequency	same as signal generator
Level (setting for external attenuation and expected power shall be matching; –10 to +30 to dBm)	–65 dBm to +30 dBm (for level meter) –30 dBm to +30 dBm (for broadband FM demodulator and signalling), values shifted by about –40 dB for input 2
FM demodulator	for TX postprocessing and analog output
Range	0 to 450 kHz deviation
Resolution	1 kHz
Level meter (transient response)	for TX postprocessing and analog output
Range	–65 dBm to 30 to dBm
Dynamic	70 dB
Analog DECT ADPCM interface	
Output	balanced
Range	1 V, 300 Hz to 3 kHz
S/N + THD	50 dB at full-range level
Input	balanced
Range	50 mV, 300 Hz to 3 kHz
S/N + THD	50 dB at full-range level
DC measurements	
DC voltmeter	0 to ±30 V
DC ammeter	0 to ±10 A

Option CMD-B4 with CMD-B41

AF meter	
Frequency range	50 Hz to 10 kHz
Input voltage	0.1 mV to 30 V
Load impedance	1 MΩ
AF distortion meter	
Frequency range	300 Hz to 3 kHz
Input voltage	100 mV to 30 V
Load impedance	1 MΩ
AF counter	
Frequency range	20 Hz to 10 kHz
Input voltage	10 mV to 30 V
Resolution	1 Hz
Load impedance	1 MΩ
60 MHz counter	
Frequency range	10 kHz to 60 MHz
Input signal	min.: 100 mV; max.: TTL signal
Resolution	1 Hz
Load impedance	1 MΩ ‖ 100 pF
AF generator	
Frequency range	50 Hz to 10 kHz
Resolution	0.1 Hz
Accuracy	0.05 Hz
Output voltage	10 µV to 5 V
Max. current	20 mA
Source impedance	<5 Ω

General data

Power supply, AC	100 V to 120 V ±10%, 200 V to 240 V ±10%, 50 Hz to 400 Hz ±5%
Power consumption	approx. 60 VA
Dimensions (W x H x D)	435 mm x 192 mm x 363 mm
Weight (without options)	approx. 12 kg

Ordering information

Digital Radiocommunication Tester	CMD60	1050.9008.60
GSM900, GSM1800, DECT	CMD65	1050.9008.65
GSM900 and GSM1800 Extension	CMD-U65	1059.8104.02
Options	see overview of options	

Digital Radiocommunication Tester CMD80

Precise, high-speed CDMA, D-AMPS and analog measurements for production, development, quality control and service

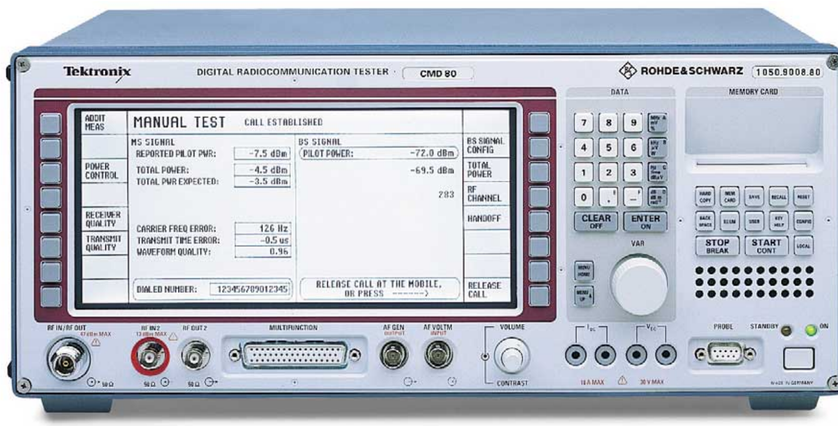


Photo 42164

Brief description

CMD80 is the first compact tester worldwide for CDMA, AMPS, D-AMPS (TDMA) and TACS mobile stations. The mobile's RF parameters are verified under the same conditions as in the real network, ie the tester simulates a tri-mode/dual-band base station, makes a call to the mobile and performs the measurements without any special test mode in the DUT. The following networks and frequency bands are supported:

US Cellular (800 MHz)	CDMA(IS95) D-AMPS/NADC (IS136, IS54) AMPS/ N-AMPS (IS95)
Japan Cellular	CDMA (T53, IS95) N-TACS/J-TACS
China Cellular	CDMA (IS95) E-TACS/TACS
US PCS (1900 MHz)	CDMA (UB-IS95, J-STD008) D-AMPS/NADC (IS136, IS54)
Korea PCS (1800 MHz)	CDMA (J-STD008, UB-IS95)

High measurement speed and remote-control capability via IEEE/IEC bus make the tester ideal for use in production. Its high measurement accuracy is indispensable in particular in the development of mobile stations. A user-friendly operating concept and fast functional tests allow cost-effective working in service applications.

Main features

Fast measurements
State-of-the-art digital technology leads to quick and efficient measurements. In remote-control mode via IEEE/IEC bus, the instrument is exceptionally fast and yields high throughput in production.

High flexibility
Almost every signalling and measurement parameter can be modified by the user either dynamically during a test or in advance in the configuration menu. Even the tolerances for the pass/fail limits can be changed to match the requirements of the application. The different configurations can be separately stored and recalled any time at the push of a button.

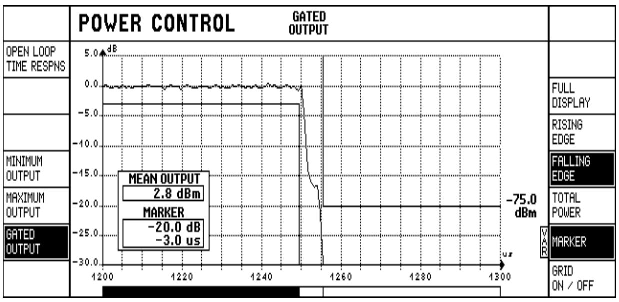
Easy to use
Operation of the CMD80 is extremely user-friendly and requires no detailed knowledge. The large high-contrast LCD with softkeys on both sides allows convenient menu-guided access to the test routines. A voice loop-back allows quick verification of the performance of a mobile as it is perceived by the user. During a call in data loop-back mode CMD80 checks the basic signalling features and the RF performance.

Test capabilities

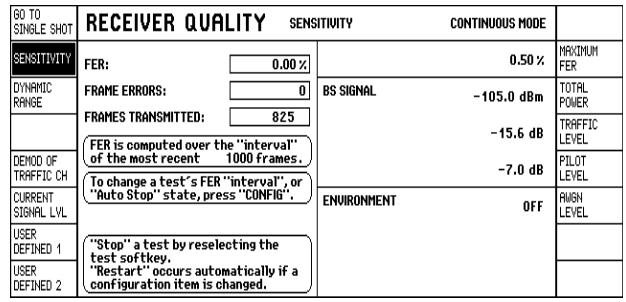
Simulation of a base station
Digital Radiocommunication Tester CMD80 simulates a tri-mode/dual-band base station and provides all the signalling necessary for a call (synchronization, registration, incoming/outgoing call origination, tri-mode/dual-band handoffs and echo mode). This also allows checking of all software features that are required for correct operation of the network. This eliminates in many cases the need for expensive customer-specific test beds in development and quality assurance.

Autorun
Custom-tailored autorun applications allow any test routines to be implemented. Complete tests of mobile phones can be performed at the push of a button. Due to the individual configuration, the test time is reduced to a minimum.

Digital Radiocommunication Tester CMD80



Graphic display of gated output power



Sensitivity test by measuring frame error rate

Tests

All essential features of a mobile station can be tested with high accuracy. CMD80 not only verifies the RF performance of the mobile station but, but in addition checks all software features that are important for the correct operation of the network.

CMD80 measures for instance the following parameters to IS98/J-STD-18 specification in CDMA:

- Transmitter measurements
  - Magnitude error
  - Phase error
  - Error vector amplitude
  - Signal quality
  - Carrier feedthrough
  - Frequency accuracy
  - Power measurements
- Receiver measurements
  - Transmission error

DC measurements

The DC ammeter/voltmeter for pulsed signals allows accurate measurement of the power consumption of the mobile station.

Measurements at protocol level

The optional Message Monitor (CMD-B83) allows measurements at protocol level. The convenient Windows program clearly displays CDMA forward/reverse link messages and is an indispensable tool especially in the development of mobile units.

Specifications in brief

CDMA

Signal generator

Frequency range,	US Cellular	869 MHz to 894 MHz
	PCS (US)	1930 MHz to 1990 MHz
	PCS (Korea)	1805 MHz to 1870 MHz
Output level,	RF IN/OUT	– 20 dBm to –124 dBm
	RF OUT2	0 dBm to –105 dBm
Modulation		QPSK

Analyzer

Frequency range,	Cellular	824 MHz to 849 MHz
	PCS (US)	1850 MHz to 1910 MHz
	PCS (Korea)	1715 MHz to 1780 MHz
Power measurement (reference level range)		
RF IN/OUT (full scale)		+41 dBm to –28 dBm
RF IN2 (full scale)		0 dBm to –69 dBm
Dynamic range		50 dB below reference level
Demodulator		O-QPSK
Modulation measurements		signal quality (ρ) phase error magnitude error error vector amplitude carrier feedthrough I/Q imbalance carrier frequency error transmission error
DC voltage measurements		
Range		0 to ±30 V
DC current measurements		
Range		0 to ±10 A
Signalling		
Digital modes		IS95, UB-IS95, J-STD008, T53

D-AMPS; option CMD-B84

Signal generator

Frequency range,	Cellular	869 MHz to 894 MHz
	PCS	1930 MHz to 1990 MHz
Output level,	RF IN/OUT	–17 dBm to –131 dBm
	RF OUT2	+3 dBm to –112 dBm
Modulation		π/4 DQPSK or unmodulated

Digital Radiocommunication Tester CMD80

Analyzer

Frequency range, Cellular	824 MHz to 849 MHz
GSM	1850 MHz to 1910 MHz
Power measurement (reference level range)	
RF IN/OUT (full scale)	+39 dBm to – 60 dBm
RF IN2 (full scale)	–2 dBm to –100 dBm
Power ramp	
Adjacent-channel power	
Modulation measurements	phase error magnitude error error vector amplitude carrier feedthrough I/Q imbalance carrier frequency error
Bit error rate measurement	
Signalling	
Digital modes	IS136, IS54

AMPS/TACS; option CMD-B82

RF signal generator

Frequency range	
AMPS	869 MHz to 894 MHz
N-AMPS	869 MHz to 894 MHz
TACS	935 MHz to 960 MHz
J-TACS	860 MHz to 870 MHz
E-TACS	917 MHz to 950 MHz
N-TACS	843 MHz to 846 MHz 863.5 MHz to 867 MHz
Output level	
RF IN/OUT	– 20 dBm to –124 dBm
RF OUT2	0 dBm to –105 dBm
FM modulation	

RF analyzer

Frequency range	
AMPS	824 MHz to 849 MHz
N-AMPS	824 MHz to 849 MHz
TACS	890 MHz to 915 MHz
J-TACS	915 MHz to 925 MHz
E-TACS	872 MHz to 905 MHz
N-TACS	898 MHz to 901 MHz 918.5 MHz to 922 MHz
Reference level range	
RF IN/OUT	+41 dBm to –28 dBm
RF IN2	0 dBm to –69 dBm
RF frequency measurement	
Dynamic range (rel. to ref. level)	>40 dB
RF power measurement	
RF IN/OUT	0 dBm to +41 dBm
RF IN2	0 dBm to –69 dBm
FM demodulation	
Signalling	analog signalling AMPS (IS95), NAMPS, TACS, J/E/N-TACS

Audio source

Frequency	50 Hz to 4 kHz (single tone)
Output voltage	
Range	0.1 mV to 5 V, rms

AF analyzer

Measurements	frequency AC voltage THD SINAD

General data

Rated temperature range	0 °C to 45 °C to DIN IEC 68-2-1/2
Storage temperature range	–40 °C to +60 °C
Power supply	110 V to 120 V/200 V to 240 V (AC) ±10%, 50 Hz to 400 Hz ±5%
Dimensions (W x H x D)	435 mm x 192 mm x 363 mm
Weight (without options)	approx. 15 kg

Ordering information

Digital Radiocommunication Tester	CMD80	1050.9008.84
Options		
IS-95 CDMA 800 MHz		
Test Functions	CMD-K1	1082.2550.02
GSM 1900/1700 MHz		
Test Functions	CMD-K2	1082.2650.02
OCXO Reference Oscillator	CMD-B1	1051.6002.04
Reference Frequency Inputs/Outputs	CMD-B3	1051.6202.02
Rate Set 2 (13k vocoder support)	CMD-B14	1059.6101.02
I/Q Modulation Outputs	CMD-B17	1099.3003.02
Carrier Board for CMD-B61/B62	CMD-B60	1059.5405.02
IEEE/IEC bus Interface	CMD-B61 [1)]	1051.7609.02
Memory Card Interface	CMD-B62 [1)]	1051.8205.04
AWGN Generator	CMD-B81	1059.7508.02
AMPS/TACS Option	CMD-B82 [1)]	1059.4344.12
Message Monitor	CMD-B83	1099.5706.02
IS136 Option	CMD-B84 [2)]	1099.5806.02
Extras		
Universal Shielded Chamber with Mobile Radio Antenna Coupler	CTD-Z10	1084.0003.02

1) CMD-B60 required

2) CMD-B62 required

Digital Radiocommunication Test Set CRTC02

for GSM 900, GSM 1800 and GSM 1900 mobile stations

Photo 43475-1

Brief description

CRTC02 is a extremely powerful test set providing all simulation and analysis capabilities from measurement of GSM 900/1800 and 1900-specific RF parameters through to detailed checking for errors in the signalling protocol.

Radiocommunication Test Set CRTC02 simulates a base station (BTS, cell) with two independent radio channels in the GSM 900/1800/1900 band. With CTRC02 almost every GSM feature relevant for the communication between mobile and network can be tested. Besides the standard speech service the instruments optionally support the following services:

- Short message service
- Supplementary services
- Transparent data services
- Non-transparent data services (RLP)
- Ciphering A5-1 and A5-2
- GSM phase II+
- GPRS

The sets consist of a digital unit, analog unit, colour monitor and keyboard. Due to their flexible structure the instruments can easily follow the evolution of the GSM standard by software upgrades.

Applications

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 preparation and quality assurance

Testing of conformance with GSM Specification 11.10. Phase II+ with respect to

- channel coding
- datalink protocols
- network signalling
- GSM-specific RF parameters

Chip design

Thanks to built-in TTL input/output of bits and an optional I/Q interface at the baseband, the instruments are ideal for use in development and validation of integrated circuits and modules.

Operation

CRTC02 may be operated in three different ways:

- via convenient menus
- by running ready-to-use test cases selected from a pick list
- by running user-programmed tests

Menu interface

The convenient, menu-guided user interface permits simple and fast call-up of test routines and RF measurements.

Test routines

- Synchronization of mobile
- Location update of mobile
- Incoming/outgoing call setup

Digital Radiocommunication Test Set CRTC02

- Power level control of mobile
- Bit error in loopback mode
- Channel change
- Call clearing by mobile
- Call clearing by network
- SACCH measurements
- Speech loopback
- GPRS connections

RF measurements
- Phase error
- Frequency error
- Power level
- Power characteristics versus time

Test routines and measurements are clearly indicated on the screen and activated by simple selection. Test results are displayed in graphical and numerical form.

Ready-to-use programs
About 20 of the ready-to-use test programs complying with GSM Spec. 11.10 GSM 900 and GSM 1800/1900 are delivered with the instrument's basic operating software. Numerous additional test programs are available as software options.

Signalling

The instrument performs all channel coding and layer 2 signalling functions automatically in real time. The detailed signalling sequence is determined by the user-written or ready-to-use C program, defining the order in which layer 3 messages have to be transmitted.

The messages are generated by a special editor which can handle the coding rules of GSM 4.08. The same tool is also used to examine the log memory. In order to test the layer 2 or RLP function, the layer 2 functionality can be modified during the execution of a test. In particular, it is possible to ignore a certain number of layer 2 frames, wait for the arrival of a specific frame or modify the layer 2 status variables V(R), V(S) and V(A). A built-in speech encoder/decoder may be used to test voice transmission. Data traffic may be routed to the display, the COM interface or the Ethernet card of the instrument.

Protocol analysis

Every transmitted or received layer 3 or layer 2 message, or even the bits of a burst, are marked with a frame number, channel type and recorded in the log memory. The menu-controlled message editor operating in line with the coding rules of GSM 4.08 can be used to navigate through the log memory and to display the recorded sequence at the various layers in mnemonic form. The user may look at the message sequence or in more detail at all the elements of a single layer 3 message. Besides the message type and a frame number the channel type is displayed. The BsChan column allows to distinguish between the two radio channels of the instrument.

Data services

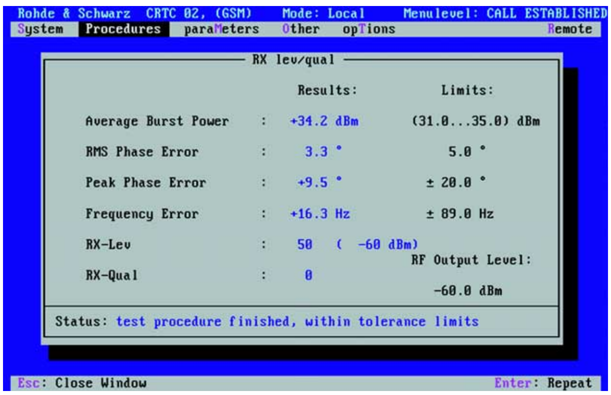
CRTC02 supports the testing of transparent and non-transparent data services. In the transparent, asynchronous case the instrument performs rate adaptation and checks for missing stop bits, wrong parity bits etc. The instrument is also able to generate data streams with over- and underspeed.

All necessary layers and coders for GPRS are available. Four time slots can be served for each RF channel.

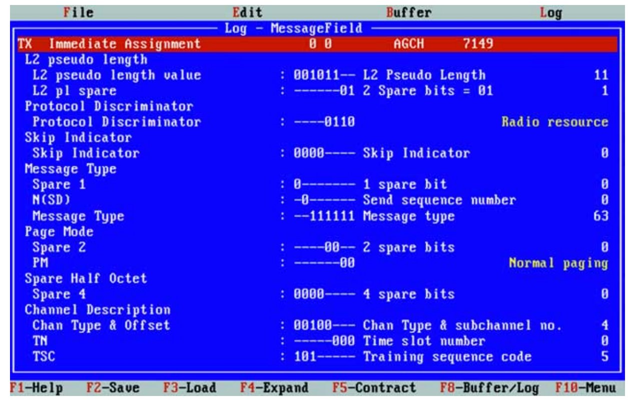
Supplementary services

The instrument is able to test supplementary services such as call forwarding, call restriction and call charging by using a set of ready-to-use test programs.

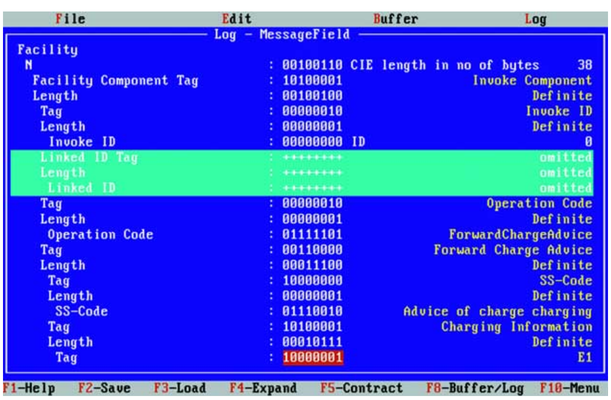
Digital Radiocommunication Test Set CRTC02



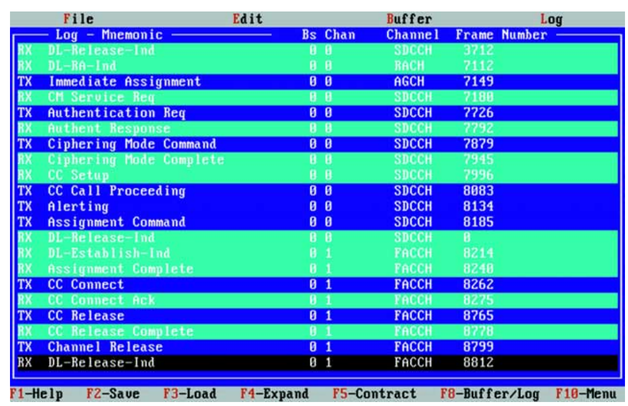
Menu-driven RF measurements



Facility information element for charging supplementary services



Display of detailed content of a layer 3 message



Display of message sequence at layer 3 level

Overview of options

Hardware	Type	Order No.	Description
2nd Basic Generator	CRTP-B9	1052.9005.02	Enables multiband handover tests between GSM900 and GSM1800
I/Q Inputs/outputs	CRTP-B7	1052.9257.02	This option provides access to the interface between the modulator and the radio section of the instrument and enables the testing of mobiles at module level.The digital section of a mobile can be examined in the baseband at an early stage when the RF module is not yet available
GSM Test SIM	CRT-Z2	1039.9005.02	A special SIM card with known content enables the testing of authentication and ciphering

Software	Type	Order No.	Description
GSM Phase 2 Operational Software (Accessory supplied)	CR02PH2	1053.0501.02	Operational software according to GSM Phase 2 for CRTC02 and CRT-WS inclusive different speech coders and SMS/TDS basis software
GSM Phase 2+ Operational Software (Accessory supplied)	CR02P2P	1119.2241.02	Operational software according to GSM Phase 2+ for CRTC02 and CRT-WS inclusive different speech coders and SMS/TDS basis software

Digital Radiocommunication Test Set CRTC02

Software	Type	Order No.	Description
Additional Operational Software for NTDS/RLP data transfer	CR28PH2	1081.6852.02	Addition to operational software for data transmission in circuit switched mode
Additional Operational Software for AMR (Adaptive Multi Rate)	CRT-K4	1131.0451.02	Addition to operational software for channel coding according to AMR (without speech coding)
Additional Operational Software for GPRS (RLC/MAC, UACK)	CRGPRS1	1119.2506.02	Addition to operational software for the lower layers of the GPRS protocol in unacknowlegde mode
Additional Operational Software for GPRS (RLC/MAC, ACK)	CRGPRS2	1119.2306.02	Addition to operational software for the lower layers of the GPRS protocol in acknowlegde mode
Additional Operational Software for GPRS (LLC, SNDCP, PPP)	CRGPRS3	1119.3154.02	Addition to operational software for the upper layers of the GPRS protocol. Requires an external Windows NT Work Station CRT-WS
Additional operational software for HSCSD	diverse		Addition to operational software for TDS/NTDS data transfer with HSCSD
Additional operational software for CRT-DUO	diverse		Addition to operational software for a multi carrier system with 4 RF channels consisting of two CTRC02 (hardware upgrade required)
Ready-to-use test case packages according to GSM Specification 11.10	diverse		Validated test cases, bundled with different packages for GSM 900, GSM 1800 and GSM 1900. The tests are supplied in source code

Specifications in brief

Analog unit

Signal generator

Frequency range	GSM 900	935.2 MHz to 959.8 MHz
	GSM 1800	1805.2 MHz to 1879.8 MHz
	GSM 1900	1930.2 MHz to 1989.8 MHz
Temperature variation		<2 x 10–9/°C
Maximum output level		13 dBm
Static attenuation setting		0 to 135 dB
Resolution		5 dB
Dynamic attenuation		0 to 35 dB (electronic)
Modulation		GMSK, bit rate 270 833 bit/s acc. to GSM Spec. 05.04

Analyzer

Frequency range	GSM 900	890.2 MHz to 914.8 MHz
	GSM 1800	1710.2 MHz to 1784.8 MHz
	GSM 1900	1930.2 MHz to 1989.8 MHz
Reference level for full dynamic range	GSM 900	13 dBm to +47 dBm ($RF_{IN/OUT}$) –17 dBm to +19 dBm (RF_{IN2}),
	GSM 1800/1900	9 dBm to +36 dBm ($RF_{IN/OUT}$) –21 dBm to +6 dBm (RF_{IN2})

RF inputs/outputs

Fading simulator	2 N connectors, 50 Ω (output level 8 dBm to 13 dBm)
$RF_{IN/OUT}$ and RF_{IN2}	N connectors, 50 Ω

Digital unit

CPU

Processor	Pentium
RAM	32 Mbyte
Floppy disk drive	3½", 1.44 Mbyte
Hard disk	>2 Gbyte
Graphics	VGA
Interfaces	parallel Centronics, RS-232-C, Ethernet
Channels supported	C0 channels with FCCH + SCH + BCCH + CCCH + CBCH + SDCCH/4 + SACCH traffic channel (voice and data) with TCH + FACCH + SACCH, SDCCH/8 + SACCH

I/Q Inputs/Outputs (CRTP-B7)

Input level/output level	±1.5 V_{pp} The option is required separately for each of the two channels of CRTC02/CRTP02

General data

Power supply	110/220 V ±10% 47 Hz 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

Ordering information

Digital Radiocommunication Test Set	CRTC02	1081.6006.02

Test set for protocol verification of GSM terminal equipment CRTU-G

Protocol simulation and analysis at the GSM air interface (Um) for development and conformance testing of GSM terminal equipment

Photo 43667-2

Brief description

CRTU-G simulates a GSM base station with two independent channels and records the sent and received messages at the Um interface. The messages are then available for detailed analysis.

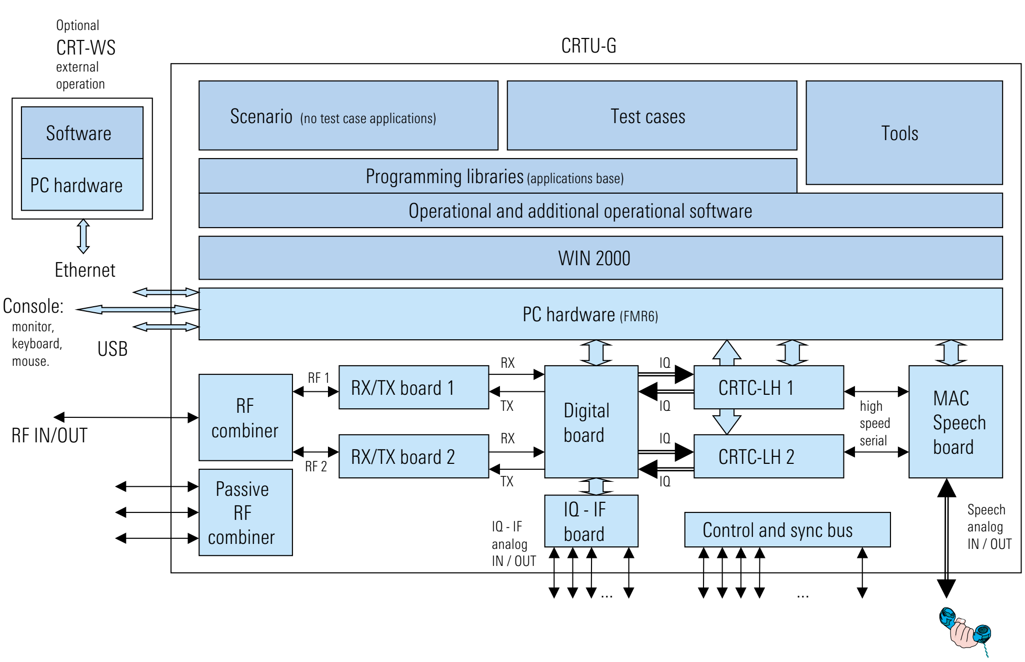
The software used by CRTU-G corresponds to the Phase II plus software of CRTC02 for operation with the CRT workstation. CRTU-G offers the following features in addition to the test capabilities of CRTC02:

- Largely compatible with the CRTC02 Phase II plus software
- Extended frequency range from 100 MHz to 2.7 MHz for more GSM frequency bands
- EGPRS-8PSK modulation and EDGE protocol characteristics
- Microsoft Windows 2000 operating system
- Several CRTU-G sets can be combined to support a test scenario with several channels
- Prepared for W-CDMA

Applications

- Development of GSM terminal equipment
- Conformance testing of GSM terminal equipment
- Development of GSM chip sets

For availability and details call www.rohde-schwarz.com in the Internet or contact your local Rohde & Schwarz representative.



Digital Radio Testers CTS55, CTS60, CTS65 for mobile phones

Tester family for fast and conclusive GSM and DECT measurements in service

CTS65 (photo 43115-1)

Brief description

Digital Radio Tester CTS from Rohde & Schwarz comes in three models:

- **CTS55**
  for mobile phones to GSM900/1800/1900
- **CTS60**
  for DECT phones (portable part and fixed part)
- **CTS65**
  for GSM and DECT

Digital Radio Tester CTS is an extremely compact, modular yet powerful measuring instrument. It combines great ease of operation and the necessary test depth for use in all service areas for mobile and cordless phones: from a simple functional test to repairs. Both the newcomer and the service specialist will be able to conveniently carry out fast automatic functional tests as well as complex and comprehensive manual measurements down to component level.

Main features

- User-friendly menu-guided control via softkeys
- Logical user prompting without interleaved submenus
- Brilliant TFT colour display: an own dimension in this class of instruments
- Menus in seven different languages
- Compact and robust design, low weight
- Eye-strain-free working
- Dynamic range for measuring the power ramp: GSM >55 dB, DECT >60 dB
- Built-in reference oscillator TCXO or OCXO (option CTS-B1)
- Combined RF input/output for GSM and DECT
- DECT off-air measurements via additional input/output
- Remote control via RS-232-C (option CTS-K6)

GSM measurement functions

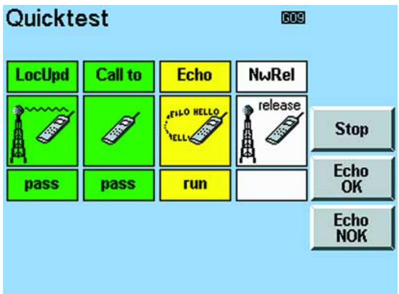
CTS55 simulates a GSM base station for testing mobile phones. The following measurements and tests can performed by automatic test routines or manually.

- Synchronization of mobile phone with base station (which is simulated by CTS)
- Location update
- Call setup (incoming/outgoing)
- Call cleardown (incoming/outgoing)
- Dualband handover
- Control and measurement of transmitter power
- Handover (channel change)
- Sensitivity
  – Bit error rate BER and RBER
  – RxLev and RxQual
- Phase and frequency error
- Power ramp versus time
- Timing error
- Echo test (voice test, includes also testing of loudspeaker and microphone)
- Function test of mobile's keypad through display of dialled number
- Display of
  – IMSI (international mobile subscriber identity)
  – IMEI (international mobile equipment identity)

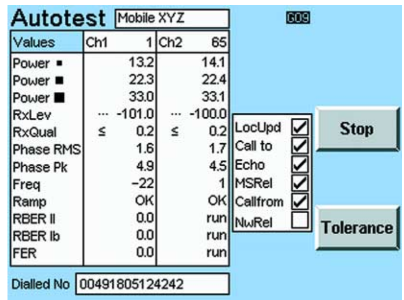
DECT measurement, test and adjustment capabilities

- Synchronization of DUT with the CTS
- Call setup
- Call release
- Echo test
- Detection and display of RFPI (FP)
- Normal transmit power (NTP)
- Power ramp versus time
- Modulation characteristics versus time
- Frequency offset
- Maximum modulation deviation
- Frequency drift
- Timing (jitter, packet delay)
- Bit error rate (BER), frame error rate (FER)

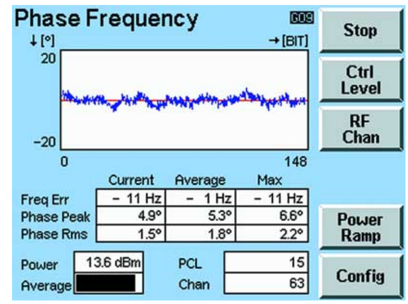
Digital Radio Testers CTS55, CTS60, CTS65 for mobile phones



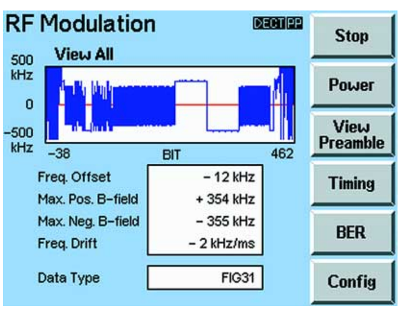
The quick test provides an extremely fast Go/NoGo information covering all essential parts of the mobile phone. A speech test (echo test) is carried out immediately after the call setup (GSM)



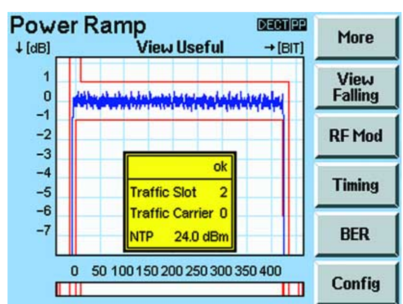
The autotest routines allow complete functional tests to be started at a keystroke. The tests cover all essential signalling functions as well as the transmitter and receiver characteristics of the mobile phone (GSM)



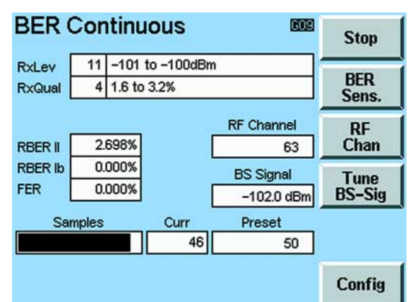
As soon as the training sequence is recognized, the CTS carries out these measurements in accordance with the GSM specifications. The results are displayed graphically and numerically (GSM)



In the RF modulation menu the demodulated signal is graphically displayed in an oscilloscope window in order to allow simple and fast detection of typical data patterns with the aid of various zoom functions (DECT)



The CTS measures the power ramp of the signal sent by an FP or PP with a dynamic range of >60 dB (DECT)



The BER is an essential criterion for evaluating the receiver characteristics of the mobile phone. The CTS measures these characteristics with the aid of various test routines such as RBER (class Ib; II; FER) and BER (class Ib; II) (GSM)

Specifications in brief

Built-in reference oscillator	standard
Frequency drift in	
temperature range +5 °C to 40 °C	$\leq 1 \times 10^{-6}$
Aging	$\leq 0.5 \times 10^{-6}$/year at 35 °C

GSM

GSM signal generator

Frequency range	
GSM900 band	935 MHz to 960 MHz
GSM1800 band	1805 MHz to 1880 MHz
GSM1900 band	1930 MHz to 1990 MHz
Resolution	GSM channel spacing 200 kHz
Output level	
RF IN/OUT	
with 0 dB ext. attenuation	–50 dBm to –110 dBm
RF OUT2 GSM	
with 0 dB ext. attenuation	–15 dBm to –75 dBm
Level error	
RF IN/OUT	≤1.5 dB
RF OUT2 GSM	≤2.0 dB
Modulation	GMSK, BxT=0.3

Narrowband Spectrum Monitor Option CTS-B7

Span	300 kHz
Resolution bandwidth	4/10/20/50/100 kHz
Dynamic range	(P >5 dBm)
Δf = 0 kHz to 30 kHz	typ. 35 dBc
Δf = 30 kHz to 150 kHz	typ. 50 dBc
Markers	3 markers and delta-marker

GSM peak power meter

Frequency range	
GSM900 band	890 MHz to 915 MHz
GSM1800 band	1710 MHz to 1785 MHz
GSM1900 band	1850 MHz to 1910 MHz
Measurement range	
with 0 dB ext. attenuation	–20 dBm to +39 dBm (peak values up to 41 dBm)
with 15 dB ext. attenuation	0 dBm to +39 dBm (peak values up 41 dBm)

GSM measurement of phase and frequency error

Frequency range	
GSM900 band	890 MHz to 915 MHz
GSM1800 band	1710 MHz to 1785 MHz
GSM1900 band	1850 MHz to 1910 MHz
Level range	–15 dBm to 39 dBm (peak values up to 41 dBm)

Digital Radio Testers CTS 55, CTS 60, CTS 65 for mobile phones

GSM measurement of burst power

Frequency range	
GSM 900 band	890 MHz to 915 MHz
GSM 1800 band	1710 MHz to 1785 MHz
GSM 1900 band	1850 MHz to 1910 MHz
Reference level for full dynamic range with 0 dB ext. attenuation	0 dBm to +39 dBm (peak values up to 41 dBm)
Dynamic range (P >5 dBm)	≥55 dB
Resolution	0.1 dB

DECT

DECT signal generator

Frequency range	1876.608 MHz to 1935.360 MHz and half channels
Frequency drift	same as reference oscillator
Output level	
RF IN/OUT	–100 dBm to –40 dBm
RF OUT2 DECT	–40 dBm to 0 dBm (–20 dBm to 0 dBm if RF IN2 DECT is active), useable up to 5 dBm
Level error	
RF IN/OUT	≤1.5 dB
RF OUT2 DECT	≤2.0 dB
Modulation	GFSK (BxT = 0.5)
DECT analyzer	
Frequency range	same as signal generator
Measurement range	with 0 dB external attenuation
RF IN/OUT	30 dBm to –30 dBm
RF IN2 DECT	–35 dBm to –55 dBm
FM demodulator	
Frequency range	0 kHz to 450 kHz
Resolution	1 kHz
DC offset	<3 kHz
Residual FM	
RF IN/OUT	<15 kHz, peak, 95% confidence (30 dBm to 5 dBm) <5 kHz, peak, 95% confidence (30 dBm to 15 dBm)
RF IN2 DECT	<15 kHz, peak, 95% confidence (–35 dBm to –55 dBm) <5 kHz, peak, 95% confidence (–35 dBm to –40 dBm)
Level meter	
Range	
RF IN/OUT	30 dBm to –30 dBm
RF IN2 DECT	–35 dBm to –55 dBm
Dynamic range	≥60 dB (for P = 24 dBm)
Resolution	0.5 dB
Accuracy	
RF IN/OUT	<1 dB + resolution (30 dBm to 5 dBm) <2 dB + resolution (<5 dBm)
RF IN2 DECT	<2 dB + resolution (–35 dBm to –51 dBm) <2.5 dB + resolution (<–51 dBm)

Audio Interface

Output	unbalanced
Range	558 mV, 300 Hz to 3 kHz
Output impedance	<10 Ω (R_L >2 kΩ)
S/N + THD	30 dB at max. level
Passband ripple	0.5 dB
Input	unbalanced
Range	80 mV, 300 Hz to 3 kHz
Input impedance	22 kΩ
S/N + THD	35 dB at max. level
Passband ripple	0.5 dB

DECT applications	averaging 10 bursts
Modulation section 1, 2, 4	
Error	approx. 11 kHz with min. (202 kHz) permissible deviation approx. 13 kHz with max. (403 kHz) permissible deviation
Frequency drift	approx. 1 kHz/ms (over 200 bursts)
Transmit power	
Measurement accuracy	
RF IN/OUT	<1 dB + resolution (30 dBm to 5 dBm) <2 dB + resolution (<5 dBm)
RF IN2 DECT	<2 dB + resolution (–35 dBm to –51 dBm) <2.5 dB + resolution (<–51 dBm)

General data

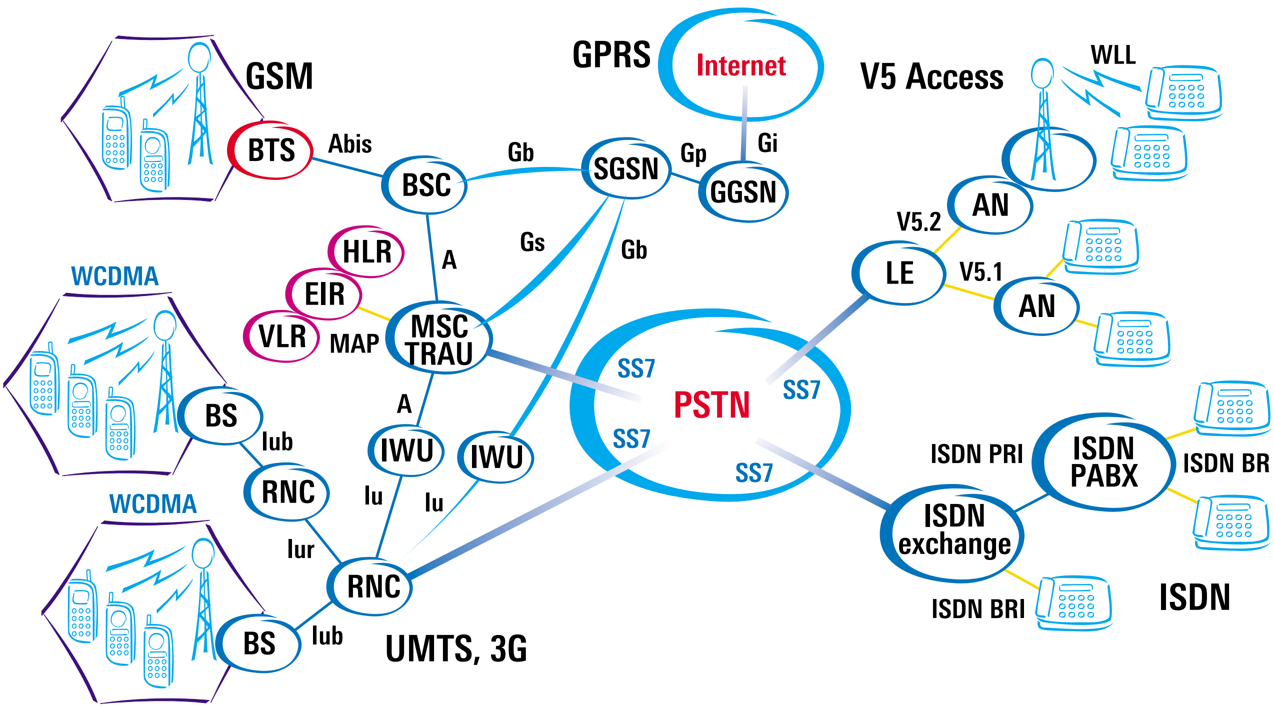
VSWR at all RF connectors	≤1.5
Rated temperature range	+5 °C to +40 °C
Operating temperature range	+0 °C to +45 °C
Storage temperature range	–25 °C to +60 °C
Power supply	200 V to 240 V AC ±10%, 100 V to 120 V AC ±10%, 50 Hz to 60 Hz ±5%
Power consumption	approx. 60 W
Dimensions (W x H x D)	319 mm x 177 mm x 350 mm
Weight	
CTS55, CTS60	approx. 7.8 kg
CTS65	approx. 8.8 kg

Ordering information

Digital Radio Tester		
GSM	CTS 55	1094.0006.55
DECT	CTS 60	1094.0006.60
GSM and DECT	CTS 65	1094.0006.65
Options		
OCXO Reference Oscillator Aging 0.2 x 10^{-6}/year	CTS-B1	1079.0809.02
GSM Remote Control (with Application Software for Windows)	CTS-K6	1079.2001.01
GSM Module Test [1)]	CTS-K7	1079.2501.02
Modification and upgrade kits		
Upgrade CTS55 to CTS65[1)]	CTS-U56	1079.1605.02
Upgrade CTS60 to CTS65	CTS-U65	1079.1705.02
Modification: new front panel with RF OUT2 on front	CTS-U7	1079.1805.02
Extras		
Universal shielded Chamber	CTS-Z12	1079.1470.02
Antenna Coupler for Handheld Phones 900/1800/1900 MHz	CTS-Z10	1079.1240.02
DECT-Antenna with N connector		1086.3116.00
GSM Test SIM	CRT-Z2	1039.9005.02
Compakt keyboard		
German	PSP-Z1	1091.4000.02
US	PSP-Z2	1091.4100.02
Production Calibration	DCV-1	0240.8733.08
Service Manual		1094.3405.24

1) CTS-U7 is required for units manufactured in May 1998 or before.

Analysis and Simulation Software NetHawk™



For all modern telecommunication systems like ISDN, GSM, GPRS, EDGE, UMTS

Brief description

NetHawk™ products comprise plug-in cards for PCs and **analysis and simulation** software for measurements on the interfaces commonly used for modern telecommunication systems such as

- GSM
- ISDN
- GPRS
- UMTS/ATM

The software analyzes and simulates all interfaces used for modern telecommunication networks:

- E1, T1, J1
- V5.1 and V5.2
- GSM: A and A_{bis}
- GPRS: Gn and Gb
- 3G: Iub, Iu and Iup

NetHawk™ servers allow the integration of user-generated programs into telecommunication systems via a flexible TCP/IP interface.

Common features

- Windows-based tools
- Standard PC or laptop
- Data output in ASCII to file or printer
- Extensive help texts for applications and protocols
- Generation of automatic test routines for simulators by means of script languages

Detailed protocol analysis

- On-line in real time or off-line with free software licence
- Separate representation of uplink and downlink
- Scanner function
- Call trace feature
- Extensive trigger functions
- Protocol details colour-highlighted
- Filtered display of protocol details
- Storage of protocols with complete setups
- Statistical analysis

Analysis and Simulation Software NetHawk™

NetHawk cards for mobile use with laptop PC

Designation	Interface	Data bus	System	Pentium
N2 5400	E1 and T1 RJ 45	Card Bus slot II	Windows 98	266 MHz 32 MB
N3	STM-1 optical SC	Card Bus slot II	Windows 2000 Windows 98	266 MHz 64 MB

NetHawk cards for stationary use with desktop PC

Designation	Interface	Data bus	System	Pentium
NAP 5200	E1 and T1 RJ45	PCI	Windows NT Windows 98	233 MHz 64 MB
STM-1 Adapter G3	STM-1 optical SC	PCI ATM adapter	Windows NT	350 MHz 64 MB 20 MB

GSM mobile network

GSM analyzer

The GSM analyzer is a PC-based protocol analyzer for monitoring and analyzing of all layers in GSM networks. Its key features include:

- Monitoring of GSM signals at A, A_{bis} and B to G interfaces
- Monitoring of half rate (HR), full rate (FR), enhanced full rate (EFR) and optionally of TRAU frames
- Monitoring of data and fax protocols and supplementary services
- Optional SS7 MAP analysis
- GSM phase 1, 2, 2+, ITU-T and ANSI modes for SS7 common channel signalling protocol layers (MTP and SCCP)
- Analysis of up to 16 different PCM timeslots

GSM-GPRS analyzer

The GSM analyzer comprises a PC adapter card and the associated software for analyzing the A and A_{bis} interfaces. The adapter card is either a PC-bus-compatible N2 card for laptops with Windows 98/2000 or a PCI-compatible NAP card for desktop PCs with Windows NT.

For simultaneous monitoring of the Gb interfaces a software upgrade can be installed. Some of the extra features are BTSM, SNDCP, BSSGP, LLC, PCU frames and RLC/MAC analysis.

An Ethernet card is supplied for the Gn/Gi interfaces. The IP, TCP and UDP protocols as well as WAP over IP and the GTP analysis of the Gn/Gp interface are fully supported.

All GSM/GPRS-relevant interfaces and their protocols can be displayed on a single PC screen.

3G UMTS analyzer

The high UMTS bit rates are realized by using ATM for the data feed; data rates of 2 Mbit/s and 155 Mbit/s are planned. The 2 Mbit/s correspond to E1 for ATM and are transmitted on shielded electrical lines. For 155 Mbit/s, fiberoptic cables are used to carry ATM cells using SDH technology and the STM-1 interface.

For the 3G analysis on desktop PCs, the software comes with a PCI-compatible ATM card and an external E1 or STM-1 adapter. The STM-1 adapter G3 has three interfaces for uplink and downlink at 155 Mbit/s. The data from one interface are passed on to the PC, while the other two interfaces are available as test inputs.

Analysis and Simulation Software NetHawk™

The STM-1 adapter can be cascaded up to three times. It then has a total of nine interfaces for STM-1 optical, one of which being required by the PC for the analysis, so that up to eight 155 Mbit/s STM-1s are available for connection to the DUT.

The STM-1 adapter G3 is able to simultaneously analyze up to 64 ATM channels with different VPI/VCI addresses for UNI and NNI; the PDU types AAL0, AAL2 and AAL5 are supported. The analysis is to 3GPP standard and – for the signalling – to SSCOP, MTP3B, AAL2, SCCP, B-ISDN, UNI 3.1 and 4.0.

3G adapter card E1 and STM-1 with PC bus
For laptops with a conventional N2 card suitable for the bit rates E1, T1 and JT1, the 3G analysis software can handle measurements with ATM at 2 Mbit/s.

Fitted with the new N3 card, a laptop can analyze both interfaces – E1 electrical and STM-1 optical. The optical connection is made via SC connectors for the uplink and downlink of a 155 Mbit/s ATM link.

GSM simulator
- MSC/A
- – Simulates MSC and VLR towards BSS (BSC and BTS)
- – A interface
- – Tests on BSS and mobiles
- – Max. 30 voice links within the same BSS
- – Max. eight voice links between two BSS
- BSC/A_{bis}
- – Simulation of BSC/MSC/VLR towards BTS
- – A_{bis} interface
- – GPRS as option
- – Tests on BTS and mobiles
- – Max. 25 simultaneous calls

Supported GSM procedures
- Location updating
- Call setup and cleardown
- – mobile-originated (MO)
- – mobile-terminating (MT)
- – mobile-to-mobile
- Emergency call setup
- Handover
- – intra-BTS
- – inter-BTS
- Transmission of MT point-to-point SMS
- Reception of MO point-to-point SMS
- SMS cell broadcast
- Voice links

RNC simulator
The RNC simulator is a function tester for the UMTS base station and is operated via the Iub interface. The software can be used with the N2 card (E1, T1, J1) or N3 card (STM-1) in mobile applications and with the STM-1 adapter G3 in stationary applications.

The simulator initializes the base station, generates the signalling, sets up and clears calls and allows monitoring of the protocol. It contains the ATM-specific protocols AAL0, AAL2, AAL5 and SSCOP.

V5 access networks (LAN, WAN, WLL, trunked radio)

Main applications
NetHawk™ simulators and analyzers for V5 networks are designed for the following typical applications:

- Wireless local loop (WLL) in GSM and DECT
- PSTN access control
- Cable TV operators, public utilities and transport companies providing telephone services
- PSTN type approval tests

V5 analyzer
The NetHawk™ V5 analyzer is a PC-based protocol analyzer for monitoring and analyzing the signalling protocols of V5.1 and V5.2 networks. Its key features include:

- Support of ISDN via V5
- Support of ISDN supplementary services
- Analysis of up to 16 different PCM timeslots

PC-based V5 simulator
- Simulation of
- – LE functionality towards AN
- – AN functionality towards LE
- Supports both V5.1 and V5.2
- Max. six timeslots for signalling
- Max. 60 simultaneous calls

Analysis and Simulation Software NetHawk™

Fixed networks

SS7 analyzer
The SS7 analyzer is a PC-based protocol analyzer for monitoring and analyzing all the SS7 signalling protocols used by the fixed network. Its key features include:

- Supports several national ISUP and TUP protocols
- Analysis of up to 16 PCM timeslots

ISDN PRI analyzer
The ISDN PRI analyzer with PC card is a protocol analyzer for monitoring and analysis at S_{2M} interfaces. Its key features include:

- Analysis of up to 16 PCM timeslots
- Supports ISDN supplementary services

Servers

Characteristics
NetHawk™ servers allow the integration of PC programs into telecommunication systems via a flexible TCP/IP interface. In product development, they are reliable components of automatic test systems. They enable service providers to minimize the time-to-market of their PC-based telecommunication services because they allow the development of higher layers in effective workstation environments. Moreover, they can be used as stable link layer interfaces in telecommunication networks.

The frame relay server for GPRS is hyperchannel-compatible. It supports up to twelve 64 kbit/s links or a 1984 kbit/s link by allocating all timeslots except timeslot 0.

The SAAL server features an ATM/UNI interface based on STM-1 and can convert (SAR) user data into ATM cell streams and vice versa. An AMR coder provides voice coding for UMTS and prevents any transmission in silent periods.

Overview

Server	Max. number of channels	Max. number of timeslots	Max. logical links	Monitoring (option)
G703	4	12	12	V5, GSM, ISDN
MTP3/MTP3b	4/4VCI	4	4	GSM, SS7, SAAL
LAPD PRI	4	12	12	GSM, ISDN
LAPV 5	4	12	12	V5
Frame Relay	4	31	12 LAPF	GSM, GPRS
SAAL/UNI	1 STM-1	14 links	22 AAL2	SSCOP/FP

The number of supported channels can be doubled using a second plug-in card.

The **NetHawk products** enhance the RF GSM test systems from Rohde & Schwarz on the wired end by providing detailed protocol analysis and simulation of the A, A_{bis} and also of the GPRS and UMTS interfaces to the fixed network. Systems for comprehensive final testing of base stations are supplied on this basis. The high acceptance of NetHawk is based on the early availability of this measurement and simulation tool. New technologies of the third generation like GPRS and UMTS need NetHawk at the development and production stage – long before any products go into service.

Universal Shielded Chamber with Antenna Coupler CTD-Z10

Photo 42167

Interference-free testing of mobile telephones of any cellular networks; simple coupling in 900-MHz band

Brief description

Anyone engaged in mobile phone testing is only too familiar with problems such as getting hold of a suitable RF adapter or keeping RFI away which would otherwise falsify the measurement result. CTD-Z10, consisting of a coupler and a shielded chamber, is the solution to these problems. As an alternative to coupling via various manufacturer-specific adapters, the RF connection between mobile phone and test set can be made in the 900 MHz band via a single universal antenna coupler. Moreover, the shielded chamber ensures constant and defined test conditions which without protective measures against external radio fields – eg caused by neighbouring base stations – are usually not given.

With its excellent shielding characteristics both in the 900 MHz band and in all other frequency bands of cellular mobile radio, CTD-Z10 is the ideal accessory not only for the Go/NoGo Tester CTD52, but for all digital and analog radio testers from Rohde&Schwarz.

The shielded chamber of CTD-Z10 provides sufficient space for accommodating all customary analog and digital mobile phones. The antenna of the phone to be tested is connected to the coupler via a spring clamp. To achieve reproducible results, the coupler can be fixed to the chamber base. The radio-specific attenuation factors can be determined through calibration.

As an alternative to the antenna coupler supplied, the mobile phones may also be connected via manufacturer-specific couplers or cables with connectors.

Specifications in brief

Shielded chamber	
Shielding effectiveness in all bands of cellular mobile radio	>50 dB
Material	aluminium, interior lined with foam mats
RF connector	N female (connecting cable supplied)
Dimensions (W x H x D)	4810 mm x 325 mm x 145 mm
Weight	3.4 kg
Antenna coupler	
Frequency range	900 MHz band
Coupling attenuation	typ. 6 dB
Mech. connection phone - coupler	antenna clamp
Dimensions (W x H x D)	170 mm x 80 mm x 60 mm
Weight	0.3 kg

Ordering information

Universal Shielded Chamber with Antenna Coupler for Mobile Radio	CTD-Z10	1084.0003.02
Equipment supplied	shielded chamber, antenna coupler, cable for internal connection between coupler and shielded chamber, cable for external connection between shielded chamber and test set, operating manual	

Antenna Coupler CTS-Z10/ Shielded Chamber CTS-Z12

Simple coupling and interference-free testing in all GSM bands

Photo 43405-1

Brief description

Anyone engaged in mobile phone testing is only too familiar with problems such as getting hold of a suitable RF adapter or keeping RFI away which would otherwise falsify the measurement results.

Antenna Coupler CTS-Z10 and Shielded Chamber CTS-Z12 are the solution to these problems. As an alternative to coupling via various manufacturer-specific adapters, the RF connection between mobile phone and test set can be made via a single universal antenna coupler. Shielded Chamber CTS-Z12 ensures constant and defined conditions which without protective measures against external radio fields – eg caused by neighbouring base stations – are usually not given.

With their excellent RF characteristics in all frequency bands of cellular mobile radio, CTS-Z10 and CTS-Z12 are ideal accessories not only for the Digital Radio Tester CTS, but for all digital and analog radio testers from Rohde & Schwarz.

Antenna Coupler CTS-Z10 and Shielded Chamber CTS-Z12 provide sufficient space for accommodating all customary analog and digital mobile phones. The phone to be tested is connected to the coupler via a mobile holder with a spring clamp. The radio-specific attenuation factors can be determined through calibration.

Specifications

Antenna Coupler CTS-Z10

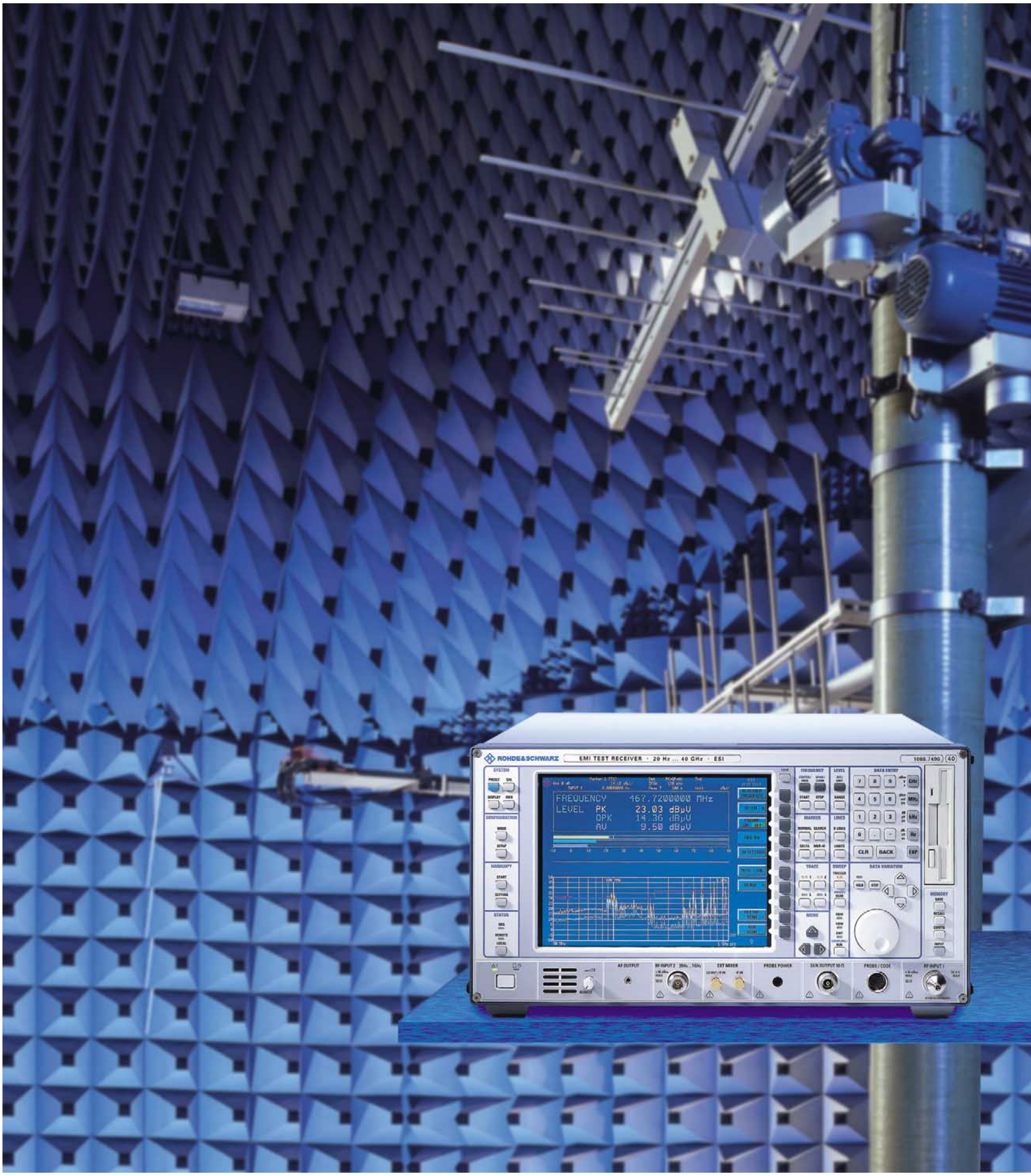
Frequency range	900 MHz, 1800 MHz and 1900 MHz GSM bands
Coupling	typ. 10 dB in 900 MHz band, typ. 20 dB in 1800 MHz band, typ. 25 dB in 1900 MHz band
RF connector	SMA female at coupler, connecting cable with N connector supplied
Mechanical connection	mobile holder with clamp
Dimensions (W x H x D)	264 mm x 170 mm x 85 mm
Weight	0.8 kg

Shielded Chamber CTS-Z12

Frequency range	up to 2 GHz
Shielding	≥35 dB
Material	aluminium interior lined with foam mats
Connectors	opening for SMA connector of coupler, 25-pin connector feedthrough
Dimensions (W x H x D)	319 mm x 202 mm x 200 mm
Weight	2.7 kg

Ordering information

Antenna Coupler 900 MHz, 1800 MHz, 1900 MHz	CTS-Z10	1079.1240.02
Equipment supplied	antenna coupler, cable for connection between coupler and test set, manual	
Shielded Chamber for Mobile Radios	CTS-Z12	1079.1470.02



EMI measurements up to 40 GHz conforming to standards with EMI Test Receiver ESI (photo 43176-5)

Contents of Chapter 2

Introduction

EMC = EMI + EMS

Electromagnetic compatibility (EMC) is the capability of an electrical device or system to operate in its electromagnetic environment without disturbing or being disturbed by it. EMC is an important criterion of product quality.

To ensure EMC of a product in the most economical way, appropriate measures should be taken as early as in the design phase.

According to the definition, EMC is subdivided into electromagnetic interference (EMI) and electromagnetic immunity or susceptibility (EMS). Legislation prescribes compliance with maximum values for EMI and minimum values for EMS. The relevant limit values, the measurement methods and instruments to be employed are specified in the relevant standards.

Conformity mark
To show their conformity to the EMC requirements prescribed by law, all electrical devices have to be marked accordingly.

European CE conformity mark

Since beginning of 1996 uniform marking is prescribed for the European Economic Area (EEA). From that date on electrical and electronic equipment not bearing the CE conformity mark may not be marketed any more in the whole European economic area.

EMI measurements

For measuring the electromagnetic interference, the interference sink, which in the commercial sector is always the listener or viewer, is replaced by the measuring instrument. As a result, all test receivers for commercial EMI measurements should have man-like response built-in: they must have a quasi-peak-weighting display to show the human perception of interference as a measured value.

In the military sector the interference sink is assumed to be a technical device which responds to the maximum interference level. Therefore, the peak interference is measured.

Interference is emitted by the equipment under test in completely undefined ways. Therefore, the EMC standards contain regulations for connecting the test receiver to the equipment under test, for the environment of the EUT and its operation.

EMS measurements

For measuring the electromagnetic susceptibility, the different interference sources occurring in practice are replaced by appropriate generators, the interfering signals of which are applied to the EUT via suitable coupling/decoupling networks.

For monitoring the proper functioning of the EUT, suitable monitoring equipment must be provided, which so far has not been defined in the relevant EMC standards. In many cases, highly shielded video cameras with a monitor are used for this purpose.

EMC measurement software

Correct EMC measurements are only possible upon strict compliance with a number of regulations and standards for the measuring instruments used and for the measurement methods adopted.

EMI test equipment from Rohde & Schwarz complies with the relevant regulations for measuring instruments. Compliance with the prescribed measurement methods, however, is the user's own problem. Support is rendered in the form of special measurement programs allowing time-saving and correct measurements.

These measurement programs are available as software packages (ES-K1 and ESxS-K1 for EMI measurements and EMS-K1 for EMS measurements). They relieve the user of routine settings and offer every convenience from automatic consideration of frequency-dependent transducer factors of the coupling/decoupling networks, automatic selection of the applicable limit lines, display of the results in graphical or tabular form through to the generation of test reports. Similar convenience is provided by the automatic EMI test routines implemented in the Test Receivers of the ESPC, ESHS, ESVS, ESCS and ESI series. They allow fully automatic time-saving measurements without an external controller, so that extremely compact test setscan be implemented.

Introduction

EMC measuring instruments

Rohde & Schwarz not only offers suitable test receivers covering a frequency range from 20 Hz to 40 GHz for EMI measurements, but also the necessary accessories. In the range from 9 kHz to 2.75 GHz, four different types of test receivers of the ESHS, ESVS, ESCS, ESPC and ESI families are available. The frequency range of the ESI receivers starts at 20 Hz and extends to 7 GHz, 26.5 GHz or 40 GHz. There is the right instrument for every application and measurement problem, from the precertification test receiver ESPC for development-accompanying diagnostic measurements through to the high-end ESI.

Line impedance stabilization networks (LISN) are required as coupling/decoupling networks (CDN) for RFI measurements on power lines in the frequency range from 9 kHz to 30 MHz. These are available for a current drain of up to 16 A for two-phase feeding and up to 200 A for three-phase feeding of the EUTs. Symmetrical LISNs are available for RFI voltage measurements on data lines which are becoming ever more important.

Radiated interference is measured above 30 MHz, with calibrated antennas being required. The Rohde & Schwarz range of products comprises various high-precision antennas, as well as absorbing clamps, which are required for RFI power measurements eg on household appliances. Remote-controlled antenna positioning masts and turntables for the EUT round off the range of products.

For EMS measurements, the Rohde & Schwarz range of products includes control generators whose modulation and level control characteristics are tailored to the specific requirements of these measurements. Suitable antennas and power meters are also available.

EMC test systems

Planning and implementation of practice-oriented EMC test systems requires a great deal of specialized knowledge and experience. This is what Rohde & Schwarz specialists have. All their expertise goes into turnkey EMC test systems which provide the fastest way of yielding correct EMC measurements. These systems are always tailored to the specific needs of the customer to provide the optimum solution to the tasks on hand. We can offer everything from small systems through to complete equipment of test houses with shielded anechoic chamber and the complete infrastructure required. Naturally, the main emphasis is on fully automatic measurements with comprehensive documentation of the test results and, if desired, statistical evaluation. One of the important factors of automatic EMC test systems is calibration and continuous monitoring of the measurement accuracy to make sure that all test results will pass another compliance test.

EMC seminars

Successful work in the field of EMC requires an accurate knowledge of all the relevant regulations, laws, standards and techniques required. It is not easy to be familiar with all of them and – in view of the frequent modifications – to remain up to date. Support is given in the form of seminars, in which experts both from Rohde & Schwarz and from outside will impart the necessary knowledge to the participants. These seminars are held at the training center in Munich, but are also offered at various Rohde & Schwarz branch offices; or also directly at the customer's if there is such a demand.

EMC legislation and standards

For the European Economic Area (EEA) EMC is regulated in the "Council Directive of 3 May 1989 on the approximation of the laws of Member States relating to electromagnetic compatibility (89/336/EEC)", which was published in the Official Journal of the EU on 23 May 1989.

In the meantime this directive has been transformed into national laws in all EEA member states, eg in Germany into the "Law on Electromagnetic Compatibility" (EMVG) of 9 November 1992.

The directive prescribes "protection goals" for all equipment containing electric or electronic components. These protection goals apply to EMI as well as to EMS. The directive does not contain any EMC limits, but refers to the appropriate standards. It is assumed that compliance with these standards entails compliance with the protection goals.

In order to be recognized by the directive and the EMVG, the numbers ("sources") of EMC standards must be published in the Official Journal of the European Communities or the Official Journal of Posts and Telecommunications.

Introduction

EMC standards

The number of standards published in the Official Journals is steadily increasing. The different types of standards include "generic standards", which are to be applied in all cases which are not covered by specific product or product family standards. The product (family) standards are divided into standards limiting low-frequency and high-frequency emission (radio disturbance suppression) and standards defining the requirements of immunity to electromagnetic emission. Besides, there is a series of specific product standards defining EMC requirements.

Individual EMC standards (extract of Official Journal 10/2000):

Generic standards – emission

- EN 50081-1
  Residential, commercial and light industry environment
- EN 50081-2
  Industrial environment

Generic standards – immunity

- EN 50082-1
  Residential, commercial and light industry environment
- EN 50082-2
  Industrial environment

Product family standards and product standards for low-frequency emission

- EN 61000-3-2
  EMC Part 2: Limits for harmonics
- EN 61000-3-3
  EMC Part 3: Limits for voltage fluctuations and flicker

Product family standards for high-frequency emission

- EN 55011
  ISM equipment
- EN 55013
  Sound and TV broadcast receivers
- EN 55014-1
  Electrical devices and systems (household appliances and electric tools)
- EN 55015
  Radio disturbance suppression of electrical devices and systems (lighting equipment)
- EN 55022
  Radio disturbance suppression of information technology equipment
- EN 55103-1
  Audio and video equipment

Product standards for immunity

- EN 55020
  Sound and TV broadcast receivers
- EN 55014-2
  Household appliances, tools and similar apparatus
- EN 61547
  Lighting equipment; EMC immunity requirements
- EN 55024
  Informatics equipment
- EN 55103-2
  Audio and video equipment

Special standard for disturbance of signals in electrical installations

- EN 50065-1
  Signalling on low-voltage electrical installations.
  Part 1: General requirements, frequency bands and electromagnetic disturbances (incl. amendment A1)

Product standards containing EMC requirements:

- EN 50083-2
  Cable distribution systems for TV and sound signals
- EN 50090
  Electrical system technique for home and buildings
- EN 50091-2
  Uninterruptible power systems (UPS);
- EN 50130-4
  Alarm systems
- EN 50148
  Electronic taximeters
- EN 50199
  Light arch welding equipment
- EN 50227
  Nearing sensors
- EN 50263
  Measuring relays
- EN 50270
  Gas sensors
- EN 60204-31
  Sewing machines
- EN 60521, EN 60687, EN 61036
  Several AC watt-hour meters
- EN 60601-1-2
  Medical electrical apparatus, General safety requirements – EMC requirements and tests
- EN 60669-2-x
  Electronic switches for household and similar
- EN 60687
  Alternating current static watt-hour meters for active energy, classes 0.2 S and 0.5 S
- EN 60730-x-x
  Automatic electrical control units
- EN 60870-2-1
  Telecontrol equipment and systems
- EN 60945
  Maritime navigational equipment

Introduction

- EN 60947-1
  Low-voltage switchgear and control gear
- EN 61036
  AC electronic watt-hour meters for active energy classes 1 and 2
- EN 61037
  Electronic ripple control receivers for tariff and load control
- EN 61038
  Time switches for tariff and load control
- EN 61131-2
  Programmable controllers
- EN 61800-3
  Adjustable speed electrical power drive systems
- EN 12016
  Elevators and escalators, immunity
- EN ISO 14982
  Agricultural and forestry machines

EMC standards for radio and telecommunication equipment
These include the ETSI standards ETS30x xxx and EN30x xxx, e. g. ETS300 086 Land Mobile Radio. So far, 48 of these standards have been published in the Official Journal.EMC test methods.

As already described above, since January 1996 all electrical products offered on the EEA market must be identified with the CE mark, the prerequisite for this conformity mark being compliance with the relevant EMC standards.

The EMC directive prescribes different test methods, depending on whether the equipment tested is "normal" equipment or radio transmission equipment; in the former case it is also of importance whether complete standards, ie relating to both EMI and EMS, exist for that equipment.

In the simplest possible case, ie if a complete standard is available, the manufacturer or importer in the EEA is authorized to carry out the required tests himself and to label the product with the CE mark without supervision. Incomplete standards, however, require the involvement of a competent body.

All in all, the EMC directive gives the manufacturer or importer more possibilities than previously to pursue independently the certification of the electromagnetic compatibility of his products, which is then recognized on the entire European market.

Field-strength measurements

Wide measurement ranges (30 nV to 7 V) in conjunction with high selectivity and large dynamic range permit the Rohde & Schwarz test receivers to be used as high-accuracy selective voltmeters in labs and test departments. With built-in tracking generators, the test receivers can also perform twoport measurements. Antennas make them suitable for field-strength measurements.

Radiocommunication services (regulation authorities, broadcasting corporations, military, traffic and security authorities as well as civil providers) use field-strength meters for radio control and propagation measurements in the planning stage and for coverage measurements during operation of communication networks.

Field-strength measurements – in particular propagation and coverage measurements – are usually made in mobile mode (vehicle or helicopter). Portability and battery operation are important criteria in the choice of the test receiver.

Hardware from Rohde & Schwarz

Rohde & Schwarz offers the complete range of measuring equipment from a single source: from automatic test receivers through to turnkey systems with power amplifiers and remote-controlled antennas. The Rohde & Schwarz products feature future-oriented design and advanced circuit technology; they comply with the highest international standards both electrically and mechanically.

Software from Rohde & Schwarz

For years Rohde & Schwarz has been creating programs which are extremely user-friendly and can be used without any in-depth programming knowledge. Using modern software development tools and in close cooperation with the customers, program packages are tailored to the specific needs.

Equipment required for EMI measurements to specific standards

Group of equipment			Industrial, scientific and medical equipment	Vehicles with combustion engines, remote/built-in RFI suppression	Sound and TV broadcast receivers	Electrical devices, household appliances	Fluorescent lamps and luminaires	Information technology equipment (ITE)	Military equipment and systems	Generic emission standards	Mains signalling equipment	Cable distribution systems TV/sound	Uninterruptible power systems (UPS)	Professional audio/video equipm.	Electric railways	Medical electrical apparatus	Maritime navigation equipment
Standards		International Europe + Germany Japan USA	CISPR 11; EN 55011 VDE 0875 Part 11 EACL Sect. 2 FCC Part 18, Subpart C	CISPR 12/CISPR 25 ECE 10, DIR95/54/EG VDE 0879 Part 1, Part 2, 3; JASO D001-82	CISPR 13; EN 55013 VDE 0872 Part 13 EACL Sect. 3 & 8	CISPR 14; EN 55014 VDE 0825 Part 14 EACL Sect. 5; FCC Part 15, Subpart B;	CISPR 15; EN 55015 VDE 0875 Part 2/ Part 15 EACL Sect. 6 & 7	CISPR 22; EN 55022 VDE 0878 Part 22 EACL Sect. 4; FCC Part 15, Subpart B; Subpart B	VG 95370, 95373 — MIL-STD-461 (CE/RE) DEF-STAN 59-41 (UK)	EN 50 081-1/2	EN 50 065-1	EN 50083-2	EN 50 091-2	prEN 55103-1	prEN 50121	EN 60601-1-2	EN 60945
Frequency range	**Test Receivers**	**Accessories and extras**															
from 20 Hz	ESI	Current Probe EZ-17							●								
		H-Field Coil HZ-10							●					●			
from 9 kHz		Current Probe EZ-17	❍	❍	❍	❍	❍	●	●		❍	❍					
		H-Field Coil HZ-10							● 4)					●			
	ESS	Tripod HFU-Z	●						● 5)						●		●
		Loop Antenna HFH2-Z2	●						● 5)						●		●
	ESCS30	Tripod HZ-1							●								
		Rod Antenna HFH2-Z6							●								
	ESHS 10	V-Network ESH2-Z5	●		●	●	●	●	● 6)	●	●	●	●	●	●	●	●
		V-Network ESH3-Z5	●		●	●	●	●	● 6)	●	●	●	●	●	●	●	●
	ESPC 1)	V-Network ENV 4200	●		●	●	●	●	● 6)	●	●	●	●	●	●	●	●
		V-Network ESH3-Z6		●					●								
	ESI	Coupling Network ENY22						●	● 5)								
		Coupling Network ENY41						●									
		Probe ESH2-Z2	●		●	●	●	●		●	●	●	●	●	●	●	●
		Probe ESH2-Z3	●		●	●	●	●		●	●	●	●	●	●	●	●
		Ant. Imp. Converter EZ-12		●													
		Probe Set EZ-11	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
		Probe Set EZ-14	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
		Triple-Loop Ant. HM 020	❍				●										❍
		RF Cable HZ-3/HZ-4	❍		❍	❍	❍	❍	❍								
from 30 MHz		Current Probe EZ-17	❍	❍	❍		❍	❍	●	●	❍		❍				
		Current Probe ESV-Z1	❍	❍	❍		❍	❍	●	❍	❍						
	ESS	Absorb. Clamp MDS-21/22	●	●	❍	●		❍		●	●	●		●			
		Probe Set HZ-11	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
	ESCS30	Probe Set HZ-14	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
		Tripod, Mast HFU-Z	●	●	●		●	●		●	●		●	●	●	●	●
	ESVS 10	Broadband Dipole HUF-Z1	●	●	●		●	●		●	●		●	●	●	●	●
		Log Periodic Ant. HL 023A1	●	●			●	●		●	●		●	●	●	●	●
	ESPC 1)	Biconical Antenna HK 116	●	●	●		●	●	●	●	●		●	●	●	●	●
		Log Periodic Ant. HL 223	●	●	●		●	●	● 7)	●	●		●	●	●	●	●
	ESI	Con. Log Spir. Ant. HUF-Z4							● 8)								
		Tripod HZ-1							●								
		RF Cable HFU2-Z4/-Z5	●	●	●		●	●		●	●		●	●	●	●	●
		Shielded TEM-Line S-LINE						❍		❍	❍		❍	❍		❍	❍
from 1 GHz	ESPC ESCS 30 ESI	Antennas HL 025, AC 008	●		●			● 2)				●					
		on request							●								
from 2 GHz	ESI	Antennas HL 025, AC 008	●		●			● 3)				●					
		on request							●								
from 5 GHz	ESI 26	Antennas HL 025, AC 008	●					●				●					
	ESI 40	on request							● *								
from 10 GHz	ESI 26	Antennas HL 025, AC 008	●					●				●					
	ESI 40	on request							● **								
from 18 GHz	ESI 40	Accessories							● ***			●					
to 40 GHz		on request															

1)) ESPC has limited compliance with CISPR 16-1
2) FCC: clock frequency <200 MHz.
3) FCC: clock frequency <500 MHz.
4) VG up to 200 kHz
5) VG
6) VG, MIL.

Equipment required for EMI measurements to specific standards

Legend

- ● necessary accessory
- ❍ recommended extra
- * 10 GHz = upper freq. limit to GAM-EG 13
- ** 18 GHz = upper freq. limit to CISPR 11, VG standards and DEF-STAN 59-41
- *** 40 GHz = upper frequency limit to ANSI C63.2, C63.4 and MIL-STD-461

Further European standards see page 70

Low-voltage switchgear and controlctear EN 60 947-1	Telecom systems with large dimensions ETS 300 127	Short range devices (SRD) 9 kHz to 25 GHz ETS 300 220, 330 ETS300 440, 683	PMR equipment DECT equipment ETS 300 279 ETS 300 329	Generic EMC standard for radio equipment prETS300339	ERMES paging receivers ETS300340	GSM 900 MHz GSM 1800 MHz ETS300342-1/2	Digital fixed radio links ETS300385	Equipment of public telecom networks ETS300386-1 ETS 300 386-2-2, -3-4	Wireless microphones and similar equipment ETS 300 445	Second generation cordless telephones (CT2) ETS 300 446	VHF FM broadcasting transmitters ETS 300 447	VSAT, SNG and TES equipment ETS 300 673	CB radio and ancillary equipment ETS 300 680-1, -2	On-site paging equipment ETS 300 682	Commercially available amateur radio equipment ETS 300 684	Analog cellular radio comm. equipment ETS 300 717	Wide-area paging equipment ETS 300 741	2.6 GHz wideband trans-mission and HIPERLAN ETS 300 826	TETRA and ancillary equipment ETS 300 827	VHF maritime mobile radio telephone ETS 300 828	1.5 GHz maritime MES with LBRDC for GMDSS ETS 300 829	1.5 GHz receive-only MES for data comm. ETS 300 830	1.5/2.5 GHz MES for satellite GSM ETS 300 831	<1 GHz MES with LBRDC using LEOs ETS 300 832	
																									Current probe 5 Hz to 2 MHz/20 Hz to 100 MHz
																									Shielded, calibrated field coil 5 Hz to 10 MHz
		●																							Current probe 20 Hz to 100 MHz
																									Shielded, calibrated field coil 5 Hz to 10 MHz
		●																		●	●				Tripod for Loop Antenna HFH2-Z2
		●																		●	●				Active loop antenna 9 kHz to 30 MHz
																									Tripod for Rod Antenna HFH2-Z6
																									Active rod antenna 9 kHz to 30 MHz
●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	V-network up to 25 A (70 A), 4-line LISN
●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	V-network up to 10 A (16 A), 2-line LISN
●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	V-network up to 200 A, 4-line LISN
			●	●		●	●		●		●	●		●	●	●	●								V-network up to 150 A (500 A), single-phase LISN
								❍																	2-wire Coupling Network
								❍																	4-wire Coupling Network)
●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	Active probe for RFI voltage measurement
●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	Passive probe for RFI voltage measurement
																									Antenna impedance converter 9 kHz to 30 MHz
❍		❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	Near-field probe set 100 kHz to 2 GHz
❍		❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	Near-field probe set 9 kHz to 1 GHz
		❍																		❍	❍				Triple-loop antenna 9 kHz to 30 MHz
																									Low-loss coaxial cables 3 m/10 m
																									Current probe 20 Hz to 100 MHz
																									Current probe 20 to 300 MHz (cal. up to 600 MHz)
																									Absorbing clamp 30 to 1000 MHz
❍		❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	Near-field probe set 100 kHz to 2 GHz
❍		❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	Near-field probe set 9 kHz to 1 GHz
																									Absorbing Clamp Slideway HCA f. autom. meas.
●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	Broadband dipoles 20 to 80 MHz
●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	Log-periodic antenna 80 to 1300 MHz
●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	Biconical antenna 30 to 300 MHz
●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	Log-periodic antenna 200 to 1300 MHz
																									Conical log spiral antenna 200 to 1000 MHz
																									Tripod for HK116, HL223 and HUF-Z4
●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	RF connecting cable 12 m/7 m, common-mode suppr.
		❍	❍	❍	❍	❍			❍	❍			❍	❍	❍	❍	❍								Shielded TEM-Line, 0.15 to 1000 MHz (2 models)
		●													●										Log-periodic antenna/directional ant. 1 to 18 GHz
																									eg double-ridged waveguide horn antennas
		●													●										Log-periodic antenna/directional ant. 1 to 18 GHz
																									eg double-ridged waveguide horn ant.
		●													●										Log-periodic antenna/directional ant. 1 to 18 GHz
																									eg double-ridged waveguide horn antennas
		●													●										Log-periodic antenna/directional ant.1 to 18 GHz
																									eg double-ridged waveguide horn ant.
		●													●										Double-ridged waveguide horn antenna

7) VG, DEF-STAN.

8) MIL-STD-461 C.

9) Requirements regarding spurious, adjacent-channel power emissions etc are covered by other ETS standards but may be tested using the above equipment.

EMI Test Receiver ESPC

(9) 150 kHz to 1 (2.5) GHz

EMC-compatible development and production

Photo 42092

Brief description

EMI Precertification Test Receiver ESPC has been derived from various Rohde & Schwarz full-compliance receiver models and thus opens up versatile applications in the field of EMI precompliance. It is a budget-priced solution for emission tests at all stages of development and production of electrical products. With a view to obtaining the "CE conformity mark", this test receiver will be used wherever EMI tests become necessary prior to acceptance testing in order to minimize the risks involved and the time taken for full-compliance tests.

Featuring built-in preselection, the ESPC is able to perform accurate interference measurements with pulse repetition frequencies (PRF) to as low as 10 Hz in line with CISPR 16-1.

The ESPC offers a compact and economical solution for

- development-accompanying EMI diagnostic measurements,
- pre- and post-qualification tests,
- production tests

Due to the increasing number and higher frequencies of mobile radio services, useful and interfering emissions up to 2.5 GHz have often to be investigated. The ESPC provides an optional frequency range extension up to 2.5 GHz which can also be retrofitted.

Main features

- Correct interference weighting to CISPR 16-1 down to 10-Hz pulse repetition frequency
- Integrated preselection
- For all commercial EMI standards such as CISPR, EN, ETS, FCC and ANSI C63.4, VCCI as well as VDE
- Parallel detectors for average, peak and quasi-peak reading
- Automatic overload detection
- Automatic level calibration
- Measurement of voltage, field strength, current and pulse spectral density with display of relevant units
- Automatic consideration of frequency-dependent transducer factors
- Easy to use thanks to built-in macro functions
- Power sourcing from internal or external battery
- EMI software under Windows™ supplied as standard

Operation

Users not specialized in EMI can also easily handle and carry out complete test runs. At the press of a button the ESPC starts as a stand-alone unit measurement of

- RFI voltage,
- RFI power,
- RFI field strength.

A comprehensive test report can be output on a printer or plotter. The report contains comments and description, test receiver settings, graphs and final results.

Enhanced EMI measurement convenience through an external controller
The Windows™ Software ESPC-K1 supplied with the ESPC supports EMI measurements in line with commercial standards. The results are displayed as graphs and lists on the screen of a PC.

Specifications in brief

Frequency range		
Lower limit	150 kHz (optionally 9 kHz, ESPC-B2)	
Upper limit	1 GHz (optionally 2.5 GHz, ESPC-B3)	
Frequency setting	in 10 Hz, 100 Hz and 100 kHz steps or user-selectable	
Automatic scan	for RF analysis	
Display	8-digit LCD with backlighting, can be switched off	
Resolution	up to 1000 MHz: 10 Hz, from 1000 MHz: 100 Hz	
Frequency drift	$<3 \times 10^{-6}$, after 30 min warm-up	
RF input	Z_{in} = 50 Ω, N female	
VSWR, f_{in} <1 GHz	1.5 with ≥10 dB RF attenuation <2 with 0 dB RF attenuation	
RF attenuator	0 to 70 dB, 10-dB steps	
Preselection		
9 kHz to 1000 MHz	2 fixed-tuned, 6 tracking filters	
1000 to 2500 MHz	2 tracking filters	
Maximum input level (RF attenuation ≥10 dB)		
Sinewave AC voltage	130 dBµV (corresp. to 1 W)	
Max. pulse voltage	150 V	
Max. pulse energy (10 ms)	10 mWs	
Interference rejection, f <1000 MHz		
IF rejection, 1st and 2nd IF	70 dB	
IF rejection	70 dB	
IF bandwidths		
Nominal bandwidth	–3 dB	–6 dB
200 Hz[1] (with option ESPC-B2)	180 Hz	200 Hz
10 kHz[1]	7 kHz	9.5 kHz
120 kHz[1]	90 kHz	120 kHz
Displayed noise floor, average		
9 kHz to 3 MHz, BW = 200 Hz	typ. +10 dBµV to –28 dBµV	
f >3 MHz, BW=200 Hz/10/120 kHz	typ. –28/–12/–2 dBµV	
Voltage measurement range		
Lower limit (additional error caused by inherent noise <1 dB)		
Average indication (AV), f >3 MHz		
BW = 200 Hz/10/120 kHz	typ. –24/–8/+2 dBµV	
Upper limits AV, PK, QP	130 dBµV (RF attenuation ≥10 dB)	
Level display		
Digital	in dBµV, dBµA, dBm, dB(µV/m), dB(µA/m), dBpW, 3-digit LCD, resolution 0.1 dB	
Analog	on moving-coil meter in operating range of IF detector with digital display of lower range limit	
Operating ranges	30 dB, 60 dB	
Overload indication	by level detectors in RF and IF signal path	
Detectors	average (AV), peak (PK), quasi-peak (QP); 2 detectors can be switched on simultaneously	
Measurement times	1 ms to 100 s (1/2/5 steps)	
Accuracy		
Average indication		
9 kHz to 1000 MHz	≤1.5 dB, typ. 1 dB	
1000 to 2500 MHz (optional)	typ. 1 dB	
Quasi-peak indication	to CISPR 16, ≥10 Hz pulse repetition frequency	
Demodulation modes	AM, FM, A0 (zero beat), internal loudspeaker, headphones connector	
Volume	adjustable with rotary knob	
Date, time of day	internal clock	

1) Tolerances to CISPR 16-1.

Internal memory	
Transducer	22 transducer factors with up to 50 reference values, nonvolatile, can be combined
Limit lines	22 limit lines with up to 50 reference values, nonvolatile
Instrument settings	9 complete setups, nonvolatile

Automatic modes

Frequency scan – definable start and stop frequency and step size, max. 5 ranges with individual settings
Frequency lists – automatic measurement at max. 400 frequencies
RFI voltage measurements
– automatic control of line-impedance stabilization networks, determination of maximum values in up to 400 subranges, checking for out-of-tolerance values
RFI power measurement
– interactive mode with MDS absorbing clamps, determination of maximum values in up to 400 subranges, checking for out-of-tolerance values
RFI field-strength measurement
– interactive mode with automatic antenna switchover, determination of maximum values in up to 400 subranges, checking for out-of-tolerance values

Connectors and interfaces

Remote control	IEC 625-2 (IEEE 488.2)
Plotter	via IEEE/IEC bus interface
Printer	Centronics
Front-panel outputs	
Supply and coding connector for antennas etc	12-contact Tuchel connector
AF output	jack JK34, adjustable level
Rear-panel outputs	
IF 10.7 MHz	Z_{out}=50 Ω, BNC connector
User port	25-contact Cannon connector for control of LISNs (phase switching) and antennas
Keyboard connector	5-contact connector for MF2 keyboard
Rear-panel inputs	
Reference input	BNC connector, 10 MHz, >1 V
External battery	3-contact connector
Required voltage	11 to 33 V (switch-on voltage >12 V)

General data

Power supply	
AC supply	100/120/240 V ±10%, 230 V +6/–10%, 47 Hz to 420 Hz (80 VA)
Battery (external)	11 V to 33 V
Dimensions (W x H x D); weight	435 mm x 236 mm x 350 mm; 17 kg

Ordering information

EMI Test Receiver	ESPC	1082.8007.10
Accessories supplied	Windows™ Software ESPC-K1, power cable, connector for external battery, operating manual	
PC configuration required for ESPC-K1	Windows 3.1/95/98/NT4.0; IBM AT compatible PC min. 486 or higher, min. 8 MB RAM; IEEE bus interface with Windows driver from National Instruments	
Options		
Internal Battery with Automatic Charging	ESPC-B1	1082.9503.02
Frequency Extension 9 kHz to 150 kHz and IF bandwidth 200 Hz	ESPC-B2	1082.9555.02
Frequency Extension 1000 to 2500 MHz	ESPC-B3	1082.9603.02

EMI Test Receiver ESCS30

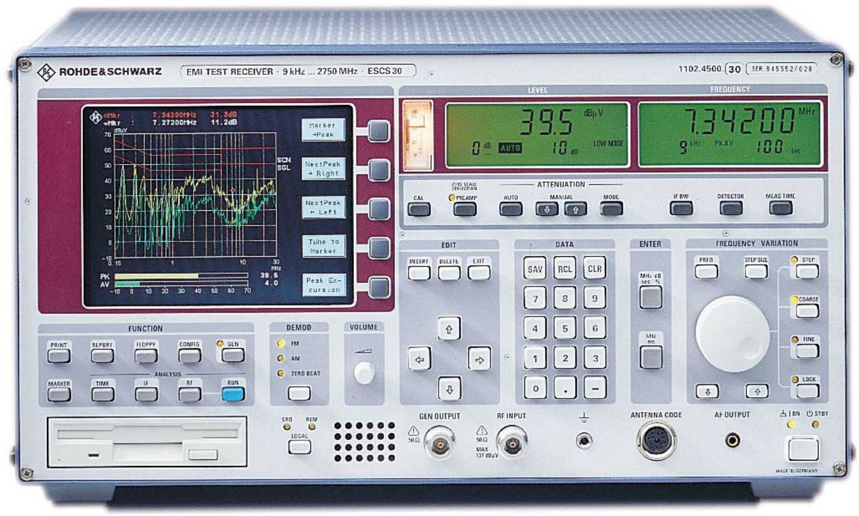


Photo 42987-1

9 kHz to 2.75 GHz

Compact EMI test receiver conforming to all standards

Brief description

EMI Test Receiver ESCS30 is used for measuring electromagnetic emissions in line with all commercial standards and combines three types of instruments in one:

- a portable, manually tunable test receiver with built-in battery,
- an automatic test receiver which as a stand-alone unit performs measurements and reports the results,
- a system-compatible test receiver with IEEE/IEC bus interface and EMI software packages running under Windows™

The number of measurements required to ensure electromagnetic compatibility is continuously increasing and is governed by laws in many countries. Thanks to the built-in intelligence of EMI Test Receiver ESCS30, the time required for measurements is reduced considerably. This specialist for EMI measurements supplies the results fast and highly accurately in line with the standards from CISPR, CENELEC, ETSI, FCC, VCCI and VDE.

Complete tests at a keystroke

Using the SPECTRUM OVERVIEW function and the peak detector, the critical ranges of the spectrum can be determined. With the aid of data reduction routines the final measurement is then made accurately at the critical frequencies using quasi-peak and average detectors.

This concept saves valuable measurement time which would otherwise be wasted for ranges with low emission levels.

At a single keystroke the ESCS30 measures as a stand-alone unit

- RFI voltage,
- RFI power,
- RFI field strength

Main features

- Correct weighting to CISPR 16-1 and VDE 0876
- Integrated preselector
- Level measurement range –38 to +137 dBµV
- For all commercial EMI standards such as CISPR, EN, ETS, FCC, ANSI C63.4, VCC, VCCI and VDE
- Automatic overload detection
- User port for control of LISNs
- Ease of use through internal macro functions
- Battery operation

High-grade RF circuit design

- High measurement accuracy
- Fast synthesizer with high frequency resolution
- Wide dynamic range
- CISPR filters with constant group delay
- Parallel detectors for peak, quasi-peak and average indication; all detectors can be switched on simultaneously
- Tracking generator for attenuation and gain measurements; eg for checking test cables (9 kHz to 2750 MHz; option ESCS-B5)

Powerful firmware functions

- Macros for automatic and interactive test routines
- Frequency scan over up to 400 user-selectable channels
- Automatic level calibration
- Automatic consideration of frequency-dependent transducer factors
- Nonvolatile storage of all important parameters
- Frequency scan modes
  - Spectrum overview: with fixed attenuation and step size with maximum speed
  - Scan: with automatic attenuation setting and selectable step size
  - Channel: on up to 400 preset frequencies

Optimum result display for every application

- 16.5 cm (6.5") TFT colour LCD for display of interference spectra including limit lines
- Clear digital level indication with 0.1 dB resolution on separate level display
- Quasi-analog display of results in form of bargraphs
- Time domain analysis (oscilloscope mode)
  – Measurement of pulse width and amplitude with a display range from 5 ms to 1 h, zooming up to maximum resolution
  – With a resolution of 100 µs, the time domain analysis satisfies the requirements of CISPR16-1 regarding the accuracy of pulse duration measurements
  – Triggering: internally by level setting using the display line or externally with TTL levels
- IF spectrum analysis with 10 MHz display range for visual check of the spectrum (option ESCS-B4)

Full storage and logging of results

- Built-in 3½" disk drive
- Storage of test results and test reports as HP-GL file
- Output of results as lists and diagrams including limit lines and user-definable labelling

Specifications in brief

Frequency range	9 kHz to 2750 MHz
Frequency setting	in 10 Hz, 100 Hz, 100 kHz steps; or user-selectable
Resolution	up to 1000 MHz: 10 Hz from 1000 MHz: 100 Hz
Frequency drift	$<1 \times 10^{-6}$ (after 30 min warm-up) $<5 \times 10^{-7}$ (with option ESCS-B6)
RF input	50 Ω, N female
VSWR, f <1000 MHz	<1.2 with >10 dB RF attenuation
f >1000 MHz	typ. 1.5 with >10 dB RF attenuation
RF attenuator	0 to 60 dB, 5 dB steps
Preamplifier	gain 10 dB nominal
Maximum input level (RF attenuation >10 dB)	
DC voltage	7 V
Sinewave AC voltage	137 dBµV (1 W)
Max. pulse voltage (10 µs)	150 V
Max. pulse energy (20 µs)	10 mWs
Preselector 9 kHz to 1000 MHz	2 fixed-tuned filters, 6 tracking filters
1000 to 2750 MHz	2 tracking filters
IF bandwidths	200 Hz/9 kHz/120 kHz/1 MHz

Displayed noise level (average)

Range	Bandwidth	Preamplifier off	on
9 kHz to 30 MHz	200 Hz	<–25 dBµV, typ. –28 dBµV	<–34 dBµV, –38 dBµV
50 MHz to 30 MHz	9 kHz	<–12 dBµV	<–18 dBµV
30 MHz to 1000 MHz	120 kHz	<+1 dBµV, typ. –1 dBµV	<–4 dBµV, –7 dBµV
1000 MHz to 2750 MHz	120 kHz	<+5 dBµV	<0 dBµV

Dynamic range	
Noise figure	typ. 5 dB (<30 MHz, preamplifier on) typ. 9 dB (>30 MHz, preamplifier on)
Intercept point d3	typ. 10 dB (preamplifier off)
Level display	
Digital	in dBµV, dBµA, dBm, dBµV/m, dBµA/m, dBpW, dBpT
Display	3½-digit LCD, resolution 0.1 dB
Analog	on analog meter in operating range of IF detector with digital display of lower range limit
Bargraph display	horizontal bar; resolution 0.1 dB
Operating range	60 dB
Overdrive indication	for RF and IF signal path
Detectors	AV/PK/QP, (switched on simultaneously)
Measuring times	1 ms to 100 s (1/2/5 steps)
in overview mode	50 µs to 1 s (1/2/5 steps)
Measurement accuracy	
Average indication for S/N >16 dB	
9 kHz to 1000 MHz	<1.0 dB (typ. 0.5 dB)
1000 MHz to 2750 MHz	<1.5 dB
Quasi-peak indication	to CISPR 16-1
RF spectrum analysis	
X axis (frequency)	user-selectable, linear or logarithmic
Y axis (level)	10 dB to 200 dB, 10-dB steps
Marker, traces	2 traces, 2 markers with digital display of frequency/time/level
Display modes	Clr/Write, Max Hold, View
Time domain analysis	
Display range (sweep time)	5 ms to 10,000 s
Minimum resolution (X axis)	100 µs
Level display range (Y axis)	10 dB to 200 dB, autoscale function
IF spectrum analysis (option ESCS-B4)	
Display range	10 kHz to 10 MHz, 1/2/5 steps
IF input attenuation	0/20 dB (selectable)
Resolution	1/3/10 kHz
Sweep time	50 ms to 10 s, 1/2/5 steps
Level display range	80 dB
Demodulation modes	AM, FM, A0 (zero beat)
Loudspeaker	built-in; headphones connection
Date, time of day	built-in clock module
General data	
Rated temperature range	0 to +50°C
Storage temperature range	–20°C to +60°C
Power supply	
AC supply	100/120/230/240 V ±10%, 47 Hz to 420 Hz (60 VA), safety class I to VDE 0411 (IEC348)
Battery (external)	11 V to 33 V: 2.5 A/24 V, 4.7 A/12 V
Dimensions (W x H x D)	435 mm x 236 mm x 350 mm
Weight	18.4 kg
with ESCS-B1 and 3 x ESCS-B2	22.9 kg

Ordering information

EMI Test Receiver	ESCS30	1102.4500.30
Options		
IF Spectrum Analysis	ESCS-B4	1102.6890.02
Tracking Generator 9 kHz to 2750 MHz	ESCS-B5	1102.7097.02
OCXO Reference Oscillator	ESCS-B6	1102.9397.02
RMS Detector	ESCS-B9	1102.7897.02

EMI Test Receivers ESHS 10 and ESVS 10

ESHS 10: 9 kHz to 30 MHz

ESVS 10: 20 MHz to 1000 MHz

Test receivers for commercial EMI measurements

ESHS 10 (photo 42407)

Brief description

The receivers ESHS 10 and ESVS 10 are suitable for measuring electromagnetic interference in line with commercial standards:

- CISPR 16, VDE 0876 and ANSI C63.2
- EN 55011 to 55022, ETS, FCC, VCCI and VDE 0871 to 0879 and ANSI C63.4

Applications

The instruments are ideal for routine tasks in industry such as development and approval tests in line with commercial standards. Featuring mains-independent battery powering, they are also suitable for mobile applications at EMC service providers, test houses and safety standard authorities.

Main features

Superior circuit design

- High measurement accuracy, typical error 0.5 dB
- Wide dynamic range, typical noise figure 7 dB with preamplifier, third-order intercept point 20 dBm (without preamplifier)
- Calibrated attenuator with high pulse loading capacity, switchable in 10-dB steps from 0 to 120 dB
- Comprehensive preselection filters
- Switchable preamplifier with wide dynamic range
- Crystal-stabilized, fast synthesizer with high resolution and sweep mode for fast frequency scanning
- High-level mixer with high oscillator rejection
- Delay-equalized IF filters

Demodulation

- Parallel detectors for average, peak and quasi-peak indication
- 60 dB operating range also for quasi-peak and average value indication
- Highly linear envelope detector with more than 70 dB dynamic range
- AM and A0 demodulators (ESVS also FM)
- Logarithmic amplifier with more than 70 dB dynamic range
- Peak indication with automatic consideration of IF bandwidth correction values for broadband interference measurements
- Automatic overload detection in mixer stages and in test channel by permanently activated peak detectors

Powerful processor system

- Manual operation or internal or external processor control
- Flash EPROMs for convenient and fast firmware update through PC
- Macros for automatic and semi-automatic test runs
- Automatic level calibration
- Automatic consideration of frequency-dependent transducer factors
- All built-in functions fully programmable via IEC/IEE bus
- Fast measurement in external trigger mode; output of up to 5000 values/s via IEEE/IEC bus, up to 400 values/s including frequency change within certain frequency bands
- 12-bit A/D converter with short conversion time, measurement time selectable between 1 ms and 100 s
- High measurement accuracy thanks to automatic total calibration
- Automatic monitoring of all synthesizer loops and supply voltages during operation

EMI Test Receivers ESHS 10 and ESVS 10

Optimum result display and printout

- Measurement of voltage, field strength, current and pulse spectral density with display of relevant units
- Indication of result on analog meter or digital display with 0.1 dB resolution
- Output of results as lists and diagrams on printer including limit lines

Further features

- Digital level indication on LCD and analog level indication on moving-coil meter taking into account transducer factors and their units
- Numerous interfaces for driving or feeding additional devices
- AC supply as well as battery powering for mobile applications

Operation

RFI field-strength and RFI power measurements

For solving complex EMC problems, manual measurement often is the most efficient way, since the operator can make full use of his experience in identifying interference sources. The receivers feature conventional test receiver operation with tuning knob, indication of results on a meter and built-in loudspeaker.

Nonvolatile storage of 22 limit lines and transducer factors with up to 50 values is possible. By combining the transducer factors, all test configurations occurring in practice can be covered.

Macros for semi-automatic test runs (ANALYSIS OPTIONS) match the test receivers to the specific configuration, device under test and test specification. Being thus prepared, the test receivers perform the following routines:

- Fast prescan measurement using peak or average detector
- Determination of critical frequencies by means of limit lines with data reduction to shorten the measurement time
- Final measurement at critical frequencies using average and/or peak detector
- Output of results on printer

The test receivers offer a choice between automatic, semi-automatic and user-controlled test runs. Scan options are available for prescan measurements, data reduction and final measurements.

Data reduction is the main criterion for optimizing the test run. It is the link between prescan interference measurement and correct weighting with test parameter variation (final measurement) to reduce measurement time. There are also scan options taking account of the test configuration, for instance measuring RFI voltage with LISNs, RFI power with an absorbing clamp and RFI field strength with antennas.

Design

The modular design of the test receivers provides excellent RF shielding and great convenience for servicing. An extremely low-noise, temperature-controlled fan ensures low self-heating. The comprehensive selftest functions allow easy identification of a faulty module which can be replaced with a minimum of effort and without affecting the other modules.

Specifications in brief: ESHS

Frequency range	9 kHz to 30 MHz
Frequency setting	in 10 Hz, 10 kHz steps or user-selectable step size
Automatic scan	for RF analysis
Display	7-digit LCD
Resolution	10 Hz
Frequency drift	$<3 \times 10^{-6}$ +30 Hz
RF input	N connector, 50 Ω
VSWR	<1.2 with 10 dB RF attenuation, <2 with 0 dB RF attenuation
Preamplifier	10 dB, can be connected between preselector and 1st mixer
Preselector	5 fixed-tuned filters
Maximum input level (with and without preamplifier, RF attenuation ≥10 dB)	
DC voltage	7 V (corresp. to 1 W)
Sinewave AC voltage	137 dBµV
Max. pulse voltage (10 µs)	700 V
Max. pulse energy (10 µs)	100 mWs

Interference rejection, nonlinearities		
Image-frequency rejection		
1st IF	>90, typ. 100 dB	
2nd IF	>75 dB	
IF rejection	>90, typ. 100 dB	
Intercept point d3 with $\lvert f_1 - f_2 \rvert$>100 kHz and 0 dB RF attenuation	preamplifier off	preamplifier on
Level (f_1, f_2) at receiver	2x –10 dBm	2x –20 dBm
f_{in} <2 MHz	typ. 15 dBm	typ. 0 dBm
f_{in} ≥2 MHz	>15 dBm, typ. +20 dBm	>0 dBm, typ. +5 dBm
Intercept point k2	>40 dBm	>20 dBm

EMI Test Receivers ESHS 10 and ESVS 10

RF shielding		
Voltage indication at field strength of 10 V/m with 0 dB		
RF attenuation ($f \neq f_{in}$)	<–10 dBµV	
Additional error in CISPR indication range at 10 V/m	<1 dB	
IF bandwidth	200 Hz/10 kHz	
Displayed noise floor	preamplifier off	preamplifier on
Average value, BW = 200 Hz		
f_{in} = 9 to 50 kHz	<–24 to <–30 dBµV	<–30 to <–36 dBµV
f_{in} >50 kHz	typ. –35 dBµV	typ. –41 dBµV
Average value, BW = 10 kHz		
f_{in} >50 kHz	typ. –17 dBµV	typ. –25 dBµV
Peak value (typ.increase relative to average value)	+11 dB	+11 dB
Quasi-peak		
Band A 9 kHz to 50 kHz	typ. –24 to –30 dBµV	typ. –30 to –36 dBµV
50 kHz to 150 kHz	typ. –32 dBµV	typ. –38 dBµV
Band B (≥150 kHz)	typ. –13 dBµV	typ. –19 dBµV
PK/MHz (BW_{IF} = 10 kHz)	typ. 34 dB (µV/MHz)	typ. 28 dB (µV/MHz)
Voltage measurement range (f_{in} >50 kHz)		
Lower limit: (additional error caused by inherent noise <1 dB)	preamplifier off	preamplifier on
Average indication (AV)		
BW_{IF} = 200 Hz	typ. –31 dBµV	typ. –37 dBµV
BW_{IF} = 100 kHz	typ. –13 dBµV	typ. –20 dBµV
Peak indication (PK)	+11 dB	+11 dB
BW_{IF} = 200 Hz	typ. –8 dBµV	typ. –14 dBµV
BW_{IF} = 100 kHz	typ. –10 dBµV	typ. +4 dBµV
Quasi-peak indication (QP) to CISPR		
Band A (25 Hz pulse frequency)	typ. –30 dBµV	typ. –36 dBµV
Band B (100 Hz pulse frequency)	typ. –11 dBµV	typ. –17 dBµV
Upper limit:		
AV, PK, QP	137 dBµV (RF attenuation≥10 dB)	
Inherent spurious responses	<–10 dBV (equiv. input voltage)	
Level display		
Digital	3½ digits, resolution 0.1 dB in dBµV, dBµA, dBm, dB(µV/m) or dB(µA/m)	
Analog	on moving-coil meter in operating range of IF detector with additional digital display of lower range limit	
Operating ranges	30 dB, 60 dB	
Display modes (detectors)	average (AV), peak (PK), spectral density measurement (PK/MHz), quasi-peak (QP)	
Averaging, hold and meas. times	1 ms to 100 s (1/2/5 steps)	
Measurement accuracy (AV for S/N >16 dB)		
Digital display	<1 dB	
IF	A0 (zero beat) A3 (for A3E emissions)	
Date, time of day	internal clock	
Remote control	to IEC 625-2 (IEEE 488-2)	
Plotter language	HP-GL	

Front-panel outputs	
Supply and coding connector for antennas, etc	12-contact Tuchel connector
AF output	jack JK34, 10 Ω
Rear-panel outputs	
IF 74.7 MHz (ESHS 10 only)	BNC connector, 50 Ω
Bandwidth (–3 dB)	2 MHz or bandwidth of preselector
IF 80 kHz	BNC connector, 50 Ω
Video output (envelope demod.)	BNC connector

Interfaces
25-contact Cannon connector, includes 6 control lines for an external device (eg LISN), display voltage with and without meter simulation, input for external triggering, RS-232-C interface for firmware update

Printer connection	parallel interface
Keyboard connection	5-contact connector for MF2 keyboard
Rear-panel inputs	
Ext. reference frequency	BNC connector
Frequency	5/10 MHz
Ext. battery	3-contact connector
Required voltage	11 V to 33 V
General data	
AC supply	100/120/220/240 V ±10%, 47 Hz to 440 Hz
Power consumption	50 VA
Internal battery	12 V, 10 Ah
Operating hours	approx. 4 h
External battery	11 V to 33 V
Current drain 24 V/12 V	1.2 A/2.3 A
Dimensions (W x H x D)	435 mm x 236 mm x 363 mm
Weight	18 kg (21 kg with battery

Specifications in brief: ESVS

Data specified below differ from that of ESHS.

Frequency range	20 MHz to 1000 MHz
Frequency setting	
with tuning knob	in 100 Hz, 100 kHz steps or user-selectable step size
numerical	by keyboard entry
in steps	any size selectable
automatic scan	for RF analysis
Display	8-digit LCD
Resolution	100 Hz
Frequency drift	$<3 \times 10^{-6}$
RF input	N connector, 50 Ω
VSWR	<1.2 with ≥10 dB RF attenuation, <2 with 0 dB RF attenuation
Preamplifier	can be switched between preselector and 1st mixer
Gain	10 dB
Preselector	1 fixed-tuned and 5 tracking filters
Maximum input level (with and without preamplifier)	
RF attenuation ≥10 dB	
DC voltage	50 V
Sinewave AC voltage	137 dBµV (corresp. to 1 W)
Max. pulse voltage	150 V
Max. pulse energy (20 µs)	10 mWs

EMI Test Receivers ESHS 10 and ESVS 10

RF attenuation ≥10 dB (option ESVS-B1)		
DC voltage	7 V	
Sinewave AC voltage	137 dBµV (corresp. to 1 W)	
Max. pulse voltage	1500 V	
Max. pulse energy (10 µs)	100 mWs	
Interference rejection, nonlinearities		
Image frequency rejection	typ. 100 dB	
IF rejection	>90, typ. 100 dB	
Intercept point d3	preamplifier off P_{in}=2x (–10 dBm)	preamplifier on P_{in}=2x (–20 dBm)
$\|f_1–f_2\|$≥5 MHz	typ. +20 dBm	typ. +10 dBm
Intercept point k2	>35 dBm	>25 dBm
RF shielding		
Intermediate frequencies		
1st/2nd/3rd IF	1354.7/74.7/10.7 MHz	
IF bandwidths	10/120 kHz	
Displayed noise floor	preamplifier off	preamplifier on
Average value, BW=10 kHz	typ. –15 dBµV	typ. –21 dBµV
BW=120 kHz	typ. –4 dBµV	typ. –10 dBµV
Peak value, BW=10 kHz	typ. –4 dBµV	typ. –9 dBµV
BW=120 kHz	typ. +7 dBµV	typ. +1 dBµV
Quasi-peak band C/D	typ. +2 dBµV	typ. –4 dBµV
PK/MHz (spectral density measurement, BW_{IF}=120 kHz)	typ. 25 dB (µV/MHz)	typ. 21 dB (µV/MHz)

Voltage measurement range	
Lower limit (additional error caused by inherent noise <1 dB):	
Average indication (AV)	values 4 dB higher than displayed noise (AV)
Peak indication (PK)	values 27 dB higher than displayed noise (PK)
Quasi-peak indication(QP)	
CISPR band C/D	
(100 Hz pulse frequency)	
Preamplifier off	<10, typ. 6 dBµV
on	<4, typ. 0 dBµV
Upper limit:	
AV, PK, QP	137 dBµV (RF attenuation ≥10 dB)
Inherent spurious responses	<0 dBµV (equivalent input voltage)
Level display	
Digital	3½ digits, resolution 0.1 dB in dBµV, dBµA, dBm, dB(µV/m), dB(µA/m) or dBpW
Analog	on moving-coil meter in operating range of IF detector with additional display of lower range limit
Display modes (detectors)	average (AV), peak (PK), spectral density measurement (PK/MHz), quasi-peak (QP)
Measurement accuracy (AV for S/N >16 dB)	
Digital display (0 to 55 °C)	≤1 dB
Demodulation modes	A0, A3, F3
Date, time of day	internal clock
Remote control	to IEC 625-2 (IEEE 488-2)
Front-panel outputs	
Supply and coding connector for antennas, etc	12-contact Tuchel connector
AF output	jack JK34, 10 Ω
Rear-panel outputs	
IF 74.7 MHz (ESVS 10 only)	BNC connector, 50 Ω
IF 10.7 MHz	BNC connector, 50 Ω
IF 80 kHz	BNC connector
Video output	BNC connector

Interfaces

25-contact Cannon connector, includes 6 control lines for an external device (eg LISN), display voltage with and without meter simulation, input for external triggering, RS-232-C interface for firmware update

Printer connection	parallel interface
Keyboard connection	5-contact connector for MF2 keyboard
Rear-panel inputs	
Ext. reference frequency	BNC connector
Frequency	5/10 MHz
Ext. battery	3-contact connector
Required voltage	11 V to 33 V
General data	
AC supply	100/120/220/240 V ±10%, 47 Hz to 440 Hz
Power consumption	60 VA
Internal battery	12 V, 10 Ah
Operating hours	approx. 2.5 h
External battery	11 V to 33 V
Current drain 24 V/12V	1.9 A/3.3 A
Dimensions (W x H x D)	435 mm x 236 mm x 363 mm

Ordering information

EMI Test Receiver	ESHS 10	1004.0401.10
	ESVS 10	1011.2006.10

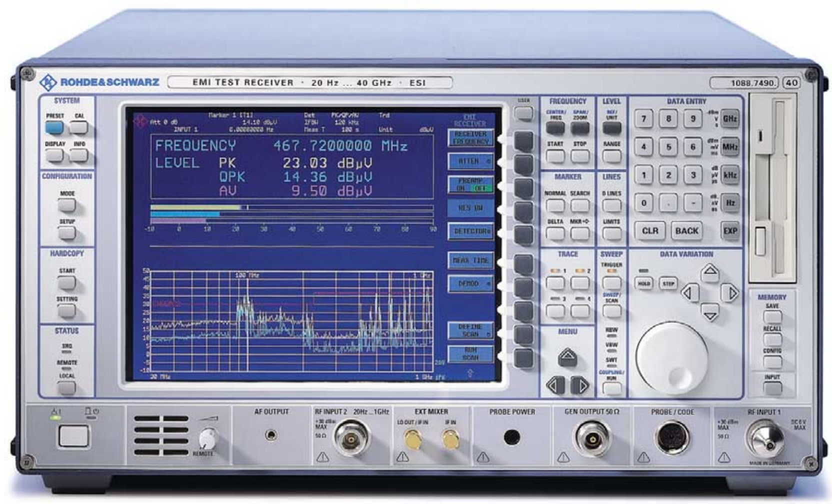
EMI Test Receiver ESI

ESI 7: 20 Hz to 7 GHz

ESI 26: 20 Hz to 26.5 GHz

ESI 40: 20 Hz to 40 GHz

EMI measurements up to 40 GHz conforming to standards



ESI 40 (photo 43176)

Brief description

EMI test receivers of the ESI family combine the versatility and speed of spectrum analyzers with the large dynamic range required for EMI measurements in conformance with standards. The ESI family comprises three models with different upper frequency limits. The upper frequency limit of ESI26 and ESI40 can be extended by means of external mixers (option FSE-B21).

Main features

State-of-the-art technology
- Low inherent noise
- Wide dynamic range
- Preselection + preamplifier
- Automatic overload control
- Pulse-protected 2nd RF input
- Fast overview measurements

Current standards
- Correct weighting of pulses to CISPR 16-1 and VDE 0876
- All commercial and military standards such as CISPR, EN, ETS, FCC, VDE, ANSI, VCCI, MIL-STD, VG, DEF-STAN, and many others

Straightforward operation
- Active colour LCD
- Analog level display for each detector (parallel operation)
- Split-screen display for detailed analysis (i. e. combination of Analyzer and receiver settings)
- Receiver-oriented operating concept allowing manual operation
- EMI software package ESI-K1 supplied

System integration
- Fast data processing for use in automatic test systems. The IEEE/IEC bus command set (IEC 625-2) is SCPI-conformal (1994.0)
- Integrated computer function under Windows NT provided as standard
- Use as test system controller by adding a second IEEE/IEC bus card (option FSE-B17)
- Space- and cost-saving implementation of complete test systems without need for an additional controller

Documentation of results
- All printers for which Windows NT drivers are available can be used
- Storage of results also on floppy disk or built-in hard disk in standard formats such as EMF, WMF or BMP

Fit for the future

The ESI family can be upgraded by a wide variety of options to extend its range of applications and add extra functionality without requiring additional instruments.

Selftest

The built-in selftest supports fault localization down to module level. With individual correction tables being stored on each module, defective modules can be replaced largely without any adjustment or additional instruments. Downtimes and repair costs are reduced to a minimum.

Practice-oriented test routines

During the various development phases of a product, different measurements are performed as required for each stage. The ESI family offers appropriate features and routines for the different development stages. Early in development, functional measurements play the predominant role. While EMI measurements are important right from the beginning to avoid redesigns, ESI at this stage primarily functions as a high-grade spectrum analyzer (see FSE, page 1).

EMI Test Receiver ESI

As development progresses, EMI measurements become more and more important, for example on modules and their interfaces. Here, too, the ESI family meets all relevant requirements in terms of performance, functionality and economy of operation:

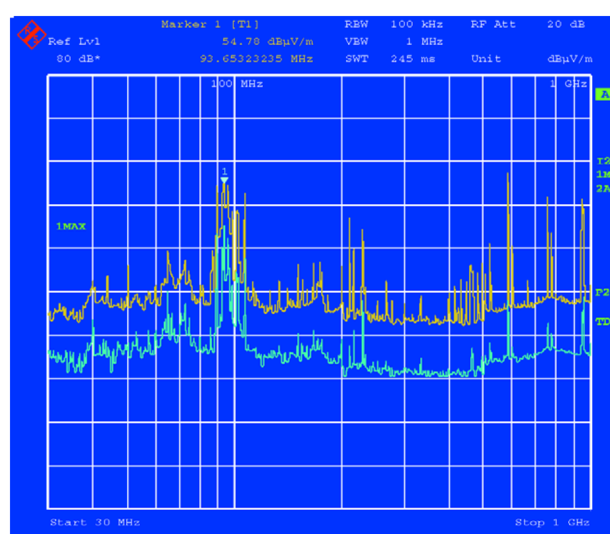
- Fast overview measurements with linear or logarithmic frequency scale in spectrum analyzer mode (sweep mode) or in test receiver mode (scan mode) with tuning in user-defined frequency steps with selectable measuring times per step
- Bandwidths conforming to CISPR16-1 (200 Hz, 9 kHz and 120 kHz), to MIL-STD (10 Hz to 1 MHz and 10 MHz), and analyzer bandwidths between 1 Hz and 10 MHz, selectable in steps of 1, 2, 3 and 5
- Pulse weighting using quasi-peak, peak and average detectors. The detectors operate in parallel and can be switched in as required
- User-selectable transducer factors for the output of results in the correct unit. Transducer factors for practically any number of transducers can be stored on the internal hard disk. Active transducers are powered and coded via a socket on the ESI front panel
- User-definable limit lines with linear or logarithmic frequency scale; limit lines are stored on the internal hard disk
- Preselection, preamplifier and 6-dB EMI bandwidths selectable in analyzer mode, too
- Time-domain measurements at up to 50 ns resolution for interference source analysis
- Automatic scan: From 1 measuring curve with max. 250 000 measuring values up to 4 storable traces with max. 80 000 measured values each
- Second, pulse-protected input for the frequency range 20 Hz to 1 GHz. In the case of ESI 7, for example, this input can handle pulses with voltages up to 1500 V and powers up to 30 mWs without any damage being caused
- Preselection with 3 fixed-tuned and 6 or 7 (models 26 and 40) tracking filters: in receiver mode fixed, in analyzer mode switch-selectable
- 20-dB preamplifier switch-selectable at switched-on preselection (standard 1 kHz to 7 GHz, expandable to 26 GHz or 40 GHz with option ESI-B2)
- Level measurement accuracy <±1 dB in frequency range up to 1 GHz

Definition of standard test sequences

To meet the requirements of relevant standards, measurements over various frequency ranges and bandwidths have to be performed, using different step sizes and measurement times or different receiver settings regarding RF attenuation and preamplification. It must also be possible to configure a scan matched to DUT characteristics. For this purpose, ESI offers a user-configurable scan table with up to 10 subranges.

Calibration values for transducer factors of absorbing clamps or antennas, for example, are stored in tables and can be switched on as required. The transducer factors can also be combined into transducer sets, for example to display the interference spectrum in the correct unit dBµV/m in measurements with an antenna and a connecting cable.

- EMI emissions are usually measured in two steps. An overview measurement made with the peak detector identifies critical emissions above or close to limit values. In a second measurement with the prescribed detectors (quasi-peak and average to CISPR) and an appropriate measurement time, the critical frequencies are checked for compliance with limit values. The ESI family supports this procedure by two independent measurement windows on the screen, automatic or interactive investigation of frequencies that have the highest distortion levels as well as application of a partly range maximum method (acceptance analysis).



Overview measurement

EMI Test Receiver ESI

Specifications in brief

Frequency

	ESI 7	ESI 26	ESI 40
Frequency range			
Input 1	20 Hz to 7 GHz	20 Hz to 26.5 GHz	20 Hz to 40 GHz
Input 2		20 Hz to 1 GHz	
Internal reference frequency (nominal)			
Aging per day[1)]		1×10^{-9}	
Total drift (per year)		2.5×10^{-7}	
External reference frequency		10 MHz or n x 1 MHz, n=1 to 16	
Frequency display (receiver mode)		numeric display	
Frequency display (analyzer mode)		with marker	
Accuracy (Sweep time >3xauto sweep time)		± (marker frequency x reference error + 0.5% x span + 10% x resolution bandwidth + ½ (last digit))	
Frequency counter		measures the marker frequency	
Count accuracy (S/N > 25 dB)		±(frequency x ref. error + ½ (last digit))	
Display range for frequency axis	0 Hz, 10 Hz to 7 GHz	0 Hz, 10 Hz to 27 GHz	0 Hz, 10 Hz to 40 GHz
Accuracy		±1%	
Spectral purity			
SSB phase noise, f ≤500 MHz			
Carrier offset 100 Hz		<–81 dBc (1 Hz)	
1 kHz		<–100 dBc (1 Hz)	
10 kHz		<–114 dBc (1 Hz)	
100 kHz[2)]		<–111 dBc (1 Hz)	
1 MHz[2)]		<–129 dBc (1 Hz)	
Frequency scan (receiver mode)		scan with max. 10 subranges with different settings	
Measurement time per frequency		100 µs to 1000 s, selectable	
Sweep (analyzer mode)			
Span 0 Hz (zero span)		1 µs to 16000 s selectable in steps of 5%	
Span ≥10 Hz		5 ms to 1000 s selectable in steps of ≤10%	
Accuracy		±1%	
Picture refresh rate/s (span ≤7 GHz)		>20 updates/s with 1 trace, >15 traces/s with 2 traces at shortest sweep time	
Sampling rate		50 ns (20 MHz A/D converter)	
Number of pixels		500	
Time-domain measurement		with marker and cursor lines	

Preselector (receiver mode)

Filter	Frequency range	Bandwidth (–6 dB)	
1	<150 kHz	230 kHz	fixed
2	150 kHz to 2 MHz	2.6 MHz	fixed
3	2 MHz to 8 MHz	1.9 MHz	tracking
4	8 MHz to 25 MHz	5.6 MHz	tracking
5	25 MHz to 80 MHz	15 MHz	tracking
6	80 MHz to 200 MHz	40 MHz	tracking
7	200 MHz to 500 MHz	85 MHz	tracking
8	500 MHz to 1000 MHz	104 MHz	tracking
9	1 GHz to 7 GHz	highpass filter	fixed
		Bandwidth (–3 dB)	
10	7 GHz to 26.5 GHz (ESI 26)	35 MHz + f / 1000	YIG filter
	7 GHz to 40 GHz (ESI 40)	35 MHz + f / 1000	YIG filter

	ESI 7	ESI 26	ESI 40
Preamplifier (1 kHz to 7 GHz)		selectable, between preselector and 1st mixer, gain 20 dB	
IF bandwidths (receiver mode)			
6 dB bandwidths		10/100/200 Hz, 1/9/10/100/120 kHz, 1/10 MHz	
Bandwidth error			
RBW ≤1 MHz		<10%	
Shape factor BW_{60dB}:$BW_{6\ dB}$			
RBW ≤1 kHz		<5	
RBW >1 kHz		<10	
Resolution bandwidths (analyzer mode)			
3 dB bandwidth		1 Hz to 10 MHz, in steps of 1/2/3/5	
Bandwidth error			
RBW ≤3 MHz		<10%	
RBW = 5 MHz		<15%	
RBW = 10 MHz		+25%, –10%	
Shape factor BW_{60dB}:$BW_{3\ dB}$			
RBW <1 kHz		<6	
RBW = 1 kHz to 2 MHz		<12	
RBW >2 MHz		<7	
Video bandwidths		1 Hz to 10 MHz, in steps of 1/2/3/5	
FFT filter			
3 dB bandwidths		1 Hz to 1 kHz, in steps of 1/2/3/5	
Bandwidth error, nominal		2%	
Shape factor BW_{60dB}:$BW_{3\ dB}$, nom.		25	
Display range for frequency axis		min. 25 x RBW, max. 100000 x RBW or 2 MHz	
Additional level error (reference: RBW = 5 kHz)		<1 dB	
Max. display range		100 dB	
Inherent spurious response		<–100 dBm	

Level

	ESI 7	ESI 26	ESI 40
Display range		displayed noise floor to 137 dBµV	
Max. input level (input 1)			
RF attenuation ≥10 dB			
DC voltage		0 V	
CW RF power		137 dBµV (= 1W)	
Max. pulse volt age (10 µs)	150 V		50 V
Max. pulse energy (10 µs)	1 mWs		0.5 mWs
Input 2 (receiver mode)		20 Hz to 1 GHz	
DC voltage (DC/AC coupling)		0 V/50 V	
RF attenuation ≥10 dB			
CW RF power		137 dBµV (= 1 W)	
Max. pulse voltage (10 µs)	1500 V		250 V
Max. pulse energy (10 µs)	30 mWs		15 mWs
1 dB compression of input mixer (0 dB RF attenuation)			
Analyzer mode		+10 dBm nominal	
Intermodulation			
3rd-order intercept point (T.O.I.) in dBm			
Analyzer mode, Δf>5 x IF bandwidth or resolution bandwidth, or >10 kHz	≥12, typ. 15 for f >150 MHz		≥12,typ. 15 for f >150 MHz; ≥10 for f>7 GHz
Receiver mode, preamplifier off		≥2, typ. 5 for f >150 MHz	
Receiver mode, preamplifier on		≥ –18, typ. –15 for f >150 MHz	
Intercept point k2, analyzer mode		>25, typ. for f <150 MHz	
		>40, typ. for f >150 MHz	

EMI Test Receiver ESI

Level display (receiver mode)	**ESI 7**	**ESI 26**	**ESI 40**
Digital	numeric, 0.1 dB resolution		
Analog	bargraph display, separate for each detector		
Spectrum	level axis 10 dB to 200 dB in 10 dB steps, frequency axis user-selectable, linear or logarithmic		
Units of level display	dBµV, dBm, dBµA, dBpW, dBpT, dB(µV/m), dB(µA/m), dB (x)/MHz		
Detectors	average (AV), RMS, peak (PK) and quasi-peak (QP), 4 detectors simultaneously selectable		
Measurement time	100 µs to 1000 s, selectable		

Level display (analyzer mode)	
Result display	500 x 400 pixels (per diagram), max. 2 diagrams with independent settings
Logarithmic level display range	10 dB to 200 dB in 10 dB steps
Linear level display range	10% of reference level per division (10 divisions) or logarithmic scaling
Traces	max. 4 per diagram (max. 2 per diagram with display of 2 diagrams); quasi-analog display of all results
Trace detectors	max peak, min peak, auto peak (normal), sample, rms, average
Trace functions	clear/write, max hold, min hold, average

Setting range of reference level	
Logarithmic level display	–130 dBm to 30 dBm in 0.1 dB steps
Linear level display	7.0 nV to 7.07 V in 1% steps
Unit of level axis	dBm, dBµV, dBµA, dBpW (logarithmic level display); mV, µA, pW, nW (linear level display)

Displayed noise floor (receiver mode)

Linear AV display in dBµV (preamplifier off/on)	ESI 7	ESI 26	ESI 40
20 Hz to 1 kHz, RBW=10 Hz	20 to –10/–	20 to –10 / –	
1 kHz to 9 kHz, RBW=10 Hz	–10 to –16 / –25 to –30	–10 to –16 /–25 to –30	
9 kHz to 150 kHz, RBW=200 Hz	0 to –12 / –10 to –24	0 to –12 /–10 to –24	
150 kHz to 2 MHz, RBW=9 kHz	5 to –5 / –7 to –17	5 to –5 /–7 to –17	
2 MHz to 30 MHz, RBW=9 kHz	<–5 /<–17	<–5 /<–17	
30 to 200 MHz, RBW=120 kHz	<10 /<–6	<13 /<–3	
200 to 1000 MHz, RBW=120 kHz	<7 /<–6	<10 /<–3	
1 GHz to 5 GHz, RBW=1 MHz	<15 /<6	<18 /<9	
5 GHz to 7 GHz, RBW=1 MHz	<22 /<9	<25 /<12	
7 GHz to 18 GHz, RBW = 1 MHz	–	<19	<23
18 to 26.5 GHz, RBW = 1 MHz	–	<22	<26
26.5 to 30 GHz, RBW = 1 MHz	–	–	<37
30 to 40 GHz, RBW = 1 MHz	–	–	<41
RMS, typ. increase rel. to AV display	+1 dB		
PK, typ. increase rel. to AV display	+11 dB		
Quasi-peak (preamplifier off/on) Band A	3 to –9 / –7 to –21	3 to –9 /–7 to –21	
Band B	9 to 0 / –2 to –12	9 to 0 /–2 to –12	
Band C	17 /1	20 /4	
Band D	14 /1	17 /4	

Displayed noise floor (analyzer mode)

Displayed average noise level in dBm, typical values in parentheses, 0 dB RF attenuation, RBW = 10 Hz, VBW = 1 Hz, 20 averages, trace average, zero span, 50 Ω termination

		ESI 7	ESI 26	ESI 40
Frequency	20 Hz	<–74	<–74	
	1 kHz	<–104	<–104	
	10 kHz	<–119	<–119	
	100 kHz	<–129	<–129	
	1 MHz	<–142 (145)	<–142 (145)	
	10 MHz to 6 GHz	<–142 (147)	<–138 (140)	
	6 GHz to 7 GHz	<–139 (141)	<–135 (138)	
	7 GHz to 18 GHz	–	<–138 (140)	<–134 (139)
	18 GHz to 26.5 GHz	–	<–135 (138)	<–131 (136)
	26.5 GHz to 30 GHz	–	–	<–120 (125)
	30 GHz to 40 GHz	–	–	<–116 (122)

Max. dynamic range	ESI 7	ESI 26 / ESI 40
1 dB compression point/displayed noise floor (1 Hz bandwidth)	162 dB	160 dB

Max. harmonics suppression, f >50 MHz	>90 dB

Max. intermodulation-free range	ESI 7	ESI 26 / ESI 40
150 MHz to 7/26.5 GHz (nominal)	115 dB	112 dB
Intermodulation-free range at –40 dBm mixer input level	105 dB	

Immunity to interference		
Image frequency	>80 dB, typ. >90 dB	>80 dB
Intermediate frequency	>75 dB	>80 dB
Spurious response (f >1 MHz, without input signal, 0 dB RF attenuation)		
Receiver mode or span <30 MHz	<–3 dBµV	
Span ≥30 MHz	<7 dBµV	
f_{in}=25.175 MHz, 60 MHz, 5.7172 GHz	<7 dBµV	
Other spurious	<–75 dBc	

RF leakage	
Voltage display at field strength of 10 V/m and 0 dB RF attenuation ($f \neq f_{in}$, $f \neq f_{IF}$, $f_s \leq 1$ GHz)	<0 dBµV
Additional error in quasi-peak display range (10 V/m) ($f \neq f_{in}$, $f \neq f_{IF}$, $f_s \leq 1$ GHz)	<1 dB

Level measurement accuracy	
Level error at 120 MHz (level = –40 dBm, RF attenuation 20 dB, reference level –15 dBm, RBW 5 kHz)	±0.3 dB
Attenuator error	±0.3 dB
IF gain error	±0.2 dB, typ. ±0.1 dB
Linearity error	
Logarithmic level display (RBW ≥1 kHz, analog, S/N >15 dB)	
0 dB to –50 dB	±0.3 dB
–50 dB to –70 dB	±0.5 dB
–70 dB to –95 dB	±1 dB
Linear level display	5% of reference level

EMI Test Receiver ESI

<table>
<tr><th></th><th>ESI 7</th><th>ESI 26</th><th>ESI 40</th></tr>
<tr><td>Bandwidth switching error</td><td></td><td></td><td></td></tr>
<tr><td>1 Hz to 30 kHz/100 to 300 kHz</td><td colspan="3">±0.2 dB</td></tr>
<tr><td>1 MHz to 10 MHz</td><td colspan="3">±0.3 dB</td></tr>
<tr><td>Frequency response (analyzer mode, 10 dB RF attenuation)</td><td></td><td></td><td></td></tr>
<tr><td>≤1 GHz</td><td colspan="3">±0.5 dB</td></tr>
<tr><td>1 GHz to 7 GHz</td><td colspan="3">±1 dB</td></tr>
<tr><td>7 GHz to 18 GHz</td><td>–</td><td colspan="2">±2 dB</td></tr>
<tr><td>18 GHz to 26.5 GHz</td><td>–</td><td colspan="2">±2.5 dB</td></tr>
<tr><td>26. 5 GHz to 40 GHz</td><td>–</td><td>–</td><td>±3 dB</td></tr>
<tr><td>Total error</td><td></td><td></td><td></td></tr>
<tr><td>Receiver mode (AV display, display range =0 dB to –50 dB, S/N >15 dB, preamplifier off)</td><td></td><td></td><td></td></tr>
<tr><td>≤9 kHz</td><td colspan="3">±1.5 dB</td></tr>
<tr><td>≤150 kHz</td><td colspan="3">±1.2 dB</td></tr>
<tr><td>≤1 GHz</td><td colspan="3">±1 dB</td></tr>
<tr><td>1 GHz to 4.5 GHz</td><td colspan="3">±2 dB</td></tr>
<tr><td>4.5 GHz to 7 GHz</td><td colspan="3">±2.5 dB</td></tr>
<tr><td>7 GHz to 18 GHz</td><td>–</td><td colspan="2">±2.5 dB</td></tr>
<tr><td>18 GHz to 26.5 GHz</td><td>–</td><td colspan="2">±3 dB</td></tr>
<tr><td>26.5 GHz to 40 GHz</td><td>–</td><td>–</td><td>±3.5 dB</td></tr>
<tr><td>Additional error with preamplifier</td><td colspan="3"><0.5 dB</td></tr>
<tr><td>Analyzer mode (display range = 0 dB to –50 dB, S/N >15 dB, span/RBW <100)</td><td></td><td></td><td></td></tr>
<tr><td><1 GHz</td><td colspan="3">±1 dB</td></tr>
<tr><td>1 GHz to 4.5 GHz</td><td colspan="3">±1.5 dB</td></tr>
<tr><td>4.5 GHz to 7 GHz</td><td colspan="3">±2 dB</td></tr>
<tr><td>7 GHz to 18 GHz</td><td>–</td><td colspan="2">±2.5 dB</td></tr>
<tr><td>18 GHz to 26.5 GHz</td><td>–</td><td colspan="2">±3 dB</td></tr>
<tr><td>26.5 GHz to 40 GHz</td><td>–</td><td>–</td><td>±3.5 dB</td></tr>
</table>

General data

<table>
<tr><td>Display</td><td colspan="3">24 cm colour LC display (9.5")</td></tr>
<tr><td>Resolution</td><td colspan="3">640 x 480 pixels (VGA resolution)</td></tr>
<tr><td>Pixel error rate</td><td colspan="3"><2 x 10^{-5}</td></tr>
<tr><td>Mass memory</td><td colspan="3">1.44 Mbyte 3½" disk drive, hard disk</td></tr>
<tr><td>Rated temperature range</td><td colspan="3">+5 °C to +40 °C</td></tr>
<tr><td>Limit temperature range</td><td colspan="3">0 °C to +50 °C</td></tr>
<tr><td>Power supply</td><td colspan="3">200 V to 240 V / 50 Hz to 60 Hz; 100 V to 120 V / 50 Hz to 400 Hz,</td></tr>
<tr><td>Power consumption</td><td>195 VA</td><td colspan="2">230 VA</td></tr>
<tr><td>Dimensions (W x H x D)</td><td colspan="3">435 mm × 236 mm × 570 mm</td></tr>
<tr><td>Weight</td><td>25.1 kg</td><td>26.4 kg</td><td>27.0 kg</td></tr>
</table>

Ordering information

EMI Test Receiver		
20 Hz to 7 GHz	ESI 7	1088.7490.07
20 Hz to 26 GHz	ESI 26	1088.7490.26
20 Hz to 40 GHz	ESI 40	1088.7490.40
Options		
Vector Signal Analyzer	FSE-B7	1066.4317.02
Tracking Generator 7 GHz	FSE-B10	1066.4769.02
Tracking Generator 7 GHz with I/Q Modulator	FSE-B11	1066.4917.02
Switchable Attenuator for Tracking Generator	FSE-B12	1066.5065.02
Ethernet Card for FSE, ESIx	FSE-B16	1073.5973.0x
Second IEEE Bus Card	FSE-B17	1066.4017.02
External Mixer Output for ESI 26/40	FSE-B21	1084.7243.02
Software		
EMI Software (Windows)	ES-K1	1026.6790.02
Script Development Kit	ES-K2	1026.6890.02
Driver for ESI 7/26/40	ES-K16	1108.0288.02
Extras		
Service Kit	FSE-Z1	1066.3862.02
DC Block, 5 MHz to 7000 MHz (type N)	FSE-Z3	4010.3895.00
DC Block, 10 kHz to 18 GHz (type N)	FSE-Z4	1084.7443.02
Microwave Measurement Cable and Adapter Set	FS-Z15	1046.2002.02
3 m control cable for Artificial Mains Network ESH3-Z5	EZ-4	0816.0560.03
10 m control cable for Artificial Mains Network ESH2-Z5	EZ-5	0816.0625.03
3 m control cable for Artificial Mains Network ENV4200	EZ-22	1107.2235.03
IEEE/IEC Bus Cable, 1 m	PCK	0292.2013.10
IEEE/IEC Bus Cable, 2 m	PCK	0292.2013.20

Test Receiver ESVN 40

9 kHz to 2750 MHz

Useful and interfering signal measurements

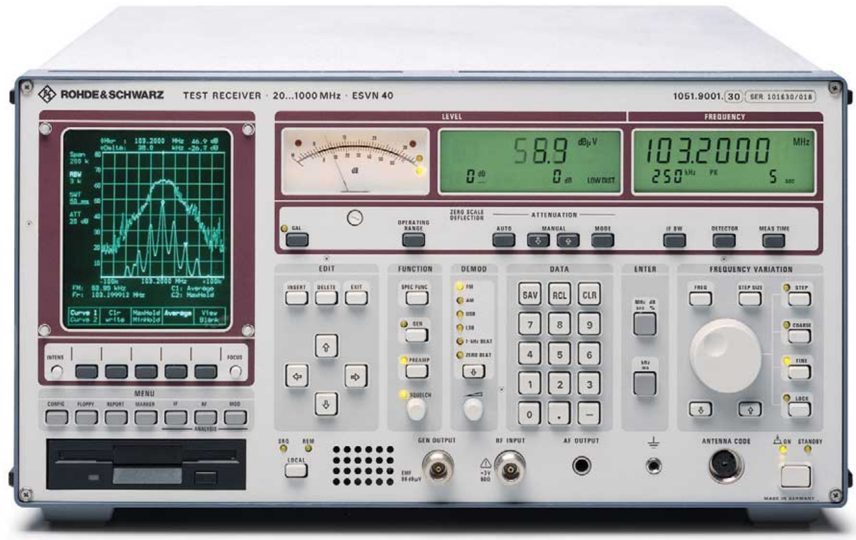


Photo 40630

Brief description

Test Receiver ESVN is used to measure and demodulate both amplitude-modulated (DSB, SSB, pulse) and frequency-modulated signals as well as narrowband and broadband interference. Its high overload capability, wide dynamic range, high measurement rate and versatile analysis functions make the test receiver ideal tool for

- all applications in useful field-strength measurements (eg radio surveillance measurements, radio network planning and radiomonitoring),
- commercial RFI measurements in line with all relevant standards,

Main features

- 13 fixed-tuned, 5 tracking preselection filters up to 2.75 GHz
- Crystal-stabilized synthesizer as 1st LO, variable in 10 Hz/100 Hz steps, sweep mode
- IF filters for all analog radio services with bandwidths between 1 kHz and 250 kHz; 9 kHz and 120 kHz filters with low delay distortion for quasi-peak and average value measurements to CISPR 16
- Peak, average, rms and quasi-peak detectors
- Demodulators for FM, AM, SSB (LSB and USB), zero beat and 1 kHz beat; loudspeaker, headphones connector; squelch; demodulation using signal processors
- Frequency and frequency-offset measurements with built-in counter
- Demodulators for measuring modulation depth and frequency and phase deviation
- IF analysis with resolution bandwidth 1, 3 and 10 kHz; span 0.01 to 10 MHz; runs in parallel with level measurement
- Detection of faulty modules by self-test function

Manual operation

ESVN 40 measures at a fixed frequency with the desired bandwidth, attenuation, measurement time and mode of indication. The following measurements are carried out simultaneously:

- level measurement,
- modulation and deviation measurement,
- frequency and frequency-offset measurement.

Thanks to simultaneous measurements, the parameters of the receive signal can be determined comprehensively in a single test cycle. The level is indicated on a digital LCD display and an analog meter, which is ideal for alignments or determination of maximum signal strength. The results of modulation and frequency measurements are digitally displayed on the screen.

IF analysis

While measurements are being performed, the IF analysis function allows the spectrum about the receive frequency to be analyzed. Measurement of level, modulation and frequency as well as signal assessment using the built-in loudspeaker are made at the center frequency displayed on the screen.

Two test curves can simultaneously be displayed in different modes:

- Max Hold: to detect pulse-shaped or short-time signals
- Max/Min: to detect CW signals, eg in TV channels
- Average: to suppress broadband signals and thus highlight narrowband signals

These display modes allow fast identification and measurement of useful and interference signals in a signal spectrum.

Test Receiver ESVN40

Marker functions support precise evaluation and measurement of the signals identified.

Automatic operation

RF analysis
The receive frequency range is scanned and the result displayed as a spectrum on the screen. Single-shot or repetitive scanning can be selected. Two test traces can be displayed at a time. For comparison measurements waveforms can also be loaded from a floppy.

Three different modes are provided for frequency scanning:

- **Overview:** scanning over the desired frequency range is at maximum speed and with constant attenuation.
- **Scan:** scanning is quasi-continuous with selectable step size and measurement time. Thanks to automatic attenuation control, an extremely wide dynamic range is available at full measurement accuracy.
- **Channel:** the receiver performs a scan over a frequency table with up to 400 different values. The measurement can be triggered at a specific frequency by an adjustable threshold with defined dwell time which in turn switches a carrier-operated relay (COR). The results can be output automatically together with the time of the day as lists on a printer. ESVN40 can thus be used without an external controller for unattended useful field-strength measurements over long periods of time

Use in radiomonitoring

Thanks to its comprehensive measurement and analysis functions, the test receiver is able to perform all important radiomonitoring and measurement tasks in manual, semi-automatic and fully automatic operation:

- Field-strength measurements to ITU-R Rec. 378-4 with direct display of results
- Frequency and frequency-offset measurements with internal or external precision reference
- Modulation depth, frequency deviation and phase deviation measurements
- Visual spectrum monitoring with RF and IF analysis, the latter with simultaneous aural check of the signal received

Use in computer-controlled systems

Full benefit of the high measurement rate of the test receiver is obtained only in the remote mode using a high-speed controller. For the determination of field-strength profiles, the test receiver can furnish up to 5000 measured values per second after being triggered by a positioning system or a timebase. 3000 measured values with a dynamic range of up to 100 dB can be attained if the IF autorange function is activated. The field strength can be determined at different frequencies within a particular frequency band at a rate of 2.5 ms per measured value. With cellular networks it is thus possible to measure for instance the field strength of several base stations according to Lee's statistical method using a single receiver at the normal speed of the test vehicle.

For radiomonitoring, up to 10,000 frequencies can be stored and combined to give a maximum of 100 segments. A set of 20 different receiver setups at the most can be assigned to each segment. The modulation limit values can be defined separately for each segment. The measurement results are output to the controller either in blocks, continuously or depending on a limit-value violation detected by the receiver. Automatic user-port control with programmable wait time supports even complex test sequences involving several antennas.

- 10.7 MHz IF output, switchable between regulated and unregulated IF voltage for connection to a direction finder (external access to control voltage possible) or analysis of the IF signal (eg using an oscilloscope)
- CCVS output for connection to a TV monitor, switchable between positive and negative video polarity, measurement of vision carrier or one sound carrier selectable with simultaneous picture display on the monitor through access to the internal LO
- Inphase and quadrature outputs for most general type of demodulation, eg connection to A/D converters and external further processing

Test Receiver ESVN40

Specifications in brief

Frequency range 9 kHz to 2750 MHz, subdivided into

	Range I	Range II	Range III	Range IV
ESVN40	–	20 MHz to 1000 MHz	1000 MHz to 2050 MHz	–
ESVN40 with options ESVN-B1 and ESVN-B2	9 kHz to 30 MHz	30 MHz to 1000 MHz	1000 MHz to 2050 MHz	2050 MHz to 2750 MHz

Frequency setting

With tuning knob	in fine, coarse or user-selectable steps
Automatic scan	for RF analysis
Display	8-digit LCD
Frequency drift	$<1 \times 10^{-7}$ (after 30 min warm-up)

RF input N connector, 50 Ω

RF attenuator	0 to 120 dB, switchable in 10 dB steps
VSWR	
9 kHz to 1000 MHz	<1.2 with 10 dB RF attenuation <2 with 0 dB RF attenuation
1000 to 2750 MHz	<1.35 with 10 dB RF attenuation <2 with 0 dB RF attenuation
Preselector	
Range I	5 fixed-tuned bandpass filters
Range II	1 fixed-tuned and 5 tracking bandpass filters
Range III	4 fixed-tuned bandpass filters
Range IV	3 fixed-tuned bandpass filters
Preamplifier	can be connected between preselector and 1st mixer
Gain	10 dB

Interference rejection, nonlinearities

Image-frequency rejection	
1st IF	typ. 100 dB (1.9 to 2.75 GHz, typ. 90 dB)
2nd IF	typ. 100 dB
IF rejection	>90 dB, typ. 100 dB

	preamplifier off	preamplifier on
Intercept point d3	$P_{f1,\,f2} = -10$ dBm	$P_{f1,\,f2} = -20$ dBm
Range I, $f_{in}>2$ MHz ($BWI_F<15$ kHz, $\lvert f_1-f_2\rvert \geq 100$kHz)	>15, typ. 20 dBm	>0, typ. 5 dBm
Range II ($\lvert f_1-f_2\rvert \geq 10$ MHz)		
$f_{in}<50$ MHz	typ. 15 dBm	typ. 5 dBm
$f_{in}\geq 50$ MHz	>15, typ. 20 dBm	>5, typ. 10 dBm
Ranges III, IV ($\lvert f_1-f_2\rvert \geq 10$ MHz)	>13, typ. 18 dBm	>3, typ. 8 dBm
Intercept point k2		
Range I	>40 dBm	>20 dBm
Range II	>35 dBm	>25 dBm
Ranges III, IV	>50 dBm	>40 dBm

Maximum input signals
(RF attenuation >0 dB)

DC voltage	7 V corresp. to 1 W
Sinewave AC voltage	137 dBμV
Max. pulse voltage	
Range I	700 V
Ranges II, III and IV	150 V
Max. pulse energy (10 μs)	
Range I	100 mWs
Ranges II, III and IV	1 mWs

RF shielding

Voltage indication at field strength of 10 V/m with 0 dB RF attenuation ($f \neq f_{in}$)	<0 dBμV
Additional error in CISPR indication range (10 V/m)	<1 dB

Intermediate frequencies

Range I	74.7/10.7 MHz/100 kHz
Range II	1354.7/74.7/10.7 MHz/100 kHz
Ranges III, IV	394.7/74.7/10.7 MHz/100 kHz
IF bandwidths	1/3/9*)/15/120*)/250 kHz

*) Complying with tolerances to CISPR 16.
For SSB demodulation a 2.4 kHz IF filter is connected into the audio channel.
Customer-specific bandwidths available on request.

Displayed noise floor (average (AV), bandwidth =1 kHz)

	preamplifier off	preamplifier on
Range I ($f_{in}>50$ kHz)	typ. –27 dBμV	typ. –33 dBμV
Range II	typ. –23 dBμV	typ. –28 dBμV
Ranges III, IV	typ. –22 dBμV	typ. –28 dBμV

RMS value	displayed AV noise +1 dB (typ.)	
Peak value	displayed AV noise +12 dB (typ.)	
Quasi-peak (typ. values)		
Band B (150 kHz to 30 MHz)	–13 dBμV	–19 dBμV
Bands C/D (30 to 1000 MHz)	+2 dBμV	–4 dBμV

Level measurement range
Lower limit (additional error caused by inherent noise <1 dB)

Average value (AV)	4 dB above displayed noise
RMS value	5 dB above displayed noise
Peak value (PK)	15 dB above displayed noise
Quasi-peak (100 Hz pulse freq.)	3 dB above displayed noise
Upper limit	
AV, RMS, PK, QP	137 dBμV (RF attenuation >0 dB)

Level display

Digital	3 digits, in dBμV, dBμA, dBm, dB(μV/m), dB(μA/m), dBpW
Resolution	0.1 dB
Analog	on moving-coil meter in operating range of IF detector with additional digital display of lower range limit
Operating ranges	30 dB, 60 dB
Screen	5" CRT with digital memory
Resolution	1024 x 1024 pixels

RF analysis

Display range	
X axis (frequency)	selectable, linear or logarithmic
Y axis (level)	10 to 200 dB, adjustable in 10-dB steps
Test curves	max. 2 traces
Display modes	Clr/Write, Max Hold, View
Frequency scan modes	
Overview	scan with fixed attenuation and step size at maximum speed
Scan	scan with automatic attenuation setting and selectable step size
Channel	scan at up to 400 predefinable frequency values
Marker	2 markers with digital display of frequency and level
Marker functions	normal marker, delta marker, marker to peak,marker to receiver frequency

Test Receiver ESVN40

Measurement accuracy (digital display, average value for S/N >16 dB)	
Range I, II	1 dB
Ranges III, IV	2 dB
Frequency drift	digital display in kHz
Measurement range/resolution	0.5 x IF bandwidth/0.1 Hz to 100 Hz
Measurement time	1 ms to 100 s (1/2/5 steps)
Frequency deviation	digital display in kHz
Measurement range	deviation + f_{mod} <0.5 x IF bandwidth
Resolution	0.1/0.01 kHz
Modulation frequency f_{mod}	<100 kHz
Phase deviation	
(bandwidths 1/3/9/15 kHz)	digital display in rad
Measurement range/resolution	0.1 rad to 8 rad/0.1 rad
Modulation frequency	300 Hz to 5 kHz
Amplitude modulation depth	digital display in %
Measurement range/resolution	1 to 99%/0.1%
Modulation frequency f_{mod}	<100 kHz
IF analysis	
Frequency display	
Range I	10 kHz to 2 MHz, 1/2/5 steps
Ranges II, III and IV	10 kHz to 10 MHz, 1/2/5 steps
Level display range	80 dB
Resolution bandwidths (–3 dB)	1/3/10 kHz
Sweep time	50 ms to 10 s, 1/2/5 steps
Test curves, markers	same as for RF analysis
AF demodulation modes	zero beat, 1 kHz beat, AM, USB and LSB, FM
Squelch	adjustable
Trigger functions	
External	TTL levels, pos. or neg. edge
Internal	controlled by RF level, threshold adjustable
Date, time of day	internal clock

Connectors and interfaces

Remote control	interface to IEC 625-2 (IEEE 488)
Plotter	via IEEE/IEC bus
Plotter language	HP-GL
Printer	parallel interface
Keyboard	5-contact connector for MF2 keyboard
Floppy disk drive	3½", 1.44 MByte (formatted)
Front-panel outputs	
Supply and coding connector for antennas, etc	12-contact Tuchel connector
AF output	jack JK34, 10 Ω
Rear-panel outputs	
IF 10.7 MHz	BNC connector, 50 Ω, switchable between regulated and unregulated IF voltage
AM/FM	output for demodulated AF voltage
I/Q demodulator outputs	1 BNC connector each, 50 Ω
CCVS output	BNC connector for CCVS TV monitor, video polarity and vision/sound carrier offset selectable for all TV standards
Reference output	BNC connector, can be switched to input for external reference, 10 MHz
User port	25-contact Cannon connector, includes 6 TTL control lines for an external device (eg controlled by RF level), analog voltage indication, input for external trigger, input for IF control, RS-232-C interface for firmware update
Rear-panel inputs	
External battery	3-contact connector
Reference input	BNC connector, can be switched to reference output

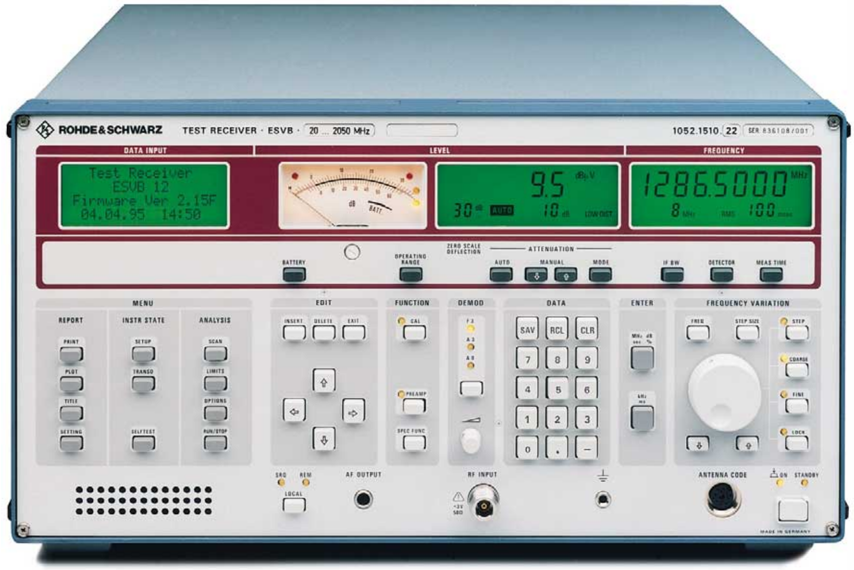
General data

Rated temperature range	–10°C to +55°C (condensation not permissible)
Operation of floppy disk drive	+5°C to +50°C
Storage temperature range	–25°C to +70°C
Power supply	
AC supply	100 V/120 V/240 V ±10%, 230 V +6%/–10%, 47 Hz to 420 Hz, safety class I to VDE 0411
Power consumption	155 VA
Battery (external)	11 V to 33 V (switch-on voltage >12 V) 4.4 A at 24 V/8 A at 12 V
Dimensions (W x H x D)	435 mm x 236 mm x 572 mm
Weight	35 kg incl. ESVN-B1 and ESVN-B2 32 kg without options

Ordering information

Test Receiver	ESVN40	1056.9497.40
Options		
Frequency Extension 9 kHz to 20 MHz for ESVN40	ESVN-B1	1070.4501.02
Frequency Extension 2050 to 2750 MHz for ESVN40	ESVN-B2	1070.4001.02
Balanced 600 Ω Audio Output for ESN and ESVN	ESN-B3	1056.9422.02

Test Receivers ESVB



ESVB (photo 42081)

20 MHz to 1 (2.05) GHz

Coverage measurements in digital audio and video broadcast networks DAB, DVB-T

Brief description

For planning and operation of sound and TV broadcast networks it is essential to know the propagation conditions in the area to be covered. Test Receiver ESVB features the bandwidths and signal weighting facilities required for terrestrial digital video (DVB-T) as well as for digital audio broadcasting (DAB). In conjunction with its high measurement rate it is ideal for use in mobile and stationary coverage measurements.

Being a triple-heterodyne receiver, the ESVB is equally suitable for measuring signal and interfering field strengths; it includes all functions of EMI Test Receiver ESVS 10 (see catalog "Test and Measurement Products").

ESVB can be upgraded for measurements in digital mobile radio networks (GSM) (with optional I/Q Demodulator ESN-B1). This option also allows the frequency range to be extended to 2050 MHz.

Main features

- Large display range, 60 dB even for quasi-peak and average indication; 70 dB for DAB/DVB signal measurements without changing input attenuation
- 1 fixed-tuned and 5 tracking preselection filters, optionally 4 additional fixed-tuned filters
- Crystal-stabilized synthesizer as 1st local oscillator, variable in 100 Hz steps, sweep mode for fast frequency scanning; frequency accuracy complying with GSM recommendations
- IF filters (10 kHz,120 kHz, 300 kHz) with optimized group delay in the third IF stage; additional 1.5 MHz and 8 MHz channel filters for DAB/DVB
- I/Q demodulator (1.5/4 MHz bandwidth per demodulated channel); I/Q demodulator for narrowband IF filters included in ESN-B1 (bandwidth = 1/2 IF bandwidth)

Field-strength measurements in digital sound and TV broadcast networks

With a bandwidth of 1.5 MHz and 8 MHz matching the DAB/DVB-T channel, ESVB is able to cover the entire COFDM spectrum.

The power of the total spectrum at the receiver input is the measure of DAB/DVB-T coverage. Due to the addition of very many carriers with pseudo-random phases, the DAB/DVB-T signal behaves like white noise within the transmission bandwidth, so that only the RMS measurement method is suitable for determining the power. A thermal power meter is inadequate for mobile measurements because of the speed. Therefore, the ESVB features an RMS detector allowing the power at the receiver input to be indicated very quickly and over a wide range.

Specifications in brief

Frequency range	20 MHz to 1000 MHz	
with option ESN-B1	20 MHz to 2050 MHz	
Frequency setting steps	100 Hz/100 kHz/user-selectable	
Automatic scan	for RF analysis	
Frequency display; Resolution	8-digit LCD; 100 Hz	
Frequency drift (after 30 min)	$<1 \times 10^{-7}$	
RF input	N connector, 50 Ω	
VSWR 20 MHz to 1000 MHz	<1.2 at ≥10 dB RF attenuation	
VSWR1000 kHz to 2050 MHz	<1.35 at ≥10 dB RF attenuation	
Preamplifier	10 dB, can be connected between preselector and 1st mixer	
Maximum input signals (RF attenuation ≥10 dB, with and w/o preamplifier)		
DC voltage	7 V	
Sinewave AC voltage	137 dBµV (= 1 W)	
Max. pulse voltage	150 V	
Max. pulse energy (10 µs)	1 mWs	
Interference rejection, nonlinearities		
Image-frequency rejection 1st IF	typ. 100 dB (1,9 to 2,05 GHz, typ. 90 dB)	
2nd IF	typ. 100 dB	
IF rejection	typ. 100 dB	
Intercept point d3 ($\lvert f_1 - f_2 \rvert \geq 10$ MHz)	preamplifier off	preamplifier on
Level (f_1, f_2) at receiver	–10 dBm	–20 dBm
20 MHz to 50 MHz	typ. 15 dBm	typ. 5 dBm
50 MHz to 1000 MHz	typ. 20 dBm	typ. 10 dBm
1000 MHz to 2050 MHz	typ. 18 dBm	typ. 8 dBm
Intercept point k2		
20 MHz to 1000 MHz	>35 dBm	>25 dBm
1000 MHz to 2050 MHz	>50 dBm	>40 dBm
Preselector		
20 to 1000 MHz	1 fixed-tuned, 5 tracking filters	
1000 to 2050 MHz	4 fixed-tuned filters	
Intermediate frequencies		
1st IF 20 to 1000/2050 MHz	1354.7 MHz/394.7 MHz	
2nd/3rd IF	74.7/10.7 MHz	
IF bandwidths	10/120/300 kHz; 1.5 MHz; 8 MHz	
Displayed noise floor		
20 MHz to 1000 MHz	preamplifier off	preamplifier on
Average indication (AV)		
BW = 10 kHz	typ. –15 dBµV	typ. –21 dBµV
BW = 120 kHz	typ. –5 dBµV	typ. –9 dBµV
BW = 300 kHz	typ. 0 dBµV	typ. –4 dBµV
BW = 1.5 MHz	typ. 12 dBµV	typ. 5 dBµV
BW = 8 MHz	typ. 18 dBµV	typ. 11 dBµV
RMS indication	1 dB above AV values	
Level measurement range		
Lower limit: Additional error (inherent noise) <1 dB		
20 MHz to 1000 MHz	preamplifier off	preamplifier on
Average indication (AV)		
BW = 10 kHz	typ. –12 dBµV	typ. –16 dBµV
Other bandwidths	4 dB above displayed noise floor, 20MHz to 1000 MHz, AV	
Peak indication (PK)		
BW = 10 kHz	typ. –14 dBµV	typ. 10 dBµV
BW = 120 kHz BW = 300 kHz	30 dB above displayed noise floor, 20 MHz to 1000 MHz, AV	
RMS indication	3 dB above AV values	
Quasi-peak indication (QP), CISPR bands C/D		
30 MHz to 1000 MHz	typ. 4 dBµV	typ. 0 dBµV
1000 MHz to 2050 MHz	2 dB above values for 20 MHz to 1000 MHz	same values as for 20 MHz to 1000 MHz
Upper limit:		
AV, PK, QP, RMS as above	137 dBµV (≥10 dB RF attenuation)	
Inherent spurious responses	<0 dBµV (equivalent input voltage)	
Level display		
Digital	3½ digits, resolution 0.1 dB, in dBµV, dBµA, dBm, dB(µV/m), dB(µA/m), dBpW	
Analog	on moving-coil meter in operating range of IF detector with additional digital display of lower range limit	
Operating ranges	30 dB (for ≤1.5 MHz IF bandw.), 60 dB	
Display modes	AV, RMS (for all IF BW), PK, QP, Pk/MHz (not for 1.5 and 8 MHz IF bandwidths)	
Measurement times, steps	1 ms to 100 s, 1/2/5	
Measurement accuracy		
AV for S/N >16 dB, RMS for S/N >20 dB, IF BW ≤1.5 MHz		
20 MHz to 1000 MHz (0 to +55 °C)	≤1 dB (digital display)	
1000 MHz to 2050 MHz	≤2 dB (digital display),	
20 MHz to 2050 MHz	≤2 dB (IF BW = 8 MHz)	
Demodulation modes	A0, A3, F3	
Date, time of day	internal clock	
Remote control	interface to IEC625-2 (IEEE 488)	
Plotter connection	via IEEE/IEC bus interface (HP-GL)	
Printer connection	parallel (15-contact Cannon connector)	
Front-panel outputs		
Supply and coding connector	12-contact Tuchel connector	
AF output	Z_{out} = 10 Ω, jack JK34	
Rear-panel connectors		
IF 74.7 MHz	Z_{out} = 50 Ω, BNC connector	
IF 10.7 MHz	Z_{out} = 50 Ω, BNC con. (not 8 MHz IF BW)	
Envelope demodulator output	BNC connector	
Inphase and quadrature signal	1 BNC connector each, 50 Ω	
Reference frequency output	BNC connector, 10 MHz	
User port	25-contact Cannon connector	
Keyboard connector	5-contact DIN connector	
Rear-panel input		
External battery	3-contact connector; 11 V to 33 V	
Ext. reference frequency	BNC connector; 5/10 MHz	
General data		
Power supply, AC	100/120/240 V ±10%, 230 V +6/–10%, 47 Hz to 420 Hz (70 VA)	
Power supply, battery internal	12 V, 10 Ah (operating time approx.2 h)	
Power supply, battery external	11 to 33 V (switch-on voltage >12 V), 2.1 A at 24 V, 3.9 A at 12 V	
Dimensions (W x H x D)	435 mm x 236 mm x 460 mm	
Weight	26/23 kg with/without int. battery	

Ordering information

Test Receiver (20 to 1000 MHz)	ESVB	1052.1510.22
Options		
UHF Frontend 1000 to 2050 MHz and I/Q demodulator for IF bandwidths ≤ 300 kHz	ESN-B1	1052.0508.02
Extras		
Service Kit	EZ-8	1052.0508.02
6 V Lead Storage Battery 10 Ah (2 required)		0338.4012.00

Test Receiver ESVD

20 MHz to 1 (2.05) GHz

Field-strength measurements for planning and operation of mobile radio networks (GSM)

Photo 42427

Brief description

For planning and operation of mobile radio networks it is essential to know the propagation conditions in the area to be covered. Test Receiver ESVD features optimal bandwidths for mobile radio services as well as a high measurement rate so that it is ideal for fixed and mobile coverage measurements.

The ESVD is equally suitable for measuring useful and interfering signals; it includes the functionality of Test Receiver ESVS (page 78).

Main features

- Frequency accuracy to GSM specifications
- Filter bandwidths to allow coverage measurements in cellular radio networks
- Frequency range can be extended to 2.05 GHz using option ESVD-B2 (eg GSM 1800 network)
- IF filters with optimized group delay for distortion-free demodulation of digitally modulated signals
- Inphase and quadrature signal outputs for evaluating any modulated signals (option ESVD-B1)
- Output for internal crystal reference frequency (10 MHz)

Field-strength measurements in mobile radio networks
The ESVD is ideal for propagation measurements in mobile radio networks thanks to its level display accuracy, excellent frequency resolution and precision, high sensitivity as well as the 300 kHz bandwidth specially optimized for the GSM network.

The user-friendly operating concept and the easy-to-read LCDs for settings and test results make the ESVD a highly practical test instrument for manual operation. The internal or external battery – 11 V to 33 V – makes it suitable for mobile use. Thanks to its high measurement rate, the ESVD is for instance able to supply a value every 2.5 ms in the determination of field-strength profiles with the test receiver being triggered by a positioning system.

This high measurement rate is even achieved when changing frequencies within a mobile radio band. The field strength of several transmitter stations in the respective mobile radio band can thus be determined with a single receiver at normal speed of the test vehicle.

I/Q demodulator (option ESVD-B1)
This option allows an additional evaluation of the signal received. This most general type of demodulation enables any kind of modulated signals to be further processed.

Frequency range extension up to 2.05 GHz (option ESVD-B2)
The frequency range of mobile radio networks in the range ≤ 2 GHz, can be covered by retrofitting the frequency range extension to 2 GHz. This option contains another four filters with fixed tuning.

Specifications in brief

Frequency range	20 MHz to 1000 MHz
with option ESVD-B2	20 MHz to 2050 MHz
Frequency setting	
with tuning knob	in 100 Hz, 100 kHz steps or user-selectable step size
numerical	by keyboard entry
in steps	of any selectable size
automatic scan	for RF analysis
Frequency display	8-digit LCD
Resolution	100 Hz
Frequency drift (30 min warm-up)	$<1 \times 10^{-7}$

RF input	N connector, 50 Ω	
VSWR		
20 MHz to 1000 MHz	<1.2 with ≥10 dB RF attenuation	
1000 MHz to 2050 MHz	<1.35 with ≥10 dB RF attenuation	
Preamplifier	can be connected between preselector and 1st mixer	
Gain	10 dB	
Maximum input signals (with and without preamplifier, RF attenuation ≥10 dB)		
DC voltage	7 V	
Sinewave AC voltage	137 dBμV (corresp. to 1 W)	
Max. pulse voltage	150 V	
Max. pulse energy (10 μs)	1 mWs	
Interference rejection, nonlinearities		
Image-frequency rejection		
1st IF	100 dB (1900 to 2050 MHz, typ. 90 dB)	
2nd IF	100 dB	
IF rejection	typ. 100 dB	
Intercept point d3 ($\|f_1–f_2\|$>5 MHz)	preamplifier off	preamplifier on
Level (f_1, f_2) at receiver	–10 dBm	–20 dBm
20 MHz to 1000 MHz	typ. 20 dBm	typ. 10 dBm
1000 MHz to 2050 MHz	typ. 18 dBm	typ. 8 dBm
Intercept point k2		
20 MHz to 1000 MHz	>35 dBm	>25 dBm
1000 MHz to 2050 MHz	>50 dBm	>40 dBm
Preselector		
20 MHz to 1000 MHz	1 fixed-tuned, 5 tracking filters	
1000 MHz to 2050 MHz	4 fixed-tuned filters	
Intermediate frequencies		
1st IF 20 MHz to 1000 MHz	1354.7 MHz	
1000 MHz to 2050 MHz	394.7 MHz	
2ns/3rd IF	74.7 MHz/10.7 MHz	
IF bandwidths	10/120/300 kHz; 1 MHz	
Displayed noise floor	preamplifier off	preamplifier on
20 MHz to 1000 MHz, average (AV)		
BW=10 kHz	typ. –15 dBμV	typ. –21 dBμV
BW=120 kHz	typ. –5 dBμV	typ. –9 dBμV
BW=300 kHz	typ. 0 dBμV	typ. –4 dBμV
BW=1 MHz	typ. 4 dBμV	typ. 0 dBμV
Level measurement range		
Lower limit:		
Additional error (internal noise)	<1 dB	
20 MHz to 1000 MHz	preamplifier off	preamplifier on
Average indication (AV)		
BW = 10 kHz	typ. –12 dBμV	typ. –16 dBμV
Other bandwidths	4 dB above displayed noise floor, 20 to 1000 MHz, AV	
Peak indication (PK)		
BW = 10 kHz	typ. –14 dBμV	typ. 10 dBμV
BW = 120 kHz	30 dB above displayed noise floor, 20 to 1000 MHz, AV	
BW = 300 kHz		
Quasi-peak indication (QP), CISPR bands C/D	preamplifier off	preamplifier on
30 MHz to 1000 MHz	typ. 4 dBμV	typ. 0 dBμV
1000 MHz to 2050 MHz	2 dB above values for 20 to 1000 MHz	same values as for 20 to 1000 MHz
Upper limit:		
AV, PK, QP as above	137 dBμV (≥10 dB RF attenuation)	
Inherent spurious responses	<0 dBμV (equivalent input voltage)	

Level display	
Digital	3½ digits, resolution 0.1 dB, in dBμV, dBμA, dBm, dB(μV/m), dB(μA/m) or dBpW
Analog	on moving-coil meter in operating range of IF detector with additional digital display of lower range limit
Measurement accuracy (average indication for S/N >16 dB)	
20 MHz to 1000 MHz	
0 to 55 °C	≤1 dB (digital display)
1000 MHz to 2050 MHz	≤2 dB (digital display)
Level calibration	sinewave and harmonics generator
Demodulation modes	A0, A3, F3
Date, time of day	internal clock
Remote control	interface to IEC 625-2 (IEEE 488)
Plotter connection	via IEEE/IEC bus interface
Plotter language	HP-GL
Printer connection	parallel interface (15-contact Cannon connector
Front-panel outputs	
Supply and coding connector	12-contact Tuchel connector
AF output	Z_{out}= 10 Ω, jack JK34
Rear-panel outputs	
IF 74.7 MHz	BNC connector, 50 Ω
IF 10.7 MHz	BNC connector, 50 Ω
Envelope demodulator output	BNC connector
Inphase/quadrature signal outputs (option ESVD-B1)	1 BNC connector each, 50 Ω, can be loaded with >200 Ω
Reference frequency output	BNC connector, 10 MHz
User port	25-contact Cannon connector
Keyboard connector	5-contact DIN connector
Rear-panel inputs	
Ext. reference frequency	BNC connector; 5/10 MHz
Ext. battery	3-contact connector; 11 to 33 V
General data	
Power supply	
AC supply	100/120/240 V ±10%, 230 V +6/–10%, 47 to 420 Hz (70 VA)
Battery	
internal	12 V, 10 Ah (operating time approx. 2 h)
external	11 to 33 V (switch-on voltage >12 V), 2.1 A at 24 V, 3.9 A at 12 V
Dimensions (W x H x D)	435 mm x 236 mm x 460 mm
Weight (without options)	26 kg/23 kg with/without battery

Ordering information

Test Receiver	ESVD	1026.5506.10
Options		
I/Q Demodulator	ESVD-B1	1026.9001.02
UHF Frontend 1000 to 2050 MHz (only in conjunction with ESVD-B1)	ESVD-B2	1026.9501.02
Extras		
Service Kit	EZ-8	0816.1067.02
6 V Lead Storage Battery 10 Ah (2 required)		0338.4012.00

EMI Software ES-K1

Automation of EMI measurements with R&S instruments:

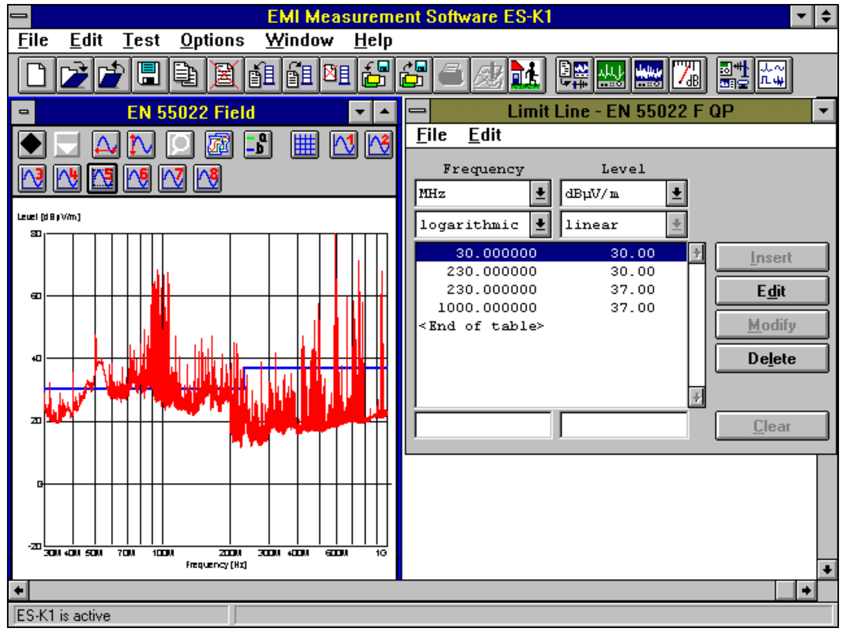
Test Receiver Families

ESCS, ESS, ESHS, ESVS, ECPC

Analyzer Families

ESI7, ESI26, ESI40

ESAI, ESBI, ESMI

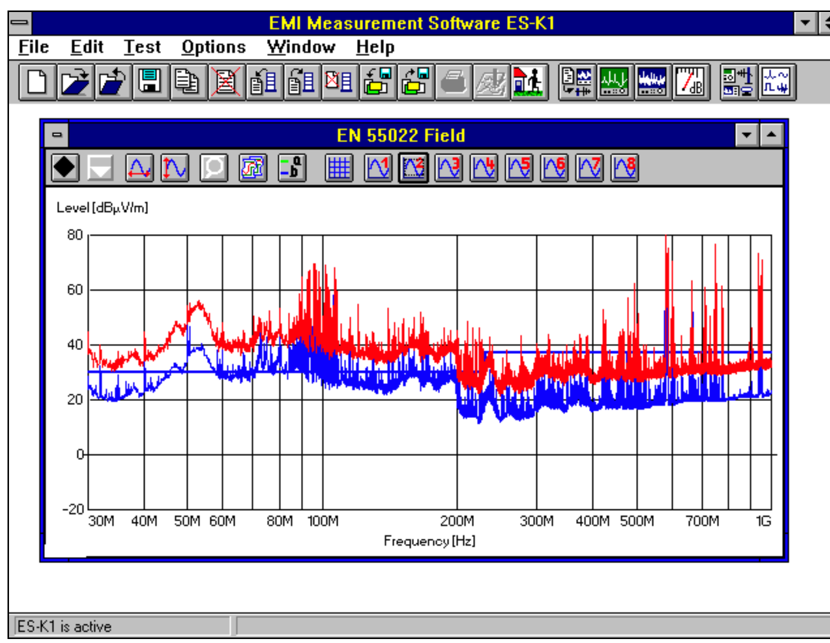


Brief description

EMI Software ES-K1 is a versatile, efficient and user-friendly tool for fully automatic measurement of conducted and radiated emissions to international commercial and military standards such as CISPR, VDE, FCC, EACL, ANSI, EN; MIL, VG, DEF-STAN, GAM-EG13.

Offering various drivers, the software not only supports EMI test receivers and EMI spectrum analyzers from Rohde&Schwarz, but also a large variety of accessories:

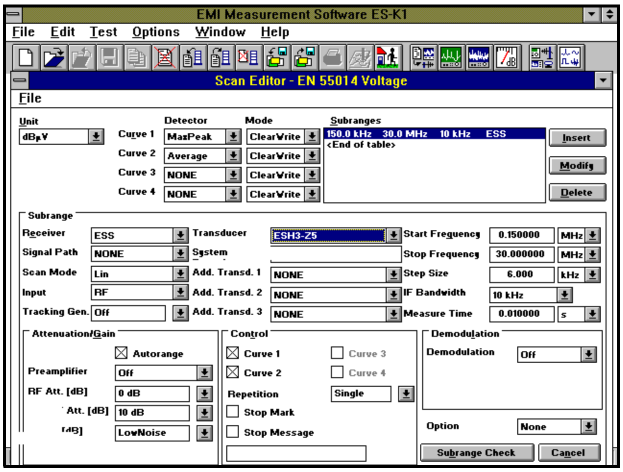
- Mast and turntable system for measurement of RFI field strength
- Artificial mains networks and absorbing clamp slideways for measurement of conducted emissions
- Matrix for switching over antennas and transducers

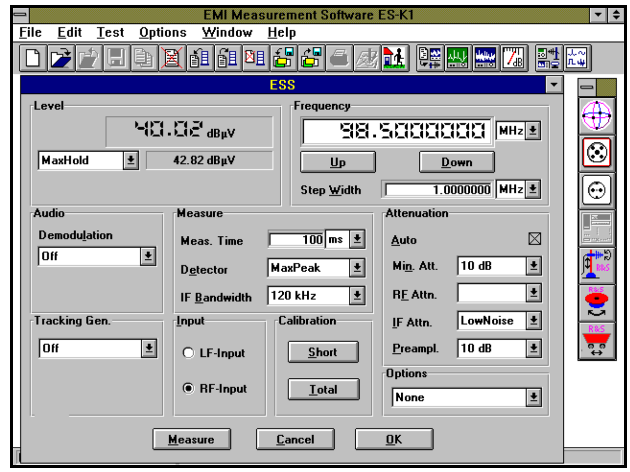


Main features

- User-friendly EMI test software under Windows
- EMI measurements to commercial and military standards
- Adaptation to other standards
- Integrated database
- User-group-specific data allocation
- Fully automatic operation or interactive single measurement
- Automatic compensation of transducers (correction factors) and limit lines
- Large choice of data reduction methods
- Azimuth chart test
- Evaluation of narrowband/broadband interferers
- Test setup calibration
- Convenient and flexible result documentation and report generation
- Universal data storage
- Hardlock key (dongle) for authentication
- Network-compatible

EMI Software ES-K1





Test runs

Depending on the application and use of the software, control of the test runs is either fully automatic or interactive. By loading automatic test routines defined in the form scripts, measurements can be started simply at the press of a button without any time-consuming entries. The scripts control the test run, evaluate the results and generate the necessary test reports. In addition to standard scripts, user-specific scripts can be generated and existing scripts modified (option ES-K2).

A database is integrated in ES-K1 for management of the measured data or of the result files derived with the aid of comprehensive test and evaluation routines. The convenient access to these files with informative short descriptions does away with tiresome file searching.

Versatile and flexible result display is possible in the form of tables or graphs. A maximum of eight test results, limit lines and transducer factors can be displayed simultaneously. A zoom function allows enlargement of any parts of the result display.

Report generation

The script run generates a user-configured report which combines the test results in an informative documentation. Another way of generating the reports is by automatic data exchange between the Windows programs, the DDE function implemented in ES-K1 allowing both graphs and texts to be exported from ES-K1 and copied into the user-generated test report wherever desired. Alternatively the test report can be stored as RTF file (Rich Text Format). For the hardcopy of the test reports all printers and plotters supported by Windows are suitable.

Hardware requirements

IBM compatible PC minimum 486 with Windows 3.1/95/98/NT4.0; minimum 8-MByte RAM; minimum memory capacity on hard disk 8 Mbyte; IEEE/IEC bus interface with Windows driver (DLL), National Instruments IEEE/IEC bus interface.

Ordering information

EMI Software	ES-K1	1026.6790.02
(Windows program with driver for Artificial Mains Networks ESH2-Z5, ESH3-Z5 and Relay Matrixes PSU, RSU and PSN)		
Script Development Kit	ES-K2	1026.6890.02

Drivers for Test Receivers and Spectrum Analyzers

ESHS, ESVS, ESVD, ESCS, ESPC	ES-K10	1026.6948.02
ESS	ES-K11	1026.7096.02
ESAI, ESBI, ESMI	ES-K12	1026.7144.02
ESI7, 26, 40	ES-K16	1108.0288.02

Drivers for accessories

Deisel Controller, Mast, Turntable, HD-MA2xx and HD-DT3xx	ES-K33	1035.1097.02
EMCO Controller, Mast, Turntable, 2090 and SUNOL SC9XV	ES-K40	1140.4591.02
User specific IEEE/IEC Bus Driver	ES-K50	1057.2496.02
Multi-User Licence	ES-K100	1057.0741.02

EMI Software ESxS-K1

User-friendly EMI test software under Windows

Can be used for all Test Receivers of ESCS, ESS, ESHS, ESVS, ESPC, ESVN, ESVD, ESVB

Photo 42219

Brief description

EMI Software ESxS-K1 combines the main features of commercial EMI measurement requirements in one complete, easy-to-use application including: setup definition and storage, scan data capture and display with automatic data reduction, peak search with acceptance margin and subrange selection, final measurement with worst case selection, report generation and measured data storage.

ESxS-K1provides for all test receiver and EMI test receiver families (except ESI, ESxI) a low-cost Windows based remote-control display and result storage solution.

All the benefits of Windows are available including: keyboard and mouse operation, report printout on any printer/plotter supported by Windows, and dynamic data exchange (DDE). Online help explains all software functions, so no user manual is required.

Main features

- Full on-screen setup entry and storage to disk, including limit lines and transducer factors
- Colour graphic display of scan data, with automatic data reduction
- Marker function, including Marker to Peak and Tune Receiver to Marker Frequency
- Automatic Peak Search with user-definable acceptance margin and subrange/peak value count
- Peak List Edit function for automatic, semi-automatic or manual measurements
- Find Worst Case function: to find max hold level
- Zoom function: expands frequency axis to display a part of the scan in greater detail
- Report generation compatible with ESxS receiver family using any printer or plotter supported by Windows
- Report data export to other applications (WinWord, Excel)

Hardware requirements

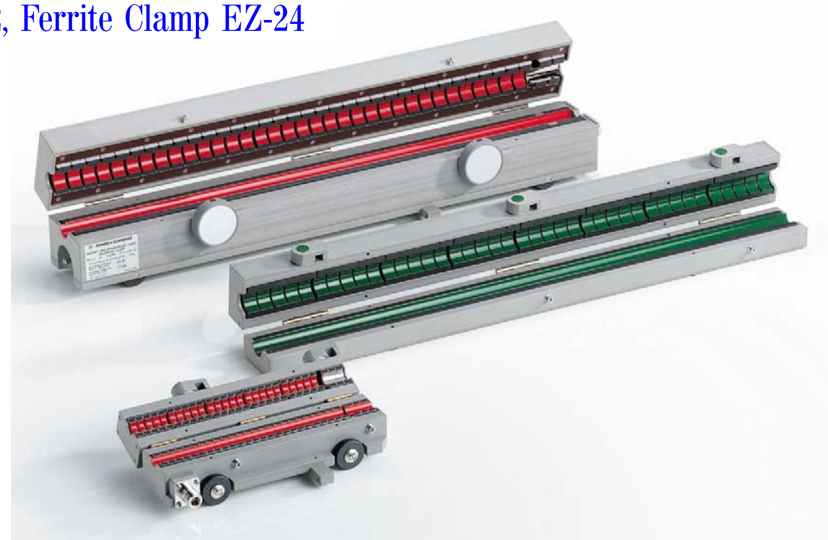
Runs under Windows 3.1/95/98/NT4.0 on any IBM-compatible machine with an 80486 processor or higher and minimum 8 MByte RAM; requires an IEEE/IEC bus interface card for receiver control, eg PS-B4 (model 04) from Rohde&Schwarz, or PCII/IIA, AT-GBIP from National Instruments.

Ordering information

EMI Software	ESxS-K1	1082.9678.02

Absorbing Clamps MDS-21/-22, Ferrite Clamp EZ-24

RFI power and shielding effectiveness measurements on lines. Reproducible interference field-strength and power measurements



Absorbing Clamps MDS-21 and MDS-22;
center: Ferrite Clamp EZ-24

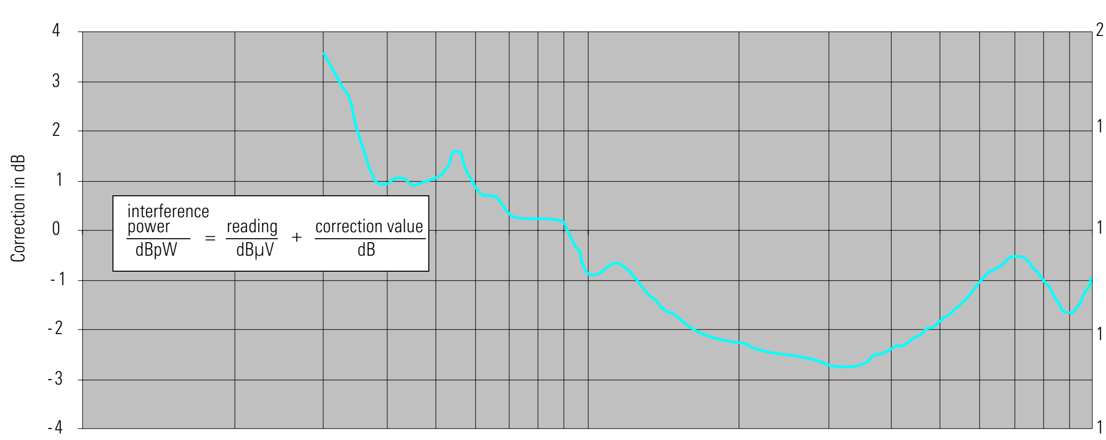
Brief description

The RFI emission of electrical appliances, machinery and systems must be kept within the limits specified by regional and international standards. Absorbing Clamps MDS can be used in conjunction with EMI test receivers to measure RFI power on lines to CISPR 14-1, EN 55014-1, VDE 0875 Part 14 and EN 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, EN 50083-2 and DIN 0855 Part 200. MDS clamps are also used for testing the effectiveness of RFI suppression devices for high-voltage ignition systems in line with VDE 0879 Part 4 and CISPR 12 (4th edition). Draft documents for the measurement of radiated interference provide for the use of ferrite absorbers for line loading to improve the reproducibility of RFI field-strength measurements. Ferrite absorbers are also used to improve RFI power and shielding effectiveness measurements.

Interference measurements in the VHF/UHF range

In the frequency range below 30 MHz, where interference is mainly propagated via lines, this interference is determined as laid down in many regulations by measuring the RFI voltage produced by the EUT across the terminals of a line-impedance stabilization network.

In the VHF/UHF range, where radiated emission predominates, interference is defined in terms of the RFI field strength at a certain distance. Small EUTs emit interference mainly via the connecting cables such as power lines. For the above reasons as well as to avoid complex field-strength measurement, several regulations prescribe the use of an absorbing clamp for measurement of the RFI power.



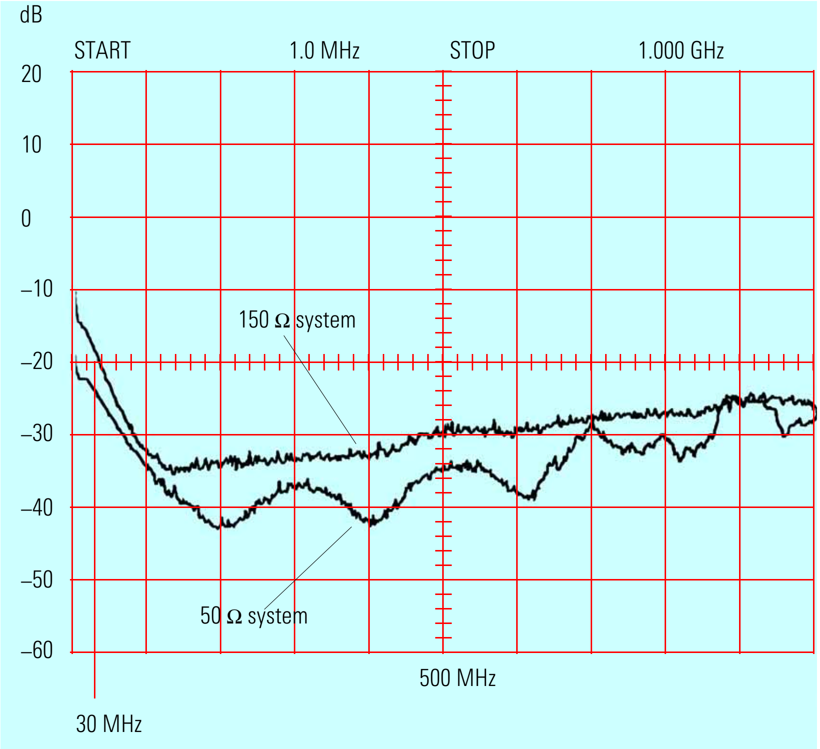
Typical calibration curve of Absorbing Clamp MDS-21

Absorbing Clamps MDS-21/-22, Ferrite Clamp EZ-24

Further applications

In addition to measuring the interference emitted by small appliances and the shielding effectiveness of cables, Absorbing Clamp MDS-21 can also be used for testing the effectiveness of RFI suppression devices for high-voltage ignition systems according to VDE 0879 Part 4/Draft 9.89 and CISPR 12. High-energy pulses are coupled out and taken to the test receiver whose inputs are protected in a special way.

MDS clamps are also suitable for use as coupling clamps for testing the susceptibility of electronic devices.



Insertion loss characteristic of Ferrite Clamp EZ-24

Specifications

	MDS-21	MDS-22
Frequency range	30 MHz to 1000 MHz	300 MHz to 2500 MHz
Insertion loss to CISPR 16-1, typ. (individual calibration report supplied with clamp)	17 ±4 dB	17 +6/–4 dB
Calibrated for receiver input impedance	50 Ω	50 Ω
Connector	N female 50 Ω	N female 50 Ω
Permissible DC current or peak value of AC current	30 A	50 A
Max. permissible RF input power for susceptibility measurement	5 W	5 W
Max. cable diameter	20 mm	12 mm
Insert sleeves supplied (diameter)	10 mm	3, 6, 9 mm
Rollers	ball bearing, dust-protected	ball bearing, dust-protected
Overall dimensions (W x H x D) in mm	610 x 115 x 80	230 x 70 x 70
Weight	6.3 kg	1.25 kg

	EZ-24
Frequency range	1 MHz to 1000 MHz
Skin current attenuation in range 30 to 1000 MHz in 50 Ω circuit	>15 dB (see typ. insertion loss)
Max. permissible skin current RF power	50 W
Overall dimensions (W x H x D) in mm	626 x 57 x 80
Weight	3.5 kg

Ordering information

Absorbing Clamp	MDS-21	0194.0100.50
	MDS-22	1052.3507.02
Ferrite Clamp	EZ-24	1107.2535.02

Accessories supplied

MDS-21	1 coaxial connecting cable (for connecting MDS-21 to EMI test receiver), 5 m long with 2 x N connector; 6 dB attenuator, 2 x N connector
MDS-22	1 calibration curve without cable insertion loss (insertion loss of connecting cable must be added)

Triple-Loop Antenna HM020

9 kHz to 30 MHz

van Veen/Bergervoet system: more sensitive, faster and cheaper than previous test methods to CISPR Publication 16

New standards:

CISPR15, CISPR 16-1 Amd 1, CISPR 11/12.97

Normal setup (photo 39533-7)

Test setup with reduced height (photo 39533-6)

Brief description

Test method to CISPR16-1 Amd 1 for electric lighting equipment to CISPR15 and for induction sources to CISPR11

- Fully automatic measurement of the magnetic field strength in the X, Y and Z planes of a centrally placed EUT

Main features

- Automatic control with Software ES-K1 from test receivers or manual remote control from optional Control Unit BG020
- Loop system suitable for mobile use; can be folded in one plane
- Wooden pedestals (100 kg load capacity) for various installation heights available
- Neither EUT nor loop need to be turned during the measurement
- The effect of the shielded room on the test result is considerably reduced
- Ambient interference is strongly suppressed in open-area measurements
- The antenna is factory-calibrated with the Calibration Dipole HM020Z3 placed at the antenna center, which is available to the user for recalibration

Specifications in brief

Frequency range	9 kHz to 30 MHz
Loops	switchable between X, Y and Z planes
Transducer factor of current probe	0 dB, referred to 1 S
RF connector	N female, 50 Ω
Dimensions (W x H x D); weight	
Loops set up, normal mode	2.49 m x 2.57 m x 2.07 m; 45 kg
Loops set up, reduced height	2.49 m x 2.09 m x 2.07 m
Transport crate	2.68 m x 2.32 m x 0.57 m
Basic Pedestal HM020Z1	0.9 m x 1 m x 0.9 m; 40 kg
Adapter Pedestal HM020Z2	0.9 m x max. 0.5 m x 0.9 m; 30 kg

Ordering information

Triple-Loop Antenna	HM020	4023.4508.02
Extras		
Control Unit	BG020	4024.1002.02
Basic Pedestal	HM020Z1	4023.5504.02
Adapter Pedestal	HM020Z2	4023.5604.02
Calibration Dipole	HM020Z3	4023.5704.02
Control Cable	EZ-14 (included)	1026.5341.05

Active Antennas AM524, HM525

Active Antenna System

AM524: 100 Hz to 1 GHz

Active H-Field Test Antenna

HM525: 100 Hz to 30 MHz

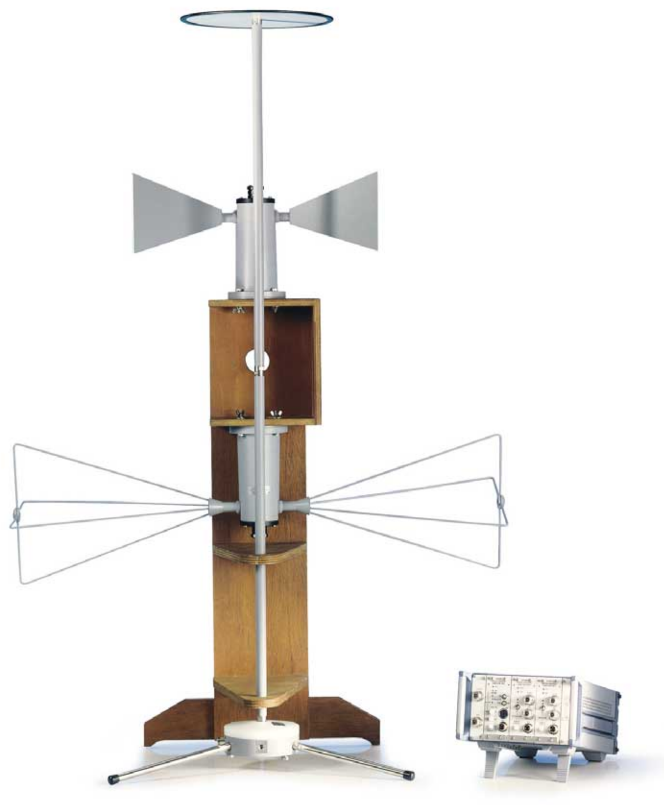
Brief description

For measuring unwanted, compromising emissions, antennas are required which allow detection of extremely low-level signals.

Active Antennas AM524 and HM525 are able to measure signals with a level 10 dB to 20 dB lower than that of signals that can be measured with conventional EMC test antennas. Therefore they are mainly used in anechoic chambers.

Equipment supplied

AM524 consists of three antennas (HE525, HE526 and HE527) with the appropriate junction units, a basic unit with power supply, transit case and support. HM525 requires the same peripheral devices as AM524.



AM524 (photo 40442)

HM525 (photo 43082)

Specifications in brief

Sensitivity at 1 Hz bandwidth				
Frequency	**HE525**	**HE526**	**HE527**	**HM525**
100 Hz	0 dB(μV/m)			18 dB(μA/m)
1 kHz	–18 dB(μV/m)			–22 dB(μA/m)
10 kHz	–35 dB(μV/m)			–50 dB(μA/m)
100 kHz	–43 dB(μV/m)			–68 dB(μA/m)
1 MHz	–48 dB(μV/m)			–88 dB(μA/m)
10 MHz	–49 dB(μV/m)			–93 dB(μA/m)
30 MHz	–51 dB(μV/m)	–49 dB(μV/m)		–92 dB(μA/m)
100 MHz		–54 dB(μV/m)		
200 MHz		–48 dB(μV/m)	–49 dB(μV/m)	
300 MHz			–54 dB(μV/m)	
400 MHz			–48 dB(μV/m)	
500 MHz			–49 dB(μV/m)	
1000 MHz			–54 dB(μV/m)	

Ordering information

Active Antenna System	AM524	4015.7001.02
consisting of		
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
HE526	GX526	4015.9504.02
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	4036.0506.02
Active H-Field Test Antenna	HM525	4031.0508.02
Support for H-Field Test Antenna	HM525-Z1	4036.1402.02
Control Unit	GS525	4035.5004.02

Shielded, Calibrated Magnetic Field Pickup Coil HZ-10

5 Hz to 10 MHz

Measurement of magnetic field strengths to relevant standards

HZ-10 with (right) and without (left) spacing plate (photo 40877)

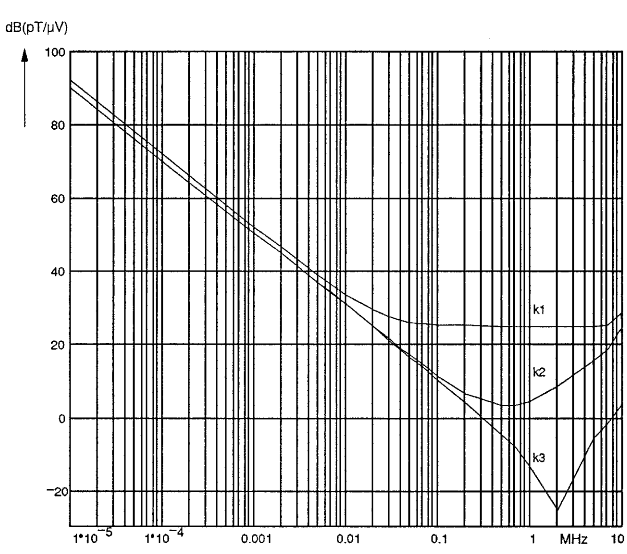
Brief description

The shielded and individually calibrated Magnetic Field Pickup Coil HZ-10 allows magnetic field strengths in the frequency range from 20 Hz to 200 kHz to be measured in line with commercial and military standards MIL-STD-461/462, DEF STAN 59-61, GAM-EG 13, VG 95377 Part 13 and EN55103-1.

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.

Main features

- 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 standard)
- Isolated coil with shielded twin-wire connection to avoid galvanic surface currents induced in the shielding
- ¼" 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 in brief

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
Extras		
RF Connecting Cable balanced/unbalanced, 0.2 m, Twinax/BNC connector	EZ-19	1052.2630.02

E and H Near-Field Probe Sets HZ-11, HZ-14


HZ-11 (photo 43417-2)


HZ-14 (photo 43441-2)

HZ-11: 100 kHz to 2 GHz

HZ-14: 9 kHz to 1 GHz

Diagnostic tools for solving EMC problems

Brief description

The near-field probe sets can be used in conjunction with test receivers, spectrum analyzers or oscilloscopes to determine electromagnetic emissions of any type. Their main applications is in the diagnosis of emissions from printed circuit boards, cables and leakage spots in shielded enclosures. The passive probes can be used for a local susceptibility test.

Probe Set HZ-11 is for a qualitative, Probe Set HZ-14 for a quantitative analysis. The probe sets come in a handy transit case.

Equipment supplied, characteristics

Probe Set HZ-11 comprises:

- three passive H-field probes
- two passive E-field probes
- one probe extension and
- one preamplifier with built-in battery and battery charger

The H-field probes are small (diameter of 1 cm, 3 cm and 6 cm) electrically shielded loop antennas with directional pattern; the E-field probes, shaped as rod and spherical probes, are for omnidirectional reception of the interference source.

Probe Set HZ-14 comprises:

- two passive H-field probes (9 kHz to 30 MHz and 30 MHz to 1 GHz)
- one active E-field probe (9 kHz to 1 GHz)
- one 30 dB preamplifier for the H-field probe (can be powered from all Rohde & Schwarz test receivers and spectrum analyzers)
- a test jig for testing the H-field probes and simplified normalization of H-field measurements with the aid of a tracking generator and normalization functions provided in spectrum analyzers

Specifications in brief

HZ-11

Type of probe	Measurement of	E- or H-field rejection	1st resonant frequency
Loop 6 cm	H-field	41 dB	790 MHz
Loop 3 cm	H-field	29 dB	1.5 GHz
Loop 1 cm	H-field	11 dB	2.3 GHz
Sphere 3.6 cm	E-field	30 dB	>1 GHz
Rod 6 mm	E-field	30 dB	>2 GHz

Gain of broadband preamplifier

100 kHz	1 MHz	100 MHz	1 GHz	2 GHz	3 GHz
35 dB	38 dB	39 dB	33 dB	26 dB	14 dB

Noise figure at 500 MHz	3.5 dB typ.
Saturated output level at 100 MHz	12 dBm typ.
1 dB compression point at 100 MHz	8 dBm typ.

HZ-14	9 kHz to 1 GHz
H-field probe, max. input power	≤30 MHz: 0.5 W >30 MHz: 0.25 W
VSWR (f >30 MHz)	<2
E-field probe	
Frequency response	3 dB
Sensitivity	13 mV/V
Connectors	SMA female
Preamplifier	9 kHz to 1 GHz
Gain	30 ±2 dB (typ. 1 dB)
Input/output	BNC female/N male
Impedance, VSWR	50 Ω, <2
Powering	10 V ±0.1 V, <100 mA
DC connector	LEMO

Ordering information

E and H Near-Field Probe Set		
with power supply 220 V	HZ-11	0816.2770.04
with power supply 110 V	HZ-11	0816.2770.05
E and H Near-Field Probe Set	HZ-14	1026.7744.02

Precision Halfwave Dipole Sets HZ-12, HZ-13

HZ-13 (photo 40784)

HZ-12 (photo 40786)

HZ-12: 30 MHz to 300 MHz

HZ-13: 300 MHz to 1000 MHz

Test standards for antenna calibration and test-site attenuation measurements

Brief description

Antenna calibration
Tunable halfwave dipoles are used for the calibration of VHF-UHF broadband antennas, which have their advantages in practical use but whose characteristics cannot be strictly calculated.

Test-site attenuation measurements
Halfwave dipoles are the only tool for checking reference sites used for antenna calibration to ANSI C63.5. They are also used for checking anechoic chamber test sites.

Characteristics
The dipoles contain balance-to-unbalance transformers and attenuators. The attenuation between the dipole connectors and the 50 Ω connector is about 10 dB. Two closely linked dipoles provide an attenuation of about 20 dB. This value can be very accurately measured with a network analyzer. The sum of the two antenna factors $2k_e$ (it is only the sum that is of significance for the test-site validation) can thus be precisely calculated:

$2\ k_e = 20\ \text{dB} + 2 \times 1.64\ \text{dB}$
$+ 2 \times 20 \log (2\ \pi/\lambda)\ \text{dB}$
1.64 dB = voltage transformation
$2\ \pi/\lambda$ = antenna factor of $\lambda/2$ dipole

Equipment supplied
Each dipole set comes in a transit case to protect the dipole rods. The dipole supports are fitted with flanges suitable for mounting on Rohde&Schwarz antenna masts. The manual supplied with the dipole sets contains the attenuation values of the dipole set and a table for height-dependent correction of the antenna factors above a conductive ground plane.

Specifications in brief

Frequency range	
HZ-12	30 MHz to 300 MHz
HZ-13	300 MHz to 1000 MHz
Power attenuation of dipole pair (closely coupled)	20 dB (calibration curve supplied with set)
Antenna factor	
HZ-12	7.5 dB to 27.6 dB (proportional to f)
HZ-13	27.4 dB to 38 dB (proportional to f)

Ordering information

Precision Halfwave Dipole Set	HZ-12	0816.2870.02
	HZ-13	0816.2940.02

Active Receiving Dipoles HE202, HE302

HE202 (photo 43529)

HE302 (photo 43518)

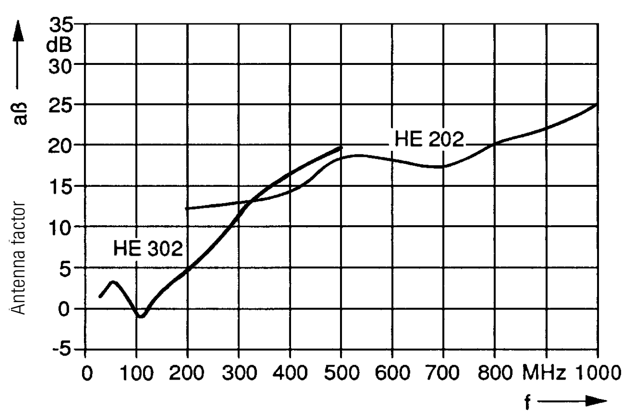
Brief description

Despite their extremely large bandwidth, HE202 and HE302 feature a field-strength sensitivity that is in the entire frequency range comparable to that of antennas with smaller bandwidth and considerably larger dimensions.

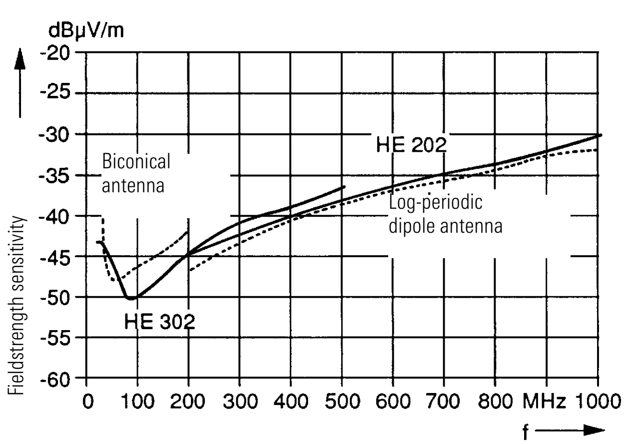
The degree of nonlinear distortion in the test system is important for signal field strength and interference field-strength measurements in shielded rooms. With 1-dB compression, for example, the Active Receiving Dipole HE 302 is in the linear range for field strengths up to 5 V/m at 20 MHz and up to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

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



Antenna factor as a function of frequency



Specifications in brief

		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 dB to 9 dB	–11 dB to +8 dB
Practical gain		7 dB to 11 dB	–9 dB to +10 dB
Directivity		2 dB average	2 dB average
Antenna factor and field-strength sensitivity		see diagrams	see diagrams
Noise figure		200 MHz: 6 dB 1000 MHz: 7 dB	20 MHz: 28 dB 500 MHz: 9 dB
Intercept point	2nd order	>55 dBm	>60 dBm
	3rd order	>30 dBm	>30 dBm
Power supply (from Power Supply Unit IN115), DC voltage		18 V to 30 V, via RF cable 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 Dipoles	HE202	0630.0310.0x
	HE302	0644.1114.0x

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

Extras		
Mast Adapter	HE202 Z1	0649.7510.02
RF Cable	HE202 Z2	0649.7785.02
Antenna Adapter	AM524Z2	4036.0658.02
Calibration at Delivery	HE202, HE302	0758.3109.23

Left: field-strength sensitivity of Active Receiving Dipoles HE 202, HE 302 compared to that of passive antennas with a receiver noise figure of 10 dB

HF Antennas

Loop Antenna HFH 2-Z2

Broadband active loop antenna for measuring the magnetic field-strength components.

Photo 28024

Rod Antenna HFH 2-Z6

Broadband active rod antenna for measuring the electrical component of radiated EMI in test setups to MIL-STD-461/462 and similar MIL standards.

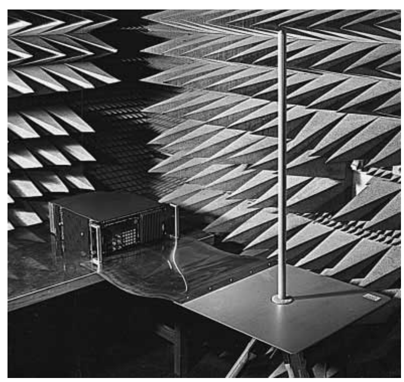


Photo 36487-1

Inductive Probe HFH 2-Z4

Inductive probe for the assessment of the magnetic field-strength components.

Photo 28826

Power Supply HZ-9

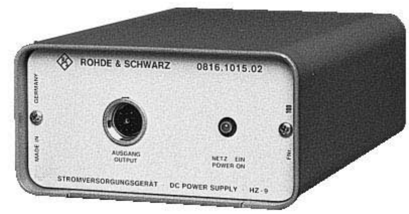


Photo 38647

Power supply for feeding the active Antennas HFH 2-Z1/Z2/Z6 if these antennas cannot be powered from the test receiver.

Specifications in brief: HZ-9

Output voltages	±10 V ±0.5 %
Min. current load	100 mA
DC connector	12-contact Tuchel female
AC supply	100 V to 240 V, −15/+10%
Dimensions (W x H x D)	125 mm x 70 mm x 188 mm
Weight	1.5 kg

Ordering information HZ-9

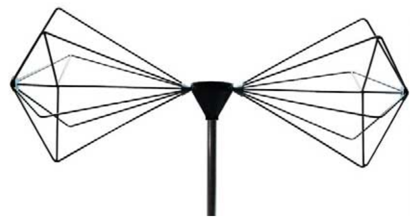
Power Supply for Active Antennas HZ-9	0816.1015.02

Specifications in brief

	Loop Antenna HFH 2-Z2	**Inductive Probe HFH 2-Z4**	**Rod Antenna HFH 2-Z6**
Frequency range	9 kHz to 30 MHz	100 kHz to 30 MHz	9 kHz to 30 MHz
Antenna factor k, referred to 1/m	20 dB (E field)	80 dB (E field)	10/20 dB, selectable
Accuracy	1 dB	6 dB	1 dB
Measurement range (IF bandw. 200 Hz, AV ind.)			
Lower limit, frequency-dependent	9 kHz to 1 MHz: +40 to +10 dB(µV/m) 1 to 30 MHz: +10 to +5 dB(µV/m)	50 dB(µV/m) (≈0 dB(µA/m))	+15 to −18 dB(µV/m)
Upper limit	140 dB(µV/m)	>190 dB(µV/m) (≈140 dB(µA/m)	140 dB(µV/m) 130 dB(µV/m) (k=10 dB)
Connectors			
RF	BNC female, 50 Ω	BNC male, 50 Ω	BNC female, 50 Ω
Supply and coding (antenna factor)	12-contact Tuchel female	12-contact Tuchel male	12-contact Tuchel female
Length of connecting cables	10 m	1 m	10 m
Current drain (±10 V)	<40 mA	—	<45 mA
Dimensions	loop dia.: 590 mm	outer dia.: 50 mm height: 20 mm	base: 60 x 60 mm rod height: 1000 mm
Weight	in transit case, without cable: 12 kg	with cable: 0.3 kg	without cable: 5 kg
Order No.	0335.4711.52	0338.3016.52	0837.1866.54

VHF, UHF and SHF Antennas

Biconical Antenna HK116, Log Periodic Antennas HL223, HL023A1, HL025 and HL040



HK116 (photo 38843)

HL025 (photo 33011-2)

Brief description

These linearly polarized antennas are used for EMI and EMS measurements in line with commercial and military standards. Depending on frequency and type of antenna, maximum field-strength values between 10 V/m and 300 V/m can be achieved. The use of Conical Log Spiral Antenna HUF-Z4 with circular polarization is limited to measurements in line with MIL-STD-461 A to C.

HL223 (photo HL023A1 on page 110)
(photo 38841)

Specifications in brief

	HK116	**HL223**	**HL023 A1**	**HL040**	**HL025**
Frequency range	20 MHz to 300 MHz	0.2 GHz to 1.3 GHz	0.08 GHz to 1.3 GHz	0.4 GHz to 3 GHz	1 GHz to 18 GHz
Antenna factor k	21 dB to 8 dB	10 dB to 26 dB	4 dB to 25 dB	17 dB to 33 dB	22 dB to 47 dB
Power-handling capacity	70 W	1500 W to 600 W	700 W to 230 W	50 W	5 W
Max. field strength	10 V/m to 40 V/m	300 V/m	150 V/m to 200 V/m	50 V/m to 100 V/m	40 V/m
VSWR	typ. 2.5	typ. 1.6 (<2)	typ. 2 (<2.5)	typ. 2 (<2.5)	<2.5
Connector/nominal impedance	N female/50 Ω	N female/50 Ω	N female/50 Ω	N female/50 Ω	SMA female
Weight	3 kg 2 kg		7.7 kg	2.8 kg	0.7 kg
Order No.	4000.7752.02	4001.5501.02	0577.8017.02	4035.8755.02	0671.5317.02

ULTRALOG HL562

30 MHz to 3000 MHz

EMS measurements with high field strengths in an extremely wide frequency range

HL562 with option HL562Z1 (photo 43317)

Brief description

The ULTRALOG antenna combines the characteristics of a biconical and a log-periodic antenna. The ULTRALOG antenna is mainly used for measuring emissions in the broad frequency range from 30 MHz to 3 GHz without change of the antenna. Symmetry and matching (VSWR) of the ULTRALOG allow its use in EMS measurements where field strengths of 10 V/m or higher are required.

The log-periodic part of the antenna is V-shaped in order to increase the system sensitivity in particular from 500 MHz to 1 GHz. Unlike with conventional designs, this gain-increasing measure brings about the compact size of the ULTRALOG.

Special features

- Only one antenna required to cover wide frequency range
- Selectable polarization plane
- Suitable for EMS measurements with high field strengths
- Gain increase at high frequencies
- Compact size
- Individual calibration (ANSI C63.5 and DIN 45003)

Specifications

Frequency range	30 MHz to 3000 MHz
Polarization	linear
Polarization isolation	>20 dB
Nominal impedance	50 Ω
VSWR	typ. <2
Max. input power (T_{amb} = +40 °C)	
30 MHz	150 W + 100% AM
80 MHz	300 W + 100% AM
250 MHz	500 W + 100% AM
1000 MHz	280 W + 100% AM
3000 MHz	180 W + 100% AM
Gain	8 dBi (typ.) from 200 MHz
RF connector	N female
Class of application	laboratory
Dimensions (W × H × L)	approx. 0.60 m × 1.65 m × 1.68 m
Weight	approx. 5 kg

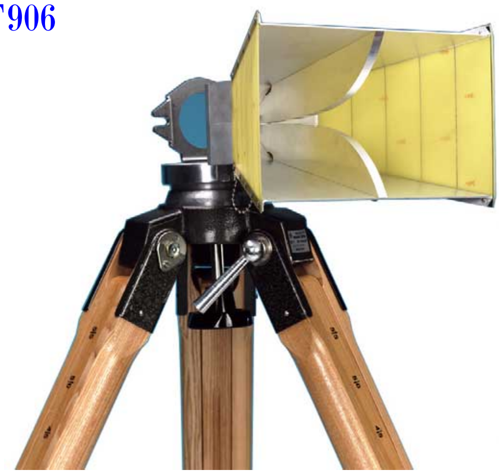
Ordering information

ULTRALOG	HL562	4041.3000.02
Extra		
Tripod, movable	HL562Z1	4041.3900.02

Double-Ridged Waveguide Horn Antenna HF906

1 GHz to 18 GHz

Broadband directional antenna, preferably for use in EMI measurements



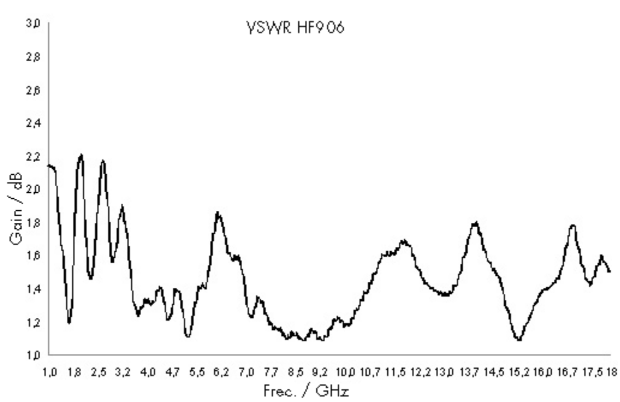
HF906 with optional Wooden Tripod HZ-1 (photo 43268-3)

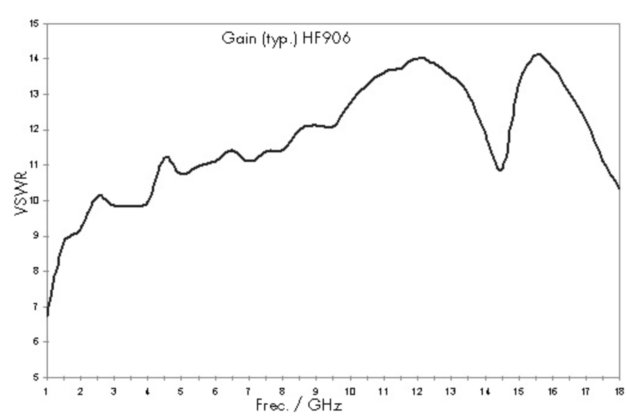
Brief description

The Double-Ridged Waveguide Horn Antenna HF906 with linear polarization is a broadband compact transmitting and receiving antenna for the frequency range from 1 GHz to 18 GHz. The calibrated antenna is ideal for use in EMI measurements. High gain and low VSWR allow the generation of high field-strength levels without any significant return loss as well as the measurement of weak signals. The principle of the exponential double-ridged waveguide makes for the wide frequency range from 1 GHz to 18 GHz of the Antenna HF906 despite its small dimensions. The gain increases with the frequency. The horn antenna requires little space and is easy to handle. The use of an N connector allows easy adaptation to existing units as well as high input power. The antenna is made of aluminium and tinned GRP boards to keep its weight low.

Main features

- Wide frequency range
- High gain
- Input power up to 300 CW/500 W PEP





Specifications

Frequency range	1 to 18 GHz
Polarization	linear
Nominal impedance	50 Ω
VSWR	<1.5 (typ.)
Max. input power	300 W CW/500 PEP
Gain	7 to 14 dB typ. (see diagram)
Connector	N female
Operating temperature	0 to +50 °C
Dimensions (L × W × H)	290 mm × 250 mm × 160 mm
Weight	1.5 kg

Ordering information

Double-Ridged Waveguide Horn Antenna	HF906	4044.4507.02
Extra		
Wooden Tripod	HZ-1	0837.2310.02

Broadband Dipole HUF-Z1

The antenna complies with CISPR16-1. The antenna factor k is nearly constant in the range 25 MHz to 80 MHz; a factor of 15 dB or 20 dB can be selected.

Specifications in brief

Frequency range	20 MHz to 80 MHz
Connector	N female
Nominal impedance	50 Ω
VSWR	
for k = 15 dB	<2
for k = 20 dB	<1.3
Antenna factor k	
for k = 15 dB	
20 MHz to 25 MHz	22.5 dB to 15 dB
25 MHz to 80 MHz	15 dB
for k = 20 dB	
20 MHz to 25 MHz	27.5 dB to 20 dB
25 MHz to 80 MHz	20 dB
Dipole length	1.77 m
Folded size	0.9 m x 0.13 m dia.
Weight	2.5 kg
Order No.	0358.0512.52

HUF-Z1 (photo 33925-1)

Mast and Tripod HFU-Z

Brief description

The mast consists of three epoxy glass laminate tubes, a swivel arm holder and an antenna carrier. Guy ropes and pegs are supplied with the mast. The receiving antenna can be positioned at a height between 1 m and 5 m. Azimuth and polarization plane can be chosen as desired; the elevation angle can be varied by a maximum of ±30°.

Specifications in brief

Dimensions (folded)	
Mast	length: 1.65 m
Tripod	length: 0.9 m dia.: 0.22 m
Transport weight	
Mast	36 kg (with crate)
Tripod	9 kg

Ordering information

Mast	HFU-Z	0100.1120.02
Tripod	HFU-Z	0100.1114.02

Mast and Tripod HFU-Z with Antenna HL023A1 (photo 29359-1)

Wooden Tripod HZ-1

Brief description

This tripod supports the Antennas HFH2-Z6, HK116, HL223 and HUF-Z4.

- Light-metal universal ball joint tiltable all round up to 25°; lockable in any position
- Antenna holder with captive ¼" screw
- Each two-section tripod leg extensible between 830 mm and 1360 mm

Specifications in brief

Length, collapsed	910 mm
Weight	6.5 kg

Ordering information

Wooden Tripod HZ-1	0837.2310.02

V-Networks ESH2-Z5, ESH3-Z5, ESH3-Z6

Interference measurements on AC-powered loads

Models -Z5 for remote-control via R&S EMI test receivers

Insertion loss calibrated to ANSI C63.4

Main features

- AC voltage supply to EUT
- Isolation of test circuit from line interference
- Standardized load impedance
- Defined feed of interference voltage produced by EUT to EMI test receiver

Brief description of ESH2-Z5

Four-line V-network (50 µH + 5 Ω) shunted by 50 Ω in line with VDE 0876 and CISPR 16-1. It uses air-core inductances and contains an artificial hand as well as a PE simulating network that can be bypassed. A built-in fan with its own

ESH2-Z5 (photo 35326)

AC supply provides automatically controlled or permanent cooling, as required.

Brief description of ESH3-Z5

Two-line V-network (50 µH + 5 Ω) shunted by 50 Ω in line with VDE 0876 and CISPR 16-1. It uses air-core inductances and contains an artificial hand as well as a PE simulating network that can be bypassed. The compact design and low weight make the ESH 3-Z5 an ideal choice for frequently varying applications.

ESH3-Z5 (photo 35760)

Brief description of ESH3-Z6

ESH3-Z6 is a single-phase V-network (5 µH + 1 Ω) shunted by 50 Ω complying with the requirements of VDE 0876 Part 1 (onboard power supply systems), CISPR Publ. 16 (low-impedance power supplies) as well as MIL-STD-462 Notice 3, MIL-I-6181D, MIL-I-16910C, MIL-E-55301, DEF-STAN 59-41 and DO 160 in the frequency range 100 kHz to 200 MHz.

ESH3-Z6 (photo 35913)

Specifications in brief

	ESH2-Z5	ESH3-Z5	ESH3-Z6
Frequency range	9 kHz to 30 MHz	9 kHz to 30 MHz	0.1 MHz to 200 MHz
Impedance accuracy	±20%	±20%	±20 %
Continuous current	4 x 25 A	2 x 10 A	100 A (150 A to T_{amb} = 35 °C)
Max. short-time current	4 x 50 A (2 min)	2 x 16 A (30 min)	500 A (30 s)
Max. AC supply voltage	250 V rms	250 V rms	250 V rms; 600 V DC
Max. AC supply frequency	63 Hz	63 Hz	440 Hz
AC supply input connector	4 x 32 A (Cekon male) European male for fan	earthing-contact type male with 1.8-m cable	screw terminal M8
AC supply connector for EUT	4 x 32 A (Cekon female) 2 x 16 A (earthing-contact type female)	earthing-contact type female	screw terminal M8, reference ground to metallic ground plate
RF output to test receiver	BNC female	BNC female	N male
Remote-control input from test receiver	50-contact Amphenol female	9-contact Cannon female	–
Input for artificial hand	two 4 mm jacks	4 mm jack	–
Dimensions (H x B x T)	492 mm x 294 mm x 603 mm	219 mm x 147 mm x 350 mm	122 mm x 128 mm x 322 mm
Weight	26 kg	5.5 kg	1.9 kg

Ordering information

	ESH2-Z5	ESH3-Z5	ESH3-Z6
V-Network	0338.5219.53	0831.5518.52	0836.5016.52
Control cable to test receiver	EZ-5, 0816.0625.02	EZ-4, 0816.0560.02 (3 m) or EZ-6, 0816.0683.02 (10 m)	–

200-A Four-Line V-Network ENV4200

150 kHz to 30 MHz

For RFI voltage measurements at high currents

Photo 42885

Brief description

Four-Line V-Network ENV4200 is used for measuring RFI voltages on AC supply connections of EUTs carrying very high currents.

It uses air-core inductances and contains an artificial hand. ENV4200 satisfies the requirements of CISPR 16-1, VDE 0876 and ANSI C 63.4 for V-networks with an impedance of 50 µH || 50 Ω in the frequency range 150 kHz to 30 MHz.

CISPR 16-1 specifies two types of V-networks for the frequency range 150 kHz to 30 MHz: one with an impedance of 50 µH || 50 Ω and another with an impedance of (50 µH + 5 W) || 50 Ω. V-Network ENV4200 corresponds to type 1.

The maximum attainable current of the V-network is limited by the voltage drop at the standardized inductances (CISPR 16-1 prescribes the voltage drop at 5% of the AC supply voltage) and by unavoidable heat losses.

Main features

- V-network to CISPR, EN, VDE, ANSI
- Impedance 50 µH || 50 Ω
- Artificial hand
- Continuous current up to 4 x 200 A
- Air-core design
- Remote control with TTL levels
- Calibrated to CISPR/A/201/CDV and ANSI C63.4

Specifications in brief

Frequency range	150 kHz to 30 MHz
Impedance characteristic of V-network	50 µH || 50 Ω
Error limits (to CISPR 16-1)	±20%
Test path (to EUT)	
Max. permissible continuous current	4 x 100 A with fans switched off 4 x 200 A with fans switched on
Operating time derated	at higher currents
DC resistance per path	6.7 mΩ (typ.)
AC supply frequency range	0 to 63 Hz
Max. permissible AC supply voltage	260 V/450 V
Test path (to test receiver)	
Pulse limiter	to 150 dBµV (built-in)
Voltage attenuation between EUT and test receiver	10 dB (built-in attenuator pad)
Cooling	with 4 built-in fans
Connectors	
EUT connectors	knob for 15 mm terminals
Ground	screw terminal M8
Reference ground	uninsulated busbars
RF connector	BNC female
Remote control	25-pin Cannon female
General data	
Rated temperature range	+5°C to +40°C
Storage temperature range	–30°C to +70°C
Dimensions (W x H x D); weight	450 mm x 315 mm x 670 mm; 43 kg

Ordering information

Four-Line V-Network	**ENV4200**	**1107.2387.02**
Extras		
25-wire remote control cable for control by Test Receivers of		
ESxS Series: control cable 3 m	EZ-21	1107.2087.03
control cable 10 m	EZ-21	1107.2087.10
2 required for shielded room		
EBxI Series: control cable 3 m (Combination with EZ-21 required for shielded chamber)	EZ-22	1107.2235.03

Coupling Networks ENY

for EMI emission and immunity tests on unshielded symmetrical telecommunication ports

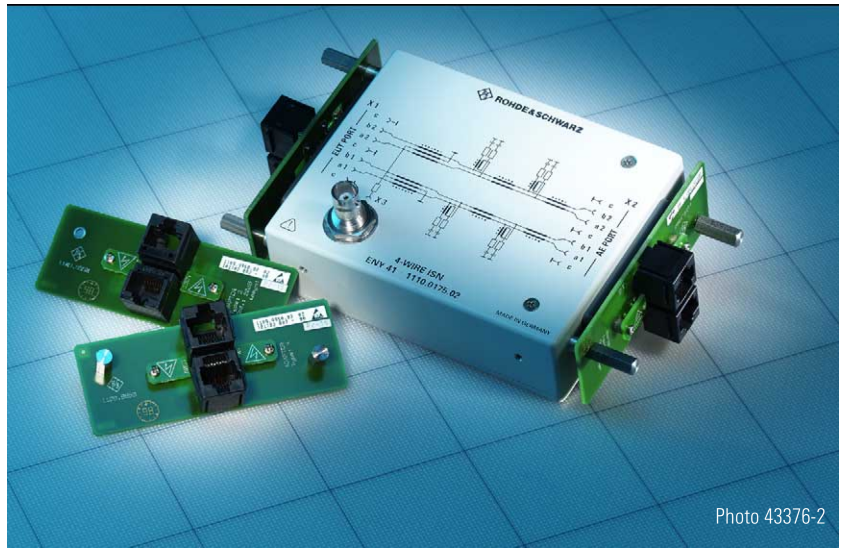


Photo 43376-2

Brief description

Coupling Networks ENY22 and ENY41 have been designed to measure the asymmetrical (common-mode) RFI voltage of unshielded symmetrical telecommunication ports of EUTs in the frequency range 150 kHz to 30 MHz according to CISPR22, 1997/EN55022, 1998. In these product standards, this type of coupling networks is referred to as ISN (impedance stabilization network), whereas in basic standards they are called AAN (asymmetrical artificial network) or Y-network (CISPR16) or CDN (coupling/decoupling network, IEC61000-4-6). In addition to emission measurements, ENY22 and ENY41 also enable immunity testing of the above-mentioned EUTs in the frequency range 150 kHz to 80 MHz according to CISPR24, 1997/EN55024, 1998 and IEC61000-4-6. They meet the requirements of CISPR22/1997.

Interface standard	Usual connectors		Pin configuration of RJ45 connector								Type
	RJ45		8	7	6	5	4	3	2	1	
		RJ11		6	5	4	3	2	1		
Deutsche Telekom		X			a	W	E	b			I
Deutsche Telekom V_{PN}, $V_{P0/E}$		X			a			b			V
Siemens	X				E	b	a	W			I
Siemens V_{PN}, $V_{P0/E}$	X					b	a				V
US-Norm	X				W	b	a	E			I
Token Ring	X				RX	TX	TX	RX			I
10Base T	X				RX			RX	TX	TX	II
100Base T	X				RX			RX	TX	TX	II
ATM	X		X	X					X	X	III
FDDI	X		X	X					X	X	III
ISDN basic rate access	X				X	X	X	X			I
ISDN primary rate access 2048 kbit/s	X					X	X		X	X	IV
ISDN primary rate access 1544 kbit/s	X					X	X		X	X	IV

The table gives an overview of available RJ45 adapter sets. The four types I through IV are available for the four-wire ISN ENY41. For the double two-wire ISN, type V is available. For the latter, pins 3, 4 and 5, 6 are connected in parallel. In addition, there is an adapter set for user-selectable wiring (type VI).

Coupling Networks ENY

Description

ENY22 comprises two separate two-wire networks with two receiver ports in one box, whereas ENY41 includes one four-wire network.

ENY22 and ENY41 terminate the interface of the EUT with 150 Ω (asymmetrical or common-mode impedance) and couple the asymmetrical impedance to the test receiver with a voltage-division factor of approx. 10 dB. The useful symmetrical (differential-mode) signal passes through the network almost unattenuated with a bandwidth of up to 100 MHz (measured for a symmetrical impedance of 100 Ω). At the same time the coupling network decouples the test circuit from interference effects (RFI voltage, impedance) at the AE (auxiliary equipment) port.

Main features

- Four-wire and double two-wire networks (ISNs)
- Conducted emission measurements to CISPR 22/1997 and EN 55022/1998 (150 kHz to 30 MHz)
- Conducted immunity measurements to CISPR 24 and EN 55024 (150 kHz to 80 MHz)
- Adapter sets to meet LCL requirements (LCL: 50 dB, 60 dB and 80 dB) and various telecommunication standards
- High transfer bandwidth for useful signal (100 MHz)

Specifications

Frequency range

Emission measurements	150 kHz to 30 MHz
Immunity measurements	150 kHz to 80 MHz

Asymmetrical impedance

Impedance in range 0.15 MHz to 30 MHz	150 Ω ± 20 Ω
Phase angle in range 0.15 MHz to 30 MHz	0 ± 20°
Impedance in range 150 kHz to 80 MHz	150 Ω ± 40 Ω

Voltage-division factor

in asymm. circuit In range 150 kHz to 30 MHz	10 dB ± 1 dB typ. (calibration data supplied[1])

Transfer bandwidth (3 dB)

in symm. circuit	>100 MHz (for 100 Ω source and load impedances)

Differential-mode rejection (LCL)	80 dB adapter	60 dB adapter	50 dB adapter
150 kHz to 1.5 MHz	(80 – 3) dB	(60 ± 3) dB	(50 ± 3) dB
1.5 MHz to 30 MHz	>(80 to 55) dB –3 dB	(60 to 35) dB ± 3 dB	(50 to 25) dB ± 3 dB

Decoupling attenuation

150 kHz to 1.5 MHz	>35 dB to 55 dB (linear increase with log frequency)
1.5 MHz to 80 MHz	>55 dB

Maximum values

Max. permitted RF input voltage	17 V
Max. permitted DC and low-frequency AC voltage between symm. line and ground	160 V
Max. DC current (phantom current)	150 mA (current on each individual wire of one pair or on different pairs)

Connectors

Output to receiver/ input from signal generator	BNC connectors
EUT and auxiliary equipment (AE)	adapters with screw terminals and RJ45 connectors

General data

Nominal temperature range	+ 5 °C to 40 °C
Storage temperature range	–40 °C to + 70 °C
Dimensions of basic unit	144 mm x 95 mm x 52 mm
Dimensions of unit with adapters	168 mm x 96 mm x 52 mm
Weight of unit with adapters	535 g
Weight of carrying case with basic adapter set	2170 g
Weight of option ENY4-B1	330 g

Order designation

Double Two-Wire ISN to CISPR22	ENY22	1109.9508.02
Four-Wire ISN to CISPR22	ENY41	1110.0175.02
Option for ENY41: 3 additional RJ45 adapter sets	ENY4-B1	1109.9950.02

Accessories supplied plastic carrying case with foam material, calibration data

Extra test accessories (on request)

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[1] The calibration data contain: asymmetrical impedance and phase, voltage-division factor, differential-mode rejection ratio.

Antenna Impedance Converter EZ-12

Photo 43427-3

EZ-12 is a broadband matching unit for test receivers and spectrum analyzers with low-impedance inputs. It is used for high-impedance measurements of interference voltage at the feedpoint of a vehicle-mounted antenna in the long-, medium- and shortwave bands to VDE 0879 Part 2 and CISPR25. For measurements in the VHF-FM range antenna signal can be switched to a separate 50-Ω input.

- Flat frequency response
- High sensitivity
- High overload capability
- Rugged metal case

The EZ-12 can be directly powered from Rohde & Schwarz test receivers or spectrum analyzers. Should this not be possible, it is recommended to use Power Supply HZ-9 (see page 106).

Specifications in brief

Frequency range	150 kHz to 30 MHz (120 MHz)
RF input	DIN 415845
Input impedance	>100 kΩ, <10 pF (at 1 MHz)
Gain factor for	
direct input to antenna connector	0 ±1 dB
correction factor –10 dB	+11.2 dB
AM output	BNC female, 50 Ω
VSWR	≤1.4
FM output, remote controlled	BNC female, 50 Ω
Noise voltage at output (input terminated with antenna simulator; average detector, BW = 10 kHz)	
f >150 kHz	<–5 dBμV
f >500 kHz	<–7 dBμV
1 dB compression point	>107 dBμV
Power supply	+10 V ±0.1 V
Current drain	<50 mA
Dimensions (W x H x D)	125 mm x 110 mm x 40 mm
Weight	0.6 kg

Ordering information

Antenna Impedance Converter	EZ-12	1026.4800.03

Current Probe EZ-17

Photo 39784-2

Model 02 with its extremely flat frequency response is optimal for current measurements as well as for measuring shielding effectiveness. Due to its high load capacity, model 03 is recommended for EMS measurements (bulk current injection). Thanks to their high magnetic overload capacity, these two models can be employed on power lines with currents up to 300 A without having an adverse effect on the measurement results. Due to its high sensitivity in the range below 100 kHz, model 04 is especially recommended for measurements to military standards.

Current Probes EZ-17 comply with the following standards:

- CISPR 16-1 and VDE 0876 Part 1 for measurement of RFI currents
- MIL-STD-461 CE 01 and CE 03
- VG 95373 Part 20, VG 95377 Part 14
- DEF-STAN 59-41 DCE 01 and 02
- RTCA/DO-160 C

Main features

- High sensitivity and overload capability
- Wide frequency range
- High load capacity for DC and AC current (300 A)
- Small dimensions in spite of large inner diameter (30 mm)
- Simple clamping thanks to spring-loaded mechanism

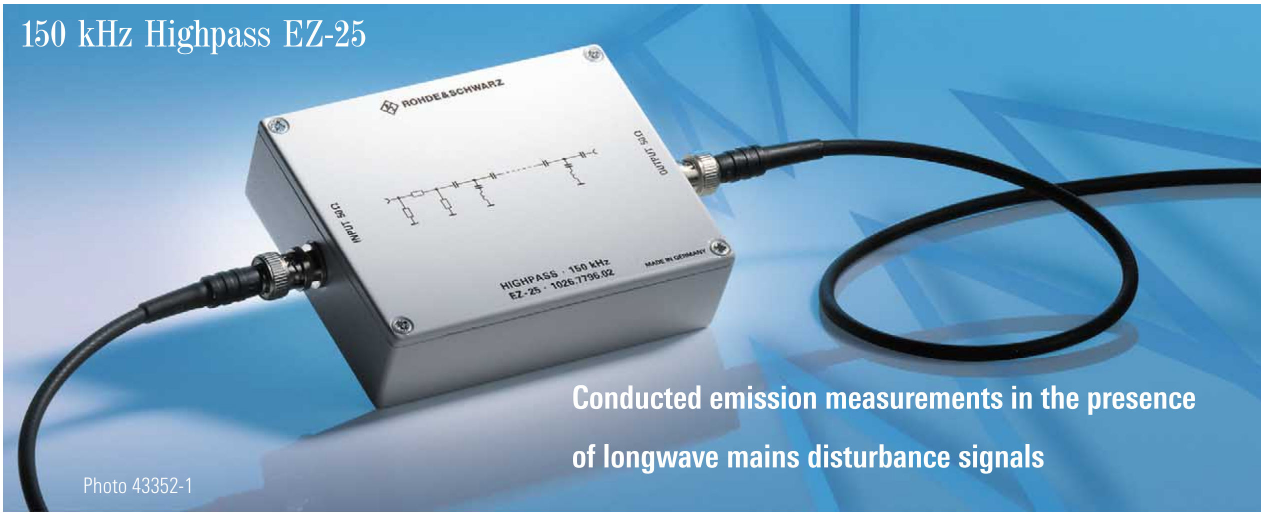
Specifications in brief

	Model 02	Model 03	Model 04
Frequency range	20 Hz to 100 MHz	20 Hz to 100 MHz	5 Hz to 2 MHz
Range with constant transducer factor (–3 dB)	1 MHz to 100 MHz	2 MHz to 100 MHz	1 kHz to 2 MHz
Transducer factor reduced by 20 dB/decade in range	20 Hz to 1 MHz	20 Hz to 2 MHz	5 Hz to 1 kHz
RF connector	N female	N female	Twinax female
Source impedance	≤0.8 Ω	≤1 Ω	≤0.1 Ω
Transfer impedance Z_T in range with constant transducer factor	3.16 Ω	7.1 Ω	0.1.27 Ω
Transducer factor k in range with flat frequency response	–10 dB	–17 dB	+15 dB
Load capacity (RF current measurement)			
Max. DC current or peak AC current	300 A (f <1 kHz)	300 A (f <1 kHz)	300 A (f <100 Hz)
Max. RF current (rms)	2 A (f >1 MHz)	1 A (f >1 MHz)	20 A (f >1 kHz)
Load capacity (EMS measurement)			
Max. power at RF connector	–	10 W (f >1 MHz)	10 W (f >10 kHz), 50 W for ≤15 min

Ordering information

Current Probe	EZ-17	0816.2063.02	0816.2063.03	0816.2063.04

150 kHz Highpass EZ-25



Conducted emission measurements in the presence of longwave mains disturbance signals

Photo 43352-1

Brief description

During signal transmission in low-voltage networks below 150 kHz, very high voltage levels may occur near the upper limit frequency of 148.5 kHz. This has been described in EN 50065-1. The selectivity of the CISPR measuring receiver specified in CISPR 16-1 can cause problems in the conformance of the equipment with the RFI voltage limits at 150 kHz. For this reason a highpass for an amendment of CISPR 16-1 has been defined in CISPR/A/244/FDIS, which can be used in front of the CISPR measuring receiver in order to improve the selectivity and so to achieve the values defined in part 1 of EN 50065, without affecting the passband of the measuring receiver.

Problems with high interfering voltages in the range below 150 kHz can also occur with EUTs, which are not involved with low-voltage signalling. Only very few EMC standards specify limits in the frequency range below 150 kHz. Therefore equipment manufacturers use suppression filters with extremely steep slopes to meet the requirements above 150 kHz. In these cases measuring receivers may be overloaded, entailing measurement errors in the frequency range above 150 kHz. Highpass EZ-25 prevents this and allows exact measurements.

Main features

- Conducted emission measurements to EN 50065 Part 1
- Pass frequency range 150 kHz to 30 MHz
- Very steep slope acc. to CISPR16-1: 1999 (selectivity)
- Suitable for any CISPR measuring receiver
- Relative attenuation >50 dB below 130 kHz
- Built-in 10 dB attenuation pad for exact 50 Ω termination of the LISN
- High pulse energy capability (50 mWs)
- Calibrated response

Specifications

Passband	150 kHz to 30 MHz
Insertion loss in passband	9.5 dB to 11 dB (calibration data supplied)
Stopband	below 130 kHz
Minimum attenuation in stopband	60 dB
Attenuation in the transition region	
146 kHz	<12 dB
145 kHz	>12 dB
140 kHz	>24 dB
130 kHz	>60 dB
Maximum input voltage (continuous)	137 dBμV
Maximum impulse energy (50 μs)	50 mWs
Connectors	BNC female
Nominal temperature range	0 to + 40 °C
Dimensions (LxWxH)	144 mm x 95 mm x 34 mm
Weight	400 g

Ordering information

Highpass 150 kHz	EZ-25	1026.7796.02
Accessories supplied	Short description with calibration data	

VHF Current Probe ESV-Z1

Photo 28825

Brief description

Current Probe ESV-Z1is used for selective or broadband measurement of very small as well as of very large RF currents in electric lines. They are shielded against electrostatic effects and comply with CISPR16-1 and VDE0876.

Specifications in brief

Frequency range	20 MHz to 300 MHz
Measurement range (average indication)	–33 to +117 dBµA (IF bandwidth 7.5 kHz)
Transfer admittance $Y_t = I_{in}/V_{out}$	0.1 S
Transducer factor k = 20 log (Y_t/s)	–20 dB
Max. current (superimposed on RF current or peak AC current)	50 A
Max. diameter of conductor	13.5 mm
RF connector	N male, 50 Ω, 1 m
Coding connector (transducer factor)	12-contact Tuchel
Dimensions (dia./height)	55 mm/20 mm
Weight	130 g

Ordering information

VHF Current Probe ESV-Z1	0353.7019.02

Pulse Limiter ESH3-Z2

ESH3-Z2 (photo 32934)

For limiting and reducing the interference level to protect the receiver input.

Specifications in brief

	ESH3-Z2
Frequency range	0 to 30 MHz
Insertion loss	10 ± 0.3 dB
Input/output VSWR	≤1.06/≤1.25
Power-handling capacity in continuous mode	1 W
Pulse power-handling capacity	E=0.1 Ws (6 µs)
RF connector, 50 Ω	BNC (female/male)
Dimensions (L x W x H or L x dia.)	94 mm x 25 mm x 25 mm
Weight	120 g

Ordering information

Pulse Limiter or Attenuator	0357.8810.52

Preamplifier ESV-Z3

ESV-Z3
(photo 34 762-1)

Brief description

Through the use of an external preamplifier the noise figure of a Rohde & Schwarz test receiver is reduced while at the same time its sensitivity is improved. Coding lines for transducers used for correcting the level and unit display of the rest receiver are looped through.

The preamplifiers can also be used for other receivers. Power Supply HZ-9 (see page 106) is recommended for feeding ESH 3-Z3 and ESV-Z3 if they cannot be powered from the test receiver. ESMI-Z7 is available with power supply 115 V and 230 V.

Main features

- Noise figure typ. 4 dB
- Noise indication typ. –20 dBµV for average value and IF bandwidth 7.5 kHz

Specifications in brief

Frequency range	20 MHz to 1000 MHz
Gain	10 dB
Input VSWR with test receiver	typ. 1.5
Noise figure	<6 dB, typ. 4 dB
1 dB compression point	typ. +13 dBm (output level) otherwise >+7 dBm guaranteed
Intercept point d3	typ. +27 dBm (output level)
Connectors	
RF input	N female, 50 Ω
RF output	N male, 50 Ω
Coding/power supply	12-contact Tuchel female for amplifier input
Dimensions (W x H x D)	160 mm x 29 mm x 110 mm
Weight	0.4 kg

Ordering information

Preamplifier	ESV-Z3	0397.7014.52

Probes ESH2-Z2, ESH2-Z3

ESH2-Z3 (photo 34981)

Active Probe ESH2-Z2

The active probe is used for measuring AC voltages on lines that do not carry AC supply voltage.

Passive Probe ESH2-Z3

The passive probe is suitable for measuring RFI voltages (on AC supply lines) to CISPR16-1 and VDE0876.

Attenuator ESH2-Z31

For checking the interference source impedance to VDE 0877, Part 1 and CISPR16-2.

Specifications in brief

	ESH2-Z2	**ESH2-Z3**
Frequency range	9 kHz to 30 MHz	9 kHz to 30 MHz
Measurement range (average indication, IF bandwidth 200 Hz with Rohde&Schwarz Test Receivers)	–20 dBμV to +120 dBμV	+10 dBμV to +150 dBμV
Attenuation/error	10 dB/<1 dB	30 dB/–1 to +5 dB
Input impedance	118 kΩ ±5% ‖8 pF	1.5 kΩ ±2% ‖9 pF
Max. input voltage f <63 Hz	100 V	250 V
f <500 Hz	5 V	250 V
9 kHz to 30 MHz	3 V	30 V

Ordering information

	ESH2-Z2	ESH2-Z3
Active or Passive Probe ESH2-Zx	0299.7210.52	0299.7810.52
Attenuator ESH2Z31	0827.6513.02	0827.6513.02
BNC Adapter URV-Z	0241.1110.02	0241.1110.02

RF Connecting Cables HFU2-Z4, HFU2-Z5

Low-loss cables for connecting antennas to test receivers. With this type of cable the outer sheath is filled with a special ferrite to reduce sheath currents.

Ordering information

RF Connecting Cable		
12 m	HFU2-Z4	0252.0090.56

Feeder Cables HZ-3, HZ-4

Connecting cables with 12-contact Tuchel male/female connectors for remote feeding of active antennas from the test receiver or from Power Supply HZ-9, page 106. The correction factor for automatic correction of unit and level display on the test receiver is also transmitted.

Ordering information

Feeder Cable		
3 m	HZ-3	0837.3469.02
10 m	HZ-4	0816.0519.02

The „National Academy of Television, Arts and Science“ has awarded its EMMY to Video Quality Analyzer DVQ from Rohde&Schwarz. DVQ received the award in the category "Advanced picture quality measurement technology for digital TV" because of its revolutionary principle requiring no reference signal.

Contents of Chapter 3

DTV Recorder Generator DVRG

Recording and generation of digital video streams

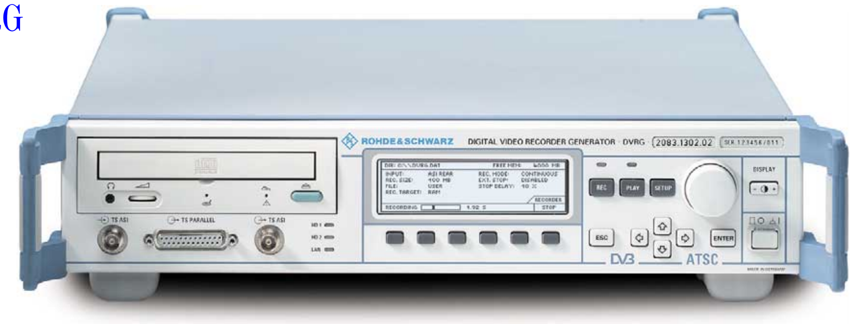


Photo 43401-1

Brief description

DVRG is a universal processing platform for digital video streams. It allows the record and play of MPEG2 transport streams. This is done either degradation free using the RAM when the transport stream is of limited length or directly using the hard disk. Minimum wear an tear can thus be achieved during continuous operation.

For error analysis, recording can be controlled by means of an external trigger signal. The stored signal includes time sections of different lengths before and after the trigger event.

In its key functions, DVRG is operated as a separate unit via keys on the front panel and the LC display. DVRG contains a complete PC platform with the Windows NT operating system whose features are available through the connection of VGA monitor, keyboard and mouse. For example, further software packages for the analysis and generation of transport streams can be installed and used. With the standard 100baseT connector, DVRG is easy to network for the remote control and transfer of transport stream files.

As a novelty, DVRG fitted with option DVRG-B4 and -B2allows the recording and replay of uncompressed video streams in SDI format (to ITU-R B.T. 601/656 or SMPTE259M) on the same platform at a data rate of 270 Mbit/s.

Thanks to its versatility and configurability, DVRG is a highly flexible working platform for all those handling digital video signals to the MPEG2, DVB and ATSC or SDI standard.

Main features

- Replay of recorded transport streams
- Endless and seamless MPEG2 generation
- Triggered recording for error analysis
- RAM or hard-disk based operation
- Large choice of test signals
- Compliant to ATSC and DVB
- Optional record and replay of uncompressed SDI video streams (to ITU-R B.T. 601/656 or SMPTE259M) at a data rate of 270 Mbit/s
- Embedded Windows NT platform
- Software options
  - STREAM COMBINER™ for creating user-specific transport streams
  - QUALITY EXPLORER™ for analyzing video elementary streams
- Easy and self-explanatory operation

Modes

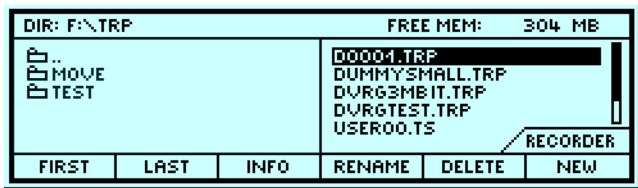
Recording

A transport stream is first recorded in the RAM either by the parallel (SPI/LVDS) or serial (ASI with loop-through output) interface. If the volume of recorded data exceeds the available RAM capacity or if the transport stream is to be achieved, storage is in the form of a file on the hard disk in TRP format. This file format contains all consecutive tranport stream packets in sequential order and can be easily exchanged with other systems.

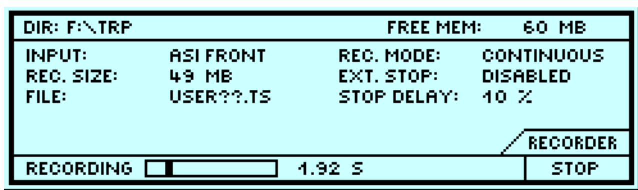
For error analysis, recording can be performed as a function of an external trigger signal applied to the trigger input on the rear panel. The transport stream is recorded continuously and cyclically in the RAM already before the trigger event occurs. Recording is completed after a settable delay following the trigger signal.

Thus transport streams (of any length depending on the setting) can be stored before (pretrigger) and after (posttrigger) the trigger time.

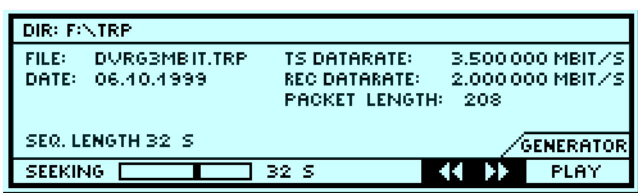
DTV Recorder Generator DVRG



File selection



Recording



Replaying

Replay of TRP files
Recorded transport streams can be replayed as often as required and are available both at a parallel (SPI/LVDS) and a serial (ASI) interface simultaneously. The replay starts immediately after selecting the file with the data being buffered in the RAM. Correct decoding of the video and audio sequences contained in the replayed transport stream is ensured at the original data rate of the recording. This original data rate is automatically determined from the transport stream file. Any other data rate can be used for test purposes. In this mode, DVRG supports files in TRP /TS format.

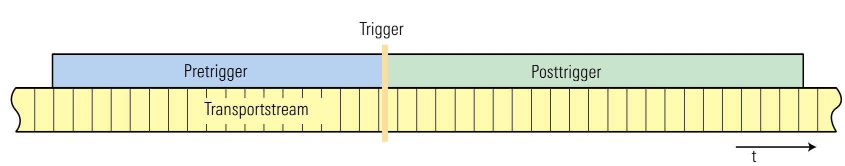
Replay of GTS files
In this mode, transport stream files are replayed in an endless loop and are available both at a parallel (SPI/LVDS) and a serial (ASI) interface simultaneously as well. The use of the GTS format provides discontinuity-free signal generation in an endless and seamless loop (see box). Files created in this format can be used even on a DVG provided the limits for maximum data rate and data volume are not exceeded.

During replay a jitter of up to ±10 ms with settable frequency and waveform can be superimposed on the PCR values. This function can be used for stress tests of multiplexers and decoders. The replay data rate can be varied within wide limits. The minimum data rate is obtained by adding the individual data rates of all elementary streams plus system and service tables. Higher data rates up to the maximum value is achieved by filling the transport stream with null packets.

Test signals

DVRG produces a large number of predefined MPEG2 transport streams to the ATSC and DVB standards at a keystroke. The transport streams contain several elementary streams and consist of video, audio and other data (eg teletext or PRBS). Video streams with different data rates, formats, frame rates and contents are available.

The signal set comprises sequences with moving picture contents and some static test patterns. It includes known test patterns such as colour bar signals, zone plate, CCIR17/18/331, ITS1 to 4 and many others as well as the Rohde&Schwarz CODEC test pattern. Thanks to integrated test signals the analog outputs of a set-top box (or IRD) can be tested within seconds with the aid of a suitable video



The length of the pretrigger and posttrigger parts of a transport stream can be defined for a triggered recording with DVRG

DTV Recorder Generator DVRG

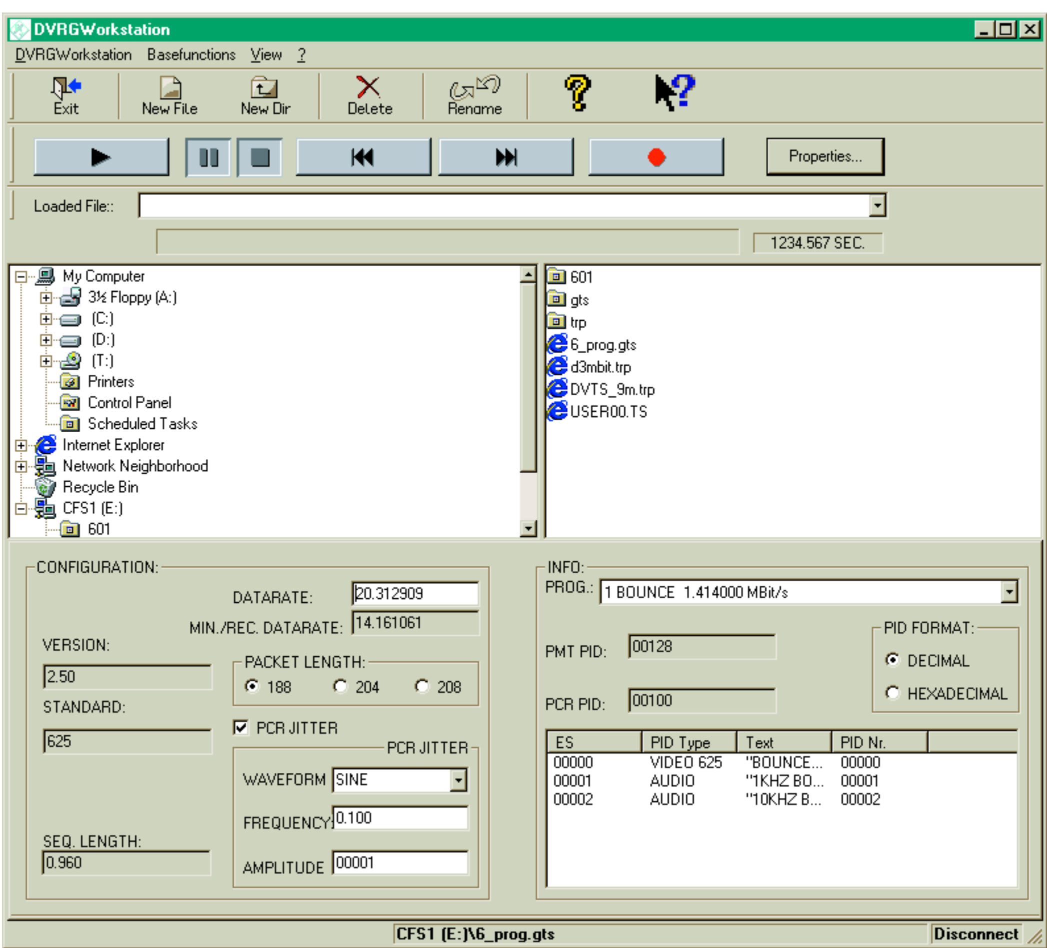
analyzer, e.g. VSA from Rohde&Schwarz. In addition, integrated moving picture elements allow visual checking of the decoder functionality.

Audio data streams with different rates and frequencies contain the accompanying sound for the video sequences as well as special audio test signals.

Applications

Thanks to its versatility, flexibility and wide range of options, DVRG is the MPEG2 platform for a whole variety of applications:

- Development of set-top boxes and all other instruments that process digital TV signals to the MPEG2 standard
- Quality management by replaying standardized transport streams
- Production of digital TV components (eg set-top boxes, MPEG2 decoders and multiplexers)
- Substitution signal source for playout center, cable headend and satellite uplink or downlink
- Error analysis by recording a part of the transport stream either before or after an external trigger event



Windows user interface of DVRG in workstation mode

DTV Recorder Generator DVRG

Specifications

Signal inputs	
MPEG2 transport stream	
Synchronous parallel (SPI), LVDS (to DVB-A010)	25-pin connector at front, 410 mV_{pp}, 1.25 V DC, 100 Ω
Asynchronous serial (ASI), 270 Mbit/s (to DVB-A010)	BNC (front and rear panel) 800 mV_{pp}, 75 Ω
Video serial digital 270 Mbit/s (SDI toITU-R B.T.601/656 or SMPTE 259M)	BNC (rear), 800 mV_{pp}, 75 Ω only with option DVRG-B4
Signal outputs	
MPEG2 transport stream	
Synchronous parallel (SPI), LVDS (to DVB-A010)	25-pin connector at front, 410 mV_{pp}, 1.25 V DC, 100 Ω
Asynchronous serial (ASI), 270 Mbit/s (to DVB-A010)	BNC (front and 2x rear, one of them as loop-through output of input), 800 mV_{pp}, 75 Ω
Video serial digital 270 Mbit/s (SDI toITU-R B.T.601/656 or SMPTE 259M)	BNC (rear), 800 mV_{pp}, 75 Ω only with option DVRG-B4
Signal characteristics	
Transport stream	to ISO/IEC 1-13818
Length of transport stream packets	
ATSC:	188 / 208 bytes (settable)
DVB:	188 / 204 bytes (settable)
Sequence length	endless or limited by hard disk size
Typical (at a net data rate of 5 Mbit/s)	100 s (RAM) or 8 h (hard disk)
Data jitter	typ. < 0.05 UIpp (10 Hz to 100 kHz)
ASI outputs	typ. < 0.1 UIpp (10 Hz...8 MHz)
SPI output	typ. < 0.05 UIpp (10 Hz to 200 kHz)
PCR jitter	
Amplitude	0 ms to 10 ms, settable in 0.1 µs steps
Signal set	test patterns with test tones, moving picture sequences
Sequence length	
ATSC:	typ. 960 video frames (32.032 s)
DVB:	typ. 192 video frames (7.68 s)
Serial video signal	to ITU-R B.T. 601/656 or SMPTE 259M
Data rate	270 Mbit/s
Operation	
Manual operation	keys on front panel with LC display
Remote control	with SCPI commands via TCP/IP (Ethernet 100baseT) or serial interface (RS232)
PC platform	
Processor	Pentium II with 266 MHz
BIOS	Award Rohde&Schwarz
RAM	128 MB
SCSI hard disk(s)	18 GB (basic unit) or 2x 18 GB (with option DVRG-B2)
CD drive	CD-ROM 48-fold reading
CD-R R/W drive	option DVRG-B4 CD-ROM 24-fold reading, CD-R 4-fold writing
CD-R R/W drive/DVD	option DVRG-B5 CD-ROM 24-fold reading, CD-R 4-fold writing DVD-ROM (2.5 to 6.5 GB) 4-fold reading
Graphics card	Savage/MX, 8 MB memory 1600x1200, 82 Hz, True Color (4 million colours)
Operating system	Microsoft Windows NT 4.0
Interfaces	at instrument rear panel
VGA	15-pin sub-D connector, for SVGA or TFT monitor
PS/2	PS/2 connector, combined for mouse and keypad
Serial interface	9-pin sub-D connector, RS232, 9.6 kBaud to 115 kbaud connection of other instruments and remote control (SCPI)
Parallel interface	25-pin sub-D connector, printer output
Network	RJ45 connector, Ethernet 100baseT for 100 Mbit/s, TCP/IP protocol remote control (SCPI) and system integration
USB	USB connector, connection of peripheral equipment

General data

Nominal temperature range	+ 5 °C to +40 °C (specs guaranteed)
Operating temperature range	+ 5 °C to +50 °C
Power supply	88 V to 264 V / 47 Hz to 63 Hz
Dimensions (W x H x D)	427 x 88 x 450 mm 16.8 x 3.5 x 17.7 in.
Weight	9.7 kg 21.4 lb.

Ordering information

DTV Recorder Generator	DVRG	2083.1302.02
Accessories supplied	power cable, operating manual	
Hardware options		
Additional hard disk internal, 18 GB	DVRG-B2	2083.1919.02
SDI (ITU-R B.T. 601/656) Record & play	DVRG-B4	2083.1931.02
CD-R R/W drive (DVD read only)	DVRG-B5	2083.1948.02
Software options		
Stream Combiner™ 1)	DVG-B1	2068.9835.02
Quality Explorer™ 2)	DVQ-B1	2079.7151.02
Extras		
Documentation of calibration test values	DRG-DCV	2082.0409.21
19" Adapter (2 HU) for installation with handles	ZZA-211	1096.3260.00
(rackmount without handles on request)		
Service manual		

1) see data sheet PD 757.3611.

2) see data sheet PD 757.5450.

MPEG2 Measurement Generator DVG

Photo 43166-3

- Digital TV test signals at a keystroke

- Large choice of signals (525- and 625-line standard)

- Endless MPEG2 sequence loop thanks to realtime updating of all time stamps

Brief description

MPEG2 Measurement Generator DVG is a universal generator for digital TV signals in the form of transport streams in line with the MPEG2 standard. The structure of these streams and the data reduction methods employed were developed and standardized by the Moving Picture Experts Group (MPEG) and the Digital Video Broadcasting (DVB) project. A main feature of the transport stream is that it contains several programs, each consisting of several substreams carrying video, audio and data signals.

DVG generates in an endless loop a large variety of selectable MPEG2 transport streams with combined video, audio and data sequences as contents and is thus a favourably priced and compact alternative to expensive MPEG2 encoders with multiplexer and external standard generators.

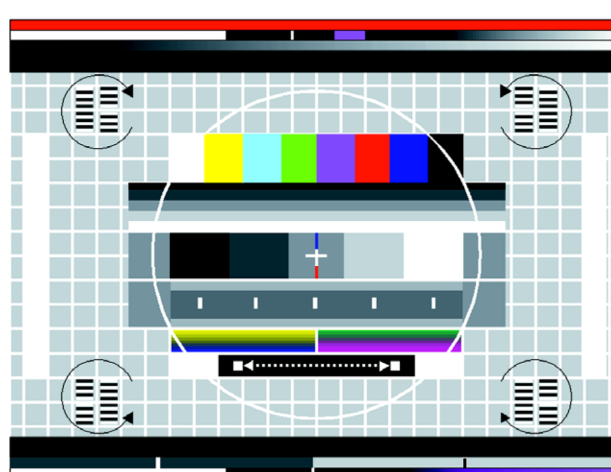
Complementary to DVG, MPEG2 Measurement Decoder DVMD (page 84) is offered for realtime monitoring, analyzing and decoding of MPEG2 transport streams.

Main features

- Endless MPEG2 sequence loop: all the required time information is continuously updated during playback of the transport stream, and the signal is available without any interruption.
- The output data rate can be varied as desired and thus adapted to the specifications of the transmission link or devices under test.
- Thanks to the settable PID of the program elements, DVG is ideal for use as a substitution signal source.
- A built-in PCR (program clock reference) jitter generator is available for stress testing of decoder PLLs.

The optional Stream Combiner™ software can be used to configure any new transport streams from the supplied or customer-specific elementary streams (ES) in addition to stored transport streams.

A PC card interface on the front panel allows the exchange of user-defined transport streams via a small exchangeable hard disk.



Rohde&Schwarz codec test pattern

Applications

The digital data streams generated by DVG are used as test signals for a variety of equipment employed on digital TV transmission links – from the studio to the domestic receiver. One field of application of DVG therefore is in the development, production, quality management and servicing of equipment processing MPEG2-coded signals.

Further applications are in the field of signal distribution and transmission (eg cable headends), where the generator can be used as a substitution signal source.

Test signals

DVG offers a variety of predefined MPEG2 transport streams which can be called at a keystroke. Video data streams of different contents and data rates are available. The set of signals stored comprises moving picture sequences as well as stationary test patterns. For fast testing of set-top boxes, ie integrated receiver decoders (IRT), DVG provides the Rohde & Schwarz codec test pattern (see right). Thanks to integrated test signals in the upper and lower picture area and using a suitable video analyzer such as VSA (page 164), analog interfaces can be tested out within a few seconds. In addition, moving elements at the corners and in the center of the picture allow visual checking of the decoder functions. Audio data streams, which are also available at different data rates, comprise the sound component accompanying the video sequences as well as special audio test signals.

Choice of test signals (625-line standard)

Moving pictures for general video and audio function test

Video contents	Audio contents
Automatic insertion machine	Classical music
Flower garden	Classical music
Table tennis	Applause
Neuschwanstein Castle	Classical music
Encoder test sequence DVTS	Classical music

Dynamic test signals

Video contents	Audio contents
Alternating all-black and all-white picture	L+R: 1-kHz sine burst only during all-white picture
Rohde&Schwarz CODEC test pattern (16:9), monitor test pattern with moving elements	L+R: sine burst 20 ms, 9.5 kHz, 6 dBr, synchronized with moving picture elements
Rohde&Schwarz CODEC test pattern (4:3), monitor test pattern with moving elements	L+R: sine burst 1 s, 1 kHz, 0 dBr, synchronized with moving picture elements
Moving zone plate	L+R: noise white/incoherent

Static test signals

Video contents	**Audio contents**
Colour bars to ITU-R-801 (100/0/100/0)	L: sine burst 15 kHz, 4 dBr R: silence
Colour bars to ITU-R-801 (100/0/75/0)	L: silence R: sine burst 15 kHz, 4 dBr
CCIR17 test signal in frame	L+R: sine burst 1 kHz, 0 dBr
H-SWEEP test signal in frame	L+R: sine burst 40 Hz, –20 dBr
Ramps in RGB signal	L+R: sine burst 12 kHz, –20 dBr
Ramps in all components	L+R: sine burst 9.5 kHz, –20 dBr
In frame	
Sweep in RGB signal	L+R: sine burst 14 kHz, –20 dBr
Sine x/x test signal in frame	L+R: sine burst 18 kHz, –20 dBr
All-white window	L: sine burst 7 kHz, –6 dBr R: sine burst 11 kHz, –6 dBr

Transport streams with several programs

Number of programs	Contents
Max. 6	various test signals (frame) and audio measurement signals

Coding of audio lev.: 0 dBr (+6 dBu or 1.55 V, DIN 45406) with a headroom of 6 dB

Specifications in brief

Output signals (see left)	transport stream to ISO/IEC 1-13818
Data rate (incl. null packets)	0.6 to 160 Mbit/s (settable in 1Hz steps)
Data rate for video/audio contents	up to 24 Mbit/s
Data quantity of video/audio contents	up to 200 Mbit
MPEG2 sequence length	endless loop
Video/audio sequence length	typ. 192 video frames, depending on data rate for video/audio contents
Length of transport stream packets	188/204 bytes (settable)
Error of data rate	±3 ppm (calibration interval: 1 year), without calibration additional error of ±0.5 ppm per year
Signal outputs	
Synchronous parallel MPEG2 data stream (SPI), LVDS (to DVB-A010)	410 mV pp, 1.25 V DC, 100 Ω
Synchronous parallel MPEG2 data stream (SPI), RS422	0 V (lo) and 4 V (hi) with ext. clock input
Asynchronous serial MPEG2 transport stream (ASI), 270 Mbit/s (to DVB-A010)	BNC, 800 mV pp, 75 Ω
Interfaces of integrated PC	1 x PC keyboard, 1 x VGA monitor, 2 x RS-232-C, 1 x Centronics, 1 PC card
Remote control	via RS-232-C interface
Special features	PID of elementary streams in instrument user-definable; PCR jitter settable in 0.1 µs steps from 0 to 10 ms
General data	
Rated temperature range	+5°C to +40°C
Storage temperature range	–40°C to +70°C
Power supply	88 V to 264 V, 47 Hz to 63 Hz (50 VA)
Dimensions (W x H x D); weight	434 mm x 43 mm x 460 mm; 5 kg

Ordering information

MPEG2 Measurement Generator	DVG	2068.8600.03
Extras		
Stream Combiner™ Software	DVG-B1	2068.9835.02
Calibration Data Documentation	DVG-DCV	2082.0490.14
19" Adapter (1HU)	ZZA-91	0396.4870.00
Service Manual		2069.0354.24

Stream Combiner™ DVG-B1

Generating user-specific MPEG2 transport streams with the PC

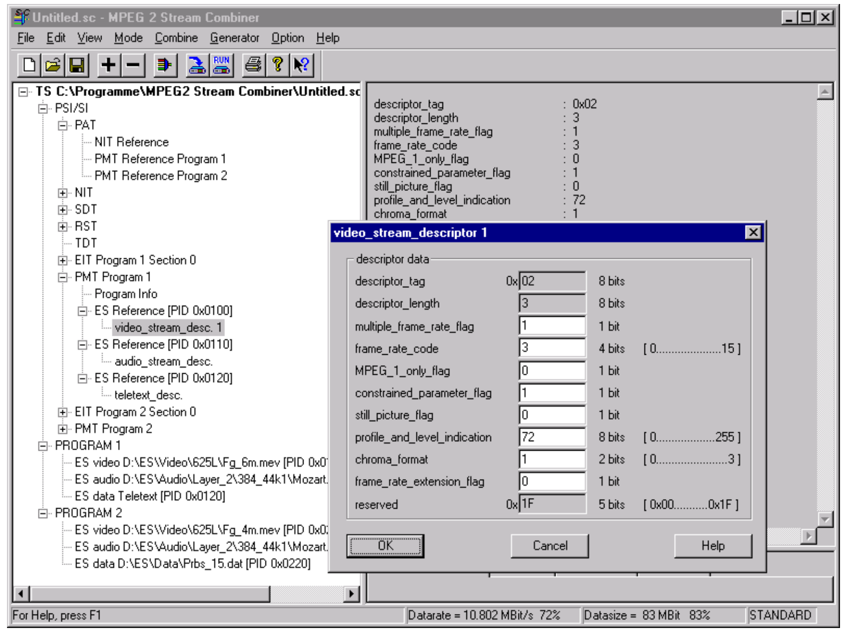


Fig. 1: Display of transport stream structure with information on individual elements

Brief description

Stream Combiner™ Software DVG-B1 in conjunction with MPEG2 Generator DVG (see page 76) allows user-specific transport streams to be generated. The software runs under Windows 9x/NT on any PC or laptop. The data are loaded into the DVG via a parallel interface or a PC card hard disk. The user-friendly operating concept with integrated help function ensures fast and efficient working right from the start without any special knowledge of MPEG2 or DVB being required.

Main features

- Generation of user-specific transport streams
- Elementary stream library
- Insertion of external elementary stream files
- Editing PSI and SI tables as required
- Setting of defined nonconformal states
- Windows 95/98/NT operating system

Defining a user-specific transport stream

A new transport stream can be defined very easily step by step with the Stream Combiner™. In the lefthand part of the program window (Fig. 1), all elements of the transport stream that have already been defined are represented as a tree structure. In the righthand part of the window, detailed information on the individual elements is displayed. The elements can be selected by means of a mouseclick.

Adding programs

In the first step, the user adds the desired number of programs (max. 6) to the transport stream. Stream Combiner™ automatically generates the required PSI tables, eg PAT and PMT, and represents these tables immediately in the tree structure. The tables contain predefined default settings which can be changed as required.

Adding elementary streams

In the second step the desired elementary streams such as video, audio or data are added to the programs. Each program may contain up to 6 elementary streams. The software comes with a comprehensive elementary stream library from which the user can configure his specific transport stream. Stream Combiner ™ automatically updates the relevant PSI tables every time a new elementary stream is added.

Adding service information

In the third step, further SI and PSI tables (PAT, PMT, CAT, NIT, BAT, SDT, EIT, RST, TDT, TOT, ST, SIT, DIT) can be added to the transport stream. Each of these tables can be fully edited; the repetition rates can be set independently for each table.

Generating the transport stream data file for the DVG

As a final step, Stream Combiner™ generates a transport stream data file for the MPEG2 Generator DVG. The file can be transferred to the DVG directly via cable. Alternatively, a PC card hard disk can be used. This is expedient if the generated transport stream is to be installed in several generators. DVG generates the new transport stream in the same way as the preconfigured stored signals as an endless MPEG2 sequence with all time stamps being continuously updated.

Inserting external elementary streams (data files)

Besides the elementary streams from the library supplied, Stream Combiner™,

Stream Combiner™ DVG-B1

allows external elementary streams (binary files to ISO/IEC 13818, MP@ML) to be inserted. Such files are offered by various suppliers on the Internet or on CD-ROMs (MPG, VID, M2V, MP2, AUD, M2A file extensions). Stream Combiner™ first checks whether the external file is suitable for integration, and then processes the file so that it can be inserted into the new transport stream. Thus it is always ensured that the DVG plays back the new transport stream as an endless MPEG2 loop.

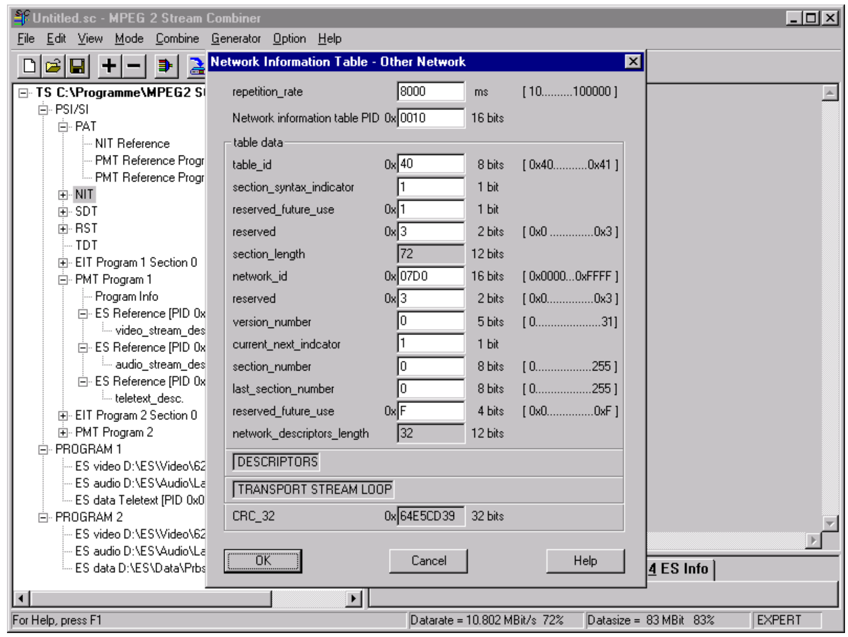


Fig. 2: Editing individual tables using the Network Information Table (NIT) as an example

Editing a user-specific transport stream

All transport streams generated with the Stream Combiner™ can subsequently be modified. This is possible for the elementary streams and for all tables of a transport stream. Editing can be performed after the respective file has been opened. The Stream Combiner™ operates in the same mode as for generating a new transport stream, ie the tree structure and the contents of the tables are displayed. Any desired element can be modified, deleted from or added to the transport stream.

Generating defined nonconformal states

Stream Combiner™ offers various possibilities of integrating nonconformal states into a transport stream:

- Insertion of descriptors into tables for which they are not intended
- Insertion of wrong information into tables and descriptors
- Changing the repetition rate of tables
- Removing specific tables
- Introducing an offset between elementary stream clock (PTS, DTS) and PCR
- Switching off PCR, PTS and DTS updating at the end of a video/audio sequence

Specifications in brief

Contents of elementary stream library
All video and audio sequences contained in the preconfigured stored transport streams of DVG
Further moving picture sequences ("Table Tennis" and "Flower Garden" with 2/4/6 Mbit/s)
Additional audio sequences of different data rates and sampling frequencies
Teletext sequences
Other sequences on request

Transport stream

Sum of elementary data stream rates	max. 24 Mbit/s [1)]
Total data volume of all elementary streams	max. 200 Mbit [1)]
Output data rate at DVG (attained by adding null packets)	max. 160 Mbit/s
Number of programs	max. 6
Number of elementary streams per program	max. 6
Sequence length of contents	max.200 Mbit/sum of elementary stream [1)] data rates
MPEG2 sequence length	endless

System requirements
PC or laptop with Pentium processor (recommended clock frequency min. 100 MHz), Windows 9x/NT operating system, min. 16 MByte RAM (Windows NT: 32 Mbyte), required space on hard disk approx. 20 Mbyte, 1 free parallel printer interface, 1 free RS-232-C interface, CD-ROM drive

Ordering information

Stream Combiner™	DVG-B1	2068.9835.02

1) Depending on Generator DVG used.

Digital Video Quality Analyzer DVQ

Indispensable tool in the quality assessment of digital DCT-coded video sequences

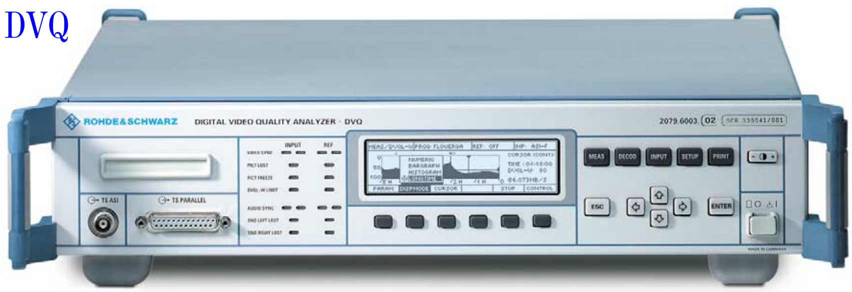


Photo 43318-3

Brief description

With Digital Video Quality Analyzer DVQ the assessment of picture quality according to subjective criteria becomes an objective realtime measurement method. This method is based on the analysis of video data and can thus also be used where no reference video material is available.

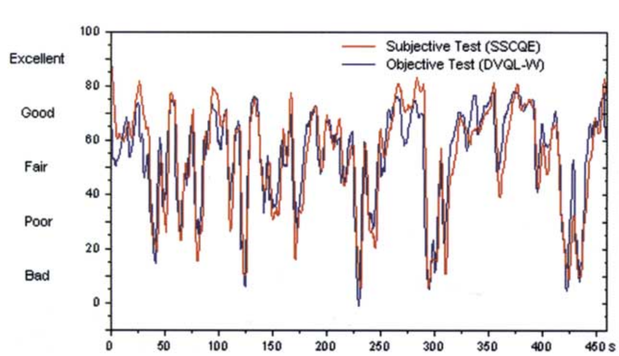
To this end, the optional PC software Quality Explorer™ is available, allowing complete display and analysis of all coding data as well as convenient remote control of DVQ and display of the recorded quality data.

The increasing use of digital, data-compressed TV signals calls for monitoring and assessment of the picture quality. Picture quality assessment is very strongly influenced by the subjective perception of the human eye. DVQ is a tool that ideally satisfies both requirements. It determines the picture quality in relation to digital compression and evaluates the results according to the subjective criteria of visual perception.

Applications
- Quality monitoring in distribution networks
- Program quality assessment
- Development as well as evaluation and setting of operational hardware
- Testing of set-top boxes

Main features

- Realtime measurement
- No reference signal required
- SSCQE scaling of quality levels
- Monitoring of picture freeze, picture and audio loss
- Recording of quality profile (long-term)
- ITU-R 601 and MPEG2 inputs
- Histogram representation of quality levels
- Internal event and error report and statistics
- Program decoding



Comparison of objective test results (DVQL-W) and subjective quality assessments (SSCQE) for 480 s sample sequence

Characteristics

In addition to the analysis unit, DVQ also has a built-in decoder for audio and video data in the format Mainprofile @ Main-Level and 4:2:2 Profile @ MainLevel. The program being analyzed is decoded and can simultaneously be viewed on a connected video monitor (CCVS or ITU-R 601 formats). The audio signals are available at the connectors both in analog and digital form (AES/EBU).

A MPEG2 transport stream usually contains several programs made up of video and audio data streams. For automatic monitoring of all programs, a scan mode is provided in DVQ allowing all or selected programs to be successively analyzed for picture quality and interference over a selectable period of time.

DVQ has a built-in 32 Mbit memory for transport stream data. Depending on the data rate of the video stream, the memory is sufficient for storing a video data sequence of approx. 5 to 10 seconds. The sequence can be read out for in-depth analysis via one of the remote-control interfaces using for instance the Quality Explorer™.

For comparative quality measurements the quality analysis can simultaneously be carried out on two different signals. Quality analysis is carried out completely

Digital Video Quality Analyzer DVQ

independently for each signal and the final result is formed from the differences found. There is no pixel comparison of two video data sources in this mode either.

Alarm outputs

Altogether 12 relay outputs which can be allocated to one or several (ORed) events are fitted as standard. The switching mode (active when open or closed) can be set separately for each relay. In addition to the data interfaces floating switching contacts are thus available for external signalling of failures and quality degradations.

Operation

DVQ can be controlled manually via the keypad with fast-access keys for the main menus and softkeys for the submenus. The displayed contents of the clearly arranged LCD is inserted into the decoded picture at the video output. With a recorder connected the quality ratings can be logged together with the associated picture contents.

Specifications

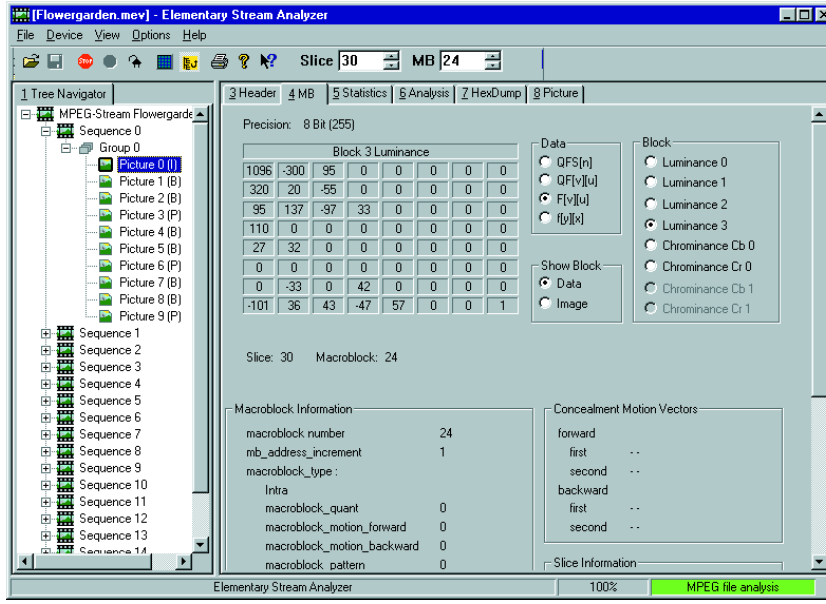
Signal inputs	
MPEG2 transport stream	to ISO/IEC 1-13818
Length of data packets	188/204/208 byte
Synchronous parallel (SPI-LVDS, to DVB-A010)	25-pin connector on front panel 100 mV to 2 V_{pp}, 100 Ω
Data rate	up to 70 Mbit/s
Asynchronous serial 270 Mbit/s (ASI, to DVB-A010)	BNC connector (front and rear panel) 200 mV to 1 V_{pp}, 75 Ω
Data rate	up to 70 Mbit/s
Video serial digital 270 Mbit/s (SDI, to ITU-R 601)	BNC connector on rear panel corresponding to SMPTE259M
Audio serial digital (AES/EBU)	LEMO-Triax connectors on rear panel 400 mV to 12 V_{pp}, 110 Ω
Signal outputs	
Video CCVS (PAL, SECAM, NTSC)	BNC (rear panel), 1 V ±1% (V_{pp}), 75 Ω
C/L gain	±2%
C/L delay	±30 ns
Return loss (0 to 6 MHz)	>34 dB
Frequency response (typical values)	
0 to 3 MHz	+2% / –2%
<4 MHz	+2% / –5%
<5 MHz	+2% / –15%
Video serial digital 270 Mbit/s (SDI, to ITU-R 601)	BNC connector on rear panel 800 mV_{pp}, 75 Ω
Audio	unbalanced, not floating
Level (full scale)	6/9/12/15 dBu ±0.5 dB
Frequency response (60 Hz to 15 kHz)	±0.5 dB relative to 1 kHz, into 600 Ω
S/N ratio	>70 dB, unweighted
THD	>70 dB
Audio left, audio right	LEMO-Triax (rear panel), <50 Ω
Audio serial digital (AES/EBU)	LEMO-Triax (rear panel), 4 V_{pp}, 110 Ω
Operation	
Manual control	front-panel keys with LC display, output of test results on LCD as well as text inserted in video output signal
Remote control	RS232 interface or Ethernet (network)
Interfaces	
Serial interface	12-pin sub-D (rear panel), RS232, 9600 to 115,000 bd remote control
Parallel interface	25-pin sub-D (rear panel) printer output
Network	RJ45 connector on rear panel Ethernet, 10BaseT, 10 Mbit/s remote control, system integration
Relay outputs	15-pin connector on rear panel
Number	12 with any allocation to events, ORed in case of allocation to several events
Active state	separately selectable (open or closed)
Test parameters	
Events	audio loss left, audio loss right picture loss, picture freeze quality below (user-selectable) level
Recording	
Statistics	error seconds of events according to type, resolution in sec, display selectable according to type
Report	listing of events according to time optional filtering according to type display per entry: time, duration, PID, type
Video data analysis	temporal activity, spatial activity
Digital video quality level, unweighted (DVQL-U),	separately for luminance and chrominance (Y, C_b, C_r)
Digital video quality level, weighted (DVQL-W)	total level corresponding to subjective assessment
Display	
Current values	bargraph, numeric values
Recorded values	time profile, histogram
Time frame for recording	5/10/30 s, 1/5/10/30 min, 1/2/5 h, single-shot or continuous
General data	
Rated temperature range	+5 °C to +40 °C
Operating temperature range	0 °C to +45 °C
Power supply	85 V to 264 V, 47 Hz to 63 Hz, 28 W
Dimensions (W x H x D); Weight	427 mm x 88 mm x 450 mm; 6 kg

Ordering information

Digital Video Quality Analyzer	DVQ	2079.6003.02
Accessories supplied	power cable, operating manual, audio adapter (Lemo-Triax to XLR), modem bypass cable	
Options		
Quality Explorer™ Software	DVQ-B1	2079.7151.02
Calibration Data Documentation	DVQ-DCV	2082.0490.20
Extras		
19" Rack Adapter (2 HU)	ZZA-211	1096.3260.00
Service Manual		

Quality Explorer™ DVQ-B1

Comprehensive quality and MPEG2 elementary stream analysis



Clear display of header information with Elementary Stream Analyzer, illustrated by picture header

Brief description

Quality Explorer™ DVQ-B1 from Rohde&Schwarz is a software package that performs comprehensive analysis on MPEG2-coded transport streams. It can be used either on an external PC connected to DVQ or fully independently of DVQ for elementary stream analysis from data media (eg hard disk, CD-ROM).

DVQ-B1 comprises two independent tools: The Quality Monitor reads the quality parameters provided by the Digital Video Quality Analyzer DVQ in real time via the remote-control interface. It displays the quality levels graphically as a histogram. Archiving on data storage media is also possible.

The Elementary Stream Analyzer analyzes the content of MPEG2-coded video elementary streams. For this purpose DVQ has a 32 Mbit internal buffer memory for the elementary stream to be analyzed. The elementary stream buffered in DVQ can also be stored as a PC file.

Alternatively, elementary streams available in the form of PC files can be analyzed. Therefore, Quality Explorer™ can be used on other instrument platforms without the DVQ.

Full remote control of DVQ is provided by a library routine (DLL) supplied with the software and the Quality Monitor's user interface.

The software runs under Windows 95/98 or Windows NT on any PC or laptop connected to the DVQ via an RS232 interface or network (10BaseT) interface. The easy-to-operate software, as well as the clear presentation of the analysis results in windows of variable size, ensure speed and success right from the start.

Specifications

Elementary Stream Analyzer

MPEG2 formats	
Profile	MP (main profile 4:2:0) 422P (4:2:2 profile)
Aspect ratios	any, eg 4:3, 14:9, 16:9
Picture formats	any SDTV & HDTV

System requirements

PC or laptop with Pentium processor (Pentium II with 266 MHz clock frequency recommended, min. Pentium I with 100 MHz), Windows 95/98 or Windows NT operating system, min. 16 Mbyte RAM (Windows NT: 32 Mbyte), required memory on hard disk approx. 20 Mbyte, 1 free serial RS232 interface (recommended data rate 115 kbit/s) or 1 free 10BaseT-network interface, CD-ROM drive, 1 parallel printer interface

Ordering information

Quality Explorer™	DVQ-B1	2079.7151.02

Equipment supplied
CD-ROM with setup program, serial cable for connecting DVQ to the PC, dongle for the parallel printer output of the PC, manual

MPEG2 Measurement Decoder DVMD

25 DVB or 18 ATSC realtime measurements at a time, analyzer and decoder in one unit, analysis of data rates, integrated long-term report, on-screen display on video monitor

Photo 42482

Brief description

MPEG2 Measurement Decoder DVMD monitors and analyzes the MPEG2 transport stream. It indicates the contents and provides comprehensive information on the quality of the transport stream.

The combination of decoder and analyzer in one unit with conventional operating concept (no PC system) makes DVMD the waveform monitor of digital television. It is suitable for use wherever MPEG2 signals have to be checked.

Realtime measurements and simultaneous in-depth analysis yield extremely fast results. This makes DVMD an indispensable tool in development, in troubleshooting as well as in quality management and production.

Another important application is in the final inspection of MPEG2 signals before they leave the studio. While DVMD checks the video and audio signals at the output, error information is inserted directly into the decoded program (on-screen display).

Remote control capability allows integration into automatic monitoring networks. DVMD is thus ideal for network operators.

Complementary to Decoder DVMD, MPEG2 Measurement Generator DVG (page 126) is offered for providing continuous MPEG2 transport streams made up of video, audio and data sequences in an endless loop.

Analyzer

The analyzer functions of DVMD comprise a protocol analysis of the measured MPEG2 transport stream in realtime. All measurements are in conformance with the Measurement Guidelines for DVB Systems (ETR 290) of the European DVB project or based on these guidelines (ATSC-Standard). In the DVB mode, the repetition rates of all EIT/SDT/NIT "other" tables are monitored in realtime in addition to ETR 290.

Any error occurring is directly indicated by front-panel LEDs. DVMD also detects sporadic errors. Moreover it provides error statistics showing how often a particular type of error has occurred within a specified time interval. A list (REPORT; see lower figure on righthand page) giving detailed information on the errors occurred including date and time can be obtained. The list contains up to 1000 entries and may be edited to cover exclusively a single type of error.

In addition, the DVMD analyzes the MIP packets (megaframe initialization packets) that are inserted into the transport stream in order to synchronize the transmitters of DVB-T single-frequency networks.If there is an error, the trigger/capture facilities of DVMD can be used to freeze part of the transport stream affected by the error (approx. 2 Mbit) and output it, analyzed down to bit level, via the RS232 interface.

In addition to in-depth analysis, the optional Stream Explorer^{TM} software (see page 138) allows further online masurements with graphic display on the screen (eg data rates, PCR jitter, etc).

Decoder

An MPEG2 transport stream usually consists of a number of programs which may contain video, audio and data streams (elementary streams). DVMD decodes a video and an audio stream from the selected program. The decoded video signal is simultaneously output in CCVS, analog Y/C and digital serial ITU-R601 formats.

Audio signals are output as analog stereo signals and as digital AES/EBU signals.

Optional alarm lines and parallel printer interface
In addition to a second parallel printer interface, 12 alarm lines for signalling errors detected in the transport stream

are available. Each alarm line can be allocated to one or several (ORed) types of errors. The contacts close to ground and in case of an error they can be chosen to close or open.

List of all elementary streams of a program

Error report with detailed information on causes of errors

Realtime measurement functions

Simultaneous monitoring of all signals in transport stream

Measurement	Priority (according to ETR 290)	Error No.	ATSC	DVB
TS_sync_loss	1	1.1	x	x
Sync_byte_error	1	1.2	x	x
PAT_error	1	1.3	x	x
Continuity_count_error[1)]	1	1.4	x	x
PMT_error[1)]	1	1.5	x	x
PID_error[1)]	1	1.6	x	x
Transport_error	2	2.1	x	x
CRC_error[1)]	2	2.2	x	x
PCR_error[1)]	2	2.3	x	x
PCR_accuracy_error[1)]	2	2.4	x	x
PTS_error[1)]	2	2.5	x	x
CAT_error	2	2.6	x	x
SI_repetition_error	3	3.2	x	x
NIT_error	3	3.1		x
SDT_error	3	3.5		x
EIT_error	3	3.6		x
RST_error	3	3.7		x
TDT_error	3	3.8		x
Unreferenced_PID[1)]	3	3.4	x	x
Base_PID_error	3	–	x	
Paradigm_error	3	–	x	
Multiplex_error	–	–	x	x
Datarate_error	–	–	x	x
SL_other_error	–	–	–	x
NIT_other_error	–	–	–	x
SDT_other_error	–	–	–	x
EIT_other_error	–	–	–	x
MIP_error	–	–	–	x

1) Simultaneously for up to 64 programs and 20 (ATSC) respectively 25 (DVB) different PMT PIDs.

Specifications in brief

Input signals	
Transport stream	to ISO/IEC 1-13818
Data rate of transport stream	up to 54 Mbit/s
Length of data packets	188/204 bytes (DVB) 188/208 bytes (ATSC)
Signal inputs	
Synchronous parallel MPEG2 transport stream (SPI), LVDS to DVB-A010	25-pin female connector on front panel, 100 mV to 2 V pp, 100 Ω
Asynchronous serial MPEG2 transport stream, 270 Mbit/s (ASI, to DVB-A010)	BNC connector on front and rear panel, 200 mV to 1 V pp, 75 Ω
Signal outputs	
Video CCVS (PAL, SECAM, NTSC)	BNC connector on front and rear panel, 1 V pp ±1%, 75 Ω
Video luminance (Y)	BNC connector on rear panel, 1 V pp ±1%, 75 Ω
Video chrominance (C)	BNC connector on rear panel, 0.7 V pp ±1%, 75 Ω
C/L gain	±2%
C/L delay	±30 ns
Return loss (0 to 6 MHz)	34 dB, CCVS on front panel: 30 dB
Audio	
Level (full scale)	6/9/12/15 dBu ±0.5 dB
Freq. response (40 Hz to 15 kHz)	±0.5 dB relative to 1 kHz
S/N ratio	>70 dB, unweighted
THD	>70 dB
Video serial digital (ITU-R 601)	BNC connector on rear panel, 800 mV pp, 75 Ω
Audio left, audio right	LEMO Triax connector on front and rear panel, <50 Ω
Audio serial digital (AES/EBU)	LEMO Triax connector on rear panel, 4 V pp, 110 Ω
Interfaces	1 serial RS-232-C interface (remote control or printer)
General data	
Rated temperature range	+5°C to +40°C
Storage temperature range	–40°C to +70°C
Power supply	88 to 264 V, 47 to 63 Hz (50 VA)
Dimensions (W x H x D)	434 mm x 43 mm x 460 mm
Weight	4.9 kg

Ordering information

MPEG2 Measurement Decoder	DVMD	2068.8597.02
Accessories supplied	power cable, operating manual, audio adapter (LEMO Triax to XLR)	
Options		
Stream Explorer™ Software	DVMD-B1	2068.8597.02
Distribution as ATSC standard	DVMD-B2	2068.9341.00
Alarm Lines + Parallel Printer Interface	DVMD-B5	2068.9393.02
Calibration Data Documentation	DVMD-DCV	2082.0490.15
Extras		
19" Adapter (1HU)	ZZA-91	0396.4870.00
Service Manual		2069.0348.24

MPEG2 Realtime Monitor DVRM

Realtime monitoring and analysis of MPEG2 transport streams

Photo 43410-1

Brief description

DVRM is the optimized solution for the continuous monitoring of MPEG2 transport streams in real time. The measurements performed are necessary to ensure smooth interplay of all components of a DTV transmission network.

Main features

- 26 DVB or19 ATSC realtime measurements at a time
- Integrated long-term report
- Analysis of data rates
- Trigger-on-error function
- Remote control via supplied PC software
- 12 built-in relays for error signalling
- PC Software STREAM EXPLORER™ is available as an option for in-depth analysis down to bit level

Analyzer

The analyzer functions of DVMD comprise a protocol analysis of the measured MPEG2 transport stream in realtime. All measurements are in conformance with the Measurement Guidelines for DVB Systems (ETR 290) of the European DVB project or based on these guidelines (ATSC-Standard). In the DVB mode, the repetition rates of all EIT/SDT/NIT "other" tables are monitored in realtime in addition to ETR 290.

Any error occurring is directly indicated by front-panel LEDs. DVMD also detects sporadic errors. Moreover it provides error statistics showing how often a particular type of error has occurred within a specified time interval. A list (REPORT) giving detailed information on the errors occurred including date and time can be obtained. The list contains up to 1000 entries and may be edited to cover exclusively a single type of error.

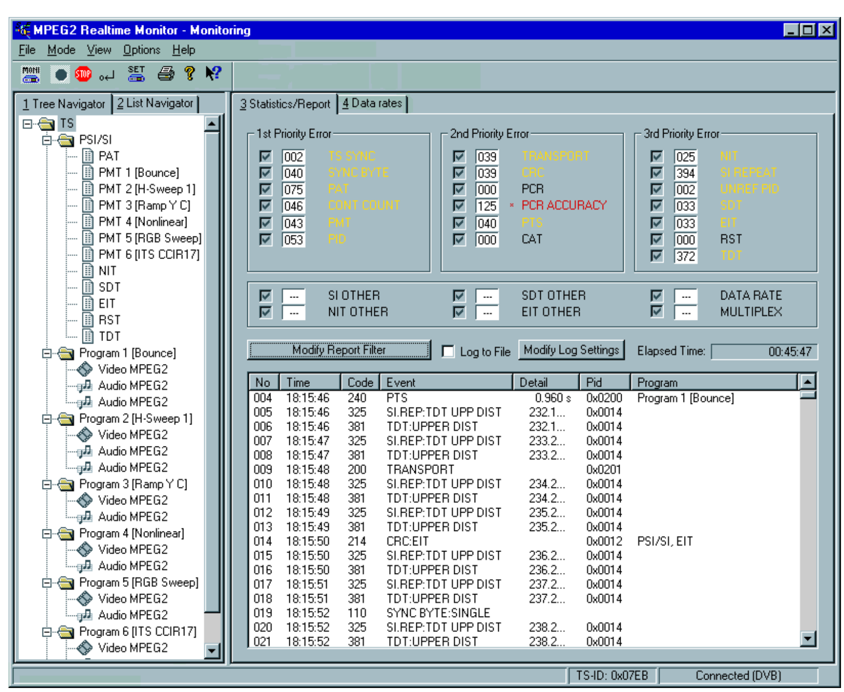
In addition, the DVMD analyzes the MIP packets (megaframe initialization packets) that are inserted into the transport stream in order to synchronize the transmitters of DVB-T single-frequency networks.If there is an error, the trigger/capture facilities of DVMD can be used to freeze part of the transport stream affected by the error (approx. 2 Mbit) and output it, analyzed down to bit level, via the RS232 interface.

If the supplied PC software running under Windows 95/98 or Windows NT is used, three information blocks are available simultaneously:

1. Structure of transport stream with all elements shown in the form of a tree or list (left)

2. Current status as well as error seconds of each error measured in realtime (top right)

3. Chronological list of all errors detected (bottom right)



MPEG2 Realtime Monitor DVRM

In addition to in-depth analysis, the optional Stream Explorer™ software (see page 138) allows further online masurements with graphic display on the screen (eg data rates, PCR jitter, etc).

Remote control

In addition to readout and display of complete error information, the MPEG2 Realtime Monitor software allows full remote control of DVRM. Moreover, it offers moving graphical representation of the data rates of all transport stream elements in the form of bargraphs. Apart from continuous storage of the error report on hard disk, the software enables integration of DVRM into networked monitoring systems via the COM/DCOM interface.

Options

Stream Explorer™ DVMD-B1
This software enhances MPEG2 Realtime Monitor DVRM to form a universal analysis system for MPEG2 transport streams.

In addition, Stream Explorer™ can activate realtime analyses in DVRM and output the results as moving graphic representations on the PC monitor.

ATSC-Standard DVRM-B2
When ordered with option DVRM-B2, the unit comes preconfigured for ATSC. For changeover of DVRM to the respective other standard, a PC Windows software is supplied with DVRM.

Realtime measurement functions

Simultaneous monitoring of all signals in transport stream

Measurement	Priority (according to ETR 290)	Error No.	ATSC	DVB
TS_sync_loss	1	1.1	x	x
Sync_byte_error	1	1.2	x	x
PAT_error	1	1.3	x	x
Continuity_count_error[1]	1	1.4	x	x
PMT_error[1]	1	1.5	x	x
PID_error[1]	1	1.6	x	x
Transport_error	2	2.1	x	x
CRC_error[1]	2	2.2	x	x
PCR_error[1]	2	2.3	x	x
PCR_accuracy_error[1]	2	2.4	x	x
PTS_error[1]	2	2.5	x	x
CAT_error	2	2.6	x	x
SI_repetition_error	3	3.2	x	x
NIT_error	3	3.1		x
SDT_error	3	3.5		x
EIT_error	3	3.6		x
RST_error	3	3.7		x
TDT_error	3	3.8		x
Unreferenced_PID[1]	3	3.4	x	x
Base_PID_error	3	–	x	
Paradigm_error	3	–	x	
Multiplex_error	–	–	x	x
Datarate_error	–	–	x	x
SL_other_error	–	–	–	x
NIT_other_error	–	–	–	x
SDT_other_error	–	–	–	x
EIT_other_error	–	–	–	x
MIP_error	–	–	–	x

[1] Simultaneously for up to 64 programs and 20 (ATSC) respectively 25 (DVB) different PMT PIDs.

Specifications in brief

Input signals	
Transport stream	to ISO/IEC 1-13818
Data rate of transport stream	up to 54 Mbit/s
Length of data packets	188/204 bytes with DVB 188/208 bytes with ATSC
Signal inputs	
Synchronous parallel MPEG2 transport stream (SPI, LVDS, to DVB-A010)	25-pin connector on front panel, 100 mV_{pp} to 2 V_{pp}, 100 Ω
Asynchronous serial MPEG2 transport stream, 270 Mbit/s (ASI, to DVB-A010)	BNC connector on front and rear panel, 200 mV_{pp} to 1 V_{pp}, 75 Ω
Control	remote control via RS232 interface
Interfaces	
Serial interface	9-pin sub-D connector on rear panel
Type	RS232
Use	remote control or printer
Relay outputs	15-pin sub-D connector on rear panel
Number	12 with arbitrary assignment to different types of error, ORed in case of multiple assignment
Active state	open or closed, selected jointly
MPEG2 Realtime Monitor software	Windows operating software for DVRM
System requirements	PC or notebook with Pentium processor (recommended clock frequency min. 100 MHz), Windows 95/98/NT operating system, min. 16 MB RAM (Windows NT: 32 MB), approx. 10 MB hard disk memory, 1 RS232 interface (recommended data rate 115 kbit/s), CD-ROM drive
Monitoring	
Number of different PMT PIDs	max. 20 with ATSC max. 25 with DVB

MPEG2 Realtime Monitor DVRM

Number of programs	max. 64
Error types	
DVB	ETR290 repetition rates of NIT/SDT/EIT "other" tables
ATSC	to ETR290 program paradigm
Both	transport stream ID (TS_Id), data rate of stuffing bytes

General data

Nominal temperature range	+ 5°C to +40°C (guaranteed spec)
Operating temperature range	0°C to +50°C
Power supply	88 V to 264 V, 47 Hz to 63 Hz, power consumption 50 W
Electrical safety	to EN 61010-1
Dimensions (W x H x D)	434 mm x 43 mm x 460 mm
Weight	4.9 kg

Ordering information

MPEG2 Realtime Monitor	DVRM	2068.8580.02
Equipment supplied	Power cable, modem bypass cable, operating manual, CD-ROM with PC operating software, update firmware for ATSC and DVB standards, factory-configured for DVB standard	
Options		
Configuration for ATSC standard	DVRM-B2	2068.9606.00
STREAM EXPLORER™ software	DVMD-B1	2068.9406.02
Documentation of calibration values	DRM-DCV	2082.0490.24
Extras		
19" adapter (1HU)	ZZA-91	0396.4870.00
Service manual		2069.0348.24

Stream Explorer™ DVMD-B1

Enhanced MPEG2 analysis with MPEG2 Measurement Decoder DVMD

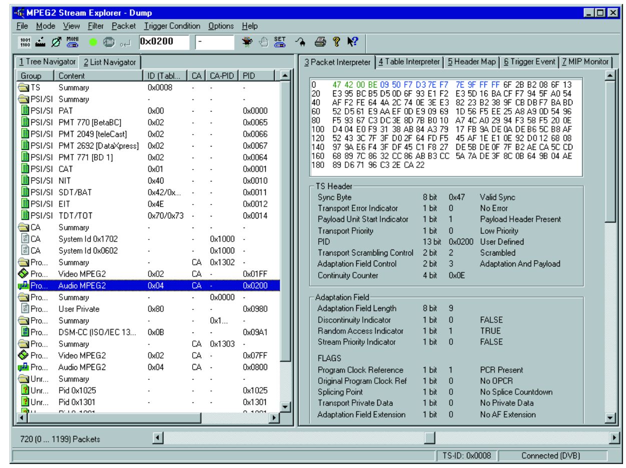


Fig. 1: All transport stream details under control with List Navigator and Packet Interpreter (DVB mode)

Brief description

Stream Explorer™ Software DVMD-B1 enhances the MPEG2 Measurement Decoder DVMD (page 133) from Rohde & Schwarz to form a universal analysis system for MPEG2 transport streams. The software runs under Windows 95, 98 or Windows NT on any PC or laptop connected to the DVMD via a serial interface. The easy-to-operate software and the clear presentation of test results ensure efficient working right from the start.

DVMD can buffer a transport stream of up to 2 Mbit and transfer it on request via the serial interface to the Stream Explorer™. DVMD uses several data or event filters (TRIGGER), which can be activated via the Stream Explorer™. The investigated data quantity of the transport stream can thus be considerably increased if required. Moreover, the software can activate realtime analyses in the DVMD and output the results as moving graphic representations. The realtime measurement functions of DVMD are thus consider-ably enhanced.

Five operating modes

- DUMP for comprehensive analysis of transport stream contents
- TRIGGER for detailed investigation of errors in transport streams
- MEASURE for graphic display of transport stream parameters in realtime
- MONITORING for remote control
- OFFLINE: for storage and subsequent recall of any test scenarios (available for all four operating modes named above)

DUMP

This operating mode allows detailed analysis of the contents of transport streams (TS). The transport stream contents is represented by Stream Explorer™ in hexadecimal format as well as in an interpreted form. This makes it very easy for the user to recognize any irregularities that may occur.

The analyzed transport stream data can be filtered as follows:

- only TS packets with a specific PID
- only TS packets with adaptation field
- only TS packets with start of a PES packet (payload unit start indicator set)

Combinations of the above selection criteria are also possible. Irrespective of the filter settings, Stream Explorer™ additionally determines the complete contents structure of the transport stream.

Display modes

- TS NAVIGATOR: Display of transport stream contents as a tree structure (Fig. 2, left) or in tabular form (Fig. 1, left) with general information about elementary streams such as PID, stream ID, data rate and information about scrambling. This display mode is always available together with a second display mode
- PACKET INTERPRETER: (Fig. 1, right) Display of a TS packet in hexadecimal format and at the same time as an interpreted list of all elements contained in the transport stream. A colour code for the various parts of the packet (header, adaptation field, payload, etc) makes for a clear representation. The packets are selected either via the NAVIGATOR or via a software slide switch allowing all buffered packets to be addressed in their original sequence
- TABLE INTERPRETER: (Fig. 2, right) Lists all elements of a selected table and interprets the contents. The following tables can be selected:
  - All standards: CAT, PAT, PMT, PT
  - DVB: BAT, DIT, EIT, NIT, RST, SDT, SIT, ST, TDT, TOT
  - ATSC: CVCT, EIT, ETT, MGT, PIT, RRT, STT, TVCT
- HEADER MAP: Gives an overview of the distribution of elementary stream packets within the transport stream. The headers of a selected elementary stream are highlighted

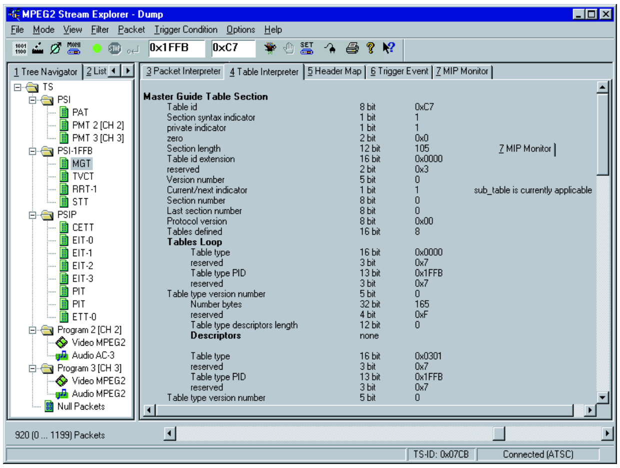


Fig. 2: Clear representation of transport stream structure with Tree Navigator and of Table Interpreter (ATSC mode)

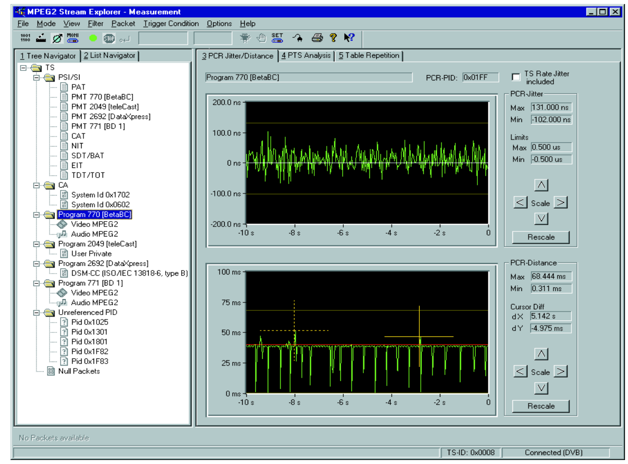


Fig. 3: Realtime measurement of PCR jitter and PCR spacings (DVB mode)

TRIGGER

If an error occurs in the transport stream applied to DVMD, the data in the region of the error are stored in the DVMD and made available to Stream Explorer™ for evaluation. The cause of the error can thus reliably be detected and displayed in detail.

TRIGGER EVENT: This display mode is additionally available for error investigation. It shows the structure elements in which the error occurred. Faulty data are shown in red. The type of error is explained in addition.

MIP MONITOR: Regularly updated display of MIP (megaframe initialization packets) data. These data are indispensable in SFNs (single frequency networks) to enable synchronized operation of the various transmitters.

MEASURE

This operating mode allows realtime analysis of several transport stream parameters and graphic display in the form of bargraphs or traces:

- PCR jitter (Fig. 3)
- Spacing of PCR values in transport stream (Fig. 3)
- Spacing of elementary-stream-related PTS values
- PTS/PCR difference
- Spacing of PSI, SI and PSIP tables
- Data rates of elementary streams

MONITORING

Full remote control of the DVMD is integrated in this operating mode, including display, filtering and storage of the monitoring report.

Other features

By switching to offline mode, the current contents of the transport stream can be stored in all operating modes for subsequent analysis.

Stream Explorer™ supports the software interface COM/DCOM (Distributed Component Object Module) which allows data and commands to be exchanged between Windows programs. In networked monitoring systems the Stream Explorer™ can be remote-controlled as an OLE automation server by application software packages.

System requirements

PC or laptop with Pentium processor (recommended clock frequency min. 100 MHz), Windows 95, 98 or Windows NT operating system, min. 16 Mbyte RAM (Windows NT: 32 Mbyte), required space on hard disk approx.10 Mbyte, 1 free RS-232-C interface (recommended data rate: 115 kbit/s),
1 parallel printer interface, 3.5'' disk drive

Ordering information

Stream Explorer™	DVMD-B1	2068.9406.02
Equipment supplied	3.5'' floppy disks with setup program; cable for connecting the DVMD to the PC, manual and dongle for connection to the parallel printer output of the PC	

TV Test Receiver Family EFA

Test receivers and demodulators for analog and digital (DVB-C, DVB-T or ATSC/8VSB) TV signals

EFA 43 (photo 43310-6)

Brief description

The TV Test Receiver and Demodulator Family EFA is an instrument generation offering outstanding performance features and excellent transmission characteristics. The instrument provides high-precision reception and demodulation of vestigial sideband AM signals (analog TV signals) as well as DVB signals:
QAM (Quadrature Amplitude Modulated) or COFDM (Coded Orthogonal Frequency Division Multiplex) and ATSC/8VSB signals (Eight Levels Vestigial Side Band). The instruments measure a comprehensive range of transmission parameters and are therefore ideal for measurement and monitoring applications in TV transmitter stations, coverage, cable networks, development labs and service.

The family members

Model 12: Analog TV test receiver, standard B/G, selective

Model 20: Digital (QAM) TV test receiver, DVB-C, selective

Model 23: Digital (QAM) TV test demodulator, DVB-C, broadband

Model 33: Analog TV test demodulator, standard B/G, broadband

Model 40: Digital (COFDM) TV test receiver, DVB-T, selective

Model 43: Digital (COFDM) TV test demodulator, DVB-T, broadband

Model 53: Digital (8VSB) TV test demodulator, ATSC, broadband

Model 72: Analog TV test receiver, standard M/N, selective

Model 78: Analog TV test receiver, standard D/K or I, selective

Model 83: Analog TV test demodulator, standard M/N, broadband

Model 89: Analog TV test demodulator, standard D/K or I, broadband

Applications

- Production of modulators and transmitters (calibration and test)
- Transmitter installation and adjustment of Single Frequency Networks (SFN in DVB-T)
- Coverage measurements on terrestrial signals
- Monitoring of TV transmitters, transposers and cable head-ends
- Research and development
- Service
- Measurement of noise margin of digital signals
- Monitoring of MPEG2 Transport streams

Features

DVB-C test receiver model 20 and DVB-C demodulator model 23 according to Standard ETS 300 429

- All measurements according to ETR 290
- 4QAM to 256QAM selectable
  - flexible symbol rate (1.5 MSymb/s to 6.995 Msymb/s)
- Constellation diagram with automatic result analysis
- Integrated noise generator for measurement of noise margin
- IF SAW filters of various bandwidth (2 MHz, 6 MHz, 7 MHz, 8 MHz)
- Self-adapting equalizer for in-depth signal analysis in transmission channel
  - echo measurement
  - amplitude and phase response
- Alarm register with 1000 memory locations for the following errors:
  - signal level (threshold adjustable)
  - synchronization
  - bit error rate (threshold adjustable)
  - non-corrected MPEG2 errors
- MPEG2 TS synchronous parallel output (LVDS TS SPI) and asynchronous serial output (TS ASI)
- MPEG2 Decoder EFA-B4 (option) can be integrated

DVB-T test receiver model 40 and DVB-T demodulator model 43

- All DVB-T modes according to ETS 300 744 supported, including hierarchical modulation

Test Receiver Family EFA

- All measurements according to ETR 290
- In depth measurement capabilities:
  - constellation diagram
  - automatic COFDM parameters analysis
  - Modulation Error Ratio (MER), over frequency
  - Impulse response with integrated zoom function
  - Amplitude distribution/CCDF (Complementary Cumulative Distribution Function) with OFDM reference markers
  - Spectrum and automatic shoulder attenuation measurement according to ETR 290
  - History function (long term monitoring)
- Channel estimation for in-depth signal analysis in transmission channel:
  - amplitude, phase and group delay response
  - polar representation
- Integrated noise generator for measurement of noise margin
- IF SAW filters of various bandwidth (6 MHz, 7 MHz, 8 MHz)
- Alarm register with 1000 memory locations for the following errors:
  - signal level (threshold adjustable)
  - synchronization
  - MER (threshold adjustable)
  - bit error rate before VITERBI decoder (threshold adjustable)
  - bit error rate before Reed Solomon decoder (threshold adjustable)
  - non-corrected MPEG2 errors
- MPEG2 TS synchronous parallel output (LVDS TS SPI) and asynchronous serial output (TS ASI)
- MPEG2 Decoder EFA-B4 (option) can be integrated
- EFA-B3 for model 43

ATSC/8VSB demodulator model 53 according to ATSC Digital TV Standard, Doc. A/53

- 8VSB demodulation including Trellis decoding
  - Flexible symbol rate (2 MSymb/s to 11 MSymb/s)
- In depth measurement capabilities:
  - constellation diagram
  - automatic VSB parameters/pilot analysis
  - Modulation Error Ratio (MER), Error Vector Magnitude (EVM)
  - Ghost pattern (impulse response) with integrated zoom function
  - Amplitude distribution/CCDF (Complementary Cumulative Distribution Function) with 8VSB reference markers
  - Spectrum and automatic shoulder attenuation measurement
  - History function (long term monitoring) according to FCC rules
- Self-adapting equalizer, for in-depth signal analysis in transmission channel:
  - amplitude, phase and group delay response
  - polar representation
- Integrated noise generator for measurement of noise margin
- IF SAW filters of various bandwidth (2 MHz, 6 MHz, 8 MHz)
- Alarm register with 1000 memory locations for the following errors:
  - signal level (threshold adjustable)
  - synchronization
  - MER/EVM (thresholds adjustable)
  - bit error rate before Reed Solomon decoder (threshold adjustable)
  - non-corrected MPEG2 errors
- MPEG2 TS synchronous parallel output (LVDS TS SPI), asynchronous serial output (TS ASI) and synchronous serial output (SMPTE310M)
- Retrofittable RF Selection EFA-B3 (option), non-selective input remains usable

TV test receiver models 12, 72 and 78

- Selective test receiver
- Frequency and channel entry
- Measurement functions for
  - vision carrier, power/level and offset frequency
  - vision/sound carrier, power ratio and frequency spacing
  - FM deviation of sound and pilot carriers
  - Residual carrier (modulation depth), option EFA-B8
- Country specific group-delay correction, switchable
- Models 12, 78: Upgradable to dual-mode instrument, i.e. analog and digital (DVB-C or DVB-T) receiver in one compact unit (option EFA-B1/-B10)
- Models 12, 78: NICAM Demodulator EFA-B2 (option)

TV demodulator models 33, 83 and 89

- Nyquist demodulator, broadband RF input
- Retrofittable RF selection EFA-B3 (option), the broadband input remains usable
- Same measurement functions as test receiver
- Country specific group-delay correction, switchable
- Models 33, 89: Upgradable to dual-mode instrument, i.e. analog and digital (DVB-C or DVB-T) demodulator in one compact unit (option EFA-B1 or EFA-B10)
- Models 33, 89: NICAM Demodulator EFA-B2 (option)
- Model 33: Switchable video bandwidth to 6 MHz (option EFA-B7)

All EFA models

- Frequency range continuously tunable from beginning of band I to end of band V
- RF selection EFA-B3 (option) with frequency range 4.5 MHz to 1000 MHz (return-channel-compatible) for demodulator models

Test Receiver Family EFA

- Simple, user-friendly hardkey and softkey control
- IEEE/IEC bus, RS-232-C interface
- Compact unit (3 height units)
- Modular design
  – easy retrofitting of options
- Comprehensive measurement and monitoring functions
- Excellent price/performance ratio
- Platform for new digital technologies

Family concept

With its modular design, the extremely compact TV Test Receiver EFA is made for easy upgrading and high versatility. In addition to the selective test receivers, the non-selective front-end of the test demodulators allows to perform measurements directly at the source of a single channel occupancy (TV transmitter) and provides results of highest precision. A high-grade selection module (option EFA-B3) can be connected ahead of this non-selective front-end.

The first digital group of the EFA family is the DVB-C test receiver or demodulator (Digital Video Broadcasting over Cable), which is able to analyze any QAM signal (Fig 1).

The second digital group of the EFA family is the DVB-T test receiver or demodulator (DVB-Terrestrial). It is able to demodulate, analyze and monitor any COFDM DVB-T signal in real time. In parallel to the measurement, the demodulated MPEG2 TS remains usable (Fig 2).

The new member of the digital EFA family is the ATSC/8VSB demodulator, which allows to demodulate, analyze and monitor in real time a 8VSB modulated carrier - digital terrestrial standard adopted in the United States of America. In parallel to the measurement, the demodulated MPEG2 TS remains usable (Fig 3).

Fig 4 shows the measurement menue of an Analog TV EFA version. A MPEG2 measurement decoder (option EFA-B4) can be integrated for the syntax analysis of the transport stream provided by the digital DVB-C or DVB-T EFA models. Furthermore, a NICAM demodulator/decoder (option EFA-B2) can be integrated on Analog TV EFA models.

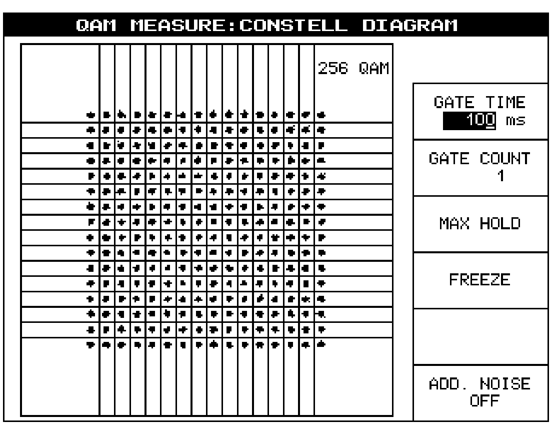


Fig 1: Constellation diagram of a 256QAM DVB C signal (EFA models 20/23)

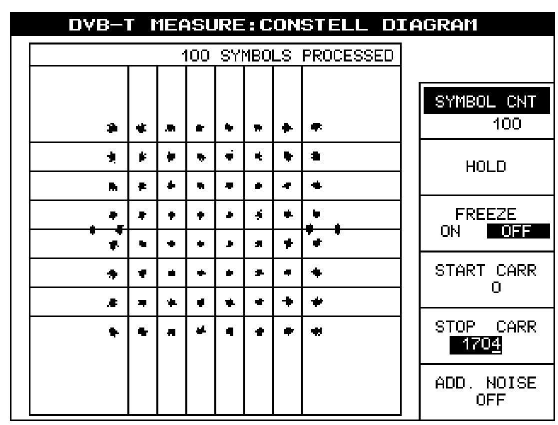


Fig 2: Constellation diagram of a 2K/64QAM DVB T signal (EFA models 40/43)

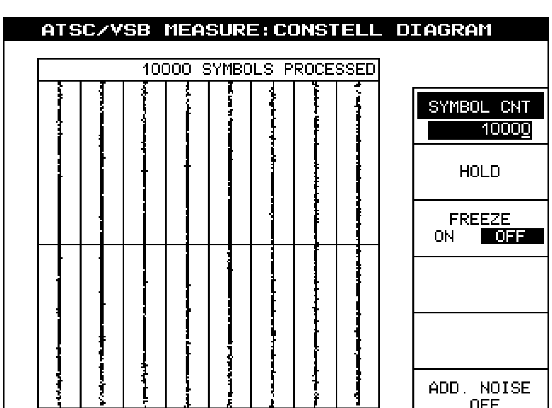


Fig 3: Constellation diagram of a ATSC/8VSB signal (EFA model 53)

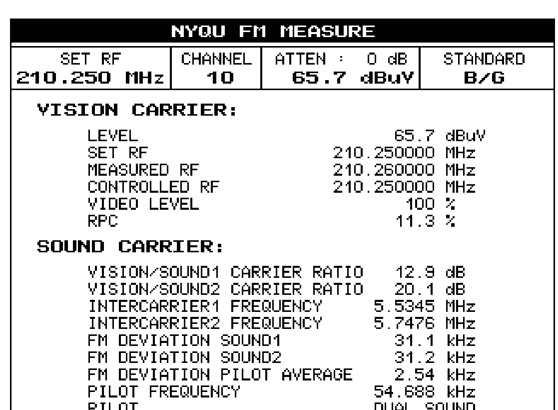


Fig 4: Measurement menu of an Analog TV test receiver

TV Test Receiver Family EFA

Specifications in brief – Digital TV, models 20, 23 (DVB-C), according to ETS300429

Model-specific characteristics	DVB-C standard test receiver, model 20	DVB-C high-end test receiver, model 23 with option EFA-B3	DVB-C high-end demodulator, model 23
RF input	selective	selective	non-selective
Connector	50 Ω or 75 Ω, BNC or N female, on front or rear panel (see configuration sheet)	50 Ω, N female, on rear panel 75 Ω, BNC female, on rear panel	50 Ω, N female, on rear panel
Return loss	≥14 dB in channel with 50 Ω connector and input attenuation ≥10 dB ≥12 dB in channel with 75 Ω connector and input attenuation ≥10 dB	≥17 dB (typ. 20 dB) in channel at 50 Ω connector ≥14 dB (typ. 17 dB) in channel at 75 Ω connector	≥ 30 dB
Frequency range	48 MHz to 862 MHz	4.5 MHz to 1000 MHz	45 MHz to 1000 MHz
Level range[1]	without preamplifier: –67 to 13 dBm with preamplifier: –70 to –47 dBm	low noise: –70 to 17 dBm[2] normal: –67 to 17 dBm[2] low distortion: –67 to 17 dBm[2]	–44 dBm to 17 dBm
Image frequency rejection	VHF: ≥ 70 dB[3] UHF: ≥ 50 dB[3]	100 dB[4]	
IF rejection		100 dB	
Local osc. (Resolution/Frequency error)	1 Hz/≤$2x10^{-6}$	1 Hz/≤$2x10^{-6}$	1 Hz/≤$2x10^{-6}$

1) Levels are rms values.

2) In receive frequency range 4.5 MHz to 15 MHz: –30 dBm to 17 dBm, SAW filter ON, additional ripple (0.7 dB_{pp}).

3) Image frequency of carrier.

4) Applies to both frequency conversions.

Common characteristics

IF input	50 Ω, BNC female, on rear panel, 36 MHz
Return loss in channel	≥30 dB
Level range (rms value)	–27 dBm to –7 dBm
IF output	50 Ω, BNC female, on rear panel, 36 MHz
Return loss in channel	≥20 dB
Level (rms value), regulated	–14 dBm
QAM demodulator characteristics	
Modulation type	4, 16, 32, 64, 128, 256QAM
Roll-off factor	0.12; 0.13; 0.15; 0.18; 0.20; 0.25; 0.30 selectable
Equivalent Noise Degradation (END)	≤1.5 dB (64QAM)
Symbol rate	1.5 to 6.995 MSPS
Equalizer	self-adapting
I/Q inversion	automatic or manual
Reed-Solomon decoder	204, 188, 8; selectable
Bit error ratio measurement range	$1x10^{-3}$ to $0.1x10^{-9}$
Interleaving	convolutional interleaver (Forney), L = 12
Energy dispersal	to DVB specification
Internal noise generator (on/off)	12 dB to 62 dB in steps of 0.1 dB
C/N ratio (noise generator) Setting, filters	automatic conversion and correct setting of C/N ratio if optional filters are fitted (eg 6 MHz, option EFA-B11)
Sync information on	symbol clock, carrier recovery, equalizer, MPEG2 frame
MPEG TS parallel output	to LVDS standard (188, 204 bytes); parallel MPEG transport stream
MPEG TS ASI output	serial MPEG transport stream (ASI); 75 Ω
SER DATA output	serial data stream ahead of Reed-Solomon decoder; 75 Ω
SER CLK output	clock output for SER DATA; 75 Ω
Alarm messages	level, BER, synchronization, MPEG TS transmission errors
Storage	with date and time, up to 1000 lines

Test parameters for 64QAM	Range	Resolution	Accuracy
Level	–60 to +10 dBm	0.1 dB	≤±3 dB, typ. ±1 dB
MER (modulation error ratio)	24 dB to 30 dB	0.1 dB	≤±0.3 dB
	30 dB to 35 dB	0.1 dB	≤±0.7 dB
	35 dB to 40 dB	0.1 dB	≤±1.5 dB
SNR (signal-to-noise ratio)	24 dB to 30 dB	0.1 dB	≤±0.4 dB
	30 dB to 35 dB	0.1 dB	≤±0.8 dB
	35 dB to 40 dB	0.1 dB	≤±1.8 dB
Carrier suppression	25 dB to 40 dB	0.1 dB	≤±1 dB
	40 dB to 50 dB	0.1 dB	≤±1.5 dB
	50 dB to 60 dB	0.1 dB	≤±3 dB
I/Q amplitude imbalance	0 to 5%	0.01%	≤±0.02%
I/Q phase error	0° to 5°	0.01°	≤±0.02°
Frequency offset	±100 kHz	1 kHz	≤±3 kHz
BER (bit error ratio)	$2x10^{-4}$ to $1x10^{-3}$	$0x10^{-9}$ to $2x10^{-4}$	$0.1x10^{-exponent}$

Measurements
(all Measurements according to ETR 290)

Level,
Frequency Offset;
BER (bit error ratio) before Reed Solomon decoder,
MER (modulation error ratio),
SNR (signal-to-noise ratio),
Carrier Suppression (2K and 8K),
Quadrature Error,
Amplitude Imbalance,
Phase Jitter

Graphic displays

Constellation Diagram,
Amplitude (f),
Phase (f),
Echo Pattern

TV Test Receiver Family EFA

Specifications in brief – Digital TV, models 40, 43 (DVB-T), according to ETS 300 744

Model-specific characteristics	DVB-T standard test receiver, model 40	DVB-T high-end test receiver, model 43 with option EFA-B3	DVB-T high-end demodulator, model 43
RF input	selective	selective	non-selective
Connector	50 Ω or 75 Ω, BNC or N female, front or rear panel	50 Ω, N female, rear panel and 75 Ω, BNC female, rear panel	50 Ω, N female, rear panel
Return loss	≥14 dB in channel with 50 Ω connector and input attenuation ≥10 dB ≥12 dB in channel with 75 Ω connector and input attenuation ≥10 dB	≥17 dB (typ. >20 dB) in channel with 50 Ω connector ≥14 dB (typ. >17 dB) in channel with 75 Ω connector	≥30 dB
Frequency range	48 MHz to 862 MHz	4.5 MHz to 1000 MHz [1)]	45 MHz to 1000 MHz
Level range	–72 dBm to 8 dBm (without preamplifier) –82 dBm to –47 dBm (with preamplifier) –88 dBm to –47 dBm (with preamplifier and high acp)	–85 dBm to 9 dBm (low noise) –80 dBm to 9 dBm (normal) –80 dBm to 9 dBm (low distortion) –90 dBm to 9 dBm (low noise and high acp)	–50 dBm to 20 dBm
Noise figure (50 Ω input, RF ≥47.15 MHz)	typ. 12 dB (low noise) typ. 7 dB (preamplifier and low noise)	7 dB typ. (low noise) 9 dB typ. (normal) 11 dB typ. (low distortion)	
Image frequency rejection	≥70 dB (VHF) and ≥50 dB (UHF)	100 dB	
IF rejection		100 dB	
Local osc. (Resolution/Frequ. error)	1 Hz/≤2×10^{-6}	1 Hz/≤2×10^{-6}	1 Hz/≤2×10^{-6}
COFDM demodulator characteristics			
Inherent MER	≥34 dB	≥35 dB	≥35 dB
Inherent SNR	≥36 dB	≥37 dB	≥37 dB

1) At low input frequencies such as 4.57MHz: additional ripple (0.7 dB_{pp} typ), minimum input level: –30 dBm, SAW filter ON.

Common characteristics

Real-time measurement functions according to ETR290

IF input	50 Ω, BNC female, rear panel, 36 MHz
Return loss in channel	≥30 dB
Level range	–30 dBm to –5 dBm
IF output	50 Ω, BNC female, rear panel, 36 MHz
Return loss in channel	≥20 dB
Level, regulated	–17 dBm
COFDM demodulator characteristics	
Bandwidth operation	6, 7 and 8 MHz switchable
SAW filter	6, 7 and 8 MHz, OFF
Bit rate clock deviation	<10 ppm (typ. <3 ppm)
FFT mode	2K or 8K carriers
Constellation	QPSK, 16QAM, 64QAM
Guard interval	1/4, 1/8, 1/16, 1/32
Code rate	1/2, 2/3, 3/4, 5/6, 7/8
Hierarchical modulation	OFF, α=1, α=2, α=4
Equivalent noise degradation (END) at 64QAM; R 2/3	≤1.5 dB
Internal noise generator	C/N = 2.0 to 56.0 dB
Channel correction	self-adapting
I/Q inversion	automatic, with indication
BER processing	before Viterbi decoder, before and after Reed-Solomon decoder

Measurements (all measurements according to ETR 290)
Level, frequency offset, bitrate offset, BER (bit error ratio) before Viterbi decoder, before and after Reed Solomon decoder, MER (modulation error ratio), SNR (signal-to-noise ratio), carrier suppression (2K and 8K), quadrature error, amplitude imbalance, phase jitter, shoulder attenuation (upper/lower) , Crest Factor

Graphic displays
Constellation diagram with zoom, MER(f) (dB/%), interference (dB), I|Q(f), frequency spectrum, amplitude(f), phase(f), group delay(f), polar plot, amplitude distribution (RF), CCDF (RF), impulse response(t) with zoom, history

Protection ratio for DVB-T
interfered with by analogue TV in the lower adjacent channel (n–1) 64 QAM, R2/3, 8 MHz, QEF, LOW DISTORTION (high adjacent channel power ON)
44 dB typ.

Protection ratio for DVB-T
interfered with by analogue TV in the upper adjacent channel (n+1) 64 QAM, R2/3, 8 MHz, QEF, LOW DISTORTION (high adjacent channel power ON)
42 dB typ.

Outputs	
MPEG2 TS parallel output	LVDS (188, 204 byte)
MPEG2 TS ASI output	serial MPEG2 transport stream (ASI 100 Ω); 75 Ω
SER DATA output	serial data stream ahead of Viterbi dec; 75 Ω
SER CLOCK output	clock output for SER DATA; 75 Ω
Alarm messages	level, synchronisation, BER before Viterbi, BER before and after Reed-Solomon, MPEG TS error
Storage	
Alarm messages	with date and time, up to 1000 lines
Instrument setups	0 to 4

Test parameters	Range	Resolution
Level	depending on model	0.1 dB
MER (modulation error ratio)	depend. on mode of QAM	0.1 dB
SNR (signal-to-noise ratio)	depending on mode of QAM	0.1 dB
Carrier suppression (2K and 8K)	–5 dB to +40 dB	0.1 dB
I/Q amplitude imbalance	±5%	0.01%
I/Q quadrature error	±5°	0.01°
Frequency offset	±300 kHz	1 Hz
Bit rate offset	±40 ppm	0.1 ppm
BER before Viterbi	1.0×10^{-2} to 0.1×10^{-15}	$0.1 \times 10^{-\text{Exponent}}$
BER before Reed Solomon	1.0×10^{-3} to 0.1×10^{-15}	$0.1 \times 10^{-\text{Exponent}}$
BER after Reed Solomon	1.0×10^{-4} to 0.1×10^{-14}	$0.1 \times 10^{-\text{Exponent}}$

TV Test Receiver Family EFA

Specifications in brief - Digital TV, models 53 (ATSC/8VSB), according to ATSC Doc. A/53

Model-specific characteristics	ATSC/8VSB High-end Test Receiver (model 53) with option EFA-B3	ATSC/8VSB High-end Demodulator (model 53)
RF input	selective	non-selective
Connector	50 Ω, N female, rear panel 75 Ω, BNC female, rear panel	50 Ω, N female, rear panel
Return loss	≥17 dB (typ. >20 dB) in channel with 50 Ω connector ≥14 dB (typ. >17 dB) in channel with 75 Ω connector	≥30 dB
Frequency range[2]	4.5 MHz to 1000 MHz[1]	45 MHz to 1000 MHz
Level range	–74 dBm to 14 dBm	–50 dBm to 20 dBm
Noise figure (50 Ω input, RF ≥47.15 MHz)	typ. 7 dB (low noise) typ. 9 dB (low distortion)	
Image frequency rejection	100 dB	
IF rejection	100 dB	
Local osc. (Resolution/Frequ. error)	1 Hz/≤2x10^{-6}	1 Hz/≤2x10^{-6}

[1] At low input frequencies such as 4.57MHz: additional ripple (0.7 dB$_{pp}$ typ), minimum input level: –30 dBm, SAW filter ON.

[2] Referred to channel center frequency.

Common characteristics

IF input	50 Ω, BNC female, rear panel, center frequency 36 MHz
Return loss in channel	≥30 dB
Level range	–30 dBm to –5 dBm
IF output	50 Ω, BNC female, rear panel, center frequency 36 MHz
Return loss in channel	≥20 dB
Level, regulated	–17 dBm
ATSC/8VSB characteristics	
Symbol Rate	2 to 11 MSymb/s
Bandwidth (SAW filter)	6 MHz, SAW filter OFF, (8 and 2 MHz optional)
Bit rate clock deviation	<10 ppm (typ. <3 ppm)
Channel correction	Self-adapting Equalizer, Equalizer Freeze, Equalizer OFF
Equivalent noise degradation (END)	≤1.0 dB
Internal noise generator	C/N = 10.0 to 56.0 dB
Measurements	Level, BER (bit error ratio) before Viterbi decoder, before and after Reed Solomon decoder, MER (modulation error ratio), SNR (signal-to-noise ratio), carrier suppression (2 K and 8 K), quadrature error, amplitude imbalance, phase jitter

Graphic display	constellation diagram, Frequency spectrum, amplitude(f), phase(f), group delay(f), Polar plot, amplitude distribution (RF), impulse response(t), history(t)
Outputs	
MPEG2 TS parallel output	LVDS (188, 204 byte)
MPEG2 TS ASI output	serial MPEG2 transport stream (ASI); 75 Ω
SMPTE310M output	800 mV$_{pp}$, 75 Ω
Alarm messages	level, MER, EVM synchronisation, BER before Reed-Solomon decoder, MPEG TS error
Storage	
Alarm	with date and time, up to 1000 lines
Instrument setups	0 to 4

Test parameters	**Range**	**Resolution**
Level	depending on model	0.1 dB
MER (modulation error ratio)	20 dB to 45 dB	0.1 dB
SNR (signal-to-noise ratio)	20 dB to 48 dB	0.1 dB
Pilot Carrier Frequency Offset	±100 kHz	1 Hz
Pilot Value	0.5 to 2	0.01
Data Signal / Pilot Power Ratio	19 to 7 dB	0.1 dB
Pilot Amplitude Error	–8 dB to 4 dB	0.1 dB
Symbol rate offset	±150 ppm	0.1 ppm
BER before Reed Solomon	1.0 x 10^{-3} to 0.1 x 10^{-15}	0.1 x 10$^{-\text{Exponent}}$
BER after Reed Solomon	1.0 x 10^{-4} to 0.1 x 10^{-14}	0.1 x 10$^{-\text{Exponent}}$

TV Test Receiver Family EFA – Specifications in brief – Analog TV

Model-specific characteristics	Standard test receivers Models 12/72/78	High-end test receivers Models 33/83/89 with option EFA-B3	High-end demodulators Models 33/83/89
RF input	selective	selective	non-selective
Connector	50 Ω or 75 Ω, BNC or N female, on front or rear panel (see configuration sheet)	50 Ω, N female, on rear panel 75 Ω, BNC female, on rear panel	50 Ω, N female, on rear panel
Return loss	≥14 dB in channel with 50 Ω connector and input attenuation ≥10 dB ≥12 dB in channel with 75 Ω connector and input attenuation ≥10 dB	≥17 dB (typ. 20 dB) in channel at 50 W connector ≥14 dB (typ. 17 dB) in channel at 75 Ω connector	≥30 dB
Frequency range (vision carrier)	45 to 860 MHz for models 12, 78 50 to 888 MHz for model 72	5 to 1000 MHz	45 to 1000 MHz for models 33, 89 50 to 1000 MHz for model 83
Level range[1]	without preamplifier: –67 to 13 dBm with preamplifier: –77 to –47 dBm	low noise: –77 to 21 dBm[2] normal: –67 to 21 dBm[2] low distortion: –67 to 21 dBm[2]	–41 to 21 dBm
Image frequency rejection	VHF: ≥70 dB[3]; UHF: ≥50 dB[3]	100 dB[4]	
IF rejection		100 dB[4]	
Local oscillator			
Resolution	1 Hz	1 Hz	1 Hz
Frequency error	$\leq 2 \times 10^{-6}$	$\leq 2 \times 10^{-6}$	$\leq 2 \times 10^{-6}$
Phase noise[5]	≥50 dB	≥58 dB	≥62 dB[6]
Video demodulation characteristics			
Noise voltage, ref. to b/w transition	P_{RF}≥–33 dBm, 0 dB input attenuation	P_{RF}=–33 dBm, 0 dB input attenuation	P_{RF}≥–1 dBm
S/Nrms unweighted			≥60 dB, typ. 63 dB
S/Nrms weighted to CCIR Rec. 567	low noise: ≥60 dB, typ. 64 dB low distortion: ≥57 dB, typ. 59 dB	low noise: ≥64 dB, typ. 66 dB normal: ≥63 dB, typ. 65 dB low distortion: ≥62 dB, typ. 64 dB	≥67 dB, typ. 70 dB
$Signal/hum_{peak}$	≥52 dB	≥52 dB	≥52 dB
Linear distortion			
Amplitude frequency response	reference: 0.5 MHz	reference: 0.5 MHz	reference: 0.5 MHz
DC to colour subcarrier	≤0.5 dB	≤0.35 dB	≤0.25 dB
Additional ripple through SAW filter	≤0.1 dB	≤0.1 dB	≤0.1 dB
Group delay response	reference: 0.1 MHz	reference: 0.1 MHz	reference: 0.1 MHz
With constant group delay	≤20 ns	≤15 ns	≤12 ns
Additional ripple through SAW filter	≤10 ns	≤10 ns	≤10 ns
Transient response			
2T pulse k factor	≤1%	≤1%, typ. 0.6%	≤1%, typ. 0.6%
2T pulse amplitude error			≤2%, typ. 1%
20T pulse amplitude error (Std. B/G, D/K, I)			≤3%
12.5T pulse amplitude error (Std. M/N)			≤5%
Chrominance/luminance gain			≤3%
Chrominance/luminance delay			
With constant group delay	≤20 ns	≤15 ns	≤12 ns
With group delay dep. on TV std.	≤20 ns	≤20 ns	≤20 ns
Tilt, 10/75% modulation			
0.25 Hz squarew. signal, Trise 2 µs			≤1%
50 Hz squarew. signal, Trise 2 µs			≤1%
15 kHz squarew. signal, Trise 200 ns	≤1%	≤1%	≤1%
Nonlinear distortion			
Luminance nonlinearity	≤2%, typ. 0.3%	≤2%, typ. 0.3%	≤2%, typ. 0.4%
Differential gain	≤2%, typ. 0.3%	≤2%, typ. 0.3%	≤2%, typ. 0.4%
Differential phase	≤1°, typ. 0.4°	≤1°, typ. 0.4°	≤1°, typ. 0.5°
Intermodulation in channel, referred to b/w transition	low noise: ≥52 dB, typ. 56 dB low distortion: ≥62 dB, typ. 66 dB	low noise: ≥52 dB, typ. 56 dB normal: ≥57 dB, typ. 61 dB low distortion: ≥62 dB, typ. 66 dB	≥55 dB
3rd-order intercept point; 0 dB attenuation	low noise: ≥0 dBm low distortion: ≥5 dBm	normal: ≥10 dBm low distortion: ≥14 dBm	

1) Levels are rms values referred to sync pulse.
2) In receive frequency range 5 MHz to 15 MHz: –41 dBm to 21 dBm.
3) Image frequency of vision carrier.
4) Applies to both frequency conversions.
5) FM S/N ratio measured at IF output, referred to ±30 kHz frequency deviation and 500 Hz modulation frequency, deemphasis 50 µs, measured to DIN45405, weighted to CCIR468-3.
6) In frequency range 45 MHz to 900 MHz of models 33 and 89; in range 50 MHz to 890 MHz of model 83.

Characteristics common to all models

IF input	50 Ω, BNC female, on rear panel
Vision carrier frequency	
TV standards B/G, I, D/K	38.9 MHz
TV standard M/N	45.75 MHz
Return loss in channel	≥30 dB
Level range	–13 to 4 dBm (eff., referred to sync)
Crosstalk attenuation, RF/IF input	≥75 dB

IF output	50 Ω, BNC female, on rear panel
Return loss in channel	≥20 dB
Vision carrier level, regulated	–7 dBm (eff., referred to sync)

Input for external zero reference		75 Ω, BNC female, on rear panel
Control voltage		>1 V
Delay of carrier blanking relative to control pulse		<3 µs
Video selectivity		
In-channel sound carrier suppression		
TV standard	B/G, I, M/N	≥50 dB
	D/K	≥48 dB
Adjacent-channel vis. carrier suppression		
TV standard	B/G, I (CATV)	≥50 dB
	I (terrestrial)	≥48 dB
	D/K	≥46 dB
	M/N	≥45 dB

Video outputs	75 Ω, BNC female, front and rear panel
Return loss (0 to 6 MHz)	≥26 dB
Decoupling of outputs	
Level variation at terminated output with other output short-circuited or open	≤1%
Video level, selectable	1 V pp ± 3 dB
Level inaccuracy	≤2%
Resolution of level control	10 mV
DC offset with carrier clamped to zero	0 V ± 20 mV

Quadrature signal output of synchronous demodulator	75 Ω, BNC female, on rear panel
Return loss (0 to 6 MHz)	≥20 dB
Gain difference, referred to nominal video output level	≤0.5 dB

Synchronous demodulation	
Phase error of switching carrier	≤1°
Vision carrier phase control	continuous, sampled (switchable)
Time constant of PLL for keyed phase control	normal, slow (switchable)
Time constant of PLL for continuous phase control	fast, normal, slow (switchable)

Audio demodulation characteristics, TV standards B/G, D/K, I

Demodulation	intercarrier method
Audio outputs	Lemo Triax female, in pairs rear panel: balanced, Z <35 Ω front panel: unbalanced, Z <10 Ω
Output signal	M1/L and M2/R
Permissible load	≥300 Ω // ≤5000 pF
Audio level, selectable	
Reference frequency deviation	±30 kHz or ±50 kHz, selectable
Setting range for ±30 kHz reference frequency deviation	–3 dBm to +10 dBm
Setting range for ±50 kHz reference frequency deviation	+2 dBm to +10 dBm
Resolution of level control	0.1 dB
Level inaccuracy, fmod 500 Hz	≤0.2 dB
Amplitude frequency response, 40 Hz to 15 kHz, referred to 500 Hz	≤ ±0.3 dB
Deemphasis	50 µs, switchable
Distortion at ±50 kHz frequency deviation, deemphasis on	≤0.5%

S/N ratio (intercarrier method) referred to ±30 kHz frequency deviation and 500 Hz modulation, frequency, measured to DIN45405, weighted to CCIR468-3; the channel not being measured is without signal

Vision modulation: all-black picture	≥55 dB
Vision modulation: test pattern	≥48 dB
Vision modulation: sinewave, 10 to 75% modulation	≥46 dB
Vision modulation: sinewave, 242 kHz ±15 kHz, 10 to 75% modulation	≥42 dB
Stereo crosstalk, 40 Hz to 15 kHz referred to ±30 kHz frequency deviation and 500 Hz modulation frequency, deemphasis on	≥40 dB
Channel crosstalk, 40 Hz to 15 kHz referred to ±30 kHz frequency deviation, deemphasis on, measured with ±30 kHz spurious FM	≥74 dB

Audio demodulation characteristics, TV standard M/N

Demodulation	intercarrier method
Intercarrier input/output	configuration as input or output by means of internal jumpers; configured as output on delivery
Connector	50 Ω, BNC female, on rear panel
Return loss, 4.4 MHz to 4.6 MHz	≥20 dB
Intercarrier output level, vision/sound power ratio 10 dB	–7 dBm ±3 dB
Intercarrier input level range	–13 dBm to –1 dBm

Main channel output (mono)	Lemo Triax female on rear panel: balanced, Z=600 Ω on front panel: unbalanced, Z=600 Ω
Audio level, selectable	
Reference frequency deviation	±25 kHz
Setting range	0 to +6 dBm
Resolution of level control	0.1 dB
Level inaccuracy, fmod 500 Hz	≤0.2 dB
Amplitude frequency response, 30 Hz to 15 kHz, referred to 500 Hz	≤±0.3 dB
Deemphasis	75 µs, switchable
Distortion, at ±25 kHz frequency deviation, fmod = 30 Hz to 15 kHz	≤0.1%

S/N ratio (intercarrier method) referred to ±25 kHz frequency deviation and 500 Hz modulation frequency, measured to DIN45405, weighted to CCIR468-3

Vision modulation: all-black picture	≥55 dB
Vision modulation: test pattern	≥48 dB
Vision modulation: sinewave, 0 to 4 MHz, 10 to 75% modulation	≥46 dB

Composite output (BTSC/MTS)	BNC female, rear panel: unbal., Z=75 Ω
Output level	10 mV/kHz FM deviation
Level inaccuracy	≤0.2 dB
Frequency response, referred to 25 kHz	
Amplitude frequency response, 30 Hz to 47 kHz	≤±0.05 dB
Amplitude frequency response, 47 kHz to 120 kHz	≤±0.5 dB
Phase frequency response, 30 Hz to 47 kHz	≤±0.5°
Distortion, ±25 kHz frequency deviation	
fmod 30 Hz to 15 kHz	≤0.1%
fmod 15 kHz to 50 kHz	≤0.5%

Alarm messages

Vision carrier level, RF offset, TV synchronization, vision/sound carrier level ratios, vision/sound carrier frequency spacings, FM pilot deviation, max. FM deviations, min. FM deviations

Additional alarm messages with option EFA-B2

Vision/NICAM sound carrier power ratio, NICAM intercarrier level, eye height, BER, data jitter; loss of: NICAM data/NICAM clock, frame sync, headroom

TV Test Receiver Family EFA – Ordering information

Test parameters, analog TV	Measurement range	Resolution	Accuracy
Vision carrier power or voltage in mV/mV, dBmV, dBmV, dBm, dBμW, dBpW			
Standard test receivers	–77 to 13 dBm	0.1 dB	≤3 dB
High-end test receivers	–77 to 21 dBm	0.1 dB	≤3 dB
High-end demodulators	–41 to 21 dBm	0.1 dB	≤2 dB
Video level	50 to 150 %	1%	≤2%
Vision carrier frequency	RF ±500 kHz	20 Hz	$\leq 2\times10^{-6}$
Vision/snd. carrier 1 level ratio			
TV standards B/G, D/K, I	–23 dB to –7 dB	0.1 dB	≤2 dB
TV standards M/N	–20 dB to –4 dB	0.1 dB	≤2 dB
Vision/sound carrier 2 level ratio			
TV standards B/G, D/K	–30 dB to –14 dB	0.1 dB	≤2 dB
Vision/sound carrier 1 frequency spacing			
TV standards B/G, D/K, I, M/N	nom. IC frequency ± 50 kHz	100 Hz	≤200 Hz[1]
Vision/sound carrier 2 frequency spacing			
TV standards B/G, D/K	nom. IC frequency ± 50 kHz	100 Hz	≤200 Hz[1]
FM sound carrier deviation	0 to 80 kHz	100 Hz	≤3% ±200 Hz[2]
FM pilot carrier deviation (average)			
TV standards B/G, D/K	1 to 5 kHz	10 Hz	≤5%
TV standards M/N	1 to 10 kHz	10 Hz	≤5%
FM pilot carrier deviation (peak value)	1 to 10 kHz	10 Hz	≤5%
Pilot frequency	pilot frequency ±300 Hz	2 Hz	≤2 Hz
Residual vision carrier[3]	0 to 30%	0.1%	0.5%
Mod. depth of vision carrier[3]	70 to 100%	0.1%	0.5%

1) With unmodulated sound carrier.

2) Without vision modulation.

3) With option EFA-B8.

General data

Display	monochrome LCD (320 x 240) with back-lighting
Interfaces	IEC625-2/IEEE488 bus, RS-232-C, printer (Centronics)
Rated/operating temperature range	+5°C to +45°C/0°C to +50°C
Power supply	100 V to 120 V/220 V to 240 V +10%/–15% (automatic voltage selection), 50 Hz to 60 Hz
Dimensions (WxHxD)	435 mm x 147 mm x 460 mm
Weight	approx. 12 kg, depending on options

Ordering information

Digital test receivers

DVB-C Test Receiver Selective, 4/16/32/64/128/256QAM, output MPEG2 data stream, constellation diagram	EFA 20	2067.3004.20
DVB-C Test Demodulator Broadband, 4/16/32/64/128/256QAM, output MPEG2 data stream, constellation diagram	EFA 23	2067.3004.23
DVB-T Test Receiver Selective, constellation diagram, output MPEG2 data stream	EFA 40	2067.3004.40
DVB-T Test Demodulator Broadband, constellation diagram, output MPEG2 data stream	EFA 43	2067.3004.43
ATSC/8VSB Test Demodulator Broadband, constellation diagram, output MPEG2 data stream	EFA 53	2067.3004.53

Analog Test Receivers

TV Test Receiver Standard B/G, dual sound IF 38.9 MHz, RF 45 MHz to 860 MHz, IEEE bus	EFA 12	2067.3004.12
Standard M/N, IF 45.75 MHz, RF 50 MHz to 888 MHz, IEEE bus	EFA 72	2067.3004.72
Standard D/K or I (mono), IF 38.9 MHz, RF 45 MHz to 860 MHz, IEEE bus	EFA 78	2067.3004.78
TV Test Demodulator Standard B/G, dual sound IF 38.9 MHz, RF 45 MHz to 1000 MHz, IEEE bus	EFA 33	2067.3004.33
Standard M/N, IF 45.75 MHz, RF 50 MHz to 1000 MHz, IEEE bus	EFA 83	2067.3004.83
Standard D/K or I (mono), IF 38.9 MHz, RF 45 MHz to 1000 MHz, IEEE bus	EFA 89	2067.3004.89

Accessories, options, extras

Accessories supplied
Lemo Triax adapter to XLR (stereo), power cable, operating manual

Options

QAM Demodulator (for analog TV units)	EFA-B1	2067.3604.02
NICAM Demodulator Standard B/G	EFA-B2	2067.3610.02
NICAM Demodulator Standard I	EFA-B2	2067.3610.04
RF Selection for Demodulator	EFA-B3	2067.3627.02
MPEG2 Decoder	EFA-B4	2067.3633.02
Video Distributor	EFA-B6	2067.3656.02
Switchable Video Bandwidth	EFA-B7	2067.3710.02
Residual Picture Carrier Measurement	EFA-B8	2067.3727.02
Pilot Deviation Measurement	EFA-B9	2067.3733.02
COFDM Demodulator (for analog units)	EFA-B10	2067.3740.02
6 MHz SAW Filter (for digital units)	EFA-B11	2067.3691.00
7 MHz SAW Filter (for digital units)	EFA-B12	2067.3591.00
8 MHz-SAW Filter (for models 40/43)	EFA-B13	2067.3579.02
8 MHz SAW Filter (models 20/23/53)	EFA-B13	2067.3579.03
2 MHz SAW Filter (models 20/23/53)	EFA-B14	2067.3562.00

Extras

EFA Calibration Values	EFA-DCV	2082.0490.09
EFA-B4 Calibration Values	EFA-DCV	2082.0490.15
19" Adapter	ZZA-93	0396.4892.00
Lemo Triax connector (mono) with connecting cable (open)		2067.7451.00
Service manual		2068.0950.24
Carrying Bag	ZZT-314	1001.0523.00

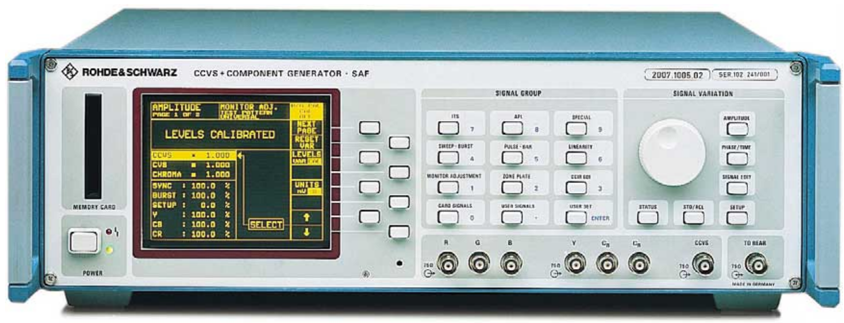
Note: please fill in the configuration sheet (available from your local representative or R&S web site www.rsd.de) so that your test receiver/demodulator can be tailored to your requirements.

CCVS+Component Generator SAF, CCVS Generator SFF

SAF: CCVS, YC_BC_R, RGB, S-VHS

SFF: CCVS

Multi-standard generators for all TV applications; optionally PALplus and ITU-R 601



SAF (photo 40328-1)

Brief description

TV Generators SAF and SFF are two multi-standard instruments (B G/PAL, M/NTSC, M/PAL, N/PAL) suitable for all applications in the field of television. CCVS+Component Generator SAF supplies all test signals and patterns required for video measurements in CCVS, YC_BC_R, RGB and S-VHS formats, for test patterns an aspect ratio of 4:3 or 16:9 being selectable. Where only the CCVS format is required, CCVS Generator SFF can be used.

SAF and SFF also generate all test signals to CCIR Rec. 801, a number of common pathological test signals, and shallow ramps with a resolution of 10 bits. The PALplus test pattern option provides all PALplus reference signals and the bits required for wide screen signalling (WSS).

Both generators afford extensive signal variations via softkey-controlled menus. Such amplitude and phase adjustments of signal components enable testing of gain controls, white-level limiting circuits and video analyzers over the whole range of the devices. User-specific signals can be defined by front-panel entry and stored in the generator or on a memory card.

Function

The generator section is of digital design. A transputer – a high-speed RISC processor – calculates the three components Y, C_B and C_R of all test signals which in CCVS+Component Generator SAF are applied to three D/A converters. An analog matrix converts the three components into the RGB format. Therefore the RGB signals are made available simultaneously with the YC_BC_R components. The digital CCVS in SAF and SFF is determined from the YC_BC_R components in realtime with the aid of two LSI gate arrays.

Digital Video Interface SAF-Z1

The optional Digital Video Interface SAF-Z1 upgrades the 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.

Main features

- Clear menu-guided operation on large-size EL display
- 12 signal groups with up to 8 signal menu pages each; each page may contain 7 signals
- Superposition of hum, sweep, noise or other signals with different clamping modes
- APL and bounce signals with preselectable parameters
- Insertion of external test signals such as teletext or data lines
- Free programming of test-line coding and monitoring
- Entry of texts as source identification or scrolling text
- Program monitoring + substitution pattern
- System compatibility and full remote control capability (IEC-625/IEEE-488 bus)
- Definition of customer-specific signals by "Signal Edit" via the front panel
- Zone-plate signals, 8 coefficients freely selectable

Specifications in brief

Inputs/outputs	BNC female connectors, 75 Ω
Return loss	≥34 dB (up to 6 MHz)
Sync output	2 V into 75 Ω
SC (colour subcarrier)	1 V pp into 75 Ω
Bounce trigger (input)	TTL level, Z_{in} approx. 10 kΩ, for external triggering of bounce function
Bypass	0/5 V for controlling bypass circuit in junction panel, Z_{out} approx. 20 Ω
EXT inputs	2, BNC, 75 Ω
Gain	0 ±0.1 dB
Differential gain	≤0.3%
Differential phase	≤0.3°
Clamping modes	– gated clamping to back porch – clamping to negative signal peak (EXT2 only) – AC-coupled signal (EXT2 only)
Superposition (EXT2 only)	– anywhere – in active picture range

Amplitude adjustment

variable in the range 0 to 140% (CCVS max. 1.6 V pp): signal components CCVS, CVS, chroma, sync pulse, burst, setup and components Y, C_B, C_R

Phase/time adjustment

H_{EXT} - H_{INT}	±9 µs
SC_{EXT} - SC_{INT}	0° to 360°
SC/H phase	–180° to +180°
H frequency	±5% (burst switched off from +1.5%)
Colour subcarrier frequency	100 Hz to 6 MHz
Burst timing reference, burst duration and rise time, as well as sync duration and rise time	setting range of each parameter dependent on settings of the other parameters
Option CCIR 601 (parallel interface)	shifting the reference clock by ±10 ns relative to data

Program path

Input/output	BNC, 75 Ω
Amplitude-frequency response	±0.1 dB (up to 6 MHz)
Group-delay error	≤5 ns (up to 5.5 MHz)
Differential gain	≤0.2%
Differential phase	≤0.2°
S/N ratio (rms, weighted, 0.2 to 5 MHz)	≥78 dB
Test signal insertion	
Level	same as generator signal – CAL (normal mode) – variation up to CVS x V_{pp} = 1.2 V

		B G/PAL, N/PAL	M/NTSC, M/PAL
Insertion range	in 1st field	lines 6 to 22	lines 10 to 22
	in 2nd field	lines 319 to 335	lines 10 to 22
Teletext signals	5 pages and teletext test line	eyetest pattern and teletext test line	
Amplitude (V_{pp})	462 ±5 mV	500 ±5 mV	
Eye height	≥96%	≥96%	
Clock	6.9375 MHz	5.72727 MHz	

Data lines	4 sequences
Amplitude (V_{pp})	500 ±5 mV
Coding	biphase
Clock	5 MHz

Option CCIR 601	test sequences to CCIR 801, pathological signals, shallow ramps, in addition all other signals digitally
Signal output	
25-pin Cannon connector	9+1 bit parallel, clock rate 27 MHz
75-Ω BNC connector	serial, 270 Mbit/s
Remote-control interface	to IEC625-2 (IEEE488)

CCVS

Level tolerances

Standard	B G/PAL, N/PAL	M/NTSC, M/PAL
Nominal luminance level (cal.)	700 ±4 mV	714 ±4 mV
Nominal chrominance level (cal.)	700 ±7 mV	714 ±7 mV
	Departure	
at nominal 500 to 700 mV	±1%	±1%
<500 mV	±5 mV	±5 mV
Squarewave pulses, staircase and sawtooth signals	nominal ±4 mV	nominal ±4 mV
2T pulse	nominal ±5 mV	nominal ±5 mV
10T and 20T pulses	nominal ±7 mV	nominal ±7 mV
12.5T pulse		nominal ±7 mV

Amplitude-frequency response

Multipulse, multiburst, sweep signals	
up to 5.5 MHz	±0.1 dB
>5.5 to 6 MHz	±0.15 dB

Group delay

10T and 20T pulses (modulated with frequencies ≤5 MHz)	≤5 ns

Rise times (10 to 90%) and half-amplitude duration

(also for YC_BC_R signals)

Sync rise time		200 ±5 ns (PAL, 625 lines) 140 ±5 ns (NTSC, 525 lines)
Luminance	rise times	125 ns to 2000 ns
	tolerances	125 ns to 249 ns ±5 ns 250 ns to 999 ns ±10 ns 1000 ns to 2000 ns ±30 ns
Chrominance	rise times	150 ns to 2000 ns
	tolerances	150 ns to 299 ns ±5 ns 300 ns to 999 ns ±10 ns 1000 ns to 2000 ns ±30 ns

Line-time nonlinearity

5-step staircase	≤0.8%

Chrominance phase

Phase between R-Y and B-Y axes	90° ±1°
Maximum departure of chrominance phase from nominal	±2°

S/N ratio

rms, weighted, 0.2 to 5 MHz	
on all-black picture	≥78 dB
on sawtooth signal	≥70 dB

Sync frame	PAL	NTSC
	sync frame and burst phase to CCIR Rec. 624-3	coupled with stable SC/H phase (to RS-170A)
SC/H phase, calibrated	0 to ±5°	0 to ±5°
V component	can be disabled for special measurements	

The tolerances in S-VHS format (SAF only) correspond to those of CCVS

Component signals

YC_BC_R (SAF only) (for 525/625 lines)	Y signal	C_B, C_R signal
Squarewave, staircase signals	nominal ±4 mV	nominal ±7 mV
Sawtooth signals	nominal ±7 mV	nominal ±7 mV
	2 to 20T pulses	nominal ±7 mV –
	3 to 20T pulses	–nominal ±7 mV
Sweep, multiburst signals		
0 to 5.5 MHz	nominal ±7 mV	nominal ±7 mV
>5.5 to 6 MHz	nominal ±10 mV	nominal ±10 mV

RGB (SAF only)	each component can be disabled separately; the rise times are determined by those of the YC_BC_R signals
Amplitude error	same as YC_BC_R signal components
Matrixing error	±1%
Matrixing frequency response	±0.2 dB (up to 6 MHz)
Sync pulse (can be disabled)	300 ±7 mV (can be added to each component or removed from it)

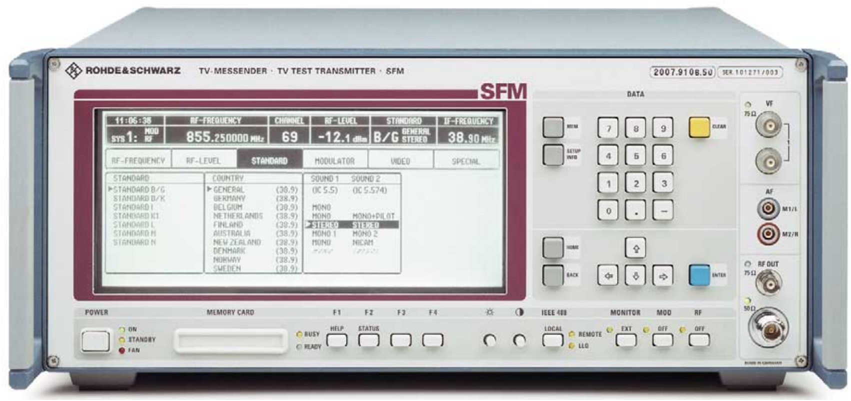
General data

Remote control interface	to IEC 625-2 (IEEE 488)
Power supply	100/120/230/240 V +10/–15%, 47 to 63 Hz (SAF: 100 VA, SFF: 80 VA)
Dimensions (W x H x D); weight	435 mm x 147 mm x 460 mm; 17 kg

Ordering information

CCVS+Component Generator	SAF	2007.1005.02
CCVS Generator	SFF	2007.1057.02
Options		
Digital Video Interface	SAF-Z1	2007.1063.02
	SFF-Z1	2007.1063.03
PALplus Test Pattern for SAF and SFF	SAF-B20	2007.1011.02
Calibration Data Documentation	SAF-DCV	2082.0490.02
	SAF-DCV	2082.0490.03
Extras		
32 kbyte Memory Card	ZZM-32	2005.4394.02
512 kbyte Memory Card	ZZM-512	2005.4388.02
Service Kit	SAF-Z	2007.1111.00
	SFF-Z	2007.1105.00

TV Test Transmitter SFM



5 MHz to 1000 MHz

Vision and sound signals

to all common TV standards

Photo 41846

Brief description

TV Test Transmitter SFM from Rohde & Schwarz supplies vision and sound signals to all common TV standards for the IF (32 MHz to 46 MHz) and RF ranges (5 MHz to 1000 MHz).

Thanks to a very flexible modular concept based on plug-ins, SFM is the compact solution for all analog applications in development, production and servicing. Each SFM frame can accommodate up to ten plug-ins so that standards B/G, D/K, I, L/L', M and N can be implemented in a single SFM.

SFM is ideal for use in EMC measurements: In Europe, EMC requirements are set down in special regulations and laws. Full compliance with prescribed limits is a prerequisite for certification with the European conformity mark CE.

For the American BTSC method, a multiplex signal with a frequency of up to 120 kHz can be applied. The frequency deviation and output level of the sound carriers are also set automatically as per standard.

Many parameters for the vision, NICAM and sound modulators can be set to non-standard values. The display outputs a warning that non-standard parameters are being used; however, compliance with the appropriate standard can be restored with a single keystroke.

Main features

- Generation of TV signals to standards B/G, D/K, I, L/L', M and N, including stereo/dual sound and digital sound (NICAM)
- Double-sideband test modulator for all IFs between 32 MHz and 46 MHz
- Internal audio generator, stereocoder and NICAM generator
- High frequency resolution of 1 Hz for precision offset
- Frequency locking for all oscillators

Operation

SFM outputs all information on a large LCD graphics display; if required an external monitor can be connected. The display is divided into different areas. The currently valid key setting parameters are displayed in the top half, these being frequency, TV channel, output level and the selected standard with the associated vision IF. Below there is the main selection line with menus such as frequency, level and standard. A special menu enables intermodulation measurements and sweep mode to be selected.

SFM is equipped with an IEEE/IEC bus interface to SCPI and also has an RS-232-C interface. Thanks to a PC card interface, complete setups can be loaded from or to a memory card. Software updates can be carried out via the serial interface or memory-card interface.

Specifications in brief

Modulator

Vision modulator

Video inputs	3 x 75 Ω; 1x front panel; 2 x rear panel
Vision carrier IF	adjustable from 32 to 46 MHz, stepwidth 10 kHz
Modulation characteristics	
Type of modulation	C3F, negative (B/G, D/K, I, M, N) C3F, positive (L/L')
Mode of operation	double sideband, vestigial sideband with SAW filter, with or without group-delay correction filter
Level control	
Clamping	to back porch (hard/soft switchover)
Average value	for symmetrical modulation

TV Test Transmitter SFM

Transmission characteristics	
Transmission range (IF)	±10 MHz (referred to vision carrier)
Vestigial-sideband filter	SAW filter for adjacent-channel operation (B/G, D/K, I, L/L', M, N)
Amplitude response	
Double-sideband operation	<±0.2 dB
Vestigial-sideband operation	depending on SAW filter
Group-delay response	
Double-sideband operation	<10 ns
Vestigial-sideband operation	depending on SAW filter
Signal-to-noise ratio	
0.2 to 5 MHz	>60 dB rms (weighted)
0 to 1 kHz	>60 dB pp (unweighted)
Hum suppression	
in clamped mode (hard)	>57 dB (with 30% superimposed hum)

Sound modulator 1, sound modulator 2	
AF signal input	+6 dBm for 0 to ±100 kHz deviation, floating, Z_{in} >5 kΩ, switchable internal/external
Sound carrier IF	$\lvert f_{vision\ carrier} - f_{sound} \rvert \leq 7$ MHz
Modulation characteristics for standards B/G, D/K, I, M, N	
Type of modulation	F3 with preemphasis option: 50 µs or 75 µs
Signal-to-noise ratio	>70 dB (referred to 30 kHz deviation)
Modulation characteristics for standard L/L'	
Type of modulation	A3 without preemphasis
AF input	+6 dBm for m = 0 to 100%
Signal-to-noise ratio	>70 dB, weighted and unweighted (m = 100%)
Internal AF generator (DSP)	30 Hz to 15 kHz

TV stereo/dual-sound coder	
AF input signals	L/R or AF_1/AF_2
Signal level	+6 dBm for ±30 kHz deviation
AF output signals	
Coding	IRT or Korea standard M
Crosstalk	
Dual sound	>70 dB
Stereo	>46 dB
Pilot carrier	in sound channel 2
Pilot frequency	
IRT	54.6875 kHz = 3.5 f_H
Korea	55.06994 kHz

NICAM sound modulator	
Standards	B/G, I, L (switchable)
Type of modulation	differential QPSK
Data rate	728 kbit/s according to NICAM
Pulse shaping	digital
cos roll-off	
Standards B/G + L	40%
Standard I	100%
Resolution	8 bit

Intermodulation measurement

(Level in dB)		Vision carrier	Sound carrier 1	Sideband
Intermodulation IM		0	–10	off
	IM/K	–8	–10	–16.5
	IM/B	–5.5	–11.5	–11.5
Linearity LIN1		–2.5/–8	–10	–32
Linearity LIN2		–2.5/–20	–10	–32

(Linearity measurement with vision-carrier switching every two seconds)

Upconverter

Frequency	
Input frequency range	32 to 46 MHz ±8 MHz for double-sideband operation (vision carrier)
Output frequency range	5 to 1000 MHz, step width 1 Hz
RF tuning	numeric frequency entry via keyboard in MHz or channel entry according to country table
RF sideband (selectable)	upper sideband (normal) or lower sideband

Level	
IF input level range	0 to –7 dBm into 50 Ω
RF output level (max. level)	
LOW NOISE	+10 dBm to –99 dBm
NORMAL	+6 dBm to –99 dBm
LOW DISTORTION	0 to –99 dBm
RF level resolution	0.1 dB
Total RF level error	<±1.5 dB
RF frequency response in TV channel	<0.5 dB (typ. 0.2 dB, channel-dependent)

Total transmission characteristics (Spurious signals with vision/sound ratio of 10:1, LOW DISTORTION mode)	
Spurious emissions	≥66 dB
Vision carrier –5.5 and 11 MHz	≥60 dB
Intermodulation products	>76 dB
Harmonics	≥50 dB
Video signal-to-noise ratio (referred to black-to-white transition)	
0.2 to 5 MHz (noise)	≥67 dB rms, weighted
10 Hz to 1 kHz (hum)	≥60 dB pp, unweighted
Audio signal-to-noise ratio up to 15 kHz (with pre- and deemphasis)	≥66 dB (30 kHz deviation)

General data

Rated temperature range	+5°C to +45°C
Operating temperature range	0 to +45°C
Power supply	100/120/220/240 V +15/–10%, 47 to 63 Hz, 150 VA
Dimensions (W x H x D); weight	435 mm x 192 mm x 460 mm; 19 kg

Ordering information

TV Test Transmitter		
Basic unit with vision modulator and FM modulator sound 1, without upconverter	SFM	2007.9106.10
Basic unit with vision modulator and FM modulator sound 1, with upconverter 5 to 1000 MHz, 50 Ω	SFM	2007.9106.50
Basic unit with upconverter 5 to 1000 MHz, 50 Ω, without vision/sound modulator	SFM	2007.9106.90
Options		
Multistandard plug-in	SFM-B7	2008.0248.02
Sound modulator 2 (switchable FM/AM), including dual-sound coder (IRT)	SFM-B9	2008.0183.02
QPSK sound modulator for NICAM728 with internal NICAM generator	SFM-B10	2008.0302.02
RF output 75 Ω (switchable)	SFM-B16	2007.9212.02

TV Test Transmitter SFQ

0.3 MHz to 3.3 GHz

Digital signals for antenna, satellite and cable

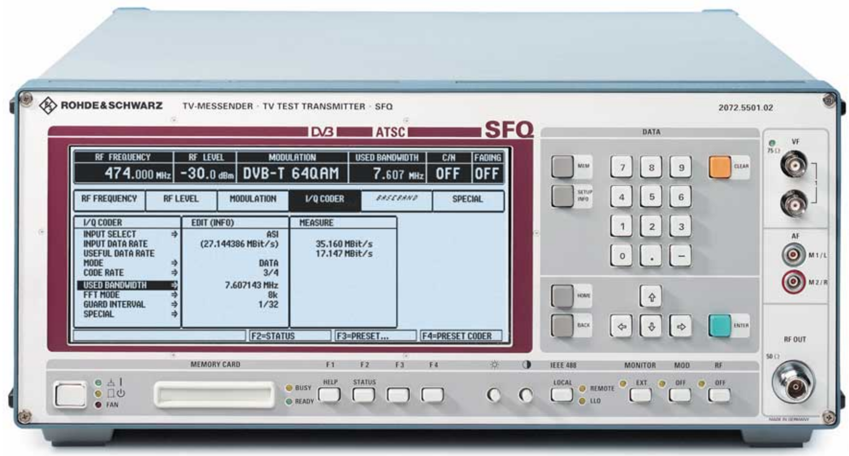


Photo 42591

Brief description

TV Test Transmitter SFQ is a complete solution for testing digital TV links and receivers (set-top boxes). An open-end software system and modular hardware configuration make for future-proofness. The ETSI standards for DVB-T, DVB-S and DVB-C as well as the ATSC standard for DTV are fully complied with. Thanks to its adaptability to future system changes, SFQ is a useful and rewarding investment for your launch onto the digital TV market.

Moreover, SFQ also processes analog frequency-modulated satellite signals in line with PAL, SECAM, NTSC standards. The sound signals are transmitted using analog FM and digital ADR sound subcarriers.

The test signals produced are of high precision and comply with the standards, but can also be varied over a wide range and provided with predefined errors to determine the performance of your products at their limits. The reproducible simulation of real transmission conditions by means of the noise generator and the fading simulator enables the specification of modules under test.

Main features

- Wide output frequency range from 0.3 MHz to 3300 MHz
- Large output level range for transmission, receiver and module measurements
- Standard DVB signals and FM satellite signals
- Several standards in one unit
- Satellite FM
  - PAL, SECAM, NTSC
  - FM and ADR sound subcarrier
- Antenna DVB-T
  - 2K and 8K COFDM
  - 6/7/8 MHz bandwidth
  - Hierarchical coding
- Antenna ATSC
  - 8VSB
- Cable DVB-C
  - Selectable QAM (quadrature amplitude modulation): 16, 32, 64, 128, 256QAM
- Satellite DVB-S
  - Selectable puncturing rate for QPSK (quadrature phase shift keying)
- Internal noise generator for high-precision C/N settings
- Internal bit error measurement (BE) for all digital modulation modes (BVC-C, DVB-S, DVB-T, 8VSB)
- Internal fading simulator
  - 6 or 12 paths
  - Predefined profiles
  - User-definable profiles
- Flexible input interfaces
  - ASI
  - SPI
- Input for external I/Q signals

Other features

- Input data rate selectable between 2 and 62.25 Mbit/s
- Energy dispersal, Reed-Solomon coder and interleaver selectable
- Variable roll-off factor of pulse shaping
- Data, pseudo random bit sequence (PRBS) and null transport stream packets as modulation signal selectable
- Output level: –99 dBm to +4 dBm (CW: +13 dBm)
- Error simulation with I/Q modulation by means of defined signal distortion

Applications

Because of its high signal quality and versatile ways of varying parameters, SFQ is ideal as a source for digital terrestrial signals (DVB-T and ATSC), for testing satellite (DVB-S and FM) and digital cable links (DVB-C), as a standard-signal generator in development, as a reference in quality monitoring, EMC labs, inspection and test centers and for use in production.

TV Test Transmitter SFQ

The output frequency range allows SFQ to be used as a back-channel generator and covers future extensions of the satellite IF range.

Operational parameters (eg roll-off, puncturing rate or QAM mode) can easily be varied. For laboratory applications, values outside those defined in the standard can be selected. For special measurements, it is possible to switch off i. e. interleaver, FEC, modulation, individual carriers or groups of carriers. Sweeps can be performed over the complete RF range.

The analog SFQ supplies frequency-modulated satellite signals conforming to standards. Various TV standards can be selected, and up to six sound subcarriers (FM and ADR) can be integrated. In addition, external sound subcarriers can be applied. Operational parameters are in line with standards; parameters such as amplitude, frequency and deviation are variable. Signals such as noise or energy dispersal can be added. It is thus possible to test satellite links and receivers using standard signals and to check the response to nonstandard signals.

Equipment and options

The basic model 02 of SFQ has to be ordered with at least one coder option, i.e. with

- SFQ-B10 for DVB-T
- SFQ-B12 for ATSC/8VSB
- SFQ-B15 for DVB-C und DVB-S
- SFQ-B13 for ITU-T/J.83B
- SFQ-B2 for FM Modulation

DVB/VSB options

- Noise generator
- Fading simulator (6 or 12 paths)
- Input interface (ASI; selectable symbol rate, precise data clock)
- I/Q output/input
- DVB-T coder
- DVB-C/DVB-S coder
- Hierarchical coding for DVB-T coder
- ATSC/8VSB coder

Optional broadband FM modulator

- FM satellite signals to standard
- Standard for FM transmission selectable (PAL, SECAM, NTSC)
- FM sound subcarriers with internal audio generators (two sound subcarriers installed as standard)
- Input for external sound subcarriers
- Input for external FM
- Baseband output
- Option: additional FM sound subcarriers
- Option: ADR (Astra Digital Radio) sound subcarrier with internal MUSICAM generators
- Noise generator

Specifications

Basic unit

Frequency (main carrier)	
Range	0.3 MHz to 3.3 GHz
Resolution	1 Hz
Accuracy	see reference frequency
Reference frequency	
Inaccuracy	$<\pm 1\cdot 10^{-6}$
Aging (after 30 days of operation)	$1\cdot 10^{-6}$/year
Temperature effect (0°C to 55°C)	$2\cdot 10^{-6}$
Output for internal ref. frequency	10 MHz
Level (V_{rms} EMF, sinewave)	1 V
Input for external reference	
Frequency	5 MHz or 10 MHz
Permissible frequency drift	$3\cdot 10^{-6}$
Input level (V_{rms})	0.1 V to 2 V
Input impedance	200 Ω
Spectral purity	
Spurious signals	
Harmonics (up to 5 GHz)	<–30 dBc
Nonharmonics	
CW	<–70 dBc
I/Q modulation	<–56 dBc (ref. to CW)
SSB phase noise	measured at 750 MHz, CW, 1 Hz bandwidth
Offset from carrier 1.1 kHz	–85 dB
2.2 kHz	–89 dB
3.4 kHz	–94 dB
4.5 kHz	–98 dB
8.9 kHz	–104 dB
13.4 kHz	–103 dB
20 kHz	<–108 dB
Spurious FM rms (f = 1 GHz), 0.3 kHz to 3 kHz (ITU-T)	<8 Hz
Level	
Range CW	–99.9 dBm to +13 dBm
DVB-C/DVB-S	–99.9 dBm to +4 dBm
DVB-T	–99.9 dBm to +6 dBm
ATSC/8VSB	–99.9 dBm to +3 dBm
J.83B	–99,9 dBm to +2 dBm
with fading	see SFQ-B11
Resolution	0.1 dB
Total level inaccuracy	<±1.5 dB
Frequency response at 0 dBm	<1 dB, typ. <0.5 dB
Output impedance	50 Ω
VSWR	
RF level 13 dBm to 0 dBm	<2
<0 dBm to –99 dBm	<1.4
RF output	with DC block (max. 50 V DC)
Non-interrupting level setting	15 dB in selectable level range
Overvoltage protection	protection against externally fed RF power
External I/Q input	
Modulation inputs for external feed of I and Q	
Input impedance	50 Ω
VSWR (DC to 30 MHz)	<1.4
Input voltage for full-scale level	$(I^2 + Q^2)^{1/2}$ = 0.5 V (1 V EMF, 50 Ω)
Level correction for nominal RF output level	0 dB...40 dB
Connector	BNC female
I/Q modulation[1])	
Modulation frequency response	
DC to 3.5 MHz	
RF = 0.3 MHz to 1000 MHz	<±0.2 dB
RF = 0.3 MHz to 3300 MHz	<±0.3 dB

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DC to 17.5 MHz, RF = 0.3 MHz to 3300 MHz	<±0.8 dB
DC to 22.5 MHz, RF = 0.3 MHz to 3300 MHz	<±1 dB
Carrier leakage at 0 V input voltage referred to full-scale level	<–50 dBc (after I/Q calibration in setup menu)
Carrier leakage	
Setting range	0% to 50%
Resolution	0.1%
I/Q amplitude imbalance	
Setting range	–25% to +25%
Resolution	0.1%
Quadrature offset (phase error)	
Setting range	–10° to +10°
Resolution	0.1°

Data input for MPEG2 data stream	
TS PARALLEL input	synchronous parallel (without stuffing), LVDS
Characteristics	meet EN 50083-9
Input impedance	100 Ω
Input level (V_{pp})	100 mV to 2 V
Connector	25-contact female, shielded
Symbol rate (DVB-C, DVB-S)	
Accuracy	
with external MPEG signal	synchronized to external MPEG signal
without external MPEG signal	see optional input interface (SFQ-B6)
ASI (asynchronous serial input, with stuffing)	see optional input interface
SPI (synchronous parallel input, with stuffing)	see optional input interface
SMPTE (synchronous input)	see optional serial input interface

DVB/8VSB/J.83B

Input Interface	**option SFQ-B6**
SPI input	synchronous parallel (with stuffing), LVDS
Characteristics	meet EN 50083-9
Input impedance	100 Ω
Input level (V_{PP})	100 mV to 2 V
Connector	25-contact female, shielded
ASI input	asynchronous serial, with stuffing
Characteristics	meet EN 50083-9
Input impedance	75 Ω
Input level (V_{PP})	200 mV to 880 mV
Connector	BNC female
Input signal	270 Mbit
Stuffing bytes	Single-byte and block mode
Input SMPTE 310	synchronous serial (only in conjunction with ATSC Coder 8VSB)
Characteristics	meet SMPTE310M
Input impedance	75 Ω
Input voltage (Vpp)	400 mV to 880 mV
Connector	BNC female
Data rate	19.392658 Mbit/s
Symbol rate (SPI, ASI)	selectable by inserting null PRBS packets (stuffing)
Inaccuracy of internal data clock	$<\pm 1\cdot 10^{-5}$
External clock	switchable between bit and byte clock
Signal	sinewave
Level	–20 dBm to 0 dBm
Input impedance	50 Ω
Connector	BNC female
Internal transport stream	Null transport stream packets with PRBS as payload (PRBS: $2^{23}-1/2^{15}-1$ to ITU-T Rec. O.151)

1) Valid for a warm-up period of 1 hour and recalibration for an operating time of 4 hours and temperature variations less than 5 degrees.

DVB/8VSB/J.83B (cont'd)

DVB-T Coder	**option SFQ-B10**
Characteristics	meet EN 300 744
Input	TS PARALLEL; with SFQ-B6: ASI, SPI
Mode	
DATA	MPEG input signal synchronized to input data rate
NULL TS PACKET	null transport stream packets as defined by Measurement Guidelines for DVB Systems
NULL PRBS PACKET	null transport stream packets with PRBS (PRBS: $2^{23}-1/2^{15}-1$ to ITU-T Rec. O.151)
PRBS before convolutional encoder	$2^{23}-1/2^{15}-1$ to ITU-T Rec. O.151
PRBS after convolutional encoder	$2^{23}-1/2^{15}-1$ to ITU-T Rec. O.151
PRBS before mapper	$2^{23}-1/2^{15}-1$ to ITU-T Rec. O.151
Special functions	scrambler, sync- byte inversion, Reed-Solomon, convolutional interleaver, bit interleaver, symbol interleaver, can be switched off
Bandwidth	6 MHz, 7 MHz, 8 MHz (selectable for variable bandwidth from: 5.164 MHz to 7.962 MHz)
Constellation	QPSK, 16QAM, 64QAM
Code rate	1/2, 2/3, 3/4, 5/6, 7/8
Guard interval	1/4, 1/8, 1/16, 1/32, OFF
FFT mode	2K and 8K COFDM
Carrier modification	switching off carriers , carrier groups, modulation for carrier groups
Hierarchical coding	can be retrofitted (see option SFQ-B16)

DVB-T/Hierarchical Coding	**option SFQ-B16**
only in conjunction with SFQ-B10	
Characteristics	meet EN 300 744
AUX input	TS PARALLEL or SPI (parallel, with stuffing); selectable
Assignment	to high-priority or low-priority path
Mode	for high-priority and low-priority path
DATA	MPEG input signal
NULL TS PACKET	null transport stream packets as defined by Measurement Guidelines for DVB Systems
NULL PRBS PACKET	null transport stream packets (PRBS: $2^{23}-1/2^{15}-1$ to ITU-T Rec. O.151)
PRBS before convolutional encoder	$2^{23}-1/2^{15}-1$ to ITU-T Rec. O.151
PRBS after convolutional encoder	$2^{23}-1/2^{15}-1$ to ITU-T Rec. O.151
PRBS before mapper	$2^{23}-1/2^{15}-1$ to ITU-T Rec. O.151
Special functions	scrambler, sync byte inversion, Reed-Solomon, convolutional interleaver, bit interleaver, symbol interleaver; can be switched off

ATSC/8VSB Coder	**option SFQ-B12**
Characteristics	meet ATSC Doc. A/53 (8VSB)
Frequency setting	pilot frequency, center frequency, channel tables
Input data rate	19.392658 Mbit/s
Range	±10% (larger range with option SFQ-B6)
Input	LVDS, with SFQ-B6: ASI, SPI, SMPTE310
Mode	
DATA	MPEG input signal with synchronization to input data rate
NULL TS PACKET	null transport stream packets as defined by Measurement Guidelines for DVB Systems
NULL PRBS PACKET	null transport stream packets (PRBS: $2^{23}-1/2^{15}-1$ to ITU-T Rec. O.151)
SYNC PRBS	sync byte with 187 bytes PRBS payload
PRBS before trellis	$2^{23}-1/2^{15}-1$ to ITU-T Rec. O.151
PRBS after trellis	$2^{23}-1/2^{15}-1$ to ITU-T Rec. O.151
Symbol rate	10.762 Msymb/s
Range	±10%

Bandwidth, range	6 MHz, ±10%
VSB level	8VSB
Pilot	1.25, can be switched off
Range	0 to 5 in steps of 0.125
Pulse filtering (root cosine)	0.115 roll-off
Special functions	randomizer, interleaver; can be switched off
Error simulation	carrier leakage, I/Q imbalance; I/Q phase error, selectable

DVB-C/DVB-S Coder	**option SFQ-B15**
Input data rate	2 Mbit/s to 62.25 Mbit/s
Mode	
DATA	MPEG input signal
Symbol rate	can be synchronized to input data rate
AUTO	automatic switchover to PRBS upon loss of input data
NULL TS PACKET	null transport stream packets as defined by Measurement Guidelines for DVB Systems
PRBS	2^{23}–1/2^{15}–1 to ITU-T Rec. 0.151
NULL PRBS PACKET	only with optional Input Interface SFQ-B6

QPSK coder	
Characteristics	meet EN 300 421
Symbol rate	2 Msymb/s to 45 Msymb/s
Energy dispersal	can be switched off
Sync inversion	to standard
Reed-Solomon coder (204,188, t=8)	can be switched off
Convolutional interleaver	can be switched off
Convolutional encoder	to standard
Puncturing rate	$^1/_2$, $^2/_3$, $^3/_4$, $^5/_6$, $^7/_8$
Pulse filtering (root cosine)	0.25/0.3/0.35/0.4/0.45 roll-off

QAM coder	
Characteristics	meet EN 300 429
Symbol rate	1.5 Msymb/s to 7 Msymb/s
Energy dispersal	can be switched off
Sync inversion	to standard
Reed-Solomon coder (204,188, t=8)	can be switched off
Convolutional interleaver	can be switched off
Convolutional encoder	to standard
Mapping	16, 32, 64, 128, 256QAM
Differential encoding	to standard
Pulse filtering (root cosine)	0.1/0.13/0.15/0.175/0.2 roll-off
S/N ratio (QAM, 6.9 Msymb/s, roll-off = 0.15, measured with TV Test Receiver EFA)	>35 dB

J.83B Coder	**option SFQ-B13**
Only in conjunction with option SFQ-B6	
Characteristics	meets ITU-T J.83B
Input data rate (nominal, range corresponding to symbol rate)	26.970 Mbit/s for 64QAM, 38.8107 Mbit/s for 256QAM
Input	LVDS, ASI, SPI
Mode	
DATA	input signal synchronized to input data rate
NULL TS PACKET	null transport stream packets
NULL PRBS PACKET	null transport stream packets with PRBS (PRBS: 223-1/215-1 to ITU-T Rec. 0.151)
SYNC PRBS	sync byte with 187 byte PRBS payload
PRBS before trellis coding	PRBS: 223-1/215-1 to ITU-T Rec. 0.151
PRBS after trellis coding	PRBS: 223-1/215-1 to ITU-T Rec. 0.151
Symbol rate	5.0569 Msymbol/s for 64QAM, 5.360 Msymbol/s for 256QAM
Range	± 10%
Bandwidth	6 MHz
Pulse filtering (root cosine)	0.18 (64-QAM), 0.12 (256-QAM) roll-off
Data interleaver	level 1 and level 2; can be switched off
Special functions	switchable: randomizer, Reed-Solomon coder
Error simulation	selectable: carrier suppression, I/Q imbalance, I/Q phase error

I/Q Output/Input	**option SFQ-B14**
Output	
Output impedance	50 Ω
Output voltage	depending on selected modulation
Connector	BNC female
Input	
Input impedance	50 Ω
VSWR (DC to 30 MHz)	<1.4
Input voltage for full-scale level	$(I^2 + Q^2)^{1/2}$ = 0.5 V (1 V EMF, 50 Ω)
Connector	BNC female

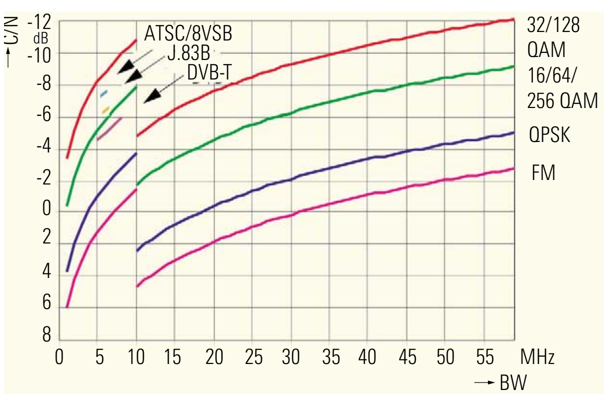
Transmission simulation

Fading Simulator	**option SFQ-B11**
Model 02	paths 1 to 6 (SFQs delivered before 1999: see SFQ-B18)
Model 04	paths 7 to 12 (only in conjunction with SFQ-B11, model 02)
Reduced maximum RF output level	–5.5 dBm for DVB-T (single-path fading without loss)
C/N ratio	remains constant if fading parameters are changed; C = sum of powers over all paths
RF bandwidth (–3 dB)	>14 MHz
Frequency response up to 5 MHz offset from carrier frequency	<0.6 dB, typ. <0.3 dB
Carrier leakage	<–45 dBc, typ. –50 dB
Number of paths with SFQ-B11	
Model 02	6
Model 02 plus model 04	12
Path loss	
Range	0 dB to 50 dB
Resolution	0.1 dB
Inaccuracy (from 0 dB to 20 dB)	<0.3 dB
Path delay	
Range	0 ms to 1600 ms
Resolution	50 ns
Inaccuracy	<5 ns
Constant phase	
Range	0° to +359.9°
Resolution	0.1°
Pure Doppler	
Frequency range	0.1 Hz to 1600 Hz
Speed range	$v_{min} = (0.03 \cdot 10^9\ m/s^2)/f_{RF}$ $v_{max} = (479 \cdot 10^9\ m/s^2)/f_{RF}$
for f_{RF} = 1 GHz	v_{min} = 0.1 km/h, v_{max} = 1724 km/h
Resolution	0.1 km/h, m/s, mph
Inaccuracy	<0.13%
Rayleigh fading	
Pseudo noise interval	>372 h
Deviation from theoretical CPDF[1]) at P_{avg} = 0 dB	
from –20 dB to +10 dB	<1 dB, typ. <0.3 dB
from –30 dB to –20 dB	<2 dB, typ. <0.3 dB
Rice fading	
Power ratio[2])	
Range	–30 dB to +30 dB
Resolution	0.1 dB
Frequency ratio	
Range	–1 to +1
Resolution	0.05
Lognormal fading, Suzuki fading	
Standard deviation	
Range	0 dB to 12 dB
Resolution	1 dB
Local constant	l_{min}: up to 200 m ($l_{min} = (12 \cdot 10^9\ m/s^2)/f_{RF}$)
Fading profile	selectable from a list of predefined profiles; each profile can be modified as required
Reference on frequency change	speed or Doppler frequency can be selected

TV Test Transmitter SFQ

Noise Generator	**option SFQ-B5**
Not in conjunction with SFQ-B2	
Bandwidth	
Receiver bandwidth	1 MHz to 60 MHz (selectable)
Actual noise bandwidth	10 MHz/60 MHz
C/N setting	
Variation range	50 dB
Minimum selectable C/N	depending on bandwidth and modulation (see diagram)
Resolution	0,1 dB
C/N error	
Absolute error	<0.3 dB (after calibration), typ. <0.2 dB
RF frequency range	
with noise bandwidth <=10 MHz	≥15 MHz
with noise bandwidth >10 MHz	≥60 MHz

Minimum selectable C/N ratio of Noise Generator SFQ-B5



BER Measurement	**option SFQ-B17**
only in conjunction with option SFQ-B10	
Characteristics	integrated BER measurement for all digital modulation modes (DVB-C, DVB-S, DVB-T, 8VSB, J.83B)
Input data rate	max. 60 Mbit/s
PRBS	$2^{23}-1/2^{15}-1$ to ITU-T Rec. O.151
Input	
Serial	BER DATA, BER CLOCK, BER ENABLE
Input impedance	75 Ω
Input level	TTL
Connector	BNC female
Clock, data	normal, inverted
Enable	always, active high, active low
BER mode	
PRBS	$2^{23}-1/2^{15}-1$ to ITU-T Rec. O.151
Parallel	TS PARALLEL AUX
Characteristics	meet EN 50083-9
Input impedance	100 Ω
Input level	100 mV to 2 V, LVDS
Connector	25-contact female, shielded
BER mode	
PRBS, PRBS INVERTED	$2^{23}-1/2^{15}-1$ to ITU-T Rec. O.151
NULL PRBS PACKET	evaluation of standard transport stream; total payload corresponding to PRBS (eg NULL PRBS PACKET of SFQ)
PID FILTER FOR PRBS PACKET	evaluation of null packets (PID=1FFF) of standard TS with payload corresponding to PRBS (eg stuffing with SFQ in ASI/SPI mode)

1) CPDF = cumulative probability distribution function, level values referred to average output level value.

2) Ratio of discrete component to distributed component.

BB-FM

Broadband FM Modulator	**option SFQ-B2**
Analog modulation	broadband FM for video and FM/ADR sound subcarrier
Video transmission characteristics	
Type of modulation	frequency modulation (F3)
Standard	PAL, SECAM, NTSC; selectable
Nominal input level (V_{pp})	1 V (75 Ω)
Video frequency deviation	
Setting range	10 MHz to 40 MHz
Resolution	0.1 MHz
Hum suppression with level clamping on	>40 dB
Linear distortion	
Frequency response, 0 MHz to 5 MHz (ref. to 1.5 MHz and 25 MHz (pp) deviation, with preemphasis and lowpass filter)	<±0.5 dB
Group delay, 0 MHz to 4.8 MHz	<±20 ns with lowpass filter
Transients (streaking) mit 200 ns	
Rise and fall time	<±2%
Energy dispersal signal	
Signal type	25 Hz or 30 Hz triangular signal, coupled to frame frequency (625/525 lines)
Deviation, selectable	0 MHz to 4 MHz, automatically doubled when the video or baseband signal is switched off
Resolution	100 kHz
Nonlinear distortion	
Measurements	with standard video signal and preemphasis and deemphasis switched on
Differential gain at 25 MHz deviation	<1.5%
Differential phase at 25 MHz deviation	<1.5°
Video-frequency S/N ratio, ref. to 22.5 MHz deviation, with preemphasis and deemphasis 100 kHz to 5 MHz	>70 dB rms, weighted to CCIR

Internal noise generator	
Bandwidth	
Receiver bandwidth	1 MHz to 60 MHz (selectable)
Actual noise bandwidth	10 MHz/60 MHz
C/N setting	
Variation range	50 dB
Minimum selectable C/N	depending on bandwidth and modulation (see diagram for SFQ-B5, FM)
Resolution	0.1 dB
C/N error	<1 dB
RF frequency range	
with noise bandwidth ≤10 MHz	≥15 MHz
with noise bandwidth >10 MHz	≥60 MHz

FM Sound Subcarriers	**option SFQ-B3**
only in conjunction with option SFQ-B2	(included once in SFQ-B2)
Number of subcarriers per module	2
Frequency range	5 MHz to 9 MHz
Resolution	10 kHz
Frequency deviation of IF carrier caused by FM sound subcarriers	
Setting range (RF deviation)	1 MHz (pp) to 4 MHz (pp)
Resolution	10 kHz
Audio signal input	
Frequency range	30 Hz to 15 kHz
Bandwidth without lowpass filter	100 kHz
Nominal input level	+9 dBm (600 Ω)
Input impedance	>5 kΩ, balanced
Connector	Lemo Triax
Internal modulation generator (DSP)	
Frequency range, resolution	30 Hz to 15 kHz, 100 Hz
Modulation distortion	<0.5%
Audio S/N ratio (ref. to 50 kHz deviation, AC-coupled)	>65 dB, weighted to CCIR
Preemphasis	50 µs, 75 µs, J.17, OFF; selectable

TV Test Transmitter SFQ

ADR Sound Subcarriers	**option SFQ-B4**
only in conjunction with option SFQ-B2 (to ADR specifications)	
Number of subcarriers	2
Frequency range	0.1 MHz to 9 MHz
Resolution	10 kHz
Frequency deviation of IF carrier caused by ADR sound subcarriers	
Setting range (RF deviation)	1 MHz (pp) to 4 MHz (pp)
Resolution	10 kHz
Type of modulation	QPSK
Source data	internal, external, PRBS
Source data rate	192 kbit/s
Transmission rate	256 kbit/s
QPSK test	4 selectable test patterns; I/Q reversal
Bit error generator (symbol errors)	10^{-2} to 10^{-6}
External data input	only for one of the two subcarriers
Type	clock (invertible) and data
Level	RS-422
Data rate	192 kbit/s
Internal MUSICAM generator	two generators independent of each other (to ISO/IEC 11172-3 Layer II)
Mode	single, dual, stereo
Ancillary data (ANC)	1 of 4 internal data records can be selected, update from memory card
Audio generator	two for each MUSICAM channel
Frequency range	10 Hz to 20 kHz; 10 Hz steps
Amplitude range	100 dB; 0.1 dB steps
Preemphasis	50/15 µs, OFF

General data

Transmitter tables	5 with 100 entries each, editable or loadable by remote control
Storage of instrument settings	internally and on memory card
Interfaces	IEC-625/IEEE-488 bus, RS-232-C
Rated temperature range	+5°C to +45°C
Operating temperature range	0°C to +50°C
Storage temperature range	–40°C to +70°C
Mechanical resistance	
Vibration, sinusoidal	5 Hz to 150 Hz, max. 2 g at 55 Hz, 55 Hz to 150 Hz, 0.5 g, meets IEC 68-2-6, IEC 1010-1, MIL-T-28800 D class 5
Vibration, random	10 Hz to 300 Hz, 1.2 g (rms)
Shock	40 g shock spectrum, meets MIL-STD 810 C and MIL-T-28800 D classes 3 and 5
Climatic resistance	95% rel. humidity, cyclic test at +25°C/+40°C, meets IEC 68-2-30
Electromagnetic compatibility	meets EMC directive of EU (89/336/EEC) and complies with German EMC legislation
Power supply	90 V to 132 V/180 V to 265 V (autoranging), 47 Hz to 440 Hz (170 VA)
Electrical safety	meets EN 61010-1
Dimensions (W x H x D)	435 mm x 192 mm x 460 mm
Weight	approx. 20 kg, depending on options fitted

Ordering information

TV Test Transmitter (0.3 MHz to 3300 MHz) for		
DVB-C and DVB-S	SFQ02+ SFQ-B15	2072.5501.02 2072.5976.02
DVB-T, 2K/8K	SFQ02+ SFQ-B10	2072.5501.02 2072.6166.02
ATSC/8VSB	SFQ02+ SFQ-B12	2072.5501.02 2072.6220.02
ITU-T, J.83B	SFQ02+ SFQ-B13	2072.5501.02 2072.6243.02
Broadband FM	SFQ02+ SFQ-B2	2072.5501.02 2072.6108.02
Options		
Please state serial number of unit when submitting new orders for options.		
Input Interface (ASI/SPI input and selectable symbol rate, SMPTE310 input), can be retrofitted	SFQ-B6	2072.7679.03
DVB-T Coder, 2K/8K COFDM Modulator, 6 MHz/7 MHz/8 MHz bandwidth (for SFQ delivered before1999 see SFQ-B18)	SFQ-B10	2072.6166.02
DVB-T/Hierarchical Coding	SFQ-B16	2072.5782.02
ATSC Coder, 8VSB (HW + FW)	SFQ-B12	2072.6220.02
ITU-T/J.83B Coder (FW)	SFQ-B9	2072.6143.02
ITU-T/J.83B Coder (HW + FW)	SFQ-B13	2072.6243.02
ATSC/8VSB Coder (FW)	SFQ-B8	2072.6120.02
DVB-C/DVB-S Coder 16QAM to 256QAM and QPSK, 2 Mbit/s to 62.25 Mbit/s	SFQ-B15	2072.5976.02
I/Q Output/Input	SFQ-B14	2072.6266.02
Power Supply Upgrade for SFQ model 10, delivered before 1999; serial number of SFQ must be stated	SFQ-B18	2072.7191.02
Factory-fitting of SFQ-B18 to SFQs delivered before 1999	SFQ-U11	2072.7040.02
Fading Simulator, paths 1 to 6 (for SFQ delivered before 1999 see SFQ-B18)	SFQ-B11	2072.6189.02
Fading Simulator, paths 7 to 12	SFQ-B11	2072.6189.04
Noise Generator, can be retrofitted and calibrated	SFQ-B5	2072.7579.03
BER Measurement	SFQ-B17	2072.7056.02
Broadband FM Modulator for baseband (PAL, SECAM, NTSC) and FM sound (2 subcarriers)	SFQ-B2	2072.6108.02
2 FM Sound Subcarriers 5 MHz to 9 MHz with 2 audio generators and 2 external audio inputs	SFQ-B3	2072.7379.02
2 ADR Sound Subcarriers 0.1 MHz to 9 MHz with 2 MUSICAM generators and 1 external data input	SFQ-B4	2072.7479.02
Extras		
Documentation of SFQ calibration values	SFQ-DCV	2082.0490.12
Cable Set for diversity	SFQ-Z5	2081.9158.02
Common Interface TS OUT	SFQ-Z17	2081.9364.02
Service Kit	SFQ-Z1	2072.5960.02
Service Manual (English)		2072.6489.22
Memory Card 10 Mbyte (Flash)		0048.5877.00
19" Adapter (4 HU) for rackmounting	ZZA-94	0396.4905.00
Matching Pads 50 Ω/75 Ω, 0 GHz to 2.7 GHz, N connectors,		
matched at both ends, attenuation 5.7 dB, no DC isolation	RAM	0358.5414.02
matched at one end, attenuation 1.7 dB	RAZ	0358.5714.02

TV Generators SGPF, SGSF, SGMF

Photo 43165

Brief description

With its TV Generators SG.F for all traditional colour standards, Rohde & Schwarz has the right unit for any production, studio and service requirement.

Main features

- More than 30 baseband signals
- General-purpose test pattern with optional text insertion for source identification
- Signal output on the front and rear panel
- Remote control of all generator functions via IEC/IEE bus
- Insertion test signals included in every signal
- Insertion of external test signals into the field blanking interval or application of sweep signals to the active picture area
- Use as test signal inserter with the genlock option fitted

Digital picture generation

With the PAL generator, the three components Y, C_B and C_R are stored for digital generation of the realtime composite colour video signal (CCVS).

For generation of the test signals to NTSC and SECAM, about 1000 different video lines are stored digitally and can be combined to obtain the desired pattern under program control.

Test signals

For all three generators the assignment of a test signal to a specific line can be programmed via DIP switches. Eight complete test signal configurations can be stored and recalled enabling the user to tackle any measurement task.

Output signal

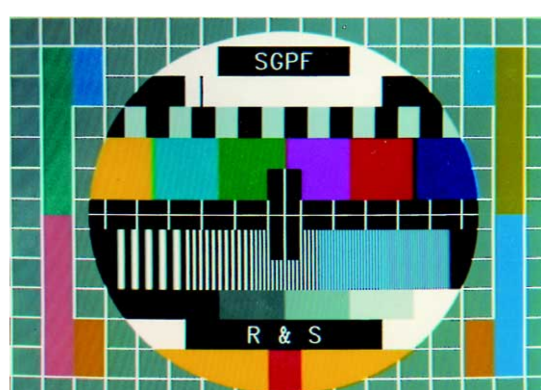
The signal amplitude can be set via the IEEE/IEC bus or manually by a potentiometer. On all models separate amplifiers ensure excellent decoupling between the front and the rear outputs.

Options

For options see ordering information. Some options cannot be retrofitted. With the genlock option for test signal insertion fitted, switchover to the selected substitution pattern is ensured in the case of program failure.

Ordering information

TV Generator for		
PAL	SGPF	2016.4049.03
SECAM	SGSF	2016.7048.03
NTSC	SGMF	2016.0943.03
Options		
(some options cannot be retrofitted)		
Source Identification	SG.F-B1	2016.1004.02
Test Signal Insertion	SGPF-B2	2016.4278.02
	SGSF-B2	2016.7190.02
	SGMF-B2	2016.1185.02
FuBK Test Pattern	SGPF-B3	2016.4284.02
French		
FrenchFront-panel		
Labelling	SGSF-B3	2016.7225.02
General-purpose Test Pattern		
of 16:9 aspect ratio	SGPF-B4	2016.4290.02
Extras		
Junction Panel		
with bypass	SG.F-Z	2016.1679.02
19" Adapter	ZZA-91	0396.4870.00
Calibration Data		
Documentation	SG.-DCV	2082.0490.04



SGPF: Optional is a general-purpose test pattern of 16:9 or 4:3 aspect ratio or an FuBK test pattern

Specifications in brief

TV Generators	SGPF (PAL)	SGSF (SECAM)	SGMF (NTSC)
Level tolerances			
Nominal luminance level (cal.)	700 ±4 mV	700 ±4 mV	714 ±4 mV
Nominal chrominance level (cal.)	700 ±7 mV	–	714 ±7 mV
Departure at nominal <500 mV	±5 mV	±5 mV	±5 mV
≥500 mV	±1%	±1%	±1%
Squarewave, staircase and sawtooth signals	nominal ±4 mV	nominal ±4 mV	nominal ±4 mV
2T pulse	nominal ±5 mV	nominal ±5 mV	nominal ±5 mV
10T and 20T pulses	nominal ±7 mV	nominal ±7 mV	–
12.5T pulse	–	–	nominal ±7 mV
Amplitude/frequency response			
Multipulse, sweep signals	±0.1 dB (up to 5.5 MHz)	±0.1 dB (up to 5.5 MHz)	±0.1 dB (up to 5.5 MHz)
Multiburst	±0.1 dB (up to 5.8 MHz)	±0.1 dB (up to 5.8 MHz)	±0.1 dB (up to 5.5 MHz)
Group delay			
10T and 20T pulses (f_{mod} ≤5 MHz)	≤5 ns	≤5 ns	≤5 ns
12.5T pulse	–	–	5 ns
Rise time (10 to 90%) and half-amplitude duration			
Sync rise time	200 ±5 ns	200 ±5 ns	140 ±5 ns
Luminance rise time	200 ±5 ns, 231 ±5 ns	200 ±5 ns, 231 ±5 ns	125 ±5 ns, 250 ±5 ns
Half-amplitude duration 2T pulse	200 ±5 ns	200 ±5 ns	250 ±5 ns
10T pulse	1000 ±15 ns	1000 ±15 ns	–
12.5T pulse	–	–	1570 ±5 ns
20T pulse	2000 ±30 ns	2000 ±30 ns	–
Chrominance rise time	300 ±10 ns, 1000 ±15 ns	–	300 ±10 ns, 1000 ±10 ns
Rise time of 4.43 MHz components	–	300 ±10 ns, 1000 ±15 ns	–
Line-time nonlinearity 5-step staircase	≤0.8%	≤0.8%	≤0.8%
Chrominance phase			
Phase between R-Y and B-Y axes	90 ±1°	–	90 ±1°
Maximum departure of chrominance phase from nominal	±2°	–	±2°
SECAM colour coding			
Tolerance of colour-difference signal preemphasis	–	±0.2 dB	–
Tolerance of subcarrier preemphasis	–	±0.15 dB	–
S/N ratio			
measured on all-black picture	≥74 dB rms, weighted, 0.2 to 5 MHz	≥74 dB rms, weighted, 0.2 to 5 MHz	≥74 dB rms, weighted, 0.2 to 4.2 MHz
measured on sawtooth signal	≥70 dB rms, weighted, 0.2 to 5 MHz	≥70 dB rms, weighted, 0.2 to 5 MHz	≥70 dB rms, weighted, 0.2 to 4.2 MHz
Clock frame			
SC/H phase	0 ±5°	–	0 ±5°
V component	can be disabled	can be disabled	can be disabled

Inputs/outputs	BNC, 75 Ω
Return loss	≥34 dB (up to 6 MHz)
Sync pulse output	2 V into 75 Ω
EXT-VITS input	
Gain	0 ±0.1 dB
Amplitude/frequency response	±0.1 dB (up to 6 MHz)
Differential gain	≤0.3%
Differential phase	≤0.3°

Genlock option with test signal insertion

Input/output	BNC, 75 Ω
Return loss	≥34 dB (up to 6 MHz)
Amplitude/frequency response	±0.1 dB (up to 6 MHz)
Group delay error	<5 ns (up to 5.5 MHz)
Differential gain	≤0.3%
Differential phase	≤0.3°

S/N ratio (rms, weighted, 0.2 to 5/4.2 MHz)	≥74 dB	
Test signal insertion		
Level (same as generator signal)	CAL (normal operation) or variable between –50 and +40% of CAL	
Insertion range		
PAL	1st field	lines 6 to 22
	2nd field	lines 319 to 335
SECAM	1st field	lines 6 and 16 to 22
	2nd field	lines 319 and 329 to 335
Identification signals of applied CCVS	in lines 7 to 15 and 320 to 328, can be replaced by all-black line or other signal	
NTSC, both fields	lines 10 to 21	

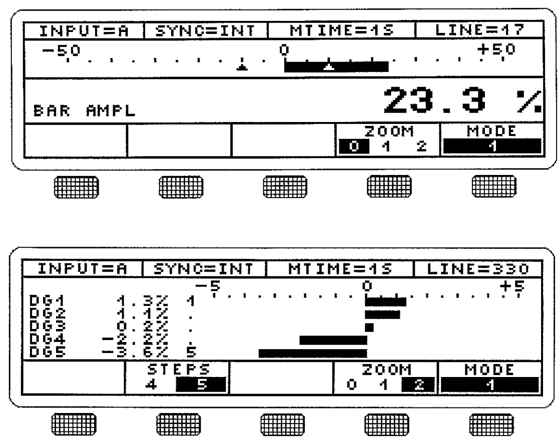
Video Analyzer UAF

Standards B/G, D/K, I, M

Perfection in video analysis:

fast, precise, reliable

Photo 39139



The test results are displayed either in the form of numeric values or as a bar

Brief description

Thanks to its outstanding characteristics, Video Analyzer UAF from Rohde & Schwarz meets all requirements as regards high measurement accuracy for the studio and fast measurements down to a few seconds. User-friendly operation and a clear display with graphics support afford straightforward measurements.

The core of the digital section is a microprocessor plus an arithmetic coprocessor. The signal analysis comprises 29 video and test line parameters and covers all important levels as well as linear and nonlinear distortion such as 2T K rating, frequency response and hum. Optionally 50 Hz tilt, 200 ns overshoot, NICAM and dual-sound intermodulation can be measured. The position of the test lines can be freely selected over the entire picture area and in the field blanking interval; storage of up to eight test configurations is possible.

Thanks to its variable integration time, the UAF can be adapted to all test conditions. Using the shortest integration time of less than 1 s, the UAF is ideal for all alignments. In the case of very noisy signals, stable results can be obtained by increasing the integration time to 2.5 s, 5 s or 10 s.

For use in quality and production control of video recorders, the UAF also handles the S-VHS component signals Y/C. Distorted test signals do not affect the operation of the UAF.

Using a plug-in memory card, customer-defined test programs can be loaded and test results stored on the card. Moreover, the memory card permits storage of complete instrument setups.

Main features

- 3 signal inputs
- 29 video parameters
- Limit monitoring
- Full-field measurements
- Freely selectable test signal
- Memory card, printer interface

Operation

The logical arrangement of the UAF front-panel controls offers a clear overview of its functions and ensures ease of operation. Each parameter is assigned its own key. The associated LED above the key blinks if the limit values are exceeded.

The keypad to the left of the display permits the setup menus of the UAF to be selected directly. Such a menu is inserted as a window above the normal result display. Thus it is possible to use the softkeys for changing general settings such as the input, synchronization, printer mode, etc.

The "option" function allows further test parameters, eg an external level or future extensions, to be called up.

Special modes are the difference and the reference measurement modes with which signal errors at the input of the device under test can be eliminated. The AUTORUN menu permits test sequences to be programmed on the UAF front panel; these sequences are executed automatically and can be repeated cyclically.

Specifications in brief (standard B/G)

Signal inputs	3; 75 Ω loopthrough filters, 3 x CCVS or 1 x Y/C and 1 x CCVS, adjustable
Level	1 V pp ±6 dB
Return loss up to 10 MHz	≥40 dB
Decoupling of inputs up to 10 MHz	≥85 dB
Synchronization	
Internal	optionally from one of the three inputs
Sync pulse level	300 mV ±6 dB
External	loopthrough filter
Nominal level	2 V/4 V into 75 Ω (V_{pp})
SIS	permissible

Test parameter	**Measurement range**	**Error limits at nominal**
Luminance bar amplitude	–100% to +100%	±0.3%
Black level distortion	–20% to +40%	±0.3%
Tilt of luminance bar	–40% to +40%	±0.3%
2T pulse amplitude	–50% to +50%	±0.5%
2T K factor	0% to +10%	±0.7%
Luminance nonlinearity	0% to +50%	±0.5%
Residual picture carrier	0% to +30%	±0.3%
Sync pulse amplitude		
Reference signal	–50% to +50%	±0.5%
Reference nominal	–80% to +100%	±0.5%
Colour subcarrier gain		
CCIR 331	–50% to +50%	±1%
CCIR 17	–50% to +50%	±1%
Chrominance/luminance intermodulation		
CCIR 331	–50% to +50%	±0.3%
CCIR 17	–50% to +50%	±1%
Chrominance/luminance delay	–500% to +500 ns	±5 ns
Differential gain		
positive/negative	–50% to +50%	±0.3%
peak-to-peak	0% to +100%	±0.5%
Differential phase		
positive/negative	–50° to +50°	±0.3°
peak-to-peak	0° to +100°	±0.5°
Nonlinearity of colour subcarrier amplitude		
positive/negative	–50% to +50%	±0.7%
peak-to-peak	0% to +100%	±1%
Nonlinearity of colour subcarrier phase		
positive/negative	–50° to +50°	±0.7°
peak-to-peak	0° to +100°	±1°
Burst amplitude		
Reference signal	–50% to +50%	±1%
Reference nominal	–80% to +80%	±1%
Multiburst amplitude	–80% to +50%	±1%
Luminance signal/noise ratio	25 dB to 80 dB	±1 dB
Intermodulation between colour subcarrier and sound carrier	30 dB to 70 dB	±1 dB
Hum	6 dB to 60 dB	±1 dB
DC measurement	–5 V to +5 V	±10 mV
Incidental phase modulation of vision carrier (ICPM)	–7° to +45°	±1°
Video data amplitude	–50% to +50%	±1%
50 Hz tilt (optional)	0% to 40%	±0.5%
200 ns overshoot (optional)	–20% to +40%	±0.3%

Noise voltage	
Measurement mode	rms
Filter	200 kHz highpass and video filter integrated, weighting filter and colour subcarrier trap can be connected
Inherent S/N ratio	>83 dB
Reference	luminance bar or 700 mV nominal, can be selected
Differential gain/phase	
Evaluation	4 or 5 steps (can be selected)
Hum	
Measurement mode	peak-to-peak
Filter	1 kHz lowpass integrated
Reference	luminance bar or 700 mV nominal, selectable
Special functions	
SETUP	for basic settings
MEAS TIME	measurement time 1/2.5/5/10 s
MEAS HOLD	measured values of all parameters are simultaneously frozen
PRINT	measured value output via printer
MONITORING	limit monitoring of single parameters, parameter groups or all parameters
AUTORUN	entry and recall of user-defined test routine
Difference measurement	selectable between two inputs
Reference measurement	one test cycle stored as reference
Indication	LC display
Display mode (selectable)	numeric, 1 parameter, 3 parameters supported by analog bar display
Language	German, English, French or Italian
Interfaces and outputs	
IEEE/IEC bus	interface to IEC 625-2/IEEE 488-2
Printer	Centronics interface
Memory card	storage of measured values, device setups, test routines, etc.
Monitor output	clamped test signal, (input signal ±1%, 75 Ω)
Zero reference control	2.5 V_{pp} ±10% into 75 Ω, position and duration adjustable
General data	
Power supply	100/120/220/240 V ±10%, 47 Hz to 63 Hz, 115 VA
Rated temperature range	0°C to +50°C
Dimensions (W x H x D); weight	435 mm x 103 mm x 460 mm; 10 kg

Ordering information

Video Analyzer	Standard B/G	UAF	2013.0807.02
	Standard D/K	UAF	2028.5780.02
	Standard M	UAF	2028.5774.02
	Standard I	UAF	2028.5768.05
	Other standards	on request	
Accessories supplied		four 75 Ω Terminations RMF2, 32 Kbyte memory card	
Options			
50 Hz tilt, 200 ns overshoot		UAF-B1	2028.6406.02
S/N extension			
552 kHz (NICAM)		UAF-B2	2028.6412.02
242 kHz (dual sound)		UAF-B3	2028.6429.02
Calibration Data Documentation		UAF-DCV	2082.0490.05
Extras			
Memory card 32 Kbyte		ZZM-32	2005.4394.02
512 Kbyte		ZZM-512	2005.4388.02
Service Manual			2013.1684.24

Digital Video Component Analyzer VCA, DTL Analysis VCA-B11

VCA: combined waveform monitor and analyzer

With VCA-B11: additional jitter analysis and spectral measurements

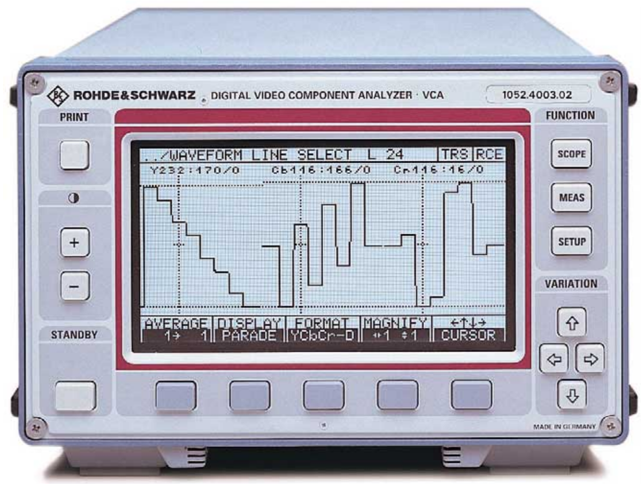


Photo 41575

Brief description

Digital Video Component Analyzer VCA is designed to solve measurement problems in the digital studio, in operation and servicing as well as in the development of digital studio equipment. Combining the characteristics of a waveform monitor and an analyzer and including all conventional display modes, the VCA is suitable for a great variety of measurements and so makes working with digital video signals easy. An optional remote control unit permits the VCA to be readily integrated into large measuring systems for comprehensive monitoring in the studio.

Main features

- To standards ITU-R 601/656, SMPTE125M/259M, 8 bits, 10 bits, 625/525 lines
- Waveform display
- Numeric output of video data
- Analysis of data frame/contents
- Timing and level measurements
- Hardcopy of screen via external printer
- DTL analysis (optional)
- Remote control (optional)

Equipped with a digital-parallel and a digital-serial video input as well as SCOPE and MEASURE functions, VCA is capable of monitoring the digital video signal at all the transfer points of a digital TV studio. Measurement results are clearly displayed on a large-size monitor. Compared to the purely visual information obtained from an oscilloscope, VCA reads out precise measurement values. A graphic display facilitates evaluation of the results.

SCOPE functions

These functions allow waveforms and numerical values of the digital video signal to be analyzed.

MEASURE functions

These functions are used for monitoring and measuring live signals and for measuring special test signals. In the SCOPE mode, too, two monitoring functions are active in the background for checking the sync frame. The results of measurements on live signals are shown on the ERROR RATE display or on a new type of HISTORY display.

DTL analysis option (VCA-B11)

The DTL analysis option (digital transport layer) allows to search for the physical causes of data errors in serial-digital video signals, with signal jitter playing an important role in this respect. VCA performs jitter measurements according to the demodulator method and also supports measurements to the clock extractor method.

Specifications in brief

Waveform monitor (SCOPE)

WAVEFORM LINE SELECT
Display of digitized video signal:
Y, C_B, C_R as original digital data,
Y, C_B, C_R and G, B, R analog simulation
Display modes: parade, overlay or single; cursor measurement with position and value of sample; average function; magnify function; line selection

WAVEFORM
Same as WAVEFORM LINE SELECT with overlay of active video lines

NUMERIC DUMP
Binary, decimal and hexadecimal display of all data words with sample numbering and data type designation (Y, C_B, C_R, EAV, SAV or ANC); quick view of data at cursor, SAV, EAV and EDH; line selection

Additional functions with option VCA-B11

AMPLITUDE SPECTRUM
Measurement of frequency-dependent signal level; 3 measurement speeds, normalize function, magnify function, cursor measurements, consideration of cable lengths

Frequency range	5 MHz to 800 MHz (RBW = 4 MHz)

Digital Video Component Analyzer VCA, DTL Analysis VCA-B11

Measurement range	–50 dB to +5 dB (referred to nominal level of serial signal)
Amplitude-frequency response (referred to 50 MHz)	5 MHz to 300 MHz: ±2.5 dB 300 MHz to 800 MHz: ±4 dB
Linearity	±1.5 dB

RETURN LOSS

Measurement of return loss (external SWR bridge required); 3 measurement speeds, normalize and magnify functions, cursor measurements

Frequency range	5 MHz to 800 MHz (RBW = 4 MHz)
Attenuation measurement range	up to –30 dB (referred to broadband noise of –10 dBm)

Analyzer (MEASURE)

TRS ERROR

Sync word monitoring with respect to preamble, frame sync flag, line sync flag, field blanking flag, ERROR RATE and HISTORY display; background monitoring with adjustable limit values and insertion of warning (TRS) in other displays

VIDEO RANGE ERROR

Data word monitoring in active video range for checking data range (standard level), separately for Y, C_B, C_R; ERROR RATE and HISTORY display

RESERVED CODE ERROR

Data word monitoring with respect to TRS preamble (#FF, #00) in active video, ERROR RATE and HISTORY display; background monitoring with adjustable limit values and insertion of warning (RCE) in other displays

CRC ERROR

Monitoring of all data bits in a field by means of cyclic redundancy check, single bit and data word analysis; CRC WORD and HISTORY display

C/L GAIN/DELAY ERROR

Luminance/nominal level diff.	display in 0.1% steps, resolution 1 LSB
Luminance/nominal delay diff.	measurement range: –2.5 µs to +2.5 µs, resolution 0.1 ns
Chrom./lum. level diff.	display in 0.1% steps, resolution 1 LSB
Chrom./lum. delay diff.	measurement range: –1 µs to +1 µs, resolution 0.1 ns, test signals: 100% and 75% colour bar, average function, magnify function

Additional functions with option VCA-B11

SIGNAL DELAY

Measurement of delay difference between two serial-digital signals

Measurement range	±1 field with standard signal, ± 16 fields with test signal sequence
Resolution	1 sample (37 ns)

JITTER TIME/JITTER SPECTRUM

Jitter measurement either in time or in frequency domain; 3 time or frequency windows, average function, magnify function, cursor measurements

Meas. range (discrete jitter freq.)	10 Hz to 200 kHz: 0.01 to 8 UI_{pp} 200 kHz to 8 MHz: 0.01 to 8 UI_{pp} x (0.2 MHz/jitter frequency [MHz])

CLOCK EXTRACT

Clock extraction with selectable division factor 1/1 or 1/4; trigger signal with same division factor; extractor band limits: 10 Hz, 1 kHz

SIGNAL HEADROOM

Adjustable superimposed noise of signal from input B to output SUP IMP

Measured in unit intervals (UI); one UI corresponds to the bit period = 3.7 ns.

Signal inputs

Serial (270 Mbit x 1)	to SMPTE 259M Return loss >25 dB (20 kHz to 270 MHz) into 75 Ω
Parallel (27 Mbit x 10)	to CCIR 601/656 and SMPTE 125M

Signal inputs with option VCA-B11

Serial A and serial B (270 Mbit x 1)	to SMPTE 259M
Parallel (27 Mbit x 10)	to CCIR 601/656 and SMPTE 125M

Signal outputs

Serial (270 Mbit x 1), signal of serial input with RECLOCKING	to SMPTE 259M Return loss >17 dB (20 kHz to 270 MHz) into 75 Ω
Parallel (27 Mbit x 10), signal of selected input with RECLOCKING	to CCIR 601/656 and SMPTE 125M

Signal outputs with option VCA-B11

Serial A (270 Mbit x 1)	signal of serial input A to SMPTE 259M with reclocking
Serial B (270 Mbit x 1)	signal of serial input B to SMPTE 259M with reslicing
Parallel (27 Mbit x 10)	signal of selected input to CCIR 601/656 and SMPTE 125M with reclocking
MONITOR (270 Mbit x 1)	signal of input to SMPTE 259M selected for measurement
SUP IMP (270 Mbit x 1)	signal of input B to SMPTE 259M with superimposed noise
EYE MON (270 Mbit x 1)	signal of input B after cable equalization or after digitization (reslicing); V_{pp} = approx. 700 mV into 75 Ω
SER CLK	clock of signal input B (270 MHz or 67.5 MHz) with jitter bandwidth <8 MHz; V_{pp} = approx. 800 mV into 75 Ω
TRIG	clock of signal input B (270 MHz or 67.5 MHz) with jitter bandwidth <10 Hz; V_{pp} = approx. 800 mV into 75 Ω
NOISE	broadband noise of typ. –90 dBm/Hz (5 MHz to 1 GHz)
Signal standards	selectable video standards: 525 lines/60 Hz and 625 lines/50 Hz, 8 and 10 bits

Instrument setups (SETUP)

SAVE/RECALL CONFIGURATION	storage and recall of 9 instrument setups
PRINTER	suitable printers: Epson RX80/FX80, HP DeskJet/LaserJet, R&S PUD3 and PDN

General data

Display (134 mm x 76 mm)	LC, illuminated, 240 x 128 pixels, intensity and contrast adjustable
Printout	hardcopy of screen via RS-232-C/RS-422
Rated (operating) temperature range	+5°C to +40°C, (0°C to +50°C)
Power supply	100/230 V, –10/+15%, 120/220 V, –15/+10%, 47 Hz to 63 Hz (60 VA, with VCA-B11: 140 VA)
Dimensions (W x H x D)	220 mm x 148 mm x 461 mm
Weight	6.4 kg, with VCA-B11: 7.7 kg

Ordering information

Digital Video Component Analyzer	VCA	1052.4003.02
Options		
Remote Control (RS-232-C/RS-422)	VCA-B1	1052.5600.02
DTL Analysis	VCA-B11	1052.5800.02
SWR Bridge 5 to 850 MHz	VCA-Z1	1052.5900.02
Calibration Data Documentation	VCA-DCV	2082.0490.06
Same for VCA-B11	VCA-DCV	2082.0490.07

Video Measurement System VSA

0 Hz to 9 MHz

Compact platform for video signal analysis: measurements of all relevant video parameters in the baseband, graphic and numeric result display, vector and waveform display

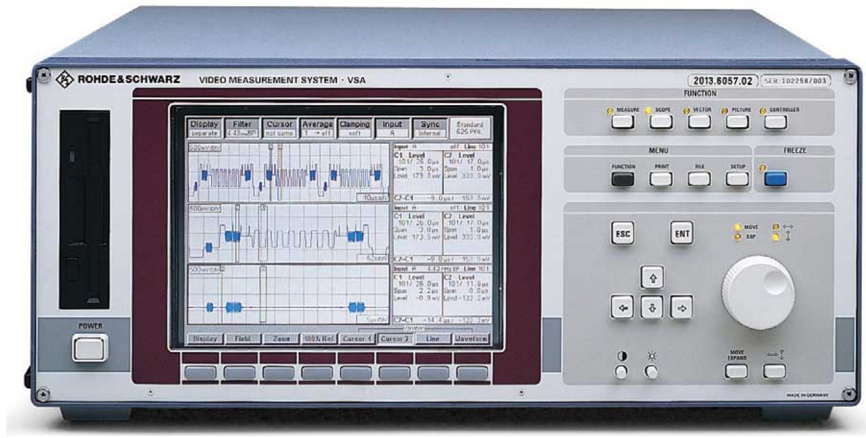


Photo 41801

Brief description

Video Measurement System VSA from Rohde&Schwarz combines the functions of a video analyzer, vectorscope, oscilloscope, monitor and controller (PC) in a 19" desktop.

Fields of applications are

- laboratory and service
- automatic test and monitoring systems
- production and quality assurance

The instrument features convenient operation as well as high measurement accuracy and speed. The compact design makes it also suitable for mobile applications. Thanks to the great number of integrated functions and system interfaces the VSA is an essential tool for measurements and system applications in all fields of video.

In addition to the versatile measurement capabilities provided, the modular software and hardware configuration offers sufficient capacity for future expansions.

Main features

- Four loopthrough video signal inputs with analog 9 MHz bandwidth
- DOS- and Windows-compatible PC with IEEE/IEC bus controller
- Multitasking operating system
- Connectors for external keyboard and colour monitor
- Monochrome graphic LCD display with 640 x 480 pixels or colour LCD
- Two serial interfaces
- SCPI remote control via IEEE/IEC or serial interface
- Printer interface
- 3.5" floppy disk drive (DOS format) for result transfer and software options
- Hard disk
- Modular design with hardware and software options

Five instruments in one

Video and FFT analyzer

- Simultaneous computation of up to 150 different signal parameters
- Automatic limit monitoring
- Automatic overall measurement of all parameters
- Individual measurements using extended test capabilities
- Test-signal and test-location display
- Standard or reference measurement for each parameter separately

3-channel oscilloscope

- Simultaneous display of up to three video signals in separate displays
- Separate test input for each part display (eg components, RGB, YC_BC_R)
- Simultaneous display of the same signal with different time scales in up to three separate windows
- Displayed signal section variable in the x and y direction from approx. 200 ns to 20 ms
- Digital filters for simulating signal manipulations, eg all CCIR filters for insertion signal measurements
- Scale automatically matched to the display
- Two cursors for each window: LEVEL, PEAK, SLOPE and PULSE functions allow analysis of complete signal elements

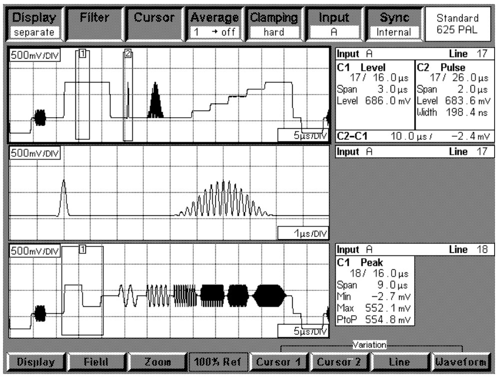


Fig. 1: With a single sin x/x measurement the result display is divided, one part showing the amplitude frequency response and the other the group delay. An info and a cursor window are assigned to each spectrum.

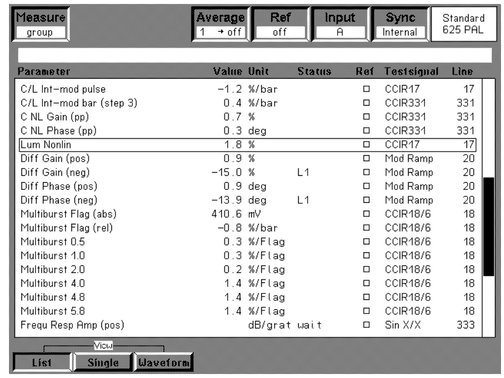


Fig. 2: In the list mode, selected video parameters and their measured values are displayed in the form of a list.

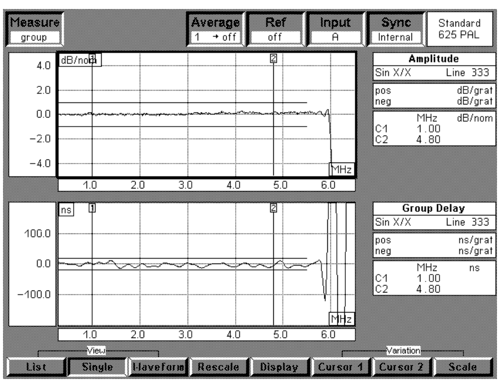


Fig. 3: In the SCOPE mode the screen is divided in a signal, an info and a cursor window. The waveform of one video signal can be displayed simultaneously in up to three windows with continuously variable time and amplitude scaling.

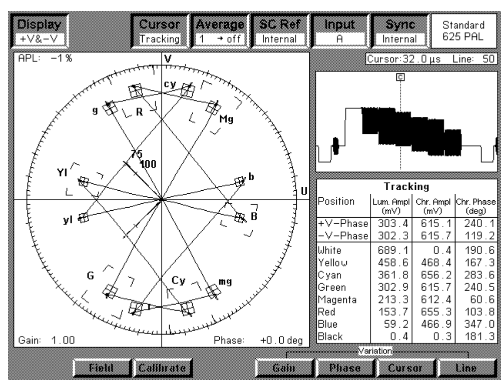
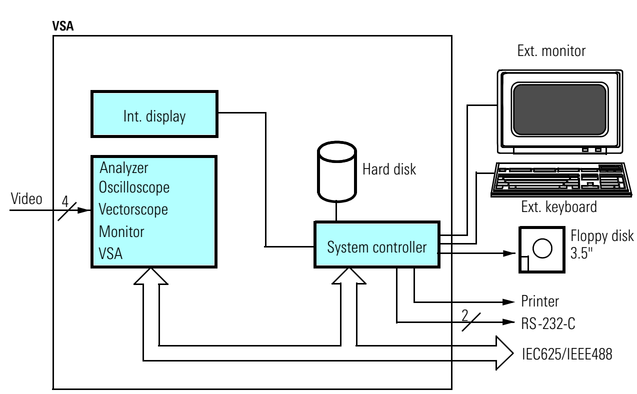


Fig. 4: In the vectorscope function the magnitude and phase of all colour parameters of a video line are shown in a graphics display; the line is also displayed in the waveform window. A cursor line in the waveform display of the video line marks the measurement time for colour subcarrier amplitude and phase. The cursor corresponds to one or two markers in the vector diagram. When the cursor line is shifted, the markers track the vector curve.

Vectorscope

- Graphic display of all colour parameters of a video line in magnitude and phase
- Accurate measurement of phase difference of two colour signal subcarriers by alternate suppression of colour subcarrier reference
- Permanent waveform display of video line
- Automatic computation and display of all colour subcarrier amplitudes and phases when a standard colour bar signal is applied



Monitor

- Easy identification of selected video signal
- Display of a video signal as monochrome TV picture with eight grey levels
- Simultaneous display of any rollkey-selected video line of the TV picture

System controller

- Comprehensive automatic test system
- Control of external devices via IEEE/IEC bus or serial interface
- Complete PC (DOS + Windows) with integrated IEEE/IEC bus card
- Computing and measurement functions independent of each other
- Simple switchover between measurement display and DOS display
- VGA colour monitor and external keyboard available as accessories

Specifications in brief

Frequency range, standard — 0 to 9 MHz, B/G, I, D, K PAL

Signal inputs

Video inputs, Level	75-Ω loopthrough filters, 1 V ±6 dB
Return loss up to 6 MHz	>40 dB (up to 10 MHz >36 dB)
Decoupling of inputs up to 10 MHz	>85 dB
DC input, Level	1 MΩ, ±5 V

Signal outputs

Zero-ref. control pulse, 75 Ω, Level	2.5 V ±10%, line pos./duration adjustab.

Interfaces

Remote control	IEC 625-2/IEEE 448-2, 2x RS-232-C
Printer	parallel interface (Centronics)
External monitor	VGA colour monitor, 640 x 480 pixels
External keyboard	PC AT keyboard
Display	colour/monoc., max. pixel error 0.017‰

Measurement parameters

Amplitude & delay	Unit	Range	Res.	Max. err
Luminance bar amplitude (abs)	mV	0 to 1400	0.1	±2.0
Luminance bar amplitude (nom)	%	–100 to +100	0.1	±0.3
Sync amplitude (abs)	mV	60 to 600	0.1	±2.0
Sync amplitude (nom)	%	–80 to +100	0.1	±0.5
Sync amplitude (bar)	%	–50 to +50	0.1	±0.5
Burst amplitude (abs)	mV	60 to 600	0.1	±3.0
Burst amplitude (nom)	%	–80 to +100	0.1	±1.0
Burst amplitude (bar)	%	–50 to +50	0.1	±1.0
C/L gain (modulated pulse)	%	–50 to +50	0.1	±1.0
C/L delay (modulated pulse)	ns	–500 to +500	1	±5
C/L gain (modulated bar)	%	–50 to +50	0.1	±1.0
Average picture level (bar)	%	0 to 200	0.1	±3.0
DC level X_1	mV	–2000 to +2000	0.1	±3.0
Residual picture carrier	%	0 to +30	0.1	±0.3
Residual picture black level	%	50 to 90	0.1	±0.3
Linear distortion				
Baseline distortion (bar)	%	–40 to +40	0.1	±0.3
2T pulse amplitude (bar)	%	–50 to +50	0.1	±0.5
2T k factor	%	0 to 10	0.1	±0.5
2T half-amplitude duration	ns	100 to 400	1.0	±3
Tilt	%	–40 to +40	0.1	±0.3
Short/field-time distortion	%	–40 to +40	0.1	±0.3
Non-linear distortion				
C/L intermod. (mod. pulse)	%	–50 to +50	0.1	±1.0
C/L intermod. (modulated bar), 1/2/3 steps	%	–50 to +50	0.1	±0.3
C NL gain, pos/neg	%	0 to +50/–50	0.1	±0.7
C NL gain, pp	%	0 to 100	0.1	±1.0
C NL phase, pos/neg	deg	0 to +50/–50	0.1	±0.7
C NL phase, pp	deg	0 to 100	0.1	±1.0
Lum NL	%	0 to 50	0.1	±0.5
Lum NL, 1/2/3/4/5 steps	%	50 to 100	0.1	±0.5
Diff. gain, ref (bar)	%	–50 to +50	0.1	±0.3
Diff. gain, pos/neg	%	0 to +50/–50	0.1	±0.3
Diff. gain, pp	%	0 to 100	0.1	±0.5
Diff. gain, 1/2/3/4/5 steps	%	–50 to +50	0.1	±0.3
Diff. phase, pos/neg	deg	0 to +50/–50	0.1	±0.3
Diff. phase, pp	deg	0 to 100	0.1	±0.5
Diff. phase, 1/2/3/4/5 steps	deg	–50 to +50	0.1	±0.3
Frequency response				
Multiburst flag (abs)	mV	0 to 1000	0.1	±2.0
Multiburst flag (nom)	%	–100 to +50	0.1	±0.3
Multiburst flag (bar)	%	–100 to +50	0.1	±0.3
Multiburst 0.5/1/2/4/4.8/5.8	%	–100 to +50	0.1	±1.0

	Unit	Range	Res.	Max. err
Multiburst 0.5/1/2/4/4.8/5.8	dB	–40 to +6	0.01	±0.1
Multiburst (national) flag (abs)	mV	0 to 1000	0.1	±2.0
Multiburst (nat) flag (nom/bar)	%	–100 to +50	0.1	±0.3
Multib. (nat) flag 0.5/1.5/3.0/4.4	%	–100 to +50	0.1	±1.0
Multib. (nat) flag 0.5/1.5/3.0/4.4	dB	–40 to +6	0.01	±0.1
Sin x/x amplitude, pos/neg	dB	–100 to +100	0.01	±0.3
Sin x/x group delay, pos/neg	ns	–1000 to +1000	1.0	±20
Spectrum, pos/neg	dB	–100 to +100	0.01	±0.3
Noise measurements				
Lum noise, unw (abs)	mV	0 to 50	0.1	±1.0
Lum noise, unw (nom/bar)	dB	25 to 75	0.1	±1.0
Lum noise, lumw (abs)	mV	0 to 50	0.1	±1.0
Lum noise, lumw (nom/bar)	dB	25 to 80	0.1	±1.0
Lum noise, chrw (abs)	mV	0 to 50	0.1	±1.0
Lum noise, chrw (nom/bar)	dB	25 to 80	0.1	±1.0
Hum (abs.)	mV	0 to 700	1	±5
Hum (nom/bar)	dB	0 to 55	0.1	±1.0
C/SND intermodulation (abs)	mV	0 to 50	0.1	±1.0
C/SND intermod. (nom/bar)	dB	30 to 70	0.1	±1.0
SND/SND intermod. (abs)	mV	0 to 50	0.1	±1.0
SND/SND intermod. (nom/bar)	dB	30 to 70	0.1	±1.0
Chroma noise AM	dB	0 to –80	0.1	±1.0
Chroma noise PM	dB	–25 to –70	0.1	±1.0
Timing measurements				
Field period, first/sec. field	µs	20 000 ±30	0.001	±0.005
Equalizing pulse duration	µs	1.35 to 3.35	0.001	±0.005
Serration pulse duration	µs	2.70 to 6.70	0.001	±0.005
Line period	µs	60 to 68	0.001	±0.005
Line blanking (nom/bar)	µs	7 to 65	0.001	±0.05
Sync duration	µs	2.7 to 6.7	0.001	±0.005
Sync slope, neg/pos	µs	70 to 1000	1	±5
Burst position	µs	4.7 to 6.0	0.001	±0.01
Burst duration	µs	1.5 to 3.0	0.001	±0.01
SC/H, line/average	deg	–90 to +90	1	±4
SC/H, pos p/neg p/pp	deg	–90 to +90	1	±4
PAL phase, line/average	deg	0 to 180	1	±4
PAL phase, pos p/neg p/pp	deg	0 to 180	1	±4
SC frequency	Hz	4433 618 ±100	0.05	±1
Jitter measurements				
Field jitter, pos p/neg p/pp	µs	0 to 30	0.001	±0.005
Field jitter, std. deviation	µs	0 to 30	0.001	±0.005
Line jitter, pos p/neg p/pp	ns	0 to 4000	1	±5
Line jitter, std. deviation	ns	0 to 4000	1	±5
Teletext measurements				
Basic amplitude (abs)	mV	0 to 1400	1	±10
Basic amplitude (nom/bar)	%	–100 to +100	0.1	±2.0
Decoding/timing margin	%	0 to 100	0.1	±2.0
Run-in bits	–	6 to 24	–	–
Data timing	µs	10 to 14	0.001	±0.01

General data

Rated temperature range	0 to +50 °C
Power supply	100/230 V –10/+15% 120/240 V –15/+10%, 47 to 63 Hz (310 VA)
Dimensions (W x H x D); weight	435 mm x 192 mm x 460 mm; 17.7 kg

Ordering information

Video Measurement System

with monochrome display	VSA	2013.6057.02
with colour display	VSA	2013.6057.03

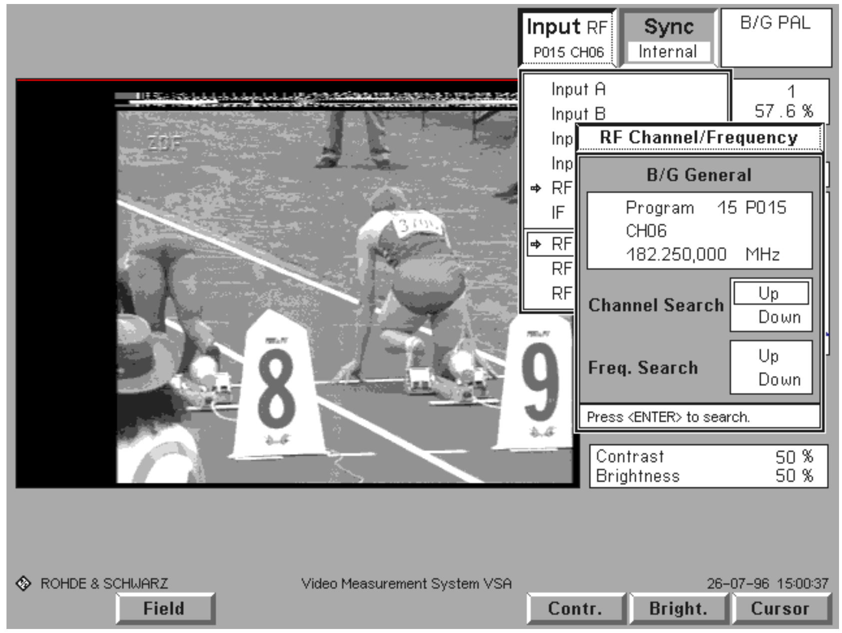
Option

Calibration Data Documentation	VSA-DCV	2082.0490.08

TV Test Receiver Option VSA-B10

47 MHz to 862 MHz

RF parameter measurement and monitoring with Video Measurement System VSA



VSA screen with channel setting of Test Receiver Option VSA-B10

Brief description

TV Test Receiver Option VSA-B10 enhances the Video Measurement System VSA (page 165) for the reception and analysis of RF and IF TV signals. The system allows all important RF and VF quality parameters to be analyzed in a single unit. VSA-B10 can easily be retrofitted – even on site – without calibration and level adjustment and with no problems regarding interfaces or cabling.

VSA with Option VSA-B10 provides the following functions:

- TV test receiver for standards B/G, I, D/K, K1
- Video and FFT analyzer
- 3-channel oscilloscope
- Vectorscope
- Monitor
- System controller

Features of VSA with Option VSA-B10

- RF/video analysis in a single unit
- Measurement of all relevant RF and VF quality parameters
- High-speed analysis
- No external cabling
- Easy to transport
- Little space required
- Uniform user interface for all measurement functions
- RF test parameters displayed in parameter list of VSA
- Display of test receiver configuration on VSA screen

VSA-B10 allows measurement of the following additional parameters:

- Incidental carrier phase modulation (ICPM) of vision carrier
- Vision and sound carrier level and frequency
- Modulation depth of vision carrier (residual carrier) and sound carrier (FM deviation)
- Pilot deviation and frequency
- Pilot decoding

Features of TV test receiver

- Models with 50 Ω or 75 Ω input
- IF input and IF output
- Video and audio outputs
- Dynamic range 40 dBµV to 120 dBµV
- Low-noise and low-distortion mode
- Low-noise preamplifier can be switched on to improve noise figure of receiver
- Video S/N ratio (weighted at 66 dBµV) >56 dB
- Intercarrier S/N ratio (weighted) >46 dB
- Program, channel and frequency entry
- Channel and frequency search
- Synthesizer with low phase noise and high frequency resolution (1 Hz)
- Digital frequency control
- Manual and automatic gain control
- Integrated zero clamping for defining vision modulation depth
- Selectable synchronous detector mode with sampled or continuous phase control as well as selectable time constants
- Sound demodulation and decoding according to IRT dual-sound carrier method
- Linear distortion of video frequency response <0.5 dB (luminance/chrominance error <±20 ns)
- Video group-delay correction of receiver and sound deemphasis can be switched off
- Sound monitoring via loudspeaker of basic unit
- Very easy installation in VSA

Specifications in brief of VSA-B10

Specifications of Video Measurement System VSA see page 165.

Inputs and outputs	
RF input	rear panel, N connector
Frequency range	47 MHz to 862 MHz
Level range	0.1 mV to 1000 mV (40 dBµV to 120 dBµV)[1]
Level range with 10 dB preamplifier	0.03 mV to 1 mV (30 dBµV to 60 dBµV)[1]
Impedance	50 Ω or 75 Ω (depending on model)
Return loss (attenuation ≥10 dB)	>14 dB (VSWR <1.5)
IF input	rear panel, BNC connector
Frequency (vision carrier)	38.9 MHz (for all standards)
Level range	20 mV to 200 mV (86 dBµV to 106 dBµV)[1]
Impedance	50 Ω
Return loss	>20 dB (VSWR <1.2)
IF output	rear panel, BNC connector
Frequency (vision carrier)	38.9 MHz
Level	100 mV, controlled (100 dBµV)[1]
Impedance	50 Ω
Return loss	>20 dB (VSWR <1.2)
Video output	rear panel, BNC connector
Level	1 V pp CVS with video modulation to standard into 75 Ω
Return loss	>26 dB (VSWR <1.1)
Audio outputs	2 x BNC con. on rear panel, unbalanced
Level for ±30 kHz deviation and f_{mod} = 500 Hz	+ 6 dBm ±0.2 dB into 600 Ω
Impedance	<25 Ω
Signals	mono, right and left (stereo), mono 1 and mono 2 (dual sound)
RF/IF characteristics	
Frequency resolution/accuracy	1 Hz/<±2x10^{-6} x receive frequency
Image-frequency rejection VHF	>70 dB
UHF	>50 dB
Adjacent-channel suppression	>48 dB
Video parameters	
Synchronous demod., phase control	continuo. or sampled (switch-selectable)
Time constants for	
continuous phase control	fast, normal, slow
sampled phase control	normal, slow
Switching carrier phase error	<1°, typ. <0.5°
Quadrature signal	for measuring the incidental carrier phase modulation (ICPM)
S/N ratio	
weighted to CCIR Rec. 567, V_{RF} = 3 mV (70 dBµV)[1]; attenuation 0 dB	>56 dB
Linear distortion	
Amplitude response	
Standard B/G, 0 to 4.5 MHz	±0.5 dB
D/K, 0 to 5.5 MHz	±0.5 dB
I, 0 to 5 MHz	±0.5 dB
Group-delay response	group-delay correction
0 to 4.43 MHz	off / on
via IF input	<±10 ns / <±15 ns
via RF input	<±15 ns / <±20 ns
Additional ripple due to SAW filter	<±20 ns
Group-delay correction	flat plus one standard-specific curve
2T k factor	<1%
15 kHz tilt	<1%
Nonlinear distortion	
Luminance nonlinearity	<3%
Differential gain/phase	<3%/<2°
Intermodulation in low-distortion mode (vision carrier: –8/sound carrier: –10/SB: –16 dB)	<72 dB
Audio parameters	
Stereo/dual-sound mode	A2 (IRT)
Frequency response, 40 Hz to 15 kHz	<0.5 dB
Deemphasis	50 µs and off
Distortion for ±50 kHz deviation	<0.5%[2]
Stereo crosstalk	>40 dB
Channel crosstalk with spurious FM	
±30 kHz	>80 dB
±55 kHz	>70 dB
Intercarrier S/N ratio (weighted to CCIR 468-3)	
All-black picture	>55 dB
FuBK test pattern	>48 dB
Sinewave modulation (10% to 75%)	
0 to 5 MHz	>46 dB
242 kHz ±15 kHz	>42 dB
Split-carrier S/N ratio, measured at IF output (weighted to CCIR 468-3)	>56 dB

Test parameters

	Resolution	Deviation
Vision carrier power/level in dBµV, dBm, dBpW	0.1 dB	±3 dB
Vision carrier offset frequency	100 Hz	±2x10^{-6} x receive frequency
Residual carrier	0.1%	±1%
Vision/sound carrier level ratio	0.1 dB	±2 dB
Vision/sound carrier freq. spacing	0.1 kHz	±0.2 kHz[3]
FM deviation of sound carrier ±500 Hz	0.1 kHz	±5x10^{-2}x $\Delta f_{carrier}$
Pilot deviation	10 Hz	±200 Hz
Pilot carrier frequency	1 Hz	±10 Hz
Incidental carrier phase modulation	0.1°	±1°

Ordering information

TV Test Receiver Option

Standard B/G Europe, dual sound,	50 Ω	VSA-B10	2014.0000.02
IF 38.9 MHz + 33.4/33.158 MHz	75 Ω	VSA-B10	2014.0000.03
Standard B/G Europe, mono sound,	50 Ω	VSA-B10	2014.0000.06
IF 38.9 MHz + 33.4 MHz	75 Ω	VSA-B10	2014.0000.07
Standard B/G Australia, dual sound,	50 Ω	VSA-B10	2014.0000.10
IF 38.9 MHz + 33.4/33.158 MHz	75 Ω	VSA-B10	2014.0000.11
Standard D/K CCIR, dual sound,	50 Ω	VSA-B10	2014.0000.40
IF 38.9 MHz + 32.4/32.642 MHz	75 Ω	VSA-B10	2014.0000.41
Standard D/K CCIR, dual sound,	50 Ω	VSA-B10	2014.0000.42
IF 38.9 MHz + 32.4/32.158 MHz	75 Ω	VSA-B10	2014.0000.43
Standard D/K NICAM, IF 32.4 MHz	50 Ω	VSA-B10	2014.0000.44
Standard I UK, mono sound,	50 Ω	VSA-B10	2014.0000.70
IF 38.9 MHz + 32.9 MHz	75 Ω	VSA-B10	2014.0000.71
Standard I SABC, mono sound,	50 Ω	VSA-B10	2014.0000.72
IF 38.9 MHz + 32.9 MHz	75 Ω	VSA-B10	2014.0000.73

Other standards on request.

Calibration Data Documentation	VSA-DCV	2082.0490.10

1) RMS values, referred to sync peak level.

2) At ambient temperatures >35°C: <1%.

3) Without FM deviation.

Video Analyzer VTA 71

25 Hz to 10 MHz

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

Photo 41081

Brief description

Video Analyzer VTA 71 sets new standards for the combination of video analyzer, oscilloscope and vectorscope that comes in one compact cabinet ½19" wide and 3 units high. It is ideal for all TV applications:

- Monitoring of multiple video signals
- Ideal for studios – eg setting up of TV cameras, measurement and broadcasting vehicles, monitoring of broadband communications equipment, research and development labs, TV set and video recorder production, service centers
- 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.

Main features

- Four CCVS loopthrough inputs
- Analog signal display as waveform parade, nine signals simultaneously, overlays
- SC/H phase display (patent)
- Digital line selector
- On-screen digital readouts
- Four cursors
- Two operating levels
- Great ease of operation
- 3D display (patent)
- Storage of 20 instrument settings
- Remote control: RS-232-C/RS-422

Specifications in brief

Vertical deflection

Frequency response	
25 Hz to 10 MHz	±0.1 dB referred to 50 kHz
14 MHz	±1 dB
Lowpass filter (luminance)	<1% FLAT
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 sin² 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%
Max. absolute input level	±3.5 V (DC + AC peak)
Input impedance	100 kΩ ll <10 pF (unterminated)
Return loss (75 Ω)	>40 dB, DC to 6 MHz
Variable gain range	–6 dB to +14 dB

Horizontal deflection

Vertical sweep magnification	x1, x5, x10, x50
Horizontal sweep magnification	x1, x5, x10, x50
Line select	3 independent, each capable of displaying: any line of any single field, or all odd or even fields, or all fields

DC restoration	back porch

Video output (monitoring 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 ll <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 dB to +14 dB
Gain instability (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

Measurement accuracy in multiple display mode

Waveform overlays (x10), relative (referred to 700 mV)	±100 ns, ±1%
Vector overlays, relative (referred to 700 mV)	±1°, ±1%
CRT	8 cm x 10 cm, internally etched graticule with variable scale illumination; scales for waveform and vector display

General data

Power supply	110/120 V (90 V to 132 V) or 220/230 V (180 V to 264 V); jumper-selectable, 48 Hz to 66 Hz (125 VA)
Rated temperature range	0°C to +50°C
Dimensions (W x H x D); weight	216 mm x 134 mm x 451 mm; 8.2 kg

Ordering information

Video Analyzer (PAL)	VTA 71	1062.5090.02
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

The Rohde & Schwarz calibration techniques offer maximum convenience and accuracy also for on-wafer measurements (Vector Network Analyzer ZVM, photo 43453-6)

Contents of Chapter 4

Spectrum Analyzers FSEA, FSEB, FSEM, FSEK

20 Hz to 40 GHz

High-performance analyzers for digital mobile radio and universal applications

FSEM30 (photo 43421-2)

Brief description

FSEA, FSEB, FSEM and FSEK are advanced, high-speed and high-performance analyzers tailored to the requirements of modern digital communication systems. They can also be used as general-purpose analyzers for many applications. High measurement speed, modular design and excellent technical features make for an excellent price/performance ratio.

In addition to measurement functions for digital communication systems, such as 1 µs sweep time in ZERO SPAN mode, pretrigger and trigger delay, gated sweep and adjacent-channel power measurement, these spectrum analyzers feature a wide dynamic range, a very low measurement uncertainty of 1 dB and a low-noise synthesizer.

FSE analyzers have low inherent noise and a wide dynamic range, so that for instance measurement of GSM power ramps is no problem.

An extremely wide intermodulation-free dynamic range of 105 dB (with 10 Hz resolution bandwidth) ensures reliable measurements on highly linear amplifiers as well as correct analysis of broadband complex signals. From the available frequency ranges, the basic models 20 and the high-performance models 30 the right instrument can be chosen for every application. Models 20 can easily be upgraded to give almost the full range of functions of models 30.

To ensure correct measurement of time variants or pulse-modulated signals, the FSE features digital resolution filters (1 Hz to 1 kHz) with a response corresponding to that of analog filters. It additionally provides FFT bandwidths from 1 Hz to 1 kHz (models 30 or models 20 + FSE-B5).

Main features

- Resolution bandwidths 1 Hz (up to 10 MHz), adjustable in steps of 1/2/3/5
- Displayed noise floor down to –150 dBm (FSEA, RBW 10 Hz)
- 3rd-order intercept point typ. +18 dBm (FSEA) 1 dB compression point of RF input +10 dBm
- Phase noise at 10 kHz from carrier: typ. –123 dBc/Hz (FSEA)
- Intermodulation-free dynamic range 105 dB (RBW 10 Hz)
- Total measurement uncertainty up to 1 GHz: <1 dB
- Headphones connector and built-in loudspeaker for AM/FM
- Internal RF trigger for GATED SWEEP measurements
- High speed:
  - FULL SPAN sweep time is 5 ms (for FSEA or FSEB) with a fully synchronized sweep – added speed is not at the expense of frequency accuracy but even enhances it
  - Shortest ZERO SPAN sweep time is 1 µs (100 ns/div) – ideal for high-resolution measurements on pulse edges
  - More than 20 sweeps/s – an optimal prerequisite for fast alignments or applications in production

Spectrum Analyzers FSEA, FSEB, FSEM, FSEK

From AF to microwave

FSEM/K 20/30 open up the microwave range through to 26.5/40 GHz and retain the excellent characteristics of the 3.5 GHz and 7 GHz basic models:

- Continuous full-span sweep
- Fundamental mixing, low noise floor as well as wide dynamic range up to 26.5 GHz
- Fully synchronized sweep with high frequency accuracy even for FULL SPAN (26.5/40 GHz)
- RF input adapters for N or PC 3.5-mm, or K connector (FSEM or FSEK)

Option FSE-B21 allows frequency range extension of FSEM and FSEK by means of external mixers. Mixers FS-Z60 (40 GHz to 60 GHz) and FS-Z75 (50 GHz to 75 GHz) are available as extras. Continuous automatic signal identification, which is used to suppress unwanted image frequency bands and mixture products, ensures fast and easy measurements. Due to the built-in diplexer, two-port as well as three-port mixers can be used.

Measurement functions

- Up to 8 markers
- Marker functions for the direct measurement of
  - phase noise and phase power density
  - NEXT MIN/PEAK, NEXT MIN/PEAK RIGHT, NEXT MIN/PEAK LEFT
- Frequency counter with selectable resolution
- LOW NOISE, NORMAL and LOW DISTORTION modes to cater for low-intermodulation and low-noise operation
- Measuring curves printout in background operation or file saving in standard graphic formats
- Simultaneous display of four traces
- Selectable colour setup
- Numerous level and frequency lines
- Split-screen display with independent windows
- Frequency zoom
- Limit lines
- User-configurable menu and keyboard macros
- Adjacent-channel power measurement for up to 7 channels
- RMS detector

FSE works as a Controller

The optional Controller FSE-B15 provides a further VGA card, a memory extension to 64 Mbyte, a serial mouse and a keyboard. With this option, Windows®-NT applications, eg statistics programs or spreadsheet analysis, can be installed on FSE. FSE can even be linked to a network using the optional Ethernet Interface FSE-B16.

Complete setups, traces, limit lines and macros can be stored non-volatile on the internal harddisk or on diskette with the built-in 1.44-Mbyte drive.

Operation

A combination of hardkeys and softkeys makes for extremely fast and easy operation. The operating convenience based on a wide variety of evaluation routines and marker functions can be accessed via the menus. There are no complicated tree structures by using menus of lateral structure and fixed control keys. Complete setups and traces, limit lines as well as macros can be stored on the hard disk or on floppy disks.

Overview of configurations and options

The analyzers of the FSE family are of modular design throughout. In the table below the right solution tailored to the needs of the various applications can be found.

Designation, characteristics (hardware)	Type	Order No.	FSEA 20	FSEA 30	FSEB 20	FSEB 30	FSEM 20	FSEM 30	FSEK 20	FSEK 30
7 GHz Frequency Extension	FSE-B2	1073.5040.02	❍	❍	–	–	–	–	–	–
Low Phase Noise and OCXO: Typ. phase noise only –123 dBc (BW = 1 Hz, at 10 kHz from carrier), ideal for measuring phase noise of oscillators or adjacent-channel power of radio equipment	FSE-B4	1073.5396.02	❍	●	❍	●	❍	●	❍	●
FFT Filter (1 Hz to 1 kHz)	FSE-B5	1073.5544.02	❍	●	❍	●	❍	●	❍	●

Spectrum Analyzers FSEA, FSEB, FSEM, FSEK

Designation, characteristics (hardware)	Type	Order No.	FSEA 20	FSEA 30	FSEB 20	FSEB 30	FSEM 20	FSEM 30	FSEK 20	FSEK 30
Vector Signal Analyzer: Demodulation of digitally modulated signals	FSE-B7	1066.4317.02	❍	❍	❍	❍	❍	❍	❍	❍
Tracking Generator (9 kHz to 3.5 GHz)	FSE-B8	1066.4469.02	❍	❍	–	–	–	–	–	–
Tracking Generator with I/Q Modulator (9 kHz to 3.5 GHz)	FSE-B9	1066.4617.02	❍	❍	–	–	–	–	–	–
Tracking Generator (9 kHz to 7 GHz)	FSE-B10	1066.4769.02	–	–	❍	❍	–	–	–	❍
Tracking Generator with I/Q Modulator (9 kHz to 7 GHz)	FSE-B11	1066.4917.02	–	–	❍	❍	–	–	–	❍
Switchable Attenuator for Tracking Generators FSE-B8/9/10/11 (0 dB to 70 dB)	FSE-B12	1066.5065.02	❍	❍	❍	❍	–	–	–	❍
1-dB Attenuator	FSE-B13[1)]	1119.6499.02	❍	❍	❍	❍	–	❍	–	❍
Controller inclusive Mouse and Keyboard	FSE-B15[3)]	1073.5696.06	❍	❍	❍	❍	❍	❍	❍	❍
Ethernet Interface AUI connector, 15 poles Thin-wire connector, BNC RJ-45 connector (Twisted Pair)	FSE-B16[2)]	1073.5973.02 1073.5973.03 1073.5973.04	❍	❍	❍	❍	❍	❍	❍	❍
2nd IEEE/IEC Bus Interface	FSE-B17[2)]	1066.4017.02	❍	❍	❍	❍	❍	❍	❍	❍
Exchangeable Hard Disk	FSE-B18[3)]	1088.6993.02	❍	❍	❍	❍	❍	❍	❍	❍
2nd Hard Disk to FSE-B18 (Firmware included)	FSE-B19	1088.7248.02	❍	❍	❍	❍	❍	❍	❍	❍
External Mixer	FSE-B21	1084.7243.02	–	–	–	–	❍	❍	❍	❍
Increased Level Accuracy up to 2 GHz	FSE-B22[3)]	1073.5544.02	❍	❍	❍	❍	❍	❍	❍	❍
Broadband Output 741,4 MHz	FSE-B23[3)]	1088.7348.02	❍	❍	❍	❍	❍	❍	❍	❍
44 GHz Frequency Range Extension for FSEK (factory-fitted only)	FSE-B24	1106.3680.02	–	–	–	–	–	–	❍	❍

1) Cannot be retrofitted in FSEM 20/FSEK 20, in conjunction with option FSE-B22 only factory-fitted.

2) Options FSE-B16 and FSE-B17 require option FSE-B15.

3) Factory-fitted only.

Designation	Type	Use	Functions
Noise Measurement Software	FS-K3	Noise figure measurements	• Measurement of noise figure and temperature to Y-factor method • Measurements on frequency converting devices • Frequency range same as basic unit, starting from 100 kHz • Editor for ENR tables • Runs under Windows NT on the internal controller (option) or on an external PC
Phase Noise Measurement Software	FS-K4	Phase noise measurements	• Easy to use phase noise measurements • measurement of residual FM an PM • logarithmic plot over 8 decades • Runs under Windows NT on the internal controller (option) or on an external PC
Application Firmware	FSE-K10, Mobile FSE-K11, BTS	Mobile radio, transmitter measurements to GSM standards 11.10 and 11.20	• Power ramp and power template • Spectrum due to modulation/switching • Spurious emissions • Mean carrier power • Phase/frequency error (with option FSE-B7)

● Fitted in basic model ❍ Option

Spectrum Analyzers FSEA, FSEB, FSEM, FSEK

Model-dependent specifications in brief

Frequency	FSEA20	FSEA30	FSEB20	FSEB30	FSEM20	FSEM30	FSEK20	FSEK30
Frequency range	9 kHz to 3.5 GHz	20 Hz to 3.5 GHz	9 kHz to 7 GHz	20 Hz to 7 GHz	9 kHz to 26.5 GHz	20 Hz to 26.5 GHz	9 kHz to 40 GHz	20 Hz to 40 GHz
Refer. frequency (aging)	1 x 10^{-6}/year	2 x 10^{-7}/year	1 x 10^{-6}/year	2 x 10^{-7}/year	1 x 10^{-6}/year	2 x 10^{-7}/year	1 x 10^{-6}/year	2 x 10^{-7}/year
With option FSE-B4	2 x 10^{-7}/year	—	2 x 10^{-7}/year	—	2 x 10^{-7}/year	—	2 x 10^{-7}/year	—
Spectral purity								
SSB phase noise, referred to 1 Hz bandwidth, f ≤500 MHz								
100 Hz[1]	—	<–87 dBc	—	<–81 dBc	—	<–81 dBc	—	<–81 dBc
1 kHz[1]	<–85 dBc	<–107 dBc	<–79 dBc	<–100 dBc	<–79 dBc	<–100 dBc	<–79 dBc	<–100 dBc
10 kHz[1]	<–95 dBc	<–120 dBc	<–90 dBc	<–114 dBc	<–90 dBc	<–114 dBc	<–90 dBc	<–114 dBc
100 kHz[2]	<–119 dBc	<–119 dBc	<–113 dBc	<–113 dBc	<–113 dBc	<–113 dBc	<–113 dBc	<–113 dBc
1 MHz[2]	<–135 dBc	<–138 dBc	<–129 dBc	<–132 dBc	<–129 dBc	<–132 dBc	<–129 dBc	<–132 dBc
Resolution bandwidths								
3 dB bandwidths	10 Hz to 10 MHz	1 Hz to 10 MHz	10 Hz to 10 MHz	1 Hz to 10 MHz	10 Hz to 10 MHz	1 Hz to 10 MHz	10 Hz to 10 MHz	1 Hz to 10 MHz
Steps	1/2/3/5	1/2/3/5	1/2/3/5	1/2/3/5	1/2/3/5	1/2/3/5	1/2/3/5	1/2/3/5
Shape factor 60 : 3 dB (1 kHz to 2 MHz)	<15	<12	<15	<12	<15	<12	<15	<12
Video bandwidths	1 Hz to 10 MHz	1 Hz to 10 MHz	1 Hz to 10 MHz	1 Hz to 10 MHz	1 Hz to 10 MHz	1 Hz to 10 MHz	1 Hz to 10 MHz	1 Hz to 10 MHz
Steps	1/2/3/5	1/2/3/5	1/2/3/5	1/2/3/5	1/2/3/5	1/2/3/5	1/2/3/5	1/2/3/5
Level								
Displayed noise floor, average level in dBm (10 Hz bandwidth, 0 dB RF attenuation,VBW = 1 Hz, no signal at RF input)								
20 Hz	—	–80	—	–74	—	<–74	—	<–74
1 kHz	—	–110	—	–104	—	<–104	—	<–104
10 kHz	–90	–125	–84	–119	<–84	<–119	<–84	<–119
100 kHz	–110	–135	–104	–129	<–104	<–129	<–104	<–129
1 MHz	<–130, typ. –135	<–145, typ. –150	<–125, typ. –130	<–142 typ. –145	<–124, typ. –129	<–142, typ. –145	<–124, typ. –129	<–142, typ. –145
10 MHz to 3.5/6 GHz	<–145, typ. –150	<–145, typ. –150	<–142, typ. –147	<–142, typ. –147	<–138, typ. –140	<–138, typ. –140	<–138, typ. –140	<–138, typ. –140
6 GHz to 7 GHz	—	—	<–139	<–139	<–135, typ. –138	<–135, typ. –138	<–135, typ. –138	<–135, typ. –138
7 GHzto 18 GHz	—	—	—	—	<–138, typ. –140	<–138, typ. –140	<–138, typ. –140	<–138, typ. –140
18 GHz to 26.5 GHz	—	—	—	—	<–135, typ. –138	<–135, typ. –138	<–135, typ. –138	<–135, typ. –138
26.5 GHz to 30 GHz	—	—	—	—	—	—	<–120, typ. –125	<–120, typ. –125
30 GHz to 40 GHz	—	—	—	—	—	—	<–116, typ. –122	<–116, typ. –122
Max. dynamic range	10 Hz bandwidth	1 Hz bandwidth	10 Hz bandwidth	1 Hz bandwidth	10 Hz bandwidth	1 Hz bandwidth	10 Hz bandwidth	1 Hz bandwidth
Displayed noise floor at 1 dB compression	155 dB	165 dB	152 dB	162 dB	150 dB	160 dB	150 dB	160 dB
Max. intermodulation-free range								
50 MHz to 3.5 GHz	105 dB	115 dB	—	—	—	—	—	—
100 MHz to 26.5 GHz	—	—	105 dB	115 dB	103 dB	112 dB	103 dB	112 dB

Total measurement uncertainty (0 to 50 dB below reference level, span/RBW <100, rss 95% reliability)

<1 GHz	<1 dB
1 GHz to 3,5/7 GHz	<1,5 dB

Intermodulation

	FSEA	FSEB	FSEM, FSEK
3rd-order intermod., intermodulation-free dynamic range, level 2 × –20 dBm, Δf >5 × RBW or 10 kHz, whichever is the greater value	>64 dBc for f >50 MHz (T.O.I. >12 dBm, typ. 18 dBm)	>70 dBc for f >150 MHz (T.O.I. ≥15 dBm, typ. 20 dBm)	>74 dBc for f >100 MHz >60 dBc for f >7 GHz (T.O.I. ≥17 dBm, typ. 22 dBm; >10 dBm for f >7 GHz)

Intermodulation-free range at –40 dBm mixer level: 105 dB

Intercept point k2 (dBm)	>25, typ. >40 for f <50 MHz, >45, typ. >50 for f >50 MHz	>25 for f <150 MHz, >35 typ. >40 for f >150 MHz, >45 typ.

1) Models 20: valid for span ≤50 kHz, RBW <1 kHz.

2) Valid for span >100 kHz.

Spectrum Analyzers FSEA, FSEB, FSEM, FSEK

Common specifications in brief

Frequency	
Frequency display	with marker
Resolution	0.1 Hz to 10 kHz (depending on span)
Frequency counter	measures the marker frequency
Resolution	0.1 Hz to 10 kHz (selectable)
Display range of frequency axis	0 Hz, 10 Hz to full span
Sweep time	
Display range	0 Hz 1 µs to 2500 s ≥10 Hz 5 ms to 16000 s
Picture refresh rate	>20 updates/s with 1 trace >15 updates/s with 2 traces
Sampling rate	50 ns (20 MHz A/D converter)
Sweep trigger	free run, single, line, video, gated, delayed, external
Zero span	additionally pretrigger, posttrigger, trigger delay
Level	
Display range	noise floor displayed to 30 dBm
Max. input level	
RF attenuation 0 dB/≥10 dB	
DC voltage	0 V
CW RF power	20 dBm (= 0.1 W)/30 dBm (= 1 W)
Pulse spectral density	97 dBµV/MHz
Max. pulse energy (10 µs)	1 mWs/FSEM/K: 0.5 mWs (RF attenuation ≥10 dB)
Max. pulse voltage (RF attenuation ≥10 dB)	FSEA/B: 150 V, FSEM/K: 50 V
1 dB compression of input mixer (0 dB RF attenuation)	+10 dBm nominal
Max. harmonics suppression	90 dB (f >50 MHz)
Level display	
Trace	500 × 400 pixels (one diagram)
Log level axis	10 to 200 dB in 10 dB steps
Linear level axis	10% of reference level per level division, 10 divisions
Setting range of reference level	
Log level display	–130 to +30 dBm in 0.1 dB steps
Linear level display	7 nV to 7.07 V in 1% steps
Units of level axis	dBm, dBµV, dBµA, dBpW (log level display); mV, µV, mA, µA, pW, nW (linear level display)
Pulse amplitude accuracy (single pulses)	
Bandwidth <1 MHz	0.5 dB nominal
≥1 MHz	2 dB nominal
Trigger function	
Trigger	free run, line, video, RF, external
Delayed sweep	
Trigger source	free run, line, external, video
Delay time	100 ns to 10 s, 1 µs
Delayed sweep time	2 µs to 1000 s
Gated sweep	
Trigger source	external, RF level
Gate delay	1 µs to 100 s
Gate length	1 µs to 100 s, resolution 1 µs
Demodulation	
Modulation modes	AM and FM
Audio output	loudspeaker and headphones output
Marker stop time	100 ms to 60 s
1 dB Attenuator	**FSE-B13**
Frequency range	max. 7 GHz (stopp frequency ≤7 GHz)
Setting range of RF attenuation	0 dB to 70 dB
Step width	1 dB
Additional attenuator uncertainty	<0.1 dB
External Mixer FSE-B21	
LO output/IF input (front panel)	SMA female, 50 Ω
LO signal	7.5 GHz to 15.2 GHz
Level	+15.5 dBm ±3 dB
IF signal	741.4 MHz
Full level	–20 dBm
Level measurement uncertainty	<1 dB
IF input (front panel)	SMA female, 50 Ω
Frequency	741.4 MHz
Full level	–20 dBm
Level measurement uncertainty	<1 dB
Inputs and outputs (front panel)	
RF input	N female, 50 Ω (FSEA/FSEB), Microwave Adapter System (FSEM/K)
VSWR (RF attenuation >10 dB), f <3.5 GHz	<1.5
Attenuator	0 to 70 dB, selectable in 10 dB steps
Probe power	+15 V/–12.6 V (DC) and ground, ≥150 mA
Power supply and coding connector for antennas etc (antenna code)	12-contact Tuchel connector
Supply voltages	±10 V, max. 100 mA, ground
AF output	jack, adjustable up to 1.5 V (Z_{in} = 10 Ω)
Inputs and outputs (rear panel)	
IF 21.4 MHz	BNC female 50 Ω, bandwidth >1 kHz or resolution bandwidth
Level	0 dBm at reference level, mixer level >–60 dBm
Video output	BNC female 50 Ω, 0 to 1 V (open-circuit voltage)
Reference frequency	
Output, usable as input	BNC female 10 MHz, 10 dBm nominal
Input	1/.../16 MHz, >0 dBm into 50 Ω
Sweep output	BNC female, 0 to 10 V, proportional to displayed frequency
Noise source connector	BNC female, 0/28 V, switch-selected
Ext. trigger/gate input	BNC, –5/+5 V, adjustable
IEEE/IEC bus control	interface to IEC625-2 (IEEE488.2), Command set SCPI 1994.0
Serial interface	RS-232-C interface (COM1 and COM2), 9-contact female connectors
Mouse interface	PS/2-compatible
Plotter 1)	via IEEE/IEC bus or RS-232-C, HP-GL
Printer interface	parallel (Centronics) or serial (RS-232-C)
Keyboard connector	5-contact female for MF2 keyboard
User interface	25-contact Cannon female
Connector for external monitor (VGA)	15-contact female
General data	
Display (640 × 480)	24 cm colour LCD (9.5")
Mass memory	3½", 1.44 MByte; hard disk
Power supply, AC	100 to 120 V: 50 Hz to 400 Hz 200 to 240 V: 50 Hz to 60 Hz
Power consumption	170 to 230 VA (depending on model)
Dimensions (W × H × D; 5 HU)	
Models 20	435 mm × 236 mm × 460 mm
Models 30	435 mm × 236 mm × 570 mm
Weight	21.5 to 25,8 kg (depending on model)

Spectrum Analyzers FSEA, FSEB, FSEM, FSEK

Ordering information

Spectrum Analyzer	FSEA 20	1065.6000.25
	FSEA 30	1065.6000.35
	FSEB 20	1066.3010.25
	FSEB 30	1066.3010.35
	FSEM 20	1080.1505.25
	FSEM 30	1079.8500.35
	FSEK 20	1088.1491.25
	FSEK 30	1088.3494.35
Options		
7 GHz Frequency Extension for FSEA	FSE-B2	1073.5044.02
Low Phase Noise and OCXO (for models 20)	FSE-B4	1073.5396.02
FFT Filter 1 Hz to 1 kHz (for models 20)	FSE-B5	1073.5544.02
Vector Signal Analyzer	FSE-B7	1066.4317.02
Tracking Generator 3.5 GHz	FSE-B8	1066.4469.02
Tracking Generator 3.5 GHz with I/Q Modulator	FSE-B9	1066.4617.02
Tracking Generator 7 GHz	FSE-B10	1066.4769.02
Tracking Generator 7 GHz with I/Q Modulator	FSE-B11	1066.4917.02
Switchable Attenuator for Tracking Generator	FSE-B12	1066.5065.02
1 dB Attenuator	FSE-B13 2)	1119.6499.02
Controller for FSE (mouse and keyboard included (English)	FSE-B15 1)	1073.5696.06
Ethernet Interface		
15-contact AUI connector	FSE-B16 2)	1073.5973.02
Thin-wire BNC connector	FSE-B16 2)	1073.5973.03
RJ-45 connector	FSE-B16 2)	1073.5973.04
2nd IEEE/IEC bus Interface for FSE	FSE-B17 2)	1066.4017.02
Removable Hard Disk	FSE-B18 2)	1088.6993.02
Second Hard Disk for FSE-B18 (firmware included)	FSE-B19	1088.7248.02
External Mixer	FSE-B21	1084.7243.02
Increased Level Accuracy up to 2 GHz	FSE-B22 3)	1106.3480.02
Broadband Output 741.4 MHz	FSE-B23 3)	1088.7348.02
44 GHz Frequency Range Extension for FSEK	FSE-B24 3)	1106.3680.02
Software		
Noise Measurement Software, Windows	FS-K3	1057.3028.02
Phase Noise Measurement Software, Windows	FS-K4	1108.0088.02
GSM Application Firmware, Mobile	FSE-K10	1057.3092.02
GSM Application Firmware, BTS	FSE-K11	1057.3392.02
EDGE Application Firmware, Mobile	FSE-K20 4)	1106.4086.02
EDGE Application Firmware, BTS	FSE-K21 4)	1106.4186.02

Extras		
Service Kit	FSE-Z1	1066.3862.02
DC Block, 5 MHz to 7000 MHz (Type N)	FSE-Z3	4010.3895.00
DC Block, 10 kHz to 18 GHz, Type N	FSE-Z4	1084.7443.02
2.4-mm female (only for FSEK)	FSE-Z5	1088.1627.02
Microwave Measurement Cable and Adapter Set for FSEM	FS-Z15	1046.2002.02
Harmonics Mixer 40 GHz to 60 GHz	FS-Z60 5)	1089.0799.02
Harmonics Mixer 50 GHz to 75 GHz	FS-Z75 5)	1089.0847.02
Service Manual	–	1065.6016.24
Headphones	–	0708.9010.00
German Keyboard	PSA-Z2	1007.3001.31
American Keyboard	PSA-Z2	1007.3001.02
PS/2 Mouse	FSE-Z2	1084.7043.02
Colour Monitor, 15", 230 V	PMC3	1082.6004.02
IEEE/IEC bus Cable, 1 m	PCK	0292.2013.10
IEEE/IEC bus Cable, 2 m	PCK	0292.2013.20
19" Rack Adapter with front handles	ZZA-95	0396.4911.00
Transit Case	ZZK-954	1013.9395.00
Transit Case (FSEM 30 and FSEK 30 only)	ZZK-955	1013.9408.00
Matching Pads, 75 Ω		
L section	RAM	0358.5414.02
Series resistor, 25 Ω	RAZ	0358.5714.02
Accessories for current, voltage and field-strength measurement	see accessories for Test Receiver ESS, data sheet PD 756.9768	
SWR Bridge, 5 MHz to 3000 MHz	ZRB 2	0373.9017.52
SWR Bridge, 40 kHz to 4 GHz	ZRC	1039.9492.52
High-Power Attenuators, 100 W, 3/6/10/20/30 dB	RBU 100	1073.8820.xx (xx=03/06/10/20/30)
High-Power Attenuators, 50 W 3/6/10/20/30 dB	RBU 50	1073.8895.xx (xx=03/06/10/20/30)
Preamplifier, 20 MHz to 1000 MHz	ESV-Z3	0397.7014.52
For FSEM only:		
Test-Port Adapter, N (male)	–	1021.0541.00
Test-Port Adapter, 3.5 mm (male)	–	1021.0529.00
For FSEK only:		
Test-Port Adapter, N (male)	–	1036.4783.00
Test-Port Adapter, K (male)	–	1036.4802.00
Test-Port Adapter, 2.4 mm (male)	FSE-Z5	1088.1627.02

1) Plot function is not available, if FSE-B15 is fitted.

2) Options FSE-B16 and FSE-B17 require option FSE-B15.

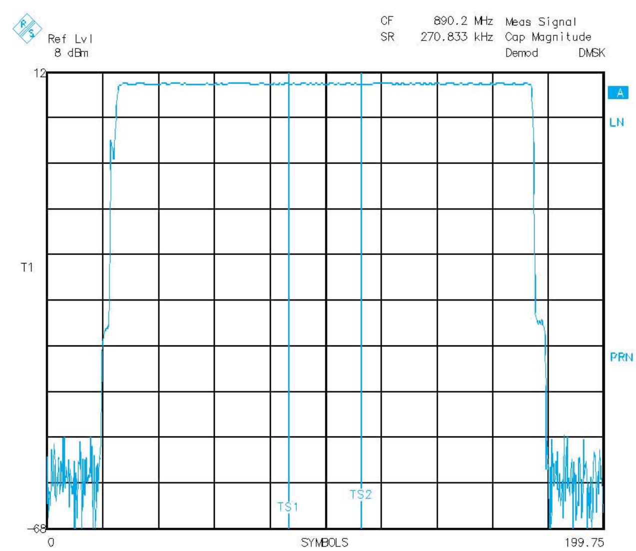
3) Not retrofittable, factory-fitted only.

4) FSE-K10 or FSE-K11 required.

5) For all FSEM/FSEK, option FSE-B21 required.

Vector Signal Analyzer Option FSE-B7 for Spectrum Analyzers FSE

Universal demodulation, analysis and documentation of digital and analog mobile radio signals



Measurement of GSM power ramps to standard with high-precision time reference through synchronization to midamble

Brief description

The vector signal analyzer option upgrades the high-quality Spectrum Analyzers FSE, adding universal demodulation and analysis capability down to bit level for digital mobile radio signals. The option supports all common mobile radio communication standards. Analyzers FSE in conjunction with option FSE-B7 replace several individual instruments:

– high-grade spectrum analyzer
– vector demodulator
– constellation analyzer
– or process controller

Main features

Standards
GSM 1800/PCS 1900, EDGE, NADC, TETRA, PDC, PHS, CDPP, WCPE, CT2, ERMES, FLEX, MODACOM, TFTS, DECT, CDPP, PWT, APCO, cdmaOne

Modulation modes
BPSK, QPSK, DQPSK, π/4-DQPSK, Offset-QPSK, 8-PSK, 8-DPSK, 3π/8-8PSK, MSK/(G)MSK, 2-/4-(G)FSK, 4-FSK, 16-QAM, AM/FM/φM

Optimum representation of results
- In-phase and quadrature signal
- Magnitude, phase
- Eye and trellis diagrams
- Vector diagram
- Constellation diagram
- Table with modulation errors
- Demodulated bits

Benefits at a glance

- All mobile radio standards at a keystroke
- Measurement and analysis of analog modulation signals
- Versatile applications in the lab
- Multi-measurement functions in a single unit
- Efficient in production

Principle of vector signal analysis

The IF signal is digitized by means of a fast A/D converter, allowing purely digital processing of all subsequent analysis steps, thus making them practically error-free and providing high long-term and temperature stability. After A/D conversion, the signal is digitally mixed into the baseband and split into a real and an imaginary component. The complete signal information is thus available for further analysis. The signal is demodulated down to bit level by several DSPs. From the data thus obtained, an ideal signal is calculated. This reference signal is compared with the test signal. The resulting difference signal contains all modulation errors. The sampling rate of the A/D converter is always set to an integer multiple of the symbol rate, which speeds up analysis and contributes towards the high rate of 5 measurements/s.

- Phase error measurements on GSM mobile phones or base stations
- EVM measurements according to standard at EDGE
- Convenient analysis with SYMBOL TABLE/ERROR SUMMARY display
- Measurements on frequency-modulated signals
- Measurement of AM/φM conversion or synchronous phase modulation
- Measurement of transmitter frequency transients

Specifications in brief

Measurement of digital modulation signals

Signal types	continuous signals, TDMA signals
Standards	GSM 1800/PCS 1900, EDGE, NADC, TETRA, PDC, PHS, CDPP, WCPE, CT2, ERMES, FLEX, MODACOM, TFTS, DECT, CDPP, PWT, APCO, cdmaOne
Modulation modes	BPSK, QPSK, DQPSK, π/4-DQPSK, Offset-QPSK, 8-PSK, 8-DPSK, 3π/8-8PSK, MSK/(G)MSK, 2-/4-(G)FSK, 4-FSK, 16-QAM, AM/FM/φM
Filters	
Filter types	raised cosine, square root raised cosine, Gaussian
Setting range α/B x T	0.2 to 3 in steps of 0.01
Filters to specific standards	
FLEX	Bessel B x T = 1.22 and 2.44
ERMES	Bessel B x T = 1.25
cdmaOne	forward and reverse channel (IS-95)
EDGE	EDGE weighting filter

Measurements (except FSK)
I and Q signals (filtered, synchronized to frequency and symbol clock)
I and Q reference signals (calculated from demodulated bits)
I and Q error (magnitude and phase)
Vector error
Bit stream/modulation error (bits demodulated at ideal decision points and table of all modulation errors)

Measurements with FSK
Frequency-demodulated signal (filtered, synchronized to symbol clock)
FSK reference signal (calculated from demodulated data)
FSK error signal
Data/bit stream/modulation error (symbols demodulated at ideal decision points and table of all modulation errors)

Display modes (except FSK)
Polar diagram: constellation diagram, vector diagram
Time domain: in-phase and/or quadrature signal, magnitude (level), phase, eye diagram, trellis diagram
Error display in time domain: error vector magnitude (EVM) in %, phase/frequency error, in-phase and quadrature signals
Numerical error readout (* rms and peak value): error vector magnitude*, magnitude error*, phase error*, frequency error, I/Q offset, I/Q imbalance, amplitude droop, ρ-factor

Display modes with FSK
Time domain: magnitude (level), frequency deviation, eye diagram (frequency signal)
Error display in time domain: frequency deviation error, magnitude error
Numerical error readout (* rms and peak value): deviation error*, magnitude error, FSK frequency deviation, frequency error, FSK reference deviation

Modulation measurement range

Symbol rate	320 Hz to 2.133 MHz
Testpoints/symbol	
Symbol rate ≤200 kHz	1, 2, 4, 8, 16
200 to ≤400 kHz	1, 2, 4, 8
>400 kHz	1, 2, 4
Memory size, symbol rate ≤1 MHz	max. 16000 samples
>1 MHz	max. 3200 points
Number of demodulated symbols	
Symbol rate ≤1 MHz	max. 1600 symbols (with 4 points/symbol), max. 800 symbols (with 8 points/symbol), max. 400 symbols (with 16 points/symbol)
>1 MHz	max. 600 symbols

Synchronization	**internal symbol clock and frequency/phase**
Trigger	free run, external, video
Trigger offset	pre- or posttrigger
Synchronization on bit sequences	definable bit sequences, max. 32 symbols, TDMA bursts
Synchronization offset	selectable, positive or negative

Measurement of analog modulation signals

Demodulation mode	offline demodulation
Demodulation bandwidth	5 kHz to 2 MHz (typ. 5 MHz)
Realtime demodulation	5 kHz to 200 kHz bandwidth in steps of 1, 2, 3, 5
Offline demodulation	5 kHz to 2 MHz (5 MHz) bandwidth in steps of 1, 2, 3, 5
Demodulation length (max. sweep time)	(5000 x 0.7)/(bandwidth/Hz) [s]
Display	AF signal, carrier power (AM AF signal DC-coupled) or modulation summary (table)
Numerical display of	– peak or rms values of modulation depth or deviation of main demodulation – SINAD 1 kHz (only with REAL TIME ON) – AF frequency – carrier power – peak values of supplementary modulations

Level measurements

Peak power	–60 dBm to +30 dBm
Dynamic range for burst measurement (mean power, ref level ≥–10 dBm, peak power = ref level +1 dB, low-noise mode, points/symbol ≤4)	80 dBc – 4 x log(symbol rate/kHz)
Absolute level error	
Average power (0 to –10 dB below reference level)	
f ≤1 GHz	<1 dB
f >1 GHz	see data sheet FSE (total measurement uncertainty)
Relative level error	
Mean power, level	
0 to –10 dB below reference level	0.2 dB
–10 to –50 dB below reference level	(0.0325/dB – 0.125)dB
Time reference (nominal)	
without clock synchronization	<1/(2 x symbol rate x points/symbol) for MSK/GMSK modulation, <1/(2 x symbol rate) for PSK/QAM/FSK modulation
with clock synchronization	<0.001 x 1/(symbol rate)

Measurement times
Readout of detected symbols and numerical modulation errors, synchronized

GSM 900/1800/1900, PHS	330 ms/measurement
NADC, TETRA, PDC	600 ms/measurement

Ordering information

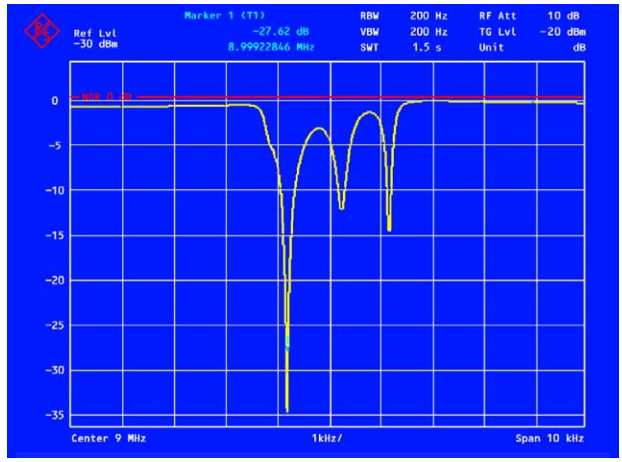
Vector Signal Analyzer	FSE-B7	1066.4317.02
Option for FSE		
Low Phase Noise and OCXO (for models 20)	FSE-B4	1073.5396.02

Tracking Generators FSE-B8 to -B11

Scalar network analysis with

Spectrum Analyzers FSE

9 kHz to 3.5/7 GHz



Measuring the passband and stopband attenuation of a filter (1)

Main features

- Attenuation measurement range >90 dB, typ. 120 dB
- I/Q modulator in FSE-B9/-B11 for generating any phase or amplitude modulation modes
- Output level 0 to –20 dBm, optionally 0 to –90 dBm
- Frequency offset up to ± 200 MHz

Brief description

The optional Tracking Generators FSE-B8, FSE-B9, FSE-B10 and FSE-B11 enhance the Spectrum Analyzers FSE for selective scalar network analysis. They allow gain, frequency response, ripple, insertion and return loss (with additional SWR bridge) to be measured in a wide dynamic range. In contrast to measurements with broadband scalar network analyzers, the selective measurement method ensures that harmonics and spurious responses of the generator or device under test have no effect on the measurement.

Spectrum Analyzers FSE with built-in tracking generators feature a very low noise floor and hence an extremely wide dynamic range for attenuation measurements. They are thus ideal for instance for measuring shielding effectiveness.

Overview

Generator	Designation	Order No.	Frequency Range	FSEA 20	FSEA 30	FSEB 20	FSEB 30	FSEM 20	FSEM 30	FSEK 20	FSEK 30
FSE-B8	Tracking Generator	1066.4469.02	9 kHz to 3.5 GHz	•	•	–	–	–	–	–	–
FSE-B9	Tracking Generator	1066.4617.02	9 kHz to 3.5 GHz	•	•	–	–	–	–	–	–
FSE-B10	Tracking Generator	1066.4769.02	9 kHz to 7 GHz	–	–	•	•	–	•	–	•
FSE-B11	Tracking Generator	1066.4917.02	9 kHz to 7 GHz	–	–	•	•	–	•	–	•
FSE-B12	Switchable Attenuator	1066.5065.02	9 kHz to 7 GHz	•	•	•	•	–	•	–	•

Permissible combinations of tracking generators and optional switchable attenuator with Spectrum Analyzers FSE
• Permissible combination – Cannot be installed

Versatile measurement functions

- Easy to operate normalization with interpolation
- Normalization for reflection measurements with open or short, or both
- Automatic bandwidth measurement ("n dB down" function)
- Shape factor 60/6 dB or 60/3 dB
- Tolerance limits with PASS/FAIL evaluation
- Level range display up to 200 dB for compensation of frequency responses of even large amplitude variation
- Frequency range settable down to 3 kHz with reduced output level

Specifications in brief

Frequency

Frequency range	
FSE-B8, FSE-B9	9 kHz to 3.5 GHz
FSE-B10, FSE-B11	9 kHz to 7 GHz
Min. start frequency	typ. 3 kHz
Frequency offset	±200 MHz
Spurious responses	
Harmonics (f >50 MHz)	25 dB
Other	30 dB

Level

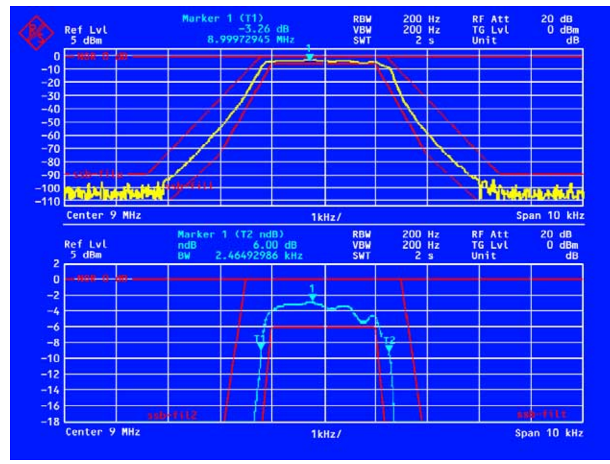
Output level	–20 to 0 dBm (can be set in 0.1 dB steps)
with option FSE-B12	–90 to 0 dBm (can be set in 0.1 dB steps)
Level accuracy	
Frequency response referred to 120 MHz, for sweep time >100 ms and start frequency >2 x RBW and start frequency >SPAN/1000	
Absolute error at 120 MHz, 0 dBm	<1 dB
Without FSE-B12:	
9 kHz to 1 GHz	<2.0 dB
1 GHz to 3.5 GHz	<3.0 dB
3.5 GHz to 7 GHz	typ. <3 dB
Additional frequency response with option FSE-B12:	
9 kHz to 3.5/7 GHz	<1.0 dB

Dynamic and measurement range

Gain measurement range	
Without option FSE-B12	50 dB
With option FSE-B12	120 dB
Attenuation measurement range	
f >10 MHz, RBW = 1 kHz	>90 dB, typ. 120 dB

Modulation

Modulation modes	AM, FM, I/Q (cannot be used simultaneously)
Start frequency	>200 kHz
Amplitude modulation	
Operating mode	EXTERN AM
Modulation depth	0 to 80%
Modulation frequency range	1 kHz to 20 kHz
Frequency modulation	
Operating mode	EXTERN FM
Deviation	max. 1 MHz
Modulation frequency range	1 to 100 kHz with modulation index <2π x 75



Measuring the return loss of a filter (2)

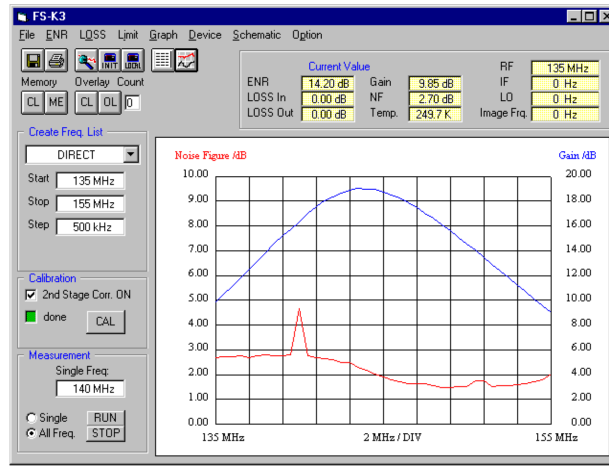
I/Q modulation (with FSE-B9 and -B11 only)

Modulation inputs I and Q	
VSWR	typ. <1.4
Input voltage for 100% modulation	±0.5V
Modulation frequency response	
f_{mod} = DC to 5 MHz	<1dB
f_{mod} = DC to 10 MHz	typ. <1dB

Ordering information

Tracking Generator		
9 kHz to 3.5 GHz	FSE-B8	1066.4469.02
9 kHz to 3.5 GHz, with I/Q Modulator	FSE-B9	1066.4617.02
9 kHz to 7 GHz	FSE-B10	1066.4769.02
9 kHz to 7 GHz, with I/Q Modulator	FSE-B11	1066.4917.02
Switchable Attenuator for Tracking Generators	FSE-B12	1066.5065.02
Extras		
SWR Bridge 40 kHz to 4 GHz	ZRC	1032.9492.52/55
SWR Bridge 50 MHz to 3000 MHz	ZRB2	0373.9017.5x
N Calibration Kit, 0 to 3 GHz, termination, short/open	ZCAN	0800.8515.52/72
Matching Pad 75 Ω, L-section	RAM	358.5414.02
Matching Pad 75 Ω, series resistor 25 Ω	RAZ	0358.5714.02
Extras for I/Q modulation		
Dual Arbitrary Waveform Generator	ADS	1012.4002.02
Software for generation of I/Q signals in conjunction with ADS	IQSIM-K	1013.1642.02

Noise Measurement Software FS-K3



Measurements on a GaAs preamplifier show an anomaly at 140 MHz, whose cause is easily traceable in the spectrum analyzer mode

Outperforming any conventional noise measurement system

Brief description

Spectrum Analyzers FSE and FSP as well as Signal Analyzers FSIQ from Rohde &Schwarz feature high sensitivity and level accuracy – in conjunction with switchable, calibrated noise sources – and are thus ideal for automatic measurement of noise figure and gain. Noise Measurement Software FS-K3 provides the high-grade analyzers with features otherwise only offered by special noise measurement systems. At a given frequency or in a selectable frequency range the following parameters can be measured:

- Noise figure in dB
- Noise temperature in K
- Gain in dB

The combination of Noise Measurement Software FS-K3 and Analyzers FSE, FSIQ or FSP offers the following advantages over conventional noise measurement systems:

- Frequency range up to 26.5 GHz (depending on analyzer model) for noise measurements in the microwave range without need for an additional downconverter
- Resolution bandwidths variable in steps of 1/2/3/5 (FSP: 1/3) for optimum matching to narrowband DUTs

Measurements on frequency-converting DUTs, eg low-noise converters
FS-K3 allows the noise figure and the gain for instance of LNCs for direct satellite reception to be measured without any problems despite the great frequency difference of typ. 10 GHz between the input and output. A particular asset in these measurements is the extremely wide dynamic range, allowing the direct determination of gain values up to 60 dB.

Specifications

Frequency range	100 kHz to 26.5 GHz (depending on analyzer model)
Measurement bandwidth	1 kHz to 5 MHz
Noise measurements	
Level range	0 to 25 dB
Resolution	0.01 dB
Measurement accuracy	±0.2 dB (preamplification 20 dB, noise figure 5 dB, bandwidth 1 MHz)
Gain measurements	
Level range	0 to 60 dB
Resolution	0.01 dB
Measurement accuracy	±0.2 dB (preamplification 20 dB, noise figure 5 dB, bandwidth 1 MHz)
Required hardware and software	
Analyzers	FSEA, FSEB, FSEM, FSIQ3, FSIQ7, FSIQ26 or FSP3, FSP7, FSP13, FSP30
Recommended noise source	NoiseCom 346 (on request)
Power supply	via 28 V connector on rear panel of FSE/FSIQ/FSP (BNC)
Preamplifier	gain approx. 20 dB, noise figure max. 5 dB
Control via external PC/IEEE bus	
CPU	80 486 or better
RAM	≥4 Mbyte
Graphics card	VGA or better
Software	Windows 3.x, 95/98/NT
Interface	IEC 625-1 (IEEE 488)
Interface card	National Instruments AT/TNT/PC card
Control via Spectrum Analyzer	
FSE	Computer Function FSE-B15 (DDE interface of Windows)
FSIQ	no options required
FSP	keyboard PSP-Z2

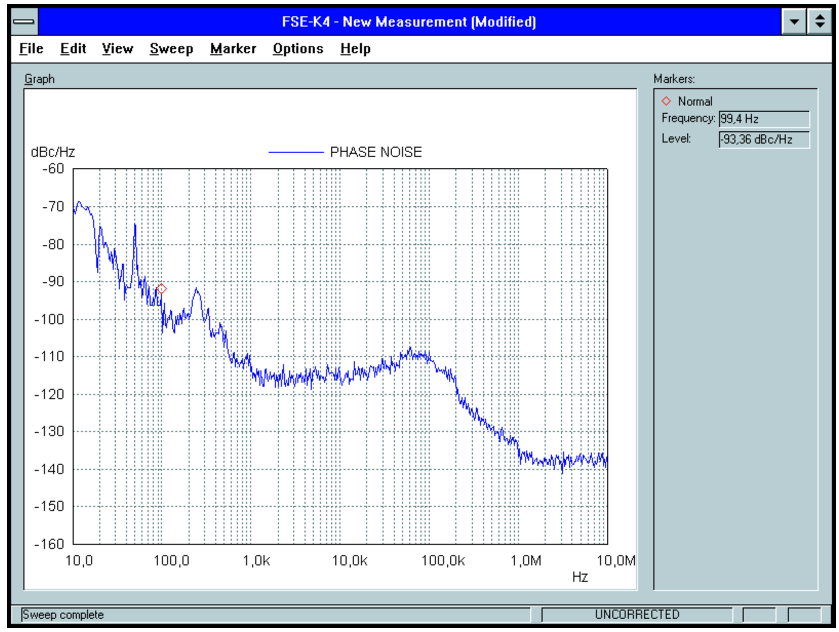
Ordering information

Noise Measurement Software	FS-K3	1057.3028.02
Options		
Computer Function for FSE (Window NT)	FSE-B15	1073.5696.06
2nd IEEE/IEC bus Interface	FSE-B17	1066.4017.02
Noise source	on request	

Note: FSE with FSE-B15 or FSIQ requires the optional 2nd IEEE/IEC bus interface to control a signal generator (eg SMIQ) in case of mixer measurements.

Phase Noise Measurement Software FS-K4

Phase noise measurements with Spectrum Analyzer FSE



Brief description

Phase Noise Measurement Software FS-K4 extends the measurement capabilities of Rohde&Schwarz Spectrum Analyzer FSE to give a phase noise tester. FSE is ideal for this purpose because of its low inherent phase noise and noise figure.

Main features

- Free editable sweep settings
- Fast residual FM/PM measurements
- Comprehensive marker functions
- Storage of results and settings
- Detailed screen printouts

Specifications

Averaging

RBW/VBW ratio in video averaging	1:10, 1:1, 10:1
Trace averaging	implemented
Smoothing window	1 to 199 points

Carrier offset frequency range/number of decades
The maximum number of representable decades in a phase noise graph is defined by the carrier offset frequency range.

Analyzer model	FSEA20 FSEB20	FSEA30 FSEB30	FSEM20 FSEK20	FSEM30 FSEK30
Lower offset limit	100 Hz	10 Hz	100 Hz	10 Hz
Upper offset limit	1 GHz	1 GHz	10 GHz	10 GHz
Max. number of decades	7	8	8	9

Nominal measurement accuracy (RSS error, 95% confidence level)
Minimum phase noise level 95 dB below reference level, FFT deactivated, return loss of source >14 dB (VSWR <1.5 : 1), signal to noise ratio ≥10 dB

Signal level <7 dBm

Center frequency	≤3.5 GHz	≤7 GHz	≤18 GHz	≤26.5 GHz	≤ 40 GHz
Offset ≤10 MHz	1.9 dB	1.9 dB	2 dB	2 dB	2 dB
Offset >10 MHz	2.2 dB	2.2 dB	2.9 dB	3.4 dB	3.9 dB

Signal level >7 dBm

Center frequency	≤3.5 GHz	≤7 GHz	≤18 GHz	≤26.5 GHz	≤40 GHz
Offset ≤10 MHz	1.5 dB	1.6 dB	1.9 dB	1.9 dB	1.9 dB
Offset >10 MHz	1.8 dB	2 dB	2.9 dB	3.4 dB	3.9 dB

Repeatability (95% confidence level) ±0,8 dB
RBW/VBW 10:1,Trace Averaging <15, smoothing window ≥9

System phase noise
A systematic measurement uncertainty is introduced by the inherent phase noise of the measuring instrument.

System Requirements

Control via external PC/IEEE bus	CPU 486 or better, RAM ≥ 8 MB, Windows 3.1/3.11/95/98/NT4.0, IEE488 interface, AT/TNT/PCMCIA IEEE card
Control via FSE	Controller FSE-B15 for FSE

Ordering Information

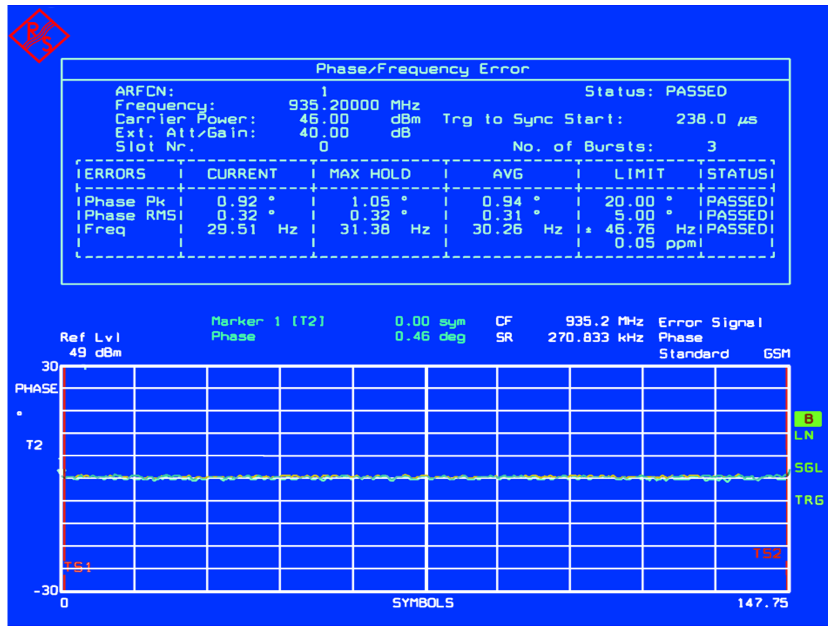
Phase Noise Measurement Software	FS-K4	1108.0088.02
Recommended Options		
Low Phase Noise and OCXO (for models .20)	FSE-B4	1073.5396.02
FFT Filter 1 Hz to 1 kHz (for models .20)	FSE-B5	1073.5544.02
Enhanced Level Measurement Certainty	FSE-B22	1106.3480.02

Application Firmware FSE-K10/FSE-K11

GSM transmitter measurements conforming to standards:

FSE-K10 for mobile phones

FSE-K11 for base stations



Measurement of phase/frequency error

Brief description

Spectrum Analyzers FSE with their wide dynamic range and high accuracy, together with optional Vector Signal Analyzer FSE-B7, are ideal for GSM transmitter measurements in development and production. Application Firmware Modules FSE-K10 and FSE-K11 now further simplify operation: complex measurements can be performed exactly in line with standards at a keystroke. The modules take into account all requirements and settings for GSM900, GSM1800 (phase I and phase II) and GSM1900.

Operation follows the sequence of measurements as specified in the standards.

Fitted with the application firmware, Spectrum Analyzer FSE automatically sets the frequency limits, measurement bandwidths, sweep times and detectors required for a given standard and the associated measurements. FSE compares results with specified limit values and verifies their compliance.

FSEM covers the frequency range up to 27 GHz, which allows the measurement of spurious through to 12.75 GHz.

Main features

- Measurement of RF parameters for GSM900, GSM1800 and GSM1900 in line with:
  - GSM 11.10
  - GSM 11.10-1
  - GSM 11.20
  - GSM 11.21
  - J-STD 007 Air Interface
  - R-GSM
- Firmware modules FSE-K10 and FSE-K11 can be fitted to all models of the FSE family

Covered standards

Standards	FSE-K11 (for base stations)	FSE-K10 (for mobile phones)
P-GSM900, Phase I	GSM 11.20	GSM 11.10
GSM1800	GSM 11.20-DCS	ETS300020-3
GSM900/1800, Phase II	GSM 11.21	ETS300067-1/GSM 11.10-1
GSM1900	J-STD-007 Air Interface	J-STD-007 Air Interface
R-GSM, GSM1800, Phase II+	GSM 11.21	GSM 11.10-1

Application Firmware FSE-K10/FSE-K11

Measurement functions with or without option Vektor Signal Analysis FSE-B7

Measurements	FSIQ	FSEx with FSE-B7	FSEx w/o FSE-B7
Phase/frequency error	✓	✓	–
Mean carrier power with synchronization to midamble	✓	✓	–
Mean carrier power without synchronization to midamble	✓	✓	✓
Transmitted power versus time (burst timing) with synchronization to midamble	✓	✓	–
Transmitted power versus time (burst timing) without synchronization to midamble	✓	✓	✓
Spectrum due to modulation	✓	✓	✓
Spectrum due to transients	✓	✓	✓
Spurious emissions	✓	✓	✓

Specifications in brief

and with options FSE-B7 and FSE-K10 or FSE-K11

Values in [ ] apply to FSE with optional Increased Level Accuracy FSE-B22 fitted and to FSIQ models.

Measurements with	FSEA30, FSIQ3	FSEB/M/K30, FSIQ7/26/40
Phase measurement error rms value	≤0.5°	≤0.7°
peak value	≤1.5°	≤2.1°
Frequency measurement error	1.45 Hz + error of reference frequency relative to carrier	
Mean carrier power versus time		
Measurement error absolute	<0.9 dB [<0.6 dB]	<0.9 dB [<0.6 dB]
relative	<0.55 dB [<0.3 dB]	<0.55 dB [<0.3 dB]
Transmitted power versus time		
Error of 0 dB reference level	<0.9 dB [<0.6 dB]	<0.9 dB [<0.6 dB]
Relative error of reference level, relative to reference level	<0.3 dB (0 to –50 dB), <0.5 dB (–50 to –70 dB)	
Trigger error (with synchronization to midamble)	±0.25 µs [±1/16 bit]	±0.25 µs [±1/16 bit]
Dynamic range (resolution bw 300 kHz)	75 dB	73 dB
Spectrum due to modulation		
Level measurement error absolute, relative to reference level	<0.9 dB [<0.6 dB] (0 to –50 dB), <1 dB (–50 to –70 dB), <1.4 dB (–70 to –95 dB)	
Level measurement error relative		
Δf ≤0.1 MHz	<0.3 dB	<0.3 dB
0.1 MHz ≤Δf ≤1.8 MHz, level difference <50 dB	<0.45 dB	<0.45 dB
1.8 MHz ≤Δf ≤6 MHz, level difference ≥50 dB	<1.3 dB	<1.3 dB
Δf ≥6 MHz	<1.3 dB	<1.3 dB
Dynamic range (carrier power 46 dBm) Frequency offset		
200 kHz	78 dB	72 dB
250 kHz	78 dB	72 dB
400 kHz	82 dB	76 dB
600 kHz	87 dB	81 dB
1200 kHz	93 dB	87 dB
1800 kHz	94 dB	88 dB
1800 to 6000 kHz (resolution bandwidth 100 kHz)	90 dB	84 dB
>6 MHz (resolution bandwidth 100 kHz), transmit band	91 dB	87 dB
Spectrum due to transients		
Level measurement error absolute	<0.9 dB [<0.6 dB]	<0.9 dB [<0.6 dB]
relative, level difference <50 dB	<0.45 dB	<0.45 dB
≥50 dB	<1.2 dB	<1.2 dB
Dynamic range (carrier power 46 dBm)		
400 kHz	76 dB	70 dB
600 kHz	81 dB	75 dB
1200 kHz	87 dB	81 dB
1800 kHz	91 dB	85 dB
Spurious emissions		
In transmit band:		
Level measurement error	<1.75 dB [<1.3 dB]	<1.75 dB [<1.3 dB]
Noise floor (peak value) (resolution bandwidth 100 kHz, 46 dBm transmit power)	–40 dBm	–38 dBm
Outside transmit and receive band:		
Level measurement error f ≤2 GHz	<1.75 dB [<1.3 dB]	<1.75 dB [<1.3 dB]
2 GHz <f ≤4 GHz	<1.75 dB (up to 3.5 GHz)	<2.15 dB (up to 7 GHz)
f >4 GHz (up to 12.75 GHz with FSEM/FSEK)	–	<2.2 dB
Noise floor (peak value) (resolution bandwidth 3 MHz, 46 dBm transmit power)	–37 dBm	–35 dBm
In receive band (carrier suppression >25 dB):		
Level measurement error	<1.5 dB	<1.5 dB
Sensitivity (noise indication averaged over 200 sweeps)	–107 dBm	–105 dBm

Ordering information

Application Firmware

for tests on

GSM mobile phones	FSE-K10	1057.3092.02
GSM base stations	FSE-K11	1057.3392.02

The 5-pole resolution filters stipulated by standards are included in all .30 FSE models; .20 models are equipped with 4-pole resolution filters.

Options

Increased Level Accuracy up to 2 GHz for FSE (factory-fitted)	FSE-B22	1106.3480.02
Vector Signal Analyzer	FSE-B7	1066.4317.02

These options are already fitted with Signal Analyzers FSIQ.

Signal Analyzer FSIQ

FSIQ3: 20 Hz to 3.5 GHz

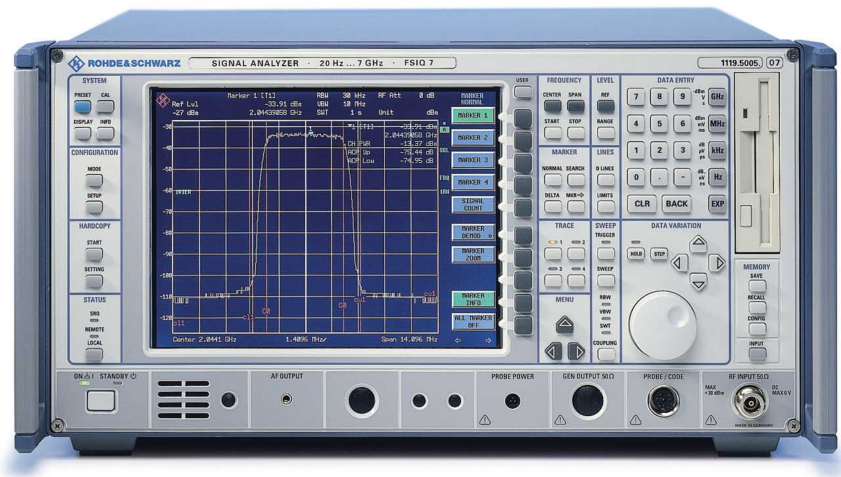
FSIQ7: 20 Hz to 7 GHz

FSIQ26: 20 Hz to 26 GHz

FSIQ40: 20 Hz to 40 GHz

75 dB ACPR for W-CDMA

The one box solution in signal analysis



FSIQ7 (photo 43185-3)

Brief description

FSIQ provides in a single unit comprehensive and easy-to-use measurement functions in the frequency time and modulation domain.

Frequency domain

In the frequency domain, FSIQ measures intermodulation and harmonics with great accuracy. The high 3rd-order intercept point in conjunction with the extremely low noise floor yields an intermodulation-free dynamic range of >110 dB and ensures reliable performance of even sophisticated measurements. The excellent dynamic range and the optimized phase noise values make the FSIQ an ideal tool for ACPR (adjacent channel power ratio) measurements in all mobile radio systems and in particular for W-CDMA. The maximum ACPR value for W-CDMA in 4.096 MHz bandwidth is 75 dB and is already attained at –12 dBm input level.

The RMS detector available for all bandwidths up to 10 MHz is the ideal tool for precise power measurements whatever the waveform. Channel power and adjacent-channel power can accurately be measured and displayed irrespective of any signal statistics. Typical measurement problems such as the high and uncertain crest factor in CDMA systems can thus be eliminated and the true RMS value be displayed.

Time domain

In the time domain, FSIQ features all modern capabilities of burst analysis in TDMA systems; gate functions, trigger delay and integrated RF trigger in conjunction with a short sweep time of 1 µs ensure precise measurement of the timing characteristics from signals of all main mobile radio systems.

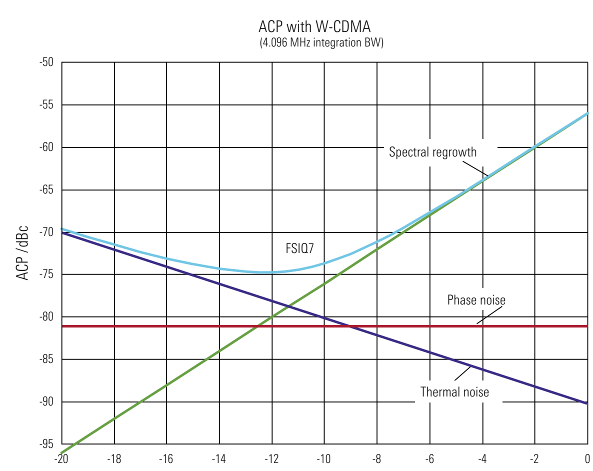
Thanks to the wide range of bandwidths available up to 10 MHz the effect of the measuring instrument becomes negligible – in particular in the case of measurements on broadband systems.

Various marker functions in conjunction with editable gated sweeps allow RMS, average and peak measurements to be carried out over any selectable time.

Modulation domain

In the modulation domain, the integrated vector signal analyzer provides diverse measurements on signals with digital or analog modulation. The variety of settings that can be called simply at a keystroke covers 18 mobile radio standards from GSM, NADC, IS-95 through to W-CDMA. These convenient presettings make it superfluous for the user to spend valuable time in looking up specifications and go towards enhancing the measurement reliability.

Display of the results caters to practically each and every need: in addition to vector and constellation diagrams, I/Q signal and eye/trellis diagrams, tables with



Signal Analyzer FSIQ

modulation errors including the demodulated bit sequence are particularly useful. EVM (error vector magnitude), phase and frequency error,waveform factor and I/Q offset are output as numeric values, with RMS and peak value being shown separately.

Besides the mobile radio standards, FSIQ can also be used as a general- purpose measurement demodulator for non-standard modulation methods. The list of the 13 digital demodulators available ranges from BPSK, QPSK and (G)MSK through to 16QAM. With a symbol rate selectable up to 6.4 Msymbol/s and cosine and root-cosine filters adjustable in 0.01 step width, configuration of customized systems is no problem.

Main features

Spectrum analysis

- Spectrum analysis with ultra-wide dynamic range for sophisticated ACPR measurements: NF = 18 dB/TOI = +20 dBm (FSIQ7); figure of merit
- 75 dB ACPR dynamic range for W-CDMA (4.096 MHz integration bandwidth)
- 82 dB ACPR in 4.096 MHz integration bandwidth for alternate channel
- Total measurement uncertainty <1 dB up to 2.2 GHz, <1.5 dB up to 7 GHz
- Resolution bandwidth 1 Hz to 10 MHz in 1/2/3/5 steps
- 5-pole resolution filters with high selectivity
- FFT filter with 1 Hz to 1 kHz RBW for fast measurements
- Displayed average noise floor typ. –150 dBm in 10 Hz bandwidth

Vector signal analysis

- Integrated vector signal analyzer for universal analysis of digital and analog modulated signals BPSK to 16QAM, (G)MSK, AM, FM, PM
- Vector signal analyzer for W-CDMA
- Symbol rate up to 6.4 Msymbol/s

General-purpose signal analysis

- High-speed synthesizer with 5 ms sweep time for FULL SPAN (FSIQ3/7)
- Fast time domain analysis with 1 µs zero span sweep time
- True RMS detector for precise and repeatable measurements of any signal type
- High display update rate up to 25 sweeps/s
- Large colour display with high resolution (24 cm/9.5" TFT)

Specifications in brief

Common data

Aging per day	$1\cdot 10^{-9}$
Aging per year[1)]	$2\cdot 10^{-7}$
Marker resolution	0.1 Hz to 10 kHz (dependent on span)
Frequency counter resolution	0.1 Hz to 10 kHz (selectable)
Display range for frequency axis	0 Hz, 10 Hz to full span
Display range with digital demodulation	
Number of displayed symbols	
Symbol rate ≤1 MHz	max. 1600 symbols (4 points per symbol)
Symbol rate >1 MHz to <3.2 MHz	½ x symbol rate / MHz x 1000 symbols in steps of 100 symbols
Symbol rate ≥3.2 MHz	max. 1600 symbols (4 points per symbol)
Display range with analog demodulation	(3500/demodulation bandwidth/Hz) s
Sweep	
Display range 0 Hz	1 µs to 2500 s in 5% steps
Display range ≥10 Hz	5 ms to 16 000 s in steps ≤10%
Sampling rate	50 ns (20 MHz A/D converter)
Number of pixels(x axis)	500

Resolution bandwidths with spectrum display	
Analog filter	
3 dB bandwidths	1 Hz to 10 MHz in 1/2/3/5 steps
Shape factor 60:3 dB	
<1 kHz	<6
1 kHz … 2 MHz	<12
>2 MHz	<7
Video bandwidths	1 Hz to 10 MHz in 1/2/3/5 steps
FFT filter	
3 dB bandwidths	1 Hz to 1kHz in 1/2/3/5 steps
Shape factor 60:3 dB	2.5 nominal
Max. display range	100 dB
Inherent spurious response	< –100 dBm
Level	
Display range	noise floor displayed to 30 dBm
Maximum input level	
RF attenuation 0 dB	
DC voltage	0 V
CW RF power	20 dBm (= 100 mW)
Pulse spectral density	97 dBµV/MHz
RF attenuation ≥10 dB	
DC voltage	0 V
CW RF power	30 dBm (=1W)
Max. pulse voltage	150 V
Max. pulse energy (10 µs)	1mWs (FSIQ3/7) 0.5 mWs (FSIQ26/40)

Signal Analyzer FSIQ

1 dB compression of input mixer (0 dB RF attenuation)

Intermodulation	+10 dBm nominal at f >150 MHz

Level display

Screen	500 x 400 pixel (one diagram), max. 2 diagrams with independent settings
Log level axis	10 to 200 dB, in steps of 10 dB
Linear level axis	10% of reference level per level division, 10 divisions or logarithmic scaling
Trace	max. 4 (with two diagrams on screen, max. 2 per diagram)
Trace detector	Max Peak, Min Peak, Auto Peak (Normal), Sample, RMS, Average
Trace functions	Clear/Write, Max Hold, Min Hold, Average

Setting range of reference level

Logarithmic level display	–130 dBm to 30 dBm, in steps of 0.1 dB
Linear level display	7.0 nV to 7.07 V in steps of 1%
Units of level axis	dBm, dBµV, dBmV, dBpW (log level display) V, A, W, dBµA (linear level display)

Total measurement error (0 to –50 dB, span/RBW <100) (rss, 95% confidence level)

< 2.2 GHz	<1 dB
2.2 GHz to 3.5/7 GHz	<1.5 dB
7 GHz to 18 GHz	<2.5 dB
18 GHz to 26.5 GHz	<3 dB

Measurement of digital modulation signals

Modulation formats
BPSK, QPSK, Offset QPSK, DQPSK, π/4DQPSK, 8PSK, D8PSK, 3π/8-8PSK,16 QAM, MSK, GMSK, 2FSK, 2GFSK, 4FSK, 4GFSK
Selectable Standards
W-CDMA, 3GPP, IS-95 CDMA forward/reverse, GSM, EDGE, NADC, TETRA, PDC, PHS,CDPD, DECT, PWT, APCO25, CT2, ERMES, FLEX, MODACOM,TFTS

Filters

Filtering	raised cosine,square root raised cosine, Gaussian
Setting range α/B x T	0.14 to 1 in steps of 0.01
Filters to specific standards	
FLEX	Bessel B x T = 1.22 and 2.44
ERMES	Bessel B x T = 1.25
IS 95 CDMA	forward and reverse channel
APCO 25 FM	
EDGE	weighting filter

Symbol rate

Symbol rate	320 Hz to 6.4 MHz (symbol rate x (1+ α)) < 8 MHz
Samples/symbol	
Symbol rate ≤200 kHz	1, 2, 4, 8, 16
200 kHz < Symbol rate ≤400 kHz	1, 2, 4, 8
Symbol rate >400 kHz	1, 2, 4
Synchronization	internal to symbol clock and frequency/ phase

Level measurements with digital demodulation

Peak power range	–60 dBm to +30 dBm
Absolute level error	
Mean power(0 dB to –10 dB below reference level)	
f ≤ 2.2 GHz	1 dB
2.2 GHz to 7 GHz	1.5 dB
7 GHz to 18 GHz	2.5 dB (FSIQ7/26)
18 GHz to 26.5 GHz	3 dB (FSIQ7/26)

Dynamic range for burst measurement

(mean power, ref. level ≥10 dBm, power = ref. level +1 dB, low-noise mode, points/symbol <4, nominal values	W-CDMA	60 dB
	GSM	74 dB
	NADC	78 dB
	TETRA	79 dB

Time reference (nominal)

without clock synchronization	
MSK/GMSK modulation,	<1/(2 x symbol rate · points/symbol)
PSK/QAM/FSK modulation	<1/(2 x symbol rate)
with clock synchronization	<0.001 x 1/(symbol rate)

Residual error in modulation measurements

(data valid for level from reference level — 6 dB, S/N >60 dB, α/BT = 0.3 to 0.7, number of demodulated symbols >100, averaging ≥10, analog bandwidth >10 x symbol rate, input frequency >15 x symbol rate, local suppression at 0 Hz input frequecy adjusted), symbol rate (1+α) ≤ 8 MHz

Frequency error	± (symbol rate × 5 × 10-6 + 0.1 Hz + reference error × carrier frequency)
I/Q offset error	0.2% (–54 dB)

Error with modulation standard

GSM900/1800/1900	phase error ≤0.5° rms, typ. <1.5° peak
NADC, CDPD	EVM ≤0.5% rms, typ. <1.5% peak
TETRA, PDC, PHS	EVM ≤0.7% rms, typ, <2% peak
PWT	EVM ≤1% rms, typ. <3% peak
IS-95 CDMA,	forward/reverse channel ρ factor ≥ 0.9995
W-CDMA	EVM ≤1.8% rms, typ. <5% peak

Measurement of analog modulation signals

Demodulation bandwidth	
Realtime demodulation	5 kHz to 200 kHz in steps of 1,2,3,5
Offline demodulation	5 kHz to 5 MHz in steps of 1,2,3,5
Demodulation length (max. sweep time)	3500/(demod. bandwith/Hz) s

Readout
Trace with AF signal, carrier power (AM DC-coupled), or modulation summary (table) with numerical display of: peak and rms values of modulation depths or deviations of main demodulation;
SINAD value 1 kHz (only with realtime demodulation); AF frequency; carrier power; peak values of incidental modulation

The following specifications are valid for demodulation bandwidth ≤2 MHz, resolution bandwidth ≥5 x demodulation bandwidth, RF input level ≤–10 dBm, reference level setting = peak input level + 0 to +6 dB.

Amplitude demodulation

Range	up to 100%
AF	
Offline demodulation	0.001 to 0.2 x demod. BW
Realtime demodulation	30 Hz to 0.2 x demod. BW, max. 20 kHz

Signal Analyzer FSIQ

Frequency demodulation

Deviation range	max. 0.4 x demodulation bandwidth
AF	
Offline demodulation	DC/0.001to 0.2 x demod. bandwidth
Realtime demodulation	DC/30 Hz to 0.2 x demodulation bandwidth, max. 20 kHz

Phase demodulation

Deviation range	up to 10 rad
AF Offline demodulation	DC/0.001 to 0.1 x demodulation bandwidth <(0.4 x demod. BW)/(phase deviation/rad)
Realtime demodulation	200 Hz to 0.1 x demod. BW, max. 15 kHz < (0.4 x demod. BW)/(phase deviation/rad), smaller limit values apply

Measurement of unmodulated carrier power

Measurement error, (ref. level to ref. level –30 dB)	1.5 dB

SINAD measurements

Realtime demodulation, AF = 1 kHz ± 4 x 10^{-4} x demod. BW	
Error with 6 to 54 dB SINAD	±1 dB + error due to demodulator SINAD

Display of AF frequencies

Range	
Offline demodulation	0.001 to 0.3 x demodulation bandwidth
Realtime demodulation max. 20 kHz	30 Hz to 0.3 x demodulation bandwidth
Resolution	1 mHz to 1 Hz
Error (S/N ≥40 dB)	1 · 10^{-6} x demod.BW + error of reference frequency +1 mHz ±1 digit
AF filters	
Realtime demodulation	
Lowpass	3 kHz, 15 kHz (Butterworth, 12 dB/oct.)
Highpass	30 Hz, 300 Hz (6 dB/oct.)
Weighting filters	CCITT P.53, C message
Offline demodulation	
Lowpass (12 dB/oct.)	5%, 10%, 25% of demod. bandwidth

Audio demodulation

Modulation modes	AM and FM
Audio output	speaker and phone jack
Marker stop time in spectrum mode	100 ms to 60 s
Squelch	adjustable with level line

Trigger functions

Trigger Span ≥10 Hz	free run, line, video, RF level, external
Span = 0 Hz	plus pretrigger, posttrigger, trigger delay
with digital demodulation	plus burst trigger and synchronization to bit sequence (max. 32 symbols)
with analog demodulation	plus trigger to demodulated AF
Gated sweep, trigger source	external, RF level
Gate delay	1 µs to 100 s
Gate length	1 µs to 100 s, resolution min. 1 µs or 1% of gate length
Error of gate length	±(1 µs + (0.05% x gate length))

Inputs and outputs (front panel)

RF input	N female, 50 Ω
FSIQ26 only	adapter system, 50 Ω, N/3.5 mm male and female
FSIQ40 only	adapter system, 50 Ω, N and K (male and female), 2,4-mm female
VSWR (RF attenuation >0 dB)	<1.5 (f <3.5 GHz)
Attenuator	0 dB to 70 dB, switchable in 10 dB steps
Probe power supply	+15/–12.6 V DC, max. 150 mA
Supply and coding connector for antennas, etc)	±10 V, max. 100 mA, ground
AF output	Z_{out} = 10 Ω, JK34 jack
Reference frequency	
Output, usable as input	BNC female, 10 MHz, 10 dBm nom.
Input	1 MHz to 16 MHz, >0 dBm from 50 Ω
Sweep output	BNC female, 0 V to +10 V, proportional to displayed frequency
Power supply for noise source	BNC female, 0 V and 28 V, switched
External trigger/gate input	BNC female, >10 kΩ –5 V to +5 V, adjustable
IEEE/IEC bus remote control	IEC 625-2 (IEEE 488.2), SCPI 1994.0
Serial interface	RS-232-C (COM1 and COM2)
Mouse interface	PS/2 compatible
Printer interface	parallel (Centronics compatible) or serial (RS-232-C)
Keyboard connector	5-pin DIN female for MF2 keyboard
User interface	25-pin Canon female
Connector for external monitor (VGA)	15-pin female

Model-dependent data

3rd-order intermodulation

Intermodulation-free dynamic range,
level 2 x –20 dBm, Δf >5 x RBW or 10 kHz, whichever is the greater value

FSIQ3	>64 dBc for f >100 MHz (TOI >12 dBm, typ. 18 dBm)
FSIQ7	>70 dBc for f >150 MHz (TOI >15 dBm, typ. 20 dBm)
FSIQ26/40	>74 dBc for f >150 MHz (TOI >17 dBm, typ. 22 dBm) >60 dBc for f >7 GHz (TOI >10 dBm)

Intercept-Punkt K2	>25 dBm, typ. >35 dBm for f <150 MHz >40 dBm, typ. >45 dBm for f >150 MHz

Spectral purity (dBc/1Hz) SSB phase noise, f ≤500 MHz, for carrier offset >1 MHz see diagram below

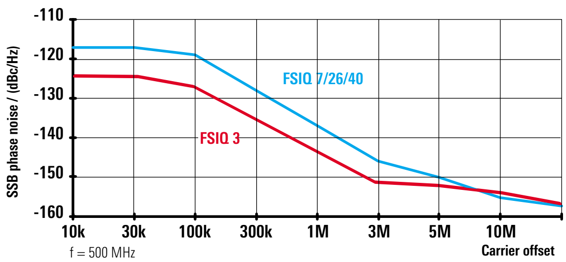
Carrier-Offset	FSIQ3	FSIQ7	FSIQ26	FSIQ40
100 Hz	<–87	<–81	<–81	<–81
1 kHz	<–107	<–100	<–100	<–100
10 kHz	<–120	<–114	<–114	<–114
100 kHz [1]	<–119	<–113	<–113	<–113
1 MHz [1]	<–138	<–132	<–132	<–132

Displayed average noise level (DANL)
(0 dB RF attenuation, RBW10 Hz,
VBW = 1 Hz, 20 averages, trace average, span 0 Hz, termination 50 Ω)

	FSIQ3	FSIQ7	FSIQ26	FSIQ40
10 MHz to 6 GHz	<–145, typ. –150	<142, typ. –147	<–138, typ. –140	<–138, typ. –140
6 GHz to 7 GHz	–	<–139	<–135, typ. –138	<–135, typ. –138
7 GHz to 18 GHz	–	–	<–138, typ.–140	<–134, typ.–139
18 GHz to 26,5 GHz	–	–	<–135, typ. –138	<–131, typ. –136
26,5 GHz to 30 GHz	–	–	–	<–120, typ. –125
30 GHz to 40 GHz	–	–	–	<–116, typ. –122

1) Values valid for span >100 kHz.

Signal Analyzer FSIQ



Typ. phase noise for FSIQ 3 (red) and FSIQ 7/26/40 (blue)

Maximum dynamic range
1 dB compression to DANL (1 Hz)

	FSIQ 3	FSIQ 7	FSIQ 26	FSIQ 40
	170 dB	165 dB	165 dB	160 dB

Inherent error on modulation measurements
General modulation modes (except FSK)
Error vector magnitude (EVM) and magnitude error (f < 1 GHz) 1)

Symbol rate 1)	FSIQ 3	FSIQ 7/26/40
≤30 kHz	0.5% rms	0.7% rms
30 kHz to 300 kHz	1% rms	1.4% rms
300 kHz to 1 MHz	2% rms	2.8% rms
1 MHz to 4.2 MHz	2% rms	2% rms
4.2 MHz to 6.4 MHz	2.4% rms	2.4% rms
Phase error (f<1 GHz) 2)		
Symbol rate		
≤30 kHz	0.3° rms	0.4° rms
30 kHz to 300 kHz	0.5% rms	0.7% rms
300 kHz to 1 MHz	1.5% rms	2% rms
1 MHz to 4.2 MHz	1.5% rms	2% rms
4.2 MHz to 6.4 MHz	2% rms	2.8% rms

General data

Display	24 cm colour display TFT (9.5")
Resolution	640 x 480 pixels (VGA resolution)
Mass memory	1.44 Mbyte 3½" FDD, hard disk
Rated temperature range	+5°C to +40°C
Power supply	200 V to 240 V: 50 Hz to 60 Hz, 100 V to 120 V: 50 Hz to 400 Hz,
Power consumption	195 VA to 245 VA (depends on model)
Dimensions (W x H x D)	
FSIQ 3/7	435 mm x 236 mm x 460 mm
FSIQ 26	435 mm x 236 mm x 570 mm
Weight	24 kg to 27.1 kg (depends on model)

Ordering information

Signal Analyzer

20 Hz to 3.5 GHz	FSIQ3	1119.5005.13
20 Hz to 7 GHz	FSIQ7	1119.5005.17
20 Hz to 26.5 GHz	FSIQ26	1119.6001.27
20 Hz to 40 GHz	FSIQ40	1119.6001.40

Accessories supplied

FSIQ3/7/26	keyboard, mouse, power cable, operating manual, fuses, Windows NT 4.0
FSIQ26	Testport ad. 3,5-mm female– 1021.0512.00 Testport ad. N female– 1021.0535.00
FSIQ40	Testport adaptor N male– 1036.4783.00 K male – 1036.4802.00 2,4-mm female FSE-Z5 1088.1627.02

Options, Software (Windows)

7 GHz Frequency Extension for FSIQ 3	FSE-B2	1073.5044.02
Tracking Generator 3.5 GHz	FSE-B8 3)	1066.4469.02
Tracking Generator 3.5 GHz with I/Q modulator	FSE-B9 3)	1066.4617.02
Tracking Generator 7 GHz	FSE-B10 4)	1066.4769.02
Tracking Generator 7 GHz witht I/Q modulator	FSE-B11 4)	1066.4917.02
Switchable Attenuator for Tracking Generator	FSE-B12	1066.5065.02
1 dB Attenuator	FSE-B13	1119.6499.02
Ethernet Interface 15-contact, AUI	FSE-B16	1073.5973.02
Thin-wire, BNC	FSE-B16	1073.5973.03
RJ-45 connector	FSE-B16	1073.5973.04
2nd IEEE/IEC Bus Interface	FSE-B17	1066.4017.02
Removable Hard Disk	FSE-B18	1088.6993.02
Second Hard Disk for FSE-B18 (firmware included)	FSE-B19	1088.7248.02
Additional Memory and Compute Power for Firmware FSIQK71	FSIQB70	1119.6747.02
External Mixer Input/Output for FSIQ 26	FSE-B21	1084.7243.02
Noise Measurement Software	FS-K3	1057.3028.02
Phase Noise Measurement Software	FSE-K4	1108.0088.02
GSM Test Software, Mobile	FSE-K10	1057.3092.02
GSM Test Software, BTS	FSE-K11	1057.3392.02
EDGE-Application Firmware, Mobile	FSE-K20 5)	1106.4086.02
EDGE-Application Firmware, BTS	FSE-K21 5)	1106.4186.02
cdmaOne (IS-95) Code-Domain Power	FSIQK71 6)	1126.4498.02
3GPP (BTS, FDD) Code-Domain Power	FSIQK72 5)	1126.4746.02

1) For frequencies >1 GHz the specified values have to be multiplied by $10^{0.552 \times \lg (f/GHz / 1 GHz)}$.

2) For frequencies >1 GHz the specified values have to be multiplied by $10^{0.354 \times \lg (f/GHz / 1 GHz)}$.

3) For FSIQ 3 only.

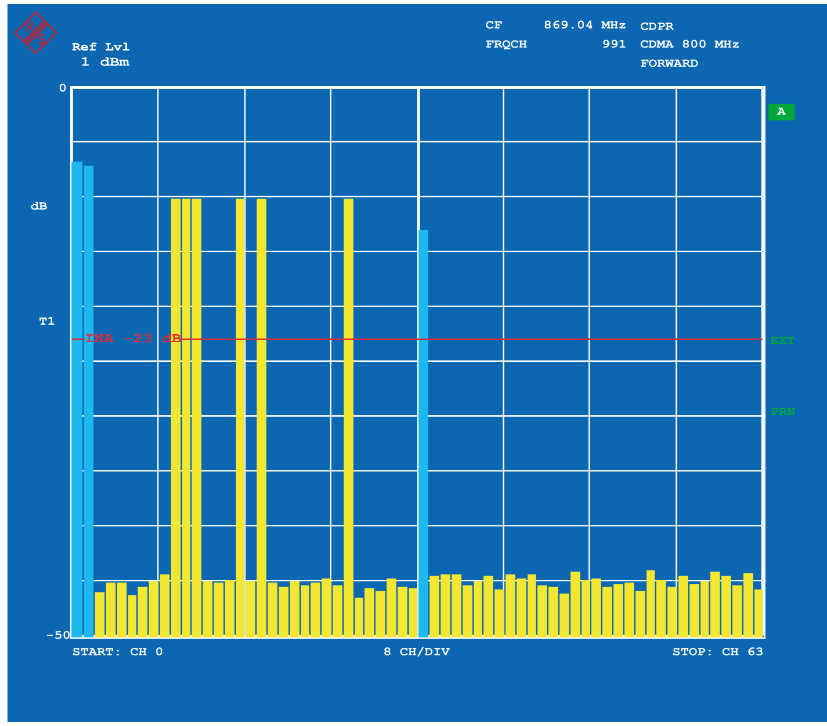
4) For FSIQ 7 and FSIQ 26 only.

5) FSE-K11 or FSE-K11 required.

6) FSIQB70 required.

Application Firmware FSIQK71

cdmaOne code-domain power measurement on base stations with Signal Analyzer FSIQ



Code-domain power: 64 Walsh code channels are displayed simultaneously

Brief description

Application Firmware FSIQK71 for Signal Analyzers FSIQ allows to characterize the Walsh code channels of a CDMA base station to US standards TIA/EIA-97-B/C.

- Simultaneous measurement of code-domain power of 64 channels and bargraph result display
- Measurement of time and phase offset error relative to pilot signal (nominal test case with 9 Walsh code channels)
- Measurement of pilot time alignment
- Easy operation thanks to common menu structure for cdmaOne measurements available in FSIQ

Application Firmware FSIQK71 further extends the wide range of applications offered by the FSIQ models and now even allows code-domain power measurements on cdmaOne signals. Complex tests as those stipulated for CDMA base stations by the TIA/EIA-97-B/C standard can be performed by using FSIQ and FSIQK71.

Application Firmware FSIQK71 also offers a common selection menu for all available cdmaOne measurements, which makes operation a great deal easier. An additional menu provides the functions already implemented in the basic unit for the determination of the channel and adjacent-channel power, and the waveform quality (ρ factor) besides the code-domain power (Table 1).

The powers of the individual code channels are displayed either as a bargraph (64 channels) or in tables (9 channels). The test interval can be selected from 1k chips to 24k chips and is adapted to the S/N ratio of the CDMA signal in the auto mode.

Measurements	Without FSIQK71	With FSIQK71 (FSIQB70 prerequisite)
Total power	✓	✓
ACPR	✓	✓
Pilot channel power	–	✓
Waveform quality (ρ factor)	✓	✓
Forward link frequency tolerance	–	✓
Pilot time tolerance	–	✓
Pilot channel to code channel time tolerance	–	✓
Pilot channel to code channel phase tolerance	–	✓
Code-domain power	–	✓

Measurement functions with and without Application Firmware FSIQK71

Application Firmware FSIQK71

Specifications

Measurements	FSIQ3, FSIQ7, FSIQ26, FSIQ40	Test specifications and permissible measurement uncertainty for measuring equipment to TIA/EIA-97-B/C
Channel power measurement		
Channel bandwidth		
Default	1.23 MHz	
Range	1 kHz to 1000 MHz	
Power range (1.23 MHz bandwidth)	–90 dBm to +30 dBm (S/N ≥10 dB)	–70 dBm to +47 dBm
Absolute error (95% confidence level)		
0 dB to –50 dB from ref. Level	<0.5 dB	±1 dB
Relative error (same channel, input attenuator fixed)		
Input level (ref. level = 0 dB)		
0 dB to –50 dB	<0.3 dB	±1.5 dB
–50 dB to –70 dB	<0.5 dB	
Adjacent-channel power measurement		
Power range at RF input	–50 dBm to +30 dBm	
Dynamic range (nominal, referred to channel power in 1.23 MHz bandwidth)		
Offset frequency / Channel bandwidth		
±750 kHz / 30 kHz	84 dB (–23 dBm mixer level [1])	
±885 kHz / 30 kHz	84 dB (–23 dBm mixer level [1])	
±1.25MHz / 12.5 kHz	87 dB (–24 dBm mixer level [1])	
±1.98MHz / 30 kHz	85 dB (–23 dBm mixer level [1])	
±2.25MHz / 1 MHz	74 dB (–18 dBm mixer level [1])	
Relative ACPR error		
0 dB to –50 dB	<0.3 dB	±1.5 dB
–50 dB to –70 dB	<0.5 dB	
Waveform quality measurement		
ρ factor	≥0.9995	

1) Mixer level = mean power in 1.23 MHz bandwidth at RF input – RF attenuation.

Measurements	FSIQ3, FSIQ7, FSIQ26, FSIQ40	Test specifications and permissible measurement uncertainty for measuring equipment to TIA/EIA-97-B/C
Code-domain power measurement		
Range at RF input (total power)	+30 dBm to –50 dBm	
Test interval range	1024, 2048 to 24k chips	Nx64 chips, N≥20
Code-domain power (test interval 2048 chips/ 1.25 ms)		12.4.2.2
Display dynamic range	10 dB to 100 dB, settable, default 50 dB	
Accuracy (Walsh channel power within 20 dB of total power	±0.3 dB	
Resolution	0.01 dB	
Frequency error	±10 Hz (excludes frequency reference of analyzer)	±10 Hz
Pilot time alignment (from even second trigger to start of PN sequence)		
Range	–13.33 ms to 13.33 ms	
Accuracy	±135 ns	±135 ns
Resolution	10 ns	
Code-domain timing offset (pilot to code-channel time tolerance)		
Range	±50 ns	
Accuracy	±10 ns	±10 ns
Code-domain phase offset (pilot to code-channel phase tolerance)		
Range	±150 mrad	
Accuracy	±10 mrad	±10 mrad

Ordering information

Application Firmware FSIQK71 can be integrated into any member of the FSIQ family. Option FSIQB70, which provides additional memory capacity and a higher computing power, is the precondition to operate the application firmware.

Application Firmware to test cdmaOne base stations	FSIQK71	1126.4498.02
Extensions required to operate Application Firmware FSIQK71	FSIQB70	1119.6747.02

For further options and recommended extensions see FSIQ data sheet (PD 757.4160)

Spectrum Analyzer FSP

The new medium-class standard:

Unparalleled range of functions

High measurement speed

Maximum in precision

Photo 43389-2

Brief description

With the new FSP family, the well-known advantages of high-end Analyzers FSE and FSIQ have been systematically integrated into the medium class of analyzers. FSP sets the standard for the medium class regarding the vital criteria of functionality, measurement speed and accuracy. The use of innovative techniques such as an highly integrated front-end and fully digital signal processing in the back end, together with ASICs developed by Rohde & Schwarz, has resulted in a product of top-class specifications and high reliability.

The FSP option list is short – all important functions and interfaces are implemented as standard. FSP features future-oriented characteristics such as an RMS detector and a CCDF routine for fast statistical measurements on digitally modulated signals not offered by any other medium-class spectrum analyzer.

Main features

The new FSP Spectrum Analyzers from Rohde & Schwarz are outstanding for their innovative measurements and a host of standard functions.
Instead of a wide choice of options, FSP offers as standard all the functions and interfaces you may expect from a state-of-the art spectrum analyzer:

- Largest colour display in its class
- Resolution bandwidths from 1 Hz to 10 MHz
- Highly selective digital and FFT filters
- Quasi-peak detector and EMI bandwidths
- Convenient documentation of results as a hardcopy or file in PC-compatible formats
- Interfaces: GPIB, Centronics, RS232
- Automatic test routines for measuring TOI, OBW, phase noise and ACP(R)
- Split screen with separate settings and up to 3 traces per screen
- Editable limit lines including PASS/FAIL indication
- Fast measurements in the time domain: minimum sweep time 1 µs
- Gated sweep for measurements on TDMA signals

On top of this, FSP features as standard the following unique attributes:

- RMS detector for fast and reproducible power measurements on digitally modulated signals in frequency and time domain
- Statistical measurement functions for determining crest factor and CCDF (complementary cumulative distribution function)

Featuring such a wealth of functions, FSP offers state-of-the-art spectrum analysis at an extremely attractive price-performance ratio.

Speed
Time is a finite resource – so high measurement speed is indispensable for competitiveness and cost-effective testing. Here, too, the new FSP offers characteristics that make it top of the class:

- Up to 30 measurements/s on GPIB interface including trace transfer of 501 binary data
- 70 measurements/s on GPIB interface in zero span mode including trace transfer of 501 binary data
- Minimum sweep time of 2.5 ms
- 1 µs time domain measurements
- Unique fast ACP mode for high-speed ACPR measurements in time domain using the standard-stipulated test filters

With 30 measurements/s in manual operation and digital filters with sweep time 2.5 times faster than comparable analog filters, FSP will also help in your day-to-day work to develop your product much faster.

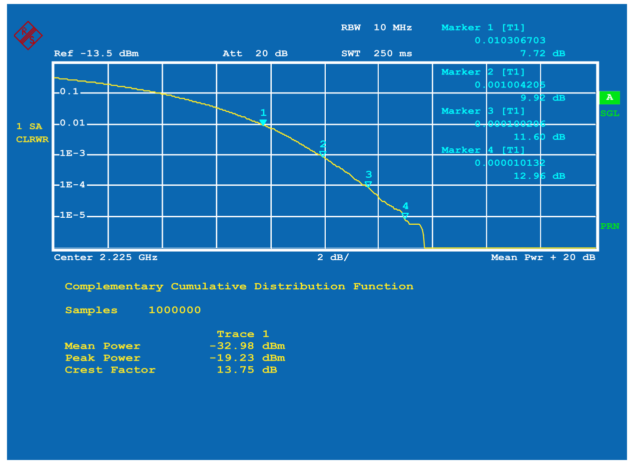
Spectrum Analyzer FSP

Performance
Modern communication systems are required to achieve optimum spectral efficiency at high data rates. For the 3rd generation of CDMA mobile radio systems currently under development this is achieved, among other things, by high-precision power control.

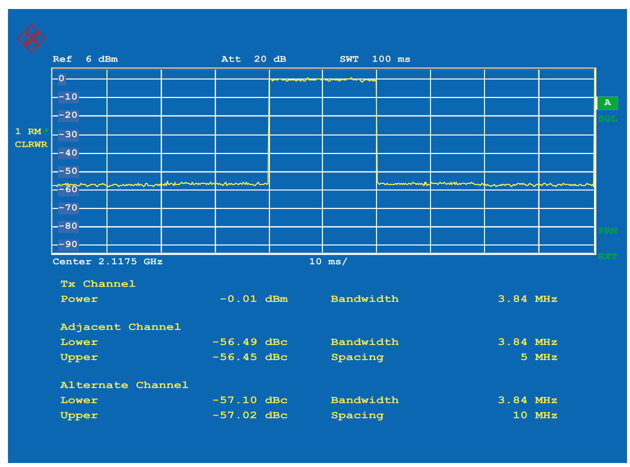
FSP is the ideal partner in development and production, featuring the smallest level measurement uncertainty of all spectrum analyzers on the market, as well as excellent RF characteristics:

- 0.5 dB total measurement uncertainty allows higher tolerances for the DUT, thus increasing production yield
- 0.07 dB linearity uncertainty (1 σ) is ideal for precise measurements, for example of gain control and ACPR
- RMS detector with 100 dB dynamic range measures power fast and accurately irrespective of the signal shape – almost like a thermal power sensor
- The displayed average noise level of typ. –155 dBm (1 Hz) is attained without the use of preamplifiers and thus without any reduction in dynamic range.
- Typ. –145 dBc (1 Hz) phase noise at 10 MHz offset offers optimum conditions for ACPR measurements on W-CDMA systems.

Resolution bandwidths of up to 100 kHz are fully digital and provide – in addition to high selectivity – an ideal basis for accurate (adjacent-) channel measurements thanks to a maximum bandwidth deviation of 3%.



FSP is the first spectrum analyzer to offer statistical analysis of signals by means of the complementary cumulative distribution function (CCDF) as standard and at an impressively high speed. FSP furnishes in only 250 ms the exact CCDF characteristic, average and peak power as well as the crest factor over 1 million measured values



Adjacent-channel power ratio (ACPR) measurements, which many mobile radio standards stipulate for components and units, are implemented in FSP by means of automatic test routines. All settings, measurements and filters required for a selected standard are activated at a keystroke

Open for the PC world ...

- PC-compatible screenshots, no conversion software needed
- Windows™ printer support
- LabWindows driver
- LabView driver
- Software
- SCPI-compatible
- FSE/FSIQ-compatible GPIB command set
- GPIB command set with search function on CD-ROM

Electronic attenuator for high production throughput

The optional Electronic Attenuator FSP-B25 (only for FSP3 and FSP7) supplements the standard mechanical attenuator and provides a wear-and-tear-free setting range of 30 dB in 5 dB steps. The option does away with frequent switching of the mechanical attenuator as called for in high production throughput and so increases the availability and reliability of the measurement facility. The integrated switchable 20 dB preamplifier allows high-sensitivity measurements in the useful frequency range from 10 MHz to 7000 MHz.

Spectrum Analyzer FSP

LAN interface

With the aid of the optional LAN Interface FSP-B16, FSP can be connected to common networks such as 100Base-T so that functions like file logging on network drives or documentation of measurement results via network printer are available. In addition, FSP can be remote-controlled via LAN.

Support

- After-sales service
- 3-year warranty
- 2-year calibration cycle
- Customized training
- Pre-sales support
- Solution-oriented consulting
- Leasing

Specifications in brief

Specifications are guaranteed under the following conditions:
15 minutes warm-up time at ambient temperature, specified environmental conditions met, calibration cycle adhered to, and total calibration performed.
Data without tolerances: typical values only.
Data designated "nominal" apply to design parameters and are not tested.
Data designated "σ = xx dB" are shown as standard deviation.

Frequency		**FSP3**	**FSP7**	**FSP13**	**FSP30**
Frequency range	9 kHz to	3 GHz	7 GHz	13.6 GHz	30 GHz
Frequency resolution		0.01 Hz			
Reference frequency internal (nominal)					
Aging per year[1]		1 x 10^{-6}			
Temperature drift		1 x 10^{-6}			
with option FSP-B4 (OCXO)					
Aging per year[1]		1 x 10^{-7}			
Temperature drift		1 x 10^{-8}			
External reference frequency		10 MHz			
Frequency display		with marker or frequency counter			
Marker resolution		span/500			
Max. deviation (sweep time >3 x auto sweep time)		± (frequency x reference error + 0.5% x span + 10% x resolution bandwidth + ½ (last digit))			
Frequency counter resolution		0.1 Hz to 10 kHz (selectable)			
Count accuracy (S/N >25 dB)		±(frequency x reference error + ½ (last digit))			
Frequency span	0 Hz, 10 Hz to	3 GHz	7 GHz	13.6 GHz	30 GHz
Max. span deviation		0.1%			

Spectral purity (dBc (1 Hz))

SSB phase noise, f = 500 MHz		
Carrier offset	100 Hz	<–84, typ. –90
	1 kHz	<–100, typ. –108
	10 kHz	<–106, typ. –113
	100 kHz[2]	<–110, typ. –113
	1 MHz[2]	<–120, typ. –125
	10 MHz	typ. –145
Residual FM f = 500 MHz, RBW 1 kHz, Sweep time 100 ms		typ. 3 Hz

[1] After 30 days of operation.

[2] Valid for span >100 kHz.

Sweep time

Span ≥10 Hz	2.5 ms to 16000 s in steps of 10%
Error	1%
Span 0 Hz	1 µs to 16000 s in steps of 5%
Resolution	125 ns

Typical values for SSB phase noise (referred to 1 Hz bandwidth)

Offset	f_{in}= 3 GHz	f_{in}= 7 GHz	f_{in}= 13 GHz	f_{in}= 22 GHz	f_{in}= 26 GHz
100 Hz	–74 dBc	–67 dBc	–61 dBc	–57 dBc	–55 dBc
1 kHz	–100 dBc	–94 dBc	–88 dBc	–84 dBc	–82 dBc
10 kHz	–108 dBc	–104 dBc	–98 dBc	–94 dBc	–92 dBc
100 kHz	–108 dBc	–106 dBc	–100 dBc	–96 dBc	–94 dBc
1 MHz	–118 dBc	–118 dBc	–112 dBc	–108 dBc	–106 dBc

Resolution bandwidths

Bandwidths	10 Hz to 10 MHz (–3 dB), in 1, 3 sequence
EMI bandwidths	200 Hz, 9 kHz, 120 kHz (–6 dB)

Bandwidth accuracy

≤100 kHz	<3%
300 kHz to 3 MHz	<10%
10 MHz	+10%, –30%

Shape factor -60 dB:-3 dB

≤100 kHz	<5:1 (Gaussian filter)
300 kHz to 3 MHz	<15:1 (4-pole synchronously tuned filters)
10 MHz	<7:1

Shape factor -60 dB:-6 dB

EMI bandwidths	<5:1
Video bandwidths	1 Hz to 10 MHz in 1, 3 sequence

FFT filter

Bandwidths	1 Hz to 30 kHz (–3 dB) in 1, 3 sequence
Bandwidth accuracy	5%, nominal
Shape factor -60 dB:-3 dB	2.5:1 nominal

Level

Display range	displayed average noise level to 30 dBm

Maximum input level

RF attenuation 0 dB	
DC voltage	50 V (FSP3, FSP7), 0 V (FSP13, FSP30)
CW RF power	20 dBm
Pulse spectral density	97 dBµV (1 MHz)
RF attenuation ≥10 dB	
CW RF power	30 dBm
Max. pulse voltage	150 V (FSP3, FSP7), 50V (FSP13, FSP30)
Max. pulse energy (10 µs)	1 mWs (FSP3, FSP7), 0.5 mWs (FSP13, FSP30)

Spectrum Analyzer FSP

1 dB compression of input mixer

RF attenuation 0 dB, f>200 MHz — 0 dBm nominal

Intermodulation

3rd-order intermodulation

Intermodulation-free dynamic range, level 2 x -30 dBm, Δf > 5 x RBW or 10 kHz, whichever the greater value

	FSP3	FSP7	FSP13	FSP30
20 MHz to 200 MHz	>70 dBc, TOI >5 dBm			
200 MHz to 3 GHz	>74 dBc, TOI >7 dBm (typ. 10 dBm)			
3 GHz to 7 GHz	–	>80 dBc, TOI >10 dBm (typ. 15 dBm)		
7 GHz to 20 GHz	–	–	>80 dBc, TOI >10 dBm	
20 GHz to 30 GHz	–	–	–	>76 dBc, TOI>8 dBm
with optional Electronic Attenuator FSP-B25 switched on				
20 MHz to 200 MHz	>74 dBc, TOI >7 dBm		–	
200 MHz to 3 GHz	>80 dBc, TOI >10 dBm		–	
3 GHz to 7 GHz	>84 dBc, TOI >12 dBm		–	

Second harmonic intercept point (SHI)

<100 MHz	>25 dBm			
100 MHz to 3 GHz	>35 dBm			
3 GHz to 7 GHz	–	>45 dBm		
7 GHz to 13.6 GHz	–	–	typ. 45 dBm	
13.6 GHz to 30 GHz	–	–	–	typ. 45 dBm

Displayed average noise level

(0 dB RF attenuation, RBW 10 Hz, VBW 1 Hz, 20 averages, trace average, span 0 Hz, termination 50 Ω)

	FSP3	FSP7	FSP13	FSP30
9 kHz	<–95 dBm			
100 kHz	<–100 dBm			
1 MHz	<–120 dBm, typ. –125 dBm			
10 MHz to 1 GHz	<–142 dBm, typ. –145 dBm	<–140 dBm, typ. –145 dBm		
1 GHz to 3 GHz	<–140 dBm, typ. –145 dBm	<–138 dBm, typ. –143 dBm		
3 GHz to 7 GHz	–	<–138 dBm, typ. –143 dBm	<–135 dBm, typ. –145 dBm	
7 GHz to 13.6 GHz	–	–	<–132 dBm, typ. –138 dBm	
13.6 GHz to 22 GHz	–	–	–	<–120 dBm, typ. –130 dBm
22 GHz to 30 GHz	–	–	–	<–115 dBm, typ. –123 dBm

Displayed average noise level with preamplifier on (option FSP-B25)

10 MHz to 2 GHz	<–152 dBm		–
2 GHz to 7 GHz	<–150 dBm		–

Immunity to interference

Image frequency	>70 dB
Intermediate frequency (f <3 GHz)	>70 dB
Spurious response (f >1 MHz, without input signal, 0 dB attenuation))	<–103 dBm
Other spurious (with input signal, (mixer level <–10 dBm, Δf >100 kHz)	f <7 GHz: <-70 dBc f <13.6 GHz: <-64 dBc f <30 GHz: <-56 dBc

Level display

Screen	501 × 400 pixels (one diagram), max. 2 diagrams with independent settings
Log level scale	10 dB to 200 dB, in steps of 10 dB
Linear level scale	10% of reference level per level division, 10 divisions
Traces	max. 3, with two diagrams on screen max. 3 per diagram
Trace detector	Max peak, Min Peak, Auto Peak, Sample, Quasi-Peak, Average, RMS
Trace functions	Clear/Write, Max Hold, Min Hold, Average

Setting range of reference level

Logarithmic level display	–130 dBm to 30 dBm, in steps of 0.1 dB
Linear level display	70.71 nV to 7.07 V in steps of 1%
Units of level scale	dBm, dBmV, dBμV, dBμA, dBpW (log level display), mV, μV, mA, μA, pW, nW (linear level display)

Max. uncertainty of level measurement

at 128 MHz, –30 dBm (RF attenuation 10 dB, RBW 10 kHz, ref. level –20 dBm)	<0.2 dB (σ = 0.07 dB)

Frequency response

<50 kHz	<+0.5/–1.0 dB
50 kHz to 3 GHz	<0.5 dB (σ = 0.17 dB)
3 GHz to 7 GHz	<2 dB (σ = 0.7 dB)
7 GHz to 13.6 GHz	<2.5 dB (RF attenuation 10 dB, sweep time >1 s/1 GHz) (FSP13, FSP30)
13.6 GHz to 30 GHz	<3 dB (RF attenuation 10 dB, sweep time >1 s/1 GHz) (FSP30)
Attenuator	<0.2 dB (σ = 0.07 dB)
Reference level switching	<0.2 dB (σ = 0.07 dB)

Display nonlinearity LOG/LIN (S/N >16 dB)

RBW ≤100 kHz	
0 dB to –70 dB	<0.2 dB (σ = 0.07 dB)
–70 dB to –90 dB	<0.5 dB (σ = 0.17 dB)
RBW ≥300 kHz	
0 dB to –50 dB	<0.2 dB (σ = 0.07 dB)
–50 dB to –70 dB	<0.5 dB (σ = 0.17 dB)

Bandwidth switching uncertainty (ref. to RBW = 10 kHz)

10 Hz to 100 kHz	<0.1 dB (σ = 0.03 dB)
300 kHz to 10 MHz	<0.2 dB (σ = 0.07 dB)
1 Hz to 3 kHz, FFT	<0.2 dB (σ = 0.03 dB)

Trigger functions

Span ≥10 Hz

Trigger source	free run, video, external, IF level
Trigger offset	125 ns to 100 s, resolution 125 ns min. (or 1% of offset)

Span = 0 Hz

Trigger source	free run, video, external, IF level
Trigger offset	±125 ns to 100 s, resolution 125 ns min., dependent on sweep time
Max. deviation of trigger offset	±(125 ns + (0.1% x delay time))

Gated sweep

Trigger source	external, IF level, video
Gate delay	1 μs to 100 s
Gate length	125 ns to 100 s, resolution min. 125 ns or 1% of gate length
Max. deviation of gate length	±(125 ns + (0.05% x gate length))

Spectrum Analyzer FSP

Inputs and outputs (front panel)

RF input	N female, 50 Ω
FSP3/7/13	N female, 50 Ω
FSP30	test port system 50 Ω, N female, 3.5 mm female
VSWR (RF attenuation>0 dB)	
f <3 GHz/7 GHz/13 GHz/30 GHz	1.5:1/2.0:1/2.5:1/3.0:1
Input attenuator	0 dB to 70 dB in 10 dB steps
Probe power supply	+15 V DC, –12.6 V DC and ground, max. 150 mA
Keyboard connector	PS/2 female for MF2 keyboard
AF output (optional)	3.5 mm mini jack, 10 Ω
Open-circuit voltage	up to 1.5 V, adjustable

Inputs and outputs (rear panel)

IF 20.4 MHz		Z_{out} = 50 Ω, BNC female
Level	RBW ≤100 kHz, FFT	–10 dBm at reference level, mixer level >–60 dBm
	RBW ≥300 kHz	0 dBm at reference level, mixer level >–60 dBm
Reference frequency output		BNC, 10 MHz, 0 dBm nominal
Reference frequency input		BNC, 10 MHz, min. 0 dBm, 50 Ω
Power supply for noise source		BNC, 0 V and 28 V, selectable
External trigger/gate input		BNC, >10 kΩ, TTL level
IEEE/IEC bus control		interface to IEC-625-2 (IEEE 488.2), command set SCPI 1997.0
Serial interface		RS-232-C (COM), 9-pin sub-D
Printer interface		parallel (Centronics)
Mouse connector		PS/2 female
Connector for ext. monitor (VGA)		15-pin sub-D

Tracking Generator FSP-B9

Unless specified otherwise, specifications are not valid for the frequency range from –3 x RBW to +3 x RBW, however at least not valid from –9 kHz to +9 kHz.

Frequency

Frequency range	9 kHz to 3000 MHz
Frequency offset setting range	±150 MHz
Resolution	1 Hz

Spectral purity

SSB phase noise, f = 500 MHz, carrier offset 100 kHz

Normal mode	typ. –90 dBc (1 Hz)
With FM modulation switched on	typ. –70 dBc (1 Hz)

Level

Level range	–30 dBm to 0 dBm in 0.1 dB steps
Level range with AM	–30 dBm to –6 dBm in 0.1 dB steps
Max. deviation of output level, 128 MHz, 0 dBm	<1 dB

Frequency response

Output level 0 dBm, 100 kHz to 2 GHz	<1 dB
Output level 0 dBm to –25 dBm, 9 kHz to 3 GHz	<3 dB

Dynamic range

Attenuation measurement range, RBW=1 kHz, f >10 MHz	120 dB

Spurious

Harmonics, output level –10 dBm	typ.–30 dBc
Nonharmonics, output level 0 dBm	typ.–30 dBc

Electronic Attenuator FSP-B25 (only for FSP3 and FSP7)

Frequency

Frequency range	10 MHz to 7000 MHz
Input attenuator range (mechanical)	0 dB to 75 dB in 5 dB steps
Electronic attenuation range	0 dB to 30 dB in 5 dB steps
Preamplifier	20 dB, switchable

Displayed average noise level with preamplifier on

(0 dB RF attenuation, RBW 10 Hz, VBW 1 Hz, 20 averages, trace average, span 0 Hz, termination 50 Ω)

10 MHz to 2 GHz	<–152 dBm
2 GHz to 7 GHz	<–150 dBm

Intermodulation with electronic attenuator on

3rd-order intermodulation, intermodulation-free dynamic range, level 2 x –30 dBm, Δf > 5 x RBW or 10 kHz, whichever the greater value

Frequency	
20 MHz to 200 MHz	>74 dBc, TOI >7 dBm
200 MHz to 3 GHz	>80 dBc, TOI >10 dBm
3 GHz to 7 GHz	>84 dBc, TOI >12 dBm

Max. deviation of level measurement

128 MHz, –30 dBm (RF attenuation 10 dB, RBW 10 kHz, reference level –20 dBm),

preamplifier on	<0.2 dB (σ = 0.07 dB)
Electronic attenuator	<0.2 dB (σ = 0.07 dB)

Frequency response with preamplifier, electronic attenuator

10 MHz to 3 GHz	<1.0 dB (σ = 0.33 dB)
3 GHz to 7 GHz	<2 dB (σ = 0.7 dB)

General data

Display	21 cm TFT colour display (8.4”)
Resolution	640 x 480 pixels (VGA resolution)
Pixel failure rate	$<2 \times 10^{-5}$
Mass memory	1.44 Mbyte 3 ½” disk drive (built-in), hard disk
Data storage	>500 instrument settings and traces
Temperature ranges	
Rated temperature range	+5 °C to +40 °C
Limit temperature range	+5 °C to +45 °C
Power supply	
AC supply	100 V AC to 240 V AC, 50 Hz to 400 Hz, 3.1 A to 1.3 A
Typical power consumption	
FSP3	70 VA
FSP7	120 VA
FSP13, FSP30	150 VA
Dimensions in mm (W x H x D)	412 x 197 x 417
Weight	
FSP3	10.5 kg
FSP7	11.3 kg
FSP13, FSP30	12 kg

Spectrum Analyzer FSP

Ordering information

Spectrum Analyzer

9 kHz to 3 GHz	FSP 3	1093.4495.03
9 kHz to 7 GHz	FSP 7	1093.4495.07
9 kHz to 7 GHz	FSP 13	1093.4495.13
9 kHz to 7 GHz	FSP 30	1093.4495.30

Accessories supplied

Power cable, operating manual, service manual

Options

Delete Manuals	FSP-B0	1129.8394.02
Rugged case, carrying handle (factory-fitted)	FSP-B1	1129.7998.02
AM/FM Audio Demodulator	FSP-B3	1129.6491.02
OCXO Reference Frequency	FSP-B4	1129.6740.02
TV Trigger/RF Power Trigger	FSP-B6	1129.859.4.02
Internal Tracking Generator 9 kHz to 3 GHz, IQ modulator, for all FSP models	FSP-B9	1129.6991.02
External Generator Control for all FSP models	FSP-B10	1129.7246.02
LAN Interface 100BT for all FSP models (factory-fitted	FSP-B16	1129.8042.02
Electronic Attenuator, 0 dB to 30 dB, 5 dB steps, integrated preamplifier for FSP3 and FSP7	FSP-B25	1129.7746.02

Software

Noise Measurement Software	FS-K3	1057.3028.02
Phase Noise Measurement Software	FS-K4	1108.0088.02
GSM/EDGE Application Firmware, Mobile	FS-K5	1141.1496.02
AM/FM Measurement Demodulator	FS-K7	1141.1796.02

Extras

Headphones	–	0708.9010.00
US Keyboard with trackball	PSP-Z2	1091.4100.02
PS/2 Mouse	FSE-Z2	1084.7043.02
Colour Monitor, 15", 230 V	PMC3	1082.6004.02
IEEE/IEC bus Cable, 1 m	PCK	0292.2013.10
IEEE/IEC bus Cable, 2 m	PCK	0292.2013.20
19" Rack Adapter	ZZA 478	1096.3248.00
Trolley	ZZK-1	1014.0510.00
Transit bag	ZZT 473	1109.5048.00
Matching Pads, 75 Ω		
L Section	RAM	0358.5414.02
Series Resistor, 25 Ω[1]	RAZ	0358.5714.02
SWR Bridge, 5 MHz to 3000 MHz	ZRB2	0373.9017.52
SWR Bridge, 40 kHz to 4 GHz	ZRC	1039.9492.52
High-Power Attenuators, 100 W 3/6/10/20/30 dB	RBU 100 (XX=03/06/10/20/ 30)	1073.8820.XX
High-Power Attenuators, 50 W 3/6/10/20/30 dB	RBU 50 (XX=03/06/10/20/ 30)	1073.8695.XX
For FSP30		
Test port Adapter, 3.5 mm male	–	1021.0529.00
Test port Adapter, N male	–	1021.0541.00

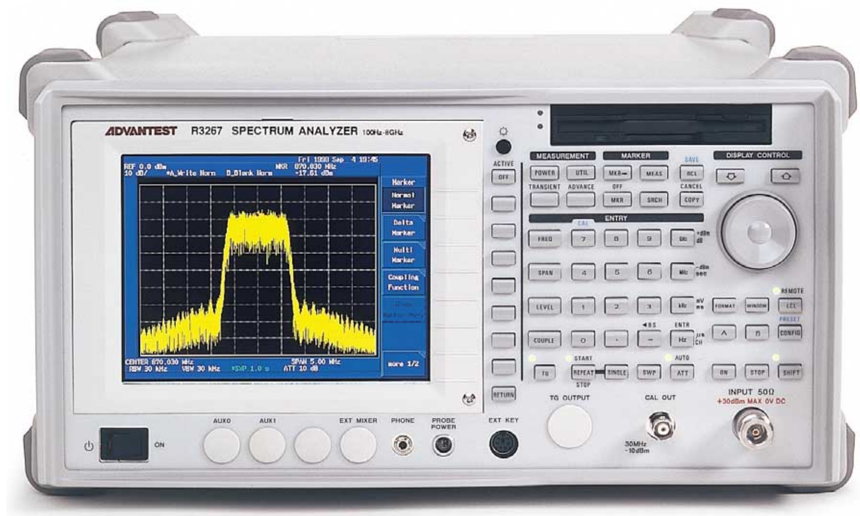
1) Taken into account in device function RF INPUT 75 Ω.

Spectrum Analyzers R3267/73

20 Hz to 8 GHz (R3267)

20 Hz to 26.5 GHz (R3273)

General purpose spectrum analyzers with option to retrofit digital demodulation capability



R3267 (photo 43232-1)

Brief description

The new spectrum analyzer series from Advantest is a general-purpose spectrum analyzer with the frequency range 20 Hz to 8 GHz (R3267) and 20 Hz to 26.5 GHz (R3273). Both analyzers are fully synthesizer-controlled (DDS) featuring high frequency span accuracy (typ. <±0.2%), phase noise <–145 dBc/Hz and noise floor –154 dBm/Hz. The concept features YIG tuned preselector filter from 1.6 GHz and 5 dB step attenuation (R3267).

High signal purity and high dynamic range are some of the outstanding specifications of this analyzer series meeting the high demands for the future telecommunication market.

The concept of the analyzer is based on the general-purpose analyzer with the option to retrofit digital demodulation capability meeting the 2nd and 3rd generation demands on digital telecommunication. Systems like GSM EDGE, DECT, IS-95, WCDMA (NTT, ARIB and future 3GPP) are some of the systems available as easy software upgrades via built-in 3½" FDD.

The analyzer series features simple keystroke (macro) functions for measuring ACP, OBW, power (channel, total and average) as RMS voltage calculated values and further harmonics, spurious, two tone test, phase noise measurement, counter function and several other functions.

The detector circuit contains 4 different detector types (positive, negative, sample and normal) and with the two simultaneous traces two different detectors can be assigned. The analyzer series is further equipped with a wide range of resolution filters (1 Hz to 10 MHz) meeting the various needs on the market. To meet the demands for fast time domain sweep the analyzer has a 40 Mbps ADC featuring sweep times from 20 ms to 1000 s and in zero span mode 1 µs to 1000 s.

The analyzer is equipped with 3½" FDD and 6.5" TFT colour liquid crystal display with refresh rate of 20 traces/s. GPIB and RS232 and parallel ports are standard together with VGA output.

The R3273 can be extended in frequency range with external mixers up to 60 GHz (level correction possible) and up to 325 GHz (tuning possible).

Furthermore, the digital standard options are equipped with I/Q baseband inputs (DC to 2.5 MHz for each channel) as standard for I/Q baseband analysis.

Overview of digital communication standards

The concept of the R3267 and R3273 is the combination of high performance spectrum analysis and modulation analysis in one instrument.

The basic R3267 and R3273 plus a hardware platform for digital standards (option 1) is needed to perform the modulation analysis.

The following standards can be implemented in the R3267 and R3273:

- Option 61: cdmaOne
- Option 62: W-CDMA/3GPP
- Option 63: GSM/EDGE/DECT
- Option 64: IS-136/PDC/PHS
- Option 65: cdma2000
- Option 66: Bluetooth
- Option 61: cdmaOne
- Option 62: W-CDMA/3GPP
- Option 63: GSM/EDGE/DECT

R3267/73

- Option 64: IS-136/PDC/PHS
- Option 65: cdma2000
- Option 66: Bluetooth

CdmaOne (Option 61)

- Channel (F-domain) power
- Gated output (T-domain) power
- Tx power
- On/off ratio
- Occupied bandwidth (OBW)
- ACP due to transients
- Waveform quality
- Code domain power
- In-band/out-band spurious
- T-domain spurious
- Graphics analysis (constellation diagram, eye diagram, EVM versus chip, magnitude and phase error versus chip)

Special features

- RF and baseband IQ measurements possible
- All channel assignments covered

WCDMA/3GPP (Option 62)

- Channel (F-domain) power
- Gated output (T-domain) power
- Tx power
- On/off ratio
- Occupied bandwidth (OBW)
- Adjacent-channel power ratio (ACPR)
- In-band spurious
- Out-band spurious
- T-domain spurious
- Peak/crest factor , CCDF (complementary cumulative distribution function)
- Waveform quality ρ
- Time alignment error τ
- Carrier frequency error
- I/Q origin offset
- Magnitude and phase Error (normal and peak)
- Error vector magnitude EVM (normal and peak)
- Code domain power with auto rate and auto channel detection
- Time code domain power
- Graphical analysis (constellation diagram, eye diagram , EVM versus chip, magnitude and phase error versus chip)
- Primary CPICH power

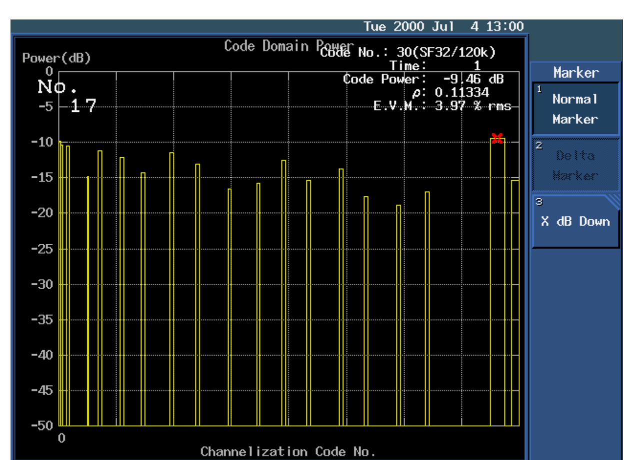
Special features

- RF and baseband IQ measurements possible
- All channel assignments covered
- Uplink and downlink
- Measurement on slot or frame
- Auto channel and auto rate detection

GSM/EDGE/DECT (Option 63)

- Channel (F-domain) power
- Gated output (T-domain) power
- On/off ratio
- Spurious in frequency domain
- Spurious in time domain
- Spectrum due to switching transients
- Spectrum due to modulation
- Power versus time (with TSC Trigger)
- Tx power
- GSM
  - Phase and frequency error
  - Graphical analysis (constellation diagram, eye diagram, Trellis diagram, phase error versus bit, FFT of phase error, frequency versus bit, frequency eye)
  - Demodulated data
- EDGE
  - Magnitude and phase error (normal and peak)
  - Error vector magnitude EVM (normal and peak)
  - Burst amplitude droop
  - Carrier frequency error
  - I/Q origin offset
  - Graphical analysis (constellation diagram, eye diagram, magnitude and phase error versus symbol, EVM versus symbol)
  - Demodulated data

3GPP total result



Code domain power measurement for 3GPP

Spectrum Analyzers R3267/73

- DECT
  - Frequency deviation
  - Graphical analysis (frequency versus bit, frequency eye)
  - Demodulated data

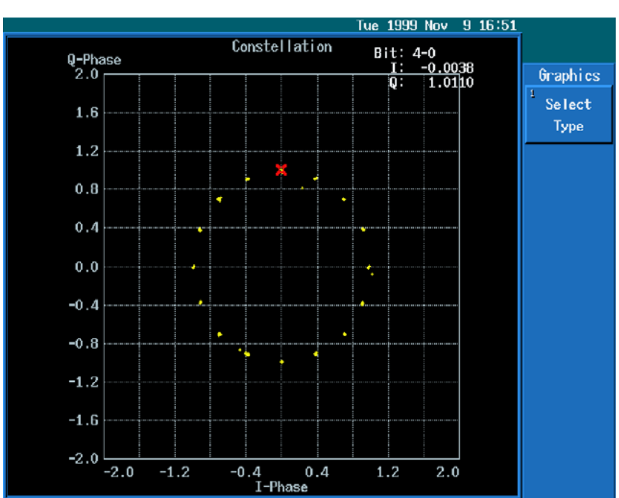
Special features
- RF and baseband IQ measurements possible
- All channel assignments covered
- TSC synchronization (GSM/EDGE)
- Multi-burst measurements (GSM/EDGE)
- Base station and mobile station

IS-136/PDC/PHS (Option 64)
- Channel (F-domain) power
- Gated output (T-domain) power
- On/off ratio
- Spurious in frequency domain
- Spurious in time domain
- Occupied bandwidth (OBW)
- Adjacent-channel power (ACP)
- Modulation accuracy
- Carrier frequency error
- I/Q origin offset
- Bit error rate
- Power versus time
- Tx power
- Graphics analysis

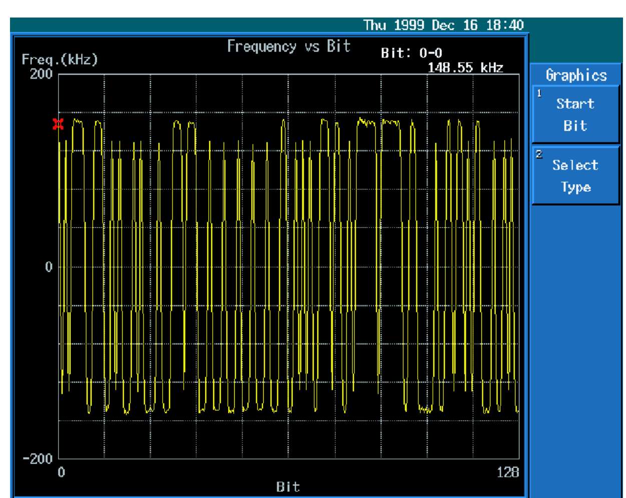
Cdma2000 (Option 65)
- Channel (F-domain) power
- Gated output (T-domain) power
- Tx power
- On/off ratio
- Occupied bandwidth (OBW)
- Adjacent-channel power ratio (ACPR)
- In-band/out-band spurious
- T-domain spurious
- Peak/crest factor, CCDF (complementary cumulative distribution function)
- Waveform quality ρ
- Time alignment error τ
- Carrier frequency error
- I/Q origin offset
- Magnitude and phase error (normal and peak)
- Error vector magnitude EVM (normal and peak)
- Code domain power
- Code domain error

Bluetooth (Option 66)
- Channel (F-domain) power
- Gated output (T-domain) power
- Tx power
- On/off ratio
- Occupied bandwidth (OBW)
- Spurious in frequency domain
- Spurious in time domain
- Due to transients
- Due to modulation
- Lock-up time / settling time measurement
- FM deviation (maximum and minimum)
- Frequency error
- Graphics analysis (spectrum due to modulation, frequency versus bit, frequency eye)
- Demodulated data

Special features
- RF and baseband IQ measurements possible
- All channel assignments covered
- Hopping catch mode
- Variable burst length
- LAP synchronization possible

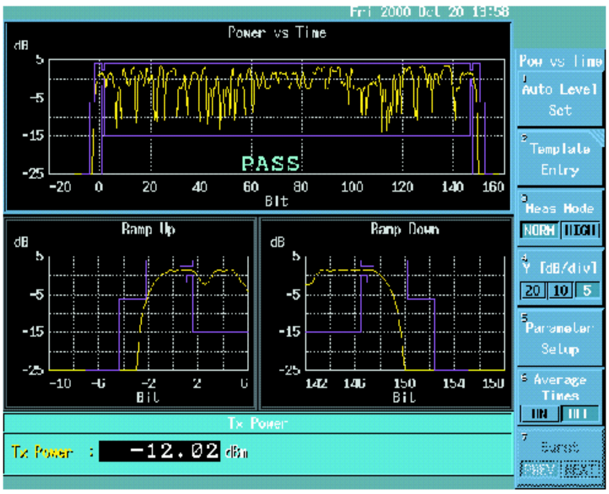


Constellation diagram for EDGE



Frequency-bit measurement for Bluetooth

Spectrum Analyzers R3267/73



Power versus time measurement for EDGE

Specifications

Frequency

Frequency range	R3267	20 Hz to 8 GHz
	R3273	20 Hz to 26.5 (31.8) GHz
Frequency bands		20 Hz to 3.5 GHz N = 1
		1.6 to 8 GHz N = 1
		7.4 to 15.4 GHz N = 2
		15.4 to 26.5 GHz N = 4
Preselector	R3267	selectable from 1.6 GHz
	R3273	from 3.6 GHz
Frequency accuracy		±(f x reference frequency + span x 1% + 0.15 x RBW + 10 Hz)
Counter		
Resolution		1 Hz to 1 kHz
Accuracy		±(marker frequency x ref. frequency accuracy + 5 Hz x N + 1 LSD) (S/N ≥ 25 dB, span ≤200 MHz)
Reference frequency		$\pm1\times10^{-7}$ / year
with option 21		$\pm2\times10^{-8}$ / year
(0°C to 50°C)		$\pm1\times10^{-6}$
Span		200 Hz to 8/26.5 (31.8) GHz, zero span
Inaccuracy		≤±1%
Frequency stability		
Residual FM		≤3 x N Hz p-p/100 ms

Spectral purity (SSB phase noise [-dBc/Hz]

Carrier offset	<1 GHz	<2.6 GHz	<7.5 GHz	<26.5 GHz
1 kHz	<100	<100	<98	<83
10 kHz	<113	<110	<108	<98
100 kHz	<118	<118	<112	<100
1 MHz	<135	<135	<135	<123

Resolution bandwidths (3 dB)	
Range	1 Hz to 10 MHz; 1-to-3 increments
Selectivity (60:3 dB)	<15:1
Video bandwidth	1 Hz to 10 MHz; 1-to-3 increments

Level

Display range		+30 dBm to displayed average noise level
Max. input level		+30 dBm, ±0 V DC
Display range		
Log		10; 5; 2; 1; 0,5 dB/div 10 x 10 grid
Linear		10% of reference level per division
Reference level range		
Log		–140 dBm to +60 dBm, in steps of 0.1 dB
Linear		+22.4 nV to 223.6 V
RF input attenuator (range)	R3267	0 to 75 dB, in 5 dB steps
	R3273	0 to 70 dB, in 10 dB steps

Sweep

Sweep time		20 ms to 1000 s zero span 1 µs to 1000 s
Accuracy		±3%
Trigger modes		free-run, line, video, external, IF in zero span mode additionally trigger delay (pretrigger/posttrigger)
Sweep modes		continuous, single-shot, window sweep
Gated sweep		
Gate position		100 ns to 1 s, 100 ns resolution
Gate width		1 µs to 1 s, 100 ns resolution external trigger, external gate
Delayed sweep		100 ns to 1 s, 100 ns resolution
Displayed average noise level (RBW 100 Hz; VBW 10 Hz; ATT 0 dB)		<–90 dBm, 1 to 10 kHz <–100 dBm, 10 kHz to 1 MHz <–125 dBm, 1 MHz to 10 MHz <–130 dBm + f[GHz] dB 10 MHz to 3.5 GHz <–125 dBm, 3.5 GHz to 8 GHz
	R3273	<–122 dBm, 7.4 GHz to 15.4 GHz <–120 dBm, 15.4 GHz to 22 GHz <–117 dBm, 22 GHz to 26.5 GHz
1 dB compression point of input mixer	R3267	>0 dBm, 100 MHz to 8 GHz
	R3273	>0 dBm, 100 MHz to 3.5 GHz >–10 dBm, 3.5 GHz to 7.5 GHz >–3 dBm, 7.5 GHz to 26.5 GHz
2nd-order interfering signals		
–30 dBM mixer level		≤–70 dBc, 10 MHz to 3.5 GHz
–10 dBM mixer level (R3267)		≤–90 dBc, 1.6 GHz to 8 GHz
–10 dBM mixer level (R3273)		≤–100 dBc, >3.5 GHz
3rd-order intermodulation		
100 MHz to 1 GHz		≤–80 dBc
1 GHz to 3.5 GHz		≤–85 dBc
1.6 GHz to 8 GHz		≤–90 dBc (R3267)
3.5 GHz to 7.5 GHz		≤–70 dBc (R3273)
Other interfering signals at input		≤–100 dBm, 1 MHz < f <3.5 GHz
Residual response (ATT 0 dB, input terminated with 50 Ω)		≤–90 dBm, f > 3.5 GHz

Amplitude accuracy

Calibration signal	30 MHz
Accuracy	–10 dBm ± 0.3 dB
Frequency response (ATT =10 dB)	
50 MHz to 2.6 GHz	≤±1.0 dB
1.5 GHz to 8 GHz	≤±1.5 dB
7.4 GHz to 15.4 GHz	≤±3.5 dB
15,4 GHz to 26.5 GHz	≤±4.0 dB
Scale accuracy/linearity error	(after autocalibration)
Log	≤±0.85 dB/90 dB ≤±0.2 dB/1 dB
Lin	5% of reference level
Input attenuator switching error	≤±1.1 dB/10 dB (20 dB to 70 dB) max. 2.0 dB, f <12.4 GHz max. 3.5 dB, f >12.4 GHz
RBW switching error (after autocalibration)	≤±0.3 dB, RBW ≥100 Hz
IF gain error (after autocalibration)	<±0.5 dB, >–50 dBm

Spectrum Analyzers R3267/73

Total level accuracy (REF –50 dBm to 0 dBm, ATT = 10 dB, 2 dB/div, RBW = 300 kHz, f < 3.5 GHz)	±1.5 dB

Inputs/outputs

RF input	N female, 50 Ω (R3273: adapter system, 3.5 mm)
VSWR (ATT ≥10 dB)	≤1.5 (100 kHz to 3.5 GHz) ≤2.0 (>3.5 GHz)
Calibration output	30 MHz, –10 dBm
Connector	BNC female, 50 Ω
10 MHz reference (input/output)	–5 dBm to +5 dBm
Connector	BNC female, 50 Ω (rear panel)
External trigger and gate input	TTL, 10 kΩ (nominal), DC-coupled
Connector	BNC female (rear panel)
Trigger output	TTL level, BNC female
IF output (BNC female)	21.4 MHz, bandwidth same as RBW 421.4 MHz, BW approx. 20 MHz (3 dB)
X output (sweep)	–5 V to 5 V sawtooth f_{START} to f_{STOP}
Connector	BNC female, 1 kΩ
Y output	2 V full-scale deflection (100 dB) BNC female, 220 Ω
AF output	subminiature female earphone output (rear panel) max. 0.2 W into 32 Ω (nominal) option 05: AM/FM demodulator, internal loudspeaker
Probe power output	±12.6 V, 100 mA, 4-pin, power supply for active probes
IEEE/IEC bus	IEEE488 bus connector (rear panel)
Serial interface (RS232)	D-SUB 9-pin (rear panel)
VGA monitor output	D-SUB 15-pin (rear panel)
Printer interface	D-SUB 25-pin (rear panel) ESC/P; PCL printer

Digital communication standards

cdmaOne analysis	option 61

Waveform quality measurement

Frequency range	30 MHz to 3.0 GHz
Input level	–30 dBm to +30 dBm (total power in ATT AUTO mode)
Forward link	
Waveform quality ρ	measurement accuracy <±0.0015
Time alignment error τ	measurement accuracy <±300 nsec
Carrier frequency error	<± (reference frequency accuracy x carrier frequency + 10 Hz) (in Expand mode within carrier frequency ±4 kHz)
Reverse link	
Waveform quality ρ	measurement accuracy <±0.003
Time alignment error τ	measurement accuracy <±300 nsec
Carrier frequency error	<± (reference frequency accuracy x carrier frequency +10 Hz) (within carrier frequency ±4 kHz)

Code domain power measurement

In 15-97 "Base Station Test Mode" measurement

Frequency range	30 MHz to 3.0 GHz
Input level	–30 dBm to +30 dBm (total power in ATT AUTO mode)
Precise mode (measured with 64 x 20 chips)	
Power i	measurement accuracy <±0.1 dB (however, τ i =0)
Carrier frequency error	<± (reference frequency accuracy x carrier frequency + 10 Hz) (in Expand mode within carrier frequency ±4 kHz)
τ i	measurement accuracy <±10 nsec
Δθi	measurement accuracy <±10 mrad
Normal mode (measured with 64 x 20 chips)	
Power i	measurement accuracy <±0.1 dB (however, τ i =0)
Carrier frequency error	<± (reference frequency accuracy x carrier frequency + 10 Hz) (in Expand mode within carrier frequency ±4 kHz)

W-CDMA analysis	option 62

W-CDMA measurement

Frequency range	30 MHz to 3.0 GHz
Input level	–30 dBm to +30 dBm (total power in ATT AUTO mode)
Carrier frequency error	<± (reference frequency x carrier frequency 30 Hz) (within carrier frequency ±1 kHz)

W-CDMA, BS signal

BS 4-multiplex wave	(perch: DTCH = 1:2:2:2, level ratio, for each DTCH signal of –5.44 dBc)
Waveform quality	measurement accuracy <0.002
Modulation accuracy	residual vector error <3%
Code domain power	measurement accuracy <±0.1 dB

W-CDMA, UE signal

Waveform quality	measurement accuracy <0.001
Modulation accuracy	residual vector error <3%

QPSK measurement

Frequency range	30 MHz to 3.0 GHz
Input level	–30 dBm to +30 dBm (total power in ATT AUTO mode)
Carrier frequency error	<± (reference frequency x carrier frequency 30 Hz) (within carrier frequency ±1 kHz)
Waveform quality	measurement accuracy <0.001
Modulation accuracy	residual vector error; <3%

I/Q input

Input level range	0.25 V to 0.9 V p-p (however, ±0.47 V or less)
Input impedance	50 Ω (nominal), DC coupling, AC coupling
Modulation accuracy	residual vector error <3%

GSM/DECT analysis	option 63

GSM measurement

Applicable modulation system	GMSK (GSM, DCS1800, PCS1900)
Frequency range	30 MHz to 3.0 GHz
Input level	–30 dBm to +30 dBm

Spectrum Analyzers R3267/73

Frequency error	range <±10 kHz accuracy <± (reference frequency accuracy x carrier frequency + 5 Hz)
Phase error	Range ≤±30° (peak) accuracy ≤±5° (peak), ≤±1° (rms)
DECT measurement	
Applicable modulation system	GFSK (DECT)
Frequency range	30 MHz to 3.0 GHz
Input level	–30 dBm to +30 dBm
Frequency deviation	accuracy <± (reference frequency accuracy x carrier frequency + 10 kHz) for max./min. deviation
Frequency error	accuracy <± (reference frequency accuracy x carrier frequency + 10 kHz)
Jitter measurement	accuracy <±0.1 psec, the jitter between bursts (PP→PP, RFP→RFP, RFP→PP) is measured
PDC/PHS/IS-136 analysis	option 64
PDCIIS-136 measurement	
Frequency range	30 MHz to 3.0 GHz
Input level	–30 dBm to +30 dBm
Frequency error	accuracy ± (reference frequency accuracy x carrier frequency + 5 Hz) range <±1.4 kHz (Normal) <±5 kHz (Expand)
Modulation accuracy	measurement accuracy <± (1% + measured value x 2%)
Transfer speed	<1 ppm
PHS measurement	
Frequency range	30 MHz to 3.0 GHz
Input level	–30 dBm to +30 dBm
Frequency error	accuracy ± (reference frequency accuracy x carrier frequency + 20 Hz) range <±13 kHz (Normal) <±50 kHz (Expand)
Modulation accuracy	measurement accuracy <± (1% + measured value x 2%)
cdmaOne analysis	option 61

General data

Floppy disk drive	3.5"; MS-DOS format
Display	16.5 cm (6.5"), 1000 x 700 pixels, 104 x 76 mm grid (W x H), 2 simultaneous display memories A and B, quasi-analog display, split screen, auxiliary line editor, date/time, colour selection, setting parameters (switch-selected)
Analysis functions	marker, delta marker, multimarkers (10), signal track, peak search, next peak, offset input for frequency and level, display line, reference line, limit lines with pass/fail comparator, 10 memories for setups and traces, averaging, noise measurements, harmonics measurement, power measurements, OBW and ACP measurements, autotune, autotest, calibration routines, transducer input
Operating temperature	0°C to 50°C
Storage temperature	–20°C to +60°C
Relative humidity	<85%
AC supply	115/230 V AC autom. switchover
115 V AC	90 V to 132 V
230 V AC	198 V to 250 V
Line frequency	50 Hz to 60 Hz
Power consumption	<300 VA
Dimensions (H x W x D)	approx. 177 mm x 350 mm x 420 mm, excluding feet and front cover
Weight	<18 kg

Ordering information

Spectrum Analyzer

100 Hz to 8 GHz	R3267
100 Hz to 26.5 GHz	R3273

Options

01	Hardware Platform for Digital Modulation Analysis
02	PC Card Drive (instead of floppy drive)
08	Test Source Control for R3562
16	External Mixer, 26.5 GHz to 40 GHz, WR 28 (R3273 only)
17	External Mixer, 40 GHz to 60 GHz, WR 19 (R3273 only)
21	Precision Frequency Reference ±5 x 10-9/day, ±2x 10-8/year
61	CDMA (IS95) Analysis
62	W-CDMA Analysis (3688)
63	GSM/EDGE/DECT Analysis
64	PDC/PHS/IS-136 Analysis
73	FM Deviation Measurement
74	Tracking Generator Frequency range: 100 kHz to 3.5 GHz Output power: –50 dBm to 0 dBm, in steps of 0.1 dB Accuracy: <±0.5 dB Frequency response: <±3.0 dB Harmonics: <-20 dBc RF input protection, power sweep
86	19" Rack Adapter

Extras

Transit case		
Service manual		
IEEE/IEC bus Cable	408JE-101/102	
VSWR Bridge		
5 MHz to 3000 MHz	ZRB2 (R&S)	1039.9492.x

Spectrum Analyzer R3131A

9 kHz to 3 GHz

General-purpose analyzer for use in development, production, testshop, service and training. Thanks to special filters also suitable for EMC precertification measurements

Photo 43157-2

Brief description

Spectrum Analyzer R3131A features the performance of a medium-class analyzer but at lower costs. With its wide frequency range from 9 kHz to 3 GHz it is suitable for many applications. Thanks to a highly stable synthesizer-controlled LO it satisfies exacting requirements in lab and system use. Its 19" size makes it particularly suitable for use in systems.

Operation, functions

Clear arrangement of the control elements and keys predominantly without multiple assignment make for great ease of operation. The basic model provides a large variety of measurement and marker functions as well as a built-in frequency counter. It also features the 6 dB bandwidth of 9 kHz and 120 kHz and a QP detector for EMC measurements.

A second, optional RF input allows input levels up to +40 dBm.

Disk drive, printer support, RS232 and IEEE488 interfaces are standard. An optional tracking generator allows scalar network analysis.

Specifications in brief

Frequency range	9 kHz to 3 GHz
Reference oscillator	
Aging	$>\pm 2\times 10^{-6}$/year
Resolution bandwidths	1 kHz to 1 MHz/auto, (6 dB) 9/120 kHz
Shape factor	<15 : 1
Frequency span	5 kHz to 300 MHz, zero span
Residual FM	<100 Hz/0.1 s (zero span)
Input level	+30 dBm to displayed average noise level/±50 V (DC), option 40: +40 dBm
Displayed average noise level	–113 +2f [GHz] dBm (1 kHz bandwidth) (f>1 MHz)
Intermodulation	<–70 dBc at –30 dBm (>10 MHz)
Spurious responses	–100 dBm (>1 MHz)
Phase noise	–100 dBc (1 Hz measurement bandwidth) at 20 kHz from carrier
Frequency response	<±0.5 dB (>100 kHz)
Reference level	–64 to +40 dBm/0.1 dB steps
Amplitude display units	dBm, dBmV, dBμV, Watt, Volt
Level resolution	10, 5, 2, 1 dB/div, linear
RF attenuator	0 to 50 dB in 10 dB steps
Video filter	10 Hz to 1 MHz, 1 to 10 steps
Sweep time	50 ms to 500 s, zero span
Frequency counter resolution	1 Hz to 1 kHz
Tracking generator	
Frequency range	100 kHz to 3 GHz
Output level range	–59.9 to 0 dBm, 0.1-dB steps

General data

Remote control interface	IEEE488, RS232
Power supply	100/240 V, 50 to 60 Hz
Power consumption	150 VA
Dimensions (W x H x D)	424 mm x 177 mm x 300 mm
Weight	12 kg

Ordering information

Spectrum Analyzer	R3131A
Options	
+40-dBm Input 2	40
Tracking Generator	74
Extras	
EMC software (Windows)	EPS9980
IEEE/IEC bus Cable 1 m	408JE-101
IEEE/IEC bus Cable 2 m	408JE-102
Transit Case	R16080M
19"-Rack Adapter	A02468

BasePak+ - for all measurements on antenna installations

Complete hardware and software for full qualification measurements on antennas

Brief description

BasePak+ is an ideal tool for measuring transmit and receive signals and for qualification measurements on antennas of analog and digital transmission systems. BasePak+ is a combination consisting of Advantest Spectrum Analyzer U3641 and tracking generator (see page 209), Windows software, SWR bridge and further accessories. It allows measurement and monitoring of the receive spectrum, measurement of SWR and transmission characteristics as well as detection of cable faults using FDR (frequency domain reflectometry).

Measurement capabilities

- Spectrum
- Transmission
- SWR
- Faults in cables
- Optional burst analysis

All measurements are carried out using a small-size and lightweight spectrum analyzer controlled from a notebook. Results can be stored in the notebook and recalled later. This allows fast comparisons to be made and changes recognized immediately. Through the use of Microsoft Windows the data can be output on all commercial-type printers and even be integrated in other programs.

Ordering information

BasePak+ consisting of:		
Advantest Spectrum Analyzer	U3641, U3641-74	
Battery	U4000-B5	
Battery Charger	U4000-C4	
Accessory case with		
RSWinTDR Software		
SWR Bridge	ZRB2	0373.9017.5x
Coupler		
Calibration kit		
Cables		

Options (for U3641)

Internal controller	15
Improved reference frequency	20
100/300 Hz resolution bandwidths	26
TV demodulator including option 78	72
Broadband FM demodulator	73
Tracking generator	74
Channel input	78

Extras (for U3641)

Battery 60 Wh	U4000-B5	
Charger for 2 batteries B5	U4000-C4	
Charger for 4 batteries B5	U4000-C5	
Charger for 4 batteries B5 and diagnostic module	U4000-C6	
Memory Card 256 k	A09508	
GSM MS Application		
Program for Internal Controller	PU36410300-IC	
GSM/PCN BS application		
Program for Internal Controller	PU36410310-IC	
Display Hood	R16601	
DC Connecting Cable	A01434	
SWR Bridge	ZRB2	0373.9017.5x
Transit Case	R16072	
Carrying Case	R16216	
Front Cover	A02806	

Spectrum Analyzers U3641, U3661

U3641: 9 kHz to 3 GHz

U3661: 9 kHz to 26.5 GHz

Lightweight, portable analyzers with synthesizer accuracy for mobile use

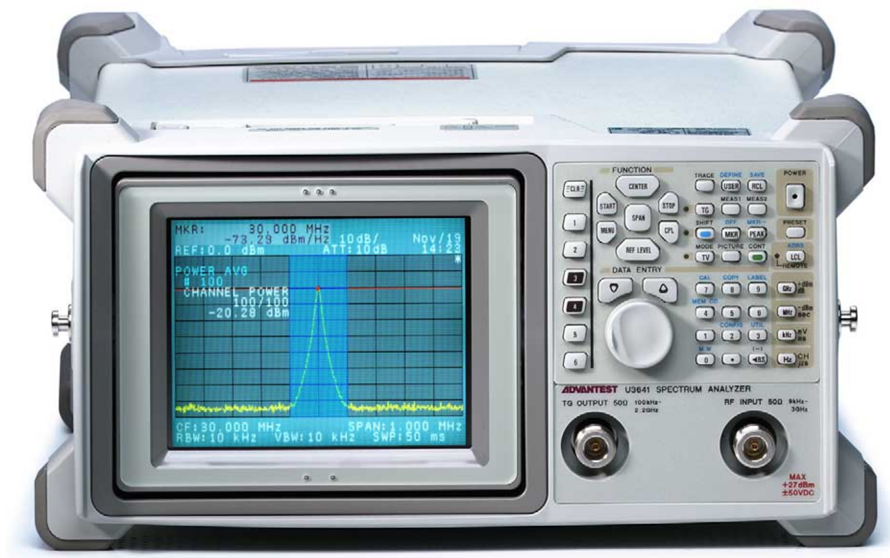


Photo 42774

Brief description

Spectrum Analyzers U3641 and U3661 (Advantest) feature exceptional characteristics such as:

- Size and weight: only 148 mm x 291 mm x 330 mm and 6.5 kg/8.3 kg (without battery or power supply unit)
- Three types of power supply possible: AC supply, battery (up to 1.5 h/1 h) or direct DC supply
- 15.2 cm (6 inch) colour LCD
- Integrated preamplifier with a gain of >25 dB
- Full dynamic range, eg for GSM pulse measurements
- Two memory card drives to PCMCIA standard for saving measurement results and instrument settings

The main technical features at a glance

- Optional OCXO reference oscillator with aging of 2 x 10^{-8}/day
- Operation independent of AC supply

Measurements on mobile radio base stations

- Dynamic range >70 dB for measuring the power ramp of GSM base stations
- SWR measurements on antennas in conjunction with tracking generator and SWR Bridge ZRB2 (see page 232)
- With BasePak hardware and software package (see page 208): SWR measurements and detection of cable faults using FDR (frequency domain reflectometry)
- Precision measurement of pulse power with the aid of various power measurement functions
- Different power measurement functions
- Gated sweep for display of spectrum due to modulation or switching
- GSM application software for optional controller (only U3641)

Radiomonitoring

- High sensitivity through built-in preamplifier up to 3 GHz for measurements down to –135 dBm with 1 kHz resolution bandwidth
- Input of antenna correction factors and limit curves
- Output of all results also in dBµV
- Ideal combination with Rohde & Schwarz antennas

Modularity through retrofittable options

Options and their functions	Option
Internal controller	15 (only U3641)
Improved reference frequency	20 (not usable with option 73)
100 Hz, 300 Hz RBW additionally	26
CDMA measurements at a key stroke	60 (only U3641, not usable with option 72)
TV demodulator including screen display	72
FM deviation measurements	73 (not usable with option 20)
Tracking generator 100 kHz to 2.2 GHz (typ. 2.7 GHz)	74
Channel input	78

Spectrum Analyzer U3641, U3661

Specifications in brief

Internal reference oscillator	standard
Frequency drift in temperature range 0 to +50°C	≥± 1 x 10^{-5}
Aging	≥± 2 x 10^{-6}
OCXO reference oscillator	option 20
Frequency drift in temperature range 0 to +50°C	≥± 1 x 10^{-7}
Aging	≥± 2 x 10^{-8}
Frequency	
Frequency range	
U3641	9 kHz to 3 GHz
U3661	9 kHz to 26.5 GHz
Resolution bandwidths	1 kHz to 3 MHz, wide (5 MHz)/auto
option 26	100 Hz, 300 Hz
Shape factor	15 : 1
Frequency span	1 kHz to 3.2 GHz/zero span
Residual FM	≤60 Hz pp/100 ms
Max. input level	
Preamplifier off	≥±27 dBm
Preamplifier on	≥±13 dBm
Sweep time	50 ms to 1000 s 50 µs to 100 s Zero Span
Tracking generator	option 74
Frequency range	100 kHz to 2.2 GHz
Output level	0 to –31 dBm in 1 dB steps
Level accuracy	≤±0.5 dB at 30 MHz
Frequency response	≤±0.7 dB up to 1 GHz ≤±1.5 dB from 100 kHz to 2.2 GHz
General data	
Operating temperature range	0 to 50°C
Storage temperature range	–20 to +60°C
EMC	complies with the requirements of the European EMC Directives EN 50081-1 and EN 50082-1
Permissible humidity	<85% non-condensing
Power supply	200 to 240 V AC ±10%, 48 to 66 Hz 100 to 120 V AC ±10%, 48 to 66 Hz 10 to 16 V DC at XLR connector
Power consumption	approx. 60 W
Dimensions (W x H x D)	148 mm x 291 mm x 330 mm
Weight	approx. 6.9 kg without battery, without power supply

Ordering information

Spectrum Analyzer		
50 Ω	U3641	
75 Ω	U3641N	
50 Ω	U3661	
Options		
Internal controller	15 (only for U3641)	
Improved reference frequency	20	
100/300 Hz resolution bandwidths	26	
CDMA measurements	60 (only for U3641)	
TV demodulator including option 78	72	
Broadband FM demodulator	73	
Tracking generator	74	
Channel input	78	
Extras		
Battery 60 Wh	U4000-B5	
Charger for 2 batteries B5	U4000-C4	
Charger for 4 batteries B5	U4000-C5	
Charger for 4 batteries B5 and diagnostic module	U4000-C6	
Memory card 256 k	A09508	
GSM MS application		
Program for Internal Controller	PU36410300-IC	
GSM BS application		
Program for Internal Controller	PU36410310-IC	
CATV application		
Program for Internal Controller	PU36414001-IC	
Display Hood	R16601	
DC Connecting Cable	A01434	
SWR Bridge	ZRB2	0373.9017.5x
Transit Case	R16072	
Carrying Case	R16216	
Front Cover	A02806	

Distortion signals, frequency response	**U3641**	**U3661 band 0 (N = 1)**	**U3661 band 1 (N = 1)**	**U3661 band 2 (N = 2)**	**U3661 band 4 (N = 4)**
Frequency range	9 kHz to 3 GHz	9 kHz to 3.2 GHz	3.0 GHz to 7.1 GHz	6.7 GHz to 14.5 GHz	13.7 GHz to 26.5 GHz
Noise floor RBW 1 kHz, ATT 0 dB, VBW 10 Hz	Preamplifier off: ≤–117 dBm + 2.7 f[GHz]dB Preamplifier on: ≤–135 dBm + 4.3 f[GHz]dB	–118 dBm + 2f [GHz] >1 MHz	–115 dBm	–110 dBm	–105 dBm
Intermodulation	Preamplifier off: ≤–70 dBc Preamplifier on: ≤–70 dBc	–70 dBc <1.7 GHz –80 dBc >1.7 GHz	–100 dBc	–100 dBc	–100 dBc
Internal distortion signals	Preamplifier off: ≤–100 dB Preamplifier on: ≤–105 dB	–100 dBm >1 MHz	–90 dBm	–90 dBm	–90 dBm
Phase noise	≤–100 dBc/Hz (10 kHz carrier offset)	≤–100 dBc/Hz + 20 logN	≤–100 dBc/Hz + 20 logN	≤–100 dBc/Hz + 20 logN	≤–100 dBc/Hz + 20 logN
Frequency response	Preamplifier off: ≤±1.0 dB (100 kHz to 2.7 GHz) ≤±2.0 dB (9 kHz to 3 GHz) Preamplifier on: ≤±1.0 dB (100 kHz to 2.7 GHz) ≤±2.0 dB (9 kHz to 3 GHz)	±2 dB	±1.5 dB	±3.5 dB	±4 dB

Spectrum Analyzers R3132/N, R3162, R3172, R3182

R3132: 9 kHz to 3 GHz

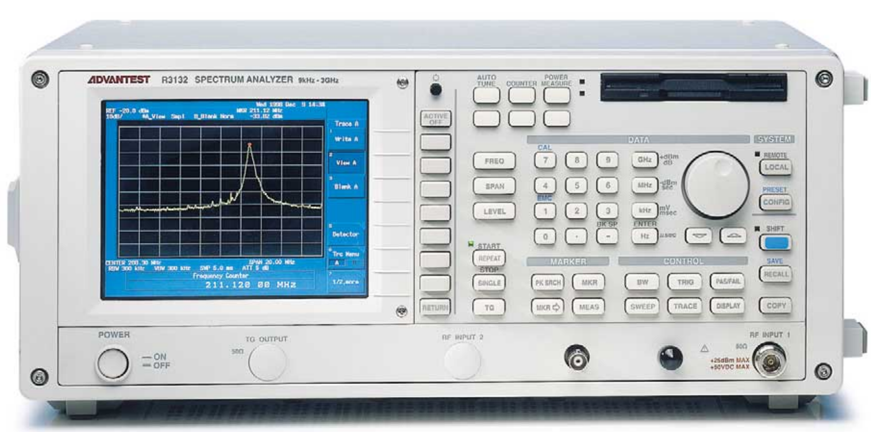
R3132N: 9 kHz to 3 GHz

R3162: 9 kHz to 8 GHz

R3172: 9 kHz to 26.5 GHz

R3182: 9 kHz to 40 GHz

Multi-purpose analyzers for universal uses in development, production, testshop and service



R3132 (photo 43265-1)

Brief description

The medium-class Spectrum Analyzers of series R31x2 from Advantest from 9 kHz up to 40 GHz are powerful allrounders suitable for a wide variety of applications for manual as well as system operation. They constitute cost-effective measurement solutions in the development, production and service of communication products, consumer electronics and in EMC precertification measurements. These analyzers offer very good characteristics in terms of signal resolution, noise floor and dynamic range.

A wide range of analysis functions affords great ease of operation. The growing importance of radio systems in particular makes increasing demands on spectrum analyzers. This aspect has been taken into account by fast sweep time in the zero span, gated sweep, adjacent-channel power measurements and spectrum maks with predefined settings.

Options can be fitted to match individual requirements.

Main features

- A TFT colour screen with a diagonal of 16.5 cm facilitates reading and signal identification
- The noise floor of –131 dBm at 30 Hz resolution bandwidth and as low as –146 dBm with the internal preamplifier switched on allows the analysis of even very weak signals in the range up to 3 GHz
- The ≥8 GHz models incorporate a preselector which does not deteriorate the noise floor
- The sweep time of only 20 ms with a repetition rate of 20 traces/s ensures fast operation, so variations in alignment can be perceived in an almost analog way
- Wide dynamic range with 100 dB logarithmic display range
- The RF input attenuator can be switched up to 8 GHz in 5 dB steps permitting optimization of the intermodulation-free dynamic range
- Resolution bandwidths of 1 kHz to 3 MHz, 10 MHz in zero span; bandwidths of 30 Hz, 100 Hz and 300 Hz are optionally available
- The frequency span error is smaller than 1% due to direct digital synthesis (DDS)
- AM/FM demodulator with loudspeaker and headphone connector
- An IEEE/IEC bus and an RS232 interface with fast data transmission are provided as standard interfaces
- The MS-DOS-compatible floppy disk drive allows the storage of setting parameters and traces in CSV format for integration into Windows applications
- The standard parallel printer interface with PCL and ESC/P formats permits the documentation of measurement results
- Flexible trigger modes for TV applications; model R3132N with 75 Ω input impedance
- Integrated EMC functions enable EMC precompliance testing with 6 dB resolution bandwidths of 200 Hz (optional), 9 kHz, 120 kHz and 1 MHz and quasi-peak detectors
- Frequency range expansion up to 325 GHz for R3172 and R3182 with external mixers
- With a weight of 15 kg to 18 kg, the analyzers are the right choice for laboratory applications as well as on-site servicing. The front and rear panels provide protection against damage during transport

Spectrum Analyzers R3132/N, R3162, R3172, R3182

Measurement functions

- Built-in counter with 1 Hz resolution; no separate frequency counter needed
- PASS/FAIL comparator function for visual checking of compliance with defined limit values
- Autotune function for centering the strongest signal on the screen at a keystroke and displaying it on an expanded frequency range
- Various power measurements at a keystroke
- Further single-knob control functions, eg for occupied bandwidth OBW, % AM, % AM video, FM deviation
- Channel setting for TV and mobile radio systems
- Automatic spurious and S/N ratio measurement in selectable frequency ranges
- Noise measurements for the determination of noise levels or the signal purity of oscillators, normalized to the system bandwidth
- Split-screen display with separate windows

Operation

The control keys on the front panel are logically arranged and easy to operate. There are practically no double assignments. The combination of hardkeys and softkeys allows fast and simple operation and offers a variety of signal processing functions. Results are displayed in a separate window for ease of reading. The instruments can be accommodated in 19" rack adapters for use in systems.

Options

- Narrow resolution bandwidths 30/100/200/300 Hz
- 3-GHz tracking generator for all models up to 26.5 GHz, expanding the built-in analyzer functions by scalar transmission measurements and matching measurements on components
- Fast sweep of 50 µs for measurements on demodulated pulsed and burst signals in the time domain
- Precision frequency reference
- External mixers up to 325 GHz (only R3172 and R3182)

Specifications

Frequency		
Frequency range	R3132	9 kHz to 3 GHz
	R3132N	9 kHz to 2.2 GHz, nutzbar bis 3 GHz
	R3162	9 kHz to 8 GHz
	R3172	9 kHz to 26.5 GHz
	R3182	9 kHz to 40 GHz
Frequency error		±(f x reference frequency + span x 1% + 0.15 x RBW + 60 Hz)
Counter		
Resolution		1 Hz to 1 kHz
Error		±(marker frequency x ref. frequency accuracy + 1 LSD) (S/N ≥25 dB, span ≤200 MHz)
Reference frequency		±2 x 10^{-6}/year
with Option 20		±1 x 10^{-7}/year
		±1 x 10^{-5} (0°C to 50°C)
Span		
Range		1 kHz to 3 (8, 26.5, 40) GHz, zero span
Error		≤±1%
Frequency stability		
Residual FM		≤60 Hz p-p/100 ms
with Option 20		≤20 Hz p-p/100 ms
Signal purity		
Sideband noise (SSB), f<8 GHz		
10 kHz carrier offset		≤100 dBc/Hz
20 kHz		≤105 dBc/Hz
100 kHz		≤118 dBc/Hz, typ.
1 MHz		≤135 dBc/Hz, typ.
Resolution bandwidths (3 dB)		
Range		1 kHz to 3 MHz; in 1 to 3 sequence 10 MHz for zero span
with Option 27		30/100/300 Hz
Selectivity (60:3 dB)		< 15 : 1
6dB bandwidth		9 kHz, 120 kHz, 1 MHz
with Option 27		200 Hz
Video bandwidth		10 Hz to 3 MHz, 1 to 3 sequence
Level		
Display range		+30 dBm down to displayed average noise level
Max. input level		
Preamplifier OFF		+30 dBm, ±50 V DC max. (0 V DC R3162/72/82)
R3132N		+134 dBµV, ±50 V DC max.,
Preamplifier ON		+13 dBm, ±50 V DC max. (0 V DC R3162/72/82)
Display range		
Log		10, 5, 2, 1 dB/div 10 x 10 grid
Linear		10%/div of reference level
Reference level range		
Preamplifier OFF		
Log		–64 dBm to +40 dBm, 0.1 dB steps
Linear		+141.1 µV to 22.36 V
Preamplifier ON		
Log		–82 dBm to +20 dBm, 0.1 dB steps
Linear		+17.8 µV to 281.5 mV
RF input divider (range)		
R3132/N		0 to 50 dB, 5 dB steps
R3162		0 to 75 dB, 5 dB steps
R3172		0 to 70 dB, 10 dB steps
R3182		0 to 70 dB, 10 dB steps

Spectrum Analyzers R3132/N, R3162, R3172, R3182

Sweep

Sweep time	20 ms to 1000 s (R3172/82: 10 ms at deviation ≤100 MHz) zero span 50 µs to 1 s
Sweep error	±1%
Trigger functions	free run, line, video, external, TV-H/V, with zero span also trigger delay (pre-/post trigger)
Sweep types	repeating, one-time, window sweep
Detector	normal (max./min.), sample, positive/negative peak

Dynamic range

Inherent noise	
RBW 1 kHz; VBW 10 Hz; ATT 0 dB	
1 MHz to 3.3 GHz	
Preamplifier OFF	<–118 dBm + 2 f [GHz] dB
Preamplifier ON	<–132 dBm + 3 f [GHz] dB
Displayed average noise level	
R3162	
3.3 GHz...8 GHz,	<–115 dBm + 0.5 f [GHz] dB
R3172	
3.3 GHz...7.1 GHz	<–115 dBm + 0.5 f [GHz] dB
7 GHz to 14.7 GHz	<–111 dBm
14.5 GHz to 22 GHz	<–107 dBm
22 GHz to 26.5 GHz	<–104 dBm
R3182	
3.2 GHz to 7.1 GHz	<–115 dBm
7 GHz to 14.7 GHz	<–113 dBm
14.5 GHz to 27 GHz	<–110 dBm
26.5 GHz to 30 GHz	<–107 dBm
29.5 GHz to 40 GHz	<–106 dBm
1 dB compression of input mixer (f >100 MHz and <3 GHz)	>0 dBm (mixer input level)
RF input with preamplifier ON	>–25 dBm
2nd order interference signal	
100 to 800 MHz	≤–75 dBc (R3172/82: ≤–70 dBc), –30 dBm mixer level
0.8 to 3.3 GHz	≤–80 dBc, –30 dBm mixer level
> 3.3 GHz	≤–100 dBc (R3182: ≤–95 dBc), –10 dBm mixer level ≤–70 dBc (f >3.3 GHz)
3rd order intermodulation	≤–80 dBc, –30 dBm input (frequency 200 MHz to 3.3 GHz, offset of both signals >50 kHz)
3rd order intercept point, TOI	>10 dBm
2nd order intercept point, SHI	>50 dBm
Other input interference	≤–70 dBc, ≤–60 dBc (>18 GHz)
Inherent spurious	
1 MHz to 3.3 GHz	≤–100 dBm (Preamplifier OFF)
f > 3.3 GHz	≤–90 dBm, ATT 0 dB, input terminated with 50 Ω
1 MHz to 3.3 GHz	≤–105 dBm (Preamplifier ON)

Amplitude error

Calibration signal	30 MHz
Error	–20 dBm ±0.3 dB
Frequency response (ATT = 10 dB, relative to 30 MHz and following automatic calibration), preamplifier OFF	
100 kHz to 3 GHz	≤±0.5 dB
9 kHz to 3,3 GHz	≤±1.5 dB
3,3 GHz to 7,1 GHz	≤±1.6 dB
7,1 GHz to 14,7 GHz	≤±1.8 dB
14,7 GHz to 27 GHz	≤±2.5 dB
27 GHz to 30 GHz	≤±3.0 dB
30 GHz to 40 GHz	≤±3.5 dB
Scale fidelity/linearity (following internal calibration)	≤±0.5 dB (0 to –20 dB)
Log	≤±1.5 dB/90 dB ≤±1.0 dB/10 dB ≤±0.2 dB/1 dB
Linear	5% of reference level
Input divider (switching error relative to an attenuation of 10 dB at 30 MHz)	≤±0.3 dB (0 to 50 dB)
Resolution bandwidth switching error (following internal calibration)	≤±0.5 dB
IF amplification error (following internal calibration)	<±0.5 dB
Total level error (REF = –50 to 0 dBm, ATT = 10 dB, 2 dB/div., RBW = 300 kHz, f = 100 kHz to 3 GHz)	±1.5 dB (R3132N to 2.2 GHz)

Interfaces

RF input	
R3132/N, R3162	N female
R3172	SMA female
R3182	K female
Impedance	50 Ω, (R3132N: 75 Ω)
VSWR (Preamplifier OFF)	
100 kHz to 3.3 GHz, ATT ≥10 dB	≤1.5 : 1
3.2 GHz to 27 GHz, ATT ≥10 dB	≤2.0 : 1
26.5 kHz to 40 GHz, ATT ≥10 dB	≤2.2 : 1
9 kHz to 3.3 GHz	≤1.5 : 1 (Preamplifier ON)
Calibration output	BNC connector, 50 Ω (R3132N: 75 Ω)
Frequency, level	30 MHz, –20 dBm
10 MHz reference input	BNC connector at rear panel, 50 Ω
Level range	0 dBm to +16 dBm
External trigger and gate input	BNC connector at rear panel 10 kΩ (nominal), DC-coupled
Y output	0 to 2 V (100 dB), BNC connector, rear panel
AF output	subminiature headphone connector at rear panel, 0.2 W max. into 8 Ω (nominal)
External mixer output	R3182 standard, R3172 optional
Frequency range	4 GHz to 7.6 GHz
Level, impedance, connector	>+8 dBm, 50 Ω, SMA female
AM/FM demodulation, internal loudspeaker	
Probe power output	±12 V, 100 mA, 4 pin, power supply for active sensors
IEEE/IEC bus	IEEE-488-bus connector, rear panel
Serial interface	RS-232, D-SUB 9 pin, rear panel
VGA monitor output	D-SUB 15 pin, rear panel
Printer interface	D-SUB 25 pin, rear panel ESC/P; PCL printer
Disk drive	3.5 ''; MS-DOS format

Tracking generator option

R3132/3162/3172	100 kHz to 3 GHz
R3132N	100 kHz to 2.2 GHz
Output power	0 to –59.9 dBm, 0.1 dB steps
Frequency response	<±1.5 dB
Harmonics	<–20 dBc
RF input protection	

Spectrum Analyzers R3132/N, R3162, R3172, R3182

General data

Screen	16,5 cm (6.5 ")
Resolution	1000 x 700 pixels
Grid (W x H)	104 x 76 mm
	2 screen memories A and B, split screen, auxiliary line editor, date/clock, colour selection, setting parameters (can be switched off)
Evaluation functions	marker, delta marker, multimarker (10), signal track, peak search, next peak, offset settable for frequency and level, display line, reference line, limit traces with comparator pass/fail, 10 memories for setting configurations and traces, averaging, noise measurements, power measurements, OBW and ACP measurements, auto-tune, automatic selftest, calibration routines, transducer selectable
Operating temperature	0° to 50°C
Storage temperature	–20°C to + 60°C
Relative humidity	<85%
Power supply	automatic switching between 100 V AC and 220 V AC
100 V AC	90 V to 132 V, 50 to 60 Hz
220 V AC	198 V to 250 V, 50 to 60Hz
Power consumption	<150 to 200 VA
Dimensions (W x H x D)	424 mm x 177 mm x 300 mm, without feet, without connectors
Weight	15 kg to 18 kg, depending on model and options fitted

Ordering information

Spectrum Analyzer

50 Ω, 9 kHz to 3 GHz	R3132
75 Ω, 9 kHz to 2.2 (3) GHz	R3132N
50 Ω, 9 kHz to 8 GHz	R3162
50 Ω, 9 kHz to 26.5 GHz	R3172
50 Ω, 9 kHz to 40 GHz	R3182

Options

Connector for external mixer	3 (only R3172, R3182 standard)
Precision frequency reference	20
Resolution bandwidths 30/100/300 Hz	27
Sweep time for zero span 50 µs to 1 s	29
Tracking generator	74 (not for model R3182)

Extras

Transport case	R16080
19" rack adapter	A02468
IEEE/IEC bus cable	408JE-101/102
VSWR bridge, 5 to 3000 MHz	ZRB2 (Rohde&Schwarz)
N cable, BNC cable, filter	

Vector Network Analyzers ZVM, ZVK

ZVM: 10 Hz to 20 GHz

ZVK: 10 Hz to 40 GHz

Extremely fast, high-precision and versatile vector network analyzers

Photo 43453-2

Brief description

ZVM and ZVK extend the frequency range of the Rohde&Schwarz network analyzers to 20 GHz and 40 GHz. Their outstanding performance in terms of speed, dynamic range and accuracy shows already in standard applications such as S-parameter or group delay measurements. This is enhanced by a wealth of measurement, display and logging functions. In addition, ZVM and ZVK can be used for complex measurement tasks, for example measurements on frequency-converting DUTs (conversion loss, intermodulation, spurious) and nonlinear measurements (intercept point and compression point).

Short measurement times
A powerful microprocessor system combined with ultra-fast synthesizers makes for extremely short measurement times even with a large number of test points and small measurement bandwidths. This in conjunction with short IEEE/IEC bus access and transfer times considerably speeds up automated test and production sequences.

Wide dynamic range
The extremely low-noise front end, using fundamental mixing, yields a dynamic range that, with appropriate configuration, by far exceeds the specified values of 115 dB and 110 dB. This exceptionally wide range makes it possible to measure RF components with high stopband attenuation and achieve high accuracy also at low power levels.

Measurements on linear and nonlinear components
The system concept of ZVM and ZVK with two independent synthesizers for the generator and receiver sections enables versatile measurements with excellent accuracy, wide dynamic range and high measurement speed on linear and nonlinear DUTs such as amplifiers and mixers. Three generators (one internal, two external) can be configured and controlled independently of each other. The fundamental mixing concept of ZVM and ZVK and the resulting high selectivity make additional external filters superfluous.

The receiver will even detect weak signals such as intermodulation products and spurious, since the full sensitivity and dynamic range of ZVM and ZVK are available also for frequency-converting DUTs.

Typical measurements on amplifiers, frequency converters, multipliers, dividers, synthesizers etc are:

- K factor
- Power added efficiency (PAE)
- sidebands of mixers with fixed or tracking IF
- any harmonics versus frequency or power
- intermodulation products of amplifiers and mixers (e.g. IP3, IP5, IP7...)
- spurious
- mixture products of DUTs with multiple frequency conversion, multipliers, dividers and combinations of such components

Vector Network Analyzers ZVM, ZVK

	ZVM	ZVK
Frequency range	10 MHz to 20 GHz	10 MHz to 40 GHz
Frequency resolution	100 µHz	
Impedance	50 Ω	
Test ports	PC 3.5 male	2.92 mm male
Measurement time (normalized)	<0.5 ms/point	<0.7 ms/point
Output power	+5 dBm/+2 dBm to –85 dBm	0 dBm/–5 dBm to –85 dBm
Power uncertainty	<1 dB to 2 dB	
Dynamic range* **(IF bandwidth 10 Hz)** *When using direct receiver access, dynamic range and sensitivity are increased to typ.10 dB.	>85 dB (<0.5 GHz) >115 dB (0.5 GHz to 8 GHz) >110 dB (8 GHz to 16 GHz) >100 dB (16 GHz to 20 GHz)	>80 dB (<0.5 GHz) >110 dB (0.5 GHz to 8 GHz) >105 dB (8 GHz to 16 GHz) >90 dB (16 GHz to 20 GHz) >90 dB (20 GHz to 28 GHz) >80 dB (28 GHz to 40 GHz)
Measurement bandwidths	1 Hz to 10 kHz (in 9 steps) and 26 kHz	
Calibration techniques	TOM, TRM, TNA, TOM-X, AutoKal (all Rohde&Schwarz patents), TRL, TOSM, normalization techniques	

Embedding and de-embedding of virtual networks, CAE software
The Virtual Embedding Networks option enables virtual embedding of arbitrary linear two-port networks into the test setup.

In testing for example components that have to be matched to a given impedance, an automatic embedding process allows the necessary matching network to be taken into account through mathematical algorithms of ZVM and ZVK.

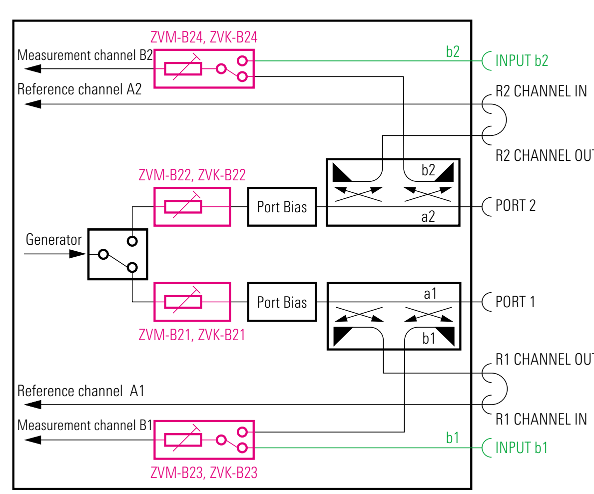
Conversely, by de-embedding, the influence of a known network can be eliminated.

The required data (*.S1P, *.S2P, *.S4P, *.flp) are obtained from a measurement of the existing network or generated by CAE tools from the theoretical model.

Time-domain measurements
By transforming measurement data from the frequency to the time domain, discontinuities or impedances along the DUT can be displayed as a function of DUT length. With a maximum number of 2001 points, ZVM and ZVK can measure even very long DUTs with high resolution. Five filters allow the location of a discontinuity and the sidelobe suppression to be determined with optimum resolution. The S-parameters of a given discontinuity can be displayed in the time domain by setting a window (gating).

Special calibration techniques
ZVM and ZVK feature modern calibration techniques patented by Rohde&Schwarz that allow full two-port calibration using fewer or only partially known standards. This simplifies the design of calibration standards used for example in test fixtures or on wafers. Thus calibration in non-coaxial systems can be performed with a minimum of effort at maximum accuracy and dynamic range.

Internal PC and Ethernet
ZVM and ZVK are based on Windows NT. The user has complete access to the hard disk, the floppy disk drive and all interfaces of the internal PC. This allows, for example, the connection of an external monitor, the installation of any type of printer, or the use of software tools on ZVM or ZVK for result processing or control of the network analyzers via the IEEE/IEC bus or an internal RSIB data bus. ZVM and ZVK can thus act as controllers of their own or for a complete test or production system. Moreover, the internal PC enables control and data exchange via Ethernet.



Test set of ZVM and ZVK

Vector Network Analyzers ZVM, ZVK

Specifications

Unless otherwise stated, specifications apply to test ports PORT 1 and PORT 2, a nominal output power of –10 dBm at the source port and an IF bandwidth ≤10 kHz.

Especially important data are framed in blue

Measurement range

Characteristic impedance	50 Ω

Port connectors

ZVM	3.5 mm (male)
ZVK	2.92 mm (male)

Frequency

Range ZVM	10 MHz to 20 GHz
Range ZVK	10 MHz to 40 GHz
Uncertainty	$4 \times 10^{-6} + 1 \times 10^{-6}$ x operating time in years
Resolution	100 µHz

Number of test points (selectable)	1 to 2001

Measurement time per point

with min. 400 points		ZVM	ZVK
and IF bandwidth of	10 Hz	10 kHz	10 kHz
with system error correction	<200 ms	<0.9 ms	<1.1 ms
normalized	<100 ms	<0.5 ms	<0.7 ms

Dynamic range (without system error correction, without optional attenuator)

	ZVM	ZVM	ZVK	ZVK
at IF bandwidth of	10 Hz	10 kHz	10 Hz	10 kHz
up to 500 MHz	>75 dB	>45 dB	>70 dB	>40 dB
500 MHz to 8 GHz	>115 dB	>85 dB	>110 dB	>80 dB
8 GHz to 16 GHz	>110 dB	>80 dB	>105 dB	>75 dB
16 GHz to 20 GHz	>100 dB	>70 dB	>90 dB	>60 dB
20 GHz to 28 GHz			>90 dB	>60 dB
28 GHz to 40 GHz			>80 dB	>50 dB

Measurement bandwidths (IF bandwidths)	1 Hz to 10 kHz (half-decade steps) and 26 kHz (full)

Measurement accuracy

ZVM uncertainty of transmission measurements
after system error correction
Specifications are based on a matched DUT, an IF bandwidth of 10 Hz, and a nominal output power of –10 dBm at the source port.

10 MHz to 500 MHz	
for +15 dB to –25 dB	0.2 dB or 2°
for –25 dB to –35 dB	1 dB or 6°
500 MHz to 8 GHz	
for +15 dB to +5 dB	0.2 dB or 2°
for +5 dB to –50 dB	0.1 dB or 1°
for –50 dB to –65 dB	0.2 dB or 2°
for –65 dB to –80 dB	1 dB or 6°
8 GHz to 16 GHz	
for +15 dB to –55 dB	0.2 dB or 2°
for –55 dB to –70 dB	1 dB or 6°
16 GHz to 20 GHz	
for +12 dB to +5 dB	0.3 dB or 3°
for +5 dB to –30 dB	0.2 dB or 2°
for –30 dB to –45 dB	0.3 dB or 3°
for –45 dB to –60 dB	1 dB or 6°

ZVM uncertainty of reflection measurements
after system error correction
Specifications are based on an isolating DUT, an IF bandwidth of 10 Hz, and a nominal output power of –10 dBm at the source port.

10 MHz to 20 GHz	
for +10 dB to +3 dB	0.6 dB or 4°
for +3 dB to –15 dB	0.4 dB or 3°
for –15 dB to –25 dB	1 dB or 6°
for –25 dB to –35 dB	3 dB or 20°

Variation of data trace at 0 dB per Kelvin of temperature variation	<0.2 dB or <2°

ZVK uncertainty of transmission measurements
after system error correction
Specifications are based on a matched DUT, an IF bandwidth of 10 Hz, and a nominal output power of –10 dBm at the source port.

10 MHz to 500 MHz	
for +10 dB to –15 dB	0.2 dB or 2°
for –15 dB to –30 dB	1 dB or 6°
500 MHz to 8 GHz	
for +10 dB to +5 dB	0.2 dB or 2°
for +5 dB to –45 dB	0.1 dB or 1°
for –45 dB to –60 dB	0.2 dB or 2°
for –60 dB to –75 dB	1 dB or 6°
8 GHz to 16 GHz	
for +10 dB to –50 dB	0.2 dB or 2°
for –50 dB to –65 dB	1 dB or 6°
16 GHz to 28 GHz	
for +5 dB to –20 dB	0.2 dB or 2°
for –20 dB to –35 dB	0.3 dB or 3°
for –35 dB to –50 dB	1 dB or 6°
28 GHz to 40 GHz	
for +5 dB to –10 dB	0.2 dB or 2°
for –10 dB to –25 dB	0.3 dB or 3°
for –25 dB to –40 dB	1 dB or 6°

ZVK uncertainty of reflection measurements
after system error correction
Specifications are based on an isolating DUT, an IF bandwidth of 10 Hz, and a nominal output power of –10 dBm at the source port.

10 MHz to 20 GHz	
for +5 dB to –15 dB	1 dB or 6°
for –15 dB to –30 dB	3 dB or 20°
20 GHz to 40 GHz	
for +5 dB to 0 dB	2 dB or 15°
for 0 dB to –10 dB	1 dB or 6°
for –10 dB to –25 dB	3 dB or 20°

Variation of data trace at 0 dB per Kelvin of temperature variation	<0.2 dB or <2°

Vector Network Analyzers ZVM, ZVK

Effective system data

Frequency range	50 MHz to 20 GHz		above 20 GHz
	ZVM	ZVK	ZVK
Directivity	>46 dB	>42 dB	>38 dB
Source match	>36 dB	>36 dB	>33 dB
Reflection tracking	<0.1 dB	<0.1 dB	<0.1 dB
Load match	>46 dB	>42 dB	>38 dB
Transmission tracking	<0.1 dB	<0.1 dB	<0.2 dB

Output power

Range without optional generator step attenuator	ZVM	ZVK
up to 16 GHz	–20 to +5 dBm	–20 to 0 dBm
above 16 GHz	–20 to +2 dBm	–20 to –5 dBm
Uncertainty at –10 dBm		
without optional power calibration	2 dB	2 dB
150 MHz to 16 GHz in temperature range 20°C to 26°C	1 dB	1 dB
Linearity (referred to –10 dBm)	<1 dB	<1 dB
above 150 MHz in temperature range 20°C to 26°C	<0.4 dB	<0.4 dB
Resolution	0.1 dB	0.1 dB

Spectral purity

Harmonics

at maximum nominal source power	ZVM	ZVK
up to 10 GHz	<–23 dBc	<–20 dBc
10 GHz to 20 GHz	<–17 dBc	<–15 dBc
above 20 GHz		<–25 dBc
at –10 dBm source power		
up to 10 GHz	<–30 dBc	<–30 dBc
above 10 GHz	<–25 dBc	<–25 dBc

Spurious	<–35 dBc	<–35 dBc

SSB phase noise

1 Hz bandwidth,10 kHz from carrier	
up to 150 MHz	<–100 dBc
150 MHz to 1 GHz	<–90 dBc
above 1 GHz	<–90 dBc + 20 x log (f/GHz)
	<–78 dBc at 4 GHz
	<–72 dBc at 8 GHz
	<–64 dBc at 20 GHz
	<–58 dBc at 40 GHz (ZVK)

Residual FM

RMS weighting from 10 Hz to 3 kHz	
up to 150 MHz	<2 Hz
150 MHz to 1 GHz	<5 Hz
1 GHz to 2 GHz	<10 Hz
2 GHz to 4 GHz	<20 Hz
4 GHz to 8 GHz	<40 Hz
8 GHz to 20 GHz	<80 Hz
20 GHz to 40 GHz (ZVK)	<160 Hz

Input level

Maximum nominal input level

without optional receiver step attenuator	+5 dBm
with receiver step attenuator set to 0 dB	+5 dBm
with receiver step attenuator set to ≥30 dB	+27 dBm

Level measurement uncertainty (without optional power calibration) in temperature range 20 °C to 26 °C

up to 500 MHz	for +5 dBm to –45 dBm	2 dB
500 MHz to 16 GHz	for +5 dBm to –70 dBm	2 dB
16 GHz to 20 GHz	for +5 dBm to –50 dBm	2 dB
20 GHz to 28 GHz	for +5 dBm to –50 dBm (ZVK)	3 dB
above 28 GHz	for +5 dBm to –30 dBm (ZVK)	4 dB

Damage level

without optional receiver step attenuator	+27 dBm
with receiver step attenuator set to 0 dB	+27 dBm
with receiver step attenuator set to ≥30 dB	+30 dBm

Damage DC current/voltage 0.5 A or 30 V

RMS noise level at IF bandwidth 10 Hz

up to 500 MHz	<–80 dBm
500 MHz to 8 GHz	<–110 dBm
8 GHz to 16 GHz	<–105 dBm
16 GHz to 20 GHz	<–95 dBm
20 GHz to 28 GHz (ZVK)	<–95 dBm
above 28 GHz (ZVK)	<–85 dBm

Match (without system error correction)

up to 50 MHz	>10 dB
50 MHz to 8 GHz	>12 dB
8 GHz to 20 GHz	>10 dB
above 20 GHz (ZVK)	>8 dB

Reference channel inputs

R CHANNEL IN

	ZVM	ZVK
Connectors	SMA (female)	2.92 mm (female)
Match	>12 dB	>8 dB
Maximum nominal input level	+5 dBm	+5 dBm
Damage level	+20 dBm	+20 dBm

Display

Screen	26 cm colour LCD
Resolution	640 x 480 x 256
Sweep modes	frequency, power, and time
Parameter formats (examples)	S parameters and derived quantities like SWR, impedance, admittance, group delay, etc, as well as nonlinear parameters (optional) like n dB compression point, SOI and TOI. Complex parameters are displayed either in a complex form or formatted to magnitude, phase, real or imaginary part
Diagrams (examples)	Cartesian: linear, simple or double logarithmic, segmented polar: linear, logarithmic or segmented, Smith (any zoom), inverted Smith, Charter
Scaling (examples)	0.001 dB/ to 50 dB/ 1 m°/ to 200 k°/ 1 pU/ to 1 GU/ (automatically variable number of grid lines through MAX/MIN scaling)
Multichannel display	up to 4 independent display channels (CH1 to CH4)
Screen formats (examples)	overlay, dual channel split, quad channel split

Markers	8 normal markers or 7 delta markers for each display channel
Marker resolution	4 significant digits
Marker formatting	selectable, independent of trace formatting
Automatic marker functions	marker tracking, marker search, marker target, band filter functions (Q, shape factor, etc)
Trace mathematics	all four arithmetical operations with up to three operands
Display lines	horizontal lines, circles or radial lines
Limit lines	pairs of curves formed from line segments in Cartesian diagrams, any circles in polar diagrams

Further connectors (rear panel)

PORT BIAS 1/2	DC bias inputs for PORT 1/2
EXT TRIGGER	input for external trigger signal
LEVEL	input for external level control
DC MEAS INPUTS DC 1/2	DC measurement inputs
EXT FREQ REF IN	input for external reference frequency
EXT FREQ REF OUT	output of internal reference frequency
EXTERNAL GENERATOR	Connectors for high-speed control of an external generator from Rohde& Schwarz families
BLANK (input)	TTL signal
TRIGGER (output)	TTL signal
ANALYZER MONITOR	IBM-PC-compatible VGA connector for analyzer screen
PC MONITOR	IBM-PC-compatible VGA connector for PC screen
MOUSE	IBM-PC-compatible PS/2 connector
KEYBOARD	IBM-PC-compatible 5-contact DIN connector
USER (input/output)	16 bit TTL, user-programmable, 25-contact sub-D
COM 1/ COM 2	IBM-PC-compatible serial interfaces, RS232, 9-contact sub-D
IEC BUS	remote-control interface IEEE488, IEC625, 24-contact (for general applications)
IEC SYSTEM BUS	remote-control interface IEEE488, IEC625, 24-contact (for control of generators, eg as local oscillators in mixer measurements)
LPT	IBM-PC-compatible printer interface, Centronics, 25-contact sub-D
MULTIPORT	control of optional three-port and four-port adapters

General data

Temperature loading	
Specs complied with	5°C to 40°C
Operational	0°C to 50°C
Storage temperature range	–40°C to +70°C
	meets IEC68-2-1, IEC68-2-2
Calibration interval	1 year
Power supply	100 V to 120 V (AC) with tolerance ±10%, 6 A, 50 Hz to 400 Hz with tolerance –6 % and +10% or 200 V to 240 V (AC) with tolerance ±10%, 3 A, 50 Hz to 60 Hz with tolerance –6% and +10% safety class I to VDE411
Power consumption	280 W (standby: 10 W)
Test mark	VDE, GS, CSA, CSA-NRTL/, c∈ mark
Dimensions (W x H x D)	435 mm x 281 mm x 584 mm
Weight	30 kg

Option overview

Option	Type	Features and benefits
AutoKal	ZVR-B1	Full two-port calibration within a few seconds
Time Domain	ZVR-B2	Localization of discontinuities, determination of reflection coefficients of discontinuities as a function of length/delay, supplementary function for calibration, tuning of filters, optimization of connectors, etc
Mixer Measurements	ZVR-B4	Easy converter and mixer measurements (conversion gain) Convenient measurements of amplifier and mixer products vs. frequency (spurious, harmonics, intermodulation products, etc)
Nonlinear Measurements	ZVR-B5	Display of compression point and SOI/TOI versus frequency
Power Calibration	ZVR-B7	High absolute power accuracy of generators (internal and external) and receivers for amplifier and mixer measurements
3-Port Adapter	ZVR-B8	Measurements of 3-port devices such as duplex filters
Virtual Embedding Networks	ZVR-K9	Replacing various test fixtures with physical matching networks by one single standard fixture and virtual networks High accuracy and reproducibility, e.g. in SAW filter measurements
4-Port Adapter	ZVR-B14	Simultaneous measurement of two 2-port devices Measurements on diplexers
Ethernet Interface for internal PC	FSE-B16	Control and data transfer of ZVM or ZVK via Ethernet
IEEE/IEC bus Interface for internal PC	FSE-B17	Control of ZVM or ZVK and external test equipment by internal PC
Generator Step Attenuator PORT 1	ZVM-B21, ZVK-B21	Decrease of minimum generator output power down to –90 dBm at PORT 1
Generator Step Attenuator PORT 2	ZVM-B22, ZVK-B22	Decrease of minimum generator output power down to –90 dBm at PORT 2
Receiver Step Attenuator PORT 1	ZVM-B23, ZVK-B23	Increase of maximum receiver input power at PORT 1 to +27 dBm Direct access to measurement channel b1
Receiver Step Attenuator PORT 2	ZVM-B24, ZVK-B24	Increase of maximum receiver input power at PORT 2 to +27 dBm Direct access to measurement channel b22

Vector Network Analyzers ZVM, ZVK

Order designation	Type	Frequency range	Order No.
Analyzers			
Vector Network Analyzer 4-channel, 50 Ω, active test set	ZVM	10 MHz to 20 GHz	1127.8500.60
Vector Network Analyzer 4-channel, 50 Ω, active test set	ZVK	10 MHz to 40 GHz	1127.8651.60
Options			
Time Domain	ZVR-B2	–	1044.1009.02
Mixer Measurements[1]	ZVR-B4	–	1044.1215.02
Nonlinear Measurements	ZVR-B5	–	1044.1321.02
Power Calibration[2]	ZVR-B7	–	1044.1544.02
Virtual Embedding Networks[3]	ZVR-K9	–	1106.8830.02
Ethernet AUI for internal PC	FSE-B16	–	1073.5973.02
Ethernet BNC for internal PC	FSE-B16	–	1073.5973.03
Ethernet RJ45 for internal PC	FSE-B16	–	1073.5973.04
IEEE/IEC bus Interface for internal PC	FSE-B17	–	1066.4017.02
Generator Step Attenuator for ZVM, PORT 1	ZVM-B21	–	1128.1009.11
Generator Step Attenuator for ZVM, PORT 2	ZVM-B22	–	1128.1009.21
Receiver Step Attenuator for ZVM, PORT 1[4]	ZVM-B23	–	1128.1009.12
Receiver Step Attenuator for ZVM, PORT 2[5]	ZVM-B24	–	1128.1009.22
Generator Step Attenuator for ZVK, PORT 1	ZVK-B21	–	1128.1409.11
Generator Step Attenuator for ZVK, PORT 2	ZVK-B22	–	1128.1409.21
Receiver Step Attenuator for ZVK, PORT 1[4]	ZVK-B23	–	1128.1409.12
Receiver Step Attenuator for ZVK, PORT 2[5]	ZVK-B24	–	1128.1409.22
ZVM, ZVK accessories			
Test Cables (pairs)			
PC3.5 (f)/PC3.5 (m), 50 Ω (for ZVM)[6]	ZV-Z14	0 Hz to 26.5 GHz	1134.4093.02
2.92 mm (f)/2.92 mm (m), 50 Ω (for ZVK)[6]	ZV-Z15	0 Hz to 40 GHz	1134.4193.02
Calibration Kits			
PC3.5 (for ZVM)	ZV-Z32	0 Hz to 26.5 GHz	1128.3501.02
PC3.5 incl. Sliding Matches (for ZVM)	ZV-Z33	0 Hz to 26.5 GHz	1128.3518.02
2.92 mm (for ZVK)	ZV-Z34	0 Hz to 40 GHz	1128.3530.02
2.92 mm incl. Sliding Matches (for ZVK)	ZV-Z35	0 Hz to 40 GHz	1128.3547.02
N, 50 Ω	ZV-Z21	0 Hz to 18 GHz	1085.7099.02
TRL Supplementary Kit, N, 50 Ω	ZV-Z26	0.4 GHz to 18 GHz	1085.7318.02
TRL Supplementary Kit, PC3.5, 50 Ω	ZV-Z27	0.4 GHz to 26.5 GHz	1085.7401.02
TOM-X Supplementary Kit, N, 50 Ω	ZV-Z28	0 Hz to 18 GHz	1085.7499.03
TOM-X Supplementary Kit, PC3.5, 50 Ω	ZV-Z29	4 GHz to 26.5 GHz	1085.7647.03
Sliding Matches			
N (m), 50 Ω	ZV-Z41	1.7 GHz to 18 GHz	1085.8095.02
N (f), 50 Ω	ZV-Z41	1.7 GHz to 18 GHz	1085.8095.03
PC3.5 pair m, f (for ZVM)	ZV-Z42	0 Hz to 26.5 GHz	1128.3524.02
2.92 mm pair m, f (for ZVK)	ZV-Z44	0 Hz to 40 GHz	1128.3553.02
General accessories			
Hardware Options N, 50 Ω			
AutoKal[7]	ZVR-B1	0 Hz to 8 GHz	1044.0625.02
3-Port Adapter[7]	ZVR-B8	0 Hz to 4 GHz	1086.0000.02
4-Port Adapter (2 x SPDT)[7]	ZVR-B14	0 Hz to 4 GHz	1106.7510.02
4-Port Adapter (SP3T)[7]	ZVR-B14	0 Hz to 4 GHz	1106.7510.03
Test Cables (pairs)			
N (m)/N (m), 50 Ω	ZV-Z11	0 Hz to 18 GHz	1085.6505.03
N (m)/N (m), 75 Ω	ZV-Z12	0 Hz to 4 GHz	1085.6570.02
N (m)/PC3.5 (m), 50 Ω	ZV-Z13	0 Hz to 18 GHz	1134.3997.02
Calibration Kits			
N, 50 Ω	ZCAN	0 Hz to 3 GHz	0800.8515.52
N, 75 Ω	ZCAN	0 Hz to 3 GHz	0800.8515.72
Attenuators			
1 W	DNF	0 Hz to 12.4 GHz	0272.4X10.50[8]
50 W	RBU 50	0 Hz to 2 GHz	1073.8695.XX[9]
100 W	RBU 100	0 Hz to 2 GHz	1073.8495.XX[9]
Matching Pads, N, 50 Ω → N, 75 Ω			
Series Resistor	RAZ	0 Hz to 2.7 GHz	0358.5714.02
L Section	RAM	0 Hz to 2.7 GHz	0358.5414.02
Various Accessories, N, 50 Ω			
T Check	ZV-Z60	0 Hz to 4 GHz	1108.4990.50
Bias Network	ZV-Z61	2 MHz to 4 GHz	1106.8130.02
DC Block	FSE-Z3	5 MHz to 7 GHz	4010.3895.00
Power Splitter 2 x 50 Ω	RVZ	0 Hz to 2.7 GHz	0800.6612.52
External SWR-Bridges			
N (f), 50 Ω	ZRA	40 kHz to 150 MHz	1052.3607.52
N (f), 50 Ω	ZRB2	5 MHz to 3 GHz	0373.9017.52
N (f), 75 Ω	ZRB2	5 MHz to 2 GHz	0802.1018.73
N (f), 50 Ω	ZRC	40 kHz to 4 GHz	1039.9492.52
N (f), 75 Ω	ZRC	40 kHz to 2.5 GHz	1039.9492.72
Miscellaneous			
Transit Case	ZZK-965	–	1013.9437.00
19"-Rack Adapter with front handles	ZZA-96	–	0396.4928.00

1) Harmonics and arbitrary frequency conversion measurement included.

2) Power meter and sensor required.

3) Only for ZVR, ZVC, ZVM, ZVK.

4) Comprises test port 'Input b1', for bypassing coupler at PORT 1.

5) Comprises test port 'Input b2', for bypassing coupler at PORT 2.

6) For ruggedized port.

7) Two adapters PC 3.5 (f)/N (f) or 2.92 mm (f)/N (f) reqired.

8) X = 0: 3 dB, X = 1: 6 dB, X = 2: 10 dB, X = 3: 20 dB, X = 4: 30 dB.

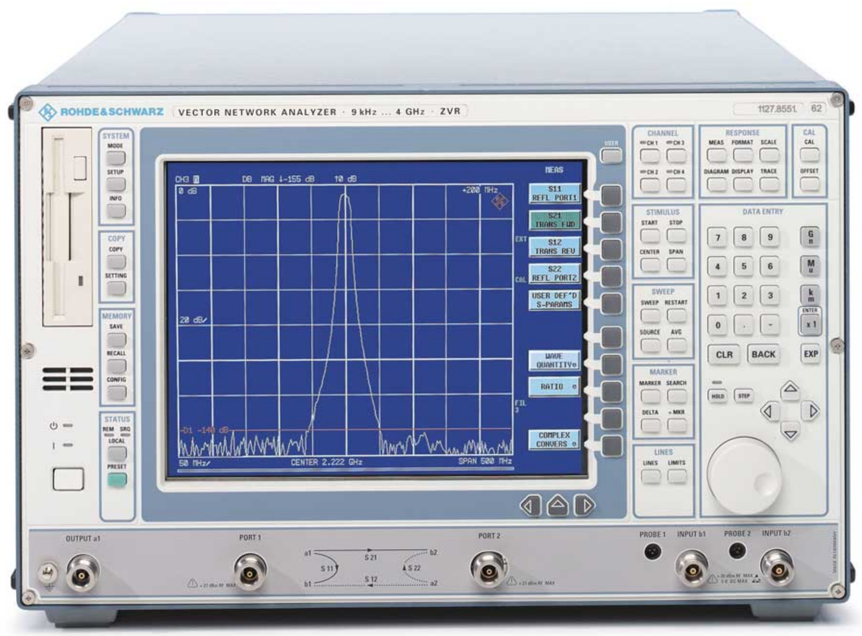
9) XX = 03: 3 dB, XX = 06: 6 dB, XX = 10: 10 dB, XX = 20: 20 dB, XX = 30: 30 dB.

Vector Network Analyzers ZVC, ZVCE, ZVR, ZVRE, ZVRL

ZVRx: (10 Hz) 9 kHz to 4 GHz

ZVCx: 20 kHz to 8 GHz

Extremely fast, high-precision and versatile vector network analyzers



ZVR (photo 43462-3)

Brief description

The family comprises the five Vector Network Analyzers ZVRL, ZVRE and ZVR as well as ZVCE and ZVC which extend the frequency range to 8 GHz. All models are compact instruments with integrated generator, test set and receiver, each tailored to a different field of application.

ZVRL – the lean model
ZVRL comprises a test set with one SWR bridge, two measurement channels and a reference channel for measuring the magnitude and phase of the forward S-parameters S_{11} and S_{21}.

ZVRE and ZVCE – the economy models
The test set of these models comprises two SWR bridges or directional couplers, an RF switch, two measurement channels and one reference channel. They measure the magnitude and phase of all four S-parameters of a DUT, allow a full two-port calibration (TOSM) and have an exceptionally high accuracy and wide dynamic range.

ZVR and ZVC – the universal models
ZVR and ZVC comprise a test set with two SWR bridges or directional couplers, an RF switch, two measurement channels and – unlike ZVRE and ZVCE – two reference channels.

With this configuration a variety of novel calibration procedures, eg TNA, can be performed, which considerably improve the accuracy particularly in non-coaxial applications. ZVR and ZVC are the allrounders of the family and suitable for applications in R&D and production no matter how sophisticated.

ZVC and ZVCE can be ordered with active or passive SWR bridges instead of active couplers. In comparison with couplers, SWR bridges considerably improve the uncorrected port matching below 1 GHz.

Main features

- High measurement speed (in fast mode <125 µs/testpoint)
- Low inherent noise (–130 dBm)
- Wide dynamic range (>130 dB)
- Fast IEEE/IEC bus(<10 ms)
- High frequency resolution (10 µHz)
- Short calibration times (<20 s)
- Active colour LCD (26 cm)

Dynamic range >130 dB
Thanks to fundamental mixing, the useful dynamic range of the R&S network analyzers is more than 25 dB better than that achieved by conventional sampling techniques. Because of the low-noise front end, the ZVR models attain a dynamic range of >130 dB, so transmission measurements on DUTs with extremely high stopband attenuation can be performed at high speed – even at low input levels.

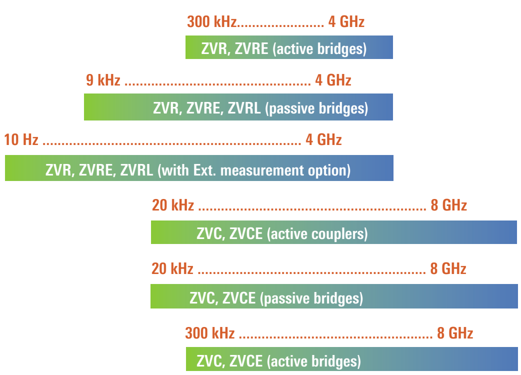
High sweep rate
The high measurement speed allows more than 25 sweeps/s with 200 points. This gives a real analog feeling for tuning sensitive DUTs in real time. The short measurement time of <125 µs per point considerably increases the throughput in automatic test systems.

Vector Network Analyzers ZVC, ZVCE, ZVR, ZVRE, ZVRL

Fast IEEE/IEC bus

Reading out a single marker value via the IEEE/IEC bus takes only 10 ms, reading out complete trace data (200 values) less than 30 ms, which speeds up complex, computer-controlled measurements.

Wide frequency range



Short calibration times

With the new R&S calibration method AutoKal a simple through-connection of the test ports is sufficient to perform automatic full two-port calibration. This calibration takes only some seconds (including computation of error parameters) and cuts time and operating errors to a minimum.

Innovative calibration techniques

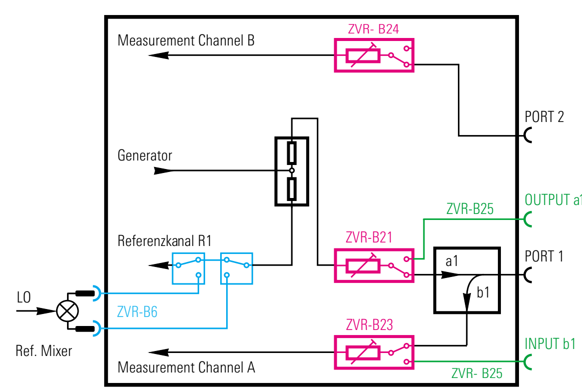
ZVR and ZVC provide an additional number of modern calibration methods (TOM, TRM, TRL, TNA). Unlike classic TOSM (12-term), they require only three different standards which may be partly unknown. This opens new application fields.

Mixer and amplifier measurements

Due to the use of two independent synthesizers for generator and receiver and the ability to control two external generators, a variety of measurements can be performed at full dynamic range (up to 140 dB) and speed on frequency-converting DUTs, eg mixing loss or intermodulation products of mixers. Thanks to the special receiver principle used by Rohde & Schwarz analyzers, add-ons like filters are not required for the suppression of spurious.

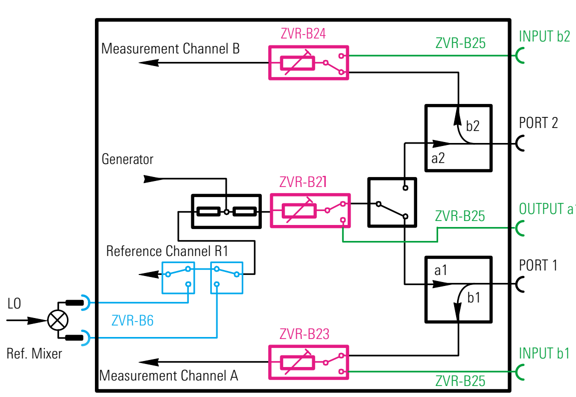
Integrated PC

The PC board with peripheral interfaces such as keyboard, mouse and external monitor as well as the use of Windows NT as operating system are now standard in the network analyzers. The PC mode gives free access to the hard disk and PC programs on ZVR. This function considerably simplifies operation, processing and data logging. The optional Ethernet link, integrated printer drivers and IEEE/IEC bus control programs stored on ZVR substantially extend the application range and improve performance.

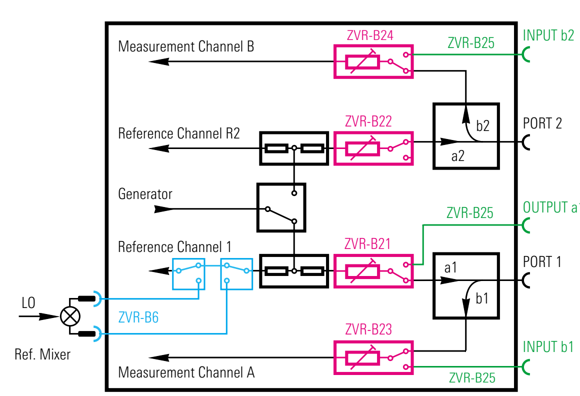


Test set ZVRL

System configuration



Test Set ZVRE and ZVCE



Test Set ZVR and ZVC

Vector Network Analyzers ZVC, ZVCE, ZVR, ZVRE, ZVRL

Specifications

Unless otherwise stated, specifications apply to test ports PORT1 and PORT2, a nominal power of –10 dBm at the test port and a receiver bandwidth ≤10 kHz.

► **The arrow marks important data**

Frequency range, measurement speed, dynamic range

Frequency range	
Without External Measurements option	
ZVRL, ZVRE, ZVR	
with passive SWR bridges	
50 Ω or 75 Ω	9 kHz to 4 GHz
with active SWR bridges	
50 Ω or 75 Ω	300 kHz to 4 GHz
► ZVCE, ZVC	
with passive SWR bridges 50 Ω	20 kHz to 8 GHz
with active SWR bridges 50 Ω	300 kHz to 8 GHz
with active couplers 50 Ω	20 kHz to 8 GHz
With External Measurements option	
ZVRL, ZVRE, ZVR	10 Hz to 4 GHz
ZVCE, ZVC	20 kHz to 8 GHz
Frequency uncertainty	$<4 \times 10^{-6} + 1 \times 10^{-6}$/a
Resolution	10 μHz

Measurement speed (above 2 MHz)

Number of points	1 to 2001 (selectable)		
Measurement time per point	**Receiver bandwidth (IFBW)**		
	3 kHz	**10 kHz**	**26 kHz**
► with system error correction	<1080 μs	<480 μs	<360 μs
normalized	<540 μs	<240 μs	<210 μs
fast mode			
with system error correction	–	–	<240 μs
► normalized	–	–	<125 μs

Dynamic range (without system error correction)

ZVRL, ZVRE, ZVR

(Models ZVRL and ZVRE: at receiver bandwidth 10 Hz values are reduced by 5 dB)

	Receiver bandwidth		
With passive SWR bridges 50 Ω	**10 Hz**	**3 kHz**	**10 kHz**
20 kHz to 200 kHz	>65 dB, typ. >110 dB	–	–
200 kHz to 20 MHz	>110 dB	>90 dB	>85 dB
► 20 MHz to 3 GHz	>120 dB	>100 dB	>95 dB
3 GHz to 4 GHz	>110 dB	>90 dB	>85 dB
With External Measurements option			
50 Hz to 200 kHz	>75 dB	–	–
200 kHz to 20 MHz	>110 dB	>95 dB	>90 dB
► 20 MHz to 1 GHz	>130 dB	>110 dB	>105 dB
1 GHz to 3 GHz	>120 dB	>100 dB	>95 dB
3 GHz to 4 GHz	>110 dB	>95 dB	>90 dB

ZVCE, ZVC

(Model ZVCE: at receiver bandwidth 10 Hz values are reduced by 5 dB)

	Receiver bandwidth		
With active SWR bridges 50 Ω			
300 kHz to 20 MHz	>95 dB	>75 dB	>70 dB
20 MHz to 3 GHz	>115 dB	>95 dB	>90 dB
3 GHz to 4 GHz	>105 dB	>85 dB	>80 dB
4 GHz to 6 GHz	>100 dB	>80 dB	>75 dB
6 GHz to 8 GHz	>95 dB	>75 dB	>70 dB
With External Measurement option			
20 kHz to 200 kHz	>75 dB	–	–
200 kHz to 20 MHz	>110 dB	>95 dB	>90 dB
20 MHz to 1 GHz	>130 dB	>110 dB	>105 dB
1 GHz to 3 GHz	>120 dB	>100 dB	>95 dB
3 GHz to 4 GHz	>110 dB	>95 dB	>90 dB
4 GHz to 6 GHz	>105 dB	>90 dB	>85 dB
6 GHz to 8 GHz	>100 dB	>85 dB	>80 dB

Stability of measurement trace	
per degree temperature variation	<0.05 dB or 0.4°
ZVCE, ZVC	<0.1 dB or 1°
Receiver bandwidths	
(IF bandwidth IFBW)	1 Hz to 10 kHz (half-decade steps) and 26 kHz (full) ◄

Measurement accuracy

The following data are valid between 20°C and 30°C provided the instrument has reached thermal equilibrium (about 1 h after switch-on) and the temperature has not varied by more than 1 degree after calibration.

ZVRE and ZVR (bidirectional network analyzers)

Accuracy of transmission measurements after full two-port system error correction (TOSM)

Specifications are based on a matched DUT and refer to a nominal source power of –10 dBm at the test port.

Test set 50 Ω (active or passive SWR bridges available 20 kHz to 300 kHz (passive SWR bridges only) 300 kHz to 4 GHz

at 10 Hz receiver bandwidth		
for +10 dB to +3 dB		<1 dB or 6°
for +3 dB to –5 dB		<0.2 dB or 1°
for –5 dB to –60 dB	(passive)	<0.05 dB or 0.4°[1] ◄
for –5 dB to –60 dB	(active)	<0.2 dB or 1°
for +3 dB to –40 dB		typ. <0.025 dB
for –60 dB to –70 dB		<0.2 dB or 1°
for –70 dB to –80 dB	(ZVRE)	<1 dB or 6°
for –70 dB to –85 dB	(ZVR)	<1 dB or 6°

[1] <1° for 300 kHz to 1 MHz

Vector Network Analyzers ZVC, ZVCE, ZVR, ZVRE, ZVRL

ZVRE and ZVR – Accuracy of reflection measurements after system error correction (TOSM or full one-port)
Specifications are based on an isolating DUT and refer to a nominal source power of –10 dBm at the test port.

Test set 50 Ω (active or passive SWR bridges available)
It is assumed that the return loss of the match used for calibration is >40 dB (effective system data: directivity D_{eff} >40 dB, test port match S_{eff} >26 dB).

20 kHz to 4 GHz (passive SWR bridges), 300 kHz to 4 GHz (active SWR bridges)

for +10 dB to +3 dB	<1 dB or 6 °
for +3 dB to –15 dB	<0.4 dB + 0.04 dB·f/GHz, <3 ° + 0.4°·f/GHz
for –15 dB to –25 dB	<1 dB or 6 °
for –25 dB to –35 dB	<3 dB or 20 °

Test set 75 Ω (active or passive SWR bridges available)
It is assumed that the return loss of the match used for calibration is >40 dB (effective system data: directivity D_{eff} >40 dB, test port match S_{eff} >26 dB.

20 kHz to 4 GHz (passive SWR bridge), 300 kHz to 4 GHz (active SWR bridge)

for +10 dB to +3 dB	<1,5 dB or 10 °
for +3 dB to –10 dB	<0.7 dB + 0.04 dB·f/GHz, <5 ° + 0.4°·f/GHz
for –10 dB to –20 dB	<1 dB or 6 °
for –20 dB to –30 dB	<3 dB or 20 °

ZVCE and ZVC (bidirectional network analyzers)

Accuracy of transmission measurements after full two-port system error correction (TOSM)

Analyzers with SWR bridges
Specifications are based on a matched DUT and refer to a nominal source power of –10 dBm at the test port.

300 kHz to 4 GHz at 10 Hz receiver bandwidth

for +3 dB to –60 dB		<0.2 dB or 1°
for +3 dB to –40 dB		typ. <0.025 dB
for –60 dB to –70 dB		<0.2 dB or 1°
for –70 dB to –80 dB	(ZVCE)	<1 dB or 6°
for –70 dB to –85 dB	(ZVC)	<1 dB or 6°

4 GHz to 8 GHz at 10 Hz receiver bandwidth

for +3 dB to –35 dB		<0.2 dB or 2°
for +3 dB to –30 dB		typ. <0.025 dB
for –35 dB to –45 dB	(ZVCE)	<1 dB or 6°
for –35 dB to –50 dB	(ZVC)	<1 dB or 6°

Analyzers with couplers
Specifications are based on a matched DUT and refer to a nominal source power of –20 dBm at the test port.
20 kHz to 10 MHz at 10 Hz receiver bandwidth

for +10 dB to +3 dB	<1 dB or 6 °
for +3 to –20 dB (typ. –55 dB)	<0.2 dB or 2 °
for –20 to –30 dB (typ. –65 dB)	<0.5 dB or 4 °
for –30 to –45 dB (typ. –80 dB)	<1 dB or 6 °

10 MHz to 4 GHz at 10 Hz receiver bandwidth

for +10 dB to +3 dB		<1 dB or 6 °
for +3 dB to –50 dB		<0.2 dB or 1 °
for +3 dB to –40 dB		typ. <0.025 dB
for –50 dB to –60 dB		<0.5 dB or 4 °
for –60 dB to –70 dB	(ZVCE)	<1 dB or 6 °
for –60 dB to –75 dB	(ZVC)	<1 dB or 6 °

4 GHz to 8 GHz at 10 Hz receiver bandwidth

for +10 dB to +3 dB		<1 dB or 6 °
for +3 dB to –45 dB		<0.2 dB or 2 °
for +3 dB to –40 dB		typ. <0.025 dB
for –45 dB to –55 dB	(ZVCE)	<1 dB or 6 °
for –45 dB to –60 dB	(ZVC)	<1 dB or 6 °

ZVCE and ZVC – Accuracy of reflection measurements after system error correction (TOSM or full one-port)

Analyzers with SWR bridges
Specifications are based on an isolating DUT and refer to a nominal source power of **–10 dBm** at the test port.

300 kHz to 8 GHz

for +3 dB to –10 dB	<0.4 dB + 0.04 dB·f/GHz, <3 ° + 0.4°·f/GHz
for –10 dB to –20 dB	<1 dB or 6 °
for –20 dB to –30 dB	<3 dB or 20 °

Analyzers with couplers
Specifications are based on an isolating DUT and refer to a nominal source power of **–20 dBm** at the test port. It is assumed that the return loss of the match used for calibration is >40 dB
(effective system data: directivity D_{eff} >40 dB, test port match S_{eff} >30 dB).

20 kHz to 8 GHz

for +10 dB to +3 dB	<1 dB or 6 °
for +3 dB to –10 dB	<0.4 dB + 0.04 dB·f/GHz, <3 ° + 0.4°·f/GHz
for –10 dB to –20 dB	<1 dB or 6 °
for –20 dB to –30 dB	<3 dB or 20 °

ZVRL (unidirectional network analyzer)

Accuracy of transmission measurements after system error correction (one-path two-port)
Specifications are based on a matched DUT and refer to a nominal source power of –10 dBm at the test port.

Test set 50 Ω (only passive SWR bridge available)
20 kHz to 300 kHz at 10 Hz receiver bandwidth

for +10 to –45 dB (typ. –80 dB)	<1 dB or 6 °

300 kHz to 4 GHz at 10 Hz receiver bandwidth

for +10 dB to +3 dB	<1 dB or 6 °
for +3 dB to –75 dB	<0.2 dB or 1 °

ZVRL – Accuracy of transmission measurements after system error correction (full one-port or one-path two-port)
Specifications are based on an isolating DUT and refer to a nominal source power of –10 dBm at the test port.

Vector Network Analyzers ZVC, ZVCE, ZVR, ZVRE, ZVRL

Test set 50 Ω (only passive SWR bridge available)
It is assumed that the return loss of the match used for calibration is >46 dB (effective system data: directivity D_{eff} >46 dB, test port match S_{eff} >30 dB).

20 kHz to 4 GHz

for +10 dB to +3 dB	<1 dB or 6 °
for +3 dB to –15 dB	<0.4 dB + 0.04 dB·f/GHz, <3 ° + 0.4°·f/GHz
for –15 dB to –25 dB	<1 dB or 6 °
for –25 dB to –35 dB	<3 dB or 20 °

Effective system characteristics (above 200 kHz)

These data are valid between 20 °C and 30 °C provided the instrument has reached thermal equilibrium (about 1 h after switch-on) and the temperature variation is not more than 1 degree after calibration.

ZVRE, ZVR, ZVCE, ZVC (bidirectional network analyzers)

after full two-port system error correction (TOSM)

	ZVRE, ZVR	ZVCE, ZVC
Directivity	>46 dB [1]	>40 dB [2]
Source match	>40 dB [3]	>36 dB [4]
Load match	>46 dB [1]	>40 dB
Transmission tracking	<0.04 dB	<0.06 dB
Reflection tracking	<0.04 dB	<0.06 dB

ZVRL (unidirectional network analyzer)

after system error correction (one-path two-port) with test set 50 Ω

Directivity	>46 dB
Source match (PORT 1)	>30 dB
Load match (PORT 2)	>18 dB
Transmission tracking	<0.2 dB
Reflection tracking	<0.06 dB

Output power

Power range (without options)

ZVRL, ZVRE, ZVR with test set 50 Ω	–25 dBm to 0 dBm
ZVCE, ZVC with SWR bridges	
300 kHz to 6 GHz	–25 dBm to –5 dBm
6 GHz to 8 GHz	–25 dBm to –8 dBm
ZVCE, ZVC with couplers	
20 kHz to 6 GHz	–25 dBm to 0 dBm
6 GHz to 8 GHz	–25 dBm to –3 dBm

Uncertainty (at –10 dBm)
These data are valid between 20 °C to 30 °C.

up to 2 MHz	<1 dB
above 2 MHz	<0.5 dB

[1] Return loss of matched load >46 dB.

[2] Return loss of matched load >40 dB.

[3] Phase deviation of open standard <1 °.

[4] Phase deviation of open standard <1.6 °.

Linearity above 40 kHz (referred to –10 dBm)

0 dBm to –15 dBm	<0.4 dB
–15 dBm to –25 dBm	<0.6 dB

Spectral purity

Harmonics	ZVRL, ZVRE, ZVR	ZVCE, ZVC
At maximum output power		
40 kHz to 70 MHz	<–22 dBc	<–25 dBc
70 MHz to 400 MHz	<–25 dBc	<–25 dBc
above 400 MHz	<–30 dBc	<–25 dBc
At –10 dBm output power		
up to 600 MHz	<–35 dBc	<–35 dBc
above 600 MHz	<–40 dBc	<–35 dBc

Spurious <–40 dBc

SSB phase noise

1 Hz bandwidth, 10 kHz from carrier	
up to 10 MHz	<–110 dBc
10 MHz to 150 MHz	<–100 dBc
150 MHz to 1 GHz	<–90 dBc
above 1 GHz	<–90 dBc +20·log(f/GHz) (<–78 dBc at 4 GHz, <–72 dBc at 8 GHz)

Residual FM

RMS weighting from 10 Hz to 3 kHz	
up to 10 MHz	<1 Hz
10 MHz to 150 MHz	<2 Hz
150 MHz to 1 GHz	<5 Hz
1 GHz to 2 GHz	<10 Hz
2 GHz to 4 GHz	<20 Hz
above 4 GHz	<40 Hz

Input level

Maximum nominal input level	**Receiver step attenuator 0 dB**	**≥30 dB**
Without options	0 dBm	–
With Receiver Step Attenuator option	0 dBm	+27 dBm
Max. permissible input level		
Without options	+27 dBm	–
With Receiver Step Attenuator option	+27 dBm	+30 dBm

Max. permissible DC current/voltage

With passive test set (internal DC short R_{in} <0.1 Ω)	0.5 A
With active test set	0.5 A or 30 V

RMS noise level (50 Ω, without options)

Frequency range	Receiver bandwidth	Noise level
9 kHz to 50 kHz	1 kHz	<–75 dBm
50 kHz to 200 kHz	3 kHz	<–70 dBm
200 kHz to 20 MHz	3 kHz	<–90 dBm
20 MHz to 3 GHz	3 kHz	<–100 dBm
3 GHz to 4 GHz	3 kHz	<–90 dBm
4 GHz to 8 GHz	3 kHz	<–80 dBm

Vector Network Analyzers ZVC, ZVCE, ZVR, ZVRE, ZVRL

System error correction techniques

All analyzer models offer simple normalizations for reflection and transmission measurements, One-path two-port calibration and a full one-port calibration (3-term). Full two-port calibration TOSM (12-term) can be carried out with models ZVRE and ZVCE. ZVR and ZVC offer the greatest variety of modern system error correction methods. Apart from the techniques already mentioned, the following full two-port procedures are available: TOM, TRM, TRL, TNA, TOM-X (15-term). The names indicate the standards used for calibration.

T = Through	R = Reflect
O = Open	L = Line
S = Short	N = Network
M = Match	A = Attenuator

TOM-X (X = crosstalk) is an extension of the TOM method. It considers all possible crosstalk between the four receiver channels (full model). This technique is particularly effective in the elimination of crosstalk and thus increases the dynamic range of the system. However, it is quite an elaborate technique. Alternatively, the new automatic calibration procedure AutoKal (R&S patent) is available as an option for ZVRE, ZVR, ZVCE and ZVC.

General data

Temperature	5°C to 40°C, complying with specs 0°C to 50°C, functions maintained
Power supply	90 V to 132 V (AC), 47 to 440 Hz or 180 V to 264 V (AC), 47 to 66 Hz
Power consumption	max. 400 VA (standby: 10 W)
Dimensions (W x H x D)	435 mm x 281 mm x 584 mm
Weight	30 kg

Options

Option	Type	ZVRL	ZVRE	ZVR	ZVCE	ZVC
Automatic Calibration AutoKal	ZVR-B1	–	●	●	●	●
Time Domain	ZVR-B2	●	●	●	●	●
Mixer Measurements	ZVR-B4	●	●	●	●	●
Nonlinear Measurements	ZVR-B5	●	●	●	●	●
Reference Channel Ports	ZVR-B6	●	●	●	●	●
Power Calibration	ZVR-B7	●	●	●	●	●
3-Port Adapter	ZVR-B8	●	●	●	●*	●*
Virtual Embedding Networks	ZVR-K9	–	–	●	–	●
Increased Output Power for Port 1	ZVR-B10	●	●	●	●	●
4-Port Adapter	ZVR-B14	●	●	●	●*	●*
Ethernet for integrated PC	FSE-B16	●	●	●	●	●
IEEE/IEC bus Interface for integrated PC	FSE-B17	●	●	●	●	●
Generator Step Attenuator PORT 1	ZVR-B21	●	●	●	●	●
Generator Step Attenuator PORT 2	ZVR-B22	–	–	●	–	●
Receiver Step Attenuator PORT 1	ZVR-B23	●	●	●	●	●
Receiver Step Attenuator PORT 2	ZVR-B24	●	●	●	●	●
External Measurements	ZVR-B25	●	●	●	●	●
Service Kit	ZVR-Z1	●	●	●	●	●

● Available   * up to 4 GHz

Ordering information

Order designation	Type	Frequency range	Order No.
Vector Network Analyzers (test sets included, up to 4 GHz)			
3-channel, unidirectional, 50 Ω, passive	ZVRL	9 kHz to 4 GHz	1127.8551.41
3-channel, bidirectional, 50 Ω, passive	ZVRE	9 kHz to 4 GHz	1127.8551.51
3-channel, bidirectional, 50 Ω, active	ZVRE	300 kHz to 4 GHz	1127.8551.52
4-channel, bidirectional, 50 Ω, passive	ZVR	9 kHz to 4 GHz	1127.8551.61
4-channel, bidirectional, 50 Ω, active	ZVR	300 kHz to 4 GHz	1127.8551.62
3-channel, bidirectional, 50 Ω, active, couplers	ZVCE	20 kHz to 8 GHz	1127.8600.50
3-channel, bidirectional, 50 Ω, passive, SWR bridges	ZVCE	20 kHz to 8 GHz	1127.8600.51
3-channel, bidirectional, 50 Ω, active, SWR bridges	ZVCE	300 kHz to 8 GHz	1127.8600.52
4-channel, bidirectional, 50 Ω, active, couplers	ZVC	20 kHz to 8 GHz	1127.8600.60
4-channel, bidirectional, 50 Ω, passive, SWR bridges	ZVC	20 kHz to 8 GHz	1127.8600.61
4-channel, bidirectional, 50 Ω, active, SWR bridges	ZVC	300 kHz to 8 GHz	1127.8600.62
Alternative test sets (up to 4 GHz)			
75-Ω SWR Bridge for ZVRL (instead of SWR bridge, 50 Ω, passive) [1]			
75 Ω, passive	ZVR-A71	9 kHz to 4 GHz	1043.7690.18
75-Ω Bridge Pairs for ZVRE and ZVR (instead of bridge pairs, 50 Ω) [1]			
75 Ω, passive	ZVR-A75	9 kHz to 4 GHz	1043.7755.28
75 Ω, active	ZVR-A76	300 kHz to 4 GHz	1043.7755.29
Options			
AutoKal	ZVR-B1	0 to 8 GHz	1044.0625.02
Time Domain	ZVR-B2	same as analyzer	1044.1009.02
Mixer measurements [2]	ZVR-B4	same as analyzer	1044.1215.02
Nonlinear Measurements	ZVR-B5	same as analyzer	1044.1321.02
Reference Channel Ports	ZVR-B6	same as analyzer	1044.1415.02
Power calibration [3]	ZVR-B7	same as analyzer	1044.1544.02
3-Port Adapter	ZVR-B8	0 to 4 GHz	1086.0000.02
Virtual Embedding Networks	ZVR-K9	–	1106.8830.02
Increased Output Power for Port1for ZVR and ZVRL [4]	ZVR-B10	same as analyzer	1106.6495.02
Increased Output Power for Port1 for ZVRE [4]	ZVR-B10	same as analyzer	1106.6495.03
Increased Output Power for Port1 for ZVC [4]	ZVR-B10	same as analyzer	1106.6495.04

Vector Network Analyzers ZVC, ZVCE, ZVR, ZVRE, ZVRL

Order designation	Type	Frequency range	Order No.
Increased Output Power for Port1 for ZVCE[4]	ZVR-B10	same as analyzer	1106.6495.05
4-Port Adapter (2 x SPDT)	ZVR-B14	0 to 4 GHz	1106.7510.02
4-Port Adapter (SP3T)	ZVR-B14	0 to 4 GHz	1106.7510.03
Ethernet AUI for integr. PC	FSE-B16	–	1073.5973.02
Ethernet BNC for integr. PC	FSE-B16	–	1073.5973.03
Ethernet RJ 45 for integr. PC	FSE-B16		1073.5973.04
IEEE/IEC bus Interface for integrated PC	FSE-B17	–	1066.4017.02
Generator Step Attenuator PORT 1	ZVR-B21	same as analyzer	1044.0025.11
Generator Step Attenuator PORT 2 [5]	ZVR-B22	same as analyzer	1044.0025.21
Receiver Step Attenuator PORT 1	ZVR-B23	same as analyzer	1044.0025.12
Receiver Step Attenuator PORT 2	ZVR-B24	same as analyzer	1044.0025.22
External Measurements, 50 Ω [6]	ZVR-B25	10 Hz to 4 GHz (ZVR/E/L) 20 kHz to 8 GHz (ZVC/E)	1044.0460.02
Service Kit [7]	ZVR-Z1		1044.1650.02
Extras			
Test Cables (pairs)			
N male, 50 Ω	ZV-Z11	0 to 18 GHz	1085.6505.03
N male, 75 Ω	ZV-Z12	0 to 4 GHz	1085.6570.03
3.5 mm male, N male, 50 Ω	ZV-Z13	0 to 18 GHz	1134.3997.02
3.5 mm male, 3.5 mm male, 50 Ω	ZV-Z14	0 to 26.5 GHz	1134.4093.02
Calibration Kits			
N, 50 Ω	ZV-Z21	0 to 18 GHz	1085.7099.02
N, 50 Ω	ZCAN	0 to 3 GHz	0800.8515.52
N, 75 Ω	ZCAN	0 to 3 GHz	0800.8515.72
F male	ZV-Z24	0 to 3 GHz	1085.7001.02
PC 3.5	ZV-Z30	0 to 26.5 GHz	1134.4293.02
TRL Suppl. Kit, N, 50 Ω	ZV-Z26	0.4 GHz to 18 GHz	1085.7318.02
TRL Suppl. Kit, PC 3.5	ZV-Z27	0.4 to 26.5 GHz	1085.7401.02
TOM-X Suppl. Kit, N, 50 Ω	ZV-Z28	0 to 18 GHz	1085.7499.03
TOM-X Suppl. Kit, PC 3.5	ZV-Z29	0 to 26.5 GHz	1085.7647.03

Order designation	Type	Frequency range	Order No.
Sliding Loads			
N male, 50 Ω	ZV-Z41	1.7 GHz to 18 GHz	1085.8095.02
N female, 50 Ω	ZV-Z41	1.7 GHz to 18 GHz	1085.8095.03
PC 3.5 male	ZV-Z43	1.7 to 26.5 GHz	1085.8195.02
PC 3.5 female	ZV-Z43	1.7 to 26.5 GHz	1085.8195.03
Attenuators, N, 50 Ω			
1 W	DNF	0 to 12.4 GHz	0272.4X10.50
50 W [7]	RBU50	0 to 2 GHz	1073.8695.XX
100 W [7]	RBU100	0 to 2 GHz	1073.8495.XX
Matching Pads, 50 Ω → 75 Ω			
Series resistor	RAZ	0 to 2.7 GHz	0358.5714.02
L-section	RAM	0 to 2.7 GHz	0358.5414.02
Accessories			
T Check	ZV-Z60	0 to 4 GHz	1108.4990.50
Bias Network	ZV-Z61	2 MHz to 4 GHz	1106.8130.02
DC Block	FSE-Z3	5 MHz to 7 GHz	4010.3895.00
Power Splitter, 2 x 50 Ω	RVZ	0 to 2.7 GHz	0800.6612.52
External SWR Bridges[8]			
50 Ω, N female	ZRA	40 kHz to 150 MHz	1052.3607.52
50 Ω, N female	ZRB 2	5 MHz to 3 GHz	0373.9017.52
75 Ω, N female	ZRB 2	5 MHz to 2 GHz	0802.1018.73
50 Ω, N female	ZRC	40 kHz to 4 GHz	1039.9492.52
75 Ω, N female	ZRC	40 kHz to 2.5 GHz	1039.9492.72
Miscellaneous			
Transit Case	ZZK-965	–	1013.9437.00
19" Rack Adapter with front handles	ZZA-96	–	396.4928.00

1) To be ordered together with ZVR/E/L.

2) Harmonic measurements included.

3) Power meter and sensor required.

4) Only together with ZVR-B23 and ZVR-B24.

5) For ZVR or ZVC only (see page 8).

6) Attenuators required (page 8).

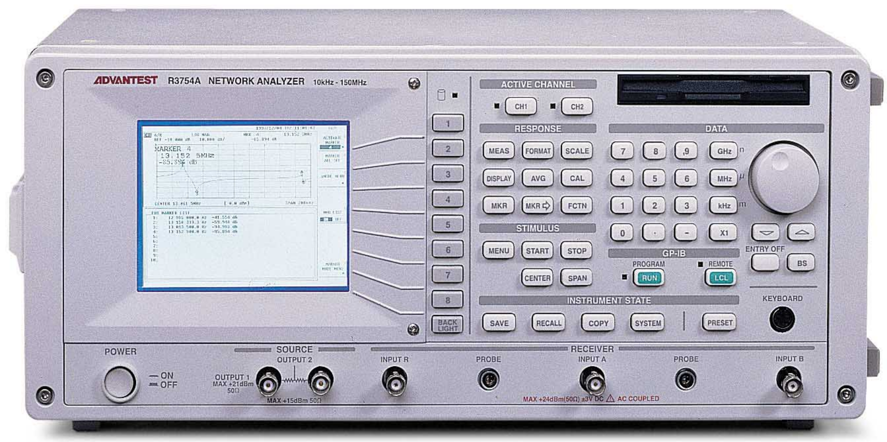
7) On request.

8) Other variants available, eg N male.

Vector Network Analyzer R3754

10 kHz to 150 (200) MHz

High-performance vector network analyzer for use in applications with high throughput and wide dynamic range



Brief description

Vector Network Analyzer R3754 up to 150 MHz (Advantest) is designed as a fast measuring instrument predominantly for use in applications with high throughput and wide dynamic range, eg for measurements on crystal oscillators and filters.

The analyzer is available as a single-channel, 2-channel or 3-channel model, with monochrome or colour display. A 15 kHz resolution filter allows sweep speeds down to 50 µs per point. The measurement uncertainty in the warm-up phase of the instrument as well as the effect of the average noise level on the measurement accuracy were substantially reduced with this analyzer model.

Main features

- Monochrome or TFT colour LCD
- High sweep speed of 50 µs/point with 15 kHz resolution
- 1 or 2 measurement channels, 1 reference channel
- 130 dB dynamic range
- Built-in process controller

Design features

Model R3754A features a high contrast monochrome LC display, whereas model R3754B has a TFT colour display but otherwise the same performance features. All models of the R3754 Series are fitted with a built-in BASIC controller as standard. Detailed user prompts can be displayed on the screen in addition to the measurement results. Test routines and instrument settings can be stored on floppy disk.

Options

The basic model comes with one measurement channel, a reference channel and a second measurement channel being available as an option. Further options include a programmable parallel interface, time range measurement as well as a measurement function for determining the dependence of the measurement parameters on the drive level of the device under test (DLD = drive level dependence) and measurement equipment for 3-gate resonators and a frequency extension up to 200 MHz.

Specifications in brief

Receiver section (23 °C ±5 °C)	
Frequency range	10 kHz to 150 MHz (optional 200 MHz)
Impedance	50 Ω
Return loss (ATT 0 dB)	≥20 dB
Max. input level	
ATT 25 dB, AMP 0 dB	+8 dBm
ATT 0 dB, AMP 0 dB	–20 dBm
ATT 0 dB, AMP 16 dB	–36 dBm
Input destruction level	+24 dBm, +3 V DC
Input crosstalk	
10 kHz to 500 kHz	105 dB
Average noise level	
RBW 10 kHz	200 kHz to 500 kHz: –102 dBm 500 kHz to 150 MHz: –112 dBm
RBW 300 Hz	10 kHz to 500 kHz: –117 dBm 500 kHz to 150 MHz: –127 dBm

Measurement format	
Input channel	1 channel, 2 channels (option 10), 3 channels (option 11)
Measurement channel	2 channels (4-trace display)
Measurement parameter	R A/R R A (option 10) A/R B/R, A/B, R, A, B (Option 11)
AC/DC display	logarithmic/linear amplitude, phase, group delay, real and imaginary parts of complex number parameters Z, R, X (impedance conversion meas.) Y, G, B (admittance conversion meas.) phase extension display
Smith chart	logarithmic/linear amplitude and phase for marker reading, real and imaginary, R+jX, G+jB

Vector Network Analyzer R3754

Polar coordinates display	logarithmic/linear amplitude and phase for marker reading, real and imaginary parts

Signal source (23°C ±5° C)

Frequency	
Range	10 kHz to 150 MHz (optional 200 MHz)
Resolution	0.1 Hz
Accuracy	+5 ppm (typ.)
Output	
Level range	+21 dBm to –43 dBm
Resolution	0.1 dB
Accuracy	+0.5 dB (0 dBm, 10 MHz)
Linearity (50 MHz)	
+21 dBm to –35 dBm	+0.5 dB
–35 dBm to –43 dBm	+1.5 dB
Flatness (at 0 dBm)	
10 kHz to 300 kHz	+ 2.0 dB
300 kHz to 150 MHz	+ 1.5 dB
Impedance (output port 1)	50 Ω
Return loss (at 0 dBm)	≥13 dB (typ.)
Signal purity	
Harmonic wave distortion	<–15 dBc
Nonharmonic wave spurious	<–20 dBc or –60 dBm, whichever is larger
Phase noise	<–95 dBc/Hz (10 kHz offset)

Sweep characteristics

Sweep parameter	frequency, signal level
Range	same as the frequency sweep frequency
Range setting	start/stop or center/span
Sweep type	linear/logarithmic frequency sweep, level sweep, sweep of a user-defined segment
Sweep time	max. 0.05 ms/point (RBW 15 kHz)
Measurement point	3, 6, 11, 21, 51, 101, 201, 301, 401, 501, 601, or 1201 points
Sweep trigger	continuous, single, external
Sweep mode	dual sweep (2-channel sweep in the same frequency range)

Marker functions

– 10 individual markers can be set for each channel
– Any of the10 markers can be specified as the reference marker enabling delta value measurements between markers
– Markers of each channel can be set in coupled or independent form
– Marker search possible for a section specified by the delta marker
– MAX search, MIN search, NEXT search
– Search is performed for each sweep
– It is possible to calculate the bandwidth, center frequency, Q at the X dB down point. It is also possible to search the phase 0° frequency value and the ±X° frequency width
– Limit line function, direct analysis function, resonator analysis, etc

Save register	allows storing of set conditions and CAL data in battery-backed internal memory
Data save/recall	allows storing/loading data to/from FDD programming functions
BASIC control function	standard control function allows control of the main unit as well as other measurement equipment with GPIB interface

Error correction functions

Normalization	corrects frequency response (amplitude, phase)
1-port calibration	corrects bridge directivity, frequency response and source matching error; error correction requires short, open and load
Data averaging	averages data 2 to 999
Transfer full calibration	high-accuracy measurement possible using transfer normalization in transfer measurement; error correction requires short and load

Interfaces

External display signal output	15-pin D-sub connector (VGA)
GPIB data output and remote control	conforming to IEEE 486
Printer port	25-pin D-sub
Serial port	based on RS-232
Keyboard	IBM PC/AT-compatible
External reference frequency input	
Parallel I/O interface	TTL level, 8-bit output (2 ports), 4-bit I/O (2 ports) (option 01)
Probe power	(option 10, option 11)
External trigger signal input	BNC connector (female)

Display

R3754A	5" STN monochrome LCD
R3754B	6.5" TFT colour LCD, 640 x 640 pixel
Backlighting	ON/OFF, no adjustment for R3754A
Contrast	contrast control provided for R3754A

General data

With FDD	
Operating temperature range	+5°C to +40°C
Humidity	80% max. (no condensation)
Without FDD	
Operating temperature range	0 to +50°C
Storage temperature range	–20°C to +60°C
Humidity	80% or less (no condensation)
Power supply	100 V to 120 V AC, 220 V to 240 V AC, 48 Hz to 66 Hz, autosetting to AC supply
Power consumption	200 VA max.
Dimensions (W x H x D)	424 mm x 177 mm x 300 mm
Weight	12 kg or less

Ordering information

Vector Network Analyzer	R3754

Options

Parallel I/O Interface	01
2-Channel Option (A, R)	10
3-Channel Option (A, B, R)	11
Frequency Range Extension 200 MHz	15
Time Range Measurement	70
DLD Function	71
3-Port Resonator Measurement	72

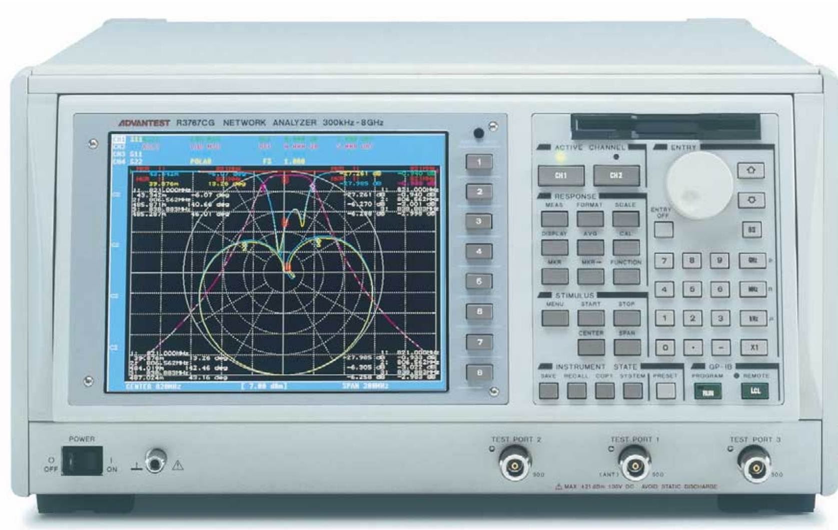
Extras

Transit Case	R16080M
Carrier Bag	R16280M
19" Rack Mount Adaptor	A02468

Vector Network Analyzers R3765, R3767G

300 kHz to 3.8 (8) GHz

High-speed vector network analyzers with 3- and 4-port test set



Modell R3767 CG (photo 43469-2)

Brief description

Network Analyzers R3765 and R3767 (Advantest) measure amplitude, phase and group delay. Thanks to high-speed signal processing, the analyzers can perform measurements at a high rate of 0.15 ms per testpoint. Models have a TFT colour LCD allowing simultaneous display of up to four diagrams and eight traces. A programmable sweep function is provided in all models and allows the user to define the resolution bandwidth, power level and measurement time for each individual testpoint. An electronic attenuator supports high-speed measurement of the performance characteristics of crystals or compression points of amplifiers.

Overview of models

- The **A models** have a built-in power splitter and two test inputs so that two DUTs can be measured simultaneously or for instance a three-port multiplexer in a single sweep.
- The **B models** have a built-in SWR bridge for simultaneous measurement of reflection and transmission
- The **C models** incorporate a full-featured S-parameter test set, thus allowing simultaneous measurement of the forward and reflected characteristics of any DUTs.

Main features

- Measurement speed: 0.15 ms/testpoint
- 1 Hz steps
- Dynamic range up to 100 dB
- Built-in process controller
- internal 3- or 4-port test set (optional)

Operation

The analyzers of this Series are provided with a built-in BASIC controller. Frequently recurring test routines can easily be executed thanks to programmable menu-guided control; an external controller is usually not required. Detailed user prompts can be displayed on the screen in addition to the test results. Limit lines facilitate evaluation of the test results. The required programs and instrument settings can be saved on floppy disk. All models are fitted with an IEEE/IEC bus for external control, the command language is SCPI-compatible. A serial interface (RS-232) for the connection of a barcode reader and a printer interface is available in addition; a user-definable parallel interface allows direct connection of component feeders.

Frequency range	Model		
300 kHz to 3.8 GHz	R3765AG	R3765BG	R3765CG
300 kHz to 8 GHz	R3767AG	R3767BG	R3767CG
Display	TFT colour LC display (640 x 480 dots), 8.4“		
Outputs	Direct	Direct	Port 1
Inputs	A, B	Transmission, reflection	Port 2
Output level	+17 to +3 dBm	+7 to –13 dBm	+10 to –10 dBm

Vector Network Analyzers R3765, R3767G

Extras

- **Option 10:** output attenuator up to 70 dB
- **Option 70:** time domain analysis
- **Option 12:** 75-Ω version
- **Option 11:** 3-port test set
- **Option 14:** internal 4-port test set
- **Option 70/71:** software fixtures

Facilitate measurements on 3-port devices, eg duplexers, without having to change the cabling with additional 3-port calibration.

Software for various applications is available for automatic test routines, eg for duplexers, filters, TDR measurements on coaxial cables for finding faults and for the use of customer-specific calibration sets.

Specifications in brief

Measurement functions	
Number of measurement channels	models A/B: 2 channels/4 traces model C: 4 channels/8 traces
Measurement settings	
AH models	A/R, B/R, A/B, A, B
BH models	transmission, reflection
CH models	S11, S12, S21, S22, S11&S21, S22&S12
Display formats	log/lin amplitude, phase, group delay, real and imaginary part,|Z|, R,X, |Y|, G, B
Smith chart	marker display for log/lin amplitude, phase, real and imaginary part, R + jX, G + jB,
Polar coordinates	marker display for log/lin amplitude, phase, real and imaginary part
Signal characteristics	
Frequency range, resolution	300 kHz to 3.8 (8) GHz, 1 Hz
Accuracy (25 ±5°C)	±10 ppm
Output level	see overview of models
Resolution	0.01 dB
Accuracy (50 MHz, 25 ±5° C)	0.5 dB
Frequency response (25 ±5°C)	2 dB (V_{pp})
Impedance	50 Ω
Signal purity	
Harmonic distortion	<–20 dB
Nonharmonic distortion	<–30 dB
Phase noise (10 kHz offset, 1 kHz RBW)	(–85 dBc +20 log (f/40 MHz)) dBc
Sweep characteristics	
Parameters	frequency, level
Range	full frequency range or full level range depending on model
Sweep mode	lin/log frequency or level sweep; user-defined
Sweep time	0.15 ms/testpoint with 2-port calibration
Testpoints	3, 6, 11, 21, 51, 101, 201, 301, 601, 801, 1201
Trigger	continuous, single, external
Receiver characteristics	
Input	N connector, 50 Ω
Maximum input level	0 dBm (models A/B) +12 dBm (model C)
Noise level	with maximum input signal –90 dBc at RBW=3 kHz –100 dBc at RBW=10 kHz
Resolution bandwidth	10 Hz to 20 kHz in 1, 2, 3, 4, 5, 7 steps
Input crosstalk	
R3765 (<3.8 GHz)	–90 dB
Model C (2.6 to 3.8 GHz)	–85 dB
R3767 (<3,8 GHz)	–90 dB
R3767 (<8 GHz)	–70 dB
Directivity	
<2.6 GHz	–30 dB
<3.8 GHz	–26 dB
<8 GHz	–22 dB
Amplitude measurement	
Resolution	0.001 dB
Accuracy	
–10 dBm, 50 MHz, 25 ±5°C	±0.2 dB
Amplitude response	max. input level –10 dB
–10 to –60 dBm	±0.05 dB
Phase measurement	±180°
Resolution	0.01°
Frequency response	±2°
–10 to –50 dB	±0.3°
Group-delay measurement	1 ps to 250 s
Resolution	1 ps
Display	see overview of models
Markers	up to 10 independent markers + delta marker with the option of showing all markers in a list
Automatic search function	min, max, bandwidth, etc. SWR, filter parameters
Data transfer	
Built-in BASIC controller	provided as standard, high-speed evaluation functions for essential trace points through direct data access; control of external devices via IEEE/IEC bus
Disk drive	3.5", 720 Kbyte (DD), 1.44 Mbyte (HD)
External interfaces	15-pin VGA, Centronics IEC bus (IEEE 488.2, SCPI) RS-232-C (for BASIC controller only)
Parallel interface	24 bit, 2 x TTL 8-bit output, 2 x 4-bit input/output for BASIC applications; PS2 connector for US keyboard
External reference frequency	1, 2, 5, 10 MHz, >0 dBm
General data	
Power supply, AC	100 to 240 V, 48 to 66 Hz, max. 300 VA
Dimensions (W x H x D)	424 mm x 220 mm x 400 mm
Weight	18 kg

Ordering information

Vector Network Analyzers	R3765, R3767G

SWR Bridges ZRA, ZRB2, ZRC, VCA-Z1

Measurement of reflection coefficient of RF circuits and components

ZRA 40 kHz to 150 MHz

ZRB2 5 MHz to 3 GHz

ZRC 40 kHz to 4 GHz

VCA-Z1 5 MHz to 850 MHz

SWR Bridge ZRC with calibration standards (photo 40527)

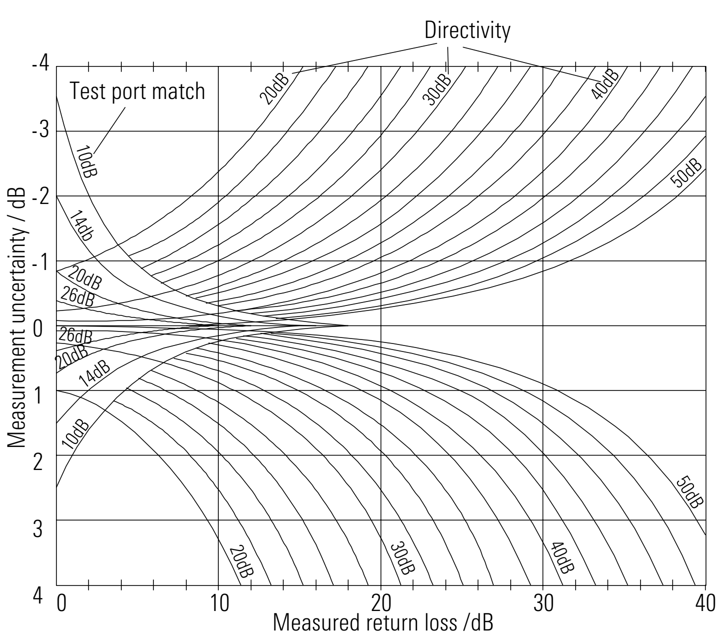
Brief description

SWR briges are used for measuring the reflection coefficient of RF circuits and components. The output signal from the signal generator, eg the tracking generator of Spectrum Analyzer FSE or Scalar Network Analyzer ZWOB is applied to the device under test via the SWR bridge. Depending on the reflection coefficient of the device under test, part of the signal is reflected to the bridge and then routed to the receiver, eg to the test input of FSE or measuring head of ZWOB, where it is detected and displayed.

Measurement accuracy

The accuracy of the bridge is limited by its directivity as well as by the SWR of the bridge at the test port. The measurement of small reflection coefficients is affected by the finite directivity. Reflection coefficients that are smaller than the directivity cannot be measured directly. In measurements of large reflection coefficients, the accuracy depends primarily on the matching at the test port.

The diagram shown allows a quantitative evaluation of the measurement accuracy.



Measurement uncertainties as a function of directivity and test port matching of the bridge

SWR Bridges ZRA, ZRB2, ZRC, VCA-Z1

Specifications in brief, ordering information

Designation	**ZRA**	**ZRB2**	**ZRB2 (precision)**	**ZRB2**
Impedance	50 Ω	50 Ω	50 Ω	75 Ω
Frequency range	40 kHz to150 MHz	5 MHz to 2.5 GHz	5 MHz to 3 GHz	5 MHz to 2 GHz
Directivity	≥45 dB (up to 1 MHz) ≥40 dB (up to 150 MHz)	≥40 dB	≥46 dB (up to 2 GHz) ≥40 dB (up to 2.5 GHz) ≥34 dB (up to 3 GHz)	≥40 dB
Test port matching	≥20 dB (up to 200 kHz) ≥30 dB (0.2 to 50 MHz) ≥20 dB (up to 150 MHz)	≥23 dB	≥26 dB (up to 2.5 GHz) ≥22dB (up to3 GHz)	≥20 dB (up to1.5 GHz)
Insertion loss[1]	7.5 dB + 6 dB	7 dB + 6 dB	7 dB + 6 dB	8 dB + 6 dB
Power-handling capacity	0.5 W	0.5 W	0.5 W	0.5 W
Test port connector	N female	N female N male	N female N male	N female N male
Accessories supplied	----	----	----	----
Rated temperature	0 to +50°C	0 to +50°C	0 to +50°C	0 to +50°C
Storage temperatúre	–40 to +70°C	–40 to +70°C	–40 to +70°C	–40 to +70°C
Connectors[2]	N female	N female	N female	N female
Weight	240 g	240 g	240 g	250 g
Dimensions[3]	72 x 57 x 33	72 x 57 x 20	72 x 57 x 20	72 x 57 x 22
Order numbers	1052.3607.52	373.9017.53 373.9017.56	373.9017.52 373.9017.55	802.1018.73 802.1018.76

Designation	**ZRC**	**ZRC**	**VCA-Z1**
Impedance	50 Ω	75 Ω	75 Ω
Frequency range	40 kHz to 4 GHz	40 kHz to 2.5 GHz	5 MHz to 2.5 GHz
Directivity	≥40 dB (up to 3 GHz)	≥40 dB	≥40 dB (up to 300 MHz) ≥34 dB (up to 850 MHz)
Test port matching	≥12 dB + 11dB log (f/40 kHz) (up to 400 kHz) ≥23 dB (up to 3 GHz) ≥20 dB (3 GHz to 4 GHz)	≥8 dB + 12 dB log (f/40 kHz) (up to 400 kHz) ≥20 dB (400 kHz to 2.5 GHz)	≥20 dB
Insertion loss[1]	7 dB + 6 dB	7 dB + 6 dB	8 dB + 5 dB
Power-handling capacity	0.5 W	0.5 W	0.5 W
Test port connector	N female N male	N female N male	BNC male
Accessories supplied	short/open, termination, connector adapter	short/open, termination, connector adapter	–
Rated temperature	0 to +50°C	0 to +50°C	0 to +50°C
Storage temperature	–40 to +70°C	–40 to +70°C	–40 to +70°C
Connectors[2]	N female	N female	BNC female
Weight	340 g	340 g	250 g
Dimensions[3]	72 x 77 x 24	72 x 77 x 24	72 x 57 x 22
Order numbers	1039.9492.52 1039.9492.55	1039.9492.72 1039.9492.75	1052.5900.02

[1] Input attenuation ----> test port + test port ---> output.

[2] input, output.

[3] in mm without connectors.

New approaches in generation of complex I/Q Signals with Vector Signal Generator AMIQ and Signal Generator SMIQ (photo 43304-5)

Contents of Chapter 5

Signal Generator SMT

SMT02: 5 kHz to 1.5 GHz

SMT03: 5 kHz to 3 GHz

SMT06: 5 kHz to 6 GHz

For receiver and EMS measurements

Photo 42353

Brief description

Signal Generator SMT covers the complete range of conventional analog receiver measurements. 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.

Main features

- Ideal EMS signal source with specified frequency range from 5 kHz
- AM, FM, φM, pulse modulation
- FM DC with high carrier frequency accuracy
- Broadband FM from DC to 8 MHz, broadband φM from DC to 2 MHz
- Convenient RF/LF/level sweep
- Programmable level correction (compensation of external frequency response)
- VOR/ILS generator (option SM-B6)
  – phase resolution 0.01°
  – DDM resolution 0.0001
- Stereo generator (option SM-B6) for measurements on FM sound broadcast transmitters and receivers
- Large, backlit LCD for clear display of all relevant settings
- Minimum RF leakage due to special shielding measures
- Calibration interval of three years

Overview of options

Designation, functions	Option
Reference Oscillator OCXO: aging <1 x 10^{-9}/day	SM-B1
LF Generator: supplies sinewave, noise 0.1 Hz to 500 kHz, triangular, squarewave 0.1 Hz to 50 kHz signals	SM-B2
Pulse Modulator: on/off ratio >80 dB, rise/fall time <10 ns — SMT02: / SMT03: / SMT06:	SM-B3 / SM-B8 / SM-B9
Pulse Generator: only in conjunction with SM-B3/SM-B8/SM-B9; provides single, delayed and double pulses	SM-B4
Multifunction Generator: produces stereo multiplex and VOR/ILS signals as well as sinewave, noise 0.1 Hz to 1 MHz, triangular, sawtooth, squarewave 0.1 Hz to 50 kHz signals	SM-B6
Rear Connectors for RF and LF: to replace front-panel connectors	SMT-B19

Specifications in brief

Frequency		
Range SMT02	5 kHz to 1.5 GHz	
SMT03	5 kHz to 3 GHz	
SMT06	5 kHz to 6 GHz	
Resolution	0.1 Hz	
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}

Spectral purity	
Spurious signals	
Harmonics	<–30 dBc, with SM-B8/-B9: <–26 dBc
Nonharmonics	
f <1.5 GHz	<–80 dBc
f >1.5 GHz	<–74 dBc
f >3 GHz	<–68 dBc
SSB phase noise at 20 kHz from carrier, 1 Hz bandwidth	
<67.5 MHz/125 MHz	<–120 dBc/<–134 dBc
250 MHz/500 MHz	<–128 dBc/<–122 dBc
1000 MHz/2000 MHz	<–116 dBc/<–110 dBc
3000 MHz/6000 MHz	<–109 dBc/<–103 dBc

Signal Generator SMT

Residual FM, rms (f = 1 GHz)	
0.3 kHz to 3 kHz (CCITT)	<8 Hz
0.03 kHz to 20 kHz	<20 Hz
Level	–144 to +13 dBm
Resolution	0.1 dB
Accuracy for levels >–127dBm	
f <1.5 GHz	±1 dB
f >1.5 GHz	±1.5 dB
f >3 GHz	±2 dB
Level frequency response at 0 dBm	1 dB, typ. 0.3 dB
Overload protection	protects the unit from externally applied RF power (50 Ω source) and DC voltages, SMT02 and 03: ≤50 W/35 V, SMT06: ≤1 W/0 V
Simultaneous modulation	any combination of AM, FM (φM) and pulse modulation
Amplitude modulation	internal, external AC/DC
Modulation depth/resolution	0 to 100%/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
Frequency modulation	internal, external AC/DC, two-tone with two separate channels FM1 and FM2
Maximum deviation	depending on carrier frequency: 5 MHz (at f_c <130 MHz) to 40 MHz (at f_c 6 GHz)
Setting error at AF = 1 kHz (FM AC)	<(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
Stereo modulation	
Crosstalk attenuation	>50 dB
Unweighted S/N ratio	>76 dB
Carrier frequency offset (FM DC)	<0.1% of deviation
Phase modulation	internal, external AC/DC, two-tone with two separate channels broadband φM or narrowband φM (broadband φM only possible with φM2)
Maximum deviation	depending on carrier frequency
φM range 1: DC to 100 kHz	12.5 rad to 400 rad
φM range 2: DC to 2 MHz	0.625 rad to 20 rad
Pulse modulation	with option SM-B3, SM-B8, SM-B9
Operating modes	external; internal with optional Pulse Generator SM-B4
On/off ratio	>80 dB
Rise/fall time (10/90%)	<10 ns
Internal modulation generator	0.4/1/3/15 kHz ±3%
Level (EMF) at LF socket	1 V ±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
Distortion (20 Hz to 100 kHz)	<0.1% (level >0.5 V)
Level (EMF) at LF socket	1 mV to 4 V (R_{out} = 10 Ω, R_L >200 Ω)
Multifunction generator	option SM-B6
Modulation signals	sinewave, triangular, sawtooth, squarewave, noise, stereo MPX, VOR/ILS
Sinewave, noise	0.1 Hz to 1 MHz
Triangular, sawtooth, squarewave	0.1 Hz to 50 kHz
Distortion (20 Hz to 100 kHz)	<0.1% (level >0.5 V)
Level (EMF) at LF socket	1 mV to 4 V (R_{out} = 10 Ω, R_L >200 Ω)
Stereo multiplex signal	with option SM-B6
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 phase/resolution	0 to 360°/0.1°
VOR modulation signal	with option SM-B6
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°
ILS modulation signal	with option SM-B6
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 MHz to 112 MHz)	<0.0004 + 1% of DDM reading
Glideslope (329 MHz to 335 MHz)	<0.0008 + 1% of DDM reading
Pulse generator	option SM-B4
Operating modes	single, delayed and double pulse
Pulse repetition period	100 ns to 85 s
Pulse width	20 ns to 1 s
Pulse delay	40 ns to 1 s
Double pulse	60 ns to 1 s
Sweep	digital sweep in discrete steps for RF, level and LF LF sweep with option SM-B2 or SM-B6
Remote control	IEC 625 (IEEE 488)
Command set	SCPI 1993.0
General data	
Power supply	90 V to 132 V/180 V to 265 V, 47 Hz to 440 Hz (300 VA)
Dimensions (W x H x D)	435 mm x 192 mm x 350 mm
Weight	20 kg for fully equipped unit

Ordering information

Signal Generator	SMT02	1039.2000.02
	SMT03	1039.2000.03
	SMT06	1039.2000.06
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
for SMT06	SM-B9	1039.5100.02
Pulse Generator (only in combination with SM-B3, SM-B8 or SM-B9)	SM-B4	1036.9310.02
Multifunction Generator	SM-B6	1036.7760.02
Rear Connectors for RF and LF	SMT-B19	1039.4003.02

Signal Generator SME

SME02: 5 kHz to 1.5 GHz

SME03 (A): 5 kHz to 3 GHz

SME03E: 5 kHz to 2.2 GHz

SME06: 5 kHz to 6 GHz

Digital communication with all types of modulation of mobile radio

Photo 42212

Brief description

The SME supplies the complex signals required for the development and testing of digital mobile radio receivers. It is capable of generating all signals used in the main digital radio networks in line with relevant standards regarding the type of modulation, data format, TDMA structure and frequency hop patterns. The SME is completely at home also in the analog signal world of conventional signal generators.

SME02, SME03 and SME06 are identical except for the frequency range. Economy Signal Generator SME03E has been designed as an especially economical solution for applications involving digitally modulated signals. Signal Generator SME03A is already factory-fitted with option Fast Controller SM-B50.

Main features

- All common digital modulation modes provided in one unit
- Great ease of operation thanks to a novel menu concept
- No external modulation and data sources required
- User-programmable data sequences and TDMA structure
- RF, LF and level sweep
- Ultra-low RF leakage for measurements on highly sensitive pagers
- List mode: programmable measurement sequence for up to 4096 frequency and level combinations, setting time <0.5 ms (not SME03E)

Overview of options

Designation, functions		Option
Reference Oscillator OCXO: aging <1 x 10^{-9}/day		SM-B1
LF Generator: supplies sinewave, noise 0.1 Hz to 500 kHz, triangular, squarewave 0.1 Hz to 50 kHz signals		SM-B2
Pulse Modulator: on/off ratio >80 dB, rise/fall time <10 ns	SME02: SME03E,SME03: SME06	SM-B3 SM-B8 SM-B9
Pulse Generator: only in conjunction with SM-B3/SM-B8/SM-B9; provides single, delayed and double pulses		SM-B4
FM/φM Modulator: FM DC to 2 MHz, φM DC to 100 kHz		SM-B5
Multifunction Generator: produces stereo multiplex and VOR/ILS signals, as well as sinewave, noise 0.1 Hz to 1 MHz, triangular, sawtooth, squarewave 0.1 Hz to 50 kHz signals		SM-B6
DM Coder: generates FSK, FFSK, 4FSK, GFSK, GMSK, QPSK, π/4 QPSK, π/4 DQPSK, O-QPSK; user-programmable data sequences and PRBS		SME-B11[1]
DM Memory Extension 8 Mbit: expands the 8-kbit memory of the DM Coders to 8 Mbit (data only); required for fitting SME-B41 and SME-B42		SME-B12
FLEX™/POCSAG/REFLEX™ Protocol: generates paging signals in line with standard for tests on pagers (SME-B11 and SME-B12 required)		SME-B41/B42/B43
Fast Controller: improves setting time of frequency and level (frequency: <3 ms, level: <2 ms)		SM-B50[2]
Rear Connectors for RF and LF: to replace front-panel connectors		SMT-B19

1) Already included in basic model of SME03E.

2) Already included in basic model of SME03A.

Signal Generator SME

Specifications in brief

Frequency

Range SME02	5 kHz to 1.5 GHz	
SME03E	5 kHz to 2.2 GHz	
SME03	5 kHz to 3 GHz	
SME03A	5 kHz to 3 GHz	
SME06	5 kHz to 6 GHz	
Underrange (specs not binding)	down to 1 kHz	
Resolution	0.1 Hz	
Setting time	<10 ms	
SME03A, SME including SM-B50	<3 ms	
after trigger pulse in list mode	<500 µs	
Phase offset	adjustable in steps of 1°	
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 °C to 55 °C)	2 x 10^{-6}	<5 x 10^{-8}

Spectral purity

Spurious signals	
Harmonics	
level ≤10 dBm [1]	<–30 dBc
level without overrange	<–26 dBc
Subharmonics	
f <1.5 GHz	none
f >1.5 GHz	<–40 dBc
f >3 GHz	<–34 dBc
Nonharmonics at >5 kHz from carrier	
f <1.5 GHz	<–80 dBc, <–66 dBc (dig. modulation)
f >1.5 GHz	<–74 dBc, <–60 dBc (dig. modulation)
f >3 GHz	<–68 dBc, <–54 dBc (dig. modulation)
Broadband noise for CW [1] at >10 MHz from carrier, 1-Hz bandwidth	
f ≤3 GHz	<–140 dBc (typ. <–145 dBc)
f >3 GHz	<–134 dBc (typ. <–139 dBc)
SSB phase noise 20 kHz from carrier at 1-Hz bandwidth, FM/φM deviation <5% of maximum deviation	
f = 6 GHz	<–110 dBc
f = 3 GHz	<–116 dBc
f = 2 GHz	<–120 dBc
f = 1 GHz	<–126 dBc
f = 500 MHz	<–132 dBc
f = 250 MHz	<–137 dBc
f = 125 MHz	<–140 dBc
f <93.75 MHz	<–129 dBc
Residual FM, rms (f = 1 GHz)	
0.3 kHz to 3 kHz (CCITT)	<1 Hz
0.03 kHz to 20 kHz	<4 Hz
Residual AM, rms (0.03 kHz to 20 kHz) [1]	<0.02%

Level

Range	–144 dBm to +13 dBm
Overrange (specs not binding)	up to 16 dBm
Resolution	0.1 dB
Total error for levels >–127 dBm [1]	
f <2 GHz	<0.5 dB
f >2 GHz to 4 GHz	<0.9 dB
f >4 GHz	<1.2 dB
Level flatness at 0 dBm [1]	
f ≤3 GHz	<1 dB
f >3 GHz	<1.5 dB
Output impedance	50 Ω

VSWR [1]	f ≤3 GHz	3 GHz < f ≤5 GHz	f >5 GHz
Level >0 dBm	<2	<2	<2
Level >0 dBm and option SM-B9 fitted (SME06)	<2	<2	<2.5
Level ≤0 dBm	<1.5	<2	<2

Setting time (IEEE/IEC bus)	<25 ms
with electronic level setting	<10 ms
SME03A, SME including SM-B50	<2 ms
Non-interrupting level setting	0 dB to 20 dB
Overvoltage protection	protects the unit from externally applied RF power (50-Ω source) and DC
Max. RF power	50 W (SME02, SME03), 1 W (SME06)
Max. DC voltage	35 V (SME02, SME03), 0 V (SME06)
Simultaneous modulation	any combination of AM, FM (φM), pulse modulation and DM (DM = FSK, 4FSK, FFSK, GFSK, GMSK or QPSK)

Amplitude modulation

Operating modes	internal, external AC/DC
Modulation depth	0% to 100%
Resolution	0.1%
Setting error at 1 kHz (m <80%) [1]	<4 % of reading ±1%
AM distortion at 1 kHz [1] [2]	
m = 30%	<1%
m = 80%	<2%
Modulation frequency range	DC to 100 kHz
Modulation frequency response (m = 60%) [1]	
20 Hz (DC) to 50 kHz	<1 dB, typ. 0.3 dB
SME06:	
20 Hz (DC) to 50 kHz	<1 dB (f ≤3 GHz)
20 Hz (DC) to 10 kHz	<1 dB (f >3 GHz)
Incidental φM with 30 % AM, AF = 1 kHz	<0.1 rad (f ≤3 GHz) <1 rad (f >3 GHz)

Frequency modulation	with option SM-B5
Operating modes	internal, external AC/DC, two tone with two separate channels FM1 and FM2
Max. deviation at carrier frequency	
<130 MHz	500 kHz
130 MHz to 187.5 MHz	125 kHz
187.5 MHz to 375 MHz	250 kHz
375 MHz to 750 MHz	500 kHz
750 MHz to 1500 MHz	1 MHz
1500 MHz to 3000 MHz	2 MHz
3000 MHz to 6000 MHz	4 MHz
Resolution	<1%, min. 10 Hz
Setting error at AF = 1 kHz	<3% of reading + 20 Hz
FM distortion at AF = 1 kHz and half max. deviation	<0.5%, typ. 0.05%
Modulation frequency range	
with maximum deviation	DC to 500 kHz
at <25% of maximum deviation	DC to 2 MHz
Modulation frequency response	
10 Hz (DC) to 100 kHz	<0.5 dB
10 Hz (DC) to 2 MHz	<3 dB
Preemphasis	50 µs, 75 µs (deviation limited to 25% of max. value)
Incidental AM at AF = 1 kHz, f >1 MHz, deviation = 40 kHz	<0.1%
Stereo modulation at 40 kHz deviation, AF = 1 kHz, f <125 MHz	
Stereo separation	>50 dB
Unweighted S/N ratio (rms)	>76 dB
Weighted S/N ratio (rms)	>76 dB
Distortion	<0.1 %

Signal Generator SME

Carrier frequency offset with FM	
<93.75 MHz	<50 Hz + 1% of deviation
93.75 MHz to 187.5 MHz	<12.5 Hz + 1% of deviation
187.5 MHz to 375 MHz	<25 Hz + 1% of deviation
375 MHz to 750 MHz	<50 Hz + 1% of deviation
750 MHz to 1500 MHz	<100 Hz + 1% of deviation
1500 MHz to 3000 MHz	<200 Hz + 1% of deviation
3000 MHz to 6000 MHz	<400 Hz + 1% of deviation

Phase modulation	with option SM-B5
Operating modes	internal, external AC/DC, two tone with two separate modulation channels φM1 and φM2
Max. deviation at carrier frequency	
<130 MHz	5 rad
130 MHz to 187.5 MHz	1.25 rad
187.5 MHz to 375 MHz	2.5 rad
375 MHz to 750 MHz	5 rad
750 MHz to 1500 MHz	10 rad
1500 MHz to 3000 MHz	20 rad
3000 MHz to 6000 MHz	40 rad
Resolution	<1%, min. 0.001 rad
Setting error at AF = 1 kHz	<3% of reading + 0.01 rad
Distortion at AF = 1 kHz and half max. deviation	<1%
Modulation frequency range	DC to 100 kHz
Modulation frequency response, 10 Hz (DC) to 100 kHz	<0.5 dB

Digital modulation	with option SME-B11; standard in SME03E
Modulation modes	FSK, 4FSK, FFSK, GFSK, GMSK, QPSK
Operating modes	internal, external
Internal data generator	programming of data, level switching and burst output
Storage capacity	8192 bit, extendable to 8 Mbit with option SME-B12
Frequency accuracy	same as for reference frequency
PRBS (pseudo random bit sequence)	selectable lengths: 2^9–1, 2^{15}–1, 2^{20}–1, 2^{21}–1 and 2^{23}–1
FSK, FFSK: Shift error (peak)	<1%
GFSK: Shift error (peak)	<7%
GMSK: Modulation phase error	
rms	<1°
peak	<3°
QPSK: Modulation vector error rms[1) 2)]	<2.5% (f ≤3 GHz)

DM memory extension	option SME-B12
Storage capacity	
8M x 1 mode (DATA)	8388480 bit
1M x 3 mode (DATA, LEV ATT, BURST)	3 x 1048560 bit

FSK modulation	without option SME-B11
Operating mode	external
Maximum shift	20% of FM deviation
Resolution	<0.1%, min. 0.1 Hz
Frequency error	<(0.1 Hz + 0.1 % of shift)
Bit rate	0 kHz to 100 kHz

Pulse modulation	with option SM-B3, SM-B8 or SM-B9
Operating modes	external, internal with Pulse Generator SM-B4
Frequency range	50 MHz to 1.5 GHz (SM-B3) 50 MHz to 3.0 GHz (SM-B8) 50 MHz to 6.0 GHz (SM-B9)
Max. output level	10 dBm (SM-B3) 9 dBm (SM-B8) 8 dBm (SM-B9)
Harmonics	<–30 dBc for levels ≤5 dBm
On/off ratio	>80 dB
Rise/fall time (10/90%)	<10 ns
Pulse repetition rate	0 MHz to 10 MHz
Pulse delay	typ. 50 ns
Video feedthrough	<–30 dBc

Internal modulation generator	
Frequency	0.4/1/3/15 kHz ±3%
Open-circuit voltage	1 V_P ± 2% (R_{out} = 10 Ω, R_L >200 Ω)

LF generator	Option SM-B2
Waveforms	sinewave, triangular, squarewave, noise
Frequency range	
sinewave, noise	0.1 Hz to 500 kHz
triangular, squarewave	0.1 Hz to 50 kHz
Resolution	0.1 Hz
Frequency error	<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)
Open-circuit voltage	1 mV_P to 4 V_P (R_{out} = 10 Ω, R_L >200 Ω)
Resolution	1 mV
Setting error at 1 kHz	1% + 1 mV (sinewave)
Frequency setting time	<10 ms

Multifunction generator	option SM-B6
Waveforms	sinewave, triangular, sawtooth, squarewave, noise, stereo MPX signals, VOR/ILS modulation signals
Frequency range	
sinewave, noise	0.1 Hz to 1 MHz
triangular, sawtooth, squarewave	0.1 Hz to 50 kHz
Resolution	0.1 Hz
Frequency error	same as for 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)
Open-circuit voltage	1 mV_P to 4 V_P (R_{out} = 10 Ω, R_L >200 Ω)
Resolution	1 mV
Setting error at 1 kHz	1% + 1 mV
Frequency setting time	<10 ms

Stereo multiplex signal	option SM-B6
Stereo operating modes	R, L, R = L, R = –L, ARI
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	0° to 360°
Resolution	0.1°
Stereo separation	>60 dB
Distortion	<0.1% (L, R = 1 kHz)
Carrier suppression (38 kHz)	>65 dB
Settings selectable for ARI [3)] (ARI = broadcast information for motorists)	
Area identification	A, B, C, D, E, F
Traffic announcement identification	on/off
Additional signals (RDS, RDS+ARI)	application via EXT1 input

VOR modulation signal [1)]	option SM-B6
Settings	30 Hz (VAR, REF)/9.96-kHz FM carrier, FM deviation, COM/ID tone
Phase	0° to 360°
Phase resolution	0.01°
Bearing error (RF output, 108 MHz to 118 MHz)	<0.05°
FM error (deviation 480 Hz)	<1 Hz

Signal Generator SME

ILS modulation signal[1]	option SM-B6
Settings	90-Hz, 150-Hz tone, COM/ID tone, marker beacon
DDM setting range	0 to ±0.8
DDM resolution	0.0001
DDM error (RF output)	
Localizer (108 MHz to 112 MHz)	<0.0004 + 2% of DDM reading
Glideslope (329 MHz 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
Accuracy	same as for reference frequency
Pulse width	20 ns to 1 s
Resolution	4-digit, min. 20 ns
Accuracy	5% of reading ±5 ns
Pulse delay	40 ns to 1 s
Resolution	4-digit, min. 20 ns
Accuracy	5% of reading –10 ns to +20 ns
Double pulse	60 ns to 1 s
Resolution	4-digit, min. 20 ns
Accuracy	5% of reading –10 ns to +20 ns
Trigger delay	typ. 50 ns
Sweep	digital, in discrete steps
RF sweep, AF sweep	AF 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)	freely selectable
step width (log)	0.01% to 100%
Level sweep	
Operating modes	automatic, single-shot, manual or externally triggered, logarithmic
Sweep range	0.1 dB to 20 dB
Step width	0.1 dB to 20 dB
Step time	10 ms to 5 s
SME03A, SME including SM-B50	2 ms to 5 s
Resolution	0.1 ms
Markers	3, freely selectable
MARKER output signal	TTL/HC logic signal, selectable polarity
X output	0 V to 10 V
BLANK output signal	TTL/HC logic signal, selectable polarity
List mode (not SME03E)	frequency and level values can be stored in a list and will be set in an extremely short time
Permissible level variation	20 dB
Operating modes	automatic, single-shot, manual, externally triggered
Max. number of channels	2000
SME03A, SME including SM-B50	4000
Step time	1 ms to 1 s
Resolution	0.1 ms
Memory for instrument settings	50
Memory sequence modes	automatic, single-shot, manual or externally triggered
Step time	50 ms to 60 s
Resolution	1 ms
Remote control	
System	IEC 625 (IEEE 488)
Instruction set	SCPI 1993.0

General data

Power supply	90 V to 132 V/180 V to 265 V (AC), 47 Hz to 440 Hz, autosetting to AC voltage, max. 300 VA
Operating temperature range	0°C to 55°C[4]
Storage temperature range	–40°C to +70°C
Dimensions (W x H x D)	435 mm x 192 mm x 460 mm
Weight	25 kg for fully equipped unit

Ordering information

Signal Generator	SME02	1038.6002.02
	SME03	1038.6002.03
	SME03A	1038.6002.53
	SME03E	1038.6002.13
	SME06	1038.6002.06
Accessories supplied	power cable, operating manual	
Options		
Reference Oscillator OCXO	SM-B1	1036.7599.02
LF Generator	SM-B2	1036.7947.02
Pulse Modulator for SME02[5]	SM-B3	1036.6340.02
SME03/A/E[5]	SM-B8	1036.6805.02
SME06[5]	SM-B9	1039.5100.02
Pulse Generator (only with option SM-B3, SM-B8 or SM-B9)	SM-B4	1036.9310.02
FM/φM Modulator	SM-B5	1036.8489.02
Multifunction Generator	SM-B6	1036.7760.02
DM Coder	SME-B11	1036.8720.02
DM Memory Extension (8 Mbit)	SME-B12	1039.4090.02
FLEX Protocol	SME-B41	1039.5645.02
POCSAG Protocol	SME-B42	1039.5745.02
REFLEX™ Protocol	SME-B43	1039.5797.02
Fast CPU	SM-B50	1104.8410.02
Rear Connectors for RF and AF	SME-B19	1039.3907.02

Possible combinations of options
The SME options can be freely combined with two exceptions:

1. The LF generator (SM-B2) and the multifunction generator (SM-B6) cannot be combined if a pulse modulator (SM-B3, SM-B8 or SM-B9) is fitted.

2. The LF generator (SM-B2) can be fitted twice if no pulse modulator (SM-B3, SM-B8 or SM-B9) and no multifunction generator (SM-B6) is fitted.

Extras		
19" Rack Adapter	ZZA-94	0396.4905.00
Service Kit	SM-Z2	1039.3520.02
Trolley	ZZK-1	1014.0510.00
Transit Case	ZZK-944	1013.9366.00
SME Service Manual		1039.1856.24

1) Does not apply to non-interrupting level setting (ATTENUATOR MODE FIXED and USER CORR).

2) Applies to levels ≤7 dBm.

3) In the ARI mode, L = R = OFF.

4) Contrast of LCD display degraded at high temperatures.

5) Retrofit by authorized service centers only.

Signal Generator SML01

SML01: 9 kHz to 1,1 GHz

SML02: 9 kHz to 2,2 GHz

SML03: 9 kHz to 3,3 GHz

Economy at its best

Photo 43412-2

Brief description

SML offers all features required of a state-of-the-art general-purpose signal generator: wide frequency range, large variety of modulation functions and high reliability – at an extremely attractive price. The fields of application of SML are virtually unlimited in development, servicing or production where it is used as a flexible signal source in automatic test systems. SML benefits both from our long-standing experience in the field of signal generators and the latest technology. Its uses are as versatile as its functionalities.

Main features

Frequency
- 9 kHz to 1.1 GHz/2.2 GHz/3.3 GHz
- 0.1 Hz frequency resolution

Level
- –140 dBm to +13 dBm (+19 dBm overrange)
- High level accuracy (deviation <0.5 dB)
- Level setting without overshoots
- Electronic attenuator
- Non-interrupting level setting

Spectral purity
- SSB phase noise <–122 dBc (1 Hz), typ. <–128 dBc (1 Hz) (at carrier offset 20 kHz)
- Broadband noise <–140 dBc (1 Hz), typ. –150 dBc (1 Hz) (f = 1 GHz, carrier offset >2 MHz)

Speed
- Setting times <10 ms for frequency and level

Modulation
- AM/FM/φM as standard
- Simultaneous operation of AM, FM/φM and pulse modulation
- Optional pulse modulator with integrated pulse generator (SML-B3)

Low cost of ownership
- 3-year calibration cycle
- Low purchase price
- High reliability through electronic attenuator (wear-free)
- Service-friendly (continuous selftest, access to internal test points via LCD)
- Options OCXO (SML-B1) and pulse modulator (SML-B3) retrofittable

Size
- Compact size: 427 mm x 88 mm x 450 mm
- Low weight: <8 kg

Applications

The use of a signal generator in the laboratory requires
- Wide frequency range
- High spectral purity
- High and accurate output level
- Very good modulation characteristics

These features are particularly important in servicing
- High mobility
- Flexible control
- Protection against overvoltage

In production these factors play a vital role
- Accuracy for high yield
- Speed for high throughput
- Reliability for undisturbed operation

EMS measurements require
- Non-interrupting level setting
- Level setting without overshoots
- Wide frequency range

User-friendly operation

- One-hand operation with EasyWheel
- All settings simple and self-explanatory
- High-contrast LC display
- User-assignable menu keys
- Online help including IEEE/IEC bus commands

Signal Generator SML01

Specifications in brief

Specifications are guaranteed under the following conditions:
15 minutes warm-up time at ambient temperature, specified environmental conditions met, calibration cycle adhered to, and total calibration performed.
Data without tolerances: typical vaues only.
Data designated with "nominal" apply to design parameters and are not tested.
Data designated "overrange" are not guaranteed.

Frequency

Range	9 kHz to 1.1 GHz
SML01	9 kHz to 1.1 GHz
SML02	9 kHz to 2.2 GHz
SML03	9 kHz to 3.3 GHz
Resolution	0.1 Hz
Setting time (for an offset of <1×10^{-7} or <90 Hz for f ≤76 MHz)	<10 ms

Reference frequency

	Standard	Option SML-B1
Aging (after 30 days of operation)	<1×10^{-6}/year	<1×10^{-7}/year or <5×10^{-10}/day
Temperature drift (0°C to 55°C)	<1×10^{-6}	<2×10^{-8}

Spectral purity

Spurious signals	
Harmonics [1]	
SML01	<–30 dBc at levels ≤+10 dBm
SML02/SML03	
f ≤20 kHz	<–25 dBc at levels ≤+8 dBm
f >20 kHz	<–30 dBc at levels ≤+8 dBm
Subharmonics	
f ≤1.1 GHz	none
f >1.1 GHz	<–50 dBc
Nonharmonics (carrier offset >10 kHz)	<–70 dBc
f ≤1,1 GHz	<–70 dBc
f >1.1 GHz to 2.2 GHz	<–64 dBc
f >2.2 GHz to 3.3 GHz	<–58 dBc
Broadband noise [2] (f = 1GHz, carrier offset >2 MHz, 1 Hz bandwidth)	<–140 dBc, typ. –150 dBc
SSB noise (f = 1 GHz, 20 kHz carrier offset, 1 Hz bandwidth)	<–122 dBc, typ. –128 dBc
Spurious FM, rms (f = 1 GHz)	
0.3 kHz to 3 kHz	<4 Hz, typ. 1 Hz
0.03 kHz to 20 kHz	<10 Hz, typ. 3 Hz
Spurious AM, rms (0.03 kHz to 20 kHz)	<0.02%

Level

Range	–140 dBm to +13 dBm[3] (Overrange +19dBm)
Resolution	0.1 dB
Total level deviation[3] Output>–120 dBm	<0.5 dB
SML01	
SML02/SML03	<0.5 dB
100 kHz to ≤ 2 GHz	<0.9 dB
f >2 GHz	
Frequency response at 0 dBm[3]	
SML01	<0.5 dB, typ. 0.3 dB
SML02/SML03	
100 kHz to ≤ 2 GHz	<0.7 dB
f >2 GHz	<1,0 dB
Characteristic impedance	50 Ω
VSWR SML01	<1,5
VSWR SML02/03	
100kHz to 1.5 Ghz	1.6
f >1.5 GHz	2.3
Setting time (IEEE/IEC bus), f >100 kHz	<10 ms, typ. 5 ms
Non-interrupting level setting[4]	20 dB, overrange 30 dB

Overvoltage protection	safeguards unit against externally applied RF power and DC voltage (50 Ω source)
Max. permissible RF power f ≤2.2 GHz	50 W
Max. permissible RF power f >2.2 GHz	25 W
Max. permissible DC voltage	35 V

Internal modulation generator

Frequency range; Resolution	0.1 Hz to 1 MHz; 0.1 Hz
Frequency accuracy	as for reference frequency + 2.4×10^{-3} Hz
Frequency response (up to 500 kHz, level >100 mV)	<0.5 dB
THD (up to 100 kHz, level 4 V, R_L = 600 Ω)	<0.1%
Open-circuit voltage V_p (LF connector)	1 mV to 4 V
Resolution	1 mV
Setting accuracy (at 1 kHz)	1% of V_P+ 1 mV
Output impedance	approx. 10 Ω
Frequency setting time	<10 ms

Simultaneous modulation	AM, FM/φM and pulse modulation

Amplitude modulation[5]

Operating modes	internal, external AC/DC, internal/external two-tone
Modulation depth; Resolution	0% to 100%; 0.1%
Setting accuracy at 1 kHz (m <80%)[6]	<4% of reading +1%
AM distortion at 1 kHz	
m = 30%	<1%
m = 80%	<2%
Modulation frequency range (3 dB), f >100 kHz	DC/10 Hz to 50 kHz
Incidental φM at AM (30%), AF = 1 kHz	<0.2 rad

Frequency modulation

Operating modes	internal, external AC/DC, internal/external two-tone
Frequency deviation	
9 kHz to 76 MHz	0 Hz to 1 MHz
>76 MHz to 151.3125 MHz	0 Hz to 125 kHz
>151.3125 MHz to 302.625 MHz	0 Hz to 250 kHz
>302.625 MHz to 605.25 MHz	0 Hz to 500 kHz
>605,25 MHz to 1,2105 GHz	0 Hz to 1 MHz
>1,2105 GHz to 1,818 GHz	0 Hz to 2 MHz
>1,818 GHz to 2,655 GHz	0 Hz to 3 MHz
>2,655 GHz to 3,300 GHz	0 Hz to 4 MHz
Resolution	<1% of set deviation, minimum 10 Hz
Setting accuracy (at AF = 1 kHz)	<4% of reading + 20 Hz
FM distortion (at AF = 1 kHz and 50% of max. deviation)	<0.2%, typ. 0.1 %
Modulation frequency range (–3 dB), standard/wide	DC/10 Hz to 100 kHz/500 kHz
Incidental AM (at AF = 1 kHz, f >10 MHz, 40 kHz deviation)	<0.1%
Stereo modulation at 40 kHz useful deviation, AF = 1 kHz, RF = 87 MHz to 108 MHz	
Crosstalk	>50 dB
S/N ratio unweighted, rms	>70 dB
S/N ratio weighted, rms	>70 dB
Distortion	<0.2%, typ. 0.1%
Carrier frequency offset at FM DC	typ. 0.1% of set deviation

Signal Generator SML01

Phase modulation

Operating modes	internal, external AC/DC, internal/external two-tone
Phase deviation[7]	
9 kHz to 76 MHz	0 rad to 10 (2) rad
>76 MHz to 151.3125 MHz	0 rad to 1.25 (0.25) rad
>151.3125 MHz to 302.625 MHz	0 rad to 2.5 (0.5) rad
>302.625 MHz to 605.25 MHz	0 rad to 5 (1) rad
>605.25 MHz to 1.2105 GHz	0 rad to 10 (2) rad
>1.2105 GHz to 1.818 GHz	0 rad to 20 (4) rad
>1.818 GHz to 2.655 GHz	0 rad to 30 (6) rad
>2.655 GHz to 3.300 GHz	0 rad to 40 (8) rad
Resolution	<1%, min. 0.001 rad
Setting accuracy at AF = 1 kHz	<4% of reading + 0.02 rad
Phase distortion (at AF = 1 kHz and 50% of maximum deviation)	<0.2%, typ. 0.1%
Modulation frequency range (–3 dB), standard/wide	DC/10 Hz to 100 kHz/500 kHz

Pulse modulation (with option SML-B3)

Operating modes	internal, external
On/off ratio	>80 dB
Rise/fall time (10%/90%)	<20 ns, typ. 10 ns,
Pulse repetition frequency	0 MHz to 2.5 MHz
Pulse delay	typ. 50 ns
Video crosstalk (V_p)	<30 mV

Pulse generator (with option SML-B3)

Operating modes	automatic, externally triggered, external gate mode, single pulse, double pulse, delayed pulse (externally triggered)
Active trigger edge	positive or negative
Pulse period	100 ns to 85 s
Resolution	5 digits, min. 20 ns
Accuracy	$<1 \times 10^{-4}$
Pulse width	20 ns to 1 s
Resolution	4 digits, min. 20 ns
Accuracy	$<(1 \times 10^{-4} + 3$ ns)
Pulse delay	20 ns to 1 s
Resolution	4 digits, min. 20 ns
Accuracy	$<(1 \times 10^{-4} + 3$ ns)
Double-pulse spacing	20 ns to 1 s
Resolution	4 digits, min. 20 ns
Accuracy	$<(1 \times 10^{-4} + 3$ ns)
Trigger delay	typ. 50 ns
Jitter	<10 ns

Sweep digital in discrete steps

RF sweep, AF sweep	
Operating modes	automatic, single shot, manually or externally triggered, linear or logarithmic
Sweep range	user-selectable
Step width (lin)	user-selectable
Step width (log)	0.01% to 100%
Level sweep	
Operating modes	automatic, single-shot, manually or externally triggered, logarithmic
Sweep range	user-selectable
Step width (log)	user-selectable
Step time	10 ms to 1 s
Resolution	0.1 ms
Memory for device settings	
Storable settings	100

Remote control

System	IEC 625 (IEEE 488) and RS-232
Command set	SCPI 1995.0

General data

Temperature resistance	
Within specifications between	0°C and 55°C; meets IEC68-2-1 and IEC68-2-2
Storage temperature range	–40°C to +70°C
Power supply	100 V to 120 V (AC), 50 Hz to 60 Hz, 200 V to 240 V (AC), 50 Hz to 60 Hz, autoranging, max. 150 VA
Dimensions (W x H x D)	427 mm x 88 mm x 450 mm
Weight	<8 kg when fully equipped

Ordering information

Signal Generator	SML01	1090.3000.11
	SML02	1090.3000.12
	SML03	1090.3000.13
Accessories supplied	power cable, user manual	
Options		
Reference Oscillator OCXO	SML-B1	1090.5790.02
Pulse Modulator	SML-B3	1090.5403.02[8]
Rear Connectors for AF, RF	SML-B19	1090.5303.02[8]
Extras		
Service Kit	SML-Z2	1090.5203.02
19" rack adapter	ZZA-211	1096.3260.00
Transport Bag	ZZT-214	1109.5119.00
Service Manual Modules		1090.3123.24

1) With option SML-B3 only for f > 20 MHz.
2) With Attenuator Mode Auto.
3) SML02, SML03: +11 dBm at f ≤5MHz, f>3GHz.
4) With Attenuator Mode Fixed.
5) With Attenuator Mode Auto, f≥100 kHz.
6) With option SML-B3 only for f > 10 MHz.
7) Values in brackets apply to wide modulation bandwidth.
8) Factory-fitted only.

Signal Generator SMY

SMY 01: 9 kHz to 1040 MHz

SMY 02: 9 kHz to 2080 MHz

Low-cost, ideal for receiver testing and component measurements

Photo 43026-3

Brief description

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, the 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 service environments.

Main features

- Level range –140 dBm to +19 dBm (25 dBm overrange with option SMY-B40), sufficient even for receivers of highest sensitivity
- High level accuracy and low RF leakage allowing accurate and undegraded sensitivity measurements
- FM-DC with high accuracy of carrier frequency for testing pagers and receivers fitted with digital squelches
- Low SSB phase noise and high spurious rejection for all in-channel and blocking measurements
- Low residual FM affording ample of margin for S/N measurements
- Modulation generator 1 Hz to 500 kHz for modulation frequency response measurements
- Stereo channel separation of 50 dB and low harmonic distortion for testing FM stereo receivers
- Non-interrupting level setting over a range of 20 dB for reproducible measurement of squelch hysteresis
- Frequency resolution 1 Hz, suitable also for narrowband DUTs
- FM-DC, deviation up to 20 MHz for VCO simulation
- FM bandwidth 2 MHz for fast FSK and telemetry applications
- AF synthesizer 1 Hz to 500 kHz, separate use as AF signal source for external applications possible, eg recording of AF frequency response
- Remote-control interface IEC 625/IEEE 488 for use in automatic test systems
- RF sweep
- Sequence function and SEQ input for semi-automatic use

Characteristics

Cost-saving synthesis concept

Single-loop synthesis is a concept that makes for simple and cost-effective circuit design without losing out on 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 the user can exactly feel each setting step. 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 100 complete instrument setups.

Reliability of operation, ease of maintenance

The built-in selftest 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 in brief

Frequency

Range SMY01/SMY02	9 kHz to 1.04 GHz/9 kHz to 2.08 GHz
Underranging	down to 5 kHz (without guarantee of specs)
Resolution	1 Hz
Setting time (to within <1 x 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 x 10^{-6}/year	<1 x 10^{-9}/day
Temperature effect (0 to 55°C)	2 x 10^{-6}	<5 x 10^{-8}
warm-up time	–	10 min
Output for internal reference	10 MHz, 1 V V_{rms} (EMF, sinewave), 50 Ω	
Input for external reference	5 or 10 MHz ±5 x 10^{-6}	

Spectral purity

Spurious signals	
Harmonics	<–30 dBc for levels <10 dBm <–25 dBc for levels <16 dBm[1]
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=>65 MHz	<–140 dBc
SSB phase noise at 20 kHz from carrier, 1 Hz bandwidth, CW f <65 MHz	<–114 dBc
100 MHz/500 MHz	<–132 dBc/<–120 dBc
1 GHz/2GHz	<–114 dBc/<–108 dBc
Residual FM, rms, <1% of max. 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; –134 to +19 dBm[1]
Overranging (without guarantee of specs)	up to +19 dBm; –140 to +25 dBm[1]
Resolution	0.1 dB
Accuracy for levels >–127dBm	±1 dB (f >1.04 GHz: ±1.5 dB)
Frequency response at 0 dBm	1 dB, typ. 0.3 dB
VSWR/Characteristic impedance	<1.5 (f >1.04 GHz: <1.8)/50 Ω
Setting time (IEEE/IEC bus)	<25 ms (<10 ms with electronic level setting)
Non-interrupting level setting	0 to –20 dB

Overload protection	protects the instrument against externally applied RF power and DC voltage (50 Ω source)
Max. permissible RF power/DC	30 W (SMY 02: 50 W)/35 V
Max. pulse load (pulse width <10 µs)	1 mWs or 150 V (peak)

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

Amplitude modulation	internal, external AC/DC
Modulation depth/Resolution	0 to 100%/0.1%
Setting error at 1 kHz (m <80%)	<4% of reading ±1%
AM distortion at 1 kHz	<1%; 3%[1] (m=30%) <2%; 5%[1] (m=80%)
Modulation frequency response (m=60%)	
30 Hz (DC) to 10 kHz	0.4 dB
10 Hz (DC) to 50 kHz	3 dB
Incidental φM at AM (30%), AF=1 kHz	<0.2 rad <0.4 rad at f >1.04 GHz (SMY 02)

Frequency modulation	internal, external AC/DC
Max. deviation for carrier frequency	
<65 MHz/65 to 130 MHz	10 MHz/1.25 MHz
130 to 260 MHz/260 to 520 MHz	2.5 MHz/5 MHz
520 to 1040 MHz/1040 to 2080 MHz	10 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 max. deviation	<0.3%, typ. 0.1%
Modulation frequency response 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	
Crosstalk attenuation	>50 dB
S/N ratio unweighted	>76 dB
S/N ratio weighted	>70 dB
Distortion	typ. 0.1%
Carrier frequency offset with FM-DC	<1 Hz + 0.1% of deviation

Phase modulation	internal, external AC
Max. deviation for carrier frequency	
<65 MHz/65 to 130 MHz	200 rad/25 rad
130 to 260 MHz/260 to 520 MHz	50 rad/100 rad
520 to 1040 MHz/1040 to 2080 MHz	200 rad/400 rad
Resolution	<1%, min. 0.01 rad
Setting error at AF=1 kHz	<5% of reading + 0.02 rad
Distortion at AF=1 kHz and 50% of max. deviation	<0.5% (typ. 0.2%)
Modulation frequency response	<3 dB (typ. 1 dB) (20 Hz to 20 kHz)

Pulse modulation	external
On/off ratio	>80 dB; >70 dB at 70 MHz [1]
Rise/fall time (10/90%)	typ. 4 µs; <20 ns [1]
Pulse delay	typ. 2.5 µs; <200 ns [1]
Modulation input	TTL/HC logic signal, polarity selectable

Internal modulation generator

Frequency range/resolution	1 Hz to 500 kHz/0.1 Hz
Display	7 digits, floating point
Frequency drift	<5 x 10^{-5}
Frequency response up to 50 kHz	0.2 dB (up to 100 kHz: <0.3 dB)
Distortion (20 Hz to 100 kHz)	<0.1%
Output voltage (peak)	1 V ±1% (R_{out} <10 Ω, R_L >200 Ω)

RF Sweep	digital sweep in discrete steps
Mode	automatic, linear
Sweep range and step width	user-selected
Step duration/Resolution	10 ms to 5 s/1 ms

General data

Remote control	IEC 625 (IEEE 488)
Memory	non-volatile, for 100 instrument setups
Power supply	100 V/230 V (AC) –10 to +15%, 120 V/220 V (AC) –12.5 to +10%, 47 Hz to 440 Hz, max. 120 VA
Dimensions (W x H x D) SMY01	435 mm x 147 mm x 350 mm
Dimensions (W x H x D) SMY02	435 mm x 147 mm x 460 mm
Weight for fully equipped unit	12 kg (SMY01), 13 kg (SMY02)

Ordering information

Signal Generator	SMY 01	1062.5502.11
	SMY 02	1062.5502.12
Options, extras		
Reference Oscillator OCXO	SMY-B1	1062.7505.02
Rear Connectors for RF and LF	SMY-B10	1062.8001.02
High Output Power	SMY-B40[2]	1062.9008.02
Service Kit	SMY-Z2	1062.7805.02
Service Manual		1062.5583.24

[1] with option SMY-B40.

[2] To be retrofitted by authorized service centers only.

Microwave Signal Generator SMP

SMP02, 22: 0.01/2 GHz to 20 GHz

SMP03: 0.01/2 GHz to 27 GHz

SMP04: 0.01/2 GHz to 40 GHz

Excellent signal characteristics and high output power up to 40 GHz

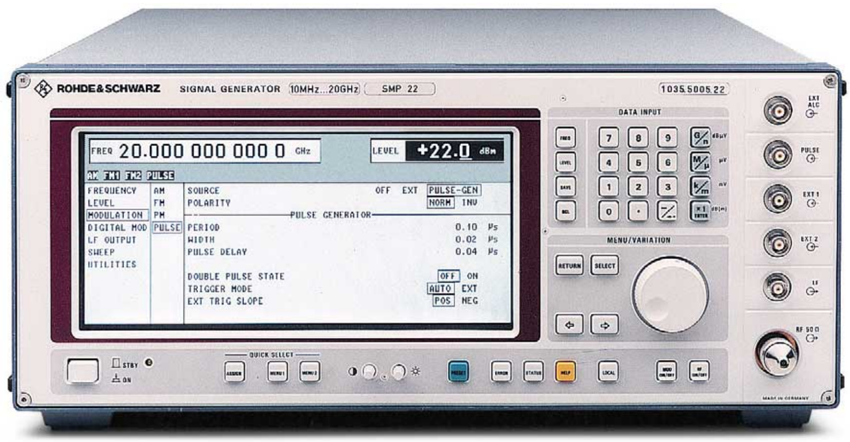


Photo 41154

Brief description

SMP is a reliable, high-precision signal source featuring high output power, high spectral purity and excellent pulse modulation. It is able to supply signals for any measurements on radar and communications receivers. A wide range of extensions ensures universal use in R&D, production, EMC and environmental measurements as well as in material testing.

Main features

- High spectral purity
- Stable output frequency
- High output level:

SMP02	SMP22	SMP03	SMP04
>11.5	>20	>13	>10 dBm
at 20	20	27	40 GHz

- Fast settling after a frequency change
- AM, FM, φM, pulse modulation
- Scan modulation
- RF, AF and level sweep
- Large choice of options for user-specific configuration
- Great ease of operation through modern menu concept

Overview of options

Designation, functions	Option
Reference Oscillator OCXO: aging $<1 \times 10^{-9}$/day	SM-B1
LF Generator: supplies sinewave, noise 0.1 Hz to 500 kHz, triangular, squarewave 0.1 Hz to 50 kHz signals	SM-B2
FM/jM Modulator: FM DC to 1 MHz, φM DC to 100 kHz, precision FM DC	SM-B5
Frequency Extension 0.01 GHz to 2 GHz[1]: extends the lower frequency limit to 10 MHz	SMP-B11
Pulse Modulator 2 GHz to 20 GHz[1]: on/off ratio >80 dB, rise/fall time <10 ns; for SMP02 and SMP22 only	SMP-B12, model 02
Pulse Modulator 2 GHz to 27 GHz[1]: on/off ratio >80 dB, rise/fall time <10 ns; for SMP03 only	SMP-B12, model 03
Pulse Modulator 2 GHz to 40 GHz[1]: on/off ratio >80 dB, rise/fall time <10 ns; for SMP04 only	SMP-B12, model 04
Pulse Modulator 0.01 GHz to 2 GHz[1]: on/off ratio >80 dB, rise/fall time <10 ns	SMP-B13
Pulse Generator: provides single, delayed and double pulses	SMP-B14
RF Attenuator 27 GHz[1]: allows level setting down to –130 dBm; for SMP02, SMP22 and SMP03 only	SMP-B15
RF Attenuator 40 GHz[1]: allows level setting down to –130 dBm; for SMP04 only	SMP-B17
Auxiliary Interface: V/GHz output, Z output for scalar network analyzers	SMP-B18
Rear Connectors for RF and AF[1]: to replace front-panel connectors; for SMP02, SMP22 and SMP03 only	SMP-B19
Rear Connectors for RF and AF[1]: to replace front-panel connectors; for SMP04 only	SMP-B20

1) Factory-fitted option.

Microwave Signal Generator SMP

Specifications in brief

Frequency

Range	standard	with option SMP-B11
SMP02, SMP22	2 to 20 GHz	10 MHz to 20 GHz
SMP03	2 to 27 GHz	10 MHz to 27 GHz
SMP04	2 to 40 GHz	10 MHz to 40 GHz
Resolution	0.1 Hz	
Setting time (to within $<1 \times 10^{-6}$) after IEEE/IEC bus delimiter	<(11 ms + 5 ms/GHz)	

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}	$<5 \times 10^{-8}$

Spectral purity

Spurious signals	**SMP02**	**SMP22**	**SMP03**	**SMP04**
Harmonics:				
f <1.8 GHz	<–30 dBc (<+8 dBm)	<–25 dBc (<+8 dBm)	<–30 dBc (<+3 dBm)	<–30 dBc (<±0 dBm)
f ≥1.8 GHz	<–40 dBc (<+10 dBm)	<–25 dBc (<+15 dBm)	<–40 dBc (<+3 dBm)	<–40 dBc (<±0 dBm
Harmonics with options SMP-B12, -B13 (pulse modulation on):				
f <1.8 GHz	<–25 dBc (<+8 dBm)	<–25 dBc (<+8 dBm)	<–25 dBc (<+3 dBm)	<–25 dBc (<±0 dBm)
f ≥1.8 GHz	<–25 dBc (<+11 dBm)	<–25 dBc (<+11 dBm)	<–25 dBc (<+3 dBm)	<–25 dBc (<±0 dBm)
Subharmonics				
f ≤20 GHz	none	none	none	none
f >20 GHz	–	–	<–40 dBc	<–30 dBc
Nonharmonics at >10 kHz from carrier:				
f <2 GHz	typ. <–60 dBc	typ. <–60 dBc	typ. <–60 dBc	typ. <–60 dBc
2 to 20 GHz	<–60 dBc	<–60 dBc	<–60 dBc	<–60 dBc
f >20 GHz	–	–	<–54 dBc	<–54 dBc

SSB phase noise, 1 Hz bandwidth, FM off:

		offset from carrier		
Frequency range	100 Hz	1 kHz	10 kHz	100 kHz
10 MHz to <2 GHz	<–64 dBc	<–92 dBc	<–98 dBc	<–101 dBc
2 to 10 GHz	<–64 dBc	<–92 dBc	<–98 dBc	<–101 dBc
>10 to 20 GHz	<–58 dBc	<–86 dBc	<–92 dBc	<–95 dBc
>20 to 27/40 GHz	<–54 dBc	<–80 dBc	<–86 dBc	<–92 dBc

Level

Maximum level SMP02, SMP22

Frequency range	SMP02, option SMP-B15 without	with	SMP22, option SMP-B15 without	with
10 MHz to <2 GHz	>+17 dBm	>+17 dBm	>+17 dBm	>+17 dBm
2 to 20 GHz	>+11.5 dBm	>+10 dBm	>+20 dBm	>+18.5 dBm

Maximum level SMP03, SMP04:

Frequency range	SMP03, option SMP-B15 without	with	SMP04, option SMP-B17 without	with
10 MHz to <2 GHz	>+12 dBm	>+12 dBm	>+12 dBm	>+12 dBm
2 to <18 GHz	>+10 dBm	>+8.5 dBm	>+10 dBm	>+8.5 dBm
18 to 20 GHz	>+6 dBm	>+4.5 dBm	>+6 dBm	>+4.5 dBm
>20 to 27/33 GHz	>+13 dBm	>+11 dBm	>+12 dBm	>+10 dBm
>33 to 40 GHz	–	–	>+10 dBm	>+8 dBm

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

Amplitude modulation	**internal, external AC/DC**
Modulation depth/resolution	0 to 90%/0.1%
AM distortion at AF=1 kHz (m=60%), f >50 MHz	<1%, typ. <0.5%
Modulation frequency range	DC to 100 kHz

Frequency modulation	int., ext. AC/DC, locked/unlocked, two-tone with two separate channels FM1 and FM2
Standard frequency modulation	without option SM-B5
Maximum deviation	f ≤20 GHz: 10 MHz f >20 GHz: 20 MHz
FM distortion at AF=50 kHz and 500 kHz deviation	<0.5%, typ. 0.05%
Modulation frequency range	
Locked mode	10 kHz to 5 MHz
Unlocked mode	DC to 5 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
FM distortion at AF=1 kHz and 500 kHz deviation	<0.5%, typ. 0.05%
Modulation frequency range	DC to 1 MHz

Phase modulation	with option SM-B5; int., ext. 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. 0.002 rad
φM distortion at AF=1 kHz and 5 rad deviation	<1%
Modulation frequency range	DC to 100 kHz

ASK modulation	external
Max. modulation depth	90%
Resolution	0.1%
Data rate	0 to 200 kHz

FSK modulation		external	
Maximum shift	standard FM	with option SM-B5	Resolution
f ≤20 GHz	10 MHz	1 MHz	<1%, min. 10 Hz
f >20 GHz	20 MHz	2 MHz	<1%, min. 20 Hz

Data rate (standard FM)	
Locked mode	20 kHz to 2 MHz
Unlocked mode	0 to 2 MHz
Data rate with option SM-B5	0 to 2 MHz

Pulse modulation ext., int. with option SMP-B14

	w/o option SMP--B12, -B13	with option SMP--B12, -B13
Frequency range	≥2 GHz	-B13:10 MHz to 2 GHz -B12: ≥2 GHz
On/off ratio	>50 dB (level >0 dBm)	>80 dB
Rise/fall time (10/90%)	<500 ns	<10 ns
Minimum pulse width	1 µs	20 ns
Pulse repetition frequency	0 to 500 kHz	0 to 10 MHz
Pulse delay	typ. 100 ns	typ. 50 ns
Video feedthrough	<15 mV (peak value)	<15 mV (peak value)

Internal modulation generator	0.4/1/3/15 kHz ±3%
Level (EMF) at LF socket	1 V ±1% (R_{out}=10 Ω, R_L >200 Ω)

Microwave Signal Generator SMP

LF generator	option SM-B2
Sinewave, noise	0.1 Hz to 500 kHz
Triangular, squarewave	0.1 Hz to 50 kHz
Distortion (20 Hz to 100 kHz)	<0.1% (level >0.5 V)
Level (EMF) at LF socket	1 mV to 4 V (R_{out} = 10 Ω, R_L >200 Ω)
Pulse generator	option SM-B4
Operating modes	single, delayed and double pulse
Pulse repetition period	100 ns to 85 s
Pulse width	20 ns to 1 s
Pulse delay	40 ns to 1 s
Double pulse	60 ns to 1 s
Sweep	digital sweep in discrete steps for RF, level and LF LF sweep with option SM-B2 or SM-B6
Interfaces	
2nd RF output	2 GHz to 20 GHz, 0 dBm
Auxiliary interface	with option SMP-B18
V/GHz output	output voltage proportional to frequency, 0.5 or 1 V/GHz selectable
Remote control	IEC 625 (IEEE 488)
Command set	SCPI 1993.0
General data	
Power supply	90 V to 132 V/180 V to 265 V, 47 Hz to 440 Hz, max. 400 VA
Dimensions (W x H x D)	435 mm x 192 mm x 570 mm
Weight	27 kg for fully equipped unit

Ordering information

Signal Generator	SMP02	1035.5005.02
	SMP22	1035.5005.22
	SMP03	1035.5005.03
	SMP04	1035.5005.04
Options		
Frequency Extension 10 MHz to 2 GHz[1)]	SMP-B11	1036.6240.02
Pulse Modulator [1)]		
2 GHz to 20 GHz (SMP02, SMP22)	SMP-B12	1036.5750.02
2 GHz to 27 GHz (SMP03)	SMP-B12	1036.5750.03
2 GHz to 40 GHz (SMP04)	SMP-B12	1036.5750.04
Pulse Modulator 10 MHz to 2 GHz[1)]	SMP-B13	1036.7147.02
Pulse Generator	SMP-B14	1036.7347.02
RF Attenuator 27 GHz[1)]	SMP-B15	1036.5250.02
40 GHz[1)]	SMP-B17	1036.5550.02
Auxiliary Interface	SMP-B18	1036.8920.02
Rear Connectors for AF, RF[1)]		
up to 27 GHz	SMP-B19	1039.4303.02
up to 40 GHz	SMP-B20	1039.4503.02
Reference Oscillator OCXO	SM-B1	1036.7599.02
LF Generator	SM-B2	1036.7947.02
FM/φM Modulator	SM-B5	1036.8489.02

1) Factory-fitted option.

Microwave Signal Generator SMR

High-performance, cost-effective and reliable up to 40 GHz

SMR40 (photo 43264-5)

Brief description

The SMR family comprises four basic models designed as CW generators with pulse modulation capability. Offering an excellent price/performance ratio, each of the four basic models is ideal for the user wishing to enter the field of microwave testing at an affordable price. Should measurements become more demanding - no problem with SMR: all basic models can be upgraded fast and easily by means of options to give a signal generator with AM/FM modulation capability or a synthesized sweep generator featuring fast, fully synthesized analog ramp sweep.

Main features

Wide frequency range

- SMR20: 1 GHz to 20 GHz
- SMR27: 1 GHz to 27 GHz
- SMR30: 1 GHz to 30 GHz
- SMR40: 1 GHz to 40 GHz
- Optional extension of lower frequency limit to 10 MHz (SMR-B11)
- Frequency resolution 1 kHz, optional 0.1 Hz (SMR-B3)

High, levelled output power

- SMR20 >+10 dBm (at 20 GHz)
- SMR27 >+11 dBm (at 27 GHz)
- SMR30/40 >+9 dBm (at 30/40 GHz)

High precisision output level

- High precision, frequency-response-compensated level control
- The setting range can be extended to –130 dBm with the optional RF attenuator (option SMR-B15/B17)

Sweep capabilities

- Digital RF and level sweep (standard version)
- Analog ramp sweep (RF sweep, option SMR-B4)
- Max. sweep rate for ramp sweeps min. 600 MHz/ms (frequency >2 GHz)
- Digital sweep of LF generator (with option SMR-B5)
- 10 freely selectable frequency markers for RF sweep
- Operating modes: automatic, single-shot, manual, externally triggered

Maximum ease of operation

- High-contrast LC display
- Online help including IEEE/IEC bus commands
- All settings simple and self-explanatory
- User-assignable keys
- One-hand operation with EasyWheel

Memory

- Space for 50 complete instrument set-ups
- Convenient memory sequence modes

Optional pulse generator (SMR-B14)

- Operating modes: single pulse, double pulse, externally triggered, gate mode
- Pulse repetition 100 ns to 85 s
- Pulse width 20 ns to 1 s

Optional IF input (SMR-B23/SMR-B24/SMR-B25)

- Built-in upconverter for digitally modulated IF signals from DC to 700 MHz or from 40 MHz to 6 GHz (SMR-B25)
- Ideal for use with Vector Signal Generator SMIQ and I/Q Modulation Generator AMIQ

Advantages at a glance

- CW generator with pulse modulation and digital frequency sweep, easily upgradeable to AM-FM signal generator and synthesized sweeper with analog ramp sweep thanks to flexible options concept
- Excellent spectral purity, high-precision output level and stable output frequency
- Simultaneous modulation modes for generation of complex modulation signals for modern communication and location systems
- Compact, lightweight, user-friendly: ideal in the lab and for field applications
- 3-year calibration cycle
- Excellent price/performance ratio

Microwave Signal Generator SMR

Specifications in brief

Specifications are guaranteed under the following conditions:
15 minutes warm-up time at ambient temperature, specified environmental conditions met, calibration cycle adhered to, and total calibration performed.
Data without tolerances: typical vaues only.
Data designated with "nominal" apply to design parameters and are not tested.
Data designated "overrange" are not guaranteed.

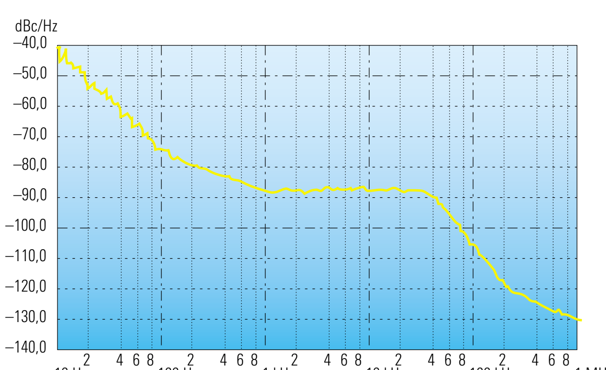
Frequency

Range	w/o option SMR-B11	with option SMR-B11
SMR 20	1 GHz to 20 GHz	10 MHz to 20 GHz
SMR 27	1 GHz to 27 GHz	10 MHz to 27 GHz
SMR 30	1 GHz to 30 GHz	10 MHz to 30 GHz
SMR 40	1GHz to 40 GHz	10 MHz to 40 GHz
Resolution	without option SMR-B3	with option SMR-B3
	1 kHz	0.1 Hz
Setting time (to within $<1\cdot10^{-6}$)	<10 ms + 1 ms/GHz	

Reference frequency	**Standard**	**Option SMR-B1**
Aging (after 30 days of operation)	$1\cdot10^{-6}$/Year	$<1\cdot10^{-7}$/Year
Temperature effect (0°C to 55°C)	$2\cdot10^{-6}$	$<1\cdot10^{-10}$/°C

Spectral purity

Spurious signals	
Harmonics	
f ≤20 GHz	<–55 dBc
f >20 GHz	<–40 dBc
Subharmonics	
f ≤20 GHz	<–65 dBc
f >20 GHz	<–30 dBc
Nonharmonics (>50 kHz from carrier)	
f <20 GHz	<–60 dBc
f >20 GHz	<–54 dBc
SSB phase noise (f = 10 GHz, 10 kHz from carrier, 1 Hz bandwidth, CW, FM OFF)	<–83 dBc
Residual FM, rms (f = 10 GHz, FM OFF)	
0.3 kHz to 3 kHz	<20 Hz
0.03 kHz to 20 kHz	<200 Hz



SSB phase noise at 10 GHz

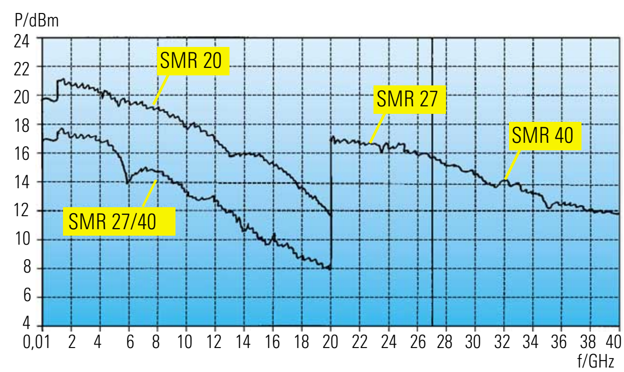
Level

Maximum level without option SMR-B23/-B24/-B25

Frequency range	SMR 20 without SMR-B15	SMR 20 with option SMR-B15	SMR 27/SMR 30/SMR 40 without option SMR-B15/-B17	SMR 27/SMR 30/SMR 40 with option SMR-B15/-B17
0.01 GHz to <1 GHz	>+13 dBm		>+13 dBm	
1 GHz to <18 GHz	>+11 dBm	>+10 dBm	>+8 dBm	>+7 dBm
18 GHz to 20 GHz	>+10 dBm	>+8 dBm	>+7 dBm	>+5 dBm
>20 GHz to 27 GHz	--	--	>+11 dBm	>+9 dBm
>27 GHz to 30 GHz	--	--	>+9 dBm	>+7 dBm
>30 GHz to 40 GHz	--	--	>+9 dBm	>+7 dBm

Maximum level with option SMR-B23/-B24/-B25, normal mode (IF input OFF)

Frequency range	SMR 20 without SMR-B15	SMR 20 with option SMR-B15	SMR 27/SMR 30/SMR 40 without option SMR-B15/-B17	SMR 27/SMR 30/SMR 40 with option SMR-B15/-B17
0.01 GHz to <1 GHz	>+13 dBm		>+12 dBm	
1 GHz to <18 GHz	>+10 dBm	>+9 dBm	>+7 dBm	>+6 dBm
18 GHz to 20 GHz	>+8 dBm	>+6 dBm	>+5 dBm	>+3 dBm
>20. GHz..27 GHz	--	--	>+8 dBm	>+6 dBm
>20 GHz to 30 GHz			>+6 dBm	>+4 dBm
>30 GHz to 40 GHz	--	--	>+6 dBm	>+4 dBm



Typical maximum output level over frequency (with option SMR-B15/-B17)

Linear amplitude modulation (option SMR-B5)

Operating modes	internal, external AC/DC
Modulation depth	0% to 100%
AM distortion (f>50 MHz, AF = 1 kHz, m = 60%)	<1%
Modulation frequency range	DC to 100 kHz

Logarithmic amplitude modulation (option SMR-B5 (SCAN AM))

Operating modes	internal, external
Dynamic range	–30 dB, overrange >30 dB
Sensitivity	–0.1 dB/V to –10 dB/V

Microwave Signal Generator SMR

Frequency modulation (option SMR-B5)

Operating modes	internal, external AC/DC
Maximum deviation	
≤15.625 MHz	39.0625 kHz
>15.625 MHz to 31.25 MHz	78.125 kHz
>31.25 MHz to 62.5 MHz	156.25 kHz
>62.5 MHz to 125 MHz	312.5 kHz
>125 MHz to 250 MHz	625 kHz
>250 MHz to 500 MHz	1.25 MHz
>500 MHz to <1 GHz	2.5 MHz
1 GHz to 2 GHz	5 MHz
>2 GHz to 10 GHz	10 MHz
>10 GHz to 20 GHz	20 MHz
f >20 GHz	40 MHz
FM distortion (NF = 1 kHz, half maximum deviation)	<0.5%
Modulation frequency range	DC to 5 MHz

ASK modulation (option SMR-B5)

Operating modes	internal, external
Maximum modulation depth	90%
Resolution	0.1%
Data rate	0 to 200 kHz

FSK modulation (option SMR-B5)

Operating modes	internal, external
Maximum deviation	
≤15.625 MHz	39.0625 kHz
>15.625 MHz to 31.25 MHz	78.125 kHz
>31.25 MHz to 62.5 MHz	156.25 kHz
>62.5 MHz to 125 MHz	312.5 kHz
>125 MHz to 250 MHz	625 kHz
>250 MHz to 500 MHz	1.25 MHz
>500 MHz to <1 GHz	2.5 MHz
1 GHz to 2 GHz	5 MHz
>2 GHz to 10 GHz	10 MHz
>10 GHz to 20 GHz	20 MHz
f >20 GHz	40 MHz
Resolution	<1 %, minimum 10 Hz
Data rate	0 to 2 MHz

Pulse modulation

Operating modes	external, internal with option SMR-B14
On/off ratio	>80 dB
Raise-/fall time (10/90%)	
62.5 MHz to 125 MHz	<50 ns
>125 MHz to 450 MHz	<20 ns
>450 MHz	<12 ns
Minimum pulse width	
ALC OFF (level control)	20 ns
ALC ON	500 ns
Maximum pulse pause	
ALC OFF	40 ns
ALC ON	free
Minimum pulse/pause ratio	
ALC OFF	1/100
ALC ON	free
Maximum pulse repeat frequency	
62.5 MHz to 125 MHz	1 MHz
>125 MHz to 450 MHz	2 MHz
>450 MHz	10 MHz
Video cross talk	<20 mV_{pp}

IF input (option SMR-B23/-B24/-B25)

	SMR-B23	SMR-B24	SMR-B25
IF input			
Frequency range	DC to 700 MHz	DC to 700 MHz	40 MHz to 6 GHz
level	<0 dBm	<0 dBm	<0 dBm
Frequency resp.	<5 dB	<7 dB	<7 dB
RF output			
Frequency range	1 GHz to 20 GHz	2 GHz to 27/30/40 GHz	1 GHz to 20 GHz
LO level	<–6 dBm	<–3 dBm	<–0 dBm
SWR	<2	<2	<2
Conversion loss (IF input/RF output)			
with option SMR-B15/-B17*)	6 dB to 15 dB	6 dB to 20 dB	6 dB to 15 dB
without option SMR-B15/-B17	6 dB to 13 dB	6 dB to 16 dB	6 dB to 13 dB

*) Option SMR-B15/-B17 in zero position. The conversion loss can be increased with option SMR-B15/-B17 by 10 dB to 110 dB in 10-dB steps. With option SMR-B19/-B20 conversion loss increases up to 0.1 dB/GHz.

LF generator (option SMR-B5)

Frequency range	0.1 Hz to 10 MHz
Resolution	0.1 Hz
Waveforms	sinewave, squarewave
Frequency error	$<1 \cdot 10^{-4}$

Pulse generator (option SMR-B14)

Operating modes	single or double pulse (automatic or externally triggered), delayed pulse (externally triggered), gate mode (external)
Pulse periode	100 ns to 85 s
Pulse width	20 ns to 1 s
Pulse delay	20 ns to 1 s
Double pulse distance	60 ns to 1 s
Resolution	4 digit, min. 20 ns

Digital sweep, sweep in discrete steps

RF sweep, AF sweep	
Operating modes	automatic, single-shot, manual or externally triggered, linear or logarithmic
	freely selectable
Sweep range	freely selectable
Step width (lin)	0.01% to 100%
Step width (log)	
Level sweep	
Operating modes	automatic, single-shot, manual or externally triggered, logarithmic
Sweep range	0 to 20 dB
Step time	1 ms to 1 s
Markers	10, free selectable

Ramp sweep (option SMR-B4)

RF sweep, AF sweep	
Operating modes	automatic, single-shot, manual or externally triggered, start/stop, center frequency, center span, marker
Sweep range	free selectable
Accuracy	(0.005% of deviation)/(sweep time/s) + reference error
Sweep time	10 ms to 100 s (≤30 ms switchover time at 1/2/10 and 20 GHz)

Microwave Signal Generator SMR

Maximum sweep speed	
≤15.625 MHz	2.34375 MHz/ms
>15.625 MHz to 31.25 MHz	4.6875 MHz/ms
>31.25 MHz to 62.5 MHz	9.375 MHz/ms
>62.5 MHz to 125 MHz	18.75 MHz/ms
>125 MHz to 250 MHz	37.5 MHz/ms
>250 MHz to 500 MHz	75 MHz/ms
>500 MHz to <1 GHz	150 MHz/ms
1 GHz to 2 GHz	300 MHz/ms
>2 GHz to 10 GHz	600 MHz/ms
>10 GHz to 20 GHz	1200 MHz/ms
f >20 GHz	2400 MHz/ms
MARKER output signal	TTL level, polarity selectable
X output	0 V to 10 V
BLANK output signal	TTL level, polarity selectable
List mode	Frequency and level values can be stored in a list and will be set very fast.
Permissable level variation	20 dB
Operating modes	automatic, single-shot, manual or externally triggered
Step time	1 ms to 1 s
Remote control	
System	IEC 625 (IEEE 488)
Command set	SCPI 1995.0

General data

Power supply	100 to 120 V (AC), 50 to 400 Hz, 200 to 240 V (AC), 50 to 60 Hz, autosetting to AC voltage, max. 200 VA
Dimensions (W x H x D)	426.7 mm x 87.6 mm x 450 mm
Weight	<12 kg when fully equipped

Ordering information

Signal generator	SMR 20	1104.0002.20
	SMR 27	1104.0002.27
	SMR 30	1104.0002.30
	SMR 40	1104.0002.40
Accessories supplied	Power cable, operating manual, adapter 3.5 mm female (SMR 20), adapter 2.9 mm female (SMR 27/30/40)	
Options		
Reference Oscillator OCXO	SMR-B1	1104.5485.02
Frequency Resolution 0.1 Hz	SMR-B3	1104.5585.02
Ramp Sweep	SMR-B4	1104.5685.02
AM/FM/Scan Modulator	SMR-B5	1104.3501.02
Frequency Extension 0.01 GHz to 1 GHz[1]	SMR-B11	1104.4250.02
Pulse Generator	SMR-B14	1104.3982.02
RF Attenuator 20 GHz (SMR 20/SMR 27)[1]	SMR-B15	1104.4989.02
RF Attenuator 40 GHz (SMR 30/SMR 40)[1]	SMR-B17	1104.5233.02
Rear Connectors for RF, AF (SMR 20/SMR 27)[1]	SMR-B19	1104.6281.02
Rear Connectors for RF, AF (SMR 30/SMR 40)[1]	SMR-B20	1104.6381.02
IF Input 20 GHz (SMR 20)[1]	SMR-B23	1104.5804.02
IF Input 40 GHz (SMR 27/SMR 30/SMR 40)[1]	SMR-B24	1104.6100.02
IF Input 0.04 GHz to 6 GHz (SMR 20)[1]	SMR-B25	1135.1998.02
Extras		
Service Kit	SMR-Z1	1103.9506.02
19" Rack Adapter	ZZA-211	1096.3260.00
Adapter (SMR 20)		
3.5 mm female		1021.0512.00
3.5 mm male		1021.0529.00
N female		1021.0535.00
N male		1021.0541.00
Adapter (SMR 27/30/40)		
2.9 mm female		1036.4790.00
2.9 mm male		1036.4802.00
N female		1036.4777.00
N male		1036.4783.00

[1] Option factory-fitted only.

Vector Signal Generator SMIQ

Digital signals of your choice

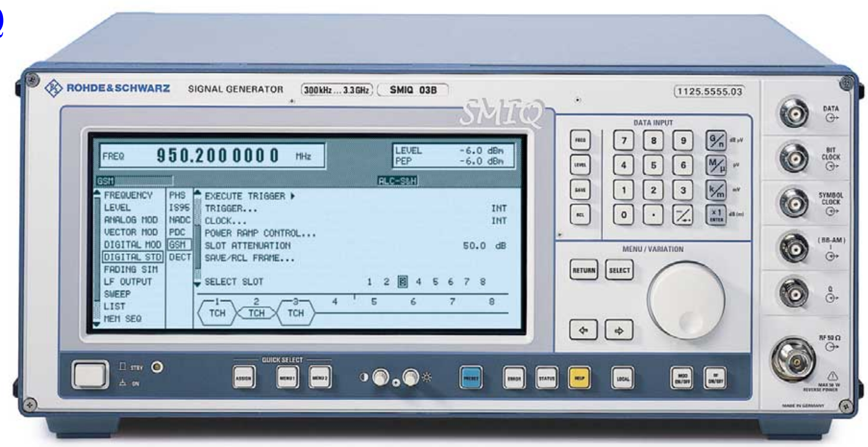


Photo 43304-3

Brief description

The B series of Signal Generator Family SMIQ for analog and digital modulation from Rohde&Schwarz is offering solutions for today and tomorrow. This series particularly takes into account future developments in the field of 3rd-generation digital mobile radio.

The SMIQ family comprises four models which differ in their upper frequency limits. These feature a hitherto unrivalled versatility regarding signal generation and signal quality and are therefore ideal for use in development and type-approval testing.

With their outstanding price/performance ratio, these signal generators are also economically attractive for applications in production. The wide frequency range from 300 kHz to 6.4 GHz covers all main radio bands including their IF ranges.

The high-grade I/Q modulator fitted as standard ensures minimum error vector magnitude and high intermodulation suppression. Using modern digital signal processor (DSP) technology, the versatile concept allows the generation of high-precision digital modulation signals with high bit rates without any limitations on modulation modes or standards.

In addition to digital modulation, the signal generators provide the full range of analog modulation modes as well as simultaneous modulation capability.

Main features

- Frequency range 300 kHz to 2.2 GHz/ 3.3 GHz/4.4 GHz/6.4 GHz
- Analog and digital modulation
- Versatile and broadband generation of digitally modulated signals up to 18 Msymbol/s
- Generation of TDMA, CDMA, W-CDMA and CDMA2000 standard signals to all main mobile radio standards
- Broadband I/Q modulator with outstanding vector accuracy
- Optional internal fading simulator to test specifications of mobile radio standards
- Optional internal noise generator and distortion simulator
- Optional BER measurement
- Optional arbitrary waveform generator
- Low ACP for IS-95 CDMA and W-CDMA (option)
- Low cost of ownership due to three-year calibration intervals
- Future-oriented platform concept
- Unrivalled price/performance ratio

Characteristics

Digital modulation

Any digital modulation modes (with option SMIQB20)

- Free choice of modulation mode from ASK through to 256QAM
- Any kind of baseband filtering with variable filter parameters
- Symbol rate adjustable up to 18 Msymbol/s
- Realtime coding of internal and external data
- Internal PRBS generators

Convenient burst generation for TDMA standards (with option SMIQB20/ SMIQB11)

- TDMA mobile radio standards provided as standard GSM, GSM-EDGE, DECT, NADC (IS-54C/IS-136), PDC, PHS
- Versatile external synchronization capabilities
- Realtime processing of external and internal data
- Generation of TDMA frames with versatile timeslot configuration
- Continuous PRBS sequences
- Optimization of burst shaping to reduce spectra due to switching
- Realtime processing with external data for BER tests
- Slot-by-slot modulation change for TDMA

Vector Signal Generator SMIQ

Overview of options

Application[1]	SM-B1 Reference Oscillator OCXO	SM-B5 FM/φM Modulator	SMIQB11[2] Data Generator (15 Mbit RAM)	SMIQB12 Memory Extension, 32 Mbit	SMIQB14 Fading Simulator (6 paths)	SMIQB15 2nd Fading Simulator (6 paths)	SMIQB17 Noise Generator and Distortion Simulator	SMIQB20 Digital Modulation Coder	SMIQB21 BER measurement	SMIQB42[3] Digital Standard IS-95 CDMA	SMIQB43[3] Digital Standard W-CDMA (NTT DoCoMo 1.0, ARIB 0.0)	SMIQB45[3] Digital Standard W-CDMA according to 3GPP (FDD)	SMIQB47 Low ACP for IS-95 CDMA and W-CDMA	SMIQB48 Extended Functions for W-CDMA 3GPP	SMIQB60 Arbitrary Waveform Generator	SMIQK11 Digital Standard IS-95 CDMA (with ARB SMIQB60)	SMIQK12 Digital Standard CDMA2000 (with ARB SMIQB60)
TDMA																	
To standard	❍		●	❍	❍			●									
Non-standard	❍	❍	●	❍	❍		❍	●	❍								
CDMA IS-95																	
To standard	❍	❍	●	❍	❍		❍	●		●					❍	❍	
W-CDMA																	
To standard	❍	❍	●	❍	❍		❍	●			●	●	●	❍	❍		
CDMA 2000																	
To standard	❍	❍	●	❍	❍		❍	●							●		●
Fading																	
					●	❍											
Vector modulation																	
	❍	❍	❍	❍	❍	❍	❍	❍		❍	❍	❍	❍				
Analog modulation (AM, FM, φM)																	
	❍	●															
Fast setting time																	
	❍	❍	❍	❍	❍	❍	❍	❍		❍	❍	❍					

1) SMIQ02B/03B (SMIQ04B/06B) can be equipped with up to three (two) of the following options: SM-B5, SMIQB14, SMIQB15 or SMIQB17

2) Option SMIQB20 required

3) Options SMIQB20 and SMIQB11 required

● = required

❍ = optional

Analog modulation

- Broadband AM with up to 30 MHz modulation frequency
- I/Q modulation with 30 MHz modulation bandwidth (3 dB), 60 MHz RF bandwidth
- Unprecedented vector accuracy and high intermodulation suppression
- Amplitude modulation
- Pulse modulation
- Optional frequency and phase modulation (SM-B5)

RF characteristics

- Wide output frequency range from 300 kHz to 6.4 GHz
- High (up to 16 dBm) and precise output level (<0.5 dB)
- Fast setting time for frequency (<3 ms) and level (<2.5 ms)[1]
- Frequency hopping (500 µs)
- High spectral purity (typ. –130 dBc (1 Hz) at 1 GHz and 20 kHz carrier offset)
- Calibrated RF level in range from –140 dBm to –5 dBm
- RF, AF and level sweep (user-programmable)

Special options

Fading simulation (options SMIQB14 and SMIQB15)

- Fading of internal or external I/Q signals conforming to mobile radio standards
- 6-path simulation can be enhanced to 12-path simulation (2-channel fading also possible with second vector signal generator)
- Rayleigh, Rice and lognormal fading profiles can be selected independently for each path
- Selectable path attenuation and delay
- Simulation of high speeds
- Preprogrammed fading profiles for mobile radio standards GSM, NADC, IS-95 CDMA and TETRA
- Frequency range of basic unit can be fully utilized

Noise generator and distortion simulator (option SMIQB17)

- Simulation of amplitude and phase distortion (AM/AM and AM/φM characteristics)
- Distortion characteristics programmable from up to 30 input values
- Superimposed noise signals (AWGN)
- C/N ratio variable with high resolution over a wide range
- Broad noise bandwidth (10 kHz to 10 MHz)

1) without switching the mechanical attenuators.

Vector Signal Generator SMIQ

Bit error rate measurements (option SMIQB21)

- Up to 30 MHz clock rate

W-CDMA für 3GPP/FDD (Option SMIQB45)

Software option SMIQB45 supports the generation of downlink and uplink signals in line with the 3GPP standard (FDD mode). As the standardization process is not yet completed, the functionality of this option will continuously be adapted to the relevant standard modifications and expansions (for functionality see specifications).

Low ACP for IS-95 CDMA and W-CDMA (option SMIQB47)

- Specially designed for 1.2288 Mcps, 4.096 Mcps and 8.192 Mcps as well as 3.840 Mcps according to 3GPP
- Can be used with internal (option SMIQB42/43/45/48) or external CDMA/W-CDMA signals
- Typical W-CDMA adjacent-channel power ratio (5 MHz offset, 3.84 Mcps): –67 dBc (1 DPCH)
- Typical IS-95 CDMA adjacent-channel power ratio (885 kHz offset): –78 dBc (9 code channels)

Enhanced functions for W-CDMA 3GPP (FDD) digital standard (Option SMIQB48)

This option expands the functionality of option SMIQB45 W-CDMA 3GPP. It allows the generation of up to four enhanced channels that can be combined with the standard channels.

- Very long signal sequences and continuous PRBS sequences (eg PN9) often required for BER measurements can be implemented for the channel under test
- Use of externally precoded data or the generation of long power control profiles for the DUT
- Testing the closed-loop power control function of a mobile station
- Receiver and performance tests to TS 25.101, TS 25.104, TS25.14. and TS25.944
- Realistic simulation of W-CDMA scenarios
- Creation and insertion of bit errors into the data of enhanced channels
- Insertion of block errors (BLERs) into the channel-coded data
- Generation of W-CDMA signals of up to 2 minutes repetition rate

Enhanced fading functions for W-CDMA 3GPP (Option SMIQB49)

Option SMIQB49 extends the functionality of fading options SMIQB14/B15 to include W-CDMA 3GPP channel simulation. It adds three new modes to the fading simulator so that all scenarios defined in 3GPP Release 99 can be simulated:

- In fine delay mode, fading simulator resolution is increased to 1 ns with up to four paths being available
- In moving delay mode, two paths are simulated: for one path the delay remains constant, whereas for the other path the delay varies continuously
- In birth-death mode, there are two paths changing delay in steps in accordance with the 3GPP channel model

Digital standard IS-95 (Options SMIQK11 and SMIQB60 (ARB))

In addition to generating IS-95 signals with option SMIQB42, SMIQ in conjunction with SMIQB60 simulates CDMA signals to the North-American standard IS-95A. Option SMIQK11 enables IS-95 functionality under WinIQSIM™.

- Up to eight complete base stations comprising 64 code channels each are available in forward link and up to 16 mobile stations in reverse link
- Channel power can be set independently for all code channels
- Adjacent-channel power can be calculated for 1. and 2. adjacent channel and output as a spectral display
- CCDF trace can be displayed

Digital standard CDMA2000 (Options SMIQK12 and SMIQB60 (ARB))

CDMA signals to the North-American standard IS-2000 can be simulated by means of software option SMIQK12 in conjunction with Arbitrary Waveform Generator SMIQB60. Option SMIQK12 enables CDMA2000 functionality under WinIQSIM™.

The modes 1X direct spread, 3X direct spread and 3X multicarrier (forward link only) are available. In forward link four base stations of max. 91 code channels can be set, in reverse link four mobile stations of max. 13 code channels each.

Arbitrary Waveform Generator SMIQB60

To further enhance the versatility of the modulation coder, a dual-channel arbitrary waveform generator (ARB) with a maximum clock rate of 40 MHz is available as an option. It can store up to 512 ksamples of externally computed I/Q values.

The supplied WinIQSIM™ software allows the calculation of arbitrary modulation signals, for example COFDM, multicarrier and noise, and downloading them

Vector Signal Generator SMIQ

into SMIQ. Together with a convenient data editor, WinIQSIM™ can calculate any kind of TDMA frame configuration, simulate impairments by superimposed interference signals, etc.

Applications

- Type-approval testing of digital base and mobile stations
- Base-station transmitter test
- Sensitivity measurements on digital receivers
- Selectivity measurements on digital receivers
- Testing of equalizers
- Tolerance tests on digital systems
- Components tests
- Development of new digital communication systems

Specifications in brief

Frequency		
Range SMIQ02B	300 kHz to 2.2 GHz	
SMIQ03B	300 kHz to 3.3 GHz	
SMIQ04B	300 kHz to 4.4 GHz	
SMIQ06B	300 kHz to 6.4 GHz	
Resolution	0.1 Hz	
Reference frequency	Standard	Option SM-B1
Aging (after 30 days operation)	1×10^{-6}/year	$<1 \times 10^{-9}$/day
Temperature effect (0°C to 50°C)	2×10^{-6}	$<5 \times 10^{-8}$
Level		
Range SMIQ02B/03B	–144 dBm to +13 dBm (PEP)[1]	
SMIQ04B/06B	–144 dBm to +10 dBm (PEP)[1]	
Overranging without guarantee of specs	up to16 dBm	
Resolution	0.1 dB or 0.01 dB	
Total level uncertainty >–127 dBm[2,3]		
f ≤2 GHz	<±1 dB	(typ. <±0.5 dB)
f >2 GHz to 4 GHz	<±1.5 dB	(typ. <±0.9 dB)
f >4 GHz to 6 GHz	<±2 dB	(typ. <±1.2 dB)
f >6 GHz	<±2.5 dB	
Frequency response at 0 dBm[2,3]		
f ≤3.3 GHz	<1 dB	(typ. <0.3 dB)
f >3.3 GHz	<±1.5 dB	(typ. <±0.5 dB)
Spectral purity[2]		
Spurious		
Harmonics at levels ≤10 dBm (SMIQ02B/03B)	<–30 dBc	
Harmonics at levels ≤7 dBm (SMIQ04B/06B)	<–30 dBc	
Broadband noise, carrier offset >5 MHz	CW	
f >20 MHz to 450 MHz	<–136 dBc	(typ.–142 dBc)
f >450 MHz to 3040 MHz	<–138 dBc	(typ.–144 dBc)
f >3040 MHz to 3300 MHz	<–136 dBc	(typ.–142 dBc)
f >3300 MHz to 6400 MHz	<–132 dBc	(typ.–138 dBc)
Broadband noise, vector modulation, (f >20 MHz) carrier offset >5 MHz	<–131 dBc	(typ. –137 dBc)
SSB phase noise, carrier offset 20 MHz, 1 Hz bandwidth	CW	Vector modulation (dig. Mod.)
f = 20 MHz to 450 MHz	<–116 dBc	<–119 dBc
f = 1 GHz	<–126 dBc	<–123 dBc
f = 2 GHz	<–120 dBc	<–120 dBc
f = 3 GHz	<–116 dBc	<–116 dBc
f = 6 GHz	<–110 dBc	<–110 dBc
Sweep		
RF sweep, AF sweep	digital sweep in discrete steps	
Modes	automatic, single shot, manual or external trigger, linear or logarithmic	

Modulation

Internal modulation generator	
Frequency range	0.1 Hz to 1 MHz
Frequency error	$<1 \times 10^{-4}$ + 0.012 Hz
Open-circuit voltage at LF socket	1 mV to 4 V peak
Vector modulation	
Level accuracy with vector modulation, additional error with ALC OFF, relative to CW	<0.3 dB
Modulation inputs I and Q	
Input voltage for full-scale input	$\sqrt{I^2 + Q^2}$ = 0.5 V (1 V EMK with 50-Ω Source)
Envelope control	RF level can be controlled with an analog voltage of 0 V to 1 V via the POWER RAMP input
Amplitude modulation[2]	internal, external AC/DC
Modulation depth	0% to 100%
Broadband amplitude modulation	external DC
Input voltage for 100% AM	0.25 V peak
Pulse modulation	external
On/off ratio	>80 dB
Rise/fall time(10/90%)	typ. 30 ns
Pulse repetition frequency	0 Hz to 1 MHz
Frequency modulation	**Option SM-B5**
	int., external AC/DC, two-tone with two modulation channels FM1 and FM2
Max. deviation	0.5/1/2/4 MHz depending on frequency
Phase modulation	**Option SM-B5**
	int., external AC/DC, two-tone with two modulation channels φM1 and φM2
Max. deviation	5/10/20/40 rad depend. on frequency
Digital modulation	**Option SMIQB20**
	internal, external, serial, ext. parallel

Predefined modulation settings
APCO C4FM, APCO CQPSK, CDPD, CT2, DECT, GSM, IRIDIUM, NADC, PDC, PHS, TETRA, TFTS, PWT, ICO BPSK, ICO GMSK, ICO QPSK, GSM EDGE, CDMA IS-95, W-CDMA, QPSK

Internal PRBS	selectable lengths: 2^9–1, 2^{15}–1, 2^{16}–1, 2^{20}–1, 2^{21}–1 and 2^{23}–1
Envelope control	internal or external
Range of function	1 ksymbol/s to 2.5 Msymbol/s
Modulation modes	ASK, FSK, GMSK, PSK, QAM
ASK, symbol rate	100 symbol/s to 18 Msymbol/s[1]
FSK, modulation modes	2FSK, 4FSK, 4FSK APCO, GFSK
GMSK, bit rate	100 bit/s to 7.5 Mbit/s[1]
PSK, modulation modes	BPSK, QPSK, OQPSK, QPSK (IS-95), OQPSK (IS-95), QPSK (ICO), QPSK (INMARSAT), π/4DQPSK, π/4QPSK, 8PSK, 8PSK EDGE
QAM, modulation modes	16QAM, 32QAM, 64QAM, 256QAM

Vector Signal Generator SMIQ

Data generator — **Option SMIQB11**

Programmable data memory for modulation data, envelope-control and trigger signals. The data generator can be operated only in conjunction with the optional modulation coder

Max. symbol rate	8.5 Msymbol/s
Operating modes	automatically repeating, single shot, manually or externally triggered

Memory extension — **Option SMIQB12**

The data generator memory can be extended to max. 79 Mbit by fitting up to two options SMIQB12.

Memory capacity	32 Mbit

Digital standards — **Options SMIQB20 and SMIQB11**

GSM / EDGE	according GSM standard
Frequency	880 to 960 MHz/1710 to 2000 MHz
Modulation	GMSK or 8PSK EDGE (8PSK with 3π/8 Rotation)
DECT	according ETS300175-2 and ETS300176-1
Frequency	1880 MHz to 1900 MHz
Modulation	GFSK (Standard), π/4 DQPSK
NADC	according IS-54 and IS-136
Frequency	824 to 894 MHz/1850 to 2000 MHz
Modulation	π/4 DQPSK
PDC	according RCR STD-27
Frequency	810 to 826 MHz/940 to 956MHz 1429 to 1453 MHz/1477 to 1501 MHz
Modulation	π/4 DQPSK
PHS	according RCR STD-28
Frequency	1895.0 MHz to 1918.1 MHz
Modulation	π/4 DQPSK

Digital standard IS-95 CDMA — **Option SMIQB42**

According TIA standard IS-95A and J-STD-008

Frequency	824 to 894 MHz/1850 to 2000 MHz
Modulation	QPSK, OQPSK

Digital standard W-CDMA — **Option SMIQB43 2)**

Frequency	1800 MHz to 2200 MHz
Modulation	QPSK, OQPSK

Digital standard W-CDMA 3GPP (FDD) Option SMIQB45 3)

according 3GPP standard 3.4.0 (FDD)

3GPP (FDD) Version	optional 3.4.0, according technical specifications 3GPP TS25.211 and TS25.213
Frequency	1800 MHz to 2200 MHz

Simultanous modulation

Any combination is possible with the following exceptions:

- Simultaneous FM and φM
- Simultaneous digital modulation and vector modulation

Pulse modulation cannot be used together with level attenuation function LEV ATT (option SMIQB20)

Options for special applications

Fading simulation — **Options SMIQB14, SMIQB15**

paths and channels	
with option SMIQB14	6 paths, 1 channel
with options SMIQB14 and -B15	12 paths, 1 channel or 6 + 6 paths, 2 channels with second SMIQ through simple retrofit
Path attenuation	0 dB to 50 dB
Path delay	0 µs to 1600 µs
Doppler shift	0.1 Hz to 1600 Hz

Speed range

$$v_{min} = \frac{0,03 \times 10^9 \frac{m}{s^2}}{f_{RF}} \qquad v_{max} = \frac{479 \times 10^9 \frac{m}{s^2}}{f_{RF}}$$

Rayleigh fading, pseudo noise intervall	>372 h
Rice fading	
Power ratio4)	–30 dB to +30 dB
Frequency ratio	–1 to +1
Lognormal fading, Suzuki fading	
Standard deviation	0 dB to 12 dB
Correlation	paths 1 to 6 with paths 7 to 12

Enhanced fading functions for W-CDMA 3GPP — **Option SMIQB49**

The following data deviate from the specifications for SMIQB14/SMIQB15

Fine delay mode	
Number of paths	2 (with SMIQB14), 4 (with SMIQB14 + SMIQB15)
Profiles	Rayleigh, pure Doppler
Delay, resolution	25 ns to 1637 µs, 1 ns
Moving delay mode	
Number of paths	2
Delay, path 1	0 to 1000 µs (in 50 ns steps)
Delay, path 2	delay path 1 + delay variation (peak-peak) x sin (2pt /variation period)
Delay variation (peak-peak)	150 ns to 50 µs
Variation period	10 s to 500 s
Delay step size	<1 ns
Birth-death mode	
Number of paths	2
Profiles	pure Doppler
Delay	5 µs to 1000 µs
Delay range	5 µs to +5 µs (not variable)
Delay grid	1 µs (not variable)
Hopping dwell	100 ms to 5 s

Noise and distortion simulation — **Option SMIQB17**

Distortion simulator	AM/AM and AM/φM distortion of modulation signal
Distortion characteristic	each characteristic programmable by entering up to 30 input values via IEEE/IEC bus or by entering up to five polynomial coefficients
Noise generator (AWGN)	
Distribution density	Gaussian, statistically indep. for I and Q
Crest-Faktor	14 dB
C/N	–30 dB to 30 dB

Bit error rate measurement — Option SMIQB21

Pseudo-random bit sequences (PRBS)	2^9-1, 2^{11}-1, 2^{15}-1, 2^{16}-1, 2^{20}-1, 2^{21}-1, 2^{23}-1
Measurement time	selectable through maximum number of data bits or bit errors (max. 2^{31} bits each), continuous measurement
Measurement result	BER in ppm, % or decade values (if selected number of data bits or bit errors is attained) status displays: not synchronized, no clock, no data

Improved adjacent-channel power ratio for W-CDMA and CDMA IS-95 — **Option SMIQB47**

Selectable baseband filters to improve ACP values (values see at Digital Standards CDMA/W-CDMA)

Enhanced functions for digital standard W-CDMA 3GPP (FDD) — **Option SMIQB48**

3GPP (FDD) version	3.4.0 to 3GPP technical specifications TS25.101, TS25.104, TS25.141, TS25.211 and TS25.213

1) PEP = peak envelope power.

2) Data apply to RF ≥5 MHz unless specified otherwise and for ATTENUATOR MODE NORMAL function.

3) Additional error with ALC OFF <0.3 dB.

Vector Signal Generator SMIQ

Enhanced Channels
Channels of W-CDMA system in SMIQ that offer enhanced functionality compared with standard channels of option SMIQB45.
Can be used in downlink for max. four DPCHs and in uplink for one DPCCH and max. three DPDCHs. All DPCHs or DPDCHs have the same symbol rate.

Enhanced functions at a glance:
- Sequences of up to 1042 frames
- Data lists for data fields and TPC field
- External power control
- Channel coding
- Bit error insertion
- Block error insertion

Simulation of realistic noise scenarios
- Orthogonal channel noise simulation (OCNS)
- Additional mobile stations

Arbitrary waveform generator	**Option SMIQB60**
Waveform memory, interpolation	
Output memory	
Length of waveform	1 to 524216 in steps of one sample
Resolution	12 bit
Downloading time for 512k I/Q samples	4 s
Nonvolatile memory	
Number of blocks	22 (one waveform occupies at least one block)
Block size	24 from firmware version 5.30
Interpolation	65527
Interpolation bandwidth (-0.1dB)	0.375 x clock rate
Repetitive spectra suppression through analog filter	>70 dB
Clock generation	
Clock rate	1 kHz to 40 MHz
Resolution	0.1 Hz
Clock mode	internal or external
Signal output, channels	2 (I and Q)
Output level (EMF, peak)	
Normal mode	$SQRT(I^2 + Q^2) = 1$ V, 50 Ω
Manual mode	–6 dB to 0 dB referred to 1 V, setting range up to +3 dB
Level difference between channels	<0.2% at 1 kHz [1)]
DC offset	<–54 dB in normal mode [1)]
Frequency response	
Magnitude up to 12 MHz/10 MHz	<1 dB/typ. 0.1 dB
Group delay up to 10 MHz	typ. 1 ns
I/Q imbalance	
Magnitude up to 10 MHz	typ. 0.05 dB
Group delay up to 10 MHz	typ. 0.5 ns
SFDR (sinewave 1 MHz, clock 4 MHz, measurement range up to 12 MHz)	>60 dB
Trigger modes	auto, retrig, armed auto, armed retrig
Trigger source	internal or external
Trigger outputs	2
Delay	0 to 524216 samples
On time	1 to 524215 samples
Off time	1 to 524215 samples
Level	TTL

1) Spectral components exceeding max. IQ bandwidth will be suppressed.

2) Cannot be fitted together with Digital Standard W-CDMA 3GPP (option SMIQB45).

3) Cannot be fitted together with Digital Standard W-CDMA NTT DoCoMo (option SMIQB43).

4) Ratio of discrete and distributed component.

5) Contrast of LCD lower at higher temperature.

General data	
Memory for instrument settings	50 storable settings
List Mode	
Frequency and level values can be stored in a list and set in an extremely short time; permissible level variation: 90 dB	
Max. number of channels	2000
Remote control	IEC 625 (IEEE 488)
Command set	SCPI 1993.0
Power supply	90 V to 265 V (AC), 50 Hz to 400 Hz, autosetting to AC supply, max. 300 VA
Dimensions (W x H x D)	435 mm x 192 mm x 460 mm
Weight	25 kg when fully equipped

Ordering information

Vector Signal Generator		
300 kHz to 2.2 GHz	SMIQ02B	1125.5555.02
300 kHz to 3.3 GHz	SMIQ03B	1125.5555.03
300 kHz to 4.4 GHz	SMIQ04B	1125.5555.04
300 kHz to 6.4 GHz	SMIQ06B	1125.5555.06

Accessories supplied power cable, operating manual

Options		
Reference Oscillator OCXO	SM-B1	1036.7599.02
FM/φM Modulator	SM-B5	1036.8489.02
Data Generator	SMIQB11	1085.4502.04
Memory Extension, 32 Mbit	SMIQB12	1085.2800.04
Fading Simulator, 6 paths	SMIQB14	1085.4002.02
Second Fading Simulator for 12 paths or 2 channels	SMIQB15	1085.4402.02
Noise Generator and Distortion Simulator	SMIQB17	1104.9000.02
RF and AF Rear Connectors	SMIQB19	1085.2997.02
Modulation Coder	SMIQB20	1125.5190.02
BER Measurement	SMIQB21	1125.5490.02
Digital Standard IS-95 CDMA	SMIQB42	1104.7936.02
Digital Standard W-CDMA acc. to NTT DoCoMo 1.0, ARIB 0.0 standard	SMIQB43	1104.8032.02
Digital Standard W-CDMA according to 3GPP (FDD)	SMIQB45	1104.8232.02
Low ACP for IS-95 CDMA and W-CDMA	SMIQB47	1125.5090.02
Modification Kit for Low ACP (factory-fitted only)	SMIQU47	1125.5149.02
Extended Functions for W-CDMA (3GPP)	SMIQB48	1105.0587.02
Extended Fading Functions for W-CDMA (3GPP)	SMIQB49	1105.1083.02
Arbitrary Waveform Generator incl. WinIQSIM™	SMIQB60	1136.4390.02
TETRA T1 Simulator	SMIQ-K8	1136.4290.02
Digital Standard IS-95 CDMA (software for SMIQB60)	SMIQK11	1105.0287.02
Digital Standard CDMA2000 (software for SMIQB60)	SMIQK12	1105.0435.02
Dig. Standard W-CDMATDD mode (3GPP) (for option SMIQB60)	SMIQK13	1105.1231.02
Digital Standard TD-SCDMA (software for SMIQB60)	SMIQK14	1105.1338.02
OFDM Signal Generation, HIPER LAN/2	SMIQK15	1105.1531.02

Additional hint: SMIQ02B/03B (SMIQ04B/06B) can be equipped with up to three (two) of the following options: SM-B5, SMIQB14, SMIQB15, SMIQB17

Application software	
Generation of data and control lists	SMIQ-K1 *)
Bluetooth signals for SMIQ	SMIQ-K5 *)
User mappings and user filters for SMIQ	User Mod *)

*) available on www.rohde-schwarz.com

Extras		
19" Adapter	ZZA-94	0396.4905.00
Service Kit	SM-Z3	1085.2500.02
BNC Adapter for rear panel, D type connector PAR DATA	SMIQ-Z5	1104.8555.02
90° Power Splitter	SMIQ-Z9	1104.9580.02
Trolley for Transit Case	ZZK-1	1014.0510.00
Transit Case	ZZK-944	1013.9366.00
Service Manual SMIQ		1085.2445.24

Instrument upgrades		
SMIQ02B to SMIQ03B	SMIQU03	1125.5855.03
SMIQ03B to SMIQ04B	SMIQU04	1125.5855.04
SMIQ04B to SMIQ06B	SMIQU06	1125.5855.06

I/Q Modulation Generator AMIQ03, AMIQ04, Simulation Software WinIQSIM

New approaches in the generation of complex I/Q signals

Photo 43419-3

Brief description

I/Q Modulation Generators AMIQ03, AMIQ04 and Simulation Software WinIQSIM open up new dimensions for the generation of I/Q signals. AMIQ is a dual-channel modulation generator that has consequently been designed for use as an I/Q source. It is programmed and set with Software WinIQSIM. Alternatively, AMIQ can be operated from a Vector Signal Generator SMIQ.

Each channel can store 4000000 (AMIQ03) or 16000000 samples (AMIQ04) respectively. Even at high symbol rates sequences of sufficient length can thus be generated. With clock frequencies of up to 100 Msample/s and a high amplitude resolution of 14 (up to 16 bits via digital I/Q output) bits, AMIQ is the ideal source for any signal in the world of digital modulation.

An automatic amplitude/offset alignment as well as fine adjustment of the skew provide excellent symmetry of the two channels which previously was extremely difficult to attain with dual-channel ARB generators. The error vector can thus be minimized.

A typical application of AMIQ and WinIQSIM is not only to drive the I/Q inputs of a vector signal generator. This combination is also ideal for direct applications in the baseband, eg for testing I/Q modulators/demodulators.

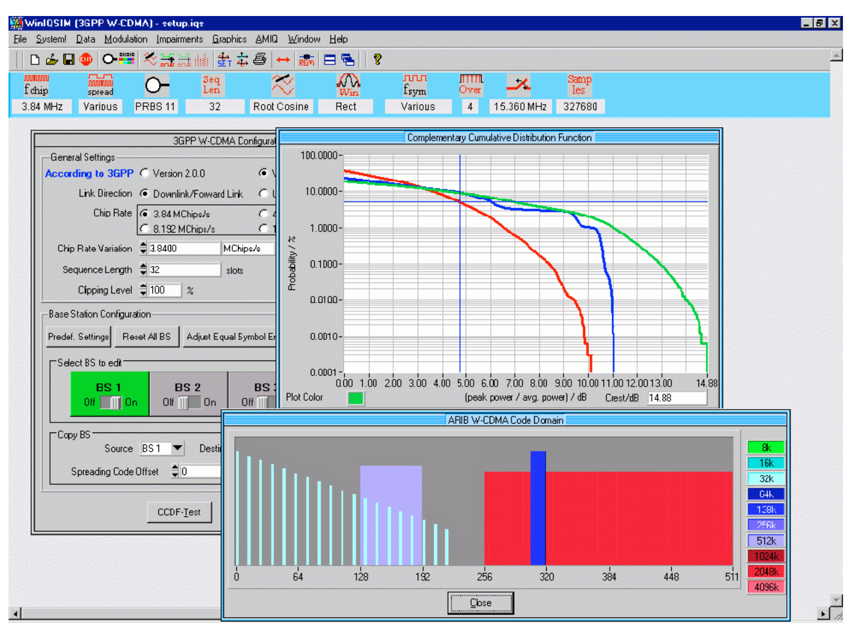
Main features

AMIQ

- 14-bit resolution (up to 16 bits via digital I/Q output) or 16000000 samples (AMIQ04) respectively
- 4000000 samples memory depth (AMIQ03)
- 100 MHz sample rate
- Integrated hard disk and floppy disk drive
- Optional BER measurement
- Optional differential I/Q outputs
- Optional digital I/Q output

WinIQSIM

- Calculation of digitally modulated I/Q and IF signals
- Single-carrier, multicarrier and CDMA and W-CDMA 3GPP signals
- Import of I/Q signals via DDE interface
- Versatile data editor
- Superposition/simulation of impairments
- Graphic display



I/Q Modulation Generator AMIQ03, AMIQ04, Simulation Software WinIQSIM

I/Q simulation software

Modulation methods like GMSK or π/4 DQPSK are used in mobile communication systems such as GSM (Global System for Mobile Communications) or NADC (North American Digital Cellular). These complex modulation modes are usually generated with the aid of an I/Q or vector modulator. The calculation and generation of the required baseband signals is of course quite complex.

WinIQSIM is a Windows software allowing calculation of I and Q baseband signals. Its capabilities range from single-carrier modulation, generation of multi-carrier, CDMA and W-CDMA signals through to TDMA frame configurations with the help of a convenient data editor. All modulation parameters and impairments can be simulated for single-carrier and multi-carrier as well as for CDMA signals. To put it in a nutshell: WinIQSIM is an indispensable tool for anyone engaged in modern digital modulation.

Specifications in brief

AMIQ

Output memory	
Waveform length (data and markers)	
Clock rate mode 1 (10 Hz to 4 MHz)	24 to 4000000 samples in steps of one
Clock rate mode 2 (2 MHz to100 MHz)	24 to 4000000 samples in steps of four
Amplitude resolution	14 bits (up to 16 bits via digital I/Q output)
Marker channels	usable as marker or trigger
Marker outputs	4
Clock	
Clock rate	internal/external 10 Hz to 100 MHz
Setting range (internal)	10 Hz to 105 MHz 1)
Resolution (internal)	1 x 10^{-7}
Reference frequency	
Internal reference output	
Frequency	10 MHz
Aging (after 30 days of operation)	1 x 10^{-5}/year
Temperature effect (0°C to 45°C)	<2 x 10^{-6}/°C
Signal output	
Number of outputs	2 (I and Q), 4 in conjunction with AMIQ-B2 ($\overline{I}$ and $\overline{Q}$ additional)
Output impedance	50 Ω
Output voltage (V_p into 50 Ω)	
Fix mode	0.5 V, same for both channels
Variable mode	0 mV to 1 V, separately adjustable for each channel
Skew between I and Q channel (filter off, clock rate 10 MHz, fix mode)	
Fine variation	typ. ±1 ns
Resolution	<10 ps
Effective bits (sinewave 5 MHz, clock frequency 50 MHz, fix mode)	typ. 11
Filters	
Operating modes	off (no filter), internal or external
Internal filters	
25 MHz, elliptic, 7th order + delay equalizer	
Freq. response Amplitude	typ. 0.15 dB up to 25 MHz
Group delay	typ. 500 ps up to 20 MHz
2.5 MHz, elliptic, 7th order + delay equalizer	
Freq. response Amplitude	typ. 0.15 dB up to 2.5 MHz
Group delay	typ. 5 ns up to 2 MHz
Trigger	
CONT mode	repetitive output of loaded waveform after occurrence of trigger
SINGLE mode	single output of loaded waveform after occurrence of trigger
GATED mode	start of (repetitive) waveform output after occurrence of trigger until end of trigger event
Trigger signal	via remote control or trigger input
Trigger input	BNC connector, selectable polarity
Input level	TTL
Marker outputs	4, BNC connectors
Level	TTL, terminatable with 50 Ω, high > 2 V

I/Q Modulation Generator AMIQ03, AMIQ04, Simulation Software WinIQSIM

BER (option AMIQ-B1)
Data supplied by the DUT can be compared with a nominal random bit sequence; the results are transferred to the host computer (via the currently used remote control)

Pseudo random bit sequences	2^9–1, 2^{11}–1, 2^{15}–1, 2^{16}–1, 2^{20}–1, 2^{21}–1, 2^{23}–1

Differential Outputs (Option AMIQ-B2)
Supports additional inverted signals to I and Q and allows simultanous overlapping of output signals with a DC level.

Digital I/Q Output (Option AMIQ-B3)
Supports digital data for both channels I and Q (either 8 or 16 bits resolution)

Remote control and memory	IEC 625-2 (IEEE 488) and RS-232-C
Command set	SCPI 1996.0 with extensions
Mass memory	floppy disk drive (3.5", 1.44 MB), hard disk >3 GB

General data	
Rated temperature range	0°C to +45°C; to IEC68-2-1 and IEC68-2-2
Storage temperature range	–40°C to +70°C
Power supply	90 V to 132 V (AC), 47 Hz to 63 Hz, 180 V to 264 V (AC), 47 Hz to 63 Hz, autoranging of AC supply, 150 VA
Dimensions (W x H x D)	427 mm x 88 mm x 450 mm
Weight	8.4 kg

WinIQSIM

User interface	Windows interface with context-sensitive help
Systems	single-carrier, IF signals up to 25 MHz, multicarrier, multicarrier mixed signal, up to 512 carriers with or without modulation, with variable power, W-CDMA, IS-95
Modulation modes	
PSK	BPSK, QPSK, offset QPSK, π/4DQPSK, 8PSK, 8PSK-EDGE; parameter: reference level, PSK rotation
QAM	16/32/64/256QAM; parameter: reference level
FSK	MSK, 2FSK, 4FSK, GTFM; parameter: modulation index 0.1 to 12 GTFM, b = 0 to 1
User-specific modulation	
Data editor	definition of TDMA data structures with power-time templates
Sequence length	1 to max. 4 M symbols/16 M symbols
Simulation of impairments and transfer characteristics	I/Q impairments, phase noise, bandpass, amplifier models, power ramping, multipath propagation, offset, addi-tive interferers, receiver filters, quantization, smoothing
Graphic output	user-selectable scaling, zoom function, delta marker; display modes: i(t), q(t), r(t), phi(t), r(t), f(t), eye I, eye Q, eye F, vector diagram, constellation diagram, magnitude/phase/group delay spectrum, additional CCDF and ACP; display of code domain at W-CDMA 3 GPP
Remote control of AMIQ	download and starting of waveforms, hardware configuration, alignment and fine adjustment, file management

Digital standard IS-95 and CDMA2000

See also „Supplements to SMIQ, AMIQ and WinIQSIM, Digital standards IS-95 and CDMA2000", PD 0757.5908.21

IS-95
Simulation CDMA signals to North American standard IS-95 A and CDMA2000, available as software option AMIQK11 of AMIQ or software option SMIQK11 in conjunction with option SMIQB60 (arbitrary waveform generator of SMIQ)

Chip rate	
Standard	1.2288 Mcps
Range	AMIQ: 10 cps to 100 Mcps SMIQB60: 1 kcps to 40 Mcps

CDMA2000	
Chip rate	
Standard	1.2288 Mcps (1X), 3.6864 Mcps (3X)
Range	AMIQ: 10 cps to 100 Mcps SMIQB60: 1 kcps to 40 Mcps
W-CDMA TDD mode (3GPP)	Option AMIQK13 see www.rohde-schwarz.com
Carrier spacing	
Standard	1.25 MHz
Variable	AMIQ: 0 to 10 MHz SMIQB60: 0 to 2 MHz

Ordering information

I/Q Modulation Generator		
4 M samples	AMIQ	1110.2003.03
16 M samples	AMIQ	1110.2003.04
Accessories supplied	WinIQSIM, version for Windows 3.x and Windows 95/98/NT on CD; manual, power cable, operating manual	
Options		
BER Measurement	AMIQ-B1	1110.3500.02
Differential I/Q Outputs	AMIQ-B2	1110.3700.02
Digital I/Q output	AMIQ-B3	1122.2103.02
IS-95 CDMA	AMIQK11	1122.2003.02
Digital Standard CDMA2000	AMIQK12	1122.2503.02
Digital Standard W-CDMA TDD mode (3GPP)	AMIQK13	1122.2603.02
Digitaler Standard TD-SCDMA	AMIQK14	1122.2703.02
OFDM Signal Generation HiPERLAN/2	AMIQK15	1122.2803.02
Rear I/Q Outputs	AMIQB19[2)]	1110.3400.02
Extras		
19" Rack Adapter	ZZA-211	1096.3260.00

1) Data at clock >100 MHz are not guaranteed, max. environment temperature 35 °C.

2) Marker outputs 3 and 4 not provided if this option is fitted, AMIQ-B19 not suitable in conjunction with AMIQ-B2.

Baseband Fading Simulator ABFS

Saving costs through real-world fading tests

ABFS (photo 43435-3)

Brief description

The characteristics of a radio channel may strongly impair signal transmission between a transmitter and in particular a moving receiver.

Baseband Fading Simulator ABFS generates signals which simulate real receive conditions in mobile applications. Thus, the response of receivers under real-world conditions can be checked already during development and QM acceptance testing. The simulation of fading signals at baseband level reduces costs.

Baseband Fading Simulator ABFS is suitable for universal mobile radio applications in research, development and production. It comprises all scenarios and statistical models for simulating sporadic fading as specified in the test regulations of mobile radio standards (eg GSM, IS-54/US-136 or IS-95 CDMA).

The open concept of ABFS allows the simulation of radio channels of existing and future communication systems (eg mobile radio, broadcasting, flight telephone, WLL, or WLAN systems). ABFS can also simulate frequency hopping systems.

The basic model of ABFS comes with two independent channels for 6-path fading. The two channels can be interconnected as follows:

- Distribution of an input to two outputs (eg with different fading profiles). This feature makes it possible to simulate several antennas with different characteristics or frequency diversity methods
- Simulation of two inputs with individual profiles and addition at output. Cell change or superposition of interferers can be tested with this configuration
- Coupling of two channels so that a channel with 12 propagation paths is obtained.

Main features

- 2 fading channels (4 with option ABFS-B2)
- 12 propagation paths (24 with option ABFS-B2)
- Max. 12 propagation paths per channel
- Universal use in research, development and production
- Simulation of present and future communication systems thanks to open concept
- Receiver tests at I/Q level together with a baseband source
- Ease of operation
- High reliability

Options

Noise Generator ABFS-B1 adds a noise source to the output of the first channel so that noise can be simulated in the frequency band used. The noise generator can be switched on or off irrespective of the operating modes of the basic version.

Second Fading Simulator ABFS-B2 offers two extra channels with the same characteristics in addition to the two channels of the basic model.

Second Noise Generator ABFS-B3 represents an additional noise source for a further output. This second noise generator is either assigned to the second channel of the basic ABFS (with first noise generator ABFS-B1 for the first channel) or to the first channel of the second fading simulator ABFS-B2.

Fading profiles of the Rayleigh, Rician, Pure Doppler, lognormal or Suzuki method can be assigned to each of the propagation paths irrespective of the

Baseband Fading Simulator ABFS

selected circuit. In addition to the fading profiles mentioned, the following parameters can be defined for each propagation path:

- Path attenuation
- Delay time
- Doppler frequency or speed between transmitter and receiver
- Coupling to another channel

Many fading models (eg GSM Rural Urban, Typical Urban) have already been programmed in ABFS. The user can quickly recall these default settings and also modify the parameters.

Specifications

IQ inputs and outputs	
Input voltage for full-scale level	$\sqrt{I^2 + Q^2} = 0.5$ V
Residual DC voltage at output	<2 mV, fine tuning by software
Insertion loss of basic unit	0.3 dB
Fading simulation	
Number of propagation paths and fading channels	
Basic model	1 channel with 12 paths or 2 channels with 6 paths each
with option ABFS-B2	2 channels with 12 paths each or 4 channels with 6 paths each
Insertion loss between input and output at 0 dB path attenuation	min. 9 dB
Frequency response up to 5 MHz offset from carrier frequency (corresponding to 10 MHz system bandwith)	+0.1 dB to –0.6 dB
Path attenuation	0 dB to 50 dB
Path delay	0 µs to 1600 µs
Doppler shift	
Frequency range	0.1 Hz to 1600 Hz
Speed range	$v_{min} = \frac{0.03 \cdot 10^9 m/s^2}{f_{RF}}$ $v_{max} = \frac{479 \cdot 10^9 m/s^2}{f_{RF}}$
For example at $f_{RF} = 1$ GHz	$v_{min} = 0.1$ km/h, $v_{max} = 1724$ km/h
Rayleigh fading	
Pseudo noise interval	>372 h
Rice fading	
Power ratio[1]	–30 dB to +30 dB
Frequency ratio	–1 to +1
Lognormal fading, Suzuki fading	
Standard deviation, range	0 dB to 12 dB
Local constant	l_{min} to 200 m, $l_{min} = \frac{12 \cdot 10^9 m/s}{f_{RF}}$
Correlation	paths 1 to 6 with paths 7 to 12 of a channel (A or B)
Range for magnitude	0% to 100%
Range for phase	0° to 360°
RF setting	setting of the RF results in an automatic calculation and display of the Doppler frequency according to the set motion speed[2]
Range (for each fading channel)	5 MHz to 8.5 GHz
Frequency hopping mode	RF can be stored in a list and quickly set via a serial interface
Interface	RS-232-C, 1 byte with start and stop bit
Addressing of frequency list	8 or 16 bit as address for each fading channel
Setting time after frequency change during Rayleigh fading	<3.5 ms
Noise generator with options ABFS-B1 or ABFS-B3	
Amplitude distribution	Gaussian, statistically independent for I and Q
Crest factor	14 dB
Noise power level in relation to full-scale level, range	–17 dBfs to –50 dBfs
Output level at full-scale level (AC)	$\sqrt{I^2 + Q^2} = 0.5$ V (= 4 dBm)
Insertion loss between input and output	0, 6, 12 to 42 dB
Output spectrum	white noise
Bandwidth	depending on set system bandwidth
Frequency response	
up to 0.7 x system bandwidth (max. 5 MHz)	<0.5 dB
RF system bandwidth[3]	bandwidth determining noise power
Setting range	10 kHz to 10 MHz
General data	
Memory for device settings	50
Remote control	IEC 625 (IEEE 488)
Power supply	90 V to 132 V (AC), 47 Hz to 440 Hz, 180 V to 265 V (AC), 47 Hz to 440 Hz, autoranging, max. 300 VA
Operating temperature range	0°C to 45°C
Storage temperature range	–40°C to +70°C
Dimensions (W x H x D)	435 mm x 192 mm x 460 mm
Weight	20 kg when unit is fully equipped

Ordering information

Baseband Fading Simulator	ABFS	1114.8506.02
Accessories supplied	power cable, operating manual	
Options		
Noise Generator	ABFS-B1	1115.0009.02
Second Fading Simulator	ABFS-B2	1115.0309.02
Second Noise Generator	ABFS-B3	1115.0609.02
Fading for 3GPP	ABFS-B49	1115.0909.02
Extras		
19'' Rack Adapter	ZZA-94	0396.4905.00
Service Kit	SM-Z3	1085.2500.02
Trolley	ZZK-1	1014.0510.00
Transit Case	ZZK-944	1013.9366.00
Service Manual	ABFS	1114.8564.94

1) Ratio between discrete and distributed component.

2) The phase differences between paths caused by different settings of path delay are taken into account when the RF is modified. This applies to fre quency hopping mode only.

3) 0.5 x system bandwidth is used for baseband.

Receiver Test Source R3562

Receiver Test Source for

W-CDMA/3GPP and cdma2000

Advantest

Brief description

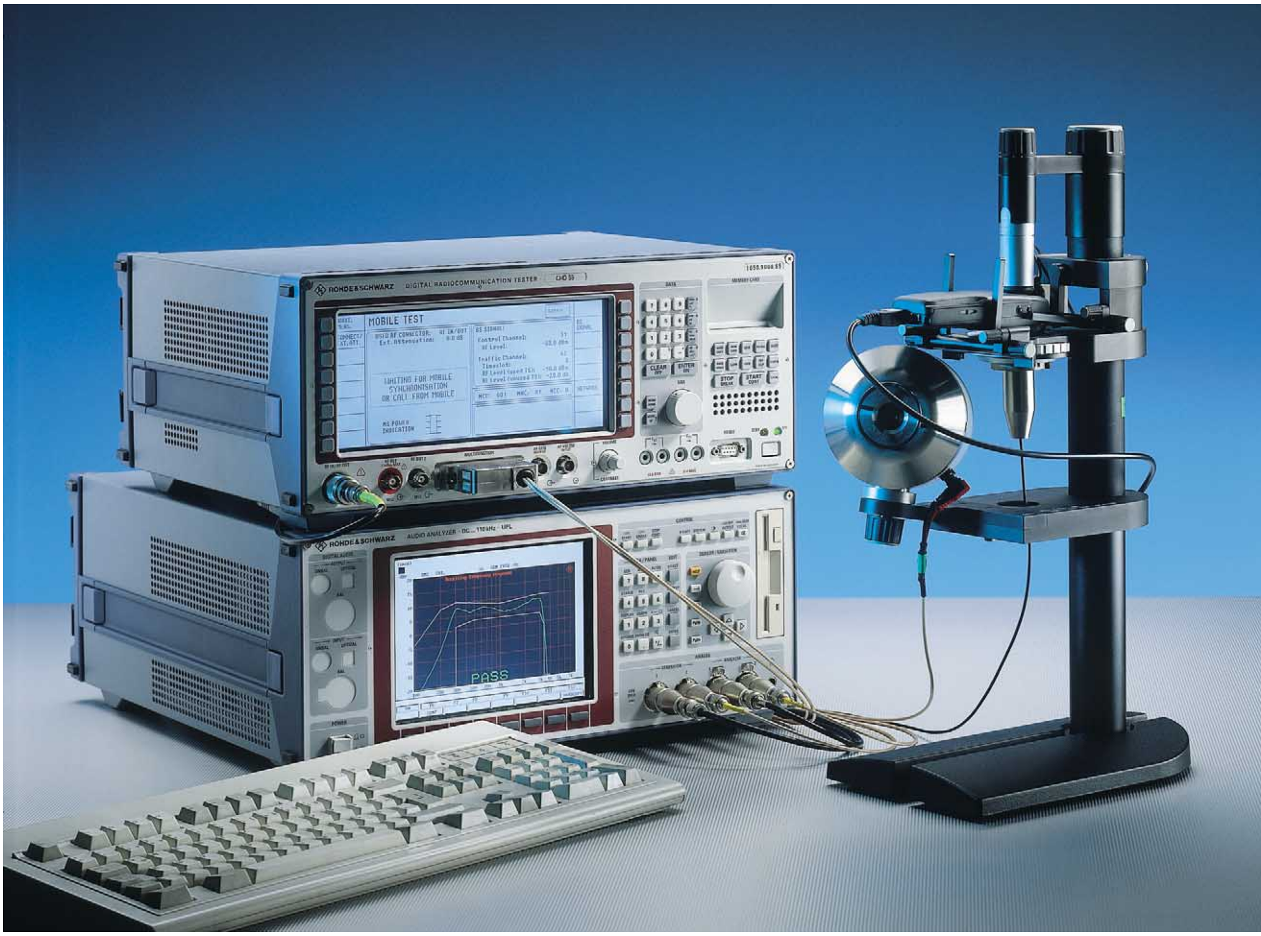
Receiver Test Source R3562 from Advantest generates W-CDMA (3GPP) and cdma2000 (3GPP2) radio frames. Equipped with various clock output functions, the R3562 can easily synchronize with mobile and base stations to carry out the receiver sensitivity test with the built in Bit Error Rate (BER) counter.

R3562 (lower unit, photo 43440-2)

Since the R3562 is capable of adding the transmission power control signal (TPC) in 3GPP mode, it is able to confirm the power control steps in combination with the Spectrum Analyzers R3267 and R3273.

Specifications in brief

Output frequency	
Range; Resolution	800 to 2300 MHz; 100 Hz
Accuracy	accuracy of frequency standard
Reference frequency	
Internal frequency standard	10 MHz
Accuracy	3×10^{-8}/day, 5×10^{-7}/year (after 24 hours) 3×10^{-7} (25°C) after 2 minutes warm up
Output level, impedance	>0 dBm, 50 Ω
External frequency standard	
Input frequency	1/2/5/10/15 MHz
Input level; impedance	>0 dBm; 50 Ω
Time base for modulation	
Input frequency; Input level	3.48 MHz x n (n=1, 2, 4); TTL
External trigger	
Input level; Variable offset widths	TTL; 20 to 200 chips
Clock/timing outputs; Level	chip clock/radio frame timing/ slot timing/TPC repeat timing/TPC insert timing; TTL
Output level	
Range; Resolution	–125 dBm to 0 dBm; 0.1 dB
Accuracy (25°C ± 10°C)	
Frequency ≤1000 MHz	<±1.5 dB (–120.0 dBm to 0 dBm) <±2.5 dB (–125.0 dBm to –120.1 dBm)
Frequency >1000 MHz	<±1.5 dB (–110.0 dBm to 0 dBm) <±2.5 dB (–125.0 dBm to –110.1 dBm)
Output impedance; Max reverse-input	50 Ω; 2 W
Signal purity	
Harmonics	<–30 dBc
Nonharmonics	<–60 dBc (offset frequency > 10 kHz)
ACP	<–45 dBc (5 kHz offset) <–55 dBc (10 kHz offset)
SSB phase noise	<–107 dBc/Hz (50 kHz offset, at 1 GHz)
Modulation	
Modulation modes; System	QPSK (DL)/ HPSK (UL); 3GPP (FDD)
Chip rate; Base-band filter	3.84 Mcps; root Nyquist type ($\alpha = 0.22$)
Data source; Error vector	PN9, PN15. ALLO, ALL1; <6% rms
Up-link	
Output channel	DPCCH, DPCCH x 1 channel
Channel bit rates	30/60/120/240/480/960 kbps (DPDCH)
Information bit rates	12.2/64/144/384 kbps (DTCH)
Long scrambling codes	0 to 16,777.215
Channelization codes	SF/4 (DPDCH)
Channel power rate	Gain filter βc, βd = 0 to 15
TFCI bits	0 to 3FF [hexadecimal] 0 to 3FFFFFFF [hexadecimal]
TPC information	Up or down or repeat the specified slot lengths (Max. 75 slot)
Down-Link	
Output channel	primary CPICH, primary SCH, secondary SCH, P_CCPCH, DPCH x 1 channel
Channel bit rates	60/120/240/480/960 kbps (DPDCH)
Information bit rates	12.2/64/144/384 kbps (DTCH)
Primary scrambling codes	0 to 8.191
Channelization codes	2 to 127 (DPCH)
Channel power rate	–20 to 0/0.1 dB steps
TFCI bits	0 to 3FF [hexadecimal]
TPC information	up or down or repeat the specified slot lengths (max. 75 slots)
Channel timing	τ_{DPCH} = 0 chip
I/Q input/output	
Input frequency range	1 kHz to 2.5 MHz, frequency characteristics <2 dB p-p
input level	$\sqrt{I^2 + Q^2}$ = 0.5 V rms, 50 Ω, max.3 V pp
Interval I/Q output level	1 V p-p, 50 Ω
BER counter	
Measurement rates	1 kbps to 5 Mbps
Measurement patterns	PN9, PN15
Measurement bit lengths	1,000 to 10,000,000 bits
Clock/data polarities	selectable, positive, negative
Input signal	clock, data (TTL level)
Local output	
Frequency; Level	5.0314 GHz to 6.5314 GHz; >0 dBm
External interface	
Remote control; Serial I/Q	IEEE-488; interface only for R3267/3273
General data	
Operating temperature range	0°C to +50°C
Storage temperature range	–20°C to +60°C
AC power supply	100 V to 120V, 50/60 Hz 220 V to 240 V, 50/60 Hz autosetting
Power consumption; Frequency	<300 VA; 50/60 Hz
Dimensions (W x H x D)	approx. 420 mm x 355 mm x 178 mm
Weight	<16 kg



Measurements on hearing aids to EN60118 or ANSI S3.22 with Audio Analyzer UPL (photo 43158-3)

Contents of Chapter 6

Audio Analyzer UPL

DC to 110 kHz

Compact instrument for audio measurements at analog and digital interfaces

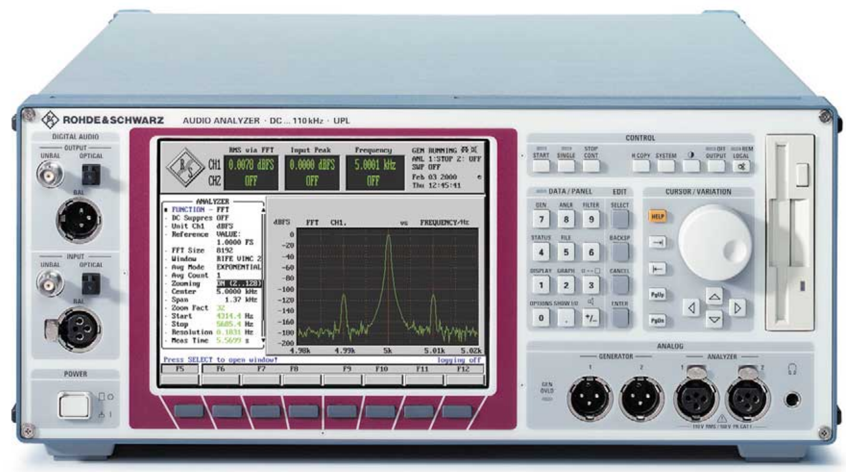


Photo 42992-2

Brief description

Audio Analyzer UPL comprises analyzers and generators for dual-channel measurements and generation of a wide variety of analog and digital audio signals. Its measurement functions and signals are available at all interfaces so that all input-output combinations (AA, AD, DA, DD) are possible. An option allows comprehensive tests of the physical parameters of the audio interfaces, including jitter amplitude and spectrum, pulse amplitude, difference and delay with respect to a reference input.

UPL is thus suitable for all types of audio measurement. Particular emphasis was placed on high measurement speed, which is a must in automatic testing in production.

Main features

- Compact instrument with integrated PC and colour or monochrome LC display
- Wide variety of test functions and numerous test signals for performing virtually all measurement tasks

Overview of options

Designation, functions	Option
Low Distortion Generator: analog sinewave generator offering lower inherent distortion and wider frequency range than built-in standard generator	UPL-B1
Digital Audio I/O: contains the balanced, unbalanced and optical digital audio interfaces with clock rate up to 48 kHz	UPL-B2
Digital Audio I/O: same as UPL-B2, but clock rate up to 96 kHz	UPL-B29
Extended Analysis Functions: coherence and transfer functions, rub & buzz measurement, third-octave analysis	UPL-B6
Digital Audio Protocol: with Digital Audio I/O fitted, this option allows the generation and analysis of additional digital data such as channel status and user data, validity bits and the evaluation of parity bits	UPL-B21
Jitter and Interface Test: with Digital Audio I/O fitted, this option enables the physical parameters of digital audio interfaces to be examined	UPL-B22
Remote Control: enables remote control via the RS-232-C interface or the IEEE/IEC bus interface (IEC 625/IEEE 488)	UPL-B4
Audio Monitor: adds a headphones output and a built-in loudspeaker to UPL	UPL-B5
Hearing Aids Test Accessories	UPL-B7
Mobile Phone Test Set: Measurement of acoustic characteristics of mobile phones	UPL-B7
Universal Sequence Controller: enables measurement sequences to be generated and executed with the aid of a built-in program generator	UPL-B10
Automatic Audio Line Measurement: enables measurement of broadcast links according to ITU-T 0.33 recommendations (UPL-B10 required)	UPL-B33

Audio Analyzer UPL

- Versatile analysis thanks to internal FFT analyzer of wide dynamic range and high frequency resolution
- Future-proof: new test functions can be loaded from diskette
- Any number of digital filters, also for analog measurements
- Maximum dynamic range for the analysis of high-grade components
- Intelligent operator guidance and context-sensitive help system (German and English)
- Mnemonic analysis and generation of channel status data of digital audio interfaces
- Measurement/generation of protocol errors at digital interfaces
- Variety of sweep functions
- More than 10 weighting filters
  – highpass, lowpass, bandpass filters

Specifications in brief

All inherent distortion values refer to the frequency range 20 Hz to 22 kHz.

Analyzers

Analog inputs	
Balanced, floating	2 channels, 300 Ω/600 Ω/200 kΩ
Voltage measurement range	0.1 µV to 110 V rms
Common-mode rejection	>100 dB (50 Hz)
Frequency range	DC to 110 kHz
Frequency response	±0.03 dB, 20 Hz to 22 kHz
Digital inputs	
Digital Audio I/O option	
Balanced input	XLR connector, 110 Ω
Unbalanced input	BNC connector, 75 Ω
Optical input	Toslink system
Clock rate	35 to 55 kHz (UPL-B2) 35 to 106 kHz (UPL-B29)
Frequency range	10 Hz to 45.7% of clock rate

Measurement functions of analog analyzers; digital analyzers in italics (option UPL-B2 or UPL-B29)

AF level	
Noise (600 Ω)	1.6 µV (CCIR unweight.); *-180 dBFS*
Weighting	RMS, peak [2], quasi-peak (CCIR 468) [2]
Accuracy	±0.05 dB (V_{rms}, 1 kHz)
Filters	weighting filter; HP, LP, BP; user-configurable in terms of cutoff frequency/attenuation; max. 3 filters can be combined
Selective level	
Center frequency	selectable/swept/coupled to generator or input frequency
Bandwidth (0.1 dB)	1%/3%/third octave/$^1/_{12}$ octave/ selectable
Total harmonic distortion (THD)	
Fundamental	10 Hz to 22 kHz
Inherent distortion (Σ 2nd to 9th order)	–120 dB [1]; *–130 dB* [1]
SINAD and THD+N	
Fundamental	20 Hz to 22 kHz
Inherent distortion	–110 dB [1]; *–126 dB* [1]
Filters	HP, LP + weighting filter
Modulation distortion	2nd plus 3rd order
Measurement method	selective to DIN IEC 268-3
Inherent distortion	–100 dB; *–123 dB*[1]
Difference-frequency distortion	2nd or 3rd order
Measurement method	selective to DIN IEC 268-3
Inherent distortion d2	–120 dB; *–130 dB*[1]
d3	–100 dB [1]; *–130 dB* [1]

Wow and flutter [2], meas. method	DIN IEC/NAB/JIS/2-sigma
Frequency	10 Hz to 110 kHz, 20 Hz to 20 kHz
Accuracy (S/N >80 dB)	±0.005%
Phase, group delay	20 Hz to 20 kHz
Accuracy (phase)	±0.5°
Polarity test	
DC voltage	0 to ±110 V; *0 to ±FS*
Waveform (2-channel)	memory depth 7424 points
FFT analyzer	
Frequency range	DC to 110 kHz; *DC to 45.7% of clock rate*
FFT size/resolution	16 k points/0.023 Hz
Window functions	rectangular/Hann/Blackman-Harris/ Rife-Vincent 1 to 3/Hamming/ flat-top/Kaiser
Averaging	max. 256-fold, exp. + linear
Noise floor	–140 dB; *–160 dB*

Filter

For all analog and digital analyzers. Up to 3 filters can be combined as required. All filters are digital filters with a coefficient accuracy of 32 bit floating point (exception: analog notch filter).

Weighting filters

A weighting; C message; CCITT; CCIR weighted, unweighted; CCIR ARM; deemphasis 50/15, 50, 75, J.17; rumble weighted, unweighted; DC noise highpass; IEC tuner; jitter weighted

User-definable filters

8th order elliptical, type C (for highpass and lowpass filters also 4th order), passband ripple +0/–0.1 dB, stopband att. approx. 20 to 120 dB selectable in steps of approx. 10 dB (highpass and lowpass filters: stopband attenuation 40 to 120 dB).

Analog notch filter

For measurements on signals with high S/N ratio, this filter improves the dynamic range of the analyzer by up to 30 dB to 140 dB for analyzer 22 kHz, or 120 dB for analyzer 110 kHz (typical noise floor of FFT). The filter is also used for measuring THD, THD+N and MOD DIST with dynamic mode precision.

Generators

Analog outputs	
Balanced, floating	2 channels, 10 Ω/200 Ω/600 Ω
Output voltage	0.1 mV to 20 V rms (no load)
Unbalanced, floating	2 channels, 5 Ω
Output voltage	0.1 mV to 10 V rms (no load)
Frequency range	2 Hz to 21.75 kHz, sine up to 110 kHz [3]
Frequency response	±0.05 dB, 20 Hz to 20 kHz
Inherent distortion [3]	–120 dB
Digital outputs	same as digital inputs

Audio Analyzer UPL

Generator functions of analog generators; digital generators in italics (option UPL-B2 or UPL-B29)

Sinewave	
Inherent THD	–120 dB [3]; *–130 dB*
Inherent THD+N	–110 dB [1]; *–126 dB* [1]
Signal for modulation distortion analysis, selectable	signal/interf. freq., amplitude ratio
Inherent distortion	–100 dB; *–123 dB* [1]
Difference-frequency signal, select.	center frequency and frequency offset
Inherent distortion d2	–120 dB; *–130 dB* [1]
d3	–100 dB [1]; *–130 dB* [1]
Multisine, selectable	amplitude/frequency; max. 17 freq.
Sine-burst, sine^2 burst	level ratio and duty cycle selectable
Noise	flat/Gaussian/triangular distribution
Multifrequency noise	band-limited/white/pink/user-defined
Arbitrary waveform	any waveform from file
Max. number of points	16 k
Polarity test signal	Sine^2 burst
Sweeps	frequency, amplitude, burst interval, burst duration, time

Sweep

Generator sweep

Parameters	frequency, level, with bursts also interval + duration, one- or two-dimensional
Sweep	linear, logarithmic, tabular, single, continuous, manual
Stepping	automatic after end of measurement time delay (fixed or loaded table)

Analyzer sweep

Parameters	frequency or level of input signal
Sweep	single, continuous

Digital audio protocol (option UPL-B21)

Generator

Validity bit	NONE, L, R, L+R
Channel status data	mnemonic entry with user-defin. masks, predefined masks for professional and consumer format to AES3 or IEC-958
User data	loaded from file (max. 384 bits) or set to zero

Analyzer

Display	validity bit L and R
Error indication	block errors, sequence errors, clock rate errors, preamble errors
Clock rate measurement	50 ppm
Channel status display	user-defin. mnemonic display of data fields, predefined settings for professional and consumer format to AES3 or IEC-958, binary and hexadecimal format
User bit display	user-definable mnemonic display, block-synchronized

Jitter and interface test (option UPL-B22)

Generator

Jitter injection	0 to 5 UI, 10 Hz to 21.75 kHz
Common mode signal	0 to 20 V pp, 20 Hz to 21.75 kHz
Phase (output to reference)	0 to ±64 UI, selectable
Cable simulator	100 m audio cable

Analyzer

Input signal	amplitude, sampling rate
Jitter measurement	amplitude, frequency, spectrum, reclocking
Common mode test	amplitude, frequency, spectrum
Phase (input to reference)	0 to ±64 UI
Delay (input to output)	100 µs to 500 ms

Extended analysis functions (option UPL-B6)

Coherence and transfer functions	can be displayed simultaneously
Averaging	2 to 2048
FFT length	256, 512, 1k, 2k, 4k, 8k points
Rub & buzz measurement	simultaneous measurement of frequency response, rub & buzz and polarity
Tracking highpass filter	2 to 20 times fundamental
Lower/upper frequency limit	selectable
Measurement time (200 Hz to 20 kHz, 200 points log.)	2 s
Multisine generator function	extended functions
Mode 1	crest factor or phase of each component selectable
Mode 2	crest factor selectable
Third octave analysis	for analyzer ANLG 22 kHz and digital 48 kHz
Number of third octaves	30
Stereo sine	in digital generator only
Other functions	under development

Hearing aids test accessories (option UPL-B7)

Consisting of acoustic test chamber, acoustic 2 cm³ coupler, various battery adapters, connecting cables, software for measurements to IEC60118 and ANSI S3.22

Additional requirements	options UPL-B5 and UPL-B10

Audio Analyzer UPL

General data

Graphical display of results	Monitor (not UPL66) 8.4" LCD, colour display display of any sweep trace display of trace groups bargraph display with min./max. values spectrum, also as waterfall display list of results bar charts for THD and intermodulation measurements
Display functions	Autoscale axis zoom full-screen and part-screen mode 2 vertical,1 horizontal cursor line search function for max. values marker for harmonics (spectrum) user-labelling for graphs change of unit and scale also possible for loaded traces
Test reports	Screen copy to printer, plotter or file (PCX, HPGL, Postscript) lists of results; sweep lists tolerance curves list of out-of-tolerance values equalizer traces
Storage functions	Instrument settings, optionally with measured values and curves spectra sweep results sweep lists tolerance curves equalizer traces
Result logging	2 x RS-232-C, Centronics
Option UPL-B4	IEC 625/IEEE 488
Printer driver	supplied for approx. 130 printers
Plotter language	HP-GL
Remote control (option UPL-B4)	IEC 625-2/IEEE 488 and RS-232-C, commands largely to SCPI
Operating temperature range	0°C to +45°C
Storage temperature range	–20°C to +60°C
Power supply	100/120/220/230 V ±10%, 50 Hz to 60 Hz, 160 VA
Dimensions (W x H x D); Weight	435 mm x 192 mm x 475 mm; 12.6 kg

Ordering information

Audio Analyzer		
with colour LCD	UPL06	1078.2008.06
without display and keyboard	UPL66	1078.2008.66
GSM model	UPL16	1078.2008.16
Options		
Low Distortion Generator	UPL-B1	1078.4400.02
Digital Audio I/O 48 kHz	UPL-B2	1078.4000.02
Digital Audio I/O 96 kHz	UPL-B29	1078.5107.02
Remote Control	UPL-B4	1078.3804.02
Audio Monitor	UPL-B5	1078.4600.03
Extended Analysis Functions	UPL-B6	1078.4500.02
Hearing Aids Test Accessories	UPL-B7	1090.2704.02
Mobile Phone Test Set	UPL-B8	1117.3505.02
Universal Sequence Controller	UPL-B10	1078.3904.02
Digital Audio Protocol	UPL-B21	1078.3856.02
Jitter and Interface Test	UPL-B22	1078.3956.02
Automatic Audio Line Measurement	UPL-B33	1078.4852.02
150 Ω Modification	UPL-U3	1078.4900.02
XLR/BNC Adapter Set	UPL-Z1	1078.3704.02
Extras		
19" Rack Adapter	ZZA-94	0396.4905.00
Service manual		1078.2089.24

1) Total inherent distortion of generator and analyzer.

2) Not in whole frequency range.

3) Only with built-in Low Distortion Generator UPL-B1.

Test System for Hearing Aids UPL + UPL-B7

Measurements on hearing aids

to EN 60118 or ANSI S3.22

Test setup with acoustic test chamber (photo 43159)

Brief description

Audio Analyzer UPL (see data sheet 757.2238) in conjunction with option UPL-B7 is a complete test system for all standard measurements on hearing aids. To carry out such measurements, UPL only requires the options Audio Monitoring (UPL- B5) and Universal Sequence Controller (UPL-B10).

The test system meets all the requirements relevant in the production, quality management and service of hearing aids. The HEARPRO software supplied with the system allows the user to generate test routines tailored to the specific characteristics of the device under test.The type and sequence of measurements are freely selectable. All test parameters can be accurately defined.

Option UPL-B7 includes

- a compact acoustic test chamber
- a complete set of cables
- a 2 cm^3 coupler with built-in microphone and calibration adapter
- a set of battery adapters for all commercial battery sizes for DUT power supply

Calibration of the complete test setup requires a sound level calibrator and a test microphone which are not part of the equipment supplied.

For all relevant measurements

The convenient HEARPRO test software supplied with the system can handle measurements according to standards EN 60118 or ANSI S3.22-1996. All standard measurements can be carried out:

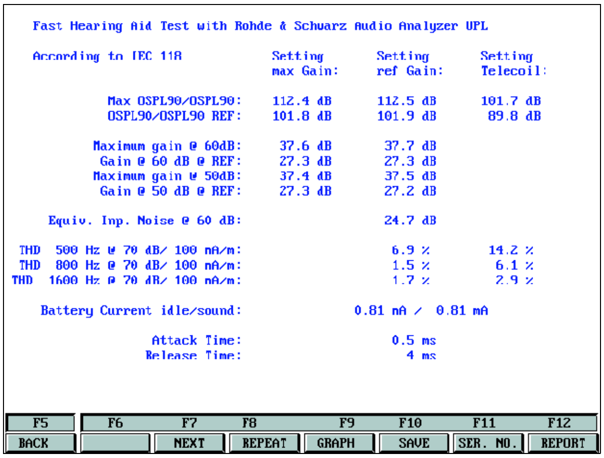
- SSPL curves
- adjustment to reference gain
- OSPL curves
- equivalent inherent noise
- THD at selectable frequencies
- battery current drain
- output sound pressure as a function of input sound pressure
- attack and release times of units using AGC
- groups of curves, eg for displaying the effect of frequency response setting at selectable sound pressure levels
- settings for telecoil measurements on hearing aid
- OSPL curve with telecoil
- THD with telecoil

Powerful in production

The high measurement speed of the system makes for high throughput in production applications. This can be further optimized by adapting the measurement speed to the DUT response.

Frequency response measurements and test results can be subjected to automatic tolerance checks. The results of these checks are documented and stored as PASS or FAIL results together with all test curves. This ensures consistent production quality. The clear-cut logging of all measurements facilitates evaluation of relevant parameters.

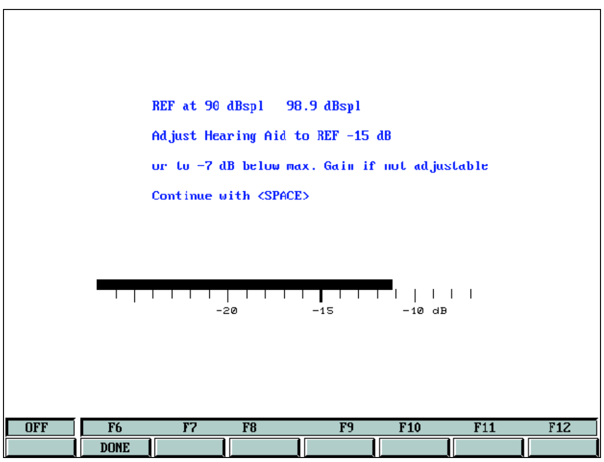
Test System for Hearing Aids UPL + UPL-B7

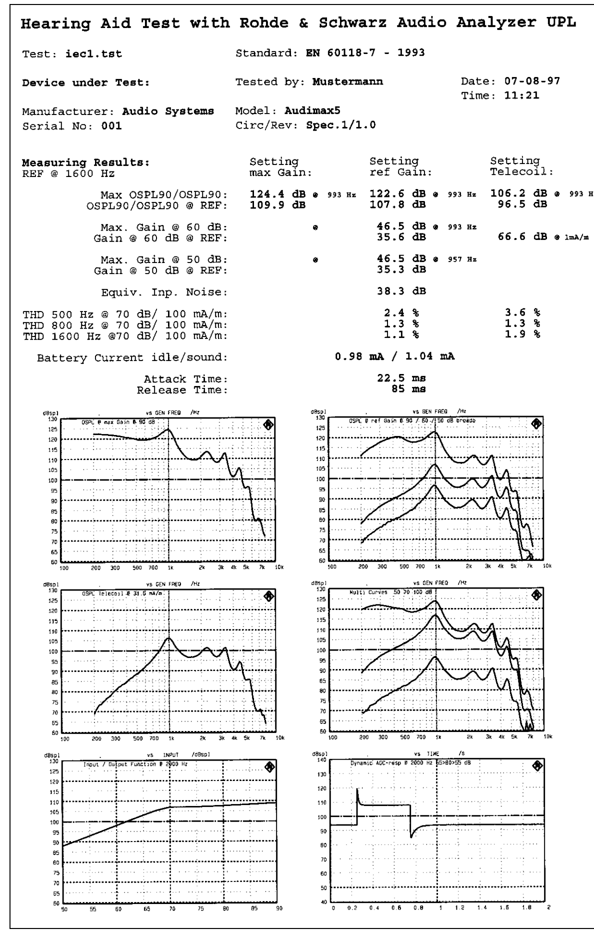


Fast Hearing Aid Test with Rohde & Schwarz Audio Analyzer UPL

According to IEC 118	Setting max Gain:	Setting ref Gain:	Setting Telecoil:
Max OSPL90/OSPL90:	112.4 dB	112.5 dB	101.7 dB
OSPL90/OSPL90 REF:	101.8 dB	101.9 dB	89.8 dB
Maximum gain @ 60dB:	37.6 dB	37.7 dB	
Gain @ 60 dB @ REF:	27.3 dB	27.3 dB	
Maximum gain @ 50dB:	37.4 dB	37.5 dB	
Gain @ 50 dB @ REF:	27.3 dB	27.2 dB	
Equiv. Inp. Noise @ 60 dB:		24.7 dB	
THD 500 Hz @ 70 dB/ 100 mA/m:		6.9 %	14.2 %
THD 800 Hz @ 70 dB/ 100 mA/m:		1.5 %	6.1 %
THD 1600 Hz @ 70 dB/ 100 mA/m:		1.7 %	2.9 %
Battery Current idle/sound:		0.81 mA / 0.81 mA	
Attack Time:		0.5 ms	
Release Time:		4 ms	

F5 BACK | F6 | F7 NEXT | F8 REPEAT | F9 GRAPH | F10 SAVE | F11 SER. NO. | F12 REPORT





Hearing Aid Test with Rohde & Schwarz Audio Analyzer UPL

Test: iec1.tst — Standard: EN 60118-7 - 1993

Device under Test: — Tested by: Mustermann — Date: 07-08-97, Time: 11:21

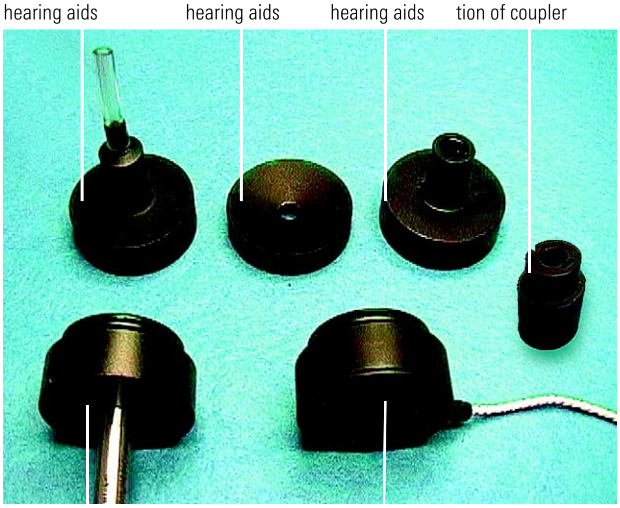
Manufacturer: Audio Systems — Model: Audimax5

Serial No: 001 — Circ/Rev: Spec.1/1.0

Measuring Results: REF @ 1600 Hz	Setting max Gain:	Setting ref Gain:	Setting Telecoil:
Max OSPL90/OSPL90:	124.4 dB @ 993 Hz	122.6 dB @ 993 Hz	106.2 dB @ 993 Hz
OSPL90/OSPL90 @ REF:	109.9 dB	107.8 dB	96.5 dB
Max. Gain @ 60 dB:	@	46.5 dB @ 993 Hz	
Gain @ 60 dB @ REF:		35.6 dB	66.6 dB @ 1mA/m
Max. Gain @ 50 dB:	@	46.5 dB @ 957 Hz	
Gain @ 50 dB @ REF:		35.3 dB	
Equiv. Inp. Noise:		38.3 dB	
THD 500 Hz @ 70 dB/ 100 mA/m:		2.4 %	3.6 %
THD 800 Hz @ 70 dB/ 100 mA/m:		1.3 %	1.3 %
THD 1600 Hz @70 dB/ 100 mA/m:		1.1 %	1.9 %
Battery Current idle/sound:		0.98 mA / 1.04 mA	
Attack Time:		22.5 ms	
Release Time:		85 ms	

Screen display of results (left top), setting aid for acoustic gain of hearing aid (left bottom) and log printout (right)

Adapter for behind-the-ear (BTE) hearing aids — Adapter for in-the-ear (ITE) hearing aids — Adapter for body-worn hearing aids — Adapter for calibration of coupler



Coupler for ¼" microphone (microphone not supplied) — Coupler with built-in microphone

Specifications for UPL with UPL-B7

Max. sound pressure	>100 dB SPL, typ. 110 dB SPL
THD	<0.3% for 90 dB SPL
Ambient noise attenuation	>40 dB (20 Hz to 1500 Hz) >45 dB (>1500 Hz)
Frequency response of acoustic chamber without correction	±2 dB (100 Hz to 8000 Hz)
Feedthroughs for	– microphone connector for coupler with built-in microphone – battery adapter – 2 x 5-contact Mini-DIN for Hi-Pro programmer and ¼" microphone preamplifier (GRAS 26 AC-R can be used)
Dimensions of acoustic chamber (W x H x D)	365 mm x 260 mm x 400 mm
Weight	22 kg

Audio Analyzer UPD

2 Hz to 300 kHz

Versatile instrument for measuring the full range of audio parameters at analog and digital interfaces

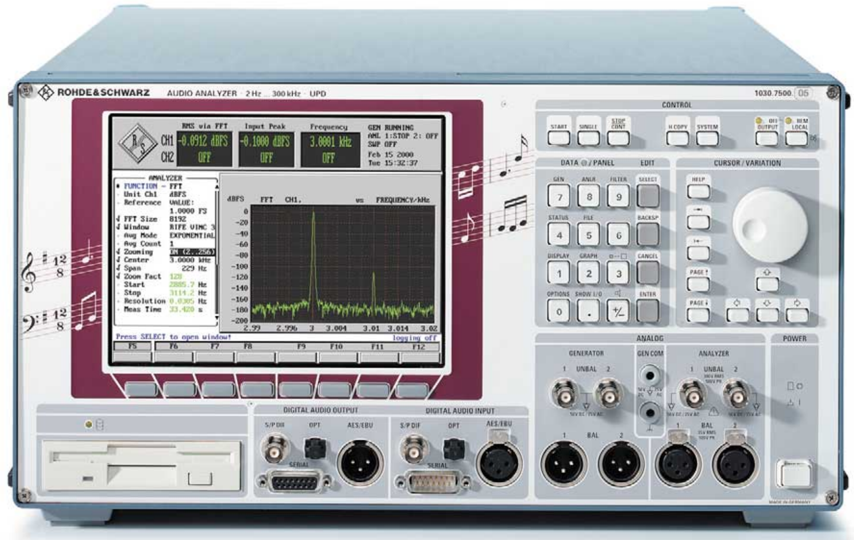


Photo 41956-6

Brief description

Audio Analyzer UPD is largely identical with UPL (see page 268). UPD has a wider frequency and level range and more interfaces. Moreover, free slots are available in the processor section for commercial plug-in boards.

- UPD moreover can generate squarewave signals
- UPD also provides less common measurements like dynamic intermodulation

- Besides the generation and analysis of channel status data, UPD generates protocol errors (eg CRC, parity, sequence errors) at digital interfaces for testing input circuits.

Features differing from UPL

- Additional BNC sockets for connecting unbalanced DUTs
- Extended level measurement range up to 300 V at unbalanced interfaces
- Extended frequency range from 2 Hz to 300 kHz

Additional measurements

User-programmable digital interfaces enable measurements on modules and audio chips that have no standardized audio interfaces. In the development of A/D and D/A converters, Audio Analyzer UPD can thus be adapted to virtually any data format via its serial or parallel lines. Clock rates are selectable between 100 Hz and 1 MHz, which covers both slow rates for telephone applications and fast rates for oversampling modules.

Overview of options

Designation, functions	Option
Low Distortion Generator: analog sinewave generator with inherent distortion lower than that of built-in standard generator	UPD-B1
AES/EBU Interface: contains the AES/EBU and the S/P DIF interface as well as optical interfaces	UPD-B2
Jitter and Interface Test: in conjunction with AES/EBU Interface UPD-B2, this option allows testing of the physical parameters of digital audio interfaces	UPD-B22
High-Speed Extension: further increases the measurement speed through parallel digital signal processing	UPD-B3
IEC-625/IEEE-488 Bus Interface: allows remote control of UPD and in conjunction with option UPD-K1 remote control of external devices	UPD-B4
Monitoring Output: provides the UPD with a headphones output and a built-in loudspeaker for monitoring the signals to be measured	UPD-B5
Universal Sequence Controller: enables test sequences to be generated and executed; with built-in program generator	UPD-K1
Arbitrary Waveform Designer: DOS program that can be run on UPD for arithmetical and graphical design of waveforms	UPD-K2
Automatic Audio Line Measurement: for measurement of broadcast links in line with ITU-T O.33 recommendations (UPD-K1 required)	UPD-K33

Audio Analyzer UPD

Specifications in brief

All inherent distortion values refer to the frequency range 20 Hz to 22 kHz.

Analyzers

Analog inputs	
Balanced, floating	2 channels, 300 Ω/600 Ω/20 kΩ
Voltage measurement range	0.1 µV to 35 V rms
Common-mode rejection	>110 dB (50 Hz)
Unbalanced, floating	2 channels, 1 MΩ
Level measurement range	0.1 µV to 300 V rms
Frequency range	2 Hz to 300 kHz
Frequency response	±0.03 dB, 20 Hz to 22 kHz
Digital inputs	AES/EBU option
AES/EBU input	XLR connector, 110 Ω and 10 kΩ
S/P DIF input	BNC connector, 75 Ω
Optical input	Toslink system
Clock rates	32/44.1/48 kHz
Serial	1- and 2-channel
Parallel	28-bit parallel, 1- and 2-channel
Clock rates (serial, parallel)	32/44.1/48 kHz/multiples thereof up to 768 kHz and adjustable
Frequency range	2 Hz to 45.7% of clock rate

Measurement functions of analog analyzers; digital analyzers in italics

AF level	
Noise (600 Ω)	1.6 µV (CCIR unweight.); *-180 dBFS*
Weighting	RMS, peak [2], quasi-peak (CCIR 468) [2]
Accuracy	±0.05 dB (V_{rms}, 1 kHz)
Filters	weighting filter; HP, LP, BP, NOTCH; user-configurable in terms of cutoff frequency/attenuation; max. 4 filters can be combined
Selective level	
Center frequency	selectable/swept/coupled to generator or input frequency
Bandwidth (0.1 dB)	1%/3%/third octave/$^1/_{12}$ octave/ selectable
Total harmonic distortion (THD)	
Fundamental	6 Hz to 110 kHz
Inherent distortion (Σ 2nd to 9th order)	–115 dB [1]; *-130 dB* [1]
SINAD and THD+N	
Fundamental	20 Hz to 110 kHz
Inherent distortion	–110 dB [1]; *–126 dB* [1]
Filters	HP, LP + weighting filter
Modulation distortion	2nd plus 3rd order
Measurement method	selective to DIN IEC 268-3
Inherent distortion	–103 dB; *–123 dB*[1]
Difference-frequency distortion	2nd or 3rd order
Measurement method	selective to DIN IEC 268-3
Inherent distortion d2	–125 dB; *–130 dB* [1]
d3	–105 dB [1]; *–130 dB* [1]
Dynamic intermodulation distortion[2]	
Measurement method	selective to DIN IEC 268-3
Inherent distortion	–90 dB [1]; *–125 dB* [1]
Wow and flutter[2], meas. method	DIN IEC/NAB/JIS/2-sigma
Frequency; Accuracy (S/N >80 dB)	2 Hz to 300 kHz; ±0.005%
Phase; group delay	2 Hz to 110 kHz; *20 Hz to 20 kHz*
Accuracy (phase)	±0.1° (1 kHz)
Polarity test, DC voltage	0 to ±35 V balanced, 0 to ±300 V unbalanced; not possible
Waveform	memory depth 7424 points
FFT analyzer	
Frequency range	2 Hz to 300 kHz; *2 Hz to 45.7% of clock rate*
FFT size/resolution	16k points/0.023 Hz
Window functions	rectangular/Hann/Blackman-Harris/ Rife-Vincent 1 to 3/Hamming/ flat-top/Kaiser
Averaging	max. 256-fold, exp. + linear
Noise floor	–140 dB; –160 dB

Generators

Analog outputs	
Balanced, floating	2 channels,10/30/200/600 Ω
Output voltage	0.1 mV to 24 V rms (no load)
Unbalanced, floating	2 channels, 5 Ω/15 Ω
Output voltage	0.1 mV to 12 V rms (no load)
Frequency range	2 Hz to 110 kHz
Frequency response	±0.05 dB, 20 Hz to 20 kHz
Inherent distortion [3]	–115 dB
Digital outputs	same as digital inputs

Generator functions of analog generators; digital generators in italics

Sinewave	
Inherent THD	–115 dB [3]; *–130 dB*
Inherent THD+N	–110 dB [1]; *–126 dB* [1]
Signal for modulation distortion analysis, selectable	signal/interf. freq., amplitude ratio
Inherent distortion	–103 dB [3]; *–123 dB* [1]
Difference-frequency signal, select.	center frequency and frequency offset
Inherent distortion d2	–125 dB [3]; *–130 dB* [1]
d3	–105 dB [1]; *–130 dB* [1]
Signal for DIM analysis [2] [3]	
Inherent distortion	–90 dB [1]; *–125 dB*
Multisine, selectable	amplitude/frequency; max. 17 freq.
Sine burst, sine^2 burst	level ratio and duty cycle selectable
Rectangular wave	max. 10 kHz
Noise	flat/Gaussian/triangular distribution
Multifrequency noise	band-limited, white/pink/user-defined
Arbitrary waveform	any waveform from file
Max. number of points	16384
Polarity test signal [2]	sine^2 burst
Sweeps	frequency, amplitude, burst interval, burst duration, time

General data

Result logging	2 x RS-232-C, Centronics
Option UPD-B4	IEC 625/IEEE 488
Remote control (option UPD-B4)	to IEC 625-2/IEEE 488, most commands in conformity with SCPI
Operating/storage temperature range	0 to +45°C/–20 to +60°C
Power supply	100/120/220/230 V ±10%, 47 to 63 Hz, 290 VA
Dimensions (W x H x D); Weight	435 mm x 236 mm x 475 mm; 22 kg

Ordering information

Audio Analyzer with colour LCD	UPD	1030.7500.05
Options		
Low Distortion Generator	UPD-B1	1031.2601.02
AES/EBU Interface	UPD-B2	1031.2301.02
Jitter and Interface Test	UPD-B22	1078.6503.02
High-Speed Extension	UPD-B3	1031.2001.02
IEC-625/IEEE-488-Bus Interface	UPD-B4	1031.2901.02
Monitoring Output	UPD-B5	1031.5300.02
Universal Sequence Controller	UPD-K1	1031.4204.02
Automatic Audio Line Measurement	UPD-K33	1031.5500.02
Arbitrary Waveform Designer	UPD-K2	1031.4404.02

1) Total inherent distortion of low distortion generator and analyzer.

2) Not in whole frequency range.

3) Only with built-in Low Distortion Generator UPD-B1.

Audio Analyzer UPA

10 Hz to 100 kHz

System-compatible analyzer for generating and measuring analog audio signals

Photo 37919

Brief description

Audio Analyzer UPA is a compact instrument allowing all essential audio parameters to be measured at balanced and unbalanced analog audio interfaces.

Due to its large variety of options (see overview on the right) it can be optimally adapted to the specific application. The great number of filters available makes the UPA suitable for numerous audio measurements.

Model UPA3 is a cost-effective test set with a generator and distortion meter.

Due to its remote-control capability (IEC 625/IEEE 488) and high measurement speed, a major application of UPA is in automated testing of audio components in series production.

Main features

- Psophometric measurements to DIN, CCIR, CCITT
- Broadband level meter with true RMS reading or quasi-peak reading
- Simultaneous measurement of level and frequency
- DC voltage measurements
- Combined digital and analog displays for all functions
- Synthesizer generator with low distortion and floating outputs (option)
- Switch-selectable generator output impedance
- Fully automatic distortion meter for measurement of total and selective harmonic distortion or SINAD (option)
- Wow and flutter meter to DIN, CCIR, IEC, NAB, JIS with amplitude variation meter (option)
- Frequency counter and phase meter
- Nonvolatile memory for 50 instrument setups

Overview of options

Designation, functions	Option
Generator: provides level- and crystal-accurate sinewave signals with low distortion and excellent S/N ratio; high frequency and level resolution	UPA-B6
Distortion Meter: measures total harmonic distortion (THD/ THD+N), selective harmonic distortion up to 9th order, sum of all even/odd distortion factors, SINAD	UPA-B8
Wow and Flutter Meter: measures wow and flutter to DIN-IEC, NAB, JIS as well as amplitude variations	UPA-B9
Special Filter: contains a large variety of customary audio filters (see specifications); selected filter is switched into the signal path	UPA-B2
Filter Circuit Board, partly fitted: plug-in filter board with control section fitted; allows configuration of customized filters	UPA-B3
Customized Filter: on request, customized filters (also several filters on one PC board) will be devised and manufactured by Rohde&Schwarz	UPA-B4
Harmonics Filter: comprises AC-supply adapter and PC program disk; allows measurement of harmonic currents of the AC supply in line with European standard EN 60555 part 2	UPA-B4, model 17
CD Filter: filter board for measurements on CD players and DAT recorders using the test CD; comprises PC program disk for complete automatic measurements	UPA-B4, model 04
Audio Test Disc: signal source for testing CD players, DAT recorders, sound broadcast links, tape recorders, etc	UPA-CD
DC Output: allows XY representation of the selected measurement functions, eg on a recorder	UPA-B1

Audio Analyzer UPA

Specifications in brief

Basic unit

AF level meter

Voltage measurement range	10 µV to 300 V, unbalanced 10 µV to 35 V, balanced
Frequency range	10 Hz to 100 kHz
Filters	22.4 Hz and 300 Hz highpass filters, 22.4 Hz and 100 kHz lowpass filters, CCIR, CCITT
Other filters	contained in option UPA-B2
Test inputs	floating
Balanced	two 3-contact female connectors, switchable R/L channel, 600 Ω/20 kΩ
Unbalance rejection	>110 dB at 50 Hz
Unbalanced	two BNC female connectors, switchable R/L channel, 1 MΩ
Crosstalk attenuation R/L	>80 dB at 20 kHz
Detector	RMS-responding rectifier, quasi-peak responding rectifier
Level indication	5 digits in mV, V, dBm, mW or W, relative indication in % or dB
Accuracy RMS (sinewave)	±1% ±1 digit (30 Hz to 20 kHz)
Inherent noise CCIR, weighted (QPK)	<10 µV (unbalanced, 600 Ω) <20 µV (balanced, 600 Ω)

S/N ratio measurement
(with Generator Option UPA-B6)

Signal frequency range	30 Hz to 100 kHz
Display range	0 to 120 dB
Accuracy (S/N ≤60 dB)	±1 dB
Inherent S/N ratio	>85 dB or <20 µV

DC voltage measurement	0 to ±300 V
Test inputs	see AF level meter, but unbalanced only
Accuracy	±1% ±1 digit

Frequency counter

Frequency measurement range	8 Hz to 250 kHz
Required input voltage	>10 mV (S/N ratio >20 dB)
Accuracy	±0.005% ±1 digit

Phase measurement

Display range	0 to 180°
Resolution	0.1°

Options

Generator (option UPA-B6, standard in UPA3)

Frequency range	10 Hz to 100 (110) kHz
Accuracy	±0.01%
Outputs	like test inputs of AF level meter
Unbalance rejection	>80 dB at 1 kHz (bal., V_{out} >1 V)
Crosstalk attenuation L/R	>80 dB at 20 kHz
Output impedance	30 Ω/200 Ω/600 Ω, selectable
Output voltage, no load	0.1 mV to 12.4 V
Load impedance, max. load	>200 Ω/54 mA
Output circuit	short-circuit-proof, switched off in case of external feeding
Inherent distortion (V_{out} >300 mV)	<–80 dB (30 Hz to 20 kHz)
Frequency response (ref. to 1 kHz)	±0.5% (10 Hz to 20 kHz)

Distortion meter (option UPA-B8, standard in UPA3)

Frequency range, fundamental	10 Hz to 100 kHz
Frequency adjustment	automatic or by frequency preselection
Display modes	total harmonic distortion THD, selective distortion d_2 to d_9, SINAD, level
Display range	–120 to 0 dB (distortion)
Accuracy THD or SINAD, 20 Hz to 20 kHz	±1 dB (harmonics up to 100 kHz)

Wow and flutter meter (option UPA-B9)

Wow and flutter meter	
Measurement method	IEC, NAB, JIS, 2-sigma
Measurement range	0.003 to 5%
Accuracy	±10%
Amplitude variation meter	
Frequency range	2 to 20 kHz
Variation range	
Level	0 to 20 dB
Frequency	0.1 to 300 Hz
Accuracy	±0.25 dB (0 to 3 dB)

Special filter (option UPA-B2)

A-filter	to DIN IEC 651
Bandstop filters	pilot-tone trap with15 kHz lowpass filter, line-frequency trap with 13 kHz LP (both filters can be combined with A-filter)
Bandpass filters	standard frequencies 315 Hz/1/ 3.15/6.3/10/12.5 kHz; additionally adjustable fixed center frequencies of 8/9/ 10/11/12/13/14/15/ 15.5/16/17/18/19/20/25 kHz; adjustable passband frequencies from 23 Hz to 25 kHz; telephone bandpass filter 320 Hz to 3.4 kHz; bandpass filter 2 to 10 kHz
Lowpass filter	350 Hz/1.04/3.5/7/10.4/15 kHz

General data

Remote control	IEC 625-1 (IEEE 488), control of all instrument functions
Operating	0 to +50°C
Storage temperature range	–40 to +70°C
Power supply	100/120/220/230 V ±10%, 47 to 63 Hz, 50 VA
Dimensions (W x H x D)	470 mm x 162 mm x 480 mm
Weight	16 kg

Ordering information

Audio Analyzer		
Basic model	UPA	0372.6014.02
with generator and distortion meter	UPA3	0372.6014.03
Options		
Generator (standard in UPA3)	UPA-B6	0373.0010.02
Distortion Meter (standard in UPA3)	UPA-B8	0373.1616.02
Wow and Flutter Meter	UPA-B9	0373.2612.02
Special Filter	UPA-B2	0373.1216.02
Filter Circuit Board, partly fitted	UPA-B3	0373.1545.02
Customized Filter	UPA-B4	1002.1200.xx
DC Output	UPA-B1	0373.2512.02
Audio Test Disc	UPA-CD	0852.8400.02

VOR/ILS Receiver/Analyzer EVS200

Monitoring terrestrial radionavigation equipment at airports and field stations

Photo 43151-1

Brief description

VOR/ILS Analyzer EVS200 is a portable combinational measuring instrument for monitoring terrestrial radionavigation equipment at airports and field stations. It provides high-precision signal analysis of ILS localizers and glidepath transmitters as well as of VOR systems including marker beacon.

Thanks to its high measurement accuracy and fast data output, EVS200 is ideal for dynamic, computer-aided measurement of runway characteristics. The wide input level range and optimal shielding of the modules allow measurements to be carried out close to antennas.

Measurement applications

- Dynamic runway measurements
- Measurement of DDM/SDM on antenna array and runway
- Clearance & glidepath (joint analysis of parameters without switching off transmitter system)
- Qualification of test signals at field testpoints and checking of bearing indication of VOR/DVOR transmitters
- Difference level measurement with dynamic range up to 110 dB
- Measurement of marker beacon signal parameters
- Point-by-point far-field measurement
- Measurement of transmitting antenna characteristic using delta level mode
- Functional monitoring of VOR/ILS transmitter systems in the field including remote data transmission
- Use in flight inspection systems
- Further analysis of received signals via multifunctional output (DSP OUT) and audio output
- Analysis of external audio signals via audio input

Main features

- VOR/ILS signal analysis with digital signal processor (DSP)
- High measurement accuracy and wide dynamic range
- High long-term stability
- High measurement speed, 90 measurements/s in ILS mode
- Minimum susceptibility to interference through special shielding, operational even at high levels up to +15 dBm
- 120 memory channels for DDM/SDM values
- Built-in test equipment (BITE)
- RF spectrum display
- RS-232-C interface for remote control of all functions and result output
- Large, illuminated LCD with clear display of results
- Simultaneous indication of parameters on display
- AC-supply-independent operation with built-in battery
- Operation in vehicles from12 V onboard supply
- Operation from AC supply voltages 87 V to 265 V at 47 Hz to 63 Hz
- High mechanical resistance to MIL-810D and DIN-IEC 68

VOR/ILS Receiver/Analyzer EVS200

Specifications

Receiver section

Frequency range	74.7 MHz to 75.3 MHz, 107 MHz to 119 MHz, 319 MHz to 341 MHz
Accuracy	≤2 ppm
Resolution	5 kHz
Input voltage	15 dBm max. into 50 Ω
VSWR	<1.5
RF input	BNC (optional N)
Sensitivity	–93 dBm ≥18 dB S/N (IF bandwidth 8 kHz)
IF bandwidth	
30 kHz	min. ±15 kHz (–3 dB), max. ±40 kHz (–60 dB)
8 kHz	min. ±4 kHz (–3 dB), max. ±12 kHz (–60 dB)
Demodulation	AM
Absolute level	
Display range	–90 dBm to +10 dBm
Accuracy	≤±2 dB
Difference level	
Bargraph (quasi-analog)	±12 dB (rel. to reference level)
Resolution	0.1 dB
Accuracy	≤±1 dB

ILS signal analysis

RF level	–70 dBm to –30 dBm
Frequency range	108 MHz to 118 MHz 328 MHz to 336 MHz
Modulation depth (10% to 80%)	
90 Hz/150 Hz ±2%	accuracy 0.5%
300 Hz to 4 kHz (identifier)	≤1.2% of reading
Phase angle 90 Hz/150 Hz	
Measurement range	±60°
Measurement accuracy	≤0.2°
Resolution	0.1°
DDM measurement (≥30 kHz IF bandwidth)	
Localizer mode, measurement accuracy at	
15% to 25% modulation (±0,1 DDM)	≤±0.0004 DDM, ±0.1% of reading
10% to 30% modulation (±0,2 DDM)	≥±0.0004 DDM, ±0.2% of reading
DDM measurement (≥30 kHz IF bandwidth)	
Glideslope mode, measurement accuracy at 30% to 50% modulation (±0,2 DDM)	≤±0.0008 DDM, ±0.1% of reading
Resolution (LOC/GS)	0.0001 DDM
Analog DDM output	
Localizer	0 to1 V in 4 subranges
Glideslope	0 to1 V in 4 subranges
SDM measurement	
SDM 10% to 80%	accuracy ±1% absolute
Resolution	0.0001 SDM

VOR signal analysis

Azimuth	
Accuracy	±0.1°
Resolution	0.05° / 0.01° (setup)
AM modulation depth 30 Hz and 9.96 kHz	
Accuracy	≤1%
Resolution	0.1%
FM deviation	
Accuracy	0.5%, ±0.1 Hz
Resolution	0.1 Hz

General data

RS-232-C interface	8N1
Selectable baud rate	1200, 2400, 4800, 9600, 19200
Operating temperature range	–5°C to +45°C
Storage temperature range	–20°C to +60°C
Power supply	
AC	87 to 265 V, 47 to 63 Hz (440 Hz optional), built-in battery charger
External DC	9 to 15 V DC (typ. 12 V DC, 1.4 A)
Battery	12V / 3.2 Ah
Charging	during AC-supply operation
Operating time	>100 min with average brightness of display
Mechanical resistance	shock-tested to MIL-810D
Vibration test	to DIN-IEC 68-2-36 and 68-2-6
EMC	
RF leakage	to EN 50081-1
RF pickup	to EN 50082-1
Dimensions (W x H x D)	219 mm x 147 mm x 350 mm
Weight	6.5 kg

Ordering information

VOR/ILS Analyzer	EVS200	0796.1800.02
Option		
Weatherproof case with 2 straps	EVS200-T	0798.4264.00

Modulation Analyzers FMA, FMAB, FMAV, FMB; Selective Modulation Analyzer FMAS

FMA: 50 kHz to 1360 MHz

FMAB: FMA with built-in FM stereo decoder

FMAS: FMA with receiver and FM stereo decoder

FMAV: analysis for air navigation systems

FMB: extended frequency range up to 5.2 GHz

FMAV (photo 40 299-1)

Brief description

Modulation Analyzer FMA

FMA combines the functions of several measuring instruments all in one unit. It allows fast and accurate analysis of all parameters of modulated signals. Thanks to its versatility, it can also be used as an RF counter, power meter, voltmeter, psophometer, distortion meter and as an FM stereo decoder. FMA is suitable for measurements in the field of broadcasting (eg on AM and FM transmitters) as well as radiotelephony and in the calibration of signal generators. It can be upgraded for many other measurement tasks.

Modulation Analyzer FMAB

FMAB has been especially designed for the analysis of FM stereo broadcast signals. Its measurement tasks include comprehensive analysis of VHF transmitters, channel transposers and VHF/baseband converters. The built-in stereo decoder with all its analysis functions can be separately used via the rear-panel input so that measurements on FM receivers and stereo coders are also possible.

Selective Modulation Analyzer FMAS

FMAS combines the characteristics of a universal modulation analyzer with those of an FM stereo/TV dual-sound receiver:

- RF/IF selection for 5 MHz to 1000 MHz can be switched on when required
- Selective audio analyzer

Modulation Analyzer FMAV

FMAV features the versatile measurement functions of the basic model and special functions for the needs of air-traffic control authorities, airport operators as well as manufacturers of air-navigation airborne and test systems.

It measures with utmost precision all modulation parameters relevant in VOR and ILS air navigation systems. With its extremely low measurement error achieved by means of digital signal processing, FMAV meets the stringent requirements placed on measuring instruments for ILS systems of category III.

Its high accuracy makes FMAV also ideal for use as a calibrator for VOR and ILS signal generators like Radiocommunication Service Monitor CMS 57 (page 14). With CMS 57 as a signal generator used in conjunction with FMAV as a demodulator, Rohde & Schwarz offers a complete, state-of-the-art test system for aeronautical radio.

Modulation Analyzer FMB

FMB enables modulation analysis right into the lower microwave range. Its fields of application are especially in outside broadcasting, radio relay links as well as testing and calibration of microwave generators. The outstanding characteristics of the basic model are fully maintained in the extended frequency range up to 5.2 GHz. The power meter function of FMB differs from that of FMA in that it is individually calibrated as a function of frequency and level.

Modulation Analyzers FMA, FMAB, FMAV, FMB; Selective Modulation Analyzer FMAS

Main features

- Fast, automatic frequency adjustment by direct frequency measurement
- Low-noise synthesizer with high frequency resolution
- Separate +PK and –PK detectors with extremely short response time
- True RMS detector
- Extremely high accuracy
- High-precision power measurement (typ. error of FMA <0.5 dB, even smaller for FMB)

Additional features of FMAS:

- Excellent static and dynamic selectivity and high sensitivity for direct measurements at the antenna
- Excellent transmission quality
- High overload capability to interfering signals
- Selective RF level measurement
- Low distortion due to phase-linear IF filters

High measurement speed

- Two independent frequency counters for simultaneous RF and AF frequency measurements
- All measurement times can be adapted to the specific measurement problem, eg lowest measurement frequency or required counter resolution
- Measurement functions that are not required can be switched off
- FM demodulator with high bandwidth for analysis of digital modulators (eg mobile radio)

Operation

- Menu-guided operation with softkeys
- Nonvolatile storage of up to 20 complete instrument setups
- Three displays for simultaneous readout of measurement results and indication of all important instrument settings
- Quasi-analog indication of high resolution with absolute or selective as well as MIN-MAX display
- IEEE/IEC bus remote control to IEEE 488.2

Overview of equipment and options

● Standard FMA-Bxx Option – not available

Functions of individual models, options	FMA	FMAB	FMAS	FMAV	FMB
AM/FM/φM	●	●	●	●	●
Weighting filters (CCITT, CCIR), lowpass filter 5 Hz, 4.2 kHz (high skirt selectivity), 30 kHz, 120 kHz (Bessel), special φM filter	FMA-B1	●	●	FMA-B1	FMA-B1
DIST/SINAD Meter: 10 Hz to 100 kHz, distortion measurable down to typ. <0.005%	FMA-B2	●	FMA-B2	FMA-B2	FMA-B2
Stereo Decoder: precision instrument, built-in RDS demodulator with external evaluation facility	FMA-B3	●	●	–	FMA-B3
AM/FM Calibrator/AF Generator: high-precision level calibration, FMA performance test, complete modulation test set for transmitters and transposers, VOR/ILS baseband signal generation/analysis	FMA-B4	FMA-B4	FMA-B4	–	FMA-B4
Same as before, but with **AF and VOR/ILS generator**	–	–	–	FMA-B4	–
VOR/ILS measurements	–	–	–	●	–
ILS distortion meter	–	–	–	●	–
AF Analyzer/DSP Unit: selective AF analysis up to 45 kHz, digital AF analyzer, true THD measurement, measurement of intermodulation products	–	–	–	●	–
Selective AF analysis up to 150 kHz	FMA-B8	FMA-B8	●	–	FMA-B8
RF/IF Selection: 5 to 1000 MHz, can be switched on when required; tracking 4-section preselection, selectable IF filters	FMA-B9	FMA-B9	●	–	–
Reference oscillator (1 x 10^{-7}/year)	FMA-B10	FMA-B10	FMA-B10	●	FMA-B10
5.2 GHz Frequency Extension: enhanced power measurement accuracy	FMA-B12	FMA-B12	–	–	●

Modulation Analyzers FMA, FMAB, FMAV, FMB; Selective Modulation Analyzer FMAS

Specifications in brief

Frequency

Frequency range		
FMA, FMAB, FMAV	50 kHz to 1.36 GHz	
FMAS	5 MHz to 1000 (1360) MHz	
FMB as well as FMA and FMAB with option FMA-B12	50 kHz to 5.2 GHz	
Frequency tuning	automatic or manual	
Display	10-digit readout	
Resolution	0.1/1/10/100 Hz selectable	
Reference oscillator	standard	option FMA-B10
Aging	2×10^{-6}/year	1×10^{-7}/year
after 30 days of operation	–	1×10^{-9}/day
warm-up time	15 min	15 min
External reference input/output	manual or remote-controlled	

RF input	N connector, 50 Ω
Overload protection	up to 5 W (15 V rms)
Maximum peak voltage	25 V (including DC)
VSWR (f_{in} up to 1.36 GHz, att. ≥20 dB)	≤1.2

RF power measurement with calibration (FMA models)

Power measurement range	0.18 µW to 1 W (–37.5 to +30 dBm)
Accuracy (P ≥0.1 mW)	±1 dB (typ. ±0.5 dB)

RF power measurement (FMB)

Measurement range	0.18 µW to 1 W (–37.5 to +30 dBm)
Accuracy (input level –10 to +5 dBm, f_{in}=50 kHz to 1.36 GHz)	±0.3 dB

Amplitude modulation measurement

Modulation frequency range	10 Hz to 200 kHz
Resolution, Accuracy	0.1% of reading, ±1%
Residual AM, f_{in} up to 1.36 GHz, CCITT	≤0.01%
Incidental AM in FM mode	≤0.1%
AF distortion	≤0.2%

Frequency modulation measurement

Modulation frequency range	10 Hz to 200 kHz		
Max. measurable deviation for f_{in}	50 to 300 kHz	0.3 to 10 MHz	≥10 MHz
	f_{in}/10	150 kHz	700 kHz
Accuracy	±1%		
Resolution	better than 0.1% of reading		
Residual FM for f_{in}, ≤1.36 GHz, CCITT, RMS	≤1 Hz		
Stereo S/N ratio, weighted	≥76 dB		
Stereo crosstalk attenuation	≥56 dB (f_{mod}=1 kHz)		
AF distortion, incidental FM	≤0.05%, ≤10 Hz		
Deemphasis	50/75/750 µs selectable		

Phase modulation measurement

Modulation frequency range	200 Hz to 200 kHz
Max. measurable deviation	
300 kHz to 10 MHz	150 rad
≥10 MHz	700 rad
Accuracy	±2%
Residual φM, f_{in} up to 1.36 GHz, CCITT	≤0.004 rad
Resolution	<0.1% (minimum 0.0001 rad)
AF distortion	≤0.1%

AF voltmeter

DC voltage measurement range	±10 µV to 20 V
Resolution, Accuracy	<0.1%, ±0.5%
AC voltage measurement range	30 µV to 20 V
Frequency range, resolution	10 Hz to 300 kHz, 0.1% of reading
Accuracy (RMS, 30 Hz to 20 kHz)	±1%

All AF measuring facilities such as detectors, filters, frequency counter and distortion meter can also be used in voltage measurements for weighting.

Inputs unbalanced	BNC, R_{in}=100 kΩ ∣∣80 pF
Inputs balanced	R_{in}= 600 Ω, 3-contact connectors, DIN 41628

AF detector

Peak detector	positive or negative peak or their arithmetic mean
RMS detector	readout as RMS value or converted to peak for sinewave
Quasi-peak detector (with FMA-B1)	detector to CCIR Rec. 468-4

Weighting filters

Highpass filters (2nd/3rd/2nd order)	10/20/300 Hz
Lowpass filters	3/23 kHz (4th order), combined with 20 Hz highpass filter meets CCIR 468-4, unweighted; 100 kHz (4th order)
Filter option FMA-B1	CCIR 468-4 (weighted), CCITT P53, 5 Hz lowpass, 30 kHz and 120 kHz Bessel lowpass of 4th order, 4.2 kHz Cauer lowpass, special φM filter

AF frequency display	5 digits
Frequency range, resolution	10 Hz to 300 kHz, 1 mHz to 10 Hz
Accuracy	±0.005% ±3 mHz ±1 digit

Distortion measurement (option FMA-B2)

Readout	in % or SINAD in dB
Automatic adjustment	for S/N ≥20 dB
Measurement range	10 Hz to 100 kHz
Display range THD/SINAD	0.005 to 50%/6 to 86 dB
Accuracy (20 Hz to 20 kHz)	±1 dB ±0.015% THD

Stereo decoder (option FMA-B3)

Crosstalk attenuation	≥60 dB (30 Hz to 15 kHz)
Frequency response	±0.1 dB (30 Hz to 15 kHz)
Level difference between L and R	≤0.1 dB
Nonlinear distortion	≤0.1% (THD, 30 Hz to 15 kHz)
Difference-frequency distortion (DIN 45403)	d_2 ≤0.05%, d_3 ≤0.1%
S/N ratio, CCIR, weighted, unweighted	≥80 dB
Deemphasis	50 or 75 µs, selectable
External decoder input	bal., 3-cont. connector (DIN 41628)
Common-mode rejection	≥50 dB (1 kHz < f ≤15 kHz)
Input level range	–12 to +12.5 dBm into 600 Ω, Z_{in} ≥40 kΩ
Resolution of level setting	≤0.2 dB
Stereo decoder outputs	
L, R, M	bal., 3-cont. connectors (DIN 41628), +6 dBm, Z_{out} ≤30 Ω, Z_L ≥300 Ω
S	unbalanced, BNC, Z_L ≥600 Ω
RDS decoder outputs	9-contact Cannon connector
Signals available	data, clock, quality signal, TP information, 57 kHz carrier (TTL)

Measurement time	typ. 1 s
Fast modulation measurement	≤120 ms

Outputs

IF output	max. 200 mV into 50 Ω
AM output	max. 1 V into 600 Ω (can be DC-coupled)
FM/φM output	+6 dBm (1.545 V) at 40 kHz deviation/40 rad into 600 Ω (DC-coupled)
Distortion measurement output (with option FMA-B2)	max. 1 V into 600 Ω
AF output	1 to 4 V into 600 Ω

Remote control	IEC 625-1/625-2 (IEEE 488.1/.2)

Modulation Analyzers FMA, FMAB, FMAV, FMB; Selective Modulation Analyzer FMAS

AM/FM Calibrator/AF Generator (option FMA-B4)

The data are tested at 23 °C (73.4 °F) and guaranteed by design in the range 23 ± 5 °C (73.4 ± 9° F).

AF (single-tone and two-tone signals)	10 Hz to 100 kHz
Resolution, Accuracy	1 mHz, 1 mHz + refer. frequency drift
Level	1 mV to 7 V (max. 10 V pp)
Accuracy at 1 kHz	≤0.1% ±10 µV
Level resolution	0.02% (min. 10 µV)
Frequency response (at Z_{in} = 20 Ω, C_L ≤200 pF), 10 Hz to 50 kHz	≤±0.1%
THD + N (level ≤6 V), 10 Hz to 20 kHz	≤0.02%
Difference-frequency distortion (two-tone signals, peak voltage ≤8 V)	≥74 dB (10 Hz to 20 kHz)

Stereo MPX

Data determined by design, not tested individually. Generation of stereo multiplex signals L, R, R=L, R= –L including 19 kHz pilot tone (disconnectible) or 19 kHz pilot tone + 57 kHz subcarrier (without mutiplex signal)

Linear distortion	
Preemphasis	50/75 µs, selectable
Frequency response (10 Hz to 53 kHz)	≤0.1%
Crosstalk attenuation	≥65 dB (30 Hz to 15 kHz)
Non-linear distortion and difference-frequency distortion	≥70 dB
Unweighted and weighted S/N ratio to CCIR 468-4	≥80 dB
Pilot tone	
Nominal frequency	19 kHz ±1 mHz + refer. frequency drift
Phase versus carrier	≤0.1°
Setting range	±10°
57 kHz subcarrier (only possible with multiplex signal switched off)	
Nominal frequency	57 kHz ±1 mHz + refer. frequency drift
Phase versus pilot tone	≤0.1°
Setting range	±30°

VOR/ILS/TACAN (FMAV only)

Data determined by design, not tested individually.

VOR	
Deviation accuracy at 9.96 kHz subcarrier	≤±0.1% ±1 Hz
Setting range	0 to 700 Hz
Phase accuracy 30 Hz	≤±0.005°
ILS	
Frequency response 90 Hz/150 Hz	≤±0.02%
Additional gain difference error	≤0.1% x amplitude difference
Phase accuracy 90 Hz/150 Hz	≤±0.05°

Outputs	2 BNC female connectors on rear panel, unbalanced, same signal at both outputs (can be individually switched off) or 1 x balanced
Output impedance	20 Ω, 200 Ω, 600 Ω selectable
Tolerance	±1% ±2 Ω

AM

Carrier frequency	10 MHz
Level	–10 dBm
Modulation depth	adjustable from 0 to 99%
Accuracy at f_{mod}=1 kHz, 80% AM	≤0.1% of reading
Additional linearity error	≤0.1% (m=10 to 95%)
Modulation frequency response	≤0.1% (15 Hz to 10 kHz)
Modulation distortion (THD + N, m = 80%)	≤0.1% (10 Hz to 20 kHz)
Incidental φM, m ≤80%	≤0.01 rad
Residual AM	typ. ≤0.02% (20 Hz to 23 kHz, RMS)

AM VOR/ILS (FMAV only)

ILS	
DDM accuracy m=18 to 22%	≤±0.00005 DDM ±0.001 x (DDM)
DDM accuracy m=32 to 48%	≤±0.0001 DDM ±0.001 x (DDM)
Phase accuracy 90 Hz/150 Hz	≤0.1°
VOR	
Deviation accuracy at 9.96 kHz subcarrier	≤±0.1% ±1 Hz
Setting range	0 to 700 Hz
Phase accuracy 30 Hz	≤0.01°
TACAN, phase accuracy 15 Hz/135 Hz	≤±0.25°

FM

Carrier frequency	10 MHz
Level	–10 dBm
Deviation (f_{mod}=1 kHz, squarewave)	100 kHz
Accuracy	≤0.1%
Additional sinewave modulation	f_{mod}=10 Hz to 100 kHz, dev. =1 to 100 kHz
Residual FM (BW=23 kHz, RMS)	≤10 Hz
Accuracy for 100 kHz deviation, f_{mod}=1 kHz	≤0.2% + residual FM
Additional linearity error for f_{mod}=1 kHz, dev. =10 to 100 kHz	≤0.1%
Modulation frequency response	≤0.5% (10 Hz to 100 kHz)
Modulation distortion for 100 kHz deviation	≤0.1% (f_{mod}=10 Hz to 20 kHz)
Incidental AM for 50 kHz deviation	typ. ≤0.05% (f_{mod} = 1 kHz, BW = 3 kHz)

Level

Carrier frequency	10 MHz
Accuracy	same as reference frequency
Level range	–50 to –4 dBm
Accuracy –10 dBm	≤0.1 dB at
Accuracy –40 dBm to –4 dBm	≤0.2 dB ±6 nW
Output	BNC female on front panel (CAL), can be internally switched to RF input
VSWR at 10 MHz	≤1.05

Specs in brief: FMAS receive mode

Instead of the optional DIST/SINAD Meter FMA-B2, the optional AF Analyzer/DSP Unit FMA-B8 is fitted in the FMAS.

RF/IF Selection (option FMA-B9)

Frequency

Frequency range	5 to 1000 MHz	
	FM wide	FM narrow/TV 2-sound
IF bandwidth (–3 dB)	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 accuracy[1)]	
5 to 500 MHz	±2 dB ± 3 µV
500 to 1000 MHz	±3 dB ± 3 µV

Modulation Analyzers FMA, FMAB, FMAV, FMB; Selective Modulation Analyzer FMAS

FM stereo

Selectivity

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

Nearby selectivity, unwanted sig. modulated, $f_{mod} = 500$ Hz, $\Delta f = 75$ kHz

	stereo FM wide	stereo FM narrow	mono FM wide	mono FM narrow
Frequency difference				
±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, $\Delta f = 75$ kHz,
Frequency difference ≥1.2 MHz (except for image frequency and 1st IF)

	stereo FM wide	stereo FM narrow	mono FM wide	mono FM narrow
87.5 to 108 MHz	–	–	≤–54 dB	≤–54 dB
rest of range	–	–	≤–40 dB	≤–40 dB

Linear distortion

Amplitude-frequency response, measured at MPX signal output, $\Delta f = 40$ 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 L↔R, measured via stereo decoder, without deemphasis

	FM wide	FM narrow
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)

FM	$\Delta f = 75$ kHz wide	$\Delta f = 75$ kHz narrow	$\Delta f = 100$ kHz wide	$\Delta f = 100$ kHz narrow
40 Hz to 5 kHz	–	≤0.5%	–	≤1%
40 Hz to 15 kHz	≤0.25%	–	≤0.5%	–

Measured via stereo decoder

FM	stereo wide	stereo narrow	mono wide	mono narrow
40 Hz to 5 kHz				
$\Delta f = 75$ kHz	≤0.3%	≤0.8%	≤0.25%	≤0.5%
$\Delta f = 100$ kHz	≤0.6%	≤1.6%	≤0.5%	≤1%

S/N ratio

To CCIR 468-4, deemphasis 50 µs, referred to $\Delta f = 40$ kHz, $f_{mod} = 500$ Hz
S/N ratio (CCIR 468-4, weighted)
LOW NOISE[1]) mode

f_{in}/MHz:	5 to 130	stereo 130 to 470	470 to 1000	5 to 130	mono 130 to 470	470 to 1000
Input voltage						
≥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 accuracy		
30 Hz to 15 kHz, Δf ≤70 kHz	±1% + residual FM	
Difference accuracy with successive dev. measurement		
sound 1/sound 2, 30 Hz to 15 kHz	±0.3% + residual FM	
Nonlinear distortion	$\Delta f = 50$ kHz	$\Delta f = 70$ kHz
Distortion		
$f_{mod} = 30$ Hz to 5 kHz	≤0.3%	0.5%
$f_{mod} = 5$ to 15 kHz	≤0.5%	1%

S/N ratio
Quasi-peak measurement to CCIR 468-4, weighted and unweighted; deemphasis 50 µs, ref. to wanted signal of $\Delta f = 30$ kHz and $f_{mod} = 500$ Hz

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

Channel crosstalk, referred to $\Delta f = 30$ kHz, $f_{mod} = 500$ Hz, selective measurements, deemphasis 50 µs, other sound carrier modulated with frequencies from 30 Hz to15 kHz, $\Delta f = 55$ 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)

Meas. acc.	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)

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

Intermodulation measurement

Difference frequency distortion d_2, d_3 to IEC 268-3

Readout	in % oder dB
Display range	0.001 to 20%, –100 to –14 dB

Meas. acc. (f_2–f_1 ≥30 Hz)

2 x f_2–f_1 ≤42 kHz	42 kHz < 2 x f_2–f_1 ≤150 kHz
±5% of rdg ±0.02% absolute	±5% of rdg ±0.05% absolute

Selective modulation and voltage measurement

using special bandpass filter, in voltmeter, AM, FM and φM mode
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
B_{-3dB}	2.3 Hz	6.8 Hz	68 Hz

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

Measurement uncertainty[2])
with meas. frequency deviation from center frequency <BW_{-3dB}/4

at center frequency f_c	10 Hz to 100 kHz	100 kHz to 150 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

Modulation Analyzers FMA, FMAB, FMAV, FMB; Selective Modulation Analyzer FMAS

Specs in brief: FMAV, VOR/ILS measurement

VOR/ILS/TACAN
Data are guaranteed within the frequency ranges specified (f_{in}).
They are typical values for all frequencies ≥10 MHz.

VOR (f_{in} = 10 MHz; 108 to 120 MHz)	
Amplitude modulation measurement	accuracy for m = 10% to 90%:
f_{mod} = 30 Hz/9.96 kHz	±0.8% of reading
f_{mod} = 300 Hz to 4 kHz	±1.2% of reading
Frequency modulation measurement	9.96 kHz carrier
Max. measurable deviation	700 Hz
Accuracy (f_{mod} = 30 Hz ±1%)	±0.5% ±0.1 Hz
Phase difference measurement at 30 Hz	
Measurement range	0 to 360°
Measurement accuracy	±0.03°
Resolution	≤0.01°
ILS (f_{in} = 10 MHz; 108 to 120 MHz; 328 to 336 MHz)	
Amplitude modulation measurement	m = 10% to 90%
Measurement accuracy	
90/150 Hz ±2%	±0.5% of reading
300 Hz to 4 kHz (identifier)	±1.2% of reading
DDM measurement	
Measurement range	0 to ±0.2 DDM
f_{mod}	90/150 Hz ±1%
Measurement accuracy	
m = 18 to 22%	±0.0002 DDM ±0.1% of reading
m = 32 to 48%	±0.0005 DDM ±0.1% of reading
Resolution	≤0.0001 DDM
Measurement of phase angle between 90 Hz and 150 Hz signals	
Measurement range	±60°
Measurement accuracy	±0.2°
Resolution	≤0.01°

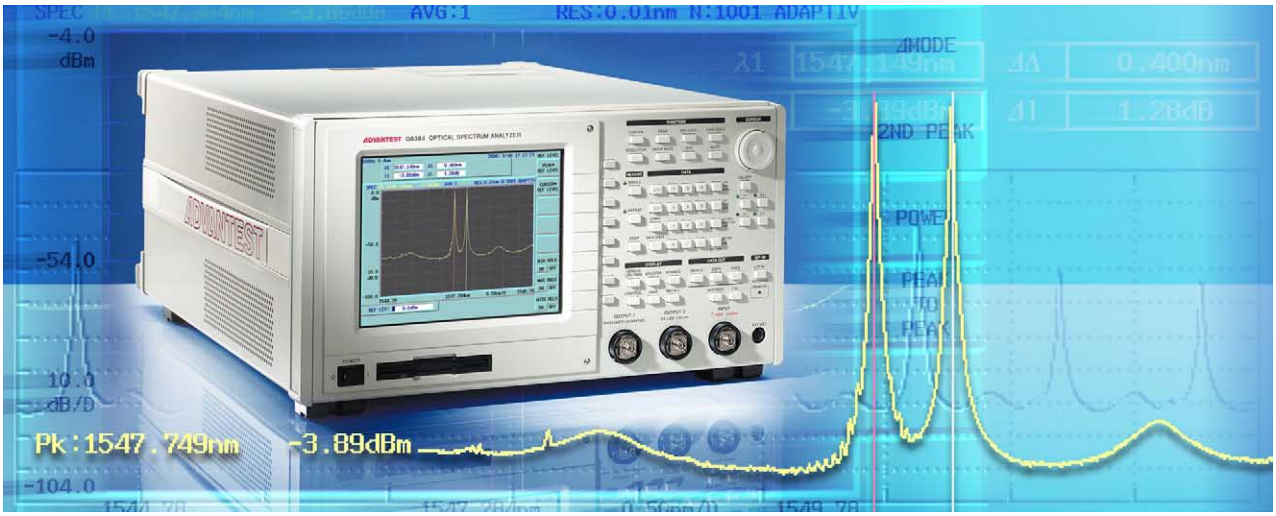
Ordering information

Modulation Analyzer	FMA	0852.8500.52
	FMAB	0856.4750.52
	FMAV	0856.4509.52
	FMB	0856.5005.52
Selective Modulation Analyzer	FMAS	0856.6001.52
Options (possible configurations see pages 280)		
Filter	FMA-B1	0855.2002.52
DIST/SINAD Meter	FMA-B2	0855.0000.52
Stereo Decoder	FMA-B3	0856.0003.52
AM/FM Calibrator/AF Generator	FMA-B4	0855.6008.52
AF Analyzer/DSP Unit	FMA-B8	0855.9007.55
RF/IF Selection 5 to 1000 MHz	FMA-B9	0856.6501.52
Reference Oscillator	FMA-B10	0856.3502.52
5.2 GHz Frequency Extension	FMA-B12	0855.8500.52
Extras		
Service Kit	FMA-Z1	0856.4009.52
For FMAV:		
High-Power Attenuator		
20 dB/50 W	RDL 50	1035.1700.52

1) In temperature range 15 °C to 35 °C; error doubles outside this range.

2) Error of selective measurement in addition to error specified for selected voltmeter, AM, FM or φM mode.

Contents of Chapter 7



Optical spectrum analyzer with highest resolution, low polarization dependence and high dynamic Q8384 (photo 43439-4)

Contents of Chapter 7

Introduction to Optical Measurements

Ever since printing was invented by Gutenberg in the middle of the 15th century, the printed word has become the basis for passing on knowledge. The invention of the printing technology was however also the basis for the development of modern technologies on the way to the communications age. Today, computers play an important part in the generation, processing and filing of information and have replaced in many cases printing as a storage and transmission medium. Magnetic and semiconductor memories can save a gigantic quantity of data on a minimum of space. Computers are nowadays practically an indispensable tool in the generation of print and online media. High-speed worldwide data transmission is playing an important role as well.

Four centuries after the Gutenberg invention a new medium is having a revolutionary effect on the recording and imparting of human knowledge – the optical transmission. Semiconductors, laser and optical fibers are the main elements in this new transmission technology. Optoelectronic circuits and systems gain information from the light by analyzing its intensity, wavelength and polarization. This light in turn is also produced by optoelectronic devices and information added to it. Research, development and further refinement of such optoelectronic circuits makes an accurate measurement of the optical parameters necessary.

Optical power meters and light sources

Optical power meters are indispens-able tools in the development of optical technologies. With their aid it is possible to determine basic parameters and thus increase the efficiency of a transmission system or components thereof. The measurement method is based either on a conversion of the light intensity into a proportional current or the light power is directly converted into thermal energy. While the latter method is frequently used for laboratory standards, the optoelectric conversion using semiconductor sensors is preferred for the industrial field. These sensors respond faster to intensity variations and nowadays also ensure stable measurement results.

A disadvantage however is the strong wavelength dependence of the semiconductor materials. To cover a range from 400 nm to 1750 nm, silicon sensors are generally used today up to about 1000 nm; for longer wavelengths, germanium or indium-gallium-arsenide (InGaAs) materials are suit-able. With modern power meters, the wavelength dependence of the sensor material in its operating range is compensated with the aid of a correction table. The user merely needs to enter the wavelength of the light to be measured and the corrected result is displayed. To ensure correct measurement, the wavelength has to be precisely known. This is also important when using light sources, which in turn should be of tight tolerances within the wavelength spectrum.

The higher the power of a light source, the greater the dynamic range that is available. Since the power meter is calibrated to a light source eg for measurement of the transmission loss of an optical fiber, it is important that the power of the source remains stable. It is therefore imperative for the light sources to be power-regulated. For LEDs, current regulation with temperature signalling is sufficient, whereas for laser diodes (LDs) the power has to be directly measured via a monitor sensor.

Spectral analysis

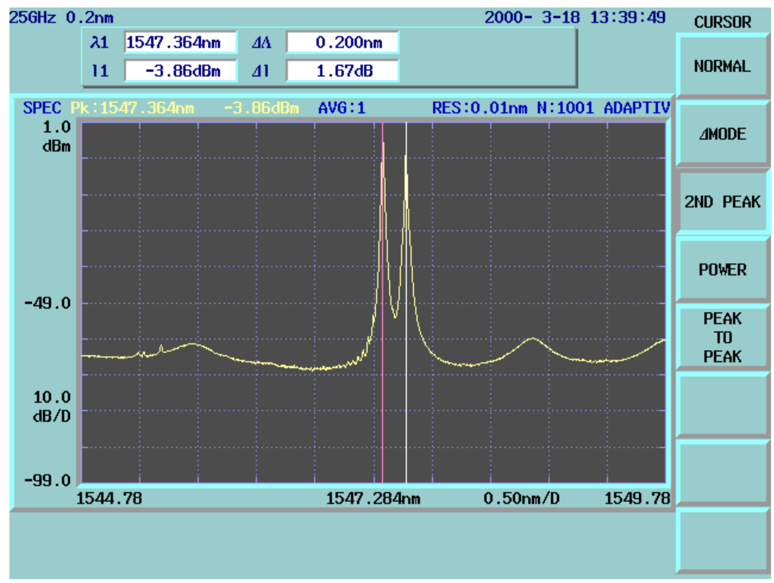
Spectral investigation of light began with the light of the sun. The human eye can perceive a wavelength range from about 400 nm to 800 nm. The short wavelength end of this range is the transition to the ultraviolet and appears to the eye in blue/violet; the long wavelengths produce deep red and are the transition to heat radiation (infrared). Within this range the different wavelengths appear as colours. Wavelengths from 850 nm to 1630 nm are used in optical communications. This "light" is invisible to the human eye so that a direct assessment is not possible. For scientific wavelength analysis socalled spectroscopes are used; in communications they are called optical spectrum analyzers. Methods for wavelength measurements are for instance:

- Diffraction of light using a diffraction grating (dispersive spectroscopy)
- Measurement of spatial intensity distribution
- Analysis of light eg with a Michelson interferometer (Fourier spectroscopy), using Fourier transform to retrieve a spectral signal from a temporal signal

Dispersive methods are used in the majority, since they allow a high measurement sensitivity. Interferometer methods are often superior in terms of measurement accuracy and resolution. Wavelength Meter Q8326 for instance achieves with this method a resolution of 1 pm with a measurement uncertainty of as low as 2 ppm. Other methods like Fabry-Perot or Macht-Zehnder interferometers are less frequently used in practice, but they also allow reliable wavelength analysis.

Measurement example

carried out with Optical Spectrum Analyzer Q8347 (page 291).



High-resolution measurement of two optical sources with 0.1 nm resolution

About the following pages

This chapter on optical measurements describes important measuring instruments of the two types described above for use in R&D, industry and professional training. Our line of products is continuously updated to keep pace with the latest developments in this complex field of measurements. You can find out about our current range of products, especially about newly developed and special models, by contacting:

Rohde & Schwarz Engineering and Sales GmbH

Munich
Telephone: +49 89 4129-13711
Telefax: +49 89 4129-13723

Optical Wavelength Meter Q8326

480 nm to 1650 nm

Optical wavelength meter of highest precision

Photo 43466-1

Brief description

Q8326 is an optical wavelength meter (Advantest) featuring high resolution of the central wavelength. It is suitable for laser diodes, LEDs and other narrowband light sources. Its high measurement accuracy and resolution are ensured over an extremely long period of time by the built-in HeNe reference laser. The light is coupled in by means of optical fiber. An analog level meter is provided to facilitate alignment of the optical axis, if the light has to be fed into the optical fiber first.

Thanks to its high accuracy, Q8326 can be used as a calibration standard for spectroscopes; it allows tuning of dye lasers. It can also be used for investigating the wavelength characteristics of semiconductor components. The high resolution allows for instance accurate measurement of the temperature and chirp response of laser diodes in case of WDM modulation. The instrument always displays the measured wavelength as a value in a vacuum, thus eliminating measurement errors due to the variable refraction index of the air. With 5 measurements per second, the instrument allows realtime observation of wavelength fluctuations. Intensity-modulated light can be accurately measured with a modulation frequency of 3 MHz or higher.

Main features

- Measurement uncertainty 2 ppm only
- Resolution 0.001 nm (averaged)
- Wavelength and frequency display
- 5 Measurements per sec

Operation

Q8326 can be switched to frequency display with a resolution of 100 MHz. The resolution is automatically set to the maximum value, the spectral width of the light source to be measured having a limiting effect and the attainable measurement accuracy being reduced by wideband sources. The display can be reset in the frequency and in the wavelength mode, so that only the frequency or wavelength variations will be displayed. This function is particularly useful for monitoring the long-term stability of sources. An optional 19" rack adapter is available for integration into systems. Beside standard FC input ST and SC connector types are to be adapted.

Specifications in brief

Wavelength ranges	480 nm to 1650 nm (181 to 625 THz)
Input sensitivity	–30 dBm (1200 nm to 1600 nm) –25 dBm (600 nm to 1650 nm)
Max. input level	+10 dBm
Display	10 digits, wavelength or frequency
Resolution	1/0.1/0.01/0.001+0.0001 nm or 100/10/1 GHz/100 MHz, automatic optimization
Measurement accuracy (25 ±5°C)	±(0.05 x half-value width of source) ±2 ppm ±resolution
Stability	±resolution for averaging
Averaging	moving average value (of last 10 measurements)
Measurement rate	5 measurements per second
Optical connector	FC/PC with internal 50/125 µm graded-index fiber, connector adapt-able
Analog output	D/A conversion from 0 to 1 V for last three digits of display
Remote control	IEC625 (IEEE488)
Operating temperature range	+10°C to +40°C
Power supply	100 V to 240 V, 50/60 Hz (60 VA)
Dimensions (W x H x D)	300 mm x 132 mm x 450 mm
Weight	10 kg

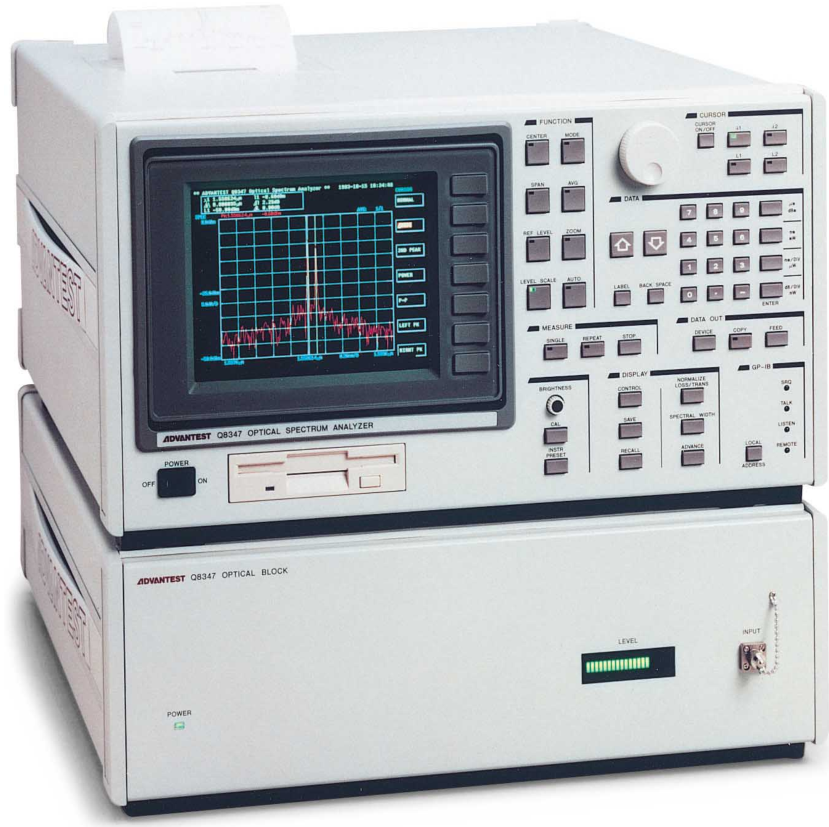
Ordering information

Optical Wavelength Meter	Q8326
Extras	
19" adaptor	A02450
SC adaptor	A08162
ST adaptor	A08163

Optical Spectrum Analyzer Q8347

350 nm to 1750 nm

Top-class, high-resolution optical analyzer



Brief description

Optical Spectrum Analyzer Q8347 (Advantest) uses a Michelson interferometer. The larger mechanical configuration of the interferometer allows max. resolutions of 1 pm or 1 GHz in the frequency mode. This resolution as well as a measurement accuracy of ±0.001 nm for interferometers of this size cannot be attained with monochromators. At 1550 nm the resolution is still as high as 0.007 nm, thus allowing accurate measurement of high-grade optical WDM components.

This resolution enables chirps from modulated LDs as well as from Soliton transmission to be analyzed. The highest resolution of 0.001 nm is attained at a wavelength of about 500 nm and is particularly useful for the analysis of blue laser diodes. The indicated wavelength is always the value in a vacuum.

In addition to the wavelength display mode, frequency display can also be selected, with deviations being read out in GHz. The use of the Fourier spectroscopy enables true measurement of the coherence length. Q8347 allows a value of up to 165 mm to be analyzed. The evaluation itself is made automatically at a keystroke.

In the spectral range a curve fitting function can be used. It directly shows the electroluminescence characteristic by fitting a Gaussian distribution into the emission spectrum – a valuable aid in the measurement of erbium-doped fiber amplifiers (EDFA), LDs and Soliton transmission systems.

Optical Spectrum Analyzer Q8347

Main features

- Max. resolution 0.001 nm (at 500 nm)
- Measurement accuracy 0.01 nm
- Coherence measurement

Operation

Alternatively to spectrum display, the instantaneous optical power can be directly read like on a power meter. The display shows the power versus time in graphical form. Versatile display modes such as

– overlay display,
– comparison with memory contents, display of two separate diagrams (split screen),
– use of several markers,
– normalization and direct readout of transmission loss as well as
– automatic bandwidth analysis (eg half-value width measurement to RMS and envelope method),
– curve fitting

and many other features facilitate operation of the analyzer and simplify analysis via IEEE/IEC bus.
The standard built-in 3 ½" disk drive is used as a storage medium. The stored binary data can be further processed under MS-Windows. The high-speed built-in thermal printer provides a hardcopy of the measurement results with all setting parameters within 8 seconds.

Specifications in brief

Spectral values	
Wavelength	350 nm to 1750 nm
Resolution (spacing between two testpoints)	 0.001 nm at 500 nm 0.01 nm at 1550 nm
Measurement accuracy	±0.01 nm, the wavelength in a vacuum is indicated
Measurement principle	Michelson interferometer with HeNe reference laser
Span	0.1 nm to 1400 nm
Level	
Sensitivity	
700 to 1600 nm	–65 dBm
450 to 1700 nm	–52 dBm
350 to 1750 nm	–42 dBm
Max. input level	+10 dBm
Measurement accuracy	±2 dB
Polarization dependence	±0.8 dB
Linearity	±0.5 dB/10 dB ±1.0 dB/25 dB
Scale	0.2 to 10 dB/division, 1/2/5 steps, linear
Processing	
Measurement time	1 to 3.5 seconds per measurement depending on setting
Memory	16 curves, 10 instrument setups, 3 ½" disk drive
Analysis	coherence to 165 mm, X dB bandwidth, peak wavelength, curve fitting, etc
Interfaces	
Optical connector	FC/PC with internal 50/125 µm graded-index fiber, connector adaptable
Remote control	IEC625 (IEEE488)
Printer	built-in printer (standard) or output to plotter via IEEE/IEC bus
General data	
Power supply	220 to 240 V, 48/66 Hz, 260 VA
Dimensions (W x H x D)	424 mm x 335 mm*) x 500 mm *) total height of both parts
Weight	36 kg in total

Ordering information

Optical Spectrum Analyzer	**Q8347**
Extras	
5 rolls of printer paper	A09075
19" Rack Adapter (please order both numbers)	 A02728 and A02732

Optical Spectrum Analyzer Q8384

600 nm to 1750 nm

Optical spectrum analyzer for DWDM applications

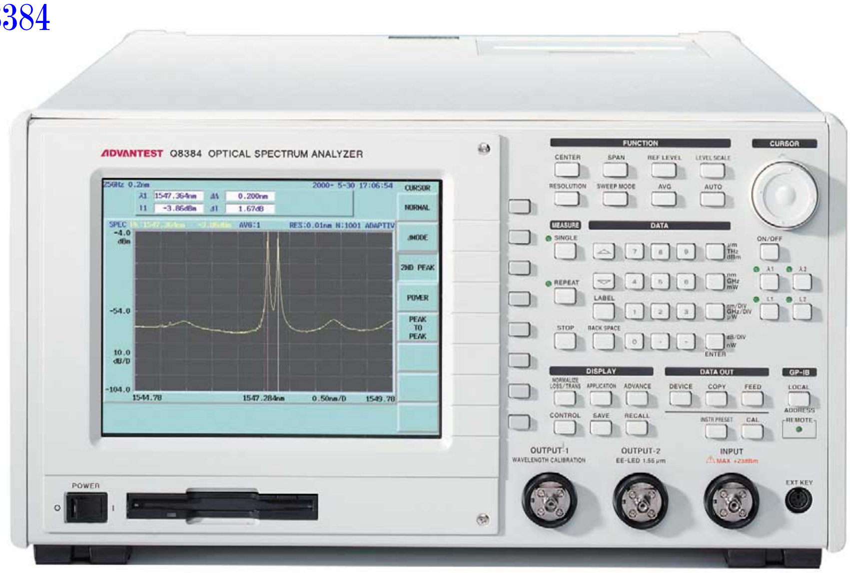


Photo 43439-5

Brief description

Q8384 is a high-grade spectrum analyzer (Advantest) with a new kind of multi-pass monochromator and extremely low polarization dependence. Thanks to a special method used, a value of ±0.05 dB can be guaranteed, the typical value is as low as 0.02 dB. Together with the narrow resolution bandwidth, the Q8384 can be used to perform accurate power measurements.

All these features, the resolution of wavelength measurement and the broad dynamic range make the Q8384 an ideal measuring instrument in the (D)WDM technology, i. e. for erbium-doped fiber amplifiers (EDFA). A special measurement function allows determination of noise figure, gain and spontaneous emission by simple comparison of the signal at the amplifier input with the signal at the amplifier output. All these features are of course also of great advantage for the measurement of laser diodes, LEDs and other light sources. A curve fitting function directly shows the electroluminescence characteristic by fitting a Gaussian distribution into the emission spectrum. This is a valuable aid in the measurement of erbium- doped fiber amplifiers (EDFA) and LDs. Special functions for pulsed light allow measurements of fiber rings and Soliton transmission systems. Internal or external triggering is possible.

The measurement time is 0.5 second for a span of 10 nm and varies as a function of the span. The highest sensitivity is attained for wideband sources with a resolution of 5 nm, while narrowband sources (laser) can reliably be analyzed down to the noise level even with narrow resolution bandwidths. A normalization function in conjunction with a white light source or an optional internal EE-LED source enables direct measurement of the transmission and loss characteristics of optical filters and fibers.

Main features

- 10 pm resolution bandwidth
- Sensitivity –87 dBm
- Polarization dependence ±0.05 dB
- Accuracy of resolution bandwidth ±2%
- Power measurement
- Pulse light measurement

Operation

In addition to the amplifier analysis, the versatile display modes such as

- overlay display,
- comparison with memory contents,
- display of two separate diagrams (split screen),
- power meter function,
- use of several markers,
- normalization and direct readout of transmission loss as well as
- automatic bandwidth analysis (eg half-value width measurement to RMS and envelope method),
- curve fitting
- level and wavelenght trend monitor
- limit lines with PASS/FAIL comparator

and many other features facilitate operation of the analyzer and simplify analysis via IEEE/IEC bus.

Optical Spectrum Analyzer Q8384

The standard built-in disk drive is used as a storage medium. The stored data can be analyzed as text and bitmap format, copied into documents and printed. The high-speed built-in thermal printer provides a hardcopy of the measurement results with all setting parameters within 8 seconds.

Option

Optional an internal EE-LED light source for transmission and attenuation measurements in the 1550-nm window is available.

Specifications in brief

Spectral values	
Wavelength	600 nm to 1750 nm
Resolution (half-value width)	10 pm to 500 pm, 1/2/5 steps
Measurement accuracy	±0.2 nm ±0.02 nm (1530 nm to 1570 nm)
Measurement principle	polarization-compensated multi-pass monochromator
Span	1 to 1200 nm, 0 nm
Level	
Sensitivity	
1250 nm to 1610 nm	–87 dBm
600 nm to 1750 nm	–55 dBm
Max. input level	+23 dBm
Measurement accuracy	±0.4 dB
Polarization dependence	±0.05 dB
Linearity	±0.05 dB/–10 to –50 dBm
Dynamic range	50 dB at ±100 pm 67 dB at ±400 pm
Scale	0.1 to 10 dB/division, 1/2/5 steps, linear
Pulse light	in pulse mode or with external trigger, pulse >10 ns; Max Hold mode
Processing	
Measurement time	0.5 second for 10 nm span
Graphic pixels	max. 10,000
Memory	15 curves, instrument setups, 3 ½" disk drive
Analysis of amplifiers (EDFA)	noise figure, spontaneous emission, power, gain; X dB bandwidth, peak wavelength, WDM signal analysisfor 256 channels, etc
Interfaces	
Optical connector	FC without contact in fiber
Remote control	IEC625 (IEEE488)
Printer	built-in printer (standard) or output via Centronics (bitmap)
Monitor, external	VGA

General data

Power supply	90 V to 250 V, 48/66 Hz, 200 VA
Dimensions (W x H x D); weight	424 mm x 221 mm x 500 mm; 29 kg

Ordering information

Optical Spectrum Analyzer	Q8384
Option	
EE-LED Light Source	Option 25
Extras	
5 rolls of printer paper	A09075
19" Rackmounting Adaptor	A02722
SC Adaptor	A08162
ST Adaptor	A08163

Optical Chirpform Test Set Q7606A/B

Instrument for easy and quick measurement of dynamic chirp of optical modulators and laser diodes

Photo 43307

Brief description

Information-carrying networks are changing rapidly due to enhanced technologies that increase transmission rates for optical communication systems. Especially for wavelength division multiplexing (WDM) transmission systems, R&D of components requires new instruments to meet increasing test needs such as testing for dynamic chirp. Therefore ADVANTEST developed the Q7606A/7606B Optical Chirpform Test Set. Together with ADVANTEST's D3186 Pulse-Pattern Generator, a digital sampling oscilloscope, and a personal computer, the Q7606A/7606B conveniently evaluates signal chirp of optical modulators and laser diodes.

Main features

- Quick time-domain chirp measurement: 30 seconds or less
- High resolution of 20 MHz or better
- Wide measurement frequency bandwidth of about 50 GHz
- Automatic polarization adjustment
- Built-in optical amplifier (Q7606A)

Characteristics

Automatic polarization adjustment
The Q7606A/7606B has an automatic polarization adjustment that facilitates fully automated high-speed and high-accuracy measurements.

Built-in optical amplifier (Q7606A)
The Q7606A comes with a built-in optical amplifier that conditions the output signal for unamplified high-bandwidth, O/E converters. This feature automatically controls the amplifier gain, which improves both measurement accuracy and S/N ratio measurements.

Quick time-domain chirp measurements
30 seconds or less – until now no simple and easy-to-use method existed to measure dynamic optical chirp. With the Q7606, ADVANTEST makes dynamic chirp measurements a simple and easy process by automatically separating the frequency-modulation (FM) and intensity-modulation (IM) components (conventional methods using spectral diffraction take 20 minutes or more for chirp measurement). Q7606A/7606B allows the user to measure dynamic chirp in 30 seconds or less.

High resolution
The Q7606A/7606B provides chirp data with approx. 20 MHz resolution or better.

Wide measurement frequency bandwidth
The measurement frequency is approx. 50 GHz or more. This allows the Q7606A/B to measure transmission signals of more than 10 Gbit/s.

Simple operation
The user can measure and display chirp using almost any personal computer. The measurement data can also be downloaded to a spreadsheet, transmission waveform simulator, etc.

Optical Chirpform Test Set Q7606A/B

Specifications

	Q7606A	Q7606B
Wavelength range	1530 to 1580 nm	1510 to 1590 nm
Input optical power range	–10 to +10 dBm	–20 to +10 dBm
Free spectral range	150 GHz ±15 GHz	
Demodulation bandwidth	100 Hz to 50 GHz	
Deviation of demodulation frequency	65 GHz peak-to-peak or less	
Resolution of demodulation frequency	20 MHz peak-to-peak or less	
Insertion loss	–	10 dB or less
Optical output power	0 dBm or higher	–
Optical input power	–	–10 dBm or higher
Optical amplifier output	built-in optical amplifier with automatic gain adjustment	–
Input light polarization compensation	Built-in automatic polarization compensator	

Input/output

Optical input/output	FC/PC connector
GPIB	in accordance with IEEE4738 1978

General data

Operating environment	
Ambient temperature	0°C to +40°C
Relative humidity	85% max. (no condensation)
Storage environment	
Ambient temperature	–20°C to +60°C
Relative humidity	90% max. (no condensation)
Power supply	100 to 120 V AC, 220 to 240 V AC, 50/60 Hz, 85 VA or less, automatic switching between 100 V and 200 V systems
Dimensions (W x H x D)	approx. 132 mm x 424 mm x 500 mm
Weight	15 kg or less (approx. 33 lb or less)

Ordering information

Optical Chirpform Test Set	Q7606A/B

Optical Network Analyzer Q7760

Performs high-speed measurement of transmission and reflection characteristics of optical components for DWDM at high optical frequency resolution

Photo 43308

Brief description

In recent years, progress in the research and development of ultra-high-speed optical transmission and high-density wavelength division multiplexing transmission (Dense WDM) has been enormous. These technologies are already in commercial use.

This research and development requires the measurement of amplitude characteristics, chromatic dispersion, and group delay time of optical devices and optical subsystems with high optical frequency resolution. Examples of devices for which such characteristics must be measured are AWG and Fibre Bragg Gratings filters, and dispersion compensator.

Because chromatic dispersion characteristics in particular are an obstacle when optical transmission bit rate increases, chromatic dispersion values must be decreased or controlled.

The Q7760 Optoscope is an optical network analyser capable of measuring many characteristics of optical devices at high resolution and high speed in the optical carrier frequency domain. It can measure amplitude characteristics, chromatic dis

persion and group delay time as phase-of-transmission characteristics and reflection characteristics. The Q7760 employs the phase-shift method of measurement to achieve both high optical frequency resolution and wide dynamic range.

Main features

- Comprehensive measurement of optical transfer characteristics in the optical carrier frequency domain
- Maximum optical frequency resolution: 50 MHz (Wavelength of 0.4 pm)
- High-speed measurement: approx. 4 second (at 60 GHz sweep span)
- Measurement wavelength range: 1525 nm to 1635 nm

Measurement item	Reflection	Transmission
	Characteristics (S11)	Characteristics (S21)
Amplitude	Yes	Yes
Chromatic Dispersion	Yes	Yes
Group delay-time	Yes	Yes

Optical Network Analyzer Q7760

- Dynamic range of 40 dB
- Group delay measurement range with a maximum resolution of 0.1 ps, maximum measurement range is 25 ns
- Optical fiber lenght measurement

The Q7760 uses a tuneable light source. By sweeping the wavelength (optical frequency), transmission and reflection characteristics (S21 and S11 in the S parameters) can be measured in the optical carrier-frequency band simultaneously. The Q7760 can measure the following items in a single sweep.

Specifications

Measurement functions	
Sweep channels	2 channels (input reflection characteristics, forward transfer characteristics)
Reflection characteristics (S11)	Amplitude, group delay time, chromatic dispersion
Forward transfer characteristics (S22)	Amplitude, group delay time, chromatic dispersion
Optical Signal Source Characteristics	
Measurement range	1525 to 1635 nm
Absolute wavelength accuracy	+0.025nm
Wavelength setting resolution	0.001nm
Sweep wavelength range	settable within 0.1 to 110 nm range (settable within the optical frequency range of 12.5 GHz to 8.75 THz)
Sweep frequency linearity	Span X (±2.5%)
Sweep repeatability	Span X (±0.3%) ±30 MHz or less
Sweep time	approx. 4 sec. (at setting wavelength span is less than 60 GHz)
Optical output power level	–14 dBm or more
Amplitude Characteristics	
Scale	Logarithmic table (0.2, 0.5, 1.0, 2.0, 5.0, 10.0 dB/div) and linear
Modulation frequency range	40 MHz to 3 GHz
Dynamic range	
Forward transfer characteristics	35 dB (typ. 40 dB)
Input reflection characteristics	33 dB (typ. 38 dB)
Linearity	
Relative level 0 to –25 dB	+0.10 dB
Relative level –25 to –30 dB	+0.25 dB
Polarisation dependency	
Forward transfer characteristics	+0.05 dB (test port 2)
Input reflection characteristics	+0.10 dB (test port 1)
Repeatability at connector insertion	±0.1 dB

Group Delay Time Characteristics		
Frequency modulation range (FM)	40 MHz to 3 GHz	
Max. measurement range		
FM = 40 MHz	25 ns	
FM = 3 GHz	333 ps	
Group delay time resolution:	0.1 psec	
Relative group delay time accuracy	Relative level (dB)	Accuracy
	0 to –15 dB	+0.2%/fm
	–15 dB to –20 dB	+0.4%/fm
	–20 dB to –25 dB	+1.0%/fm

Chromatic Dispersion	
Measurement unit	Wavelength range (ps/nm), optical frequency range (ps/GHz), displays in ps/nm x km, ps/GHz x km are also possible by entering the length of optical fibre under test
Polarization mode dispersion	
Measurement range	0.1 psec/nm to 1 µsec/nm
Measurement resolution	0.01 ps/nm
Fiber lenght measurement	0.2 m to 10,000 km
Processing Functions	
Memory function	save measurement date to memory and/or to a floppy disk
Display	optical frequency display, overlay, split screen, cursor function
Computing/analysis:	averaging, smoothing, fitting functions
Optical input/output	
Optical connector type	FC type connector (Standard), adapters to SC and ST type sold as accessories
Interfaces	
Remote control	IEEE488-1978
Floppy disk drive	3½", MS-DOS format
Printer	D-SUB 25 pin ESC/P, ESC/P-R, PCL
Keyboard	conforms to IBM PC-AT
Monitor, external	D-SUB 15 pin (VGA)
General specifications	
Operating environment	
Ambient temperature	15°C to 35°C
Relative humidity	85% or less (no condensation)
Storage environment	
Ambient temperature	–10°C to 45°C
Relative humidity	90% or less (no condensation)
Power requirement	
Display unit	AC 100 to 120 V, AC 220 to 240 V, 50/60 Hz, 300 VA or less
Optical network analyser unit	AC 100 to 120 V, AC 220 to 240 V, 50/60 Hz, 310 VA or less
Dimensions (W x H x D) approx.	
Display unit	424 mm x 220 mm x 400 mm
Optical network analyser unit	424 mm x 220 mm x 500 mm
Weight	
Display unit	16 kg or less
Optical network analyser unit	25 kg or less

Ordering information

Optical Network Analyzer	Q7760
Option	
PMD Measurement	15
Extra	
Optical/connector adapters	

Handheld Optical Power Meter Q8210

400 nm to 1650 nm; versatile, handy optical power meter

Photo 43515

Brief description

Q8210 (Advantest) is a versatile optical power meter. In conjunction with various optical sensors it covers a wavelength range from 400 nm to 1650 nm. Thanks to stringent calibration throughout, the power meter can be used in the entire wavelength range. Depending on the type of sensor, the optical power in optical fibers or in the light beam can be determined. An extremely flat sensor (TQ82017) facilitates measurements in tight spaces, eg of optical disks (CD, DVD).

The sensitivity is as good as --60 dBm even at 1550 nm. At low levels an averaging function with up to 20 average values ensures reliable measurement. The necessary zero adjustment is made automatically with the sensor darkened. A Max Hold function allows accurate power measurement even of test setups that are difficult to adjust and highly instable. An analog output is provided for recording the measurements.

Main features

- Continuous wavelength sensitivity compensation
- Backlit 4 ½-digit display
- Up to 13 hours of operation independent of AC power (built-in battery)
- Analog output

Operation

The instrument automatically identifies the sensor connected and recalls the appropriate correction values for the set wavelength, which remains indicated during the measurement. Backlighting of the display can be switched on for measurements in dark rooms.

Handheld Optical Power Meter Q8210

Specifications in brief

Basic unit	
Display	4 ½-digit LCD with selectable backlighting
Resolution	0.01 dB (measurement in dBm) 0.005 to 0.1 W (measurement in W)
Measurement rate	2 measurements/second
Measurement functions	power measurement, dBr (relative), Max Hold (for measurements in W)
Averaging	2 to 20 values, moving average value
Offset and zero adjustment	automatic upon keystroke
Analog output	0 to 2 V, impedance <10 Ω
Power supply	200 to 245 V (with AC adapter); built-in NiCd battery, max. 13 hours of operation (10 hours with LCD backlighting on)
Dimensions (W x H x D)	80 mm x 180 mm x 35 mm
Weight	400 g

Ordering information

Handheld Optical Power Meter		**Q8210**
Extras		
Optical Sensor		TQ82014A TQ82015 TQ82017A Q82018A
Charging Adapter 200 to 245 V		A08019 (standard accessory)
Adapters for connectors		
Connector/Sensor	TQ82014/15	Q82018A
FC/PC	A08012	A08081 (standard)
SC	A08090	A08082
ST	A08096	A08083
Biconical	A08025	—
D4	A08013	A08087
DIN	A08029	A08084
SMA (1/8")	A08028	—

Optical sensors

	TQ82014A	TQ82015	TQ82017A	Q82018A
Wavelength range	400 nm to 1100 nm	800 nm to 1600 nm	400 nm to 1100 nm	800 nm to 1650 nm
Field of application	measurement on optical fibers (adapter for connector to be ordered separately) or light beam	measurement on optical fibers (adapter for connector to be ordered separately) or light beam	light beam measurements also in very narrow spaces (eg in CD drives)	power measurement in optical fibers, FC/PC adapter supplied as standard
Sensor material	silicon	germanium	silicon	InGaAs PIN
Power measurement range	–60 ±17 dBm, 1 nW to 50 mW	–40 ±10 dBm, 100 nW to 10 mW	–60 ±17 dBm, 1 nW to 50 mW	–60 ±17 dBm
Photoreceptor area	approx. 8 mm dia.	approx. 5 mm dia.	approx. 10 mm x 10 mm square	–
Measurement ranges	8 ranges in 10 dB steps	5 ranges in 10 dB steps	8 ranges in 10 dB steps	8 ranges in 10 dB steps
Accuracy	±5% at 850 nm, –20 dBm	±5% at 1300 nm, –20 dBm	±5% at 850 nm, –20 dBm	±5% at 1300 nm, –20 dBm

Benchtop Optical Power Meter Q8221

400 nm to 1750 nm

Benchtop optical power meter of high measurement accuracy

Brief description

Optical Power Meter Q8221 (Advantest) provides two plug-in slots and can be fitted with five different optical sensors or nine different sources. The optical sensors cover the wavelength range from 400 nm to 1750 nm and the power range from –93 dBm to +27 dBm. A continuous wavelength sensitivity compensation allows the sensors not only to be used at specific wavelengths, but throughout the speci-fied range. Compensation is made automatically following selection of the wavelength by the user.

LEDs and LDs are the sources for all three optical windows. The high measurement accuracy and the extremely low polarization dependence make the Q8221 an ideal tool for demanding measurement tasks. A special adapter allows a return loss of at least 45 dB to be obtained even with PC polished FC connectors.

Thanks to its high speed of 20 measurements per second, Q8221 is suitable for a large variety of applications. Whether it is used as a two-channel power meter or as a combined power meter/source, its high measurement accuracy and source stability always ensure reliable measurement results.

Main features

- Two independent channels
- High measurement accuracy of 2.5% (with Q82208)
- Versatile measurement capabilities through various sensors and plug-in light sources
- Power Sensors Q82232/33 with extremely low polarization dependence

Specifications in brief (basic unit)

Basic unit	
Display	2 x 5 ½-digit
Resolution	0.001 dB (measurement in dBm)
Measurement rate	20 measurements/second
Measurement functions	power measurement in W and dBm, dBr (relative), etc
Averaging	2 to 256 values, moving average value
Offset and zero adjustment	automatic upon keystroke
Remote control	IEC 625 (IEEE 488)
Power supply	100 to 240 V, 48 to 66 Hz, 50 VA
Dimensions (W x H x D); weight	212 mm x 88 mm x 360 mm; 4 kg

Ordering information

Benchtop Optical Power Meter	Q8221

Benchtop Optical Power Meter Q8221

Optical sensors

Optical Sensor	Q82214	Q82215	Q82216	Q82227	Q82208	Q82232/Q82233[1]
Wavelength	400 to 1100 nm	800 to 1750 nm	800 to 1750 nm	800 to 1750 nm	800 to 1700 nm	900 to 1650 nm
Level	–80 to +17 dBm	–60 to +10 dBm	–77 to +10 dBm	–80 to +27 dBm	–94 to +10 dBm	–94 to +10 dBm
Sensor material	Si, 8 mm dia.	Ge, 8 mm dia.	Ge, 5 mm dia., cooled	InGaAs, cooled	InGaAs, cooled	InGaAs, cooled
Measurement accuracy (with pulsed light)	±3% (±4%) 780 nm, 0 dBm	±3% (±4%) 1300 nm, 0 dBm	±2.5% (±3.5%) 1300 nm, 0 dBm	±2.5% (±3.5%) 1550 nm, 0 dBm	±2.5% (±3.5%) 1300 nm, 0 dBm	±2.5% (±3.5%) 1550 nm, 0 dBm
Polarization	—	typ. 0.03 dB (pp)	typ. 0.03 dB (pp)	typ. 0.05 dB (pp)	typ. 0.015 dB (pp)	0.003 dB (pp)/ 0.005 dB (pp)
Adapter for connection of sensors (additionally required)	Q82202	Q82202	Q82202	Q82203	—	Q82203

Extra
19" Rack Adapter A02463

Adapters for connectors

	Q82202	Q82202	Q82202	Q82203	–	Q82203
FC	A08012	A08012	A08012	Standard	Standard	A08161
SC	A08090	A08090	A08090	—	—	A08161
ST	A08096	A08096	A08096	—	—	A08162
D4	A08013	A08013	A08013	—	—	A08163
SMA ⅛"	A08028	A08028	A08028	—	—	—
DIN	A08029	A08029	A08029	—	—	—
FC >45 dB ORL	—	—	—	A08328	A08328	—

Plug-in light sources

Light Source	Q81201	Q81202	Q81203	Q81204	Q81205
Type	LED	LED	LED	LED	LED
Wavelength	850 ±25 nm	1310 ±40 nm	1550 ±30 nm	1310 ±10 nm	1550 ±10 nm
Half-value width	55 nm	160 nm	210 nm	20 ±5 nm	20 ±5 nm
Level	–15 ±1 dBm	–20 ±1 dBm	–43 ±1 dBm[1]	–35 ±1 dBm	–53 ±1 dBm[2]
Drift 1 h/8 h	0.02 dB/0.2 dB	0.02 dB/0.2 dB	0.04 dB/0.2 dB	0.02 dB/0.2 dB	0.04 dB/0.2 dB
Modulation		270 Hz, 2 kHz, 4 kHz, ±0.1% each; duty cycle 2 (±10%; 270 Hz: ±5%)			
Type of connector	FC	FC	FC	FC	FC

Light Source	Q81206	Q81207	Q81211	Q81212
Type	LED	LED	FP-LD	FP-LD
Wavelength	1300 ±30 nm	1550 ±30 nm	1310 ±10 nm	1550 ±20 nm
Half-value width	100 nm	140 nm	5 nm	10 nm
Level	–14 ±1 dBm[1]	–27 ±1 dBm[1]	0 ±1 dBm[1]	0 ±1 dBm[1]
Drift 1 h/8 h	0.02 dB/0.2 dB	0.02 dB/0.2 dB	0.05 dB/1 dB	0.05 dB/1 dB
Modulation		270 Hz, 2 kHz, 4 kHz, ±0.1% each; duty cycle 2 (±10%; 270 Hz: ±5%)		
Type of connector	FC	FC	FC	FC

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1) ORL ≥45dB.

2) At SM 10/125 µm, otherwise GI 50/125 µm.

Optical Polarization Scrambler Q8163

High speed and precise polarization scrambler

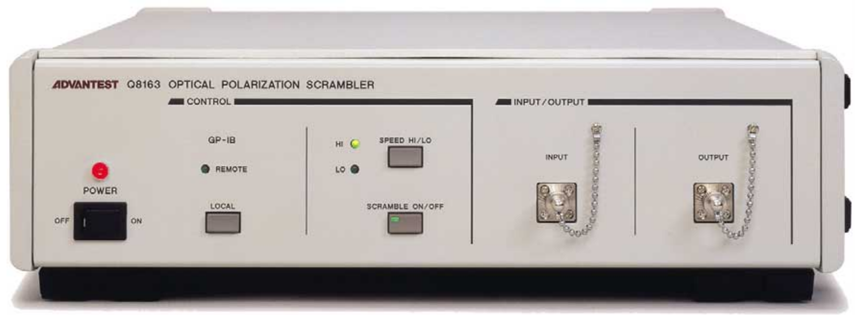


Photo 43385-1

Brief description

A key performance factor in optical communication is the Polarization Dependant Loss (PDL) of the optical devices. The quality tends to deteriorate when PDL increases. The Q8163 is a high speed and precise polarization scrambler, which forms a measurement system together with an optical power meter that uses ultra-low PDL dependant power sensors.

The scrambler uses a polarization retaining fiber and a piezoelectric element instead of a conventional fiber loop method offering non-mechanically moving parts and therefore long durability as well as low influence of environment is guaranteed.

The so-called overall polarization measurement takes hundreds of different states of polarized light on the device, measures the optical power of the transmitted light and calculates the ratio between maximum and minimum values.

The power meter to recommend is the model Q8221 with the plug-in Q82203 and the power sensors Q82232 or Q82233.

When for example a PDL of 0.2 dBpp is measured a repeatable accuracy of 0.005 dBpp can be obtained for a measurement time of less than 1 sec.

Main features

- High-speed polarization variance
- Low insertion loss 3 dB and fluctuations ±0,005 dB
- High reliability

Specifications in brief

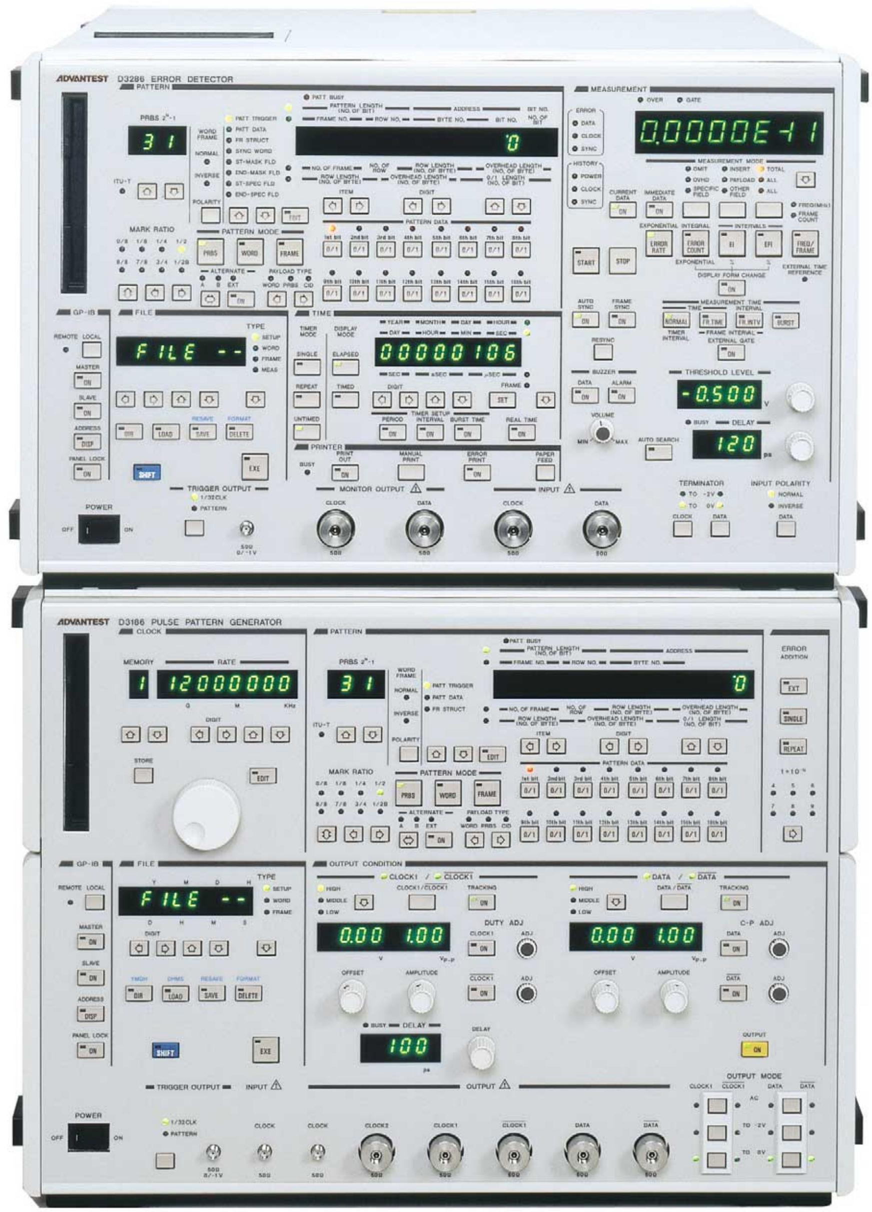
Wavelength range	1290 nm to 1580 nm
Insertion loss	< 3.0 dB
Insertion loss fluctuation	±0.005 dB
Return loss	<43 dB
Polarisation variance speed	>500 rotations of the poincare sphere
Input/output connector	FC
Interface	GPIB

Ordering information

Optical Polarization Scrambler	Q8163
Extras	
Power meter	Q8221
Plug-in for Q8221	Q82203
Power sensors	Q82232 or Q82233

Bit Error Rate Tester D3186/D3286

Evaluation and analysis in high-speed digital communication and optical transmission network systems



Pattern Generator D3186 (top) and Error Rate Detector D3286 (bottom) (photo 43438-1)

Brief description

Pattern Generator D3186 and Error Rate Detector D3286 from Advantest are used for evaluation and analysis in high-speed digital communication and optical transmission network systems – e.g. SDH, SONET and ATM technology –as well as logic devices.

The system covers a broad frequency range of 150 Mbit/s to 12.5 Gbit/s with 1 kHz setting resolution, providing 9 types of pseudo random patterns, programmable word patterns and frame patterns. Complementary data outputs in binary code NRZ with a 10 mV setting resolution, minimal jitter and lowest rise and fall time waveform characteristics with phase delay settings of 1 ps step resolution are state-of-the-art features.

The clock source is either internal with a 0.15 GHz to 12.5 GHz or a 2 GHz to 12.5 GHz generator optionally or external, using any microwave synthesizer. R&S signal generators SMP or SMR are available, controlled from the Pattern generator front panel.

The detector/receiver measures the bit error rate, error count, ES and EFS as well as frequency. Special attention was taken for the eye-opening and balance, measured with a sampling oscilloscope, due to retiming circuits, essential for the system quality, the equipment tolerances and the device phase margins. Auxiliary outputs for ¼ clock and data are available as standard.

Different modes like omit, insert, total and error addition give flexible evaluation tools. The instruments are equipped with an internal timer, GPIB, floppy disk drive and printer interface for error protocols.

Features

- Frequency range 150 Mbit/s /2 Gbit/s to 12.5 Gbit/s
- Generation of SDH/SONET frame pattern
- Pseudo random data as payload in the standard frame
- Excellent waveform quality and output impedance matching

Bit Error Rate Tester D3186/D3286

- Rise/fall time less than 30 ps, jitter less than 10 ps
- Burst data measurement effective in circulating loop tests
- Numerous outputs of clock and data signal
- 3 V output from the PPG for modulator testing
- Bit sequence masking
- Crosspoint and mark ratio adjustment
- Auto search function
- Monitor output for sampling scope
- Master/slave function, when using both instruments together and allowing pattern settings to be interlocked

Pulse Pattern Generator D3186

- Output impedance with good matching
- 3 V output for evaluation of modulators optionally
- Variable duty of the output waveform
- Generation of SDH/SONET frame pattern
- 8 Mbit word pattern, e.g. for generation of 6 STM-64 frames
- Multi-channel output: 2 data systems, 3 clock systems and 7 sub-rate systems
- Burst signal output
- Easy discovery of desirable patterns and error patterns
- Word pattern editor software

Bit Error Rate Detector D3286

- High input sensitivity
- SDH/SONET frame effective to evaluate the system synchronisation
- Burst-data measurement effective to examine the circulating loop test is possible
- Masking function for bits
- Extra adjustment of the optimum timing and voltage at any mark ratio and even with word patterns
- Q factor measurement software

Applications

- Developing E/O and O/E modules:
  - Laser diodes, photo diodes, discrimination circuits, DC amplifiers, clock recovery circuits
- Optical devices
  - Laser diodes, photo diodes, connectors, fibers, fiber amplifiers
- High-speed logic IC
  - Multiplexers, demultiplexers, frequency dividers, logic boards
- Optical transmission systems
  - WDM and DWDM systems, repeaters, fiber amplifiers, FDDI, LANs, SDH/SONET transmission equipment

Specifications

Pulse Pattern Generator D3186

Frequency	
Internal clock (optional)	
Frequency range	150 MHz to 12 GHz (option 10) 2 GHz to 12 GHz (option 11) 150 MHz to 12.5 GHz (option 13)
Frequency setting resolution	1 kHz
Frequency stability	±10 ppm/year
Reference frequency output/input	10 MHz, 1.5 V pp min., AC-coupled, BNC
External Clock	
Frequency range	150 MHz to 12 GHz 150 MHz to 12.5 GHz (option 72)
Input level	0.7 V pp to 1.5 V pp
Patterns	
Pattern modes	selectable from the 3 choices below
Pseudo random pattern (PRBS)	option xx
Pattern length	2^N–1, N can be selected from among 7 choices: N=7, 9, 10, 11, 15, 23 or 31
Number of stages N and generating function	
Mark ratio	selectable from among 1/2, 1/4, 1/8, 0/8, 1/2B, 3/4, 7/8, or 8/8, patterns 1/2B, 3/4, 7/8 and 8/8 are logical inversions of patterns 1/2, 1/4, 1/8 and 0/8 respectively
Fully programmable pattern (WORD)	
Pattern length	1 to 8,388,608 (2^{23}) bits (ALTERNATE OFF) 1 to 4,194,304 (2^{22}) bits (ALTERNATE ON)
Logical inversion	possible
ALTERNATE mode	can be turned ON/OFF; when ON, switchable to either of 2 patterns, A or B
Switching control	internal, external switching possible
Frame pattern (FRAME)	option 70
Payload format	3 types below can be selected – fully programmable (WORD) – pseudo random (PRBS) – 0/1 continuous pattern + PRBS (CID)
Frame structure (when payload format is WORD or PRBS	
Number of frames	1 to 8,192 (ALTERNATE OFF) 1 to 4,096 (ALTERNATE ON), 1 frame steps
Number of lines in 1 frame	1 to 16 (1 line steps)
Number of bytes in 1 line	44 to 32,768
No. of overhead bytes in 1 line	4 to (number of bytes in 1 line –40 bytes), 4 byte steps
Error addition	
Error addition mode	repeat, single, external
Repeat	error ratio 1´10–N, N=4 to 9, bit error is added at a set interval
Single	1 bit error is added with every error addition command
External	1 bit error is added with every falling edge of an external error addition pulse input
Inputs	
External gate	inhibits data output, inhibits at LOW
Level	0 V/–1 V
Pulse width	at least 20 ns, or at least 64 x operating clock cycle, whichever is longer
Connector, impedance	BNC, 50 Ω

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Bit Error Rate Tester D3186/D3286

External alternate	in ALTERNATE mode, switches between patterns A and B; pattern A at HIGH level, pattern B at LOW level
Level	0 V/–1 V
Connector, impedance	BNC, 50 Ω
External error addition	when pattern error addition is (EXT), 1 bit error is added for every falling edge of input pulse
Level	0 V/–1 V
Connector, impedance	BNC, 50 Ω

Outputs

Data (DATA, $\overline{\text{DATA}}$)	2 patterns
Format, coupling	NRZ, DC
Amplitude range	
0.5 V pp to 2 V pp	10 mV steps (TO 0 V, AC)
0.6 V pp to 1 V pp	10 mV steps (TO –2 V)
0.5 V pp to 3 V pp	10 mV steps (TO 0 V), option 15
Offset range	
–2 V to +2 V	10 mV steps (TO 0 V)
–1 V to –0.6 V	10 mV steps (TO –2 V) (HIGH level reference)
Rise/fall time	30 ps max.
Load terminal conditions	selectable as either DC-coupled TO 0 V, TO –2 V or AC-coupled
Offset setting level	selectable HIGH, MIDDLE, LOW
Cross point variable	ON/OFF selectable
Connector, impedance	SMA (male), 50 Ω
Clock (CLOCK1, $\overline{\text{CLOCK1}}$)	2 patterns, complementary
Format, coupling	NRZ, DC
Amplitude range	
0.5 V pp to 2 V pp	10 mV steps (TO 0 V, AC)
0.6 V pp to 1 V pp	10 mV steps (TO –2 V)
Offset range	
–2 V to +2 V	10 mV steps (TO 0 V)
–1 V to –0.6 V	10 mV steps (TO –2 V) (HIGH level reference)
Rise/fall time	30 ps max.
Load terminal conditions	selectable as either DC-coupled TO 0 V, TO –2 V or AC-coupled
Offset setting level	selectable HIGH, MIDDLE, LOW
Crosspoint variable	ON/OFF selectable
Duty ratio variable	ON/OFF selectable
Variable delay range	±400 ps, 1 ps steps (CLOCK2 output reference)
Connector, impedance	SMA (male), 50 Ω
Clock (CLOCK2)	1 pattern
Format	NRZ
Coupling	AC (built-in DC blocking condenser)
Amplitude	approx. 1 V pp fixed
Offset	0 V ± 0.1 V fixed (MIDDLE level reference)
Waveform	rectangular
Rise/fall time	30 ps max
Connector, impedance	SMA (male), 50 Ω
Trigger signal	selectable as either clock synchronization or pattern synchronization
Clock synchronization (1/32 CLK)	clock frequency 1/32 divided output
Pattern synchronization (PATTERN)	varies output position to any position in 16 bit units
Level	HIGH 0 V ±0.2 V, LOW –1 V ±0.2 V
Connector, impedance	SMA (male), 50 Ω
1/2 clock	
Format, coupling	NRZ, DC
Level	HIGH 0 V ±0.2 V, LOW –1 V ±0.2 V
Connector, impedance	SMA (male), 50 Ω
1/4 rate output	
Bit rate	¼ operating clock frequency
Number of pattern outputs	4 patterns
Number of clock outputs	1 pattern
Skew	±150 ps max.
Level	HIGH 0 V ±0.25 V , LOW –1 V ±0.25 V
Connector, impedance	SMA (male), 50 Ω

System functions

External clock generator control	when external clock generator (SG) is used, frequency and output level are controlled from D3186
Calendar/clock	selected as either year/month/day/hour or day/hour/minute/second
Storage	built-in floppy disk drive
Functions	Save, re-save, read in, erase, initialize
Data	Operating conditions, pattern settings

Error Rate Detector D3286

Frequency range	150 MHz to 12 GHz 150 MHz to 12,5 GHz (option 72)
Patterns	same as D3186 Pulse Pattern Generator
Reference measuring functions	simultaneous measurement of 6 functions, 1 function selectable for display
Error rate measurement	
Error count measurement	
Error interval (EI) measurement	
Error-free interval (EFI) measurement	
Frequency measurement	
Frame count measurement	can only be done when the pattern mode is FRAME, payload format is WORD or PRBS and measuring time mode is FRAME
TIME	FRAME TIME or FRAME
INTERVAL	FRAME INTERVAL
Error measurement mode	groups selectable, within each group 3 types of measurements can be done simultaneously, one type is displayed
Omission/insertion group	
OMISSION	logical data value at input is '0', when '1' is expected
INSERTION	logical data value at input is '1' when '0' is expected
TOTAL	sum of OMISSION and INSERTION type errors (all errors)
Overhead/payload group	only selectable when pattern mode is FRAME
OVERHEAD	errors in overhead part
PAYLOAD	errors in payload part
ALL	sum of errors in overhead part and payload part (all frame errors)

Inputs

Data	
Format, coupling	NRZ, DC
Polarity	logical inversion possible
level	0.1 V pp to 2 V pp
Threshold level	
Setting range	setting resolution
–2.040 V to + 2.040 V	0.001 V steps (0 V terminal voltage)
–1.850 V to –0.750 V	0.001 V steps (–2 V terminal voltage)
Terminal voltage	–2 V/0 V (GND)
Connector, impedance	SMA (male), 50 Ω
Clock	sine or rectangular
Format	DC termination, AC coupling
Duty ratio	50% ±5%
Polarity	identified at rise edge
Variable delay	±400 ps 1 ps steps (at monitor output)
Level	0.5 V pp to 2 V pp
Terminal voltage	–2 V/0 V (GND)
Connector, impedance	SMA (male), 50 Ω

Bit Error Rate Tester D3186/D3286

Auto search function	automatically finds optimum values for data input threshold level and clock input delay
Trigger	selectable as either clock synchronization or pattern synchronization
Clock synchronization (1/32 CLK)	clock frequency 1/32 divided output
Pattern synchronization (PATTERN)	varies output position to any position in 16 bit units
Level	HIGH 0 V ±0.2 V, LOW –1 V ±0.2 V
Connector, impedance	SMA (male), 50 Ω
External gate	controls measurement start/stop
Level	0 V/–1 V
Connector, impedance	BNC (female), 50 Ω
External alternate	switches between patterns A and B in alternate mode; pattern A at HIGH level, pattern B at LOW level
Level	0 V/–1 V
Connector, impedance	BNC (female), 50 Ω

Outputs

Monitor	
Data monitor	data input through amplifier
Connector, impedance	SMA (male), 50 Ω
Clock	clock input through amplifier and variable delay line
Connector, impedance	SMA (male), 50 Ω
Error	
Rate	1/32 clock input
Signal form	32 phase logical sum
Code	RZ
Level	HIGH –0.0 ± 0.3 V, LOW –1.0 ± 0.3 V
Connector, impedance	SMA (female), 50 Ω
Stretched	
Level	TTL positive pulse
Pulse width	approx. 100 ns
Connector, impedance	SMA (female), 50 Ω

Measuring time modes

NORMAL	sets measurement interval in second units, measurement period in day/hour/minute/second units
FRAME TIME	only selectable when pattern mode is FRAME
Measuring interval	set in number of frame units
Measuring period	set in day/hour/minute/second units
FRAME INTERVAL	only selectable when pattern mode is FRAME
Measuring interval	set in number of frame units
Measuring period	set in number of measuring interval units
BURST	each time pattern synchronization is established during period from measuring start to measuring end, only area set by burst timer is measured

Synchronization

Mask function	can only be selected when pattern mode is WORD or FRAME; synchronization and measurement are done ignoring errors in the specified mask field
Pattern	
Auto synchronization	ON/OFF selectable, when ON, resynchronization is done automatically when error rate is equal to or greater than prescribed value
Frame	can be turned ON or OFF when pattern mode is FRAME or WORD; OFF during PRBS, when ON, specified hunting pattern is searched and high speed pattern synchronization is done
Re-synchronization	command via front panel keys or GPIB

Measurement conditions display lamps

GATE	during measurement.
OVER	measurement results overflow
Error alarm	
DATA error	1 or more bit error is detected, off when error is no longer detected
CLOCK error	input clock fails or frequency is too low, off when normal clock is input
SYNC error	pattern synchronization error, off when pattern synchronization is established

Timer/clock display

ELAPSED	elapsed time since start of measurement
TIMED	remaining time to end of measurement
PERIOD	displays or sets measuring period from start of measurement until end
INTERVAL	displays or sets measuring cycle
BURST TIME	displays or sets measuring time per signal burst when measuring time mode is BURST
REAL TIME	displays or sets real time as year/month/day/hour or day/hour/minute/second

System functions

Printer	measurement results, switchable between built-in and external
Interface	Centronics
Storage	measurement results as text format

General data

Master/slave	when used together with D3186 and D3286 respectively, allows pattern settings to be interlocked
Panel lock	possible
Remote control	GPIB (IEEE 488-1978)
Numerical value display	green 7-segment LED display
Set conditions memory	after power has been ON for 12 hours, retained at least 2 weeks (backed up by secondary battery)
Operating temperature range	0°C to +40°C
Storage temperature range	–20°C to +70°C
Power supply (D3286)	AC 100 V to 120 V, AC 220 V to 240 V (automatic switchover) 48 to 63 Hz, sine wave, 550 (500) VA max.
Dimensions (W x H x D) (D3286)	424 mm x 266 (310) mm x 550 mm
Weight	32 kg max.

Ordering information

Pulse Pattern Generator	D3186
Error Rate Detector	D3286

Options

Internal clock 150 MHz to 12 GHz	10
Internal clock 2 GHz to 12 GHz	11
Internal clock 150 MHz to 12,5 GHz	13
3 V output	15
Frame format	70
12,5 Gbit/s extension	72

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Contents of Chapter 8

Installing a mobile radio base station with NRT (photo 42667)

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Contents of Chapter 8

Level Meter URV35

DC to 3/40 GHz

200 µV to 1000 V; 100 pW to 30 W

Power and voltage measurement with a unique analog/digital display

Photo 43227-3

Brief description

URV35 is a voltmeter and power meter for versatile applications in ser-vice and production as well as for precision measurements in RF and microwave labs. A large variety of probes and sensors allows voltage measurements up to 3 GHz and power measurements up to 40 GHz.

Main features

- Compact, handy and mobile
- Voltmeter and power meter in one unit
- Rugged design
- Combined (true) analog and digital display
- Menu-guided operation
- AC-supply or battery operation
- Large choice of probes and sensors
- DC frequency input for tracking frequency-response correction
- Analog output for YT recorder
- RS-232-C interface
- Test generator for checking the probe or sensor (optional)

Specifications in brief, voltage probes page 314, power sensors page 320

Probes and sensors	all URV5 probes and NRV sensors
Display	backlit LCD, moving-coil meter with short response time
Absolute readout	dBm, dBµV, V or W
Relative readout	dB, referred to stored reference value
Resolution of digital display	4½ digits: 19999 steps; 0.001 dB 3½ digits: 1999 steps; 0.01 dB
Analog display	steps of 1-2.5-5 for V, W and dB, 5 (10) dB for dBm and dBµV with windows of 10 (20) dB
Entry of scaling	left- and right-hand scale limits
Display filtering	level-dependent digital averaging filter
Accuracy (18°C to 28°C)	
Digital display	±0.02 dB ±1 digit
Moving-coil meter	1.5% of full scale
Zero adjustment	via interface or manually, approx. 4 s
Hold function	for displayed measurement result
Measurement rate	5 readouts/s in manual mode
Frequency-response correction (selectable)	sensor-specific calibration data taken into account
Attenuation compensation (selectable)	external attenuation or gain taken into account, range ±199.99 dB
Entry of reference value	measured value on keystroke, or value entered via interface or keypad
Reference impedance	50 Ω/75 Ω, automatic/selectable

Sensor check source (option NRVS-B1)

Output	50 MHz/1 mW ±0.7%; N connector
VSWR	1.05

Interfaces

Remote control	serial interface (V.24, RS-232-C)
DC frequency input	BNC, R_{in} = 9 MΩ
Input voltage range	±12 V, linear with selectable scale
DC voltage output	BNC, R_{out} = 1 kΩ, EMF proportional to pointer deflection
Left-/right-hand scale limit	corresponding to 0/+3 V
Additional settling time	250 ms
Accuracy	±5 mV

General data

Model 02 power supply	
Battery, standard	5 x 1.5 V alkaline-manganese LR20
Operating time	125 h
Rechargeable battery, retrofittable	5 x 1.2 V NiCd IEC KR35/62
Operating/charging time	60 h/24 h
AC supply with UZ-35, European version	230 V ±10%, 47 to 63 Hz
AC supply with UZ-35, US version	120 V ±10%, 57 to 63 Hz
Model 03 (AC supply)	115 V +15%/–22%, 47 to 440 Hz 230 V +15%/–22%, 47 to 63 Hz (switch-selectable); 6 VA
Dimensions (W x H x D)	220 mm x 100 mm x 240 mm
Weight model 02	3.1 kg/2.3 kg with/without batteries
model 03	2.4 kg

Ordering information

Level Meter		
battery-operated	URV35	1020.0002.02
AC-supply model	URV35	1020.0002.03
Options		
Sensor Check Source	NRVS-B1	1029.2908.02
Power Supply/Charger (for model 02)[1]	UZ-35	1020.1709.02
Power Supply/Charger (for model 02)[2]	UZ-35	1020.1709.04
Service Kit	URV35-S1	1029.2608.02

1) European power supply.

2) US power supply.

Millivoltmeter URV5

DC, 9 kHz to 3/26.5 GHz

200 µV to 1000 V

Voltage, level, power measurements; trend indication

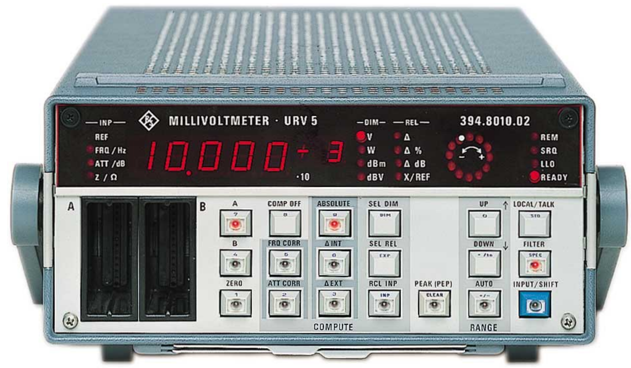


Photo 33034

Brief description

Millivoltmeter URV5 is a broadband voltage, level and power meter of high accuracy and sensitivity. It is suitable both for manual operation and for use in systems. A wide choice of individually calibrated probes and sensors allows URV5 to be used for a great variety of measurements:

- With RF probe and DC probe for no-load AC and DC voltage measurements
- Voltage (and power) measurements in coaxial 50 Ω and 75 Ω systems using low-reflection and low-loss insertion units
- Power measurements up to 26.5 GHz using Power Sensors NRV-Z1 to -Z6

Main features

- Two test inputs
- High accuracy through µP-controlled error correction: ±1%
- Dynamic range >94 dB
- IEEE/IEC bus interface
- Readout in all standard units with selectable reference impedance; relative measurements
- Optional DC output
- PEP measurement

Specifications in brief,

voltage probes page 314, power sensors page 320

Probes and sensors	all URV5 probes and NRV sensors, except NRV-Z3x and NRV-Z5x, -Z15
Test channels	2 (A and B)
Absolute measurement	A, B
Relative measurement	A/REF$_A$, B/REF$_B$, A/B, B/A
Absolute readout	V, W, dBm, dBV
Relative readout	ΔV, ΔW, Δ%, ΔdB, X/REF
Resolution	0.01% or 0.01 dB
Accuracy of voltage readout in V (18°C to 28°C)	±0.15% of rdg per channel
Filter	to reduce display noise in 6 steps (F0 to F5), selectable
Zero adjustment	via keyboard or remote control
Measurement rate (manual)	approx. 1 measurement/s with filter F0, up to 30 measurements/s with filter F5
Measurement time (IEEE/IEC bus)	approx. 0.05 s with filter F5, up to 20 s with filter F0

PEP measurement
Pulse widthapprox. 200 µs to CW
Min. pulse repetition frequency

Filter	F0	F1	F2	F3	F4	F5
f_{min}/Hz	0.05	0.25	1	5	25	100

Frequency-response correction (selectable)	sensor-specific frequency response after entry of test frequency
Attenuation compensation (selectable)	one attenuation value per channel can be entered (–199.99 to +199.99 dB)
Reference value for relative measurements	one value per channel

Optional DC Output URV5-B2

Output voltage range (EMKF)	–1.999 to +1.999 V, R_{out} = 1 kΩ
Resolution; error	1 mV (10 digit); ±2 mV

General data

Remote control	IEC 625-1 (IEEE 488) for control of all instrument functions
Interface functions	SH1, AH1, T5, L4, SR1, RL1, DC1, DT1, PP1
Power supply	100/120/220/240 V ±10% 47 Hz to 63 Hz, 400 Hz, 30 VA
Dimensions (W x H x D); weight	241 mm x 110 mm x 340 mm; 4.4 kg

Ordering information

Millivoltmeter	URV5	0394.8010.02
Options		
DC Output	URV5-B2	0079.0631.00
Service Kit for Calibration	UZ-8	0394.9968.02

Millivoltmeter URV55

DC to 3/40 GHz

200 µV to 1000 V

100 pW to 30 W

RF/DC voltage, level and power measurements

Photo 43228-3

Brief description

Millivoltmeter URV55 is suitable for voltage measurements up to 3 GHz as well as for power and level measurements up to 40 GHz. Thanks to probes with calibration data memory and temperature sensors, which make adjustments by the user superfluous, URV55 provides at all times high-precision measurements free of operator’s errors.

Main features

- Voltage, level and power measurements
- Large choice of intelligent probes and sensors (URV5-Z, NRV-Z)
- IEEE/IEC bus interface
- DC frequency input for tracking frequency-response correction
- Analog output for YT recorder
- Storage of 20 complete instrument setups
- 13 digital filters for noise suppression, automatic or manual filter selection
- Sensor check source (optional)

Measuring heads

The range of measuring heads includes high-impedance probes with plug-on dividers and adapters (URV5-Z7, -Z1) as well as insertion units for voltage measurements on coaxial lines (URV5-Z2, -Z4). All power sensors of the NRV-Z series can be used without any restrictions.

Measurement time in seconds (from trigger to output of first byte) depending on filter setting

Resolution	Filter number												
	0	1	2	3	4	5	6	7	8	9	10	11	12
NRV-Z1 to -Z15	0.045	0.05	0.06	0.08	0.15	0.27	0.49	0.95	1.85	3.6	7.2	14.5	28.5
NRV-Z31 mod. 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
NRV-Z31 to -Z33 mod. 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
NVR-Z32 mod. 05	0.435	0.44	0.45	0.47	0.53	0.64	0.84	1.24	2.07	3.7	6.9	14	27
NRV-Z51 to -Z55	0.115	0.12	0.13	0.15	0.21	0.32	0.52	0.92	1.75	3.4	6.6	13	26
URV 5-Z2, -Z4, -Z7	0.065	0.07	0.08	0.1	0.2	0.38	0.72	1.45	2.8	5.5	11	22	44

Millivoltmeter URV55

Specifications in brief,

voltage probes page 314, power sensors page 320

Measurement functions	average power, pulse power, peak envelope power, AM, reflection, DC voltage (depending on sensor)
Frequency and level range	DC to 40 GHz, 100 pW to 30 W 9 kHz to 3 GHz, 200 mV to 1000 V (depending on sensor)
Probes and sensors	all NRV sensors and URV5 probes
Display	LCD for digits, units, menu-guided operation and analog display, adjustable backlighting
Display of results	single-channel (with optional display of correction frequency) or dualchannel
Absolute readout	W, dBm, V, dBmV
Relative readout	dB, %W or %V relative to a stored reference value
Analog display	automatic or with selectable scale
Digital display and resolution	max. 4½ digits, resolution selectable (0.1/0.01/0.001 dB)
Display filtering	averaging over 1 to 512 readings to reduce display noise; manual or automatic setting depending on measurement range and resolution
Display noise	see sensors from page 314/320
Measurement rate	see table below
Accuracy (without sensor)	
18°C to 28°C	±0.02 dB ±1 digit
10°C to 40°C	±0.04 dB ±1 digit
0°C to 50°C	±0.06 dB ±1 digit
Zero adjustment	manual or via IEEE/IEC bus, duration approx. 4 s
Frequency response correction	sensor-specific calibration data taken into account; numerical entry of test frequency (keyboard or via IEEE/IEC bus) or by frequency-proportional DC voltage
Attenuation compensation	external attenuation or gain taken into account; data entry via keyboard or IEEE/IEC bus, range ±200 dB
Entry of reference value	measured value on keystroke or numerical entry via keypad or IEEE/IEC bus
Reference impedance	for conversion between voltage and power, automatic readout of reference impedance from sensor data memory or numerical entry via keyboard or IEEE/IEC bus (for RF probe)
Remote control	IEC 625 (IEEE 488), control of all instrument functions
Interface functions	SH1, AH1, T6, L4, SR1, RL1, DC1, DT1, PP0,
DC frequency input	
Connector	BNC
Input voltage range	±12 V, linear with selectable scale
DC output	
Connector	BNC, R_{out} = 1 kΩ, EMF proportional to analog display
Left-/right-hand full-scale value	corresponding to 0/+3 V
Accuracy	±5 mV
Channels	1, 2
Sensor check source	option NRVS-B1
Output power	1 mW ±0.7%
Frequency	50 MHz
VSWR	1.05
RF connector	N female

General data

Power supply	115 V +15/–22% (–15%) 47 Hz to 63 (440) Hz; 230 V +15/–22%, 47 Hz to 63 Hz, 13 VA
Dimensions (W x H x D)	219 mm x 103 mm x 350 mm
Weight	3.2 kg

Ordering information

Millivoltmeter	URV55	1029.1701.02
Option		
Sensor Check Source	NRVS-B1	1029.2908.02
Reconnended extras		
Rack adapter	ZZA-97	827.4527.00
Transsit case for URV55, sensors and accessories	UZ-24	1029.3379.02
Service Kit	NRVS-S1	1029.2708.02

Probes and Insertion Units URV5-Z1, -Z2, -Z4, -Z7, -Z9 for voltage and level measurement

RF Probe URV5-Z7 (photo 40621-10)

DC Probe URV5-Z1 (photo 40621-11)

Brief description

URV5-Z probes and insertion units are indispensable tools for RF and microwave labs, test departments and service. They cover the frequency range from 9 kHz to 3 GHz and thus fill the gap between low-frequency voltage measurement at one end and microwave power measurement at the other end.

All corrections of the rectifier such as linearization, temperature compensation or frequency-response correction are made numerically. Each probe or insertion unit has a built-in calibration data memory with its individual data which are continuously read by the meter.

All AC probes read out the RMS value for unmodulated sinewave voltages.

RF Probe URV5-Z7

A versatile tool for measuring high-frequency voltages. Thanks to its low input capacitance of 2.5 pF ideal for practically no-load measurements on non-coaxial circuits up to about 500 MHz (with accessories up to 1 GHz). Measurement range with plug-on dividers 1000 V (input capacitance 0.5 pF).

Accessory Set URV-Z6

- Plug-on divider 20 dB and 40 dB for extending the measurement range and reducing the input capacitance to100 V/1 pF or 1000 V/0.5 pF.
- BNC adapter for level measurements on coaxial 50 Ω lines (see also Insertion Units URV5-Z2, -Z4).

Adapters
URV-Z50 (50 Ω), URV-Z3 (75 Ω)

With integrated termination for power measurements on matched sources.

DC Probe URV5-Z1

Due to its low input capacitance ideal for DC voltage measurements on high-frequency modules.

Insertion Units URV5-Z2 (50 Ω), URV5-Z4 (50 Ω)

Insertion units are used for non-interrupting level measurements between source and load and for power measurements with wide dynamic range. They are made up of a short, reflection-free and low-loss line section with voltage tap and rectifier in the middle of the line.

With a well-matched load, the transmitted power P can be calculated for the measured voltage V_{rms} and the characteristic impedance Z_0 according to the formula $P = V_{rms}^2/Z_0$.

Specifications in brief

The indicated measurement uncertainties are valid in the temperature range 18°C to 28°C. Influences of the basic unit, meter noise, zero error, mismatch and temperature effects (beyond the indicated range) must also be taken into account.

Model	Frequency range Impedance	Voltage mesurement range Max. load	Power measurement range Level meas. range	Max. VSWR (reflection coefficient)		Meas. uncertainty in dB (% of voltage)		RF connector
RF Probe URV5-Z7	20 kHz to 500 MHz 2.5 pF/80 kΩ	200 µV to 10 V 15 V (RMS) 22 V (PK) 400 V (DC)	1 nW to 2 W –60/+33 dBm	–	–	0.07 to 1.1	(0.8 to 12)	BNC female/ female[1])
with 20 dB divider (URV-Z6)	1 to 500 MHz 1 pF/1 MΩ	2 mV to 100 V 150 V (RMS) 220 V (PK) 1000 V (DC)	100 nW to 20 W –40/+43 dBm	–	–	1.1 to 1.9	(12 to 20)	BNC female/ female[1])
with 40 dB divider (URV-Z6)	0.5 to 500 MHz 0.5 pF/10 MΩ	20 mV to 1000 V 1050 V (RMS) 1500 V (PK) 1000 V (DC)	10 µW to 20 W –20/+43 dBm	–	–	0.63 to 1.9	(7.3 to 20)	BNC female/ female[1])
with 50 Ω Adapter URV-Z50	20 kHz to 1 GHz 50 Ω	200 µV to 10 V 10 V (RMS) 22 V (PK)	1 nW to 2 W –60/+33 dBm	20 to 50 kHz >0.05 to 50 MHz >50 to 100 MHz >100 to 500 MHz >500 to 700 MHz >0.7 to 1 GHz	1.03 (0.015) 1.03 (0.015) 1.06 (0.030) 1.11 (0.050) 1.22 (0.10) 1.44 (0.18)	0.90 0.12 to 0.20 0.20 0.30 to 0.63 1.0 to 1.4 1.0 to 1.4	(10) (1.3 to 2.3) (2.3) (3.3 to 7.3) (11 to 18) (11 to 18)	BNC female (male)
with 75 Ω Adapter URV-Z3	20 kHz to 500 MHz 75 Ω	200 µV to 10 V 12 V (RMS) 22 V (PK)	500 pW to 1.3 W –62/+31 dBm	20 to 50 kHz >0.05 to 100 MHz >100 to 200 MHz >200 to 500 MHz	1.03 (0.015) 1.03 (0.015) 1.06 (0.03) 1.22 (0.10)	0.90 0.12 to 0.20 0.38 1.10	(10) (1.3 to 2.3) (4.3) (12)	BNC male 2.5/6 male 1.6/5.6 male
DC Probe URV5-Z1	3 pF/9 MΩ	1 mV to 100 V 400 V (PK)	–	–	–	0.013 dB 0.030 dB	(0.15%)[2]) (0.35%)[3])	BNC male
10 V Insertion Unit URV5-Z2	9 kHz to 3 GHz 50 Ω	200 µV to 10 V 15 V (RMS) 22 V (PK) 50 V (DC)	1 nW to 2 W –60/+33 dBm	9 to 20 kHz >20 to 50 kHz >50 kHz to 200 MHz >200 to 500 MHz >500 MHz to 1 GHz >1.0 to 2.0 GHz >2.0 to 3.0 GHz	1.04 (0.02) 1.04 (0.02) 1.04 (0.02) 1.10 (0.048) 1.22 (0.10) 1.35 (0.15) 1.35 (0.15)	0.20 to 0.35 0.17 to 0.20 0.13 to 0.17 0.20 to 0.25 0.25 to 0.30 0.30 to 0.50 0.40 to 0.75	(2.3 to 4) (2.0 to 2.3) (1.5 to 2.0) (2.3 to 2.8) (2.8 to 3.4) (3.4 to 5.6) (4.5 to 8.3)	N female/ male
100 V Insertion Unit URV5-Z4	100 kHz to 3 GHz 50 Ω	2 mV to 100 V 150 V (RMS) 220 V (PK) 1000 V (DC)	100 nW to 200 W –40/+53 dBm	100 to 200 kHz >200 to 500 kHz >0.5 to 3 MHz >3 to 200 MHz >200 to 500 MHz >0.5 to 1 GHz >1 to 2 GHz >2 to 3 GHz	1.04 (0.02) 1.04 (0.02) 1.04 (0.02) 1.04 (0.02) 1.04 (0.02) 1.07 (0.035) 1.07 (0.035) 1.10 (0.048)	0.50 to 1.50 0.25 to 0.60 0.13 to 0.20 0.13 0.17 to 0.20 0.20 to 0.25 0.30 to 0.50 0.45 to 1.05	(5.6 to 16) (2.8 to 6.7) (1.5 to 2.3) (1.5) (2.0 to 2.3) (2.3 to 2.8) (3.4 to 5.6) (5.0 to 11.4)	N female/ male

Ordering information

DC Probe with ground cable, clip tip and BNC adapter	URV5-Z1	0395.0512.02
10 V Insertion Unit (50 W, 3 GHz)	URV5-Z2	0395.1019.02
100-V Insertion Unit 50 Ω, 3 GHz	URV5-Z4	0395.1619.02
RF Probe with case, ground cable, ground sleeve and tape, hook and solder tip	URV5-Z7	0395.2615.02
Accessory Set for RF Probe Plug-on divider 20 dB and 40 dB, BNC adapter 50 Ω, reducing sleeve for divider, ground sleeves and ground tape	URV-Z6	0292.5364.02
50 Ω Terminating Adapter BNC female connector, with adapter to BNC male	URV-Z50	0394.9816.50
75 Ω Terminating Adapter with adapters to BNC, 2.5/6 and 1.6/5.6 connectors	URV-Z3	0243.9118.70

1) With BNC adapter (URV-Z6); maximum power is limited by power loss of the adapter.

2) 1 mV to 100 V.

3) 100 V to 400 V.

Power Meter NRVS

DC to 40 GHz

100 pW to 30 W

Power (average, pulse, PEP), level and DC voltage measurements

Photo 43225

Brief description

Power Meter NRVS is an ideal instrument for a great variety of power measurement applications in labs and systems. Thanks to its intelligent sensors with calibration data memory and thermocouple sensors, which make adjustments by the user superfluous, NRVS provides at all times high-precision measurements free of operator's errors.

Main features

- Fast power, level and voltage measurements
- Intelligent NRV-Z probes and URV5-Z sensors: plug and play
- IEEE/IEC bus interface
- DC frequency input for tracking frequency-response correction
- Analog output
- Storage of 20 complete instrument setups
- 13 digital filters for noise suppression, automatic or manual filter selection
- Sensor check source (optional)

Characteristics

Display
Measurement results, units and various items of information are displayed on a large easy-to-read $4\frac{1}{2}$-digit LC display in three selectable steps of resolution.

Pulse power
If pulse-modulated RF signals are measured, NRVS calculates the pulse peak power from the measured average power and the entered pulse duty factor, and reads out the result directly. The use of Peak Power Sensors NRV-Z31 and -Z33 for measuring the peak envelope power (PEP) is highly recommended.

Measurement rate
The attainable measurement rate not only depends on the type of sensor used but also on the setting of the averaging filter. NRVS automatically makes the appropriate settings by determining the optimum averaging time required for a steady readout as a function of level and selected resolution. This automatic selection can be switched off.

Measuring heads

The range of measuring heads includes thermocouple power sensors as well as highly sensitive diode power sensors, peak power sensors (from page 320), probes and insertion units for voltage measurement (from page 314). NRVS therefore covers a frequency range from DC to 40 GHz and a power span from 100 pW to 30 W.

The power sensors are not specifically designed for NRVS and can therefore be freely used with any of the Rohde& Schwarz power meters and voltmeters.

Power Meter NRVS

Specifications in brief,

power sensors page 320, voltage probes page 314

Measurement functions	average power, pulse power, peak envelope power, AM, reflection, DC voltage (depending on sensor)
Frequency and level range	DC to 40 GHz, 100 pW to 30 W 9 kHz to 3 GHz, 200 mV to 1000 V (depending on sensor)
Probes and sensors	all NRV sensors and URV5 probes
Display	LCD for digits, units, menu-guided operation and analog display, adjustable backlighting
Display of results	single-channel (with optional display of correction frequency) or dualchannel
Absolute readout	W, dBm, V, dBmV,
Relative readout	dB, %W or %V relative to a stored reference value
Analog display	automatic or with selectable scale
Digital display and resolution	max. 4½ digits, resolution selectable (0.1/0.01/0.001 dB)
Display filtering	averaging over 1 to 512 readings to reduce display noise; manual or automatic setting depending on measurement range and resolution
Display noise	see sensors from page 314/320
Measurement rate	see table below
Accuracy (without sensors)	
18°C to 28°C	0.4% +1 digit
10°C to 40°C	0.9% +1 digit
0°C to 50°C	1.4% +1 digit
Zero adjustment	manual or via IEEE/IEC bus, duration approx. 4 s
Frequency response correction	sensor-specific calibration data taken into account; numerical entry of test frequency (keyboard or via IEEE/IEC bus) or by frequency-proportional DC voltage
Attenuation compensation	external attenuation or gain taken into account; data entry via keyboard or IEEE/IEC bus, range ±200 dB
Entry of reference value	measured value on keystroke or numerical entry via keypad or IEEE/IEC bus
Reference impedance	for conversion between voltage and power, automatic readout of reference impedance from sensor data memory or numerical entry via keyboard or IEEE/IEC bus (for RF probe)
Remote control	IEC 625 (IEEE 488), control of all instrument functions
Interface functions	SH1, AH1, T6, L4, SR1, RL1, DC1, DT1, PP0
DC frequency input	
Connector	BNC
Input voltage range	±12 V, linear with selectable scale
DC output	
Connector	BNC, R_{out} = 1 kΩ, EMF proportional to analog display
Left-/right-hand full-scale value	corresponding to 0/+3 V
Accuracy	±5 mV
Channels	1, 2
Sensor check source	option NRVS-B1
Output power	1 mW ±0.7%
Frequency	50 MHz
VSWR	1.05
RF connector	N female
General data	
Power supply	115 V +15/–22% (–15%), 47 Hz to 63 (440) Hz; 230 V +15/–22%, 47 Hz to 63 Hz, 13 VA
Dimensions (W x H x D)	219 mm x 103 mm x 350 mm
Weight	3.2 kg

Ordering information

Power Meter	NRVS	1020.1809.02
Options		
Sensor Check Source	NRVS-B1	1029.2908.02
Extras		
Rack adapter	ZZA-97	0827.4527.00
Transit case	UZ-24	1029.3379.02
Service Kit	NRVS-S1	1029.2708.02

Dual-Channel Power Meter NRVD

DC to 40 GHz

100 pW to 30 W

Power, level and voltage measurements; attenuation and reflection measurements: precise, versatile, convenient

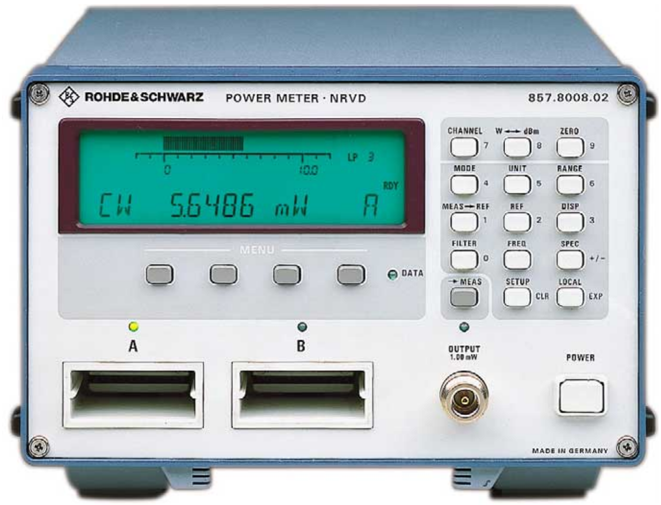


Photo 40095

Brief description

NRVD functions like two independent NRVS power meters in one enclosure performing simultaneous measurements and exchanging data with each other. The two channels can be set separately so that two completely different measurements can be carried out at the same time. The two measured values can also be related to each other for readout of reflection coefficient, SWR or return loss, for instance.

Main features

- Two independent channels performing simultaneous measurements
- LC display with variable backlighting
- IEEE/IEC bus interface (optionally SCPI or compatible with URV5)
- 13 digital filters for noise suppression, automatic or manual filter selection
- Considering frequency response of external components (attenuators or direction couplers inserted before sensor)
- Storage of 20 complete instrument setups
- Input/output option with DC frequency input, analog outputs, trigger input, ready output
- Large variety of intelligent sensors: plug and play
- Rear connectors for sensors
- Sensor check source

Characteristics

Display
Measurement results are displayed with selectable resolution on a five-digit LCD with adjustable backlighting. The values measured in the two channels or one measured value plus an additional item of information are displayed.

The NRVD measures pulse-modulated RF signals like the NRVS. Additionally, the modulation depth of amplitude-modulated signals can be determined from the power variation. After entering the source matching, the expected uncertainty for thermocouple power sensors can be displayed.

Measurement rate
See NRVS, page 316.

Sensor check source
It supplies a highly accurate, low-distortion 50 MHz signal of 1 mW (0 dBm) power for checking the sensors.

Input/Output Option NRVD-B2
Each measurement channel has an analog output wiht selectable scaling for connection of a recorder or for control purposes. Simple automatic test routines can be implemented with the aid of the trigger input and the ready output. Another input serves for taking up the frequency-proportional DC voltage from a sweep generator for tracking frequency-response correction.

Dual-Channel Power Meter NRVD

Specifications in brief,

power sensors page 320, voltage probes page 314

Measurement functions	average power, pulse power, peak envelope power, AM, reflection, DC voltage (depending on sensor)
Frequency and level range	DC to 40 GHz, 100 pW to 30 W 9 kHz to 3 GHz, 200 mV to 1000 V (depending on sensor)
Probes and sensors	all NRV sensors and URV5 probes
Display	LCD for digits, units, menu-guided operation and analog display, adjustable backlighting
Display of results	single-channel (with optional display of correction frequency) or dualchannel
Absolute readout	W, dBm, V, dBmV, dBV
Relative readout NRVD	dB, difference, percent and ratio, relative to a stored reference value or to the second measurement channel; VSWR, reflection coefficient, return loss in dB, AM modulation depth
Analog display	automatic or with selectable scale
Digital display and resolution	max. 4½ digits, resolution selectable (0.1/0.01/0.001 dB)
Display filtering	averaging over 1 to 512 readings to reduce display noise; manual or automatic setting depending on measurement range and resolution
Display noise	see sensors from page 314/320
Measurement rate	see table below
Accuracy (without sensors)	
18°C to 28°C	0.3% +1 digit
10°C to 40°C	0.8% +1 digit
0°C to 50°C	1.3% +1 digit
Zero adjustment	manual or via IEEE/IEC bus, duration approx. 4 s
Frequency response correction	sensor-specific calibration data taken into account; numerical entry of test frequency (keyboard or via IEEE/IEC bus) or by frequency-proportional DC voltage
Attenuation compensation	external attenuation or gain taken into account; data entry via keyboard or IEEE/IEC bus, range ±200 dB
Entry of reference value	measured value on keystroke or numerical entry via keypad or IEEE/IEC bus
Reference impedance	for conversion between voltage and power, automatic readout of reference impedance from sensor data memory or numerical entry via keyboard or IEEE/IEC bus (for RF probe)
Remote control	IEC 625 (IEEE 488), SCPI, control of all instrument functions
Interface functions	SH1, AH1, T6, L4, SR1, RL1, DC1, DT1, PP0, PP1
DC frequency input	option NRVD-B2
Connector	BNC
Input voltage range	±12 V, linear with selectable scale
DC output	option NRVD-B2
Connector	BNC, R_{out} = 1 kΩ,
	EMF proportional to analog display
Left-/right-hand full-scale value	corresponding to 0/+3 V
Accuracy	±5 mV
Channels	1, 2
Input/Output Option NRVD-B2	2 simultaneous DC voltage outputs, DC frequency input, trigger input (TTL, active low), ready output (TTL, active high)
Sensor check source	
Output power	1 mW ±0.7%
Frequency	50 MHz
VSWR	≤1.03
RF connector	N female
General data	
Power supply	100/120/220 V ±10%, 230 V –6/+15%; 47 Hz to 400 Hz (25 VA)
Dimensions (W x H x D)	219 mm x 147 mm x 350 mm
Weight	4.5 kg

Ordering information

Dual-Channel Power Meter	NRVD	0857.8008.02
Option		
Input/Output Option	NRVD-B2	0857.8908.02
Extras		
Rack adapter	ZZA-98	827.4533.00
Transit case	ZZK-983	1013.9172.00
Service Kit	NRVD-S1	1029.2808.02

Power Sensors NRV-Z

Brief description

For all power measurements with instruments from the URV/NRV families, 15 power sensors in all cover the frequency range from DC to 40 GHz. Three classes of sensitivity allow direct measurement of any power between 100 pW and 30 W. A 75-Ω sensor is available for TV and video applications.

The calibration data memory integrated in the sensor contains all the relevant information. With the sensor plugged in, a fully calibrated meter is ready for measurements. The calibration of all sensors can be traced to the relevant standards of the Federal German Bureau of Standards.

For calculating the total measurement uncertainty of the source power delivered to Z_0 load the following factors have to be taken into account: mismatch uncertainty, calibration uncertainty, linearity error, meter noise, zero offset, temperature effect, pulse measurement uncertainty (peak power sensors only) and measurement uncertainty of basic unit.

Calibration data for each sensor are stored in an EPROM in the sensor's connector (photo 37902)

Overview of models

High-Sensitivity Sensors NRV-Z1, -Z3, -Z4, -Z6, -Z15
These sensors measure the true RMS power from about 100 pW to 10 µW and can be used in this level range for signals with harmonic contents, noisy or modulated signals. For sinewave signals, the measurement range extends to 20 mW (13 mW into 75 Ω).

Medium-Sensitivity Sensors NRV-Z2, -Z5
Based on diode detectors with 20 dB attenuator, these sensors provide true RMS power measurement in the range from 10 nW to1 mW and up to 500 mW for sinewave signals. Compared to thermocouple sensors, shorter measurement times can be attained with these sensors.

Thermocouple Power Sensors NRV-Z51 to -Z55
They measure the average power irrespective of the waveform and therefore are also suitable for spread spectrum, IS-95 CDMA and W-CDMA measurements, irrespective of the peak-to-average power ratio of the waveform concerned. Being individually calibrated, these sensors feature an unrivalled linearity over the entire dynamic range.

Peak Power Sensors NRV-Z31 to -Z33
These sensors measure the peak envelope power (PEP) of modulated or pulsed signals. The TDMA models 04 of the sensors allow fast and precise measurement of the transmitter power of mobile stations in GSM900/1800/1900 networks. Models 03 are suitable for measuring the sync pulse power of TV transmitters. Model 02 with a minimum pulse repetition frequency of 10 Hz is designed for general applications. Model 05 of NRV-Z32 enables measurement of the power peak value of mobile stations to NADC and PDC standard.

Specifications in brief

Model	Frequency range Min. pulse width Min. PRF	Power range Max. power	Max. SWR (reflection coefficient)	Zero offset (±)	Meter noise	Linearity uncertainty in dB	Calibration uncertainty in dB
NRV-Z1 N; 50 Ω	10 MHz to 18 GHz	200 pW to 20 mW 100 mW (AVG) 100 mW (PK)	0.01 to 1 GHz: 1.06 (0.03) >1 to 2 GHz: 1.13 (0.06) >2 to 4 GHz: 1.27 (0.12) >4 to 18 GHz: 1.41 (0.17)	100 pW	40 pW	0.03	0.07 0.07 0.08 0.08 to 0.15
NRV-Z2 N; 50 Ω	10 MHz to 18 GHz	20 nW to 500 mW 2 W (AVG) 10 W (PK)	0.01 to 4 GHz: 1.05 (0.024) >4 to 8 GHz: 1.1 (0.048) >8 to 12.4 GHz: 1.15 (0.07) >12.4 to 18 GHz: 1.2 (0.09)	10 nW	4 nW	0.03	0.07 0.07 0.07 0.09 to 0.13

Power Sensors NRV-Z

Specifications in brief

Model	Frequency range Min. pulse width Min. PRF	Power range Max. power	Max. SWR (reflection coefficient)	Zero offset (±)	Meter noise	Linearity uncertainty in dB	Calibration uncertainty in dB
NRV-Z3 N; 75 Ω	1 MHz to 2.5 GHz	100 pW to 13 mW 70 mW (AVG) 70 mW (PK)	1 to 100 MHz: 1.11 (0.05) >0.1 to 1 GHz: 1.11 (0.05) >1 to 2.5 GHz: 1.2 (0.09)	40 pW	16 pW	0.03	0.06 0.07 0.07
NRV-Z4 N; 50 Ω	100 kHz to 6 GHz	100 pW to 20 mW 100 mW (AVG) 100 mW (PK)	0.1 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)	50 pW	20 pW	0.03	0.05 to 0.06 0.06 0.06 0.07
NRV-Z5 N; 50 Ω	100 kHz to 6 GHz	10 nW to 500 mW 2 W (AVG), 10 W (PK)	100 kHz to 4 GHz: 1.05 (0.024) >4 to 6 GHz: 1.1 (0.048)	5 nW	2 nW	0.03	0.05 to 0.06 1.7 to 1.9
NRV-Z6 PC 3.5; 50 Ω	50 MHz to 26.5 GHz	400 pW to 20 mW 100 mW (AVG) 100 mW (PK)	0.05 to 0.1 GHz: 1.3 (0.13) >0.1 to 18 GHz: 1.2 (0.09) >18 to 26.5 GHz: 1.4 (0.165)	200 pW	80 pW	0.04	0.06 0.06 to 0.13 0.09
NRV-Z15 K; 50 Ω	50 MHz to 40 GHz	400 pW to 20 mW 100 mW (AVG) 100 mW (PK)	50 MHz to 4 GHz: 1.15 (0.7) >4 to 18 GHz: 1.37 (0.157) >18 to 40 GHz: 1.37 to 0.157)	200 pW	80 pW	0.04	0.05 to 0.06 0.07 to 0.15 0.08 to 0.1
NRV-Z31 N; 50 Ω	30 MHz to 6 GHz 2 µs (mod. 02/03), 200 µs (mod. 04) 10 Hz (mod. 02), 100 Hz (mod. 03/04)	1 µW to 20 mW 100 mW (AVG) 100 mW (PK)	0.03 to 0.1 GHz: 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)	30 nW	3 nW	included in calibration uncertainty	0.06 0.07 0.11 to 0.15 0.12 to 0.16
NRV-Z32 N; 50 Ω	30 MHz to 6 GHz 2 µs (mod. 02/03), 200 µs (mod. 04) 10 Hz (mod. 02), 100 Hz (mod. 03/04)	100 µW to 2 W 1 W (AVG) 8 W (PK, 1 µs)	0.03 to 2 GHz: 1.11 (0.052) >2 to 4 GHz: 1.11 (0.052) >4 to 6 GHz: 1.22 (0.099)	3 µW	0.3 µW	includ. in calibration uncertainty	0.08 to 0.10 0.13 to 0.25 0.18 to 0.27
NRV-Z33 N; 50 Ω	30 MHz to 6 GHz 2 µs (mod. 03), 200 µs (mod. 04) 100 Hz (mod. 03/04)	1 mW to 20 W 12 to 18 W (AVG) 80 W (PK)	0.03 to 2 GHz: 1.11 (0.052) >2 to 4 GHz: 1.22 (0.099) >4 to 6 GHz: 1.22 (0.099)	30 µW	3 µW	includ. in calibration uncertainty	0.08 to 0.10 0.15 to 0.18 0.18 to 0.20
NRV-Z51 N; 50 Ω	DC to 18 GHz	1 µW to 100 mW 300 mW (AVG) 10 W (PK, 1 µs)	DC to 2 GHz: 1.1 (0.048) >2 to 12.4 GHz: 1.15 (0.07) >12.4 to 18 GHz: 1.2 (0.09)	60 nW	22 nW	0.02	0.05 0.05 to 0.07 0.09 to 0.12
NRV-Z52 PC 3.5; 50 Ω	DC to 26.5 GHz	1 µW to 100 mW 300 mW (AVG) 10 W (PK, 1 µs)	DC to 2 GHz: 1.1 (0.048) >2 to 12.4 GHz: 1.15 (0.07) >12.4 to 18 GHz: 1.2 (0.09) >18 to 26.5 GHz: 1.25 (0.11)	60 nW	22 nW	0.02	0.05 to 0.06 0.06 to 0.08 0.10 to 0.13 0.08 to 0.09
NRV-Z53 N; 50 Ω	DC to 18 GHz	100 µW to 10 W 12 to 18 W (AVG) 1 kW (PK, 1 µs)	0.05 to 2 GHz: 1.11 (0.052) >2 to 8 GHz: 1.22 (0.099) >8 to 12.4 GHz: 1.27 (0.119) >12.4 to 18 GHz: 1.37 (0.157)	6 µW	2.2 µW	0.03 + 0.01 P/W	0.07 0.10 0.12 to 0.13 0.14 to 0.18
NRV-Z54 N; 50 Ω	DC to 18 GHz	300 µW to 30 W 24 to 36 W (AVG) 1 kW (PK, 3 µs)	0.05 to 2 GHz: 1.11 (0.052) >2 to 8 GHz: 1.22 (0.099) >8 to 12.4 GHz: 1.27 (0.119) >12.4 to 18 GHz: 1.37 (0.157)	20 µW	7 µW	0.03 + 0.007 P/W	0.08 0.10 to 0.11 0.12 to 0.13 0.14 to 0.18
NRV-Z55 K; 50 Ω	DC to 40 GHz	1 µW to 100 mW 300 mW (AVG) 10 W (PK, 1 µs)	DC to 2 GHz: 1.1 (0.048) >2 to 12.4 GHz: 1.15 (0.07) >12.4 to 18 GHz: 1.2 (0.08) >18 to 26.5 GHz: 1.25 (0.11) >26.5 to 40 GHz: 1.30 (0.13)	60 nW	22 nW	0.02	0.05 0.06 to 0.08 0.10 to 0.13 0.08 to 0.09 0.10 to 0.11

Power Sensors NRV-Z

Dimensions and weight

NRV-Z1 to -Z15, -Z31, -Z51, -Z52	120 mm x 37 mm x 31 mm; 0.35 kg
NRV-Z32	190 mm x 37 mm x 31 mm; 0.42 kg
NRV-Z33, -Z53	240 mm x 54 mm x 60 mm; 0.53 kg
NRV-Z54	298 mm x 54 mm x 60 mm; 0.68 kg
Length of connecting cable	approx. 1.3 m; other lengths on request

Ordering information

Peak Power Sensors

50 Ω, 6 GHz, 20 mW		
Standard model	NRV-Z31	0857.9604.02
High-speed model	NRV-Z31	0857.9604.03
TDMA model	NRV-Z31	0857.9604.04
50 Ω, 6 GHz, 2 W		
TDMA model	NRV-Z32	1031.6807.04
General-purpose model	NRV-Z32	1031.6807.05
50 Ω, 6 GHz, 20 W		
High-speed model	NRV-Z33	1031.6507.03
TDMA model	NRV-Z33	1031.6507.04

Power Sensors

20 mW, 50 Ω, 18 GHz	NRV-Z1	0828.3018.02
500 mW, 50 Ω, 18 GHz	NRV-Z2	0828.3218.02
13 mW, 75 Ω, 2.5 GHz	NRV-Z3	0828.3418.02
20 mW, 50 Ω, 6 GHz	NRV-Z4	0828.3618.02
500 mW, 50 Ω, 6 GHz	NRV-Z5	0828.3818.02
20 mW, 50 Ω, 26.5 GHz	NRV-Z6	0828.5010.02
20 mW, 50 Ω, 40 GHz	NRV-Z15	1081.2305.02
100 mW, 50 Ω, 18 GHz	NRV-Z51	0857.9004.02
100 mW, 50 Ω, 26.5 GHz	NRV-Z52	0857.9204.02
10 W, 50 Ω, 18 GHz	NRV-Z53	0858.0500.02
30 W, 50 Ω, 18 GHz	NRV-Z54	0858.0800.02
100 mW, 50 Ω, 40 GHz	NRV-Z55	1081.2005.02

Power Reflection Meter NRT

200 kHz to 4 GHz

0.3 mW to 2000 W

Power and reflection measurements under operational conditions

Photo 42661

Brief description

Directional power meters are used to measure power and reflection under operational conditions. Typical applications are in installation, maintenance and monitoring of transmitters, antennas and RF generators in industrial and medical fields. Power Reflection Meter NRT is the right choice: rugged, accurate and compact. Due to the large variety of measurement functions and high accuracy it is suitable for classic applications in mobile use as well as for use in research, development, production and quality management.

Power Sensors NRT-Z43 and -Z44 for use in radiocommunications
The wide frequency range from 200 (400) MHz to 4 GHz covers all relevant frequency bands, the measurement method is compatible with all common analog and in particular digital modulation standards: GSM 900/1800/1900, DECT, PHS, NADC, PDC, DAB, DVB, IS-95-CDMA, W-CDMA and many more.

Power Sensors NAP-Z
The complete range of power sensors of the predecessor model NAP is available for the customary frequency ranges, eg shortwave, and can be connected via an option. The sensors cover all the main frequency bands, from the maritime radio frequencies in the range of 200 kHz through to the digital GSM900 network. The power measurement range extends from 0.3 mW to 2 kW. The NAP sensors are able to measure the average power irrespective of the modulation mode and some of them even the peak envelope power (PEP). All NAP sensors up to 1 GHz have a directivity of at least 30 dB and thus allow very precise reflection and power measurements.

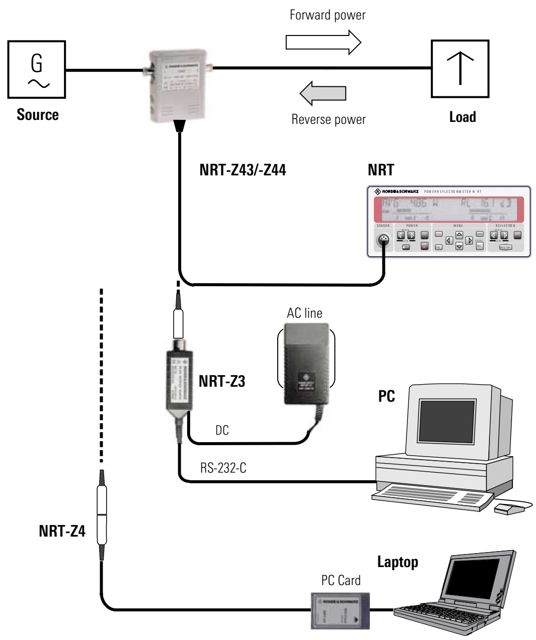
Measurement directly on PC
The sensors of the NRT family are self-contained measuring instruments which are able to communicate with the basic unit or with a PC via a standard serial data interface. Interface Adapter NRT-Z3 allows connection to the serial RS-232-C standard interface of PCs (COMx), PC Card Interface Adapter NRT-Z4 operation at the PC card connector of laptops and notebooks. A program running under Windows (V-NRT) is available for operation of the sensor and display of the measurement results.


Direct power monitoring on PC

Operation, measurement functions

Thanks to menu control, a manageable number of keys and a large display, operation of the NRT is extremely easy. Switchover between the main functions is made at a keystroke:

- Choice between average power, average burst power, peak envelope power (PEP) and peak-to-average power ratio (crest factor)
- Switchover between forward power and absorbed power
- Measurement of power differences in dB or %
- Choice between return loss, SWR or reflection coefficient in reflection measurements
- Acoustic SWR monitoring
- Indication of maximum and minimum values
- Quasi-analog bargraph display
- Choice between measurement at the source or at the load



Power and reflection measurement with NRT-Z43/-Z44: readout of results either on basic unit or directly on PC

Options

The NRT basic unit comes with an IEC-bus (IEEE488) and RS-232-C interface, both to SCPI standard. Three options allow the NRT to be adapted to different applications:

- Test input for connection of NAP sensors
- Two additional test inputs for NRT sensors for simultaneous monitoring of up to three testpoints (NRT-B2)
- Battery and built-in charger for mobile use (NRT-B3)

Specifications in brief: power sensors

General data	NRT-Z43	NRT-Z44
Power measurement range[1]	0.0007 to 30 W (average)/75 W (peak)	0.003 to 120 W (average)/300 W (peak)
Frequency range	400 MHz to 4 GHz	200 MHz to 4 GHz
SWR (referred to 50 Ω)	1.07 max. from 0.4 to 3 GHz 1.12 max. from 3 to 4 GHz	1.07 max. from 0.2 to 3 GHz 1.12 max. from 3 to 4 GHz
Insertion loss	0.06 dB max. from 0.4 to 1.5 GHz 0.09 dB max. from 1.5 to 4 GHz	0.06 dB max. from 0.2 to 1.5 GHz 0.09 dB max. from 1.5 to 4 GHz
Directivity	30 dB min. from 0.4 to 3 GHz 26 dB min. from 3 to 4 GHz	30 dB min. from 0.2 to 3 GHz 26 dB min. from 3 to 4 GHz
Average power measurement[2]		
Definition	mean value of carrier power, averaged over several modulation cycles (thermal equivalent, true rms value in case of voltage measurement)	
Power measurement range CF: peak-to-average power ratio (crest factor)	0.007 [0.0007] to 75 W (CW, FM, jM, FSK, GMSK or equivalent) to 30 [3] W (CDMA, W-CDMA, DAB, DVB) to 75 [7.5] W/CF (other modulation)	0.03 [0.003] to 300 W (CW, FM, jM, FSK, GMSK or equivalent)) to 120 [12] W (CDMA, W-CDMA, DAB, DVB) to 300 [30] W/CF (other modulation)
Modulation	for all kinds of analog and digital modulation; lowest frequency component of signal envelope should exceed 7 Hz for steady indication	
Measurement uncertainty at 18 to 28°C	unmodulated RF (CW): 3.2% of rdg (0.14 dB)	unmodulated RF (CW): 3.2% of rdg (0.14 dB)
Burst average power measurement[2]		
Definition	average on-power of periodic carrier bursts, based on the measurement of average power under consideration of burst width t and repetition rate 1/T: burst average power = average power x T/t	
Power measurement range	0.007 [0.0007] W x $\frac{T}{t}$	0.03 [0.003] W x $\frac{T}{t}$
	up to specified upper limit of average power measurement	up to specified upper limit of average power measurement
Burst width (t)	0.2 µs to 150 ms	0.2 µs to 150 ms
Repetition rate (1/T)	7/s min.	7/s min.
Measurement of peak-to-average power ratio (crest factor)		
Definition	ratio of peak envelope power to average power in dB (only with 1 ⟶ 2 forward direction)	
Power measurement range	see average power and peak envelope power specifications	
Measurement of peak envelope power (PEP)		
Definition	peak value of carrier power (only with 1 ⟶ 2 forward direction)	
Power measurement range Burst signals (repetition rate min. 20/s)	0.1(1)* to 75 W (* lower measurement limit depending on modulation)	0.4 (4)* to 300 W (* lower measurement limit depending on modulation)

Measurement of complementary cumulative distribution function (CCDF)	NRT-Z43	NRT-Z44
Definition	probability in % of forward power envelope exceeding a given threshold (only with 1 ⟶ 2 forward direction)	
Measurement range	0% to 100%	0% to 100%
Threshold level range	0.25 W to 75 W	1 W to 300 W
Reflection measurement [2] (values in { }: 3 to 4 GHz)		
Definition	measurement of load match in terms of SWR, return loss or reflection coefficient	
Reflection measurement range Return loss/SWR/reflection coefficient	0 dB to 23 {20} dB / 1.15 {1.22} to ∞ / 0.07 {0.10} to 1	
Min. forward power	0.007 [0.07] W (specs met from 0.05 [0.5] W)	0.03 [0.3] W (specs met from 0.2 [2] W)

General data	NAP-Z3	NAP-Z4	NAP-Z5	NAP-Z6	NAP-Z7	NAP-Z8
Power measurement range [1]	0.01 W to 35 W	0.03 W to 110 W	0.1 W to 350 W	0.3 W to 1100 W	0.05 W to 200 W	0.5 W to 2000 W
Frequency range	25 MHz to 1 GHz	25 MHz to 1 GHz	25 MHz to 1 GHz	25 MHz to 1 GHz	0.4 MHz to 80 MHz	0.2 MHz to 80 MHz
SWR (referred to 50 Ω)	1.03 max.	1.03 max.	1.03 max.	1.05 max.	1.03 max. (1.02 max. from 1.5 MHz to 30 MHz)	
Insertion loss up to 0.3 GHz up to 0.5 GHz total frequency range	0.10 dB max. 0.25 dB max. 0.75 dB max.	0.08 dB max. 0.15 dB max. 0.35 dB max.	0.08 dB max. 0.15 dB max. 0.20 dB max.	0.05 dB max. 0.10 dB max. 0.15 dB max.	– – 0.015 dB max.	– – 0.015 dB max.
Directivity	30 dB min. (30 MHz to 1 GHz), 26 dB min. (25 MHz to 30 MHz)				35 dB min. (1.5 MHz to 30 MHz)	
Average power measurement						
Measurement range	0.01 W to 35 W	0.03 W to 110 W	0.1 W to 350 W	0.3 W to 1100 W	0.05 W to 200 W	0.5 W to 2000 W
Measurement uncertainty at 20 to 25°C	6% of reading	6% of reading	6% of reading	6% of reading	6 [4] % of reading (1.5 MHz to 30 MHz) value in brackets: sensor-specific calibration factors taken into account	
Measurement of peak envelope power						
Measurement range	not possible	not possible	not possible	not possible	0.5 W to 200 W	5 W to 2000 W
AM Burst width t Repetition rate 1/T					30 Hz to 10 kHz 20 µs min. 30/s min.	30 Hz to 10 kHz 20 µs min. 30/s min.
Reflection measurement						
Measurement range for return loss/SWR/ reflection coefficient	0 dB to 23 dB / 1.15 to ∞ / 0.07 to 1 (30 MHz to 1 GHz)				0 to 28 dB / 1.08 to ∞ / 0.04 to 1 (1.5 to 30 MHz)	
Minimum forward power	0.1 (0.6) W	0.3 (2) W	1 (6) W	3 (20) W	0.5 (10) W	5 (100) W
	specs met with power values in ( )					

General data	NAP-Z10 (model 02)	NAP-Z11 (model 02)
Power measurement range [1]	0.005 W to 20 W	0.05 W to 200 W
Frequency range	35 MHz to 1 GHz	35 MHz to 1 GHz
SWR (referred to 50 Ω)	max. 1.03	max. 1.03
Insertion loss up to 0.3 GHz up to 0.5 GHz total frequency range	0.10 dB max. 0.25 dB max. 0.75 dB max.	0.08 dB max. 0.15 dB max. 0.20 dB max.
Directivity	30 dB min. from 40 MHz to 1 GHz 26 dB min. from 35 to 40 GHz	
Average power measurement		
Measurement range	0.005 W to 20 W	0.05 W to 200 W
Measurement uncertainty at 20 to 25°C	6.5% of reading	6.5% of reading
Measurement of peak envelope power		
Measurement range	0.05 W to 20 W	0.5 W to 200 W
AM Burst width t Repetition rate 1/T	50 Hz to 100 kHz min. 4,5 µs min. 50/s	50 Hz to 100 kHz min. 4,5 µs min. 50/s
Reflection measurement		
Measurement range Return loss/SWR/ Reflection coefficient	0 dB to 23 dB/1.15 to ∞/0.07 to 1 (40 MHz to 1 GHz)	
Minimum forward power	0.05 (0.35) W	0.5 (3.5) W
	specs met with power values in ( )	
Measurement time	equal to measurement time of selected power measurement function, shortest with average power measurement	

Specifications in brief: NRT basic unit

Frequency range	200 kHz to 4 GHz 3)
Power measurement range	0.3 mW to 2 kW 3)
Test inputs	1 to 3 (4), one active
for NRT-Z sensors	one input on front panel, two additional inputs on rear panel (option NRT-B2)
for NAP-Z sensors	one input on rear panel (option NRT-B1)
Measurement functions	
Power	forward power and power absorbed by the load in W, dBm, dB or % (dB and % referred to measured value or reference value)
Power parameters3)	average, burst average, envelope peak, peak-to-average ratio (crest factor) and complementary cumulative distribution function (CCDF)
Reflection	SWR, return loss, reflection coefficient, reverse forward power ratio and reverse power
Frequency response correction	upon input of RF frequency, the stored correction factors of the power sensor being taken into account; for NAP sensors the NRT basic unit offers memory for 3 sets of calibration factors
Display	LCD
Digital	simultaneous indication of power, reflection and frequency
Resolution	HIGH: 4½ digits (0.001 dB) LOW: 3½ digits (0.01 dB)
Analog	two 50-element bargraphs for indication of power and reflection with selectable or predefined scale-end values
Averaging	automatic, depending on selected resolution and sensor characteristics
Max/Min.	indication of current maximum, minimum or max-min value for the selected measurement functions
Remote control	to SCPI-1995.0 command set
IEEE/IEC bus	to IEC 625 (IEEE 488)
Serial interface	9-pin sub-D connector to EIA-232E; 1200, 2400, 4800 and 9600 baud
AUX connector	BNC connector as signalling output or trigger input (TTL)
General data	
Power supply	
AC supply	100 to 240 V, 50 to 60 Hz or 100 to 120 V, 400 Hz; 35 VA, max. 0.4 A
Battery	with option NRT-B3, operating time approx. 8 h with one NRT-Z power sensor and option NRT-B1; recharging within 2 hours in quick-charge mode
Dimensions	219 mm × 103 mm × 240 mm
Weight	3.5 kg with all options

Power Sensors NRT-Z43/-Z44

Measurement channels	2 (for forward and reverse power)
Forward dir. 1 → 2	standard for all measurement functions
2 → 1	only for measurement of average and burst average power (at low levels)
Measurement functions	forward power and reflection
Power parameters	average, burst average, envelope peak, peak-to-average ratio and complementary cumulative distribution function (CCDF)
Reflection	return loss, SWR, reflection coefficient, reverse power
Range selection	automatic
Video bandwidth	4 kHz, 200 kHz and "FULL" available for all power parameters except average power measurement
Frequency response correction	upon input of RF frequency, the stored correction factors of both measurement channels being taken into account
RF connectors	N (female) on both ends
Remote control	via serial RS-422 interface, 6-pin LEMOSA connector

General data

Power supply	6.5 to 28 V, approx. 1.5 W
Length of connecting cable	1.5 m
Length of extension cable	max. 500 m with 12 V supply voltage (via NRT-Z3, NRT-Z4 or line-operated NRT) max. 30 m with 7 V supply voltage (battery-operated NRT)
Dimensions (W x H x D)	120 mm x 95 mm x 39 mm
Weight	0.65 kg

Power measurement with NAP power sensors and option NRT-B1

Measurement channels	2 identical channels (for forward and reverse power)
Range selection	automatic
Frequency response correction	with NAP-Z7 and NAP-Z8 under consideration of calibration factors
Zero adjustment	with RF level switched off, duration approx. 5 s
RF connectors	N male/N female (NAP-Z6: 7/16 male, 7/16 female)
Length of connecting cable	1.5 m

Environmental conditions for NRT and Power Sensors NRT-Z and NAP-Z

Temperature range	specifications to IEC 68-2-1, IEC 68-2-2 and MIL-T-28800D, class 5
Operating	-10 to +55°C
Specifications met	0 to 50°C (unless otherwise stated)
Storage	-40 to +70°C
Climatic load	+25/40°C cyclic at 95% rel.humidity (non-condensing) to IEC 68-2-30

Ordering information

Power Reflection Meter		NRT	1080.9506.02
Power Sensors NRT (incl. V-NRT software)			
30 (75) W, 0.4 to 4 GHz		NRT-Z43	1081.2905.02
120 (300) W, 0.2 to 4 GHz		NRT-Z44	1081.1309.02
Power Sensors NAP			
35 W, 25 to 1000 MHz		NAP-Z3	0392.6610.55
110 W, 25 to 1000 MHz		NAP-Z4	0392.6910.55
350 W, 25 to 1000 MHz		NAP-Z5	0392.7116.55
1100 W, 25 to 1000 MHz		NAP-Z6	0392.7316.56
200 W, 0.4 to 80 MHz		NAP-Z7	0350.8214.02
2000 W, 0.2 to 80 MHz		NAP-Z8	0350.4619.02
20 W, 35 to 1000 MHz		NAP-Z10	0858.0000.02
200 W, 35 to 1000 MHz		NAP-Z11	0852.6707.02
Options			
Interface for NAP-Z Power Sensors		NRT-B1	1081.0902.02
2 rear inputs for NRT-Z Power Sensors		NRT-B2	1081.0702.02
Battery supply with built-in charger and NiMH battery		NRT-B3	1081.0502.02
Extras			
NiMH Battery		NRT-Z1	1081.1209.02
Extension Cable			
for NRT-Z Power Sensors	10 m	NRT-Z2	1081.2505.10
	30 m	NRT-Z2	1081.2505.30
for NAP-Z Power Sensors	25 m	NAP-Z2	0392.5813.02
RS-232-C Interface Adapter for NRT-Z Power Sensors including AC Power Supply		NRT-Z3	1081.2705.02
PC Card Interface Adapter for NRT-Z Power Sensors		NRT-Z4	1120.5005.02
Carrying Bag with Straps and Pocket of Accessories		ZZT-222	1001.0500.00
19" Rack Adapter		ZZA-97	0827.4527.00

1) Dependent on measurement function.

2) Values in []: 2→1 forward direction (if different from 1→2 forward direction).

3) Sensor-dependent.

Directional Power Meter NAS

1 MHz to 1990 MHz

10 mW to 1200 W

Convenient and precise power and SWR measurements in the entire field of radiotelephony

Photo 40346

Brief description

Directional Power Meter NAS is the ideal servicing unit wherever power and SWR of all kinds of radio equipment have to be measured. Insertion units for mobile radio make the NAS a versatile unit and an investment for the future.

Main features

- Two moving-coil meters
- Autoranging
- Battery operation
- Automatic switchoff
- High EMI immunity
- Excellent price/performance ratio

Operation

Operation of the NAS is extremely simple and reliable thanks to microprocessor control. Forward and reflected power or forward power and SWR are simultaneously indicated on two large meters. Indication of SWR does away with the cumbersome use of tables.

Insertion units

Insertion units are either plugged to the side of the NAS or connected via a 1.5 m long cable for measurements at test points that are difficult to reach. Each insertion unit contains its individual calibration data which are read by the NAS and considered in the measurement results.

GSM 900/1800/1900 applications

Insertion Units NAS-Z6 and -Z7 measure the peak envelope power (PEP) of the clocked signal with due consideration of the timing laid down in the GSM specifications. Therefore the insertion units are ideal too for measurements on mobile stations which according to definition are sending signals in only one of the eight timeslots. Transient overshoots of the signal bursts are eliminated by a signal-controlled circuit so that the forward and reflected power as well as the SWR can be correctly measured and indicated.

Standard applications

The standard Insertion Unit NAS-Z5 with its wide frequency range is suit-able for almost any application and practically covers all commercial analog RT services including air navigation.

Shortwave applications

Insertion Units NAS-Z1 and -Z2 have been especially designed for the frequency range up to 30 MHz. NAS-Z2 is for powers up to 1200 W for use in long-range shortwave communication systems.

Terminated power measurements

For measurements on transmitters, a Termination NAZ 10 or NAZ 30 acting as a dummy antenna is connected to the output of the insertion unit.

Directional Power Meter NAS

Specifications in brief: basic unit

Display	two moving-coil meters for forward and reflected power, plus SWR indication
Range selection	automatic or manual, separate for forward and reflected power
Accuracy (18°C to 28°C)	±1.5% of selected range + error of power sensor
Additional uncertainty at temperatures >28°C and <18°C	≤0.25% of rdg/°C
Automatic switchoff	approx. 1 h after last keystroke
General data	
Power supply	5 dry batteries IEC R20, service life >150 h (alkaline-manganese batteries)
Dimensions (W x H x D); weight	210 mm x 145 mm x 90 mm; 2 kg

Ordering information

Directional Power Meter	NAS	0828.6017.02
Insertion Unit	NAS-Z1	0828.6317.02
	NAS-Z2	0828.6417.02
	NAS-Z3	0828.6517.02
	NAS-Z5	0828.6717.03
for GSM900	NAS-Z6	0828.6723.02
for GSM 900/1800/1900	NAS-Z7	0828.6746.02

Extras

Connecting Cable (1.5 m) for detached operation of insertion units	NAS-Z9	0828.6969.02
Carrying Bag	NAS-Z10	0828.6917.02
Termination	NAZ 10	NAZ 30
Power-handling capacity (for 1 min)	10 W (15 W)	30 W (50 W)
Frequency range	0 to 2 GHz	0 to 4 GHz
VSWR	≤1.15	≤1.1 to 2 GHz
Connector, impedance	N male, 50 Ω	N male, 50 Ω
Order number	1029.2408.02	1029.2508.02

Specifications in brief: Insertion Units NAS-Z

Model	**NAS-Z1**	**NAS-Z2**	**NAS-Z3**	**NAS-Z5**	**NAS-Z6**	**NAS-Z7**
Frequency range	1 MHz to 30 MHz	1 MHz to 30 MHz	25 MHz to 200 MHz	70 MHz to 1000 MHz	890 MHz to 960 MHz[1)]	890 MHz to 960 MHz[1)] and 1710 to 1990 MHz
Power measurement range	0.01 W to 120 W	0.1 W to 1200 W	0.01 W to 120 W	0.01 W to 120 W	0.01 W to 120 W	0.01 W to 30 W[6)]
Accuracy (of rdg)	±4.5%	±6.5%	±5.5%	±6.5%[2)]	±5.5%	±6/8.5% (≤20 W)[5)], ±7/9.5% (<30 W)[5)]
SWR	<1.07	<1.07	<1.07	<1.07[3)]	<1.1	<1.15
Directivity	>30 dB	>30 dB	>30 dB	>30 dB[4)]	>26 dB	>26 dB

Connector, characteristic impedance	N female, 50 Ω
Dimensions (W x H x D); weight	55 mm x 120 mm x 90 mm; 0.7 kg

1) Useful frequency range: 100 to 1000 MHz for NAS-Z6, 850 to 2000 MHz for NAS-Z7 (with wider error tolerances).

2) 100 to 1000 MHz; 75 to 100 MHz: –11 to +5.5% of rdg; 70 to 75 MHz: –15 to –5.5% of rdg.

3) f <500 MHz; at f ≥500 MHz: <1.1.

4) f <500 MHz; at f ≥500 MHz: >26 dB.

5) Wider error tolerances are valid within a frequency range of 1880 to 1990 MHz.

6) Up to 100 W with wider error tolerances.

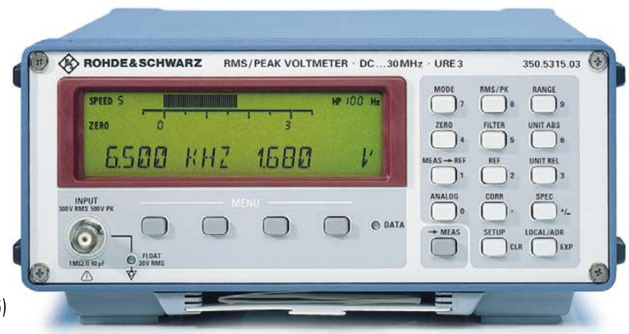
RMS Voltmeter URE2, RMS/Peak Voltmeter URE3

URE2: DC, 10 Hz to 25 MHz

URE3: DC, 20 mHz to 30 MHz

URE2 and URE3:

50 µV to 300 V (AC); 0 to 300 V (DC)



URE3 (photo 43236)

Brief description

URE2 is a broadband RMS voltmeter featuring extremely high accuracy and speed. A patented rectifier circuit allows measurement of signals with a crest factor of up 7 and frequencies of up to 25 MHz.

RMS/Peak Voltmeter URE3 further enhances the range of applications due to its greater frequency range and higher accuracy, built-in frequency counter and additional peak-responding rectifier.

Fields of application

- Level measurements in audio range
- Interference measurements on switch-mode power supplies
- Measurement of extremely fast dialling signals and detection of simultaneously transmitted supply voltages in radiotelephony
- Automatic quality control of audio and video tapes
- High-frequency measurements in digital magnetic storage and optical data storage
- Peak weighting in video measurements (sync signals)
- Secondary calibration standard

Main features

- True RMS weighting for AC and AC + DC
- More than 30 measurements/s
- 4½-digit display and analog display with selectable scale
- Very high measurement accuracy
- Highpass and lowpass filters
- Relative measurement, maxima/minima
- Convenient menu-guided operation
- Use of commercial probes, taking into account their division factor in the displayed result
- IEC bus (IEEE488)

Additional features of URE3

- Peak-value measurement (positive, negative, peak-to-peak) without tilts and overshoots
- Fast RMS measurement even of very low-frequency signals
- Frequency measurement up to 30 MHz
- Ultrahigh measurement accuracy through automatic frequency response correction
- In/out option: dual-channel analog output, ready output, trigger input, TTL frequency counter input

Characteristics

Measurement accuracy

A patented rectifier circuit with microprocessor-controlled autocalibration makes for the outstanding measurement characteristics of URE2 and URE3. In order to further enhance the accuracy, correction factors are determined for each instrument and measurement range and stored in a nonvolatile memory.

A zero function allows noise voltages and the inherent noise to be compensated for, the measurement accuracy being thus increased in particular at low levels.

The measured frequency value is used by URE3 for an internal frequency response correction. This method increases the accuracy mainly at the higher frequencies. Distortion-free measurement of signals is ensured by:

- high input impedance
- low input capacitance
- highpass and lowpass filters that can be switched in to suppress hum or high-frequency noise voltages

Specifications in brief: URE2

Measurement functions	RMS value, DC voltage
Range selection	automatic or manual
Input/impedance	BNC connector, floating/1 MΩ ‖ 40 pF
Display	LCD, 4½-digit readout, digital and analog in V, W, dBV, dBm, dBµV or dBu; difference, deviation in % or dB and ratio to a reference value
Remote control	to IEC625-2

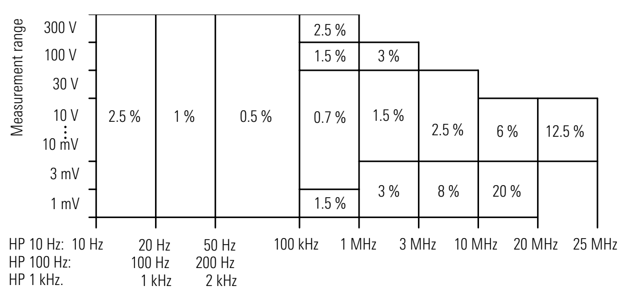
Specifications in brief: URE2

RMS measurement

Voltage measurement range	50 mV to 300 V
Ranges	1 mV to 300 V, 10 dB steps
Maximum reading	3800 or 12000 counts
Frequency range AC coupling	10 Hz to 25 MHz
Frequency range AC + DC	DC, 10 Hz to 25 MHz
Selectable lowpass filters	20 kHz, 100 kHz Butterworth (3 dB cutoff freq., 40 dB/decade)
Selectable highpass filters	10 Hz, 100 Hz, 1 kHz (lower meas. limit, AC component in AC + DC)
Time of triggered measurement	32 ms to 1.3 s (selectable; shortest meas. time with 1 kHz highpass only)
Maximum crest factor (S)	7 for nominal range
Measurement uncertainty for non-sinusoidal voltages (spectral components up to 25 MHz)	S <5: <1%, S <7: <3% (for S <3: included in basic error)

DC voltage measurement, general data same as URE3

DC voltage measurement	see URE3
General data	see URE3



Accuracy of RMS measurement (T_{amb} = 23 ±5°C), plus 10 counts for DC coupling (inherent noise taken into account by zero function)

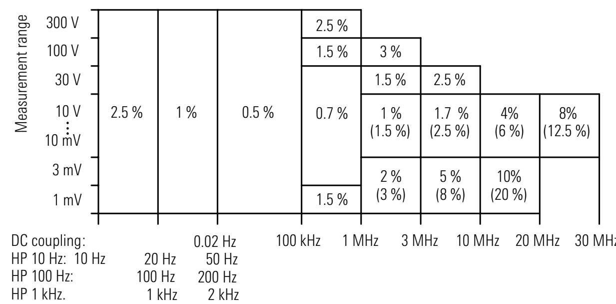
Specifications in brief: URE3

Measurement functions	RMS/peak value, DC voltage, frequency
Ra nge selection	automatic or manual
Input	BNC connector, either floating or grounded, switch-selectable
Input impedance	1 MΩ ∣∣ 40 pF
Display	backlit LCD, $4^1/_2$-digit level and 5-digit frequency indication, digital and analog in V, W, dBV, dBm, dBmV, dBu or Hz; difference, deviation in % or dB and ratio to a reference value
In/out option	two simultaneous analog outputs (level and frequency), frequency input, trigger input, ready output
Remote control	to IEC 625-2

RMS measurement

Voltage measurement range	50 mV to 300 V
Ranges	1 mV to 300 V, 10 dB steps
Maximum reading	3800 or 12000 counts
Frequency range AC coupling	0.02/10/100/1000 Hz to 30 MHz
Frequency range AC + DC	same as AC coupling, plus DC compon.
Selectable lowpass filters	same as URE2, plus 1 MHz Bessel
Selectable highpass filters	same as URE2
Time of triggered measurement	32 ms to 60 s (selectable; shortest meas. time with 1 kHz highpass only)
Maximum crest factor (S)	7 for nominal range

Measurement uncertainty for non-sinusoidal voltages same as URE2



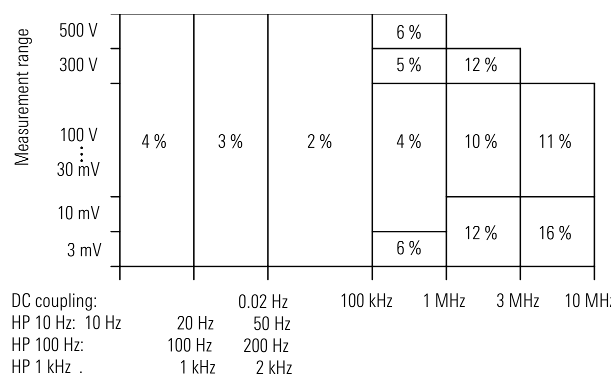
Accuracy of RMS measurement (T_{amb} = 23 ±5°C), plus 10 counts for DC coupling (inherent noise taken into account by zero functions); values in parentheses without frequency response correction

Peak measurement

Voltage measurement range	0.1 mV to 500 V
Ranges and resolution	3 mV to 1000 V, 10 dB steps
Maximum reading	1200 or 3800 counts
Frequency range AC coupling	10/100/1000 Hz to 10 MHz
AC + DC	DC, 0.02 Hz to 10 MHz
Selectable highpass/lowpass filters	same as RMS measurement
Time of triggered measurement	65 ms to 60 s (selectable; shortest measurement time with 1 kHz highpass or DC coupling only)

Frequency measurement

Frequency range	0.02 Hz to 30 MHz
Display	5 digits
Time of triggered measurement	75 ms to 60 s (selectable)



Accuracy of peak measurement (T_{amb} = 23 ±5°C), sinewave signal

Sensitivity	min.10 dB below nominal range

DC voltage measurement

Voltage measurement range	0 to ±300 V
Ranges	10 mV to 1000 V, 20 dB steps
Maximum reading	12000 counts
Time of triggered measurement	32 ms to 60 s (selectable)
Accuracy	±(0.1% of rdg +10 counts)

General data

Power supply	100/120/240 V ±10%, 230 V –10%/+6% 47 to 440 Hz (25 VA)
Dimensions (W x H x D); weight	219 mm x 103 mm x 350 mm; 4.5 kg

Ordering information

RMS Voltmeter	URE2	0350.5315.02
RMS/Peak Voltmeter	URE3	0350.5315.03
Input/Output Option	URE3-B2	0351.1513.02

Digital Multimeter R6552

High-speed and high-resolution true RMS digital multimeter

Brief description

R6552 is a high-speed and high-resolution true RMS digital multimeter which can be used for instance for measuring the current consumption of mobile phones. The product is ideal for integration into test systems and its various measurement modes allow reliable determination of current consumption of mobile phones in different operating modes.

Main features

- Display range up to 319999 (5½ digits)
- Full remote-control capability via IEEE/IEC bus and RS232
- 12 different settings for mesurement of DC voltage/current, AC voltage/current, 4- and 2-wire resistance, frequency and diodes
- Resolution of 0.1 μV or 100 μΩ for resistance measurements
- True RMS measurement of AC voltage/current even of distorted waveforms
- Measurement of DC component of AC+DC currents or voltages
- Max. sampling rate 1000 samples/second
- FAST, MED and SLOW setting modes
- BURST and LONG-IT modes for measurement of standby current of PDC, PHS and other mobile phones
- External trigger input, end-of-measurement signal output
- NULL adjustment, smoothing, range selection, dB/dBm display, comparator function and MAX/MIN functions
- High-speed autoranging
- High-intensity fluorescent display

Specifications in brief

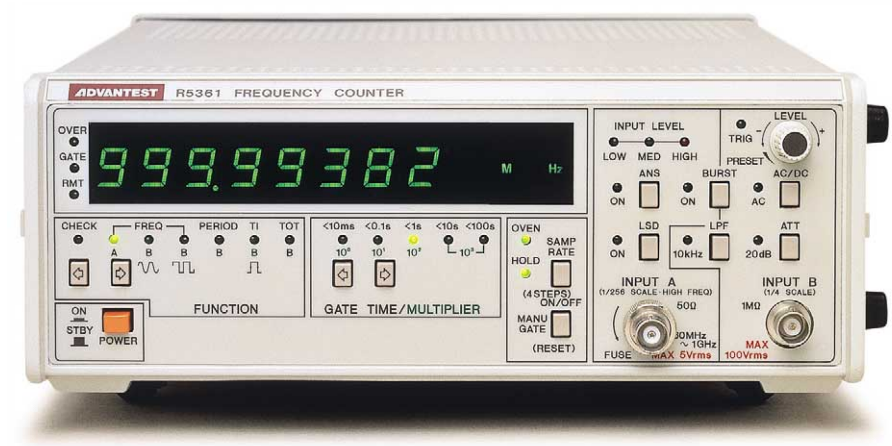
Max. display range	319999 (5½ digits)
Resolution for DC voltage measurement	0.1 μV
Resolution for resistance measurement	100 μΩ
Max. sampling rate	1000 samples/s (for BURST measurement)
Accuracy	
DC voltage	±0.01% of reading
AC voltage	±0.06% of reading
DC current	±0.05% of reading
Integration time for averaging repetitive signals	can be set in steps of 10 ms between 100 ms and 60 s
GPIB and RS-232C interfaces	standard
Data memory	for up to 10 000 measured values
Memory	for four instrument settings

Ordering information

Digital Multimeter	R6552

Universal Counters R5361B, R5362B

High-quality universal counters for general-purpose laboratory use up to 1 GHz or 3 GHz



R5361B (photo 43388-1)

Brief description

The R5360 family is a high-grade line of universal counters for general-purpose laboratory and field use up to 1 GHz or 3 GHz. Optional reference oscillators afford stability of up to 5 x 10^{-10}/day. A great variety of settings is available to facilitate measurements, control and analysis and to reduce measurement times.

Main features

- 9-digit display with 2 digits overflow
- 10 mV sensitivity up to 900 MHz
- Reciprocal method up to 1 MHz for short measurement times, eg 0.1 Hz resolution of 100 kHz signal for 1 s measurement time
- Masking function for precise time interval measurements of noisy signals and signals with superimposed noise pulses, eg relay bounce
- High-frequency signal input A allows burst signal measurement by synchronizing the time gate signal to the burst signal. Accuracy can be further enhanced by setting a delay
- Lowpass filter of low-frequency input B suppresses noise signals
- Input C incorporates RF protective fuse against high input levels
- Auto trigger facilitates instrument setting
- The counters are available with either GPIB plug-in interface or BCD output for automatic test assemblies
- In addition to AC supply operation, the counters can be operated from DC supply of +10 V to 30 V
- The use of Calculation Unit TR1644 as an external accessory adds further analysis functionality, eg arithmetic operations between the two signal inputs, frequency deviation, comparator function and min./max. value storage

Options

Reference Timebase

- Standard stability
  – 5 x 10^{-8}/day, 2 x 10^{-7}/year
- Stability with option
  – 20: 2 x 10^{-8}/day, 1 x 10^{-7}/year
  – 21: 5 x 10^{-9}/day, 8 x 10^{-8}/year
  – 22: 2 x 10^{-9}/day, 5 x 10^{-8}/year
  – 23: 5 x 10^{-10}/day, 2 x 10^{-8}/year

Universal Counters R5361B, R5362B

Specifications in brief

Frequency

Frequency range	R5361B	R5362B
Channel A	60 MHz to 1 GHz	60 MHz to 3 GHz
Channel B	0.2 mHz to 100 MHz (1 MΩ)	
Frequency accuracy	± timebase ± 1 digit	
Frequency display/digits	9, with 2 digits overflow	
Frequency resolution		
Channel A	6-digit /1 to 9 ms gate time 9-digit /1 to 9 s	
Channel B	µHz to kHz	
Gate times	10 ms to 100 s	
Clock rate	10 ms, 80 ms, 320 ms, 2.5 s, HOLD	
Period measurement	10 ns to 5000 s, channel B	
Resolution	see frequency, channel A	
Time interval measurement	200 ns to 9000 s, channel B	
Event counting	0 to 10^{10}, DC to 50 MHz	

Reference frequency (timebase)

Stability standard	5×10^{-8}/day, 2×10^{-7}/year
Option 20	2×10^{-8}/day, 1×10^{-7}/year
Option 21	5×10^{-9}/day, 8×10^{-8}/year
Option 22	2×10^{-9}/day, 5×10^{-8}/year
Option 23	5×10^{-10}/day, 2×10^{-8}/year
Reference frequency output	10 MHz, 1 V_{pp}, 50 Ω
External reference input	1, 2, 5, 10 MHz, 1 to 5 V_{pp}, 500 Ω

Input voltage

Channel A	
f < 900 MHz	10 mV to 5 V_{pp}, (+27 dBm)
900 MHz < f < 1500 MHz	20 mV to 5 V_{pp}, (+27 dBm)
1500 MHz < f < 2800 MHz	35 mV to 5 V_{pp}, (+27 dBm)
2800 MHz < f < 3000 MHz	50 mV to 5 V_{pp}, (+27 dBm)
RF attenuator	20 dB, automatically switched in for signals >500 mV_{rms}
Overload protection	12 V_{rms}
Level monitor	low, medium, high
Channel B	
RF attenuator 0 dB	
f < 10 kHz	25 mV to 10 V_{rms}
10 kHz to 60 MHz	25 mV to 1 V_{rms}
60 MHz to 100 MHz	25 mV to 500 mV_{rms}
RF attenuator 20 dB	
f <10 kHz	500 mV to 100 V_{rms}
10 kHz to 60 MHz	500 mV to 10 V_{rms}
60 MHz to 100 MHz	500 mV to 5 V_{rms}

Input impedance

Channel A	50 Ω
Channel B	1 MΩ, 25 pF
Trigger (channel B)	–1.2 V to +1.2 V, continuously variable
Noise suppression	
Channel A	automatic, ANS
Channel B	10 kHz lowpass filter, switch-selected

General data

Display	7-segment green LED
Settings memory	1
Analysis functions	with Calculation Unit TR1644: comparator, frequency offset, difference, frequency deviation, standard deviation max./min. value storage, ppm deviation, average value, arithmetic operations
Nom./operating temperature range	0°C to +40°C
Storage temperature range	–20°C to +70°C
Power supply	200 V to 240 V AC ±10%, 100 V to 120 V AC ±10%, 48 Hz to 440 Hz
Power consumption	approx. 50 VA, DC 30 W
Dimensions (W x H x D)	240 mm x 88 mm x 360 mm
Weight	approx. 4.5 kg

Ordering information

Universal Counter

0.2 mHz to 1 GHz	R5361B
0.2 mHz to 3 GHz	R5362B

Extras

Calculation Unit	TR1644
GPIB Plug-In Interface	R13002B
Carrying Case	R16204A
Front Cover	A02801

"System integration with the aid of software and engineering efforts will be given more emphasis than ever before – and the development of powerful and convenient system solutions take on importance." (photo 43443-13)

Contents of Chapter 9

The future lies with systems

Customer-specific solutions are implemented to an increasing extent by integrating measuring instruments and specially developed devices into overall systems. This is proven by the valuable experience made with turnkey EMC test centers, type-approval test systems for mobile phones of digital radio networks, mobile test systems for coverage measurements and mobile phone production lines.

System applications

In numerous branches of industry measurements and tests often have to be carried out repeatedly on a series of DUTs, eg in

- incoming inspection: component or module tests
- production: automatic alignment
- quality assurance: testing at the various stages of production and final testing
- research & development: series measurements on prototypes
- service: long-time measurements (such as temperature) at defined test intervals

The quantity of devices under test required to make investments and software development worthwhile depends on the complexity of the measurement task. The necessary expenditure may even be justified for a few DUTs if a measurement is to be continuously repeated, eg at many different frequencies (intermodulation measurement of antenna amplifiers), or if a parameter is to be monitored as a function of time (long-term drift).

Project handling by Rohde & Schwarz

A high-performance measurement system requires extensive development and design efforts. The choice of the right instruments and components as well as their careful installation make for the high performance and avail-ability of a system.

System design at Rohde & Schwarz ensures full utilization of a large variety of measuring instruments of advanced technology and highest precision both of Rohde & Schwarz and other make. System responsibility lies always with Rohde & Schwarz, irrespective of the origin of the measuring equipment and individual system components.

Rohde & Schwarz has experienced and optimally trained staff to implement a project from initial planning through to the operational system.

Our range of test systems

- Production test systems, board testers
- Type-approval test systems for mobile phones
- Coverage measurement systems for all modern radio networks
- EMC test systems and test centers

Production test systems, board testers – a strong concept

A development and production chain is only as strong as its weakest links which used to be highly complex measurement systems and time-consuming final testing. Market launch of the products was thus held up. Today, production test systems and type-approval systems from Rohde & Schwarz can be used wherever electronic equipment is produced. Efficient solutions in this field range from precompliance test equipment through to complete production lines. In addition to the classical method of board testing, there are also completely new methods such as optical checking. The unique modular hardware and software concept of Rohde & Schwarz allows a large variety of test combinations with respect to alignment, RF test, optical check, board test, etc.

Our production test systems are tailored to the needs of the customers and provide overall solutions: measurements with DUT adaptation up to 2 GHz via test prods; with conveyor belts; networking within user-specific computer network; logistics; consulting and advice in the selection of suitable tests for optimization of measurement times and test depth.

Type-approval test systems for mobile phones of analog and digital radio networks

Test systems from Rohde & Schwarz, especially for type-approval testing, are at the leading edge in their field. Our customers are benefiting from this high innovation potential. Specialists at Rohde & Schwarz have implemented well in-time the latest requirements for type-approval measurements in the appropriate test systems and were able to use ultramodern measuring equipment off our production. This synergy of available equipment and new system applications brings about optimum results.

Thus it is for instance possible to achieve maximum test depth while ensuring the highest degree of ergonomics and operational reliability. And another great advantage is self-calibration. This means a whole bundle of benefits which the customer can utilize to make his products fit both for the future and present-day market.

Coverage measurement systems for all modern radio networks

Test systems from Rohde & Schwarz are not only used where electronics is produced but also where it is made to "work": in mobile radio networks for instance. Our range of mobile coverage measurement systems ensures full monitoring of analog and digital radio networks as well as smooth and best possible operation.

EMC test systems and test centers

Rohde & Schwarz supplies complete EMC test systems covering all aspects of this complex field. The manufacturer need no longer combine individual instruments – systems will do it. Whole EMC test chambers? No problem for Rohde & Schwarz: after handing over the turnkey system, all your staff trained by us has to do is to switch on the DUT and the test will be carried out fully automatically. This is to the benefit of test houses as well as manufacturers performing comprehensive EMI and EMS measurements themselves. The test systems from Rohde & Schwarz check for full compliance with all relevant standards.

Future-oriented design

Measurement and test systems from Rohde & Schwarz feature extremely flexible hardware and software concepts allowing adaptation to modified requirements any time.

Support

Test stations from Rohde & Schwarz are powerful instruments for increasing productivity in automated production. Rohde & Schwarz products include a complete service package, which allows the full performance of the system to be utilized from the very first day. This package includes training, application support, maintenance, fixture design, 24-hours spare parts service and a telephone hotline.

References

Measurement and test systems from Rohde & Schwarz are used to success all over the world: tailored to the needs of the customers, the test systems can be found at renowned industrial companies, test houses and government institutes – the impressive list of references can be supplied on request.

Service for systems

First-hand service

Rohde & Schwarz systems combine the latest achievements in hardware and software with the knowhow and experience gained over many decades. According to the Rohde&Schwarz system philosophy, the high level of competence does not stop with system development but is maintained during the operational life of the systems in terms of the services offered.

Hotline support, continuous updating of system software, fast replacement and repair of equipment and modules in case of a fault are essential prerequisites for high availability of an operational system.

Rohde&Schwarz offers complete packages and solutions for servicing the systems. The service concept is of modular structure and consists of unit blocks providing a whole series of services for hardware and software. Thus the user will be able to adapt the service to his specific system and needs.

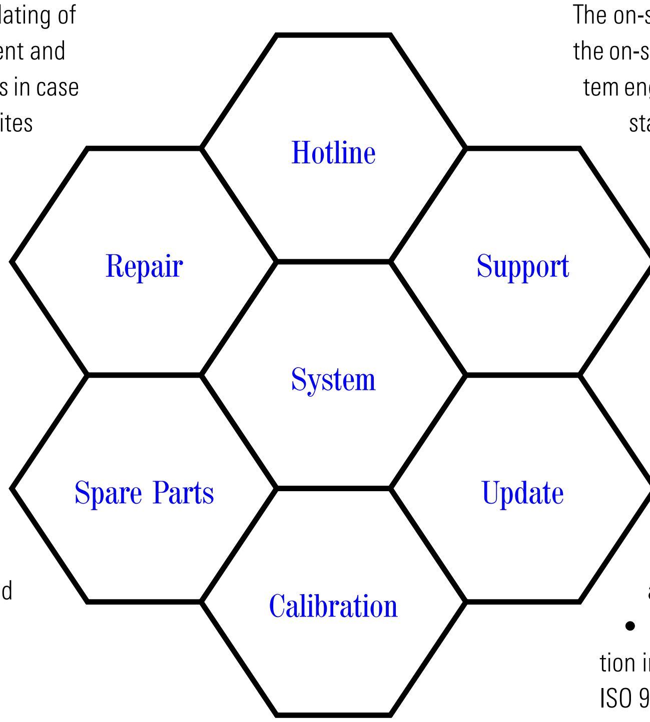
Services available

During warranty period

- Rohde & Schwarz warranty (included in price of system)
- Enhanced warranty service
  - Option: express support
  - Option: extended service time
- Startup service
- Calibration service

After warranty period

- After warranty service
  - Option: express support
  - Option: extended service time
  - Option: guaranteed availability (in conjunction with express support and calibration service)
- Calibration service



Service blocks

Enhanced warranty service

The enhanced warranty service supplements the standard warranty ser-vices of Rohde & Schwarz to satisfy already during the warranty period the high demands placed on system availability and offers a service time of eight hours and defined response time.

- Database-supported information system with direct customer access
- Hotline service
- Access to a pool of spare modules
- On-site repair, if necessary
- Escalation procedure

After warranty service

The after warranty service contains all the unit blocks of the enhanced warranty service plus the following:

- Repair of faults
- Supply of software updates

On-site startup service

The on-site startup service will give you the on-site support of an experienced system engineer during the critical phase of starting up your system. This support is to assure smooth transition to an efficient use of your system.

- Support in system handling
- Application support

Calibration service

The calibration service assures you that the parameters of your system will be checked at regular intervals and corrected if necessary.

- Calibration at specified calibration intervals in line with DIN ISO 9001/EN 21001
- Traceability of calibration to national or international standards
- Calibration reports and certificates
- On-site calibration possible

Service options

Express support

The express support is the ideal supplement both to the enhanced warranty service and the after warranty service. It ensures that any downtimes of your system will be kept to a minimum:

- Hotline service with a response time of 24 hours
- Enhanced equipment pool with express dispatch
- Express repair
- Quick on-site support

Guaranteed availability

This option in conjunction with the calibration service and the express support will assure you a system availability of more than 85% after expiry of the warranty.

Extended service time

If your working day lasts longer than eight hours, we can extend the service for your system up to 16 hours per day.

Hotline

Test systems (without board testers)

Telephone: +4989 4129-13607
Telefax: +4989 4129-13441

Production test systems (board testers)

Telefax: +498331-108225

Communication System Panel TS-CSP

Easy and fast integration of measuring instruments into production testing

Photo 43371

Brief description

Automatic test systems for functional tests and final testing in the production of electronic products require a large variety of DUT fixtures, power supplies and stimulus signals. Communication System Panel TS-CSP was developed for use in production test systems for efficient and cost-effective transmission of signals between DUTs and measuring instruments.

Simultaneous testing of several DUTs is made possible by flexible scaling and the large number of channels provided by TS-CSP.

Development costs incurred in the configuration, maintenance and modification of test systems can be reduced significantly through the use of TS-CSP.

Instead of a tangle of cables connecting the DUT fixture and the measuring devices, various relay boxes and even data acquisition cards and power supplies, switch matrix modules are used for DUT signal distribution.

Applications

- Functional test systems for telecommunication products such as mobile phones, cordless terminal equipment of all kinds and associated base stations
- Production testers for products from automation, sensor technology and telemetry sectors
- Automotive test systems
- Lab test sets

Main features

- Acquisition and switching of DUT signals for functional tests and final testing
- Scalable number of channels for multiple-panel board tests as well as simultaneous testing on several modules
- Efficient acquisition of RF signals using RF Switch Matrix TS-RFM
- Integrated analog measurement functions and flexible switching using Universal Switch Matrix TS-USM
- Input and generation of digital signals, adjustable signal levels
- Control via IEEE/IEC bus or high-speed PC card interface

Easy and fast system integration

Comprehensive driver support for C programming language has been made available under LabWindows/CVI for the TS-CSP system components. The driver software conforms to the international VISA standard drawn up to facilitate the generation of test programs using standardized software modules.

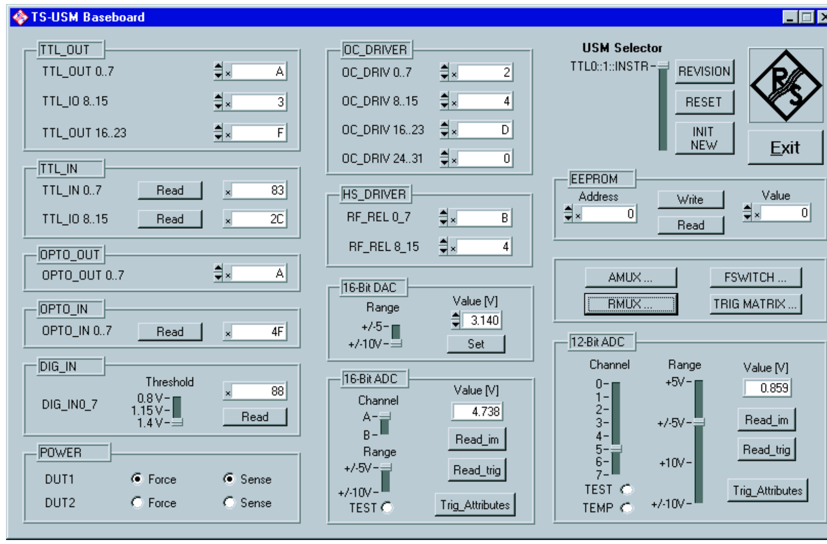
TS-CSP also features the hardware and software selftest functions that are required for use in production environments.

Based on this driver software there is an operating program for the communication system panel which allows the user to control the panel simply by mouse clicks. This reduces familiarization time to a minimum.

As the relay matrix modules too can be controlled via a GUI, the test engineer can put into operation and test the fixture wiring interactively.

As the relay matrix modules too can be controlled via a GUI, the test engineer can put into operation and test the fixture wiring interactively.

Communication System Panel TS-CSP



Interactive operation of the
Communication System Panel TS-USM

Specifications

Universal Switch Matrix TS-USM

Digital inputs	
TTL levels	8 channels
Variable input threshold	8 channels, software-configurable
Isolated by optocouplers	8 channels, TTL or 24 V levels
Digital outputs	
TTL levels	16 channels
Isolated by optocouplers	8 channels
Open collector driver	16 channels
TS-RFM control	32 channels
Digital I/O ports	
TTL levels	8 channels, can be switched as input/output or tristate
Analog inputs	
Test channels, 12 bit resolution	8 channels
Voltage ranges	6 channels with 0 to 5 V, ±5 V, 0 to 10 V, ±10 V 2 channels with 0 to 5 V, ±5 V, 0 to 10 V, ±10 V, 0 to 20 V, ±20 V, 0 to 50 V, ±50 V, 0 to 100 V, ±100 V
Test channels, 16 bit resolution	8 channels with differential measurement and multiplexer 1 channel with direct measurement
Voltage ranges	±2.5 V and ±5 V with multiplexer or ±5 V, ±10 V direct
Trigger inputs for A/D converter	
Trigger inputs	4 with separate matrix for crossbar switching, configurable
Analog output with 16 bit resolution	
Number of channels	1
Voltage ranges	±5 V, ±10 V
Power relays	2 DUT supply switches each with 4 semiconductor switches for switching all poles of the force and sense lines
Voltage range	max. 40 V (max. 6 A)
Multiplexers	
Relay multiplexer	16 floating reed relays, individually switchable
Configurations	2:1 multiplexer with a connecting relay between each relay pair, 4x 4:1, 2x 8:1, 1x 16:1 multiplexer or other configurations
Analog multiplexer	32 inputs and 8 outputs switched as 4 independent multiplexers
Configurations	2x 4:1 or 4x 8:1multiplexer
Fixed-voltage outputs	3.3 V, 1 A stabilized, short-circuit-proof 5.0 V, 1 A stabilized, short-circuit-proof ±12 V, 1 A stabilized, short-circuit-proof 24 V, 2 A unstabilized

RF Switch Matrix Module TS-RFM1	
RF relays	12
Frequency range	DC to 8 GHz, further specifications on request
RF Switch Matrix Module TS-RFM3	
RF relays	4
Frequency range	DC to 8 GHz, further specifications on request

Basic unit

Slots	5, cabinet height of 4 HU	
Control interface	GPIB or direct TTL with TTL I/O Interface PS-B11	
Rated temperature range	+5°C to +40°C	
Storage temperature range	–40°C to +70°C	
Power supply	100 V to 120 V, 200 V to 240 V 50 Hz to 60 Hz, 150 VA, automatic voltage selection	
Dimensions in mm (W x H x D)	465 x 198 x 495	4 HU
Weight (TS-CSP with 4 HU + TS-USM + TS-RFM3)	10 kg	

Ordering information

Communication System Panel		
Basic unit 4 HU	TS-CSP	1124.1504.04
Accessories supplied	power cable, fuses, operating manual	
Options		
Universal Switch Matrix TTL interface	TS-USM	1113.5503.02
Universal Switch Matrix GPIB interface	TS-USM	1113.5503.05
Fixture for TS-USM	TS-USMF	1124.3007.02
RF Switch Matrix	TS-RMF1	1124.2500.02
RF Switch Matrix	TS-RMF3	1124.2500.06
Extras		
19" Adapter for rackmounting	ZZA-411	1096.3283.00
TTL I/O Interface	PS-B11	1006.7303.04

Production Test Systems – Contents

Quality is measurable, quality is testable

Quality management
Quality management is one of the central aspects of modern electronics production. Whatever the size of the company, the quality of the products depends on the electronic components functioning perfectly. The introduction of lean production methods has placed new and greater demands on automatic testing techniques.

Economy

Product quality, product liability
Today, excellent product quality is not only important in giving the edge in international competition but also saves cost. Our test systems help to eliminate defects early in production, thus preventing the high costs involved in the removal of defects in the final stages of production or after delivery to the customer.

In-depth testing is possible due to the wide range of precise measuring facilities provided by the workstations and test stations from Rohde & Schwarz, so faults can be detected early in production and their cause removed immediately.

Start small – upgrade later

Test stations from Rohde & Schwarz are more than simply autonomous testers – they have specifically been designed for integration into development, production and service. Fixtures and programs can be exchanged directly between the testers. The systems can thus be used to maximum effect: all test stations can be utilized optimally at all times; if the unit under test is large, subsequent upgrading to larger systems is no problem; fixtures can be adopted for servicing at any time.

Due to the modular design of the Rohde & Schwarz test stations, investment decisions can be made to satisfy the requirements of today, and, at the same time, options be left open for expanding capacity or testing new products as well as for incorporating future test strategies or supplementary test facilities at a later date. Investments, costs of adaptation and running costs of the test stations can be optimized for different products and production methods.

Low follow-up costs
Budget-priced fixture sets can be offered thanks to a standardized fixture interface. Thus costs of adaptation are low, which is of major importance for products manufactured in small quantities only. The reliable and easy-to-service concept ensures high availability, so running costs are reduced to a minimum.

Electrical in-circuit test

Strategy
The electrical in-circuit test for a board checks all connections and the individual components independent of their environment.

This tried-and-tested method is an extremely reliable means of detecting and diagnosing the majority of typical manufacturing defects, such as shorts, opens, soldering and insertion defects. The influence of neighbouring components can be eliminated to a large extent, and a high degree of precision achieved, by means of 2-, 3-, 4- or 6-wire measurements, guarding and in-phase quadrature measurements. The measured values are stabilized, even under unfavourable conditions, by averaging, autocalibration and autodelay technique. The depth of testing is far superior to that of conventional prescreeners.

The electrical in-circuit test checks the following:
- Contact
- Shorts and opens
- Resistances, inductances and capacitances
- Impedances by magnitude and phase
- Diodes, Zener diodes, LEDs
- Transistors (current amplification)
- IC contacting with vectorless procedure
  - ICC (measurement of diodes)
  - Stick probe (capacitive sensor)
- Multipole components such as potentiometers, relays, operational amplifiers, optocouplers

Production Test Systems – Test strategies

Hybrid in-circuit test

Strategy
This test serves for checking digital and hybrid (mixed analog/digital) boards from simple to complex VLSI boards. The digital tests check the functions of each digital IC and the correctness of insertion. The influence of neighbouring components is eliminated by means of controlled backdriving, digital guarding and disabling.

Procedure
Functional and digital in-circuit tests, wide-ranging patterns with high clock rate of up to 10 MHz, test voltage up to ±15 V or 0 to 30 V, algorithmic patterns with loops, subroutines and conditional branches.

- All the procedures of analog in-circuit test
- Bus test and automatic diagnosis in the event of bus conflicts
- Signature analysis (CRC) for RAMs, PROMs
- Cluster test

Vectorless IC test
Analog and digital ICs, for which a test model is not available in the library (customer-specific circuits, FPGAs, etc), are tested by measurement using analog vectorless methods. The aim of this test is to verify that all component pins are soldered and that it is the correct IC with the correct orientation.

IC check method
Node impedance measurement:
Measurement of the ohmic resistance of each pin to GND and VCC. If all parallel circuits are relatively high impedance with respect to the pin, a significant difference is shown if the pin is not soldered or the IC twisted.

- Very fast method
- Does not work with bus nodes
- Free of charge (standard test function)

Stick-Probe method
Contact-free method:
A sensor positioned above the IC detects the current flowing through the IC-Pins.

- Also works with bus nodes
- Very high recognizing of shorts even at NC pins

Combined IC check and Stick-Probe
- First all "simple" nodes are checked with the aid of the IC check method (minimum debug effort, no additional mechanical parts)
- All other nodes are tested by Stick-Probe

Analog functional test

Strategy
Defined analog input signals are applied to the unit under test and the output signals are measured. This test checks all functions of the UUT and the interaction of its components.

Procedure
Rohde & Schwarz test stations provide all standard signals and measurement functions via appropriate stimulus and measurement modules. The signals are accessible either via very short paths at special fixed pins, or via the signal bus and the switch module at any pin.

The modules are equipped to trigger and synchronize with each other, the UUT, or external instruments. External IEEE/IEC bus instruments can be connected to the test stations.

Digital functional test

Strategy
The digital functional test checks all functions of a digital circuit as close as possible to operating conditions.

It covers all technologies from SSI to VLSI, microprocessors, ASICs and SMDs. Digital input patterns are applied, and the output signals are measured and compared with the reference patterns.

Due to the varying complexity – from simple to complex VLSI boards – and the widely differing timing requirements, the user is given the opportunity of choosing the most economical of the various testing procedures available. The type of fixture can thus also be varied via the connectors of the UUT, the bed-of-nails (including 2-stage fixture), a clip or probe.

Procedure
Overall functional test with reference patterns: digital patterns (vectors) are applied to the connections of the UUT in realtime mode and with a high clock rate; the response is then measured and compared with the reference values. The patterns can be generated algorithmically with loops, subroutines and conditional branches, whereby the program flow is determined by the UUT.

Production Test Systems – Test strategies – Overview of TSA System Family

- The cluster test checks the functions of associated parts of a circuit. Subdividing the circuit into several different parts makes the tests simpler and more transparent. The clusters are isolated by means of backdriving
- Signature analysis is used to measure complex patterns and check them in reduced form
- Logic-state display performs the function of a logic analyzer during debugging and when unknown signals are recorded

Combinational test

The combinational test unifies various test strategies in a single tester with one program and one fixture, eliminating the handling time for separate testers. The user can select a combination which is specially tailored to his needs. This concept allows the peculiarities of customer-specific requirements to be taken into account, for instance the production environment, production quality, test strategy, complexity of UUT and special factors such as stipulated or impermissible test procedures, inaccessible nodes or varnished boards.

Common test functions

- In-circuit test
- Analog IC check (ICC)
- Analog functional test

Common options

- Contact-free IC test method (Stick-Probe, only in combination with TS-AMV module)
- IBX interface extension for special signals such as high current/high voltage, coaxial/RF

Analog Prescreener (MDA) and Analog Functional Tester TSAC

Additional test capabilities and features

- Static digital test
- Max. 1216 pins
- Max. data rate 50 kHz

Analog Prescreener (MDA) and Analog Functional and Performance Tester TSACP

Additional test capabilities and features

- Static digital test
- Power test
- High-power switch module
- Max. 1152 pins
- Max. data rate 50 kHz

Additional options

- HV/HC stimulus and measurement modules
- Loads
- High-voltage-protected adaptation

Combinational Tester TSA

Additional test capabilities and features

- Dynamic digital functional test
- Hybrid in-circuit and functional test

Power Test Station TSAP

Additional test capabilities and features

- Power test
- Dynamic digital functional test
- Hybrid in-circuit and functional test
- High-power switch module
- Max. 1024 pins
- Max. data rate 10 MHz (sensor resolution 10 ns)

Additional options

- HV/HC stimulus and measurement modules
- Loads
- High-voltage-protected adaptation

Test Workstation TSA

TSA – extremely compact board test system, adaptable to complexity of units under test and test requirements

Photo 40413-1

Brief description

Test Workstations from the TSA Family are powerful benchtop test systems for testing loaded printed circuit boards and modules in production and service. The test workstations meet the test requirements of industrial and consumer electronics sectors, such as communications, measurements, control engineering, automobile and accessories industry. TSA systems are suitable both for small-batch production entailing boards of many different types, and mass production.

Main features

- In-circuit, functional or combinational tests
- Low initial investment making for excellent price/performance ratio
- Low costs of adaptation due to automatic program generation
- Low repair costs of UUTs thanks to automatic fault diagnosis
- Paperless repair and quality management
- High throughput
- In-depth testing and fault location
- Easy integration into systems thanks to 19" design
- Networking with CIM
- Compatible with Rohde&Schwarz tester family TSU
- Fast amortization

Design

Test unit

The test unit is the core of the system; it has 23 slots for accommodating the stimulus and measurement modules, a fixture interface with support plate and a UUT and system power supply. Extremely short signal paths ensure high-quality signal transmission between UUT and measurement modules. Due to its VLSI design, the 19" unit features on a minimum of space a maximum of measurement capabilities that were previously not possible. Moreover, the TSA is ergonomically designed and satisfies even the most stringent requirements regarding operating convenience.

Fixture concept (pylon system)

The proven fixture system transfers the signals between measurement modules and UUT. User-specific connectors can be plugged into three free ports of the fixture interface. The type of fixture is determined by the selected test strategy and the UUT. Two vacuum connectors with built-in valves allow single-chamber, double-chamber or two-stage fixtures with bed-of-nails to be used.

Pneumatic, mechanical or double-sided SMD fixtures are also available. When fixtures are used that make contact with the UUT via the connectors, in-depth measurements can be made within the circuit via clips and a probe.

Modules

The modules inserted into the 23 slots determine the measurement functions. The control module performs general transfer and control tasks. The remaining 22 slots can be filled up from a selection of 24 analog stimulus and measurement modules, digital modules, switch and application modules so that practically

Test Workstation TSA

any requirement can be fulfilled. Distributed intelligence achieved by integrated processors on different modules makes for high measurement speed.

Expansions
For special applications, external devices can be controlled via the IEEE/IEC bus which is fitted as standard. The signals are connected via various switch modules (DC, AC, video and power up to the line-voltage range) and routed to the fixture and UUT via suitable contacts. The user can integrate special circuits into the test workstation using a universal application module.

DC source	up to 10 V/200 mA, 4-quadrant operation
Voltage sources	up to 10 V/5 mA (2 ea.)
High-voltage buffer	up to –100 V to +100 V (200 V pp)/10 mA/10 kHz
Isolation amplifier	±10 V/5 mA/10 kHz
Voltage/current measurement unit	up to 100 V DC/AC max. 1 A
Voltage measurement unit	up to 500 V DC/AC
Arbitrary waveform generator	up to 20 V pp/16.8 M samples/sec, 2 channels (with high-voltage buffer and isolation amplifier up to 200 V pp floating)
Waveform analyzer	max. 500 V pp/10 MHz sampling rate 2 channels with timing measurement unit
Integrated switch matrix	12 analog busses, 8 trigger busses

Measurement configuration

AMV configuration (can be retrofitted in existing systems)
All systems of the TSA family are equipped with the multifunction module AMV (TSS 5.0 or higher required). In addition to a complete high-speed in-circuit measurement unit the AMV features comprehensive functional test capabilities in the DC/AF range covering practically any requirements (see table). An intelligent trigger concept allows extensive test sequences to be executed in absolute realtime. The unique search and analysis functions of the dual-channel waveform analyzer that are included in the module's firmware are top features and outperform many an oscilloscope.

AMV completely fits into the existing range of modules. It can be used instead of the VMM/CMM/DCS modules to replace the in-circuit measurement unit (existing in-circuit test programs can still be used with minor modifications) or used in addition, allowing practically any combination with the simultaneous use of up to four AMV modules in a system. The in-circuit measurement unit made up of the VMM/CMM/DCS modules or of the AMV covers three or two slots in the front.

With this range of comprehensive measurement functions implemented for the first time in the AMV and downloading of the complete operating firmware, AMV is setting new standards in terms of functionality, compact size and future-proof design.

Stimulus and measurement modules are inserted into the rear of TSA (photo 38860)

Test Workstation TSA

Analog in-circuit test

- Voltage and current measurement modules VMM, CMM for DC voltage measurement from 80 µV to 100 V and DC current measurement from 8 nA to 256 mA
- Alternatively: AMV (see AMV configuration)
- DC stimulus module DCS as a four-quadrant current/voltage source up to 25.6 V and 200 mA (can also be used in addition to AMV)

Hybrid in-circuit test

- Analog in-circuit measuring unit (VMM, CMM, DCS or AMV)
- Timing and address modules (TIM, ADM) for realtime control of timing and sequences of dynamic digital test (see digital functional test)
- Driver/sensor/switch modules

Analog functional test

- Analog multifunction module AMV (see explorer configuration)
- Voltage source module (VSM): provides four floating programmable sources up to 10 V. Two of them can be used for programming the programmable power module (PPM)
- DC stimulus module (DCS)
- Fixed voltages 5 V/8 A, 2 x 12 to 15 V/2 A (resistance programming)
- Programmable power module (PPM) 2 x 4.5 to 30 V/1 A (with VSM)
- External power supply units up to 100 V/10 A
- Secondary matrix module (SMM) for universal pins
- Instrument multiplexer module (IMM) for connection of external devices to hybrid switch equipment

Maximum configuration for analog in-circuit test

Switch modules	Pins/module	Slots/module	No. of modules	Maximum No. of pins
SMH	64	1	max. 19	1184

Maximum configuration for hybrid in-circuit test

Module	Test rate	Test voltage	Multiplex	Pins/module	Max. config.
Driver/sensor/ switch module DSH	10 MHz	±5 V	1 : 4	64 hybrid pins	1088 hybrid pins

Overview of driver and sensor modules

Driver/sensor module	Max. test rate	Max. level	Chanels/ module	Max. No. of modules	Max. No. of channels
DSH	10 MHz	±5 V	16	17	272
DSH	10 MHz	±5 V	16	17	272

- Input/output module (IOM) for switching and control tasks with input/output ports and assignable relays
- Application module (APM) for switching AC supply modules and user-specific expansion. Additional circuits can be fitted on this module or external devices be driven via opto-decoupled inputs/outputs
- Application relay module (ARM) with 32 assignable relays for analog and digital signals as well as four relays for AC voltage

Digital functional test

- Timing module (TIM), vector rate up to 10 MHz, resolution up to 10 ns, 2 clocks, external synchronization up to 50 MHz
- Address module with subroutines, loops, branches, conditional branches for almost unlimited pattern lengths; synchronization with external events
- Driver/sensor module DSH for two logic families; pin memory 4 K (5 bits), signature analysis, start/trigger/clock, pull-up/down, programmable slew rate, format selection, pin-by-pin logic analysis

Operation

Data entry, programming and debugging are made via the alphanumeric keyboard of the computer and the mouse. In the series test mode, the control panel is used to start programs, answer queries or control the vacuum. The program is selected automatically via barcode or using the fixture codes, so that even untrained personnel will be able to operate the testers after a brief training.

Power Test Station TSAP

Complements Test System Family TSA through adding tests for power supplies and other electronic power circuits

Photo 40959

Brief description

Power Test Station TSAP complements Test System Family TSA through the testing of power supplies and other electronic power circuits. As a full-featured in-circuit and combinational tester TSAP localizes all defects down to component level with extremely high accuracy, as a full-featured power tester it measures all data under full load and with all these capabilities combined it provides complete fault coverage in a single test run.

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 IEEE/IEC 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 test

- 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 alignment

Main features

- In-circuit, functional and power-supply test in one step, hence considerable savings in test costs
- Maximum test depth
- 100% compatible with TSA fixtures and programs
- Interactive power test generator
- Measurement of all quality data to ISO 9000 during testing
- Modular concept ensuring customized solutions for every application

Fixtures

- Combined standard and power interface: pylon (TSA-compatible), similar to DIN 41612 for power signals
- Bed-of-nails fixture (vacuum, pneumatic or mechanical system)
- Two-stage and double-chamber fixture
- Functional-test fixture or connection via cables

Universal Test System TSU

Versatile solutions for automated testing

Photo 42319

Brief description

Universal Test System TSU is an extremely versatile solution for automated testing. With the aid of a large variety of modules, the basic unit consisting of a module mainframe and a power supply can optimally be configured for any test application. The system features comprehensive test strategies such as functional test, combinational test, testing of power supplies, electronic power circuits, ISDN products through to the classical in-circuit test. A novel feature is that all test strategies can be combined with RF measurements (up to 4 GHz via a standard fixture). Due to its compact design and high modularity, the TSU is also ideal for use as a basic unit for application- or branch-specific test systems.

Design

Universal Test System TSU consists of a mainframe (for max. 13 modules), a system power supply, a 5 V/5 A UUT power supply and an optional low-power UUT power supply as well as an optional vacuum valve for use with exchangeable vacuum fixtures.

A customer-specific connector panel for the connection of signal lines to external IEEE/IEC bus devices is located in the upper section of the mainframe.

The necessary wiring to the functional test modules and the switching modules which are located in the lower section of the mainframe is implemented in the fixture.

The functional test and switching modules are plugged into the mainframe. All modules are now controlled by the central processing unit (control module TS-CTE) in the TSU. The control module coordinates all modules and also provides the interface to the IEEE/IEC bus. The internal data transfer in the TSU takes place via the multibus.

Software and hardware concept

The modular concept and open system architecture of the TSU allows almost all modules of the related test system family TSA to be used. This applies in particular to the configuration with AMV (page 346) which in TSU makes the special signals directly available at the fixture interface. Like TSA, TSU can also be retrofitted with up to four AMV modules. Simple interface cards (TS-INK) are required for other modules.

In addition, the uniform software concept TSSwindows (see page 353) employed in all the above test system families ensures full transparency throughout an entire test system installation.

Through the use of multibus interface modules (TS-MBI), not only the relay modules TS-RELx but also customer-specific applications can be integrated into the system, ensuring an open system architecture also for the hardware.

Universal Test System TSU

The compatibility of all test systems also includes the options, so that the TSU system can any time be upgraded or expanded.

Common test functions

- Analog in-circuit test
- Analog functional test
- Switching facilities from DC to 4 GHz and for power
- Use as a universal test system core

Analog Prescreener (MDA) and Universal Analog Functional Tester TSUC

Test functions and features

- Analog in-circuit test
- Analog IC check (ICC)
- Static digital test (max. data rate 50 kHz)
- Max. 576 pins
- Max. data rate 50 kHz

Options

- Stick-Probe pin contacting test

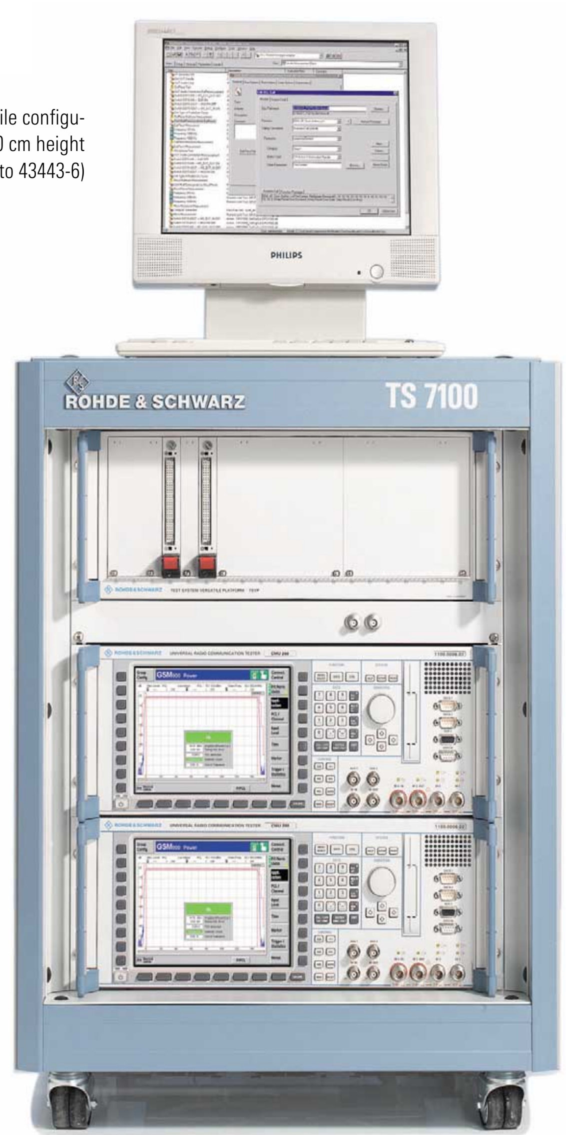
Universal Functional Tester TSU

= TSUC +

- Analog functional test

Cellular Phone Production Test Platform TS7100

The new "ready to go" production tool



TS7100 in low-profile configuration – only 80 cm height (photo 43443-6)

Brief description

The manufacturing process of mobile phones is continuously monitored. For this purpose, the various manufacturing steps are followed by comprehensive tests which ensure that no faulty product is produced and each mobile phone complies with the relevant specifications and legal stipulations.

The TS7100 system is an extremely compact, easy cabling overall solution designed for the test of mobile phones. Although the system has only a height of about 80 cm and fits below a conveyor belt, it includes all the essential components for the simultaneous testing of two mobile phones. And there is enough space left for future extensions. The different components were selected especially for high test throughput and simple enhanceability.

Main features

One basic system platform

- for all customary radio standards
- for all production steps
  board tests
  functional tests
  RF calibration
  final tests incl. RF tests, acoustic tests, display tests and keyboard/pad tests
- for multi-protocol and multiband testing with Radio Communication Tester CMU200, migration from CMD to CMU included

One simple concept

- Comprehensive modular test library for immediate use or easy customization
- Generic system using versatile configuration based on CompactPCI/PXI
- Easy upgrade to 3rd generation products

One cost effective tool

- High throughput by real parallel testing using independent IEEE/IEC bus systems
- Flexible core system for either functional, final or other tests
- Modular and versatile hardware and software, standard fixture interfaces
- All hardware and software components based on industry standards

Design and function

The essential components of a two-channel system are two radio communication testers, two special power supplies for the mobile phones as well as a CompactPCI/PXI rack with various plug-in boards.

CompactPCI/PXI – a compact and flexible standard

The TS7100 system contains the CompactPCI/PXI system platform TSVP (Test System Versatile Platform) which features up to 31 slots. The system controller, relay boards, digital I/O and measuring equipment which is not covered by the radio communication tester are combined in an instrument of 4 HU. Universal module TS-PRL1 which accommodates the relay, power relay and digital I/O functionalities in a single module provides all the necessary basic functions for the mobile phone

Cellular Phone Production Test Platform TS7100

test including fixture control. Supplemental test equipment such as DMM or additional matrix boards can be implemented as required.

Due to the unique wiring concept of the TSVP, the signals of the different test and stimulus units can be routed and switched within the TSVP. In this way, all signals are directly available at the fixture interface which allows simpler fixture and interface design.

CMU200 - fast and universal radio communication tester

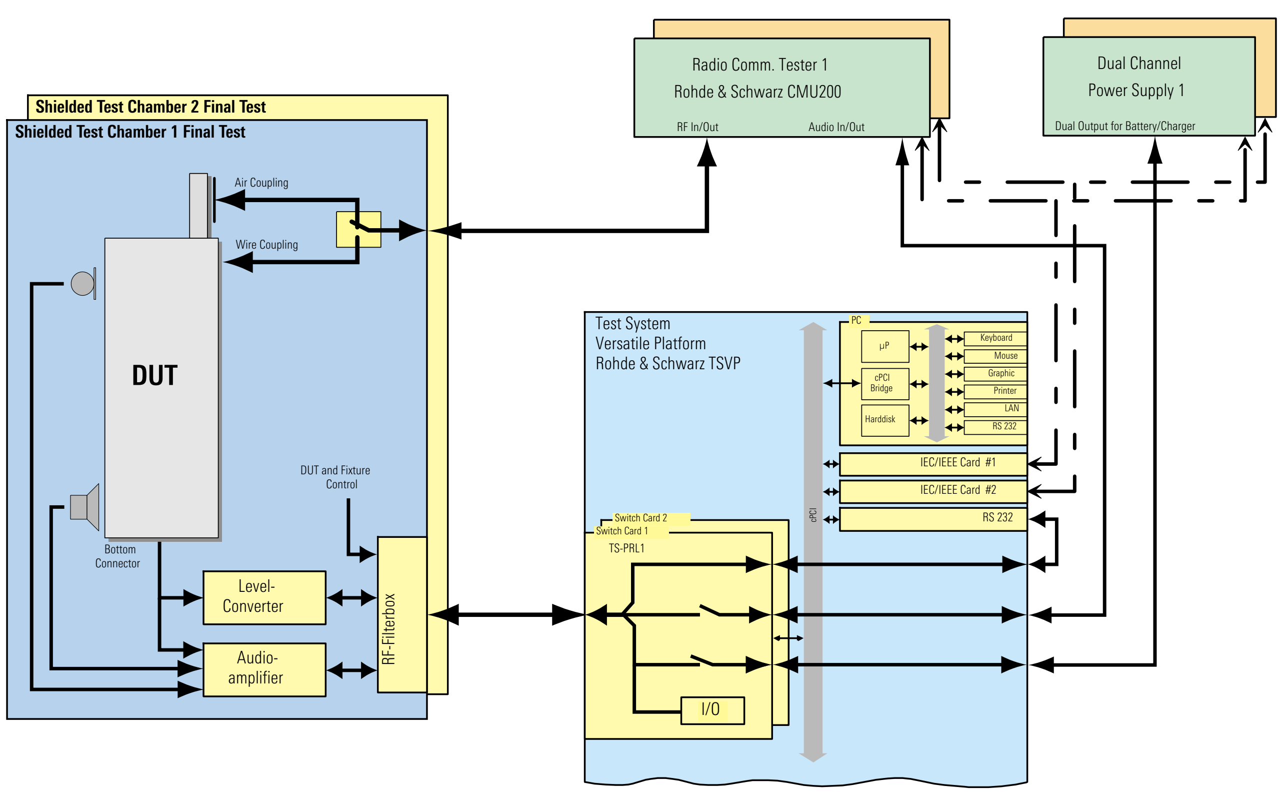
Radio Communication Tester CMU200 offers most of the cellular phone tests such as audio tests, RF measurements, signalling and RF calibration of the cellular phone. CMU200 supports all customary mobile radio standards and is prepared for the standards of the 3rd generation. As such, CMU200 is best suited for testing dual or triple band as well as multimode cellular phones. Compared to the previous generation of mobile radio testers, CMU200 is up to ten times faster and up to three times more accurate.

Optimum throughput – no compromise in parallel tests

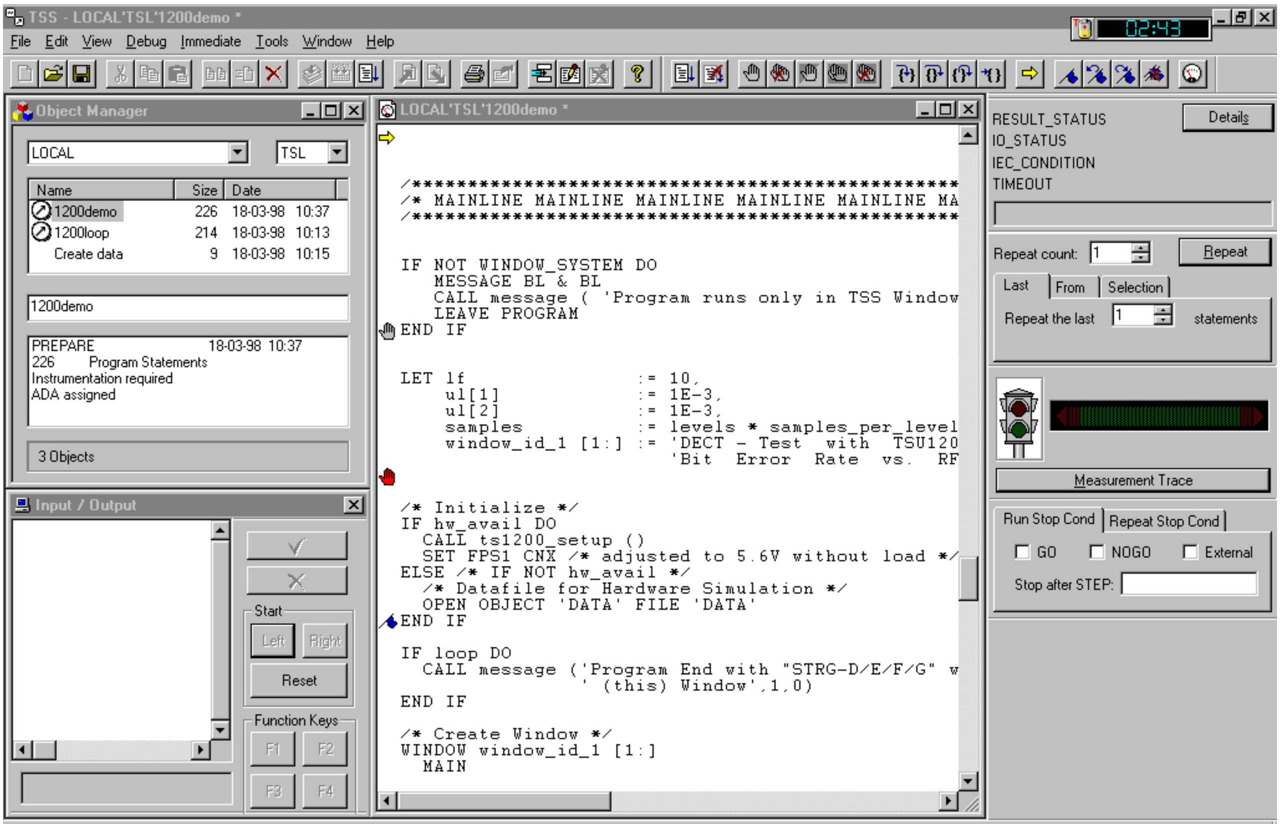
For simultaneously testing two cellular phones, all resources such as Radio Communication Tester CMU200, power supply and plug-in boards for the TSVP are doubled. There are also two IEEE/IEC busses to obtain optimum performance with ease of operation. Due to its high performance, it is not necessary to duplicate the TSVP, ie a system controller running under Windows NT drives the IEEE/IEC bus instruments and plug-in boards simultaneously and in parallel in multitasking mode.

Test programs and fixtures

For the test of mobile phones, the complete package includes ready-to-run test programs and individual test cases as well as test fixtures for the manual and fully automatic use in automated production lines. Depending on the requirements, the fixtures are fitted with built-in shielding for acoustic and RF measurements, a camera for the display test and a mechanical actuator for the keyboard test. For RF tests the fixtures are equipped with special antenna couplers and an RF connection to the test system (only 2 cables).



Production Test System Software TSS 5.0



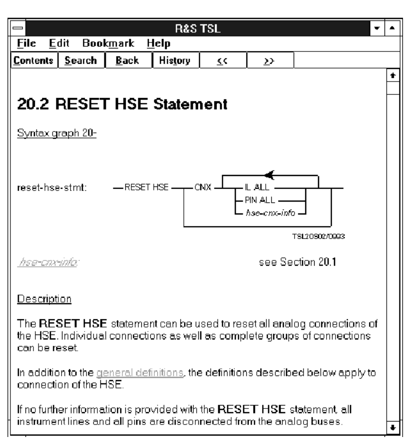
Testing under Windows NT on PCs

Brief description

TSS 5.0 is an extremely powerful system software under Windows NT which can be used on PCs. This software features a menu-controlled user interface designed for ease of use. Since the menus only contain those functions which can really be performed in a 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

High-level test language

The test language TSL is a high-level language for in-circuit and functional testing. Standard terms make it easy to follow the tests that have to be performed during program generation and updating. Node and signal names make the test program independent of the fixture, so that any changes to the wiring do not have to be subsequently entered into the test program. The digital realtime test is fully integrated in the test programs and enables clear display of analog and digital tests especially when testing hybrid components.

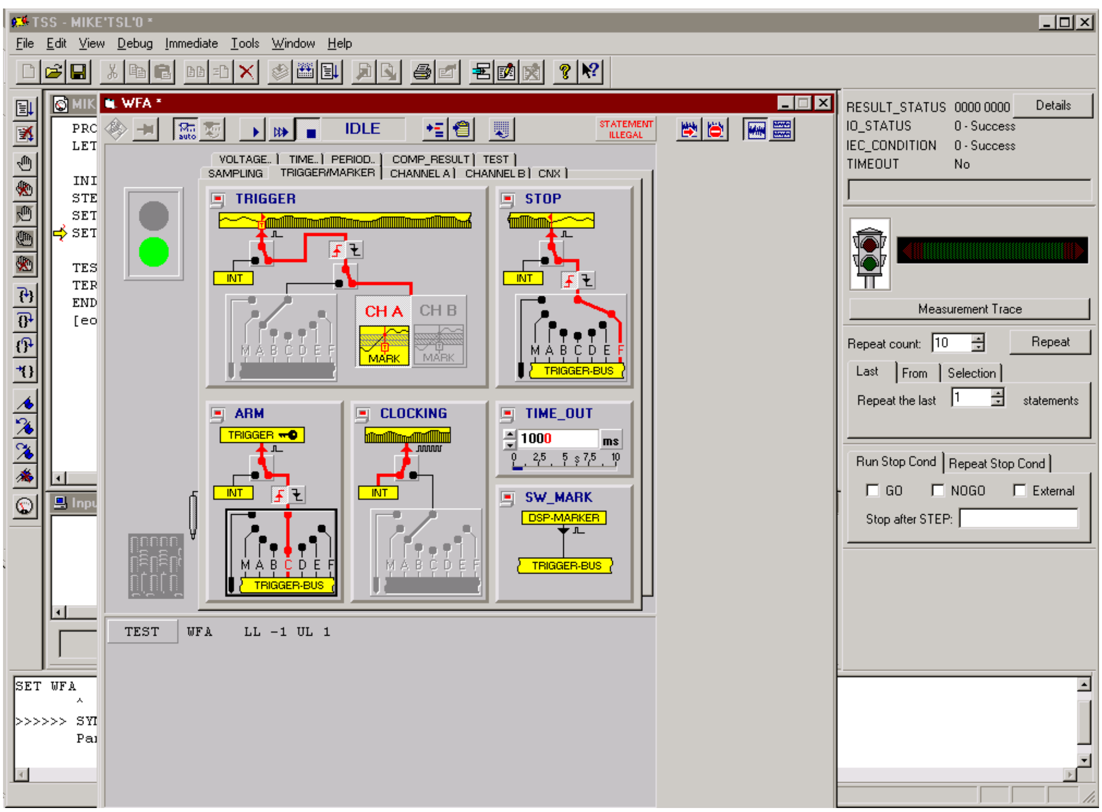
Production Test System Software TSS 5.0

User-friendly program structures are achieved with the aid of IF, CASE, FOR and WHILE constructs as well as modular technique. The test language makes user dialogs based on a form technique simple to implement so that the user will encounter a standard user interface.

Short modification procedure

The whole software system TSS 5.0 has been optimized for highly effective operation in particular with a view to the test language TSL and the editor/debugger to achieve fast program generation. The program is displayed on the screen throughout the debugging process and can be modified any time.

having to do without the benefits of a compiler language. A novel feature of TSS 5.0 are the interactive virtual device control panels embedded in TSS per OLE (object linking and embedding) standard. These control panels enable purely graphical control of individual devices within the TSA/TSU system families. An important feature is that the interactively generated device settings can be imported into the current program at the press of a button. If the control panels are called up from the debugger, the current hardware settings are automatically used in the control panel.



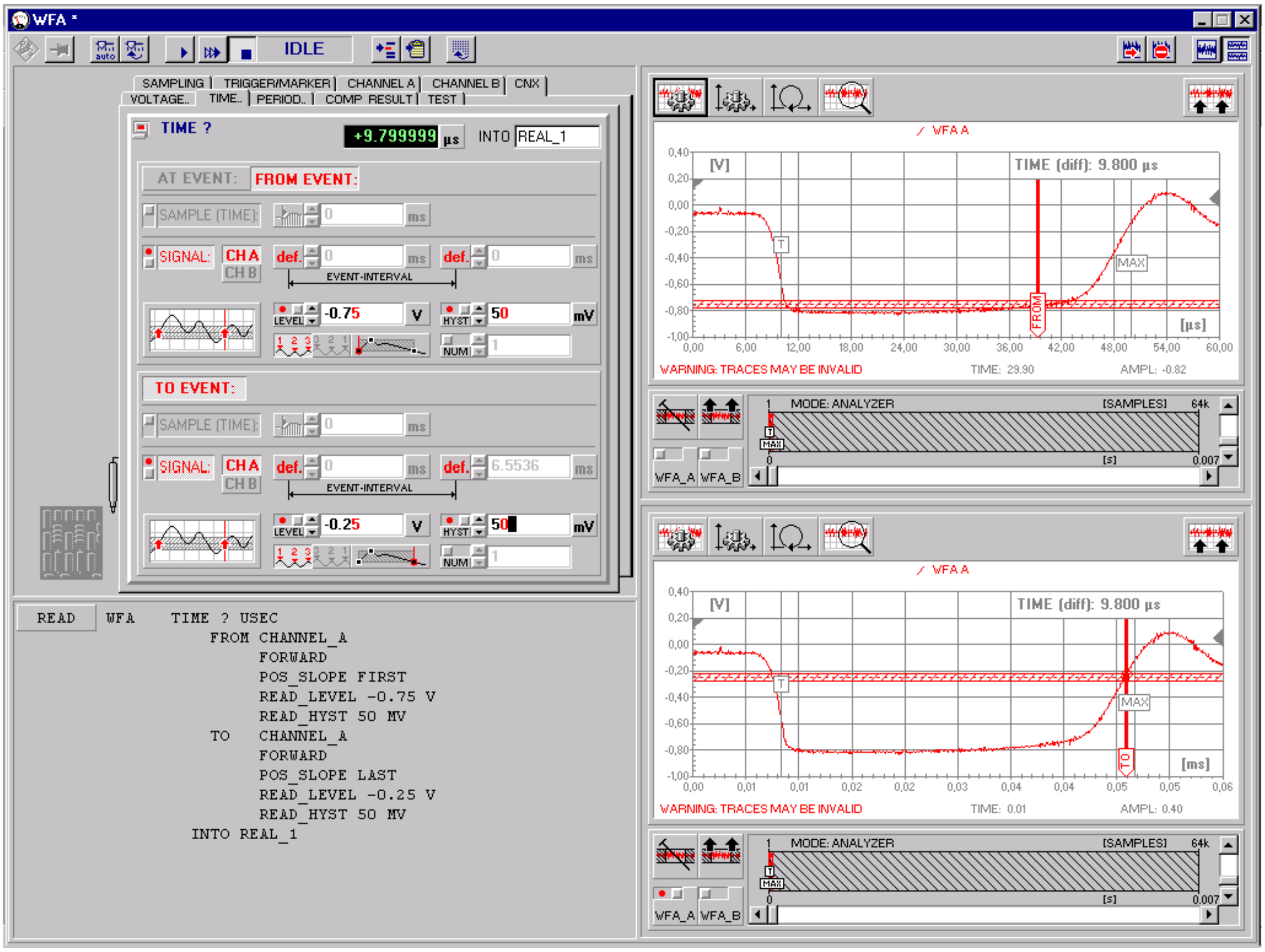
Logic state display

The programming status of the digital test unit can be called up by a keystroke. The logic state display with pin functions, timing sets and command sequence allows even very complex digital tests to be analyzed.

Modifications are directly imported into the program and can immediately be implemented without need for any time-consuming compiling. This is made possible by the "compreter" concept of TSS where due to the use of a special segmenting method only the modified part of the program is compiled. This is done automatically and immediately after each modification and goes unnoticed by the user. Operation is thus similar like with an interpreter language (eg BASIC) without

IEEE/IEC bus compatible devices

Convenient language constructs are provided for controlling external instruments via the IEEE/IEC bus. The configuration-dependent settings such as bus addresses and end characters are stored outside the program in the resource management system; this relieves the workload on the programmer and facilitates clearer programming based on the instrument names.



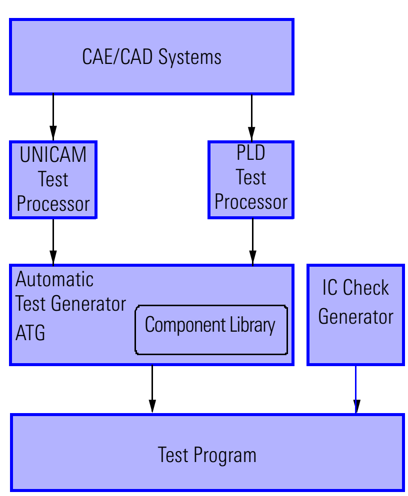
Open architecture

Any Windows applications can be called up from a test program. This, for instance, allows test data to be processed in MS Excel and graphically displayed. Programs for PC plug-in cards can also be included in the test run. A fully compatible DDE interface is available for this purpose.

Test methods

Hybrid in-circuit test

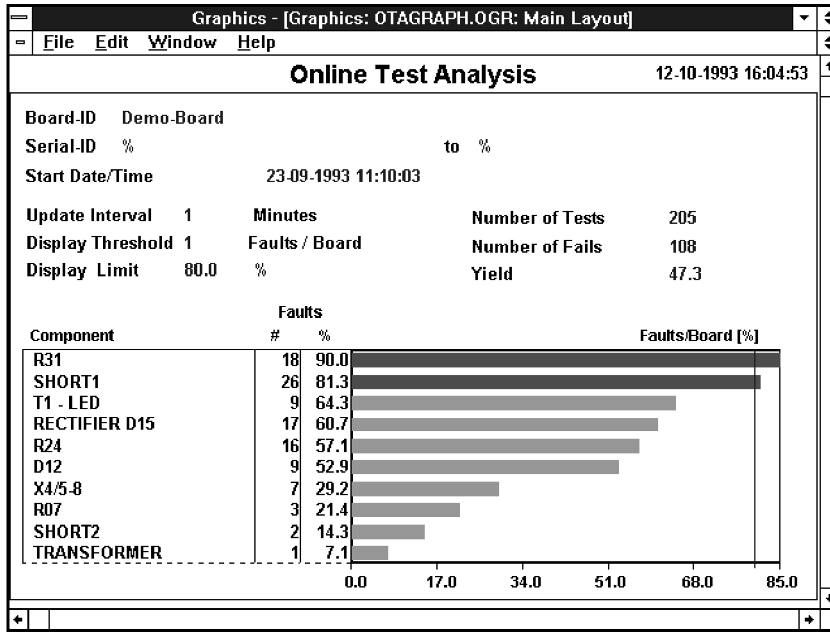
- The CAD test processor UNICAM converts CAD output lists in Editf-II code to the board description format of Test Workstation TSA
- The PLD test processor generates tests for programmable logic components. Clock, force and disable sequences are generated using the standardized JEDEC format



- 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 pin contacting 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

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.



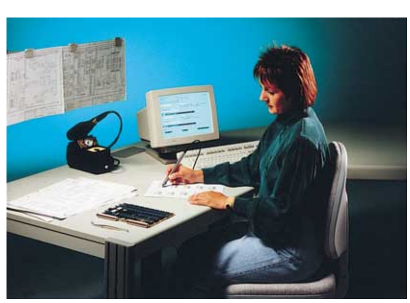
Online test analyses for detection of weak spots in production process

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 avail-able for repairs and quality reports. Via an ASCII or DDE interface test and repair data can be loaded from other systems or transferred to other PCs. The database may also be incorporated in networked computers running under different operating systems (eg UNIX,Windows NT, OS/2). Quality analysis and paperless repair are carried out using the TSA computer or a networked PC.

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. For each fault a list of the most frequent repairs carried out for this type of fault can be displayed at a keystroke. Experience made in the past



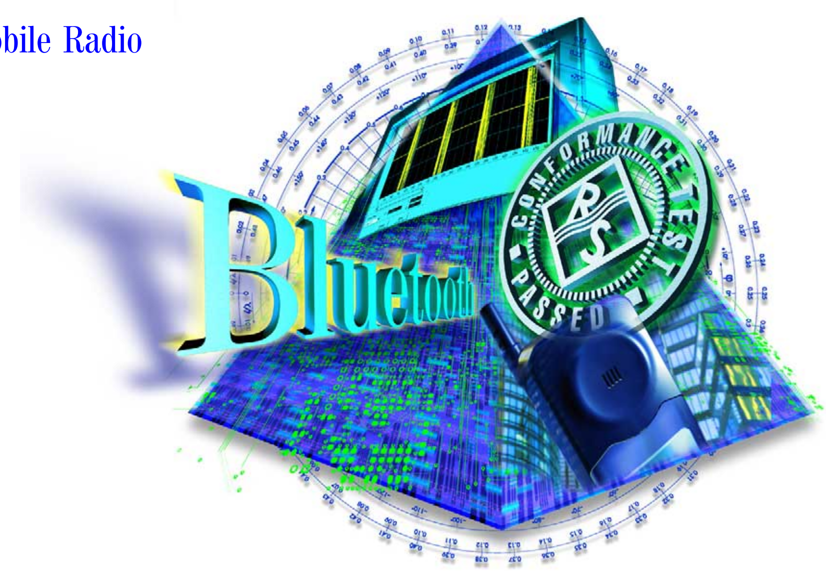
can thus be used to benefit which is a great advantage in particular where personnel frequently changes.

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 95, is very convenient and easy to learn.

Protection
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.

Type-Approval Systems for Mobile Radio

A complete range of systems for compliance tests to GSM, DECT, Tetra, ICO and Bluetooth standards



International benchmark for mobile radio test technology

Before being allowed onto the market, each and every mobile phone has to undergo a comprehensive series of checks which is referred to as the full compliance test (FTA). Rohde & Schwarz is the most important provider of system simulators of this kind for the world's most successful digital mobile radio systems.

Type	Designation	Applications	Page
TS 8916 TS 8916B-4	GSM 900/1800/1900 Simulators	Compliance testing, QA and development of GSM 900/1800/1900 mobile phones	358
TS 8913	Multi-Carrier Tester	Closes gap between CRTC 02 and TS 8916B	359
TS 8930B	DECT Compliance Test System	Compliance testing of DECT cordless phones to CTR 06	360
TS 1220	DECT Protocol Tester	Compliance testing of DECT fixed and portable parts to TBR 22	361
TS 1240	TETRA Protocol Test System	Type-approval tests of TETRA mobile radios	362
TS 8940	TETRA Test System	Type-approval tests of TETRA base and mobile stations to TBR35	364
TS 8950	3G Air Interface Simulator	Comprehensive testing of mobile communications equipment according to the 3GPP specification	366
TS 8960	Bluetooth Qualification and Compliance Test Systems	Full compliant to Bluetooth RF test specification	368
Other systems on request, eg ICO			

System solutions for all significant mobile radio systems

We provide a whole range of integrated systems and components for full compliance tests on mobiles. The approach we offer is technically innovative, practice-oriented and gives optimal performance and user-friendliness.

We set the standards – you enjoy the benefits

With our compliance systems, you are guaranteed a high level of standard conformity and result reproducibility. This is why they have been accepted as standard test tools by test houses and accredited testing organizations all over the world. Mobile radio manufacturers know that equipment that has been developed using our systems will have no problems with official acceptance tests. You can be sure of the successful outcome of approval procedures without any bother.

Future-proof thanks to high flexibility

The most striking features of the test systems from Rohde & Schwarz are the highly flexible hardware and software concepts which can be adapted to any changes in standards and any new technical requirements. Service packages tailored to your individual requirements secure your investment in equipment and keep your equipment at the leading edge of technology.

GSM900/1800/1900 Simulators TS8916, TS8916B-4 and Multi-Carrier Tester TS8913

Test System TS8916B with audio option for all GSM standards (photo 43211-2)

Conformance Testing, QA and development of EGSM, GSM900/ 1800/1900 mobile phones

Brief description

Simulators TS8913, TS8916B-4 and TS8916B have been designed for development and QA requirements. Thanks to their extraordinarily powerful hardware and software, drastic reductions in test and development times are possible.

TS8916B is a test system for development and conformance testing of GSM mobile phones. It covers the full range of present phase 2 conformance tests and provides at the same time the plat-form for complex phase 2+ tests for HSCDS and GPRS.

The tests implemented in TS8916B are validated by independent test houses and can be used for official conformance tests. The measurement functionalities of TS8916B forming the basis of the official tests are also available for development applications and can be accessed via an easy-to-handle graphical user interface.

TS8916B-4 is identical with TS8916B except for the number of RF channels fitted. Development-accompanying RF tests are the main field of applications of this system. The tests implemented in TS8916B-4 are also validated by an independent test house.

The test systems thus accompany mobile phones from the development through to final testing and provide a worldwide renowned basis for compliance with the required quality standards.

GSM900/1800/100 Simulators TS8916, TS8916B-4 and Multi-Carrier Tester TS8913

Main features

- RF transceiver tests, analysis of spurious emissions
- RF transmitter tests, eg quality of the RF output spectrum
- RF receiver tests, immunity to interference
- Link management tests (synchronization characteristics)
- Layer-2 and layer-3 signalling tests
- Multislot signalling tests and RF tests for HSCSD and GPRS
- Audio tests
- Test of supplementary services
- Short familiarization thanks to easy-to-use software (test cases and maintenance menu)
- Development of user-specific test programs in the standardized programming language C under MS-DOS

Tests to ETS 300 607-1

Thanks to Simulators TS8916 and TS8916B-4, you can test GSM900, GSM1800, GSM1900 as well as dual-band GSM900/1800 mobiles according to the test requirements of the european R&TTE Direktive, the GCF (GSM Certification Forum) and the Northern America PCTRB to the 3GPP Norm 3G TS 51.010-1. There are more than 200 system test cases for each band, offered in functional groups. Besides these all test case packages for the Digital Radiocommunication Test Set CRTC can be run on the systems TS8916B and TS8916B-4. Furthermore we also offer a dedicated research and development tool which allows in-depth analysis of RF performance beyond the limits of predefined test cases.

The test systems are therefore ideal

- verification tools for development environments (prescreening)
- QA test systems
- simulators for conformance tests

GSM900/1800/1900 Multicarrier Tester TS8913

Multicarrier Tester TS8913 closes the performance gap between the Digital Radiocommunication Test Set CRTC02 as a phase 2 stand-alone tester and Conformance Test Systems TS8916B and TS8916B-4. It has been designed for running signalling tests requiring up to 9 carriers for precompliance testing. TS8913 comes as a double-rack system which can be upgraded to a TS8916 any time.

DECT Test Systems TS 8930B, TS 8930B extended

Compliance testing of DECT cordless phones to CTR06

Photo 41583

Brief description

DECT (Digital Enhanced Cordless Telecommunications) is a flexible and well proven communication technology with a wide range of applications in the commercial and private sector.

The test requirements for DECT products are stipulated in a number of standards that can be measured with following test systems: The TS 8930 systems handle tests at the air interface to CTR 06, TS 1210 covers acoustic tests to CTR10 (see page 1) and TS1220 is for protocol analysis to CTR22 (see page 361).

TS 8930B gives DECT phone developers indispensable information while development is actually taking place. This means that their products will clear the type-approval hurdle at the first attempt, resulting in time-saving and marketing benefits.

TS 8930B extended gives test houses a system that can rapidly and comprehensively check a worldwide standard for cordless phones on the RF side complying with all relevant regulations. TS 8930B can be upgraded at a later date to give the full functionality of TS 8930B extended.

Main features

Transmitter measurements
- Accuracy and stability of RF carriers
- Timing jitter
- Referenced timing accuracy
- Transmission bursts
- TX power
- RF carrier modulation
- Emissions due to modulation, transients and intermodulation
- In-channel spurious emissions

Receiver measurements
- Sensitivity
- RFI immunity
- Intermodulation
- Blocking
- Out-of-channel spurious emissions

Other features
- High measurement accuracy due to RF path compensation
- Automatic system selftest
- Flexible concept for easy adaptations to changes in standards
- Short familiarization thanks to easy-to-use software
- Frequency extensions for all DECT ranges (optional)

DECT Protocol Tester TS 1220

Conformance testing of DECT fixed and portable parts to CTR 22

Photo 43431-1

Brief description

Classic PBXs which connect mobile stations to each other or to the PSTN by means of one or more base stations as well as PABX (private automatic branch exchange) systems are changing over to DECT, the European standard for digital, cordless information exchange.

Introducing the DECT access profile GAP (Generic Access Profile) the European Telecommunications Standards Institute (ETSI) ensured product compatibility on the market. If manufacturers want to test their products for compliance with the DECT access profile, they need a universal and versatile test system – this system is the DECT Protocol Tester TS1220.

The Generic Access Profile (GAP) only applies to the DECT voice service, ie to those sections of the standard concerned with voice transmission. This means that only part of the standard which defines a general transit system (LAN, pager applications, etc, too) is binding for telephone applications. Protocol Tester TS1220 from Rohde&Schwarz is a test system for development and conformance testing of DECT phones whose software performs all the necessary analysis and interpretation of data and timing sequences.

Further options such as the channel assignment (monitoring of air interface) ensure universal use of the test system. Software upgrades allow all DECT frequency bands (Europe, Latin America, China) to be covered.

Main features

- Full DECT-GAP implementation
- Ready-to-run TTCN test cases to CTR 22 (GAP + CAP)
- Any implementation for DECT transit systems thanks to open concept
- Frequency extensions for all DECT ranges available as an option
- Straightforward software updates to handle changes in standards and requirements

TETRA Protocol Test System TS 1240

Type-approval tests of TETRA mobile radios

Fig 1 (photo 43144-5)

Brief description

TETRA Protocol Test System TS 1240 is ideal for the development and testing of TETRA signalling procedures and able to translate TTCN test cases published by ETSI into executables. TS 1240 features all attributes of a modern protocol tester, following in the steps of a long tradition of Rohde & Schwarz protocol testers for mobile radio standards.

Main features

- Implementation to standard of TETRA protocol stack (layer 1 and 2)
- TTCN test cases executable to TBR35
- All protocol layers implemented per software
- TETRA air interface implemented
- Open platform concept for programming of scenarios
- Graphical user interface

Description of protocol tester

TETRA Protocol Test System TS 1240 consists of the universal Protocol Test Unit PTW30 and Digital Radiocom-munication Tester CMD91. The central unit PTW30 is based on a controller with hardware enhancements, ie a DSP card and an I/Q interface card. Radiocommunication Tester CMD91 serves as an RF output stage in the transmit and receive directions. Data exchange between PTW30 and CMD91 is in the form of digital I/Q data, while device settings are serially transmitted.

All functions required for the protocol test of TETRA terminal equipment are implemented in the test system software: Because of the time-critical requirements of the TETRA protocol stack, a realtime operating system – LynxOS – is used. This Unix derivative is compatible with Posix and SystemV.

The TETRA protocol engine contains all processes, data and interfaces required to control the TETRA protocol stack (Fig 2). One possible operating mode of TS 1240 is simulation of a base station for testing a TETRA mobile phone after registration via the air interface. Another operating mode allows the setting up of a direct connection from a higher layer (eg via Ethernet) to an external controller, where a single layer has been started as a DUT (virtual type approval).

A modern graphical user interface (GUI) is implemented offering the usual windows. The simulation manager enables selection and setting of the desired simulation mode. PCO (point of control and observation between logical layers) and MSC

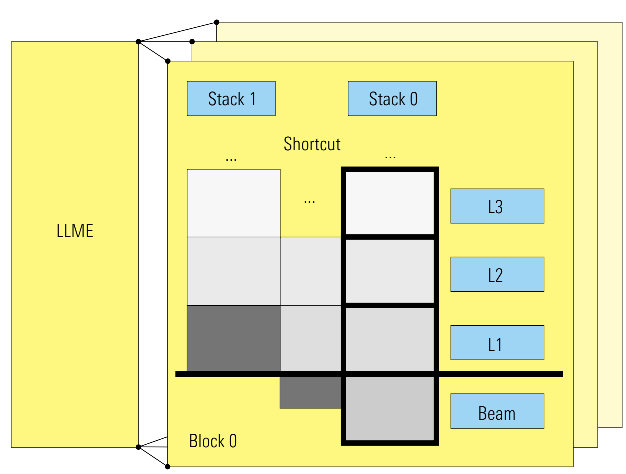


Fig 2 TETRA protocol concept: block, stack, layer (L1, L2, L3) and beam

TETRA Protocol Test System TS 1240

(message sequence chart representing data transmitted between TS 1240 and DUT in decoded form across all layers) are among the means available for result analysis. Fig 3 illustrates the interaction between the modules.

The test cases defined by ETSI (Euro-pean Telecommunications Standards Institute) are in a language particularly suitable for protocol tests: TTCN (tree and tabular combined notation, in the case of TETRA with ASN.1 notation). This language allows fast and convenient conversion of test cases into executables. This coding is implemented in Test System TS 1240 in two steps (Fig 4). First the supplied TTCN compiler translates the code into C language. Secondly, C is translated into executables using system libraries. With the aid of a test case selector, one or more test cases can be conveniently selected and started via the graphical interface, the verdicts being clearly displayed in tabular form. Trace files generated during program run permit detailed analysis down to command level.

Tests not covered by ETSI test cases can be implemented by creating their own scenario. For this TS 1240 hardware and software are available via function calls (open programming platform). A scenario executor permits the programs to be executed in realtime or line by line. TETRA Protocol Test System TS 1240 is ideal for the development and testing of TETRA signalling procedures and able to translate TTCN test cases published by ETSI into executables. TS 1240 features all attributes of a modern protocol tester, following in the steps of a long tradition of Rohde & Schwarz protocol testers for mobile radio standards.

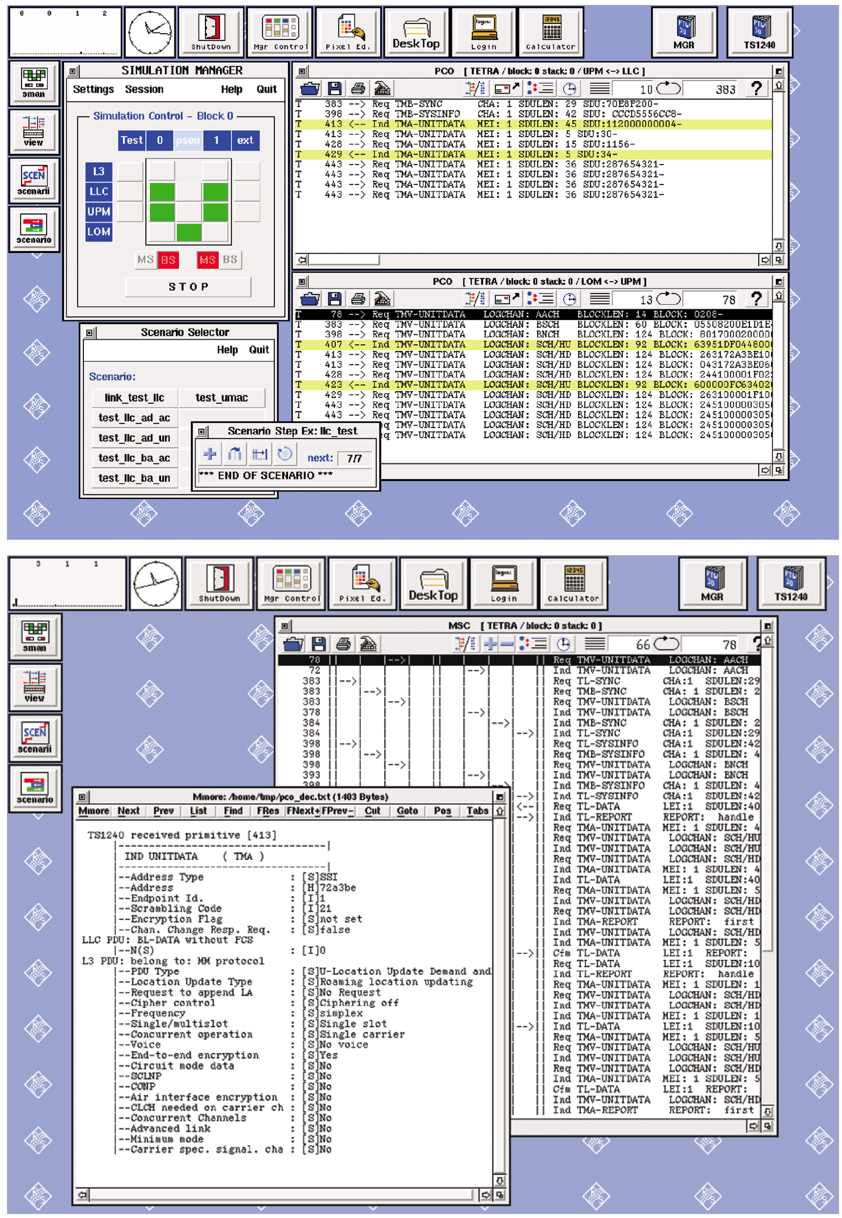


Fig 3 Test System TS 1240 offers tools like PCO (top) and MSC for analysis of test results.

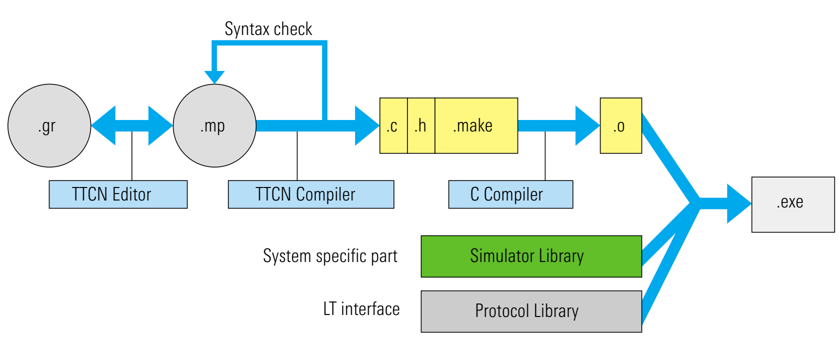


Fig 4 Two-stage implementation of ETSI test cases in TETRA Test System TS 1240

TETRA Test System TS8940

Conformance tests of TETRA base and mobile stations to TBR35

Fig 1 (photo 43142)

Brief description

Conformance tests for TETRA base and mobile stations are outlined in standard TBR35 (technical basis for regulation), which refers to the following ETS specifications: ETS300394-1 (radio), -2 (protocol testing specification voice plus data) and -3 (protocol testing specification packet data optimized). Rohde&Schwarz devised Test Systems TS8940, including the TETRA simulator and TETRA protocol tester, for verification, quality assurance and conformance of TETRA base and mobile stations.

Main features

TETRA simulator

- Graphic user interface
- RF tests executable to TBR35
- Comprehensive system selftest
- Path compensation for increased measurement accuracy
- Simple creation and implementation of user-defined tests

TETRA simulator TS8940

The TETRA simulator comprises a control unit, spectrum analyzer, three RF generators, a power meter and an RF switching matrix. The core of the system is the TETRA control unit, including the controller in addition to the basic signalling and measurement unit. The basic signalling unit consists of a data buffer, a sequence controller, a RISC processor and a digital I/Q interface card. The RISC processor generates all required call control messages and forwards them to the sequence controller, which ensures that correctly timed data are sent to the DUT. The I/Q modem modulates the data stream and sends it to the DUT via the

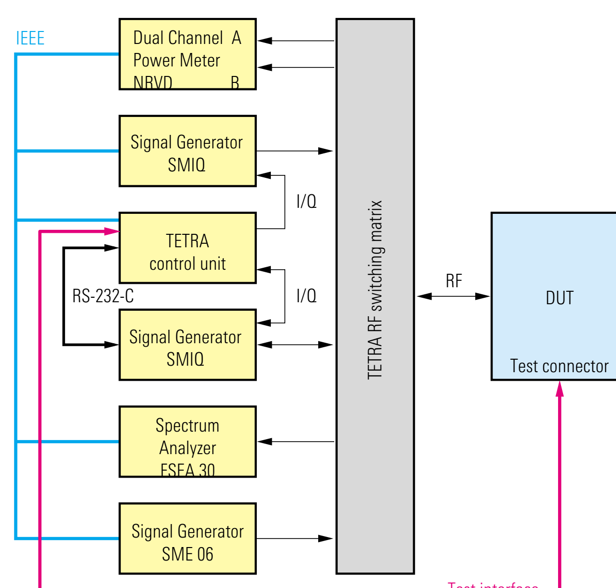


Fig 2

Block diagram of TETRA simulator

TETRA Test System TS8940

switching matrix and, in the reverse direction, demodulates and digitizes the data received from the DUT before forwarding them to the sequence controller. Data are evaluated in the RISC processor and answered as necessary. Special test cases require deliberately distorted test signals (fading). This function is integrated in the TETRA control unit, which distorts the signal in the baseband and transfers it to generator SMIQ. TBR35 prescribes the test connector (RS-232-C interface inTETRA control unit) in addition to the air interface. With the aid of a respective protocol, bit error rates of different logic channels can be measured to TBR35 on all TETRA mobile and base stations conforming to this protocol.

The system is supported by a signal generator with I/Q modulation that produces the faded TETRA interference signal, and Signal Generator SME 06 to produce the interference signal for testing blocking and immunity to intermodulation. Spectrum Analyzer FSEA30 is used to measure the power ramp, modulation spectrum and spurious emissions.

All signals are amplified and filtered in the RF switching matrix.For highly accurate RF measurement levels, TS 8940 uses two high-frequency probes at important testpoints to minimize frequency response. Channel A of Dual-Channel Power Meter NRVD is used to monitor simulator transmission level, channel B to monitor received level. Any level errors occurring during measurements are automatically corrected with the aid of previously stored reference values.

RF measurements to TBR35

The TETRA simulator uses some 20 programs to measure the RF parameters of TETRA base and mobile stations to TBR35 specifications. Measurements are grouped in transmitter, receiver and transceiver tests.

3G Air Interface Simulator TS8950

Comprehensive testing of 3rd generation mobile communications equipment according to the 3GPP specification

Photo 43413-1

Brief description

The future 3G Air Interface Simulator TS8950 from Rohde&Schwarz is a modular test platform for mobile radios and base stations that meets requirements of third-generation mobile radio according to the 3GPP specification.

The overall conceptual guidelines of the system design – flexibility and openness – shall guarantee adherence to the ongoing evolution of the 3G standard. In order to provide the appropriate test functionality right in time, the initial configuration of TS8950 will be upgradeable in three steps (A, B, C) thus matching with the testing needs in all phases of 3G product development.

During gradual evolution of TS8950 the range of applications spans from:

- Step A: RF testing without signalling (Tx basic measurements)
- Step B: RF testing with basic L1 signalling (Rx and Tx advanced meas.)
- Step C : RF testing with L1-L3 signalling (Full Tx/Rx conformance test)

The system features excellent measurement accuracy thanks to high-performance components like

- Signal Analyzer FSIQ,
- Vector Signal Generator SMIQ,
- I/Q Modulation Generator AMIQ
- and RF Signal Switching and Conditioning

Convenient access to any application range

The flexible software concept ensures conformity of the system with the 3GPP standard despite the presently still unstable test specifications (TS25.141 or TS34.121). TS8950A uses individually parameterizable test methods instead of rigid test cases that can be combined into any desired test scenario.

For generating customized test sequences the test system therefore provides different types of access to the individual layers of the system software. Access is either in the form of a dialog via the graphical user interface AUP (advanced user panel) or on the application programming interfaces API.

At the device level, a separate dialog is available for each system component that can be remotely controlled. The instrument dialogs are tailored to 3G requirements and organized in logical blocks for emulating mobile radios, base stations and services. Entries can also be made for individual device command strings, eg GPIB commands. Every instrument dialog comprises a macro recorder/player for recording and replay of specific device settings (macros).

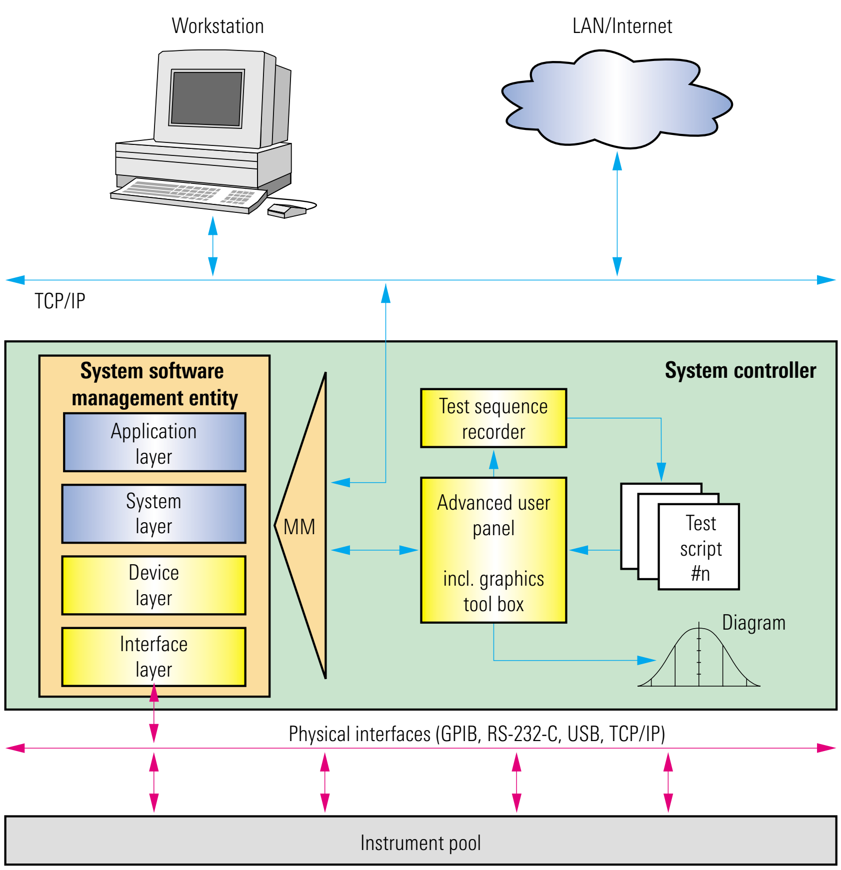
3G Air Interface Simulator TS8950

Rx/Tx measurements and result analysis at the system level are also dialog-controlled. The AUP provides a defined script for each measurement which can be edited and extended. This plain command file (PCF) allows direct addressing of the device layer and thus direct access to the individual instruments including the switching and conditioning unit. With the aid of a macro sequence manager, individual macros can be combined into sequences permitting complex measurements.

User management ensures that simultaneous access by different users does not cause a configuration conflict. Of course this restriction does not apply to simultaneous access of test results for analysis.

A logging mechanism stores all the settings made.

The AUP also supports service dialogs that perform fully automatic RF path compensation, for instance, or simplify system maintenance and configuration by selftest and diagnostic routines of individual components. The RF compensation routines of Signal Switching and Conditioning Unit SSCU need not follow fixed test-case patterns but can be started in compliance with user specifications.



Available and planned configuration levels of TS8950

The application range of the TS8950A system covers basic Rx/Tx tests without signalling.

This includes the following measurements at the transmitter end:

- frequency stability,
- occupied bandwidth,
- maximum output power,
- adjacent-channel leakage power,
- spurious emissions,
- transmitter intermodulation,
- transmitter on/off ratio,
- modulation accuracy, (EVM, rho factor),
- code domain power analysis (offline).

The following can be measured at the receiver end:

- sensitivity,
- selectivity (eg adjacent-channel selectivity, blocking).

The subsequent model TS8950B, which is available as of May 2000, extends the application spectrum especially by performance tests requiring channel coding.

The transmitter measurements of this system include:

- code domain power analysis,
- output power control (inner loop, outer loop).

Additional measurements at the receiver end:

- spurious emission,
- receiver intermodulation,
- spurious response and blocking,
- receiver dynamic range.

Model TS8950C finally performs all conformance measurements including complete layer 1 to layer 3 signalling.

Bluetooth Qualification and Conformance Test Systems TS8960

Fully compliant with Bluetooth test specifications

Photo 43434-1

Brief description

TS8960 is a qualification measurement system that is based on the Bluetooth Core Specification 1.0 and the Bluetooth RF Test Specification 0.7 (as of Dec. 1999) which contains the obligatory RF measurements for the qualification of Bluetooth devices.

The system can be used for conformance testing as well as for testing during the development phase and quality assurance process. For this purpose the parameters of the test cases can be changed in a wide range.

Besides the test cases the system offers a sophisticated software for the RF path compensation. The wanted and interfering signals as well as the signal from the EUT are combined or splitted, attenuated or amplified, filtered and switched in a switching and signal conditioning unit (SSCU).

In addition to the path compensation the system offers a selftest. During this test the main functions of the system devices are checked to ensure correct execution of the test cases. During the execution of the application programs (selftest, path compensation and test cases) a detailed test report is generated.

The system is controlled via a graphical user interface. The software platform is LINUX, the graphical user interface is based on the Qt Library.

Main features

- Fully compliant with Bluetooth RF test specification
- Test mode signalling
- All test cases implemented

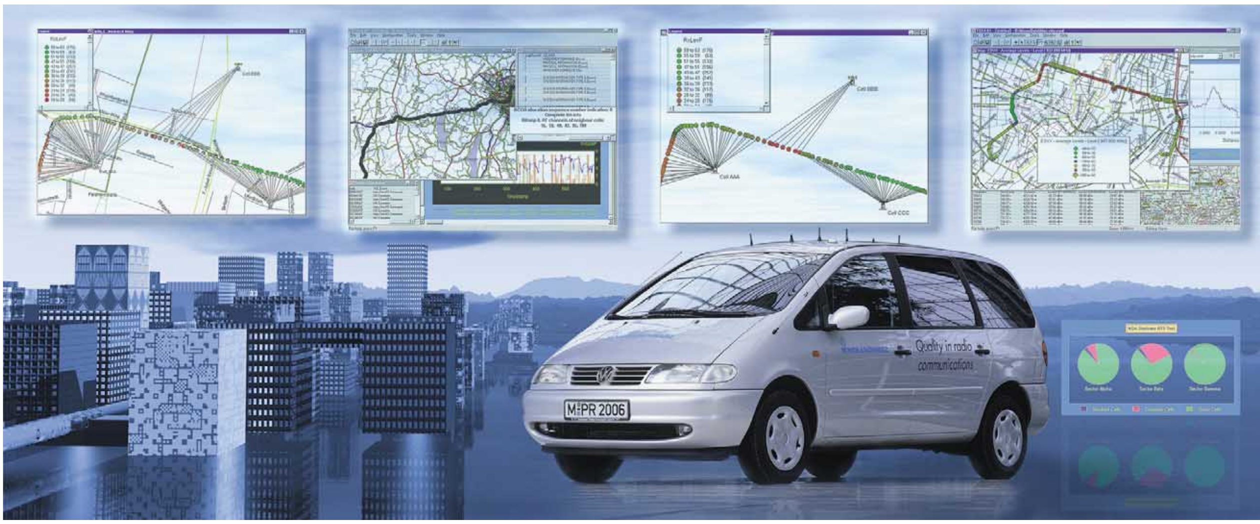
Communication Test Set PTW60

PTW60 plays a key role as a conformance test unit for the Bluetooth Telecommunication Standard. ATS (Abstract Test Suites) for both basic layers (Baseband, Link Manager and L2CAP) and profiles can be executed on the system. Additionally, tools for generating test cases that are not covered by the ATS are implemented on the system. These include eg script executer and message sequence chart. This allows full flexibility and universality in Bluetooth protocol testing.

Protocol tests

- Full protocol stack and profiles implemented
- Master/slave simulation
- TTCN tools available
- Basic layer tester
- Basic tools
  - PCO
  - Message/Scenario Editor
  - Executer
- Options: test case packages on
  - BaseBand BB (protocol part)
  - Link Manager LM
  - Logical Link Control and Adaption Layer L2CAP
  - Generic Access Profile GAP
  - Serial Port Profile SPP
  - Service Discovery Protocol SDP
  - Service Discovery Application Profile SDAP

Coverage Measurement Systems (Mobile Radio or DAB) – Overview



Successful know-how transfer: innovative ideas for coverage measurements

In the field of radio coverage measurements too, the name of Rohde&Schwarz has over the years become worldwide synonymous with top quality. As the only manufacturer of a complete range of high-performance and practice-oriented system solutions, Rohde&Schwarz is setting standards in this field.

Customer satisfaction is your capital – and your dividends

Our systems are unrivalled regarding fast and high-precision field-strength measurements wherever the location may be, detailed analysis of the receiving conditions for digital radio signals and absolute reliability of the measured data, eg through compliance with the Lee criterion. They thus create the basis for interference-free network operation as well as for the economic success of your network. Only a satisfied customer will be a faithful customer too. Therefore your aim should be lasting customer satisfaction which will pay out dividends over and over again.

The optimized network – minimum investment returning maximum performance

Whether in densely built-up areas or in the mountains: the patented interference measurement equipment of Rohde & Schwarz will show you how many base stations are in fact required and where it is best to install them. You benefit twofold: low investment costs in the network installation phase and maximum reliability in the operational phase. Your customers will appreciate it.

Digital mobile radio systems – a new challenge to measurement technology

Multipath reflection, scatter, diffraction and interference mean a new challenge to every operator in the digital radio network business. Digital mobile radio systems are far more complex than their analog counterparts. Field-strength measurements alone often prove to be inadequate to evaluate the radio coverage in difficult areas. The unique, patented interference measurement system from Rohde & Schwarz analyzes the multipath propagation of a signal as well as noise or co-channel and adjacent-channel interference - and it detects extraneous signals. There is no potential interference factor whatsoever that is not taken into account. This means that with the measuring systems from Rohde&Schwarz you are always on the safe side and optimally equipped for future digital communication.

Reliable planning through practice-oriented measurement

The dilemma in this context is that only practical experience will furnish useful data about the functioning of a network. This knowledge is required early in the planning phase to optimize the network prior to its commissioning. The solution is in operational measurements using test transmitters. The point of the Rohde & Schwarz solution is that our test transmitters are not only suitable for calibrating the planning software, but can be switched to signalling mode. This allows testing under realistic conditions with exactly the same signals that are later used by the network.

Coverage Measurement Systems (Mobile Radio or DAB) – Overview

This stage will show whether the theoretically determined transmitter sites are suitable and the realistic receiving conditions are sound. It's no longer a matter of hope ("will it run smoothly?"). You can put your radio network installed with the aid of Rohde&Schwarz test equipment into operation and be sure that you provide the customer with a fully developed and tested infrastructure.

From a single source

Efforts involved in building up a radio network are enormous: carrying out market research, procuring the licence, ensuring financing, planning the sites, determining the mobile radio method, choosing the service and sales partners, setting up the administration network, installing the network, testing, optimizing and maintaining it. Therefore it is good to have reliable partners providing competent support in important areas of the implementation and ensuring that the project remains calculable both in time and in money. To live up to all this we supply a complete range of ideally matched measuring systems and components embedded in a consistent software environment. Whether you decide for budget-priced portable test mobile systems or fully equipped test vehicles, whether you wish to make field-strength measurements or signalling measurements - the solutions offered by us are technically innovative, proven in practice and feature maximum performance and ease of use. Numerous network operators – including all providers of full-coverage digital radio networks in Germany – rely on Rohde & Schwarz systems. Our range of cost-optimized network measurement tools certainly includes the right solution for your specific requirements.

Overview of systems

Type	Designation	Description	Application	Page
TS9955	High-Performance Coverage Measurement System	High-performance measurement system for all coverage measurements; basic model for CW measurements; can be upgraded for signalling and interference measurements, Measurement Software "ROMES"	Field-strength measurement Signalling measurement Interference measurement Network optimization Quality monitoring Network planning and installation	371
TS55-C3	Coverage Measurement System	Highly compact solution for field-strength measurements	Field-strength measurement Signalling measurement Localization	372
TS9951 Outdoor	Portable Coverage Measurement System	Compact case system with 1 to 4 test mobiles for network-specific measurements as well as network comparison measurements	Signalling measurement Network optimization Quality monitoring Network installation	374
TS9951 Indoor	Handheld Coverage Measurement System	Special solutions for signalling measurements with 1 or 2 test mobiles	Signalling measurement Network optimization Quality monitoring Network installation	374
TS9958 ROGER	GSM Interference Analyzer	Quick and easy detection of CO and adjacent channel interferences for mobile applications	Network optimization Quality monitoring	376
TS9953	Test Transmitter System	System for emitting network-specific digital or CW signals	Signalling measurement Interference measurement Network planning and installation	379
TS9954 ROSEVAL	Evaluation Software	Evaluation software for all Rohde&Schwarz coverage measurement systems	Field-strength measurement Signalling measurement Data analysis Network optimization Network planning and installation	380

Coverage Measurement System TS9955 (Mobile Radio or DAB/DVB)

Highly accurate and fast coverage measurements in mobile radio or DAB/DVB networks

Photo 43218-1

Brief description

TS9955 is a high-performance system for measurements carried out in the planning, installation, optimization and quality monitoring of mobile radio or DAB networks. This system is not only suitable for high-precision and fast field-strength measurements, but in an upgraded configuration (see following pages) also for a comprehensive interference analysis which in this unique form is offered by Rohde&Schwarz only.

TS9955 means an investment in a highly efficient equipment providing extremely fast and reliable measurements. It is basic configuration for field-strength measurements, the system is able to measure four GSM900 channels simultaneously at a speed of up to 90 km/h (63 mph) and with the Lee criterion being adhered to, ie a distance of a few centimeters between the measurements. Preparing field-strength profiles and detecting any field-strength gaps is thus speeded up considerably so that accurate data required for calibrating the planning tools are quickly available.

Main features

- Measurement of field strength; up to four GSM channels at a time at speeds of up to 90 km/h and the LEE criterion being complied with
- Frequency hopping over 124 channels
- All filters required for GSM900/1800/1900 and analog systems or DAB
- Integrated test mobiles for various standards
- Acquisition of RxQual, RxLev and layer-3 information via test mobile in GSM 900/1800/1900 and GPRS networks
- Acquisition of signalling data for other mobile communication standards such as ETACS and CDMA
- Collection of positioning data via GPS (Global Positioning System)
- Removable hard disk for easy data handling (PC card)
- Realtime graphics
- Ten user-definable event keys, various system events with freely definable thresholds
- User-friendly measurement software for controlling all system components
- Comprehensive evaluation software

System configuration

The complete measurement equipment can be accommodated in a car. The system installed in the car mainly consists of test receiver, navigation systems, test mobiles, process controller and software. The core of the system is the powerful Test Receiver ESVD (ESVB for DAB, DVB-T and CDMA) which is not only extremely fast but also provides maximum level accuracy and frequency stability. Unlike conventional controllers, the robust Coverage Analyzer PCSP features excellent electromagnetic shielding so that it is absolutely neutral to the highly sensitive measuring equipment.

Software

Measurement Software ROMES integrates and administrates all system components and is ideally supplemented by the Software Package ROSEVAL (see page 380) for drafting and evaluating the test tours.

Coverage Measurement System TS55-C3

Highly compact solution for field-strength measurements

Photo 43386

Brief description

Coverage Measurement System TS55-C3 is a highly compact solution for field-strength measurements designed for indoor and outdoor environments. The system is optimized for the mobile communication networks of GSM-R, E-GSM public GSM (900/1800/1900) and GPRS.

The core function is provided by the Coverage Analyzer PCSP together with the integrated 3-channel receiver, accommodated on a single printed circuit board (TS55-RX). All hardware components such as TS55-RX, 4-COM-port interface board and trigger box are controlled by the Coverage Measurement Software ROMES.

All functions are integrated and wired in a robust aluminium transit case. This ensures reliable measurements.

Functionality

Coverage Analyzer PCSP is the platform for the integration of the additional system components and their software control. Coverage Measurement Software ROMES is part of the system. The receiver is equipped with three parallel RF sections for simultaneous measurements (measurement time for 1 to 3 frequencies: 3 ms). Thus three mobile communication frequencies can be measured at the same time.

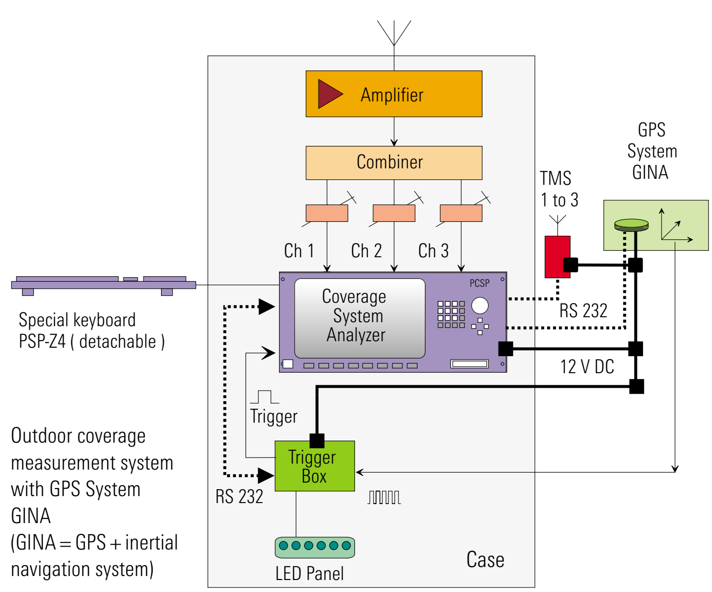
The three test receivers are triggered by means of the trigger box. This unit is connected to a pulse generator either mechanically (Peiseler pulse generator) or electronically. It is possible to run the RF measurements either time-triggered or distance-triggered. A LED panel informs about the status of the trigger box.

For indoor measurement applications the Coverage Analyzer PCSP with the trigger box and a mechanical pulse generator can be fixed on a suitable trolley. The system is powered from an external 12 V battery. When required, external monitoring of the battery's voltage and current is possible. Only one antenna is connected to the system, an internal RF splitter/amplifier ensures high isolation.

Extensions (options)

Localization

For outdoor measurements, which require additional navigation/localization information, the indoor measurement system can be extended by means of a GPS navigation system. A very compact GPS receiver (eg Garmin Mouse) is connected to the



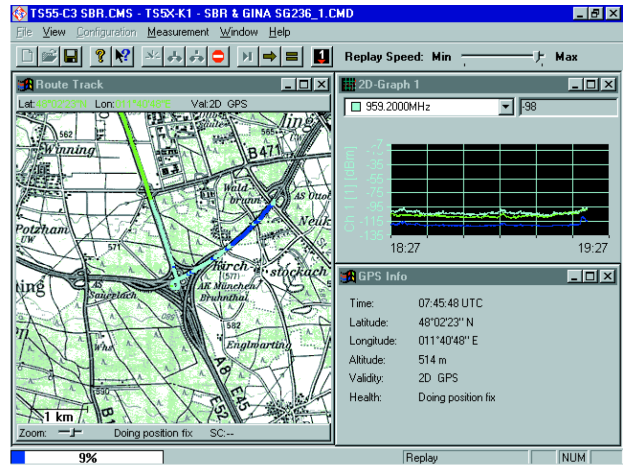
Outdoor coverage measurement system with GPS System GINA (GINA = GPS + inertial navigation system)

Coverage Measurement System TS55-C3

Coverage Analyzer PCSP via a RS232 serial interface. Control of the GPS receiver and read-out of positioning information is performed by the ROMES software; the NMEA protocol is supported. For users requiring a dead reckoning feature for GPS operation the Coverage Measurement System TS55-C3 can be equipped with the Rohde&Schwarz GPS Inertial Navigation System TS-GINA. This navigation system provides a 12-channel GPS receiver combined with an inertial navigation module. This configuration does not require any further connection to the vehicle (eg Peiseler pulse generator) and thus provides maximum flexibility.

GSM signalling

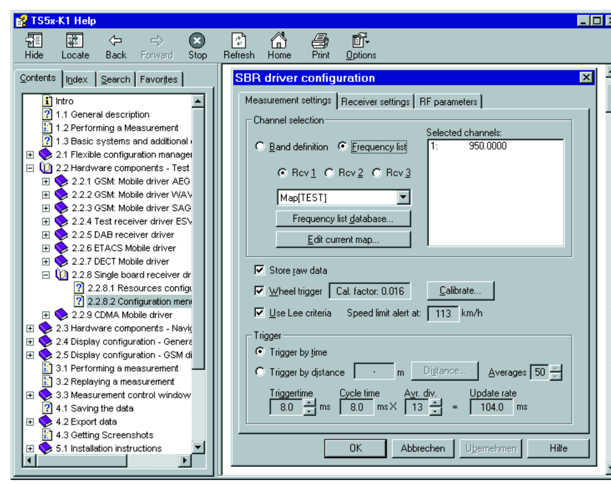
For the collection of signalling data up to four (three if GPS receiver is connected) test mobiles can be connected to the system via RS232 interfaces. Control is effected by the ROMES software extension for GSM signalling (TS95K50).



Typical online graphics for Measurement Software ROMES (here: Route Track, 2D-Graph, GPS Info); Replay mode

Software

Coverage Measurement Software ROMES, a Windows application, controls all system parts such as receiver, GPS system and test mobiles and configures the entire system. The software driver for the 3-channel receiver allows the setting of three frequencies, raw data and/or average data according to Lee criteria, time- or distance-triggering. A calibration function is also included. The software driver for the GSM test mobiles can be set for normal measurements, CAMP mode or scanning mode.



Measurement Software ROMES: software driver for 3-channel receiver, combined with on-line help

Specifications in brief

General data

Power consumption	12 V/4 A (without options)
Weight of PCSP	approx. 14 kg (including all options and transit case)
RF input	50 Ω, N female connector
VSWR	< 1.5
Dimensions in mm (W x H x D)	580 x 220 x 500 (incl. transit case)
Coverage Analyzer PCSP	see PSP7, page 402

3-Channel Receiver TS55-RX

Frequency ranges	921 MHz to 960 MHz 1805 MHz to 1880 MHz 1905 MHz to 1980 MHz
Frequency setting	100 kHz
Measurement time	3 ms for 1 to 3 frequencies
Selectivity	–110 dBm at S/N ratio of 2 dB (IF bandwidth approx. 100 kHz)
Dynamic range	80 dB (70 dB with a linearity departure of ±3 dB)
Maximum RF input level	
Continuous	10 dBm
Pulse	0.1 mWs (within 10 µs)
IF bandwidth	100 kHz
Output signal	IF 10.7 MHz (–1 V to +1 V)
Amplification	
Aging	<1 dB/year, <5 dB/10 years
Temperature drift	±2 dB (0 °C to +55 °C)
Intermodulation	70 dB (with –30 dB RF input level at two inputs)
Image frequency rejection	≥70 dB

Ordering information

Coverage Measurement System	TS55-C3	1113.2491.02

Coverage Measurement System TS9951 (Mobile Radio or DAB)

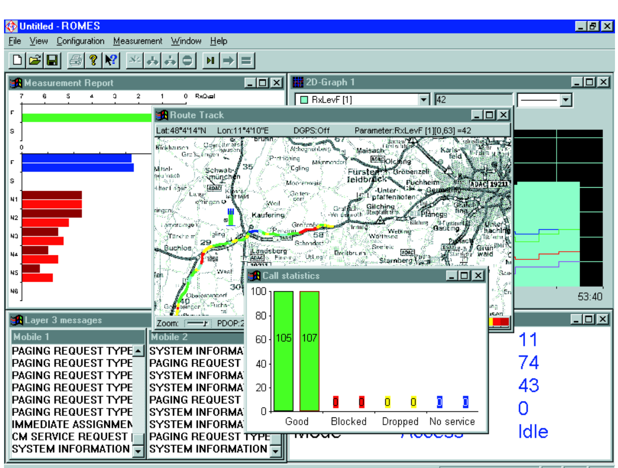
Compact case system with 1 to 4 test mobiles for network-specific measurements and network comparison measurements

Photo 43210-2

Brief description

Out and about with compact systems
System TS9951 is a budget-priced compact solution for network-specific quality parameter measurements during network installation, but mainly for quality monitoring during regular network operations. Through the integration of the main system components in a robust transit case, the systems are ready for use at any time and easy to transport. They can optionally be fitted with GSM900/1800/1900 test mobiles, as well as ETACS or CDMA test mobiles.

Simultaneous measurement of different networks to save time
TS9951 with up to four (maximum of three GSM) test mobiles allow mobiles of different standards to be used at the same time to carry out simultaneous measurements on several networks available at a site, or various antenna models or antenna positions on the vehicle to be tested. The test mobiles can readily be exchanged in no time. This flexibility is a great advantage in particular for service enterprises that have to carry out measurements on different networks on behalf of their customers often under an enormous pressure of time.



Coverage Measurement Software ROMES

The right system for every application

Different requirements call for different solution:

- TS9951 for outdoor application with one to four test mobiles for measurements in operational network or for use in conjunction with Test Transmitter System TS 9953 (GSM technology)
- TS9951 for indoor measurements

Main features

- Compact case system with built-in GPS receiver and with IBM-compatible laptop
- Test mobiles available for GSM900/ 1800/1900 CDMA or ETACS

- One, two, three or four test mobiles
- Test mobiles (level table storable)
- Basic measurement in passive idle mode – no call setup required
- Camp mode for determining the cell boundaries
- Recording of signalling and analysis of OSI layer-3 information

Coverage Measurement System TS9951 (Mobile Radio or DAB)

- Realtime graphical display of test report
- Realtime alphanumeric display for presenting signalling information
- Realtime presentation of selected parameters on underlaid road maps
- Automatic or manual measurement mode
- Outdoor positioning with the aid of GPS navigation
- GSM Network Quality Analysis (NQA) Software running under Excel 5.0 or 8.0 for statistical evaluation of network availability, quality of connection, time required for call setup, call hold time, etc
- DC (12 V) or AC supply
- Indoor navigation modes

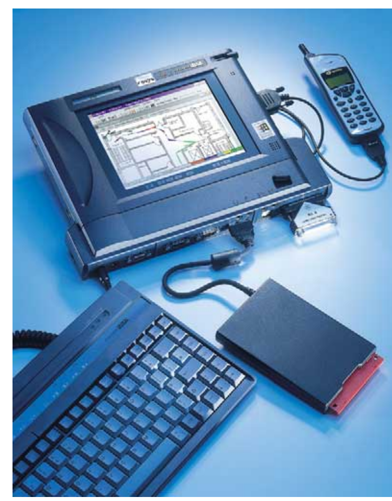
System configuration

The systems use the intelligence of the radio telephones, ie they automatically find the operating frequencies of the radio service. The measurements are not only carried out in the dedicated mode, but also in the RxQual idle mode of the mobile. The great advantage of these systems is that quality measurements can be made in conjunction with a digital test transmitter such as the TS9953 (see page 379) so that a full-featured base station is not required.

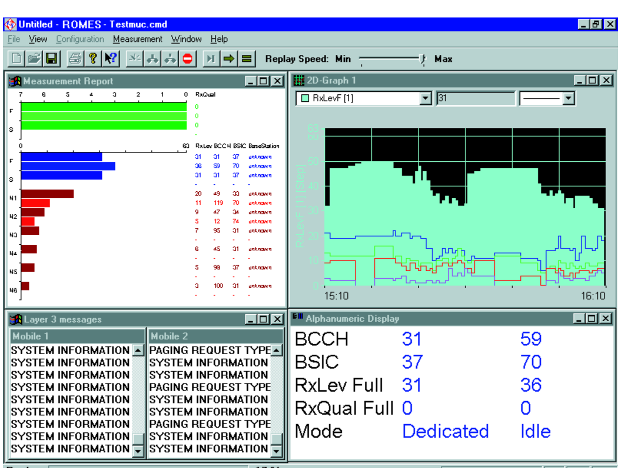
The test mobiles used are modified by adding vital measurement functions. They also allow measurements on cell boundaries to be readily per-formed (camp mode). Moreover, the mobiles can be calibrated for high measuring accuracy. The built-in GPS receiver can be supplemented by a Travelpilot or sensor system to handle situations in which GPS reception via satellite is not possible, for instance in road tunnels.

Software

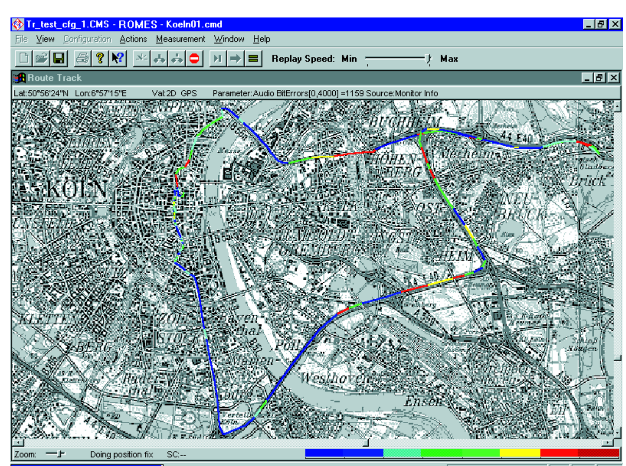
TS9951 not only features an extraordinary hardware but also a very special software providing far more than the usual capabilities. In addition to the display of standard parameters such as RxQual, RxLev or SSI, this system also allows graphical processing of data and presentation on underlaid road maps.



TS9951 for indoor measurements



Four typical windows in replay mode



Full-screen display of Route Track window with a complete DAB test tour

GSM Interference Analyzer ROGER (TS9958)

Quick and easy detection of CO and adjacent channel interferences for mobile applications

Photo 43590-4

Brief description

The GSM Interference Analyzer TS9958 is a highly practical solution for co-channel interference measurements that are mobile and fully automatic, making the way for simple analysis.

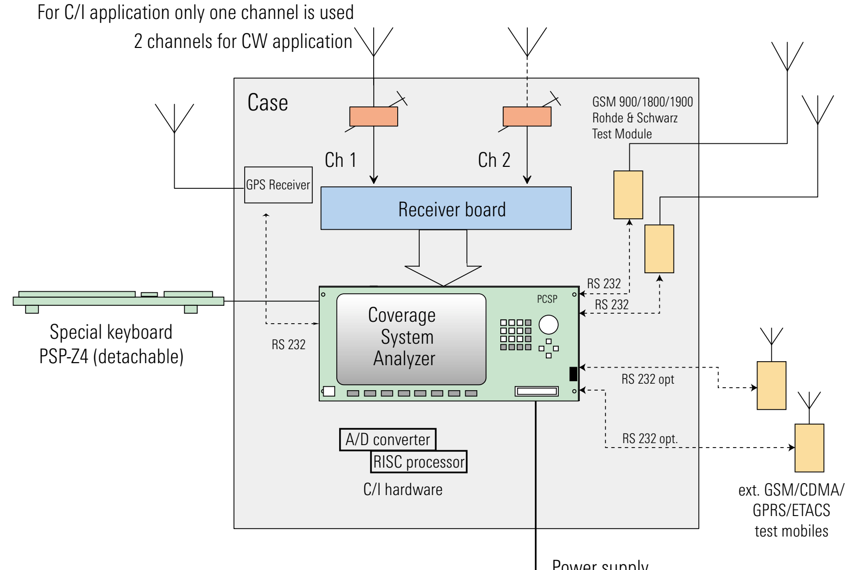
ROGER consists of:
- Test Receiver TS55-RX,
- up to four test mobiles of different make,
- a GPS receiver,
- a process controller equipped with A/D converter card and signal-processing card.

Test Receiver TS55-RX is accommodated in the controller, making ROGER a highly compact, lightweight unit. The system uses Coverage Measurement Software ROMES 3 from Rohde&Schwarz, affording a state-of-the-art operating concept and the repeated use of position data sources and mobile-phone linkups. Using an indoor module, the software even allows interference detection inside buildings.

ROGER can optionally be fitted with a position trigger so that it can carry out classic measurement of coverage in addition to interference. In particular the option of extending the system by up to eight additional mobiles of different standards (GSM 900/1800, CDMA, GPRS) allows space- and cost-saving performance of different tasks with a single unit.

Main features

- Fully automatic measurements, no manual control necessary
- Mobile measurement detects interferences everywhere
- Easy and simple evaluation of the real source of interference
- For all GSM/GPRS networks with hopping or non-hopping channels
- Not only experts can make reliable mobile C/I measurements
- Quick and reliable graphical evaluation
- A MUST for GPRS networks due to high data transmission rates
- Drastic reduction of all measurement costs
- Significant improvement of fast and reliable results
- Real interferer identification within seconds



Block diagram TS9958

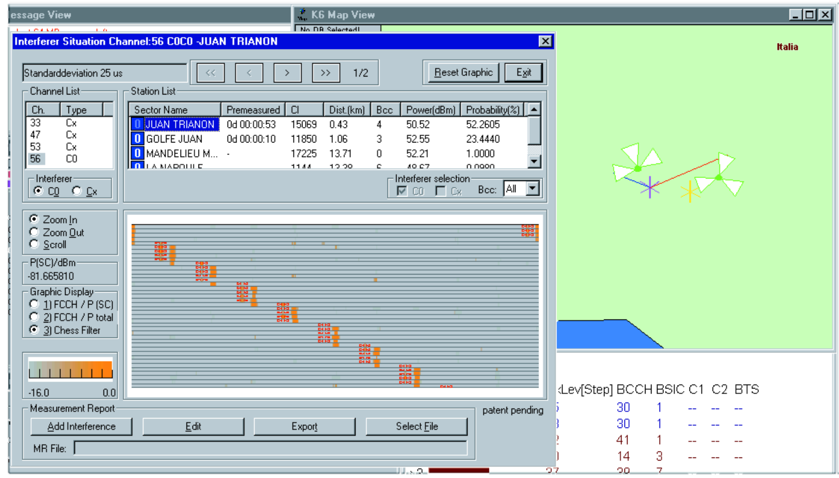
GSM Interference Analyzer ROGER (TS9958)

How ROGER works

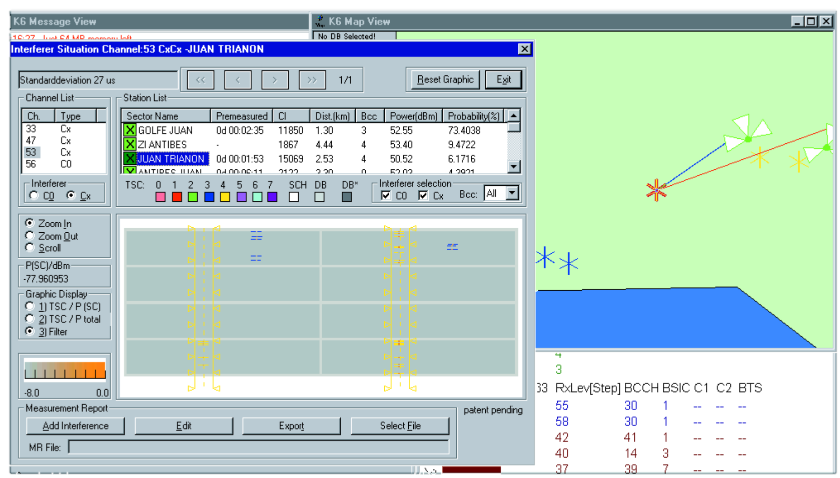
Just a short configuration of ROGER, and the test tour can start. The test run is automatically controlled by up to four mobile phones, doing away with any manual control. High vehicle speeds are no problem for ROGER either. Interference measurement is performed in three steps:

- detection of interference,
- measurement of interfered/interfering signals,
- assignment of these signals to base stations.

The signals found can be assigned to the emitting base stations already during the test tour or afterwards on a conventional PC.



PCSD-K6 Evaluation Display (here BCCH (C0) with interference from another BCCH (C0))



PCSD-K6 Evaluation Display (here TCH (Cx) with interference from another TCH (Cx))

Signal display

There are signal displays for two test modes: for C0 (BCCH) and Cx (TCH) measurements. From the disturbed composite signal, ROGER filters out frequency-correction bursts (FCCHs) for the identification of C0 carriers and displays them. The time axis is structured in lines comparable to a TV frame, arranged such that neighbouring FCCHs of an M51 frame (51 TDMA frames) come vertically one below the other. Because of the idle burst at the end of each M51 frame, a staircase pattern is obtained for each detected C0 carrier. So the graphical presentation of the C0 channel of the serving cell (SC) reveals a staircase with the FCCHs of the SC itself and further patterns in the case of C0 interference. In the analysis window for adjacent channels or TCH channels of the SC, each staircase pattern indicates the presence of C0 interference.

In Cx measurement, the composite signal is analyzed in greater detail. Synchronization as well as dummy-burst and training sequences are filtered and visualized grouped according to timeslots. The measured sequences of different base stations are shown in time grids corresponding to two vertical stripes in the Cx display. Different base stations are represented by stripes at different positions along the x axis. Interference can be identified immediately: from any further stripes displayed next to the two SC stripes. In mobile measurements, the selected signals fluctuate due to fading, reflection and other external influences, resulting in a variety of signal patterns. ROGER therefore processes interference signals for graphical representation, as the human eye can analyze complex patterns with high reliability.

GSM Interference Analyzer ROGER (TS9958)

Fast identification of base stations
To trace interference back to the emitting base station, a feature characteristic of each BTS is used: the expected arrival times of specific signals at the measuring instrument. The times are determined from the measurement position, the expected sending time and the site of the BTS. When a BTS is selected, the expected arrival time is superimposed on the displayed sequences in the form of a template. If this matches a signal measured, the latter can be assigned to the selected BTS. In the case of Cx measurements, the number of possible base stations is reduced by a factor of eight to those whose base-station colour code and training-sequence code are identical. The selected BTS is additionally shown on a map, allowing comparison of the propagation conditions of server and interferer.

Power measurement
In the interference charts, the power values are colour-coded, allowing a basic evaluation of interference. For purposes of optimization, the measurement system provides the dynamic C/I value for each base station after the SC and interference signals have been selected. The measured and averaged power values can be visualized and if necessary modified. Modification enables evaluation of the range of interference obtained with mobile measurements. The results of power analysis are stored in a file, and a test report of the analyzed interference signals is generated. The latter may serve as a basis for network modifications.

Specifications in brief

Controller	
Processor	AMD K6, 300 MHz minimum
RAM	32 Mbyte (standard), with PSP-B2 expandible to 64 Mbyte 512 kbyte cache
Hard disk	1.6 Gbyte minimum
Disk drive	1.44 Mbyte, 3½"
Operating system	MS-Windows version 98
Test & measurement software	LabWindows/CVI
Display	
PSP2	none
PSP7	LCD colour, 8.4", screen anti-glare
Resolution	
with integrated LCD	VGA standard: 640 x 480 pixels
for external monitors	1280 x 1024, 1024 x 768, 800 x 600, 640 x 480 pixels, 2 Mbyte video memory
Interfaces	
Internal	ISA, 3 x 16 bits
External	
IEEE/IEC	IEEE488.2, compatible with NI TNT
Serial	2 x RS-232-C
Printer	Centronics LPT1 (ECP, EPP)
PCMCIA	release 2.0, type III, connector
Keyboard, mouse	5-contact DIN, 5-contact PS/2
Interference measurements	GSM 900, GSM (DCS) 1800 and GSM (PCS) 1900 networks
Detection and analysis of C0 and Cx interferences	on the C0 (BCCH), Cx (TCH) and optionally on adjacent channel of the Serving Cell (SC)
Trigger on interferences	automatically or manually based on 1 to 4 GSM test mobiles

Displayed dynamic range

Type of interference	Total[1]	compared to SC[2]
C0 – C0	–16 dB to 0 dB	–13 dB to 3 dB
Cx – C0	–16 dB to 0 dB	–13 dB to 3 dB
Adj – C0	–8 dB to 0 dB	–8 dB to 8 dB
C0 – Cx	–8 dB to 0 dB	–10 dB to 6 dB
Cx – Cx	–8 dB to 0 dB	–10 dB to 6 dB
Adj – Cx	–8 dB to 0 dB	–8 dB to 8 dB

General data	
Rated temperature range	+5°C to +45°C
Operating temperature range	0°C to +50°C
AC supply	100 V to 120 V ±10%, 50 Hz to 400 Hz 220 V to 240 V ±10%, 50 Hz to 60 Hz
DC supply	DC, 12 V
Max. power consumption	typ.300 W (12 V DC/25 A)
Dimensions (W x H x D)	500 mm x 200 mm x 800 mm
Weight	19.8 kg

Ordering information

GSM Interference Analyzer ROGER	TS9958	1132.2506.02
Options		
Additional, external GSM/GPRS Test Mobiles	on request	

1) compared to the total power in the underlaying time slot.

2) compared to an average power level of the SC, measured directly before and after the actual interference.

Test Transmitter System TS9953

System for emitting network-specific digital or CW signals

Photo 42659-7

Brief description

Planning needs data
The best theoretical wave propagation model in your prediction tool can be no more than a rough approximation of the realistic conditions at the site. Experience has shown that the calculated sites of the transmitters as furnished by prediction tools are quite useful as a basis to start with, but that in digital networks such calculations do not guarantee the proper functioning of the network.

Test transmitters therefore are the solution for "fine tuning" of the transmitter sites, and in particular those test transmitters that are able to master the digital signalling of the network to address the mobile phones.

Main features

- Models for GSM900/1800/1900 (each including CW); for GSM900/1800 with integrated storage/modulator
- Generates all GSM signals required for the measurement of
  – field strength
  – RxLev
  – RxQual
  – CIR (channel impulse response)
- Can be used in parallel with an operational network
- ERP (effective radiated power) selectable between 1 W and 50 W
- Compact model with max. 2 W output power, including built-in modulator

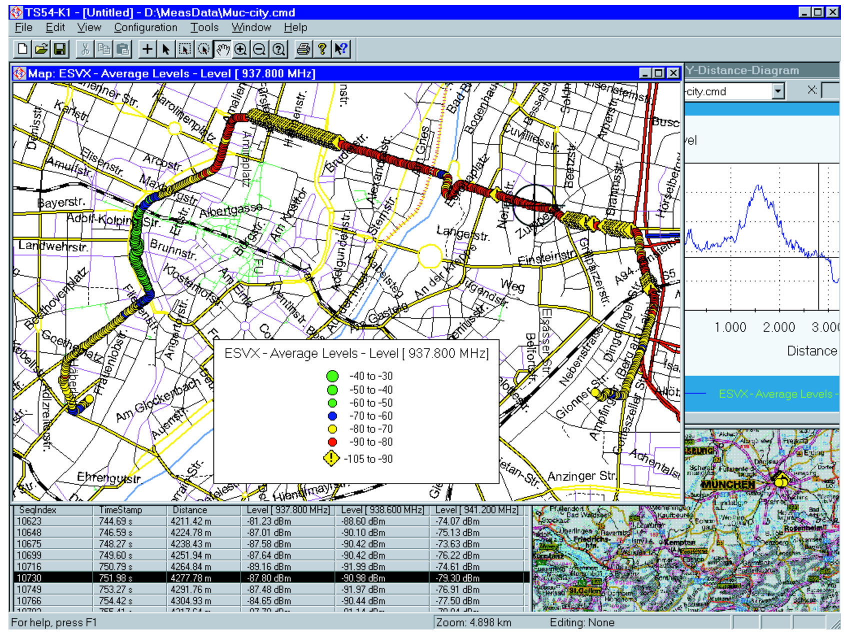
System configuration

Test Transmitter TS9953 is based on the multistandard Signal Generator SME. At the push of a button (or IEEE/IEC bus command) the SME provides all the signalling data in the network-specific modulation mode required for the quality parameter measurements with a test mobile system.
The new amplifiers with built-in GMSK modulator and synthesizer make measurements considerably easier. Only one combined unit (19", 2 height units) is required per frequency band. A 2 W model, which also has a built-in GMSK modulator/synthesizer, is available for indoor applications.

Built into a lightweight aluminium frame, the systems can easily be transported and connected to the antenna practically in no time to be ready for operation. Accessories such as protective cover and antenna guying ensure that the test transmission can take place right in line with your time schedule and is not dictated by the uncertainties of the weather.

Evaluation Software ROSEVAL

High-performance evaluation software for field-strength analysis



Graphical representation of RxLev and RxQual along a route

Brief description

The high-performance Evaluation Software TS 9954 "Roseval" (**Ro**hde & **S**chwarz **eval**uation software) is an excellent tool for analyzing all measurement data from data collection systems (Rohde & Schwarz Systems TS 9951 or TS 9955) by means of different methods.

With the aid of this software the user can ensure high network quality during the installation, optimization, service and maintenance of his network. As a Windows application it can easily be handled and installed on a standard PC. The concept is modular and adaptable to the most familiar digital networks like GSM, ETACS, CDMA.

As a subunit the well-known GIS software MAPINFO is used for geographical evaluations. The full power of this embedded software is open for designing new customer-specific layers.

Main features

- Generation of structured meta files
- Highly effective evaluation through the use of filtered and selected data
- Efficient file management of measurement data (central server)
- Fast access to all local temporary data
- Freely definable legends and comments
- Selection and evaluation of multiple measurement files in database only limited by system resources
- Exact reference of measured points to the measurement device they originate from
- Statistical evaluation and area data mapping
- Wide range of attributes assignable to each signal (colour, icons, pattern, ranges) to get the most efficient visualization of parameters
- SQL (structured query language) data selection and evaluation
- User-definable derived signals
- Global data selection (interactive and SQL)
- No special expensive hardware is needed (recommended Pentium class 300 MHz or better)

Available technologies

The most important digital network technologies and Rohde & Schwarz Test Receivers ESVx are supported.

- CW, Field-Strength Test Receiver ESVx
- GSM 900/1800/1900 test mobiles, signalling
- ETACS test mobile, signalling
- CDMA test mobile, signalling
- CIR (channel impulse response) analysis
- C/I (carrier/interference ratio)

Turnkey EMC test centers, customized solutions for test houses, electrical and car industry, etc

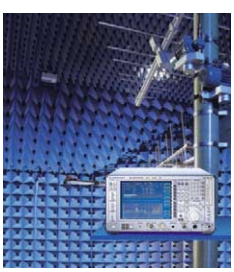
General RF measuring systems

TS 9970

EMC Test Systems and Projects from Rohde & Schwarz

Standard EMC test systems for...

...EMI measurements



TS 9975

TS 9976

...EMS measurements...

...on sound and TV receivers

TS 9980

...on other equipment...

...conducted

TS 9986

...radiated...

TS 9981 (up to 1 GHz)

TS 9983
(1 GHz to 18 GHz)

Brief description

Uses

Test System TS9970 has been designed for measuring main RF parameters of wireless communication equipment under realistic operating conditions. In addition to the spatial radiation characteristic of the communication antenna, receiver parameters such as signal-to-noise ratio and bit error rate as a function of EUT orientation can be determined.

TS9970 can be effectively used both in design and type approval testing.

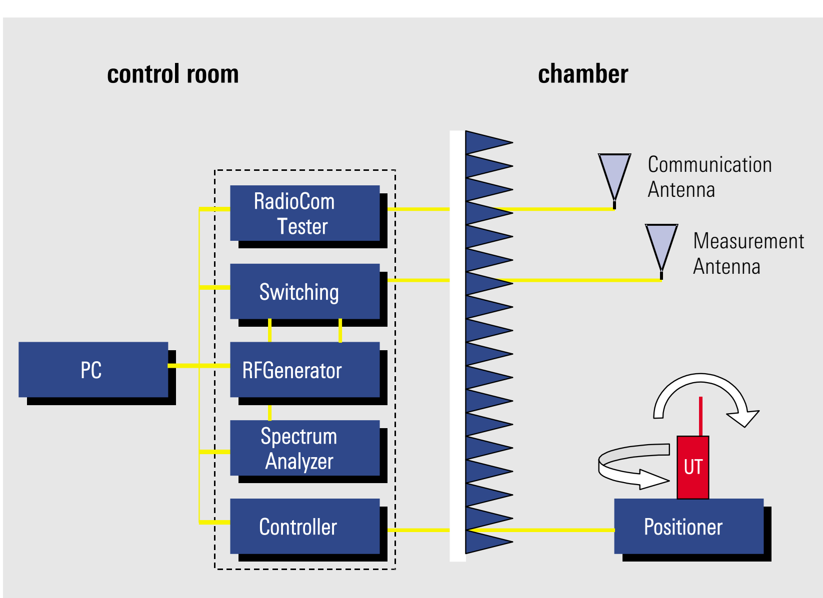
Configuration

As shown in Fig 1, TS9970 is made up of the following main components:

- The communication tester in conjunction with the communication antenna serves for establishing a radio link to the EUT
- Depending on the type of measurement to be performed, the measurement antenna is connected via a switch matrix either to the spectrum analyzer, RF generator or communication tester
- The EUT is mounted on a positioning device which is remote-controlled by a controller. An artificial head or body may be used to simulate the operator's influence
- A central process controller including the appropriate software provides for automatic measurements with documentation of results
- To simulate open area conditions, a shielded anechoic chamber or comparable test cell (ie M-LINE from Rohde & Schwarz) is required for testing

Main features

- Determination of spatial radiation and receiving characteristics of EUT
- Especially suitable for EUTs with integrated antenna
- Measurement of main RF parameters via air interface
- Automatic measurements and analysis of results
- Also available as extension for EMC lab systems



Block diagram TS9970

RF Performance Test System TS9970

System versions

Version 01 – Basic system

Main components
- Signal generator
- Spectrum analyzer
- Positioning device
- Communication tester
- Relay matrix
- RF attenuator
- Test and communication antennas
- System software

Version 02 – Extension for EMV systems
Since existing EMC systems often contain most of the instruments used in the TS9970 basic system, version 02 is available for extending such systems. Rohde & Schwarz offers an upgrade package tailored to the specific needs.

Standards
Almost any digital and analog radio standard can be implemented in the system. A suitable communication tester is the only prerequisite. Rohde & Schwarz testers support the following standards:

TACS, AMPS	CMS52/54	0840.0009.52/54
GSM900/1800/1900	CMD55/65	1050.9008.05/65
DECT	CMD60/65	1050.9008.60/65
CDMA, D-AMPS	CMD80	1050.9008.84
D-AMPS	CMD80	1050.9008.84

Implementation of Universal Communication Tester CMU into the TS9970 is also possible.
Configurations for other standards on request.

Test parameters
- Bit error rate
- Effective radiated power (ERP) or equivalent isotropically radiated power (EIRP)
- Transmission parameters such as RXQUAL, RXLEV, etc
- S/N ratio at receiver input, etc.

System software

Main features
- Standard test routines for measurement of 3D directional pattern in a spherical or semispherical volume
- Standard test routines for measurement of 2D directional pattern (azimuth pattern)
- Setting of all test parameters via the software user interface
- Automatic evaluation of results (referred to limit values, eg conforming to GSM, DECT, etc)
- Graphical and tabular display of results
- Automatic generation of test reports
- Expandable for magnitude and phase measurements (network analyzer)

Specifications

Operating temperature range	+15°C to + 40°C
Relative humidity	95% at 40°C
Power supply	110 V AC, 230 V AC
Certification	CE, VDE
The system comes in a 19" rack	

Accessories

Test environment	M-LINE
Controller	TS-PCS
Controller integrated in rack	PSM 17
Artificial head	TS-HEA
Artificial body	TS-BOD

EMI Test System TS 9975

Brief description

EMI Test System TS 9975 is used for all EMI measurements of conducted and radiated interference.

Commercial standards
- CISPR 11–22
- EN 55011–55022
- VDE 0872–0879
- ANSI-C 63.4
- FCC 15, 18
- EACL 1–8

Military standards
- VG 95370–95377
- DEF-STAN 49–41
- GAM-EG 13
- MIL-STD-461/462

Customer-specific adaptations to other standards or different regulations can be integrated into Test System TS 9975 without any problems.

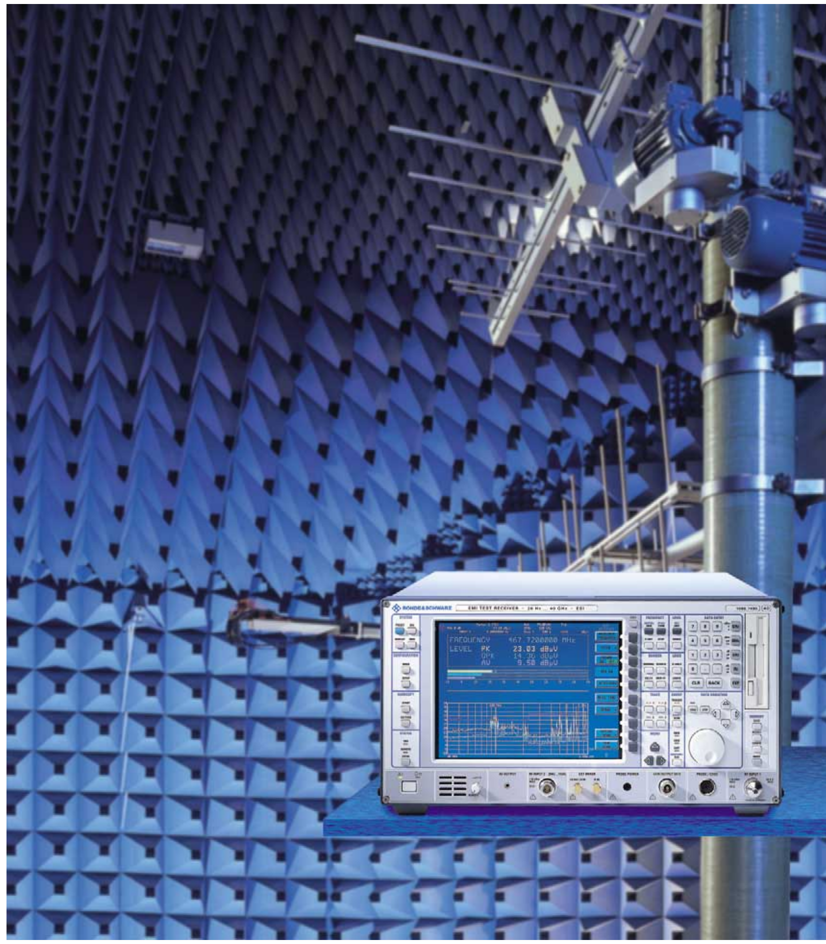


Photo 40816-1

System configuration

The system features a highly modular hardware and software concept. Customized systems can be configured from a variety of instruments and software options. The system is a complete package of hardware and user-friendly software as well as system services so that the user will be familiar with the system within the shortest possible time.

Hardware
A Process Controller (PC) is the core of the system; it controls the complete measurement system via its IEEE/IEC bus interface. Depending on the frequency range to be covered and the special test requirements, measurements are carried out by one or several test receivers.

Hardware expansions
- Artificial Mains Networks ESH 2-Z5 and ESH 3-Z5
- System Control Unit TS-RSP for switching antennas and transducers
- Rohde & Schwarz test antennas (i.e. HL 562)

Moreover, Rohde & Schwarz can offer the integration of products from other manufacturers into Test System TS 9975, if required.

Software concept

EMI Software ES-K1 from Rohde & Schwarz (page 95) is used in EMI Test System TS 9975.

Brief description

Applications
System TS9976 is used for EMI and spurious emission measurements on wireless communication equipment during EMC and type approval testing. Typical DUTs are mobile phones, base stations, radio sets and short-range devices.

Relevant standards
Measurements of this type are based on the standards and technical regulations published by ETSI (European Telecommunications Standards Institute). For example, EMI measurements on GSM systems are defined by ETS 300-342, measurements of spurious emissions by ETS 300-607 (GSM11.10), ETS 300-609 (GSM 11.20) and by TBR 5 and 9 (technical basis for regulation). ETS 300-339 provides the generic standard for the EMC of radio equipment.

Specified emission measurements
The above standards stipulate a wide variety of measurements in a very wide frequency range, all of which can be covered with TS9976:
- Conducted EMI measurements from 0.15 MHz to 30 MHz in line with EN55022
- Radiated EMI measurements from 30 MHz to 1000 MHz in line with EN55022
- Conducted spurious emission measurements from 100 kHz to 12.75 GHz on antenna connector of DUT
- Radiated spurious emission measurements from 30 MHz to 4 GHz

For some radiocommunication systems (eg short-range devices), higher frequency limits (eg 40 GHz) are already stipulated for spurious emission measurements. TS9976 can be modified accordingly to accommodate for this requirement.

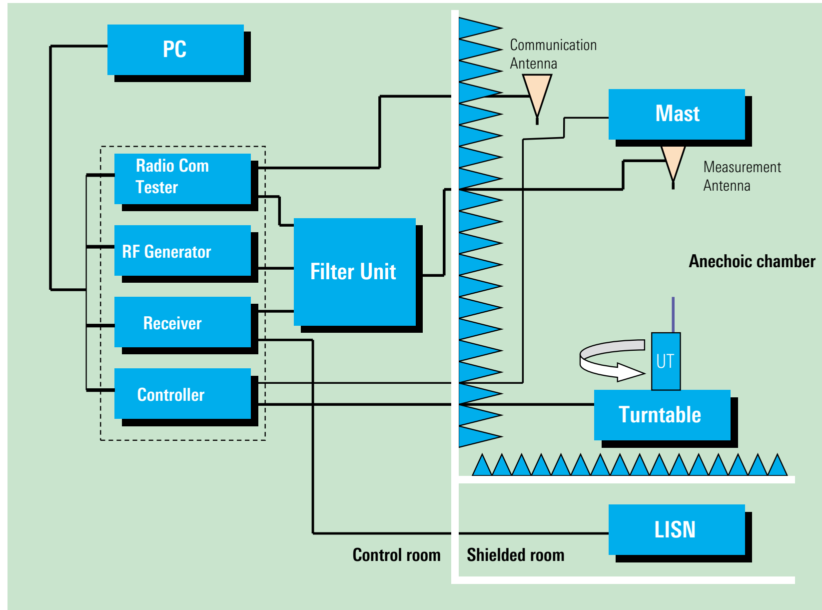
Spurious emission measurements differ from EMI measurements to EN55022 mainly in that bandwidths matching the useful signal have to be set on the receiver instead of the typical EMC bandwidths (eg 200 Hz, 9 kHz, 120 kHz). It should also be noted that EMC bandwidths are referred to the 6 dB points of the IF filters, whereas the bandwidths for spurious emission measurements are referred to the 3 dB points. In spurious emission measurements, the peak detector takes the place of the quasi-peak detector. All these differences make it necessary that for spurious emission measurements a spectrum analyzer or test receiver with spectrum analyzer functionality be used rather than a pure EMC test receiver.

In addition to EMI and spurious emission measurements, TS9976 can also measure useful signals, for example the EIRP (equivalent isotropically radiated power) of radio sets and modules with integrated antenna.

Emissionstestsystem TS 9976

Main features

- Frequency range 0.15 MHz to 18 (40) GHz
- EMC measurements to IT standards (eg EN55022, FCC)
- Use in type approval testing (eg for GSM to ETS 300-607/609)
- Measurement of spurious emissions from radiocommunication equipment



Block diagram TS 9976

System design

Test receiver
The test receiver forms the core of the system. As a typical EMC test receiver, it evaluates and displays emissions from 0.15 MHz to 1000 MHz in line with EN55022 and, in addition, it offers spectrum analyzer functionality for spurious emission measurements. If only the spurious is to be measured and if precompliance measurements are sufficient for EMC testing, a spectrum analyzer can be used instead of the test receiver.

Anechoic chamber
Radiated emissions are measured in an anechoic chamber. For this, a remote-controlled turntable and an automatic antenna mast with a control unit are required. These components can optionally be supplied with the system and controlled by the system software.

Test antennas
Suitable test antennas (usually log-periodic or horn antennas) and artificial mains networks are used for picking up emissions.

Filter unit
To measure spurious emissions, for example of mobile phones, in line with standards at a sufficiently wide dynamic range also with the DUT transmitting, the useful signal emitted by the DUT must be suppressed by means of bandstop or highpass filters.

To this effect, Rohde & Schwarz developed a special filter unit which, thanks to its flexible design, satisfies the common mobile radio standards (GSM 900, GSM 1800, DECT, CDMA, etc) and at the same time meets customer-specific requirements.

Communication tester
To switch the DUT to a defined operating state, a communication link has to be set up. This is done by a communication tester integrated in the system.

Signal generator
The signal generator is needed for system calibration and for substitution measurements which are prescribed by some standards.

Controller
The system components are controlled from a PC via the IEEE/IEC bus using EMI Software ES-K1 from Rohde & Schwarz.

Software
The control software (ES-K1), which forms part of the system, enables fully automatic simple testing. The complete software package runs on a PC or PC-compatible industrial controller. The system components are driven via the IEEE/IEC bus interface.

EMS Test System TS9980 DVB

EMS measurements on sound and TV receivers (photo 43206-6)

EMS measurements on sound broadcast and TV receivers, satellite receivers and DVB receivers

Brief description

Test System TS9980 has been designed for automatic measurement of the electromagnetic susceptibility of sound broadcast and TV receivers to EN 55020 and CISPR 20 standards.

It covers the following measurements:
- immunity to input interference (S1)
- immunity to RFI voltages (S2a)
- immunity to RFI currents (S2b)
- immunity to radiated interference (S3)
- shielding effectiveness (S4)

As part of ongoing technical development, system solutions for satellite receivers as well as DVB receivers and Set-Top-Boxes have been implemented.

The system can be used for EMC approvals as well as for development measurements and batch testing

Main features

Automatic measurement to
- EN 55020:1994
- CISPR 20:1996

Three basic systems
- TS9980 AUDIO
- TS9980 AV Multistandard
- TS9980 DVB Multistandard

Optimized software for
- Efficient test routines
- Convenient operation
- High reproducibility

Measurement technology

The growth in communications via terrestrial and satellite links and the "frequency crowding" in cable networks may affect reception quality.

Comprehensive EMS tests are used to verify the capability of receivers to operate satisfactorily – even under adverse conditions.

Since these tests are highly complex and involve a large number of single measurements, they are carried out with automatic test systems.

Test System TS9980 is available in three versions to cater for different products and applications.

TS9980 AUDIO
This system is used for testing analog sound broadcast receivers, tuners, amplifiers, equalizers, CD players, tape decks and accessories.

The test system contains two signal generators. The first generator is used to generate the carrier signal required for the sound broadcast receiver. The second generator is used to generate the interfering signal for the equipment under test (EUT). An audio analyzer (UPA) is used to measure the audio output signal at the EUT.

EMS Test System TS9980

System TS9980 AUDIO can optionally be upgraded to obtain the system versions described in the following.

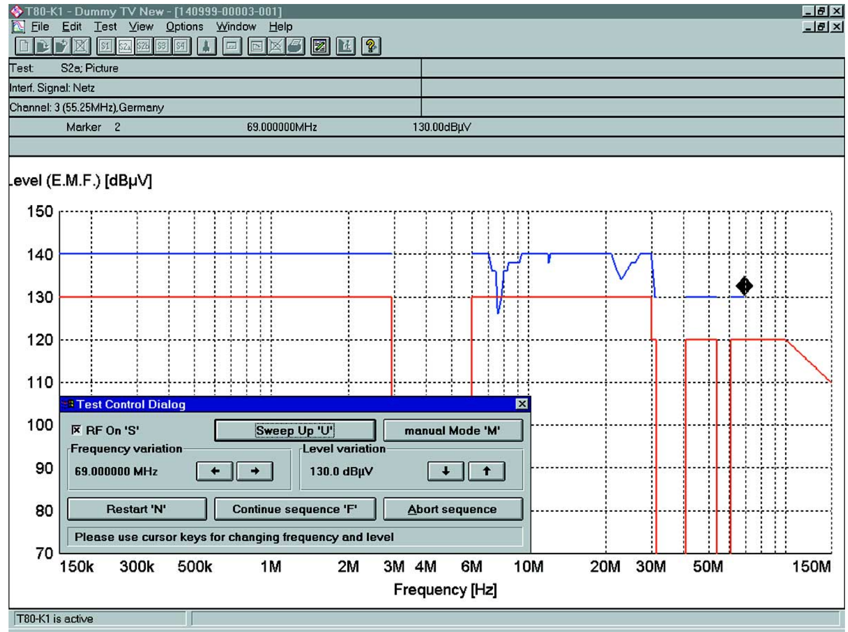
TS9980 AV Multistandard
This system is suitable for all relevant EMS measurements on analog sound broadcast receivers, TV receivers and video recorders. The following TV standards are covered:

PAL	B/G	mono / dual sound/ NICAM
PAL	I	mono / NICAM
PAL	D/K	mono / dual sound
SECAM	D/K	mono / dual sound
SECAM	L/L'	mono / NICAM
NTSC	M/N	mono / dual sound

This test system is an enhanced version of system TS9980 AUDIO described above. A TV test transmitter (SFM) is also used to generate a standard TV signal for tuning the EUT to the required carrier channel. Up to three video signal generators (PAL, SECAM and NTSC) can be connected to the SFM to provide the video signal. The first generator in this system is used to produce the second interfering signal to measure the immunity to input interference of TV receivers.

TS9980 DVB Multistandard
This system is suitable for all relevant EMS measurements on analog and digital sound broadcast and TV receivers as well as on video recorders and Set-Top-Boxes (integrated receiver decoders). The following standards are covered:

- TS9980 AV Multistandard (analog)
- DVB-C QAM (quadrature amplitude modulation) to ETS300429
- DVB-S QPSK (quadrature phase shift keying) to ETS300421



- DVB-T OFDM (orthogonal frequency division multiplexing) to ETS300744
- ATSC

An MPEG2 Measurement Generator DVG is used as the digital source. The MPEG2 generator offers a large selection of test signals in the 525- and 625-line standard. In an endless loop, it generates a large variety of selectable MPEG2 transport streams with combined video, audio and data sequences as contents.

TV Test Transmitter SFQ is used in the system to generate the digital useful signal. It features a future-proof open software system and a modular hardware concept allowing compliance with the various standards of the DVB groups. SFQ can be equipped with all DVB standards.

System Software T80-K1

System Software T80-K1 runs under Windows 95/98/NT4.0™. The integrated DDE interface allows data exchange between various Windows programs. Each test result is stored together with the test parameters. The test parameters contain all definitions of the test configuration. Thanks to the joint storage of test results and parameters, any measurement performed can be repeated with exactly the same settings - even a long time afterwards.

Thanks to the modular options, the software can easily be upgraded and adapted to future requirements. The software packages are protected by passwords and various user levels. This ensures that measurement data can only be cleared and that the system configuration only be changed by authorized users.

System expansions

- Shielding effectiveness (S4) for sound broadcast and TV receivers
- AC-line harmonics to EN 61000-3-2 / IEC 1000-3-2

EMS Test System TS9981

EMS measurements to IEC801-3/

IEC1000-4-3/EN61000-4-3 45

Photo 43652-1

Brief description

With the European standards for electromagnetic compatibility and the relevant national EMC laws that came into effect, EMS tests on electrical and electronic equipment are required in all areas of the civilian sector.

The test procedure for determining susceptibility to electromagnetic fields is described in the international standard IEC 61000-4-3. In Germany, standard VDE0843, Part 3 was derived from this standard. Product-specific European standards (EN61000-3-4) based on valid national and international standards have been established. Test System TS9981 from Rohde & Schwarz is for automatic EMS testing to IEC61000-4-3 and EN61000-3-4 with field strengths of ≥10 V/m in the frequency range 80 MHz to 1 GHz. On demand the frequency range is expandable up to 3 GHz, 18 GHz or 40 GHz. Hereby an efficient, flexible and reliable tool both for tests in development and acceptance tests is available.

Main features

Automatic measurement of susceptibility to electromagnetic fields to IEC-61000-4-3, EN61000-3-4 and other standards

- Measurements at all severity levels with test field strengths ≥10 V/m
- High accuracy and reproducibility of results
- Short preparation and test times with powerful software under MS-Windows95/98/NT4.0
- Automatic generation of detailed test reports
- Efficient test routines
- User-friendly operation

System configuration

System TS9981 includes an EMS control unit, an amplifier, a transmitting antenna and a field probe. The system is fully computer-controlled (PC). This makes for reproducible and largely automatic test sequences.

The EMS control unit comprises a signal generator, a field strength meter, a power meter, and a directional coupler unit. The broadband power amplifier used in the system covers the whole frequency range from 80 MHz to 1 GHz.

To generate electromagnetic fields, Log-Periodic Antenna HL046 is used for the frequency range from 80 MHz to 1 GHz. EMS tests can be performed without changing the antenna, thus avoiding time-consuming interruptions.

EMS Test System TS9981

Operation

Test System TS9981 includes the Rohde & Schwarz System Software EMS-K1 for Windows. The software makes it possible to perform automatic EMS measurements in line with all relevant standards. EMS-K1 is a convenient, cost-effective and reliable tool, enabling fast and easy system operation and high throughput. The test and configuration capabilities ensure high reproducibility of results.

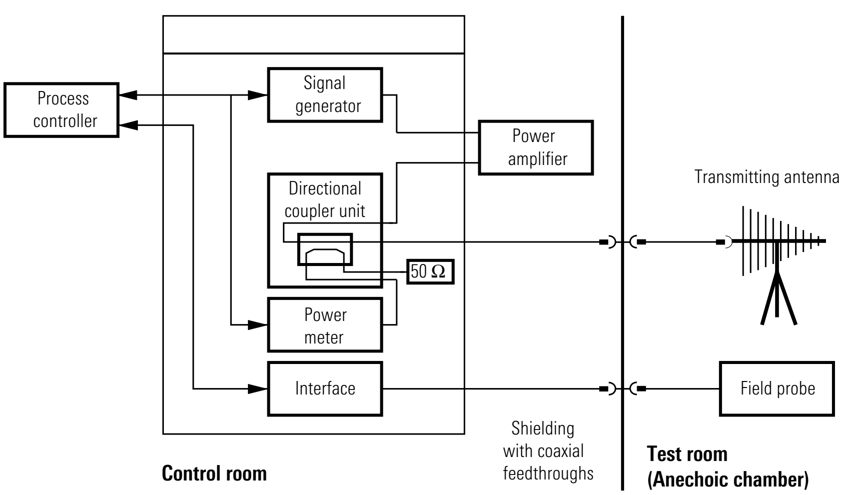
Expandability

Test System TS9981 is of modular design and can be extended by options. Various configuration levels allow for further automation of the test system, so giving an even higher throughput. Optional components include:

- EUT Monitoring System TS9981M (see page 393)
- Components and accessories for remote-controlled amplifier in separate room
- Shielded anechoic chambers
- TEM/GTEM cells

Overview of models

Model	Main applications	Technical features
TS9981A	Favourably priced test system for development labs, EMC labs and test houses; compliance tests with field strengths according to selected amplifier output power	Generator SML01, Power Meter NRVS for measurement of forward power; EMS control unit designed as a 19" desktop; amplifier power depends on desired field strength
TS9981B	Expandable test system for EMC labs (quality management) and test houses	Same as TS9981A, but with EMS control unit designed as a 19" rack; measurement of forward and reflected power with NRVD



Block diagram TS9981

EMS Test System TS9986

Photo 41942-1

EMS measurements to IEC61000-4-6

Brief description

With the new European standards for electromagnetic compatibility and the relevant national EMC laws that came into effect, EMS tests on electrical and electronic equipment are required in all areas of the civilian sector. The test procedure for determining susceptibility to conducted RFI is described in the international standard IEC61000-4-6. In Europe, a corresponding EN standard was derived from this standard (EN61000-4-6).

Test System TS9986 enables automatic EMS testing to IEC61000-4-6 with severity levels of up to 10 V in the extended frequency range 150 kHz to 230 MHz. It is an efficient and reliable tool both for tests in development and acceptance tests.

Main features

- Automatic measurement of susceptibility to conducted interference to IEC61000-4-6 and other standards
- High accuracy and reproducibility of results
- Short preparation and test times with powerful software under MS-Windows
- Efficient test routines
- Automatic generation of detailed test reports
- User-friendly operation

System configuration

System TS9986 includes a signal generator, a 25 W power amplifier and a power meter. The system is fully computer-controlled (PC) via the IEEE/IEC bus. This makes for reproducible and largely automatic test routines.

Operation

Test System TS9986 comes with the Rohde & Schwarz System Software EMS-K1 for Windows (see page 399). The software makes it possible to carry out automatic EMS measurements to all relevant standards.

EMS Test System TS9986

EMS-K1 is a convenient, cost-effective and reliable tool, enabling fast and easy system operation and high throughput. The extended test and configuration capabilities ensure high reproducibility of results.

Expandability

Test System TS9986 comes in three configuration stages plus an option for automatic EUT monitoring. One or several different coupling/decoupling networks may be required in addition to the TS9986 basic system configuration depending on the type and number of connections to the EUT. Further accessories including a computer desk, a wooden test bench with a copper surface, and feedthroughs for shielded walls are available to yield a system tailor-made to customer's requirements.

Overview of models

Model	Main applications	Technical features	Order No.
TS9986A	Budget-priced basic system for development labs, EMC labs and test houses; compliance tests already possible	25 W amplifier, EMS control unit designed as a 19" desktop	1076.6993
TS9986B	Expandable basic system for EMC labs (quality management) and test houses	25 W amplifier, EMS control unit designed as a 19" rack	1076.7090
TS9986D	Universal, high-performance expandable system; for test houses and EMC labs	150 W amplifier, current clamp, EM clamp with decoupling network, EMS control unit designed as a 19" rack	1076.7290

EMS Test System TS9982

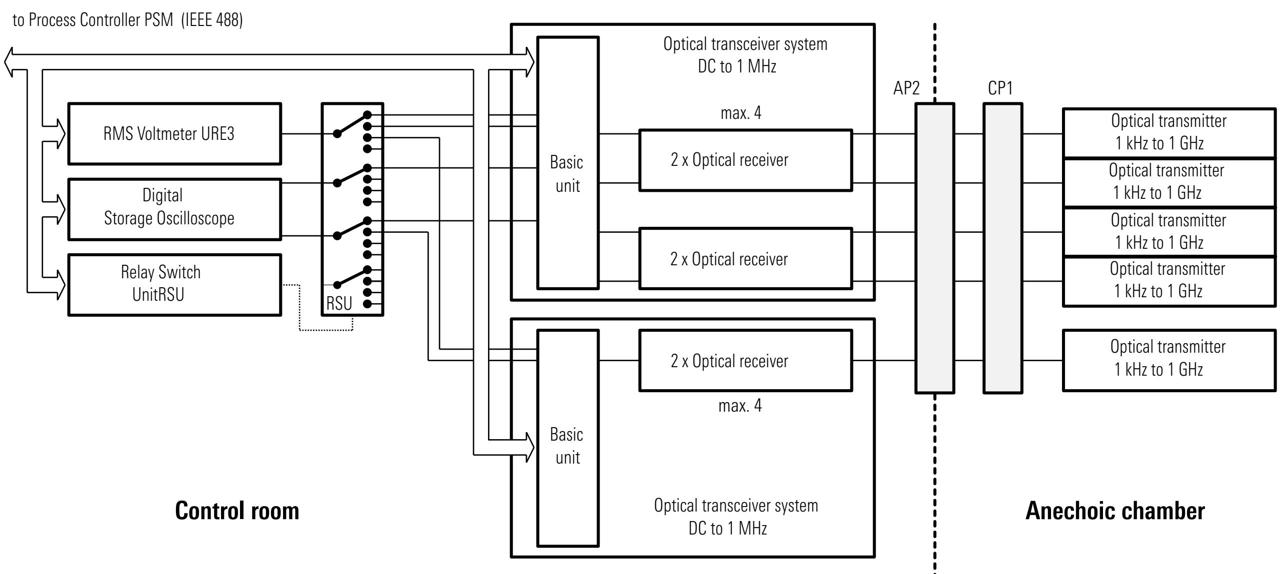
Photo 40127

EMS measurements to IEC61000-4-3/6

Brief description

This system is a combination of Test Systems TS9981 and TS9986, allowing EMS measurements in line with IEC61000-4-3 and IEC61000-4-6. It is a favourably priced alternative for users performing measurements in line with both standards.

EUT Monitoring Systems TS998xM



EUT monitoring for Test Systems TS9981 and TS9986

Brief description

EUT (Equipment under Test) Monitoring System TS998xM is used for automatic monitoring of the equipment under test for proper functioning during EMS measurements.

If the EUT does not function properly during the measurement, the field strength is reduced until the EUT resumes correct operation. The field strength is then increased until the EUT shows signs of malfunctioning or the nominal field strength is reached.

System configuration

The system functions are shown in the above diagram. The EUT Monitoring System is an option for the EMS Test Systems and can be divided into two main sections:

- Measurement section and
- Switching section

Measurement section

A data acquisition unit (option 1) is used for collecting analog and digital data signals. The instrument has 8 analog inputs and 16 digital input/output channels. It is mainly used for Go/NoGo testing of the EUT.

For accurate evaluation, eg for measuring signals of different shapes or levels, a digital storage oscilloscope and an RMS/peak voltmeter, eg URE3 (see page 329), can be used (option 2).

Switching section

The different EUT signals are switched to the Voltmeter URE3 or storage oscilloscope by means of the RF Relay Matrix RSU. All instruments feature remote control via the IEEE/IEC bus as well as manual control.

System configuration

The fully configured system takes up a 19" rack in the control room. If only the data acquisition unit is used for measurements, it will be accommodated in the 19" rack of the EMS control unit.

Software concept

Three different concepts are used for monitoring:

- Direct control of the devices from EMS-K1 (option EMS-K20) with re-cording of up to ten independent channels,
- Use of an independent computer communicating with EMS-K1 (option EMS-K21), or
- Device control via EMON-K1 on a separate monitoring computer with the possibility of asynchronous meas-urement (option EMS-K70)

In all these cases optimum protection of the EUT is ensured by the definition of switch-off criteria.

EMS Test System TS9983

1 GHz to 18 GHz (40 GHz option)

Automatic measurement of susceptibility to electromagnetic fields

Photo 42577-1

Brief description

The test procedure for determining susceptibility to electromagnetic fields in the frequency range 1 GHz to 18 GHz (40 GHz) is described in various national and international standards. EMS Test System TS9983 allows automatic EMS measurements in line with these standards with a minimum field strength of 20 V/m (distance of 1 m between antenna and EUT) over the total frequency range. It is an efficient and reliable tool both for tests in development and acceptance tests.

Main features

- Minimum field-strength level of 20 V/m over the total frequency range and at a distance of 1 m to equipment to test
- High accuracy and reproducibility of results
- Short preparation and test times with powerful software under MS-Windows
- Automatic generation of detailed test reports
- Efficient test routines
- User-friendly operation

System configuration

The test system is made up of six functional components:

- Control module
- Generator module
- Switching module
- Amplifier module
- Antenna module
- Measurement module

To minimize the losses between generator, power amplifier and antennas, these system components are integrated in a rack which is accommodated in the anechoic chamber and controlled from the control room by the system controller via an IEEE/IEC bus fiberoptic converter. The field strength is set and monitored with the aid of a power meter and field probes.

Operation

Test System TS9983 includes the Rohde & Schwarz System Software EMS-K1 for Windows (see page 399). The software makes it possible to perform automatic EMS measurements in line with all relevant standards. EMS-K1 is a convenient, cost-effective and reliable tool, enabling fast and easy system operation and high throughput. The test and configuration capabilities ensure high reproducibility of results.

Expandability

Test System TS9983 is of modular design and can be extended by options. Various configuration levels allow for further automation of the test system, so giving an even higher throughput. Optional components include:

- EUT Monitoring System EMON-K1
- Components and accessories for remote-controlled antenna positioning
- Combination with EMI and other EMS test systems

Shielded TEM Cell S-LINE

Measurement of electro-magnetic susceptibility

Photo 43101-2

Brief description

S-LINE from Rohde & Schwarz is a favourably priced test cell for measuring the susceptibility to electromagnetic fields (EMS) and electromagnetic interference (EMI) in the frequency range 150 kHz to 1 (2) GHz.

S-LINE comes in two different sizes. The larger model with dimensions of 1.5 m x 1 m x 1 m offers a test volume comparable to that of compact an-echoic chambers. Compared with conventional precompliance cells, S-LINE has clear advantages regarding the radio frequency characteristics. The enclosure prevents radiation of electromagnetic fields into the surroundings. It is fitted with a shielded door which provides easy access to the cell.
A shielded window in the door as well as illumination inside the cell allow visual monitoring of the EUT.

Main features

- In-development measurement of electromagnetic interference (EMI), eg to EN 55022
- Precompliance measurement of electromagnetic susceptibility (EMS), eg to EN 61000-4-3
- Low space requirement due to compact design
- High field strengths and field uniformity
- Concept for EMC testing in production
- Ideal for use with Rohde & Schwarz EMS instrument families and test systems

Available models

S-LINE comes in two models of different size. The choice of the model depends on the maximum size of the EUT. Both models can be get through doors with an opening of 800 mm. The large-size cell can be disassembled for transport.

Shielded TEM Cell S-LINE

Extensions

For electrical monitoring, standard filtered feedthroughs are provided as well as screw-on access panels which allow customized feedthroughs to be configured. A new model designated S-LINE P has especially been developed for use in production environments.

EMS line application package

- Automatic measurement of susceptibility to radiated and conducted interference to EN 61000-4-3/-6 and other standards
- TEM cell with excellent radio frequency characteristics
- Interfering signal generation (see TS9982)
- Software EMS-K1
- Compact design for versatile use in the lab

EMI line application package

- Correct interference weighting to CISPR 16-1 down to 10 Hz pulse repetition frequency
- For all commercial EMI standards such as CISPR, EN, ETS, FCC and ANSI-C63.4, VCCI
- TEM cell with excellent radio frequency characteristics
- EMI Test Receiver ESPC
- Software ESXS-K1

Specifications in brief

Electrical data

Frequency range	150 kHz to 1 (2) GHz
Max. RF input power	100 W CW at 40°C 150 W CW at 25°C, max. 5 min 245 W PEP at 80% AM and 40°C
Input impedance	50 Ω
Size of uniform area	
S-LINE 700	350 mm x 350 mm
S-LINE 1000	500 mm x 500 mm
RF input power for 10 V/m to EN 61000-4-3, 8/97	
S-LINE 700	33 dBm typ.
S-LINE 1000	36 dBm typ.
Shielding effectiveness	≥75 dB (up to 500 MHz) ≥60 dB (above 500 MHz)

Mechanical data

Dimensions (W x H x D)	
S-LINE 700	1062 mm x 815 mm x 790 mm
S-LINE 1000	1512 mm x 1192 mm x 1121 mm [1]
Door opening (W x H)	
S-LINE 700	598 mm x 442 mm
S-LINE 1000	1100 mm x 650 mm
Inner dimensions of test cell (W x H x D)	
S-LINE 700	525 mm x 445 mm x 695 mm
S-LINE 1000	950 mm x 704 mm x 982 mm
RF connector	N female
Weight (basic equipment)	
S-LINE 700	≤80 kg
S-LINE 1000	≤210 kg

EUT

Max. EUT dimensions (W x H x D)	
S-LINE 700	350 mm x 350 mm x 350 mm
S-LINE 1000	500 mm x 500 mm x 500 mm

General data

Operating temperature range	+5°C to +40°C
Storage temperature	−40°C to +40°C
Temperature rise inside test cell	
S-LINE 700	15°C after 2 h with 200 W dissipated power
S-LINE 1000	15°C after 2 h with 500 W dissipated power
Mechanical load	
Sine vibration	5 Hz to 55 Hz, max. 2g
Relative humidity (without condensation)	95% at 40°C

[1] The test cell can be disassembled for getting it through doors with an opening of less than 1.2 m. Disassembly and reassembly of the test cell shall only be carried out by trained staff.

Ordering information

Shielded TEM Cell

EU version	S-LINE 700	1095.2990.02
US version	S-LINE 700	1095.3980.02
EU version	S-LINE 1000	1089.9296.02
US version	S-LINE 1000	1089.9596.02
EU version	S-LINE P	1095.2990.04
US version	S-LINE P	1095.3980.04

Shielded Test Cell M-LINE

Compact environment for measurements from 0.8 GHz to 40 GHz

Photo 43418-4

Brief description

M-LINE from Rohde & Schwarz is a favourably priced test cell for a large variety of measurements in the RF and microwave bands. The test cell can be used for frequencies from 0.8 GHz to 40 GHz and is thus particularly suit-able for measurements in the fields of EMC and type approval as well as for use in development.

Design

The outer dimensions of M-LINE are 1.5 m x 1 m x 1 m. The inside walls of the test cell are provided with 21 cm high pyramid absorbers so that the test cell can be used in the frequency range 0.8 GHz to 40 GHz. Despite its small overall size, the test cell provides a uniform area of 0.3 m x 0.3 m for EMS measurements. A distance of up to 0.7 m is possible between antenna and EUT (equipment under test). The "quiet zone" of M-LINE, which is for instance important for antenna measurements, features a reflection attenuation of typically ≥35 dB in a diameter of 0.4 m.
The EUT can easily be brought into the test cell through a door in the front wall. The built-in shielded window and integrated illumination allow the EUT to be observed during the measurement.

Antennas

Various types of antennas can be installed inside M-LINE for feeding in the RF signals and receiving the signals radiated by the EUT. In the microwave band, horn antennas, small log-period or circularly polarized antennas will predominantly be used. To make their installation simple, a universal antenna support is integrated in the test cell.

Extensions

M-LINE can be equipped with a climatic box to allow measurements under extreme environmental conditions especially as required for type-approval testing. The climatic equipment comprises the non-metallic climatic box accommodated inside the test cell, a heating/cooling unit and a temperature control unit. Heating and cooling are based on the circulating air principle. With the aid of the temperature control unit the operating temperature can be adjusted manually or via a serial interface. The circulating air principle allows fast temperature changes inside the climatic box.

If M-LINE is to be retrofitted with the climatic box later, the basic model prepared for installing the climatic box must be ordered. Otherwise retrofitting will not be possible.

Shielded Test Cell M-LINE

For EUT control and monitoring, screw-on access panels for customized configuration are available in addition to the filtered feedthroughs provided as standard.

Attainable field strengths

Measurements using different antennas show that with 200 W amplifier power field strengths of typically 100 V/m can be attained inside the M-LINE in the frequency range from 1 GHz to 7.5 GHz and typically 200 V/m between 7.5 GHz and 18 GHz with the same power.

Main features

- In-development measurements of electromagnetic interference (EMI) and electromagnetic susceptibility (EMS)
- Type-approval measurements on radiocommunication ,terminal equipment
- Measurement of RF system parameters via air interface in the microwave band
- Compact design for use in labs and in production environments
- Installation and use without prior construction work
- Optimum utilization of space volume
- High reflection attenuation of typically ≥35 dB in "quiet zone"
- Additional climatic test facilities for measurements in the range from –25 °C to +50 °C can be integrated

Specifications

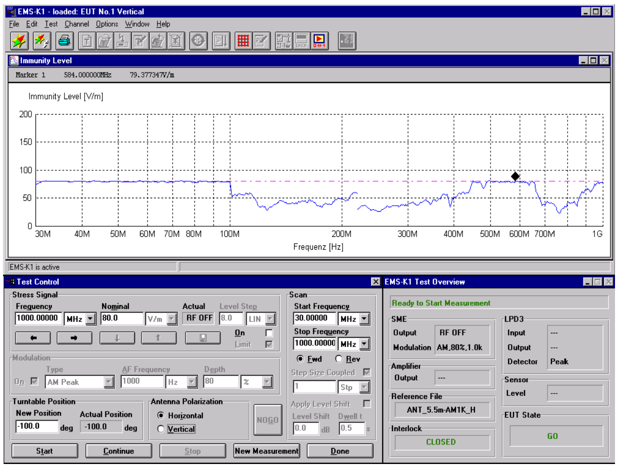
Electrical data	
Frequency range	800 MHz to 40 GHz (depending on antenna installed)
Antenna connector	K system inside and outside
Departure from theoretical free-space attenuation	≤±3 dB typ.
Quiet zone	400 mm in diameter (with reflection attenuation ≥35 dB typ.)
Door interlock contact	passive, normally open, max. 30 V, max. 1A
Lighting	12 V/25 W, cold-light halogen reflector lamp
EUT (equipment under test)	
EUT dimensions (W x H x D)	max. 40 cm x 40 cm x 40 cm recommended
Weight	<200 kg (with use of basic model)
Max. dissipated power of EUT	
Without climatic box	≤200 W
With climatic box	≤50 W
EUT monitoring/supply	
AC supply for EUT	
EU version	230 V, 50/60 Hz, 6 A
US version	110 V, 60 Hz, 6 A
Low voltage	4 x low-voltage lines (4 mm connectors), <30 V DC/AC max. 400 Hz), <2 A per line
Coaxial feedthroughs	1 x N, 2 x FSMA (fiberoptic cables
Window	shielded window with additional metal cover in door with opening of 300 mm x 300 mm
Access panel	3 x for customized configuration; W x H: 110 mm x 70 mm
Climatic box (optional)	
Material	polystyrene panels filled with hard foam PU RG 50
Inner dimensions	400 mm x 400 mm x 400 mm
Temperature range	–25 °C to +50 °C
Temperature control	manually or via serial interface
Operating mode	nominal value, nominal value ramp
Cable feedthrough	10 mm borehole for cable feedthrough at the side
General data	
Operating temperature range (lab)	+5 °C to +40 °C
Storage temperature range (lab)	–40 °C to +40 °C
Relative humidity (without condensation)	95% (at 40 °C)
Dimensions (W x H x D)	
Basic model	1512 mm x 1192 mm x 1121 mm
Model with climatic box	1512 mm x 1192 mm x 1521 mm
Door opening (W x H)	1100 mm x 650 mm
Weight	
M-LINE	200 kg
Cooler aggregate	70 kg

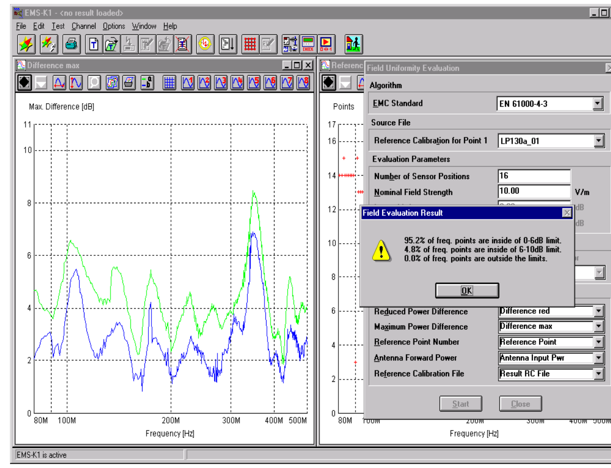
Ordering information

	EU version	US version
M-LINE		
basic model	1059.0649.02	1059.0678.02
prepared for climatic box	1059.0655.02	1059.0684.02
with climatic box	1059.0661.02	1059.0690.02

Rear view of M-LINE (with optional climatic box, photo 43418-8)

EMS Software EMS-K1





Automatic measurement of electromagnetic susceptibility

Brief description

The powerful Software Package EMS-K1 forms the basis for the automatic control and monitoring of EMS test systems and also for the acquisition and analysis of the measurement data. The advantages of automation are:

- high reproducibility and accuracy of results
- automatic generation of detailed test reports
- permanent system control
- automatic calibration and correction of frequency-dependent parameters

The software is extremely user-friendly and has been optimized both for tests in development and acceptance tests. Predefined automatic test sequences and procedures as well as high flexibility for easy adaptation to new EMC standards and test methods are further outstanding features.

The three basic functions of the EMS-K1 are:

- Automatic generation of test signals (field strength, current, voltage)
- Automatic monitoring of the EUT for malfunctions
- Determination of the immunity threshold at which an EUT malfunction occurs

The complete software package can be run on a PC or a PC-compatible industrial controller, eg Process Controller PSM (see page 406). The measurement devices are controlled via the IEEE/IEC bus using an integrated interface card.

Main features

- Automatic measurement of electromagnetic susceptibility in line with all commercial and military standards, eg
  - EN 61000 -4-3,-6
  - IEC 61000-4-3,6
  - ENV 50140/50141
  - ISO 11451/11452/10600
  - VDE 0843
  - DIN 40839
  - VG 95373, part 10,13
  - RTCA/DO-160C
- Running under Windows 95/98/NT4.0
- Open and modular system software concept
- High flexibility
- Programmable user interface
- Three types of user level:
  - normal
  - advanced
  - system manager
- Customer-specific test scripts
- Interface to other Windows programs
- Supports all EMS test systems from Rohde & Schwarz (TS 9981/82/83/86)

Automatic generation of immunity parameters

EMS-K1 is a universal EMS software package that can be used for just about any measurement method and test system:

- measurement of immunity to radiated electromagnetic fields using an antenna, stripline, TEM or GTEM cell

EMS Software EMS-K1

- measurement of immunity to conducted interference using coupling/decoupling networks or current clamps
- measurement of immunity to magnetic fields

Three operating modes are available for setting the immunity level:

- Transducer: the immunity test level is set by means of a specified transducer correction factor (constant or frequency-dependent) for the amplifier or generator output power
- Reference calibration: based on calibration data from a reference measurement, the immunity test level is set using the frequency-dependent amplifier power values derived from the calibration measurement
- Sensor: the test level is set to the required value using the actual level measured with a sensor

EUT monitoring

EMS-K1 provides logical monitor channels which can handle analog or digital data. A practically unlimited number of channels can be defined; the crucial limiting factor is processor power and the time required for monitoring. Depending on the graphics resolution, any number of channels can be displayed as on-screen diagrams during a measurement. The operator can change the selection of displayed channels while the measurement is running. If there is a NoGo condition, ie malfunction of the EUT, a variety of responses can be adopted:

- store the frequency and the EUT measurement value and continue the measurement automatically
- stop the program run to enter operator comments or
- branch to a user application routine, for instance to re-initialize the EUT

It is also possible to combine the above responses in a number of ways. A flexible control concept is implemented in the EMS-K1 by means of scripts.

Measurement sequence control

The measurement sequence control in EMS-K1 software is encoded in scripts. The scripts are accessible to the user who can adapt them to his requirements. Scripts provide a high level of flexibility and are easy to modify.

The EMS measurement sequence is implemented by two standard scripts, the qualification mode and the susceptibility mode.

In the qualification mode the selected parameter profile (limits as a function of frequency) is run automatically and the responses of the EUT are recorded. If there is no malfunction detected, the EUT passes the test and fulfills the specified immunity limits. The measurement is thus completed. Only if there is a malfunction is the frequency in question noted automatically.

In the susceptibility mode the immunity threshold is automatically determined when a malfunction occurs. Level and frequency are recorded in the test report; the susceptibility profile of the EUT can then be displayed in the form of graphs or tables.

Ordering information

Basic package		
System Software		
for Rohde & Schwarz EMS test systems		
TS9981 and TS9987 (EN 61000-4-3)	EMS-K14	1084.4296.02
TS9982(EN 61000-4-3, -6)	EMS-K15	1084.4696.02
TS9986 (EN 61000-4-6)	EMS-K16	1084.4496.00
Complete Software Package EMS-K14/15/16 with additional EUT Monitoring Drivers for EN 61000-4-3, -6	EMS-K9	1084.3948.02
Extensions		
Software extension for EMS-K1 (Script development kit)	EMS-K3	1084.3790.00
Standard device driver package for EMS-K1 for EMS test systems 1 GHz to 18 GHz (eg TS9983), requires Basic Package EMS-K14/15/16	EMS-K8	1084.3890.00
EUT Monitoring		
Software extension for EMS-K1		
Basic device driver package for EUT monitoring	EMS-K20	1084.4196.00
Interface driver for EUT monitoring with external PC	EMS-K21	1084.4244.02
External EUT Monitoring Software EMON-K1, with interface driver for EMS-K1	EMS-K70	1084.6801.02

Contents of Chapter 10

Perfection in mobile measurements and control: Portable Industrial Controller PSP 7 (photo 43267-3)

Designation	Description	Type	Page
Portable Industrial Controller	Mobile measurements and control; AMD-K6-2 processor 300 MHz, 64 Mbyte RAM, 6 Gbyte hard disk, 3½" drive Interfaces: IEEE488.2, 2 x COM, 1 x LPT, PC CARD Graphics: variable from VGA to 1600 x 1200 pixels, 8.4" colour LCD	PSP 7	402
Industrial Controller	Automated measurements; AMD-K6-2 processor (333 MHz), 64 Mbyte RAM, CD-ROM, 15-Gbyte hard disk, 3½" drive Interfaces: ultra/ultrawide SCSI, IEEE488.2, 10 base T Ethernet, 2 x PC CARD, FUP, 4 x COM, 2 x LPT Graphics: variable from VGA to1280 x 1024 pixels	PSM 12	404
	Same as PSM12, but 10.4" colour TFT display	PSM 17	404

Measurement software is described in connection with its specific applications in the individual chapters of the catalog.

Portable Industrial Controller PSP7

Mobile measurements and their control made to perfection

Photo 42674

Brief description

At long last Portable Industrial Controller makes measurements and their control mobile. Thanks to its compact size and rechargeable batteries, the built-in test and measure- ment facilities of PSP can be used at any location and in any situa-tion. The principle of "switch on and go" was consistently applied to the develop-ment of the PSP as with all of Rohde & Schwarz’s previous process controllers. Everything one is likely to need is included as standard. Low emission and highly effective shielding are as much part of the PSP as shock and vibration resistance.

Operation
The front-panel keypad comprises a numeric block, programmable func-tion keys and a cursor block with a spinwheel. The softkeys are fully integrated into Win-dows. The keypad includes as many keys as are needed to operate programs effec-tively under Windows, and few enough to avoid input errors. This is especially important for applications in the field of production. Whenever necessary, a key-board and a monitor can be connected and run parallel to the front-panel keypad and the built-in display.

Fully independent powering
Through the DC input connector PSP can be powered by a solar panel. PSP also accepts DC voltages from cars, ships or aeroplanes. With the aid of cascadeable internal batteries the PSP can be kept in operation for several hours. The power management function informs the user on how long the PSP can operate with the remaining battery charge, and thus opti-mizes the available capacity and extends battery life.

Powerful hardware and software com-ponents
PSP comes with an IEEE/IEC bus fitted as standard. Software drivers for almost any programming language are included so that the time-consum-ing task of install-ing hardware and software becomes unnecessary. More-over PSP with LabWindows/CVI comprises a highly spe-cialized tool for software development.

LabWindows/CVI
National Instruments’ LabWindows/CVI (C for Virtual Instrumentation) is an inter-active base for the programming of virtual instruments on the PSP and is regarded by most as today’s industry standard. The software is delivered with a selection of drivers and extensive analysis func-tions. With LabWindows/CVI a C source code can be generated in next to no time, allowing communication with measuring instruments via IEEE/IEC bus or serial interface.

Interfaces
Numerous interfaces like 2 x serial, 1 x parallel, IEEE/IEC bus, PC card are the links to communication between the con-troller and the controlled devices.

Modular expansion
Despite its small size, PSP incorporates everything one needs for standard meas-urement tasks. And in the case that expansions should be necessary for unu-sual tasks, PSP can accommodate up to four additional long-size measuring cards.

Best of EMC characteristics
PSP was developed and imple-mented along existing EMC guidelines. Extensive filtering measures for the electric compo-nents paired with effective shielding and a novel design of the casing led to an indus-trial controller that can safely be employed even in the vicinity of highly sensitive receivers without impairing the measure-ment results.

Fit for the future
All of the components used in the PSP were developed and selected with long-term availability in mind so that the PSP will be able to be serviced or extended even in many years’ time. An advantage that especially produc- tion engineers and system planners value.

Portable Industrial Controller PSP7

Specifications in brief

Processor	AMD K6-2, 300 MHz other processors on request
RAM	64 Mbyte, expandable with PSP-B2 to 128 Mbyte
Display	
PSP2	none
PSP7	LCD colour, 8.4"
Screen	anti-glare
Mass storage	
Hard disk	6 Gbyte minimum
Disk drive	1.44 Mbyte, 3 ½"
Interfaces	
-internal-	
Available ISA-bus interfaces (other bus systems on request)	4 x 16 bits, dimensions (L x H): 330 mm x 140 mm 330 mm x 140 mm 312 mm x 140 mm 312 mm x 140 mm
-external-	
IEEE	IEEE488.2, compatible with NI NAT
Serial	2 x RS-232-C
Printer	Centronics LPT1
PC card	release 2.0, type III, connector
Keyboard	5-contact DIN, 5-contact PS/2 for mouse & keyboard
Software	
Operating system	MS-Windows 98 (PSP-K10)
Test & measurement software	LabWindows/CVI (only with PSP-K10)
Graphics	
With integrated LCD	VGA standard: 640 x 480 pixels
For external monitors	1600 x 1200 pixels max.
General data	
Rated temperature range	+5°C to +45°C
Operating temperature range	0°C to +50°C
Storage temperature range	–25°C to +60°C
Power supply	
AC supply	100 V to 120 V ±10%, 50 Hz to 400 Hz ±5% 220 V to 240 V ±10%, 50 Hz to 60 Hz ±5%
DC supply	DC, 10 V to 32 V
Dimensions (W x H x D)	412 mm x 198 mm x 380 mm
Weight	
PSP2	7.5 kg
PSP7	8 kg

Ordering information

Portable Industrial Controller	PSP7	1099.6002.71
Accessories supplied	pocket guide, manuals, Windows, LabWindows/CVI for R&S (incl. data media), power cable, connector for external DC operation	
Options		
Interfaces		
2nd IEEE/IEC Bus (AT GPIB, 488.2)	PS-B4	1006.6207.04
TTL I/O Interface, 40 I/O ports, 8 relays, 8 optocouplers, 3 timer	PS-B11	1006.7303.02
TTL I/O Interface without relays, optocouplers, timers	PS-B11	1006.7303.04
SCSI Host Adapter	PS-B27	1064.5500.02
SCSI PC Card Adapter	PS-B5	1134.8101.02
External SCSI CD-ROM Drive	PS-B6	1134.8207.02
Memory		
PC Card Exchangeable Hard Disk 260 Mbyte (minimum)	PSM-B9	1064.5700.02
64 Mbyte Memory Expansion	PSP-B2	1091.3640.04
Compact keyboards with integrated trackball (37 cm x 13.8 cm x 1.9 cm)		
German, without swivel frame	PSP-Z1	1091.4000.02
English, without swivel frame	PSP-Z2	1091.4100.02
German, with swivel frame	PSP-Z3	1091.4200.02
English, with swivel frame	PSP-Z4	1091.4300.02
(other keyboards on request)		
Mouse, Microsoft-compatible	PS-B1	1006.6359.02
Battery operation Set of Batteries, 24 V, 2.4 Ah, Power Management, operating time per set approx. 2 h, 2 pcs can be inserted into 3 ISA slots	PSP-B3	1091.3740.02
Color Monitor 17" (43 cm)	PMC3	1082.6004.04
Industrial Monitor 15" (38 cm)	PMC4	1034.8000.03
Rack Adapter 19" (48.3 cm)	PMC4-Z1	1034.8100.02
Printer, 24 pins, colour graphics RS-232-C and Centronics interface	PDN	0351.4512.04
IEEE/IEC 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

Industrial Controller PSM

Switch on and go ...

PSM has it all: a great variety of interfaces, comprehensive software and an interactive documentation system

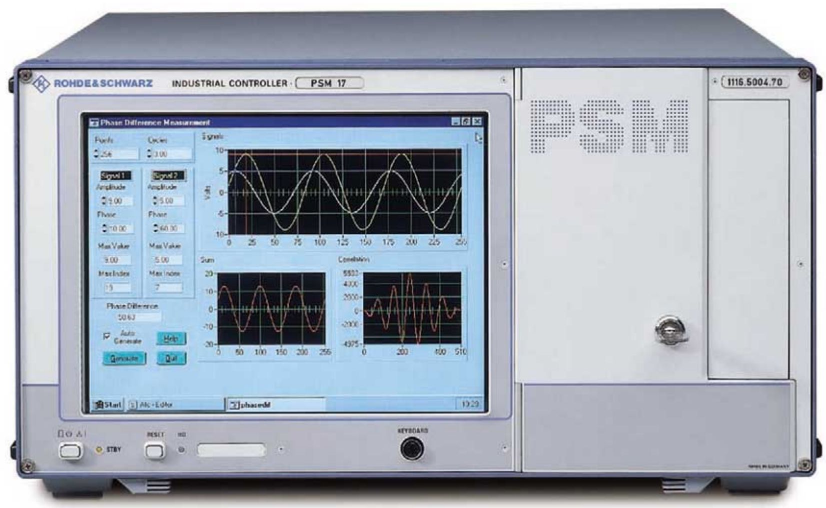


Photo 43088-3

Brief description

Especially when it comes to professional measurements, the controller should not be the weakest member of a system but rather be able to meet special requirements: shock and vibration resistance, particularly when used in vehicles or industrial environment, ultra-low temperature effect, high immunity to interference even in strong electromagnetic fields as well as low self-generated emission so that measurements will not be impaired by fields produced by the controller. Commercial PCs do not fulfill these requirements.

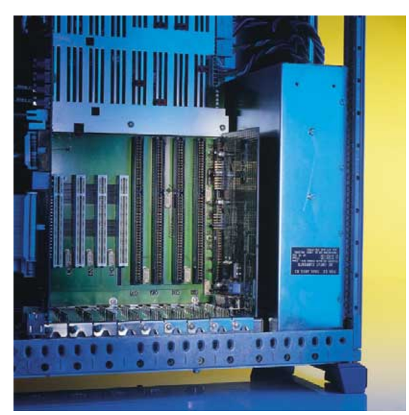
PSM offers ideal characteristics for all key applications: shock resistance in mobile applications, rackability, built-in measurement facilities for use in production and high EM shielding. For mobile applications, a DC input is provided for powering PSM from on-board supplies. The lockable cover of PSM protects the CD ROM drive, floppy disk drive and PC CARD interface against contamination and unauthorized access.

Main features

- Extremely high immunity to interference
- High shock resistance for mobile use
- Wide variety of interfaces: Ethernet, ultra/ultrawide SCSI,16-bit GPIB, PC CARD
- Brilliant colour TFT display
- CD ROM drive
- Factory user port
- Windows user interface
- Safe investment through modular concept

Comprehensive basic configuration

When purchasing a controller, the customer frequently has to buy hardware, software and interfaces from different manufacturers and integrate them into his system. This is not the case with PSM, which has been configured to cater for any demand. All key components are included in the basic unit: the built-in Ethernet interface makes it extremely easy to connect PSM eg to a company network. The state-of-the-art ultra/ultra wide SCSI interface allows adding internal and external SCSI standard components, eg streamers. The 16-bit GPIB interface as well as a large number of serial and parallel ports have always been the standard in PSM, likewise the Factory User Port (FUP), which provides a variety of extra functions (analog input, digital I/O, relays, optocouplers, pulse width modulator) required in automated test procedures. The fast CD ROM drive makes software installations a pleasure.

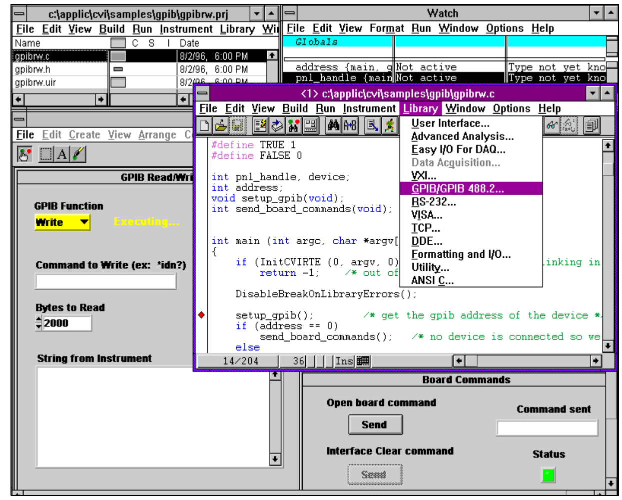


PSM has a well organized interior and, while featuring comprehensive basic configuration, offers plenty of space for extensions

Industrial Controller PSM

High flexibility

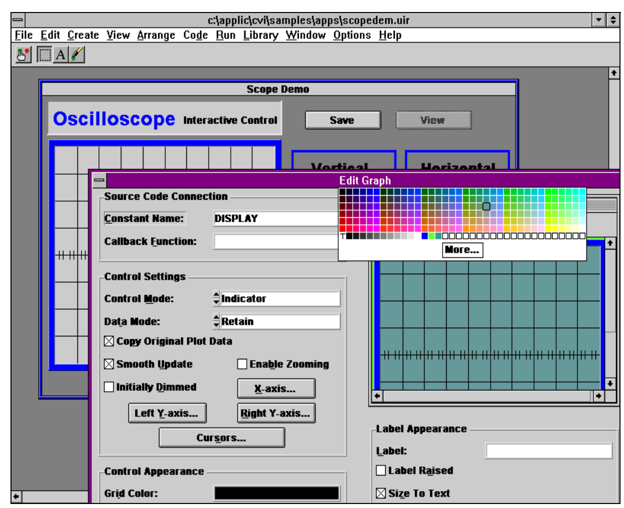
PSM can be tailored to suit specific needs: 4 free 16-bit ISA slots and 3 free PCI slots or alternatively 3 free 16-bit ISA slots and 4 free PCI slots leave ample space for expansion. Additionally, 2 PC CARD slots in the basic unit can be used for further extensions.



Interactive development and rapid testing of test software is a salient feature of LabWindows/CVI (only with PSM-K10)

Unlimited memory expansion

Expandability of memories is of particular importance. The standard 64 Mbyte RAM can be expanded to 256 Mbyte. Mass storage can be expanded to practically any size; a modern EIDE hard disk is installed as standard. The integrated SCSI interface allows any kind of SCSI peripherals, eg streamer drives, to be controlled.



LabWindows/CVI simplifies the creation of displays, ie virtual instruments. The displayed data come from either a measuring card in the PSM or from an external measuring instrument that is communicated with via the IEEE/IEC bus

Versatile auxiliary functions

For automating test procedures, control lines are needed which are not available in standard PCs. The digital I/O interfaces, partly isolated via optocouplers, allow external processes to be controlled or analog voltages to be measured without an IEEE/IEC bus-compatible voltmeter being needed. These interfaces are available as standard in PSM via the factory user port (FUP).

R&S system software

A powerful computer requires a powerful software. The system software not only contains the operating system but also the professional LabWindows/CVI measurement software. It goes without saying that the software is installed on the hard disk and tailored to the PSM hardware configuration. A CD ROM with all drivers, LabWindows/CVI and utility programs is supplied as a backup.

LabWindows/CVI (only in conjunction with PSM-K10)

National Instruments' LabWindows/CVI (C for Virtual Instrumentation) is an interactive base for the programming of virtual instruments on the PSM and is regarded by most as today's industry standard. The visual instruments for creating graphic user interfaces are an integral component of the C development environment allowing EXE programs and DLL files to be generated.

Industrial Controller PSM

Options

TTL I/O Interface PS-B11
The interface extends the control inputs/outputs of the factory user port. PS-B11 offers 40 digital I/O lines, eight single-pole switching relays and four two-pole optocoupler inputs/outputs each that can be read or set just like the FUP by means of the supplied driver software. Eight of these 40 lines can be configured to detect interrupt events.

Analog I/O Interface PS-B13
The interface provides eight differential or 16 unipolar analog inputs as well as two analog outputs, each with a resolution of 16 bits. Signals applied to the inputs can be sampled up to 100,000 times a second, thus covering the entire audio frequency range.

PS-B11 and PS-B13 are supplied with drivers for numerous programming languages such as R&S BASIC, QuickBASIC, MS-C or VisualBASIC for DOS and Windows. Interfaces are addressed by means of simple instructions.

PC CARD Exchangeable Hard Disk PSM-B9
Exchangeable hard disks simplify data logging and software installation. The handy hard disk is operated via the PC CARD connector on the front of PSM. Thanks to a compact design, the hard disk is particularly shock-proof and therefore ideal for mobile applications.

Security

Data security through the use of power-up passwords is a matter of course today. PSM takes it even further and "hides" all drives (CD ROM, floppy, PC CARD) behind a lockable cover. This not only enhances passive security but improves electromagnetic compatibility of PSM.

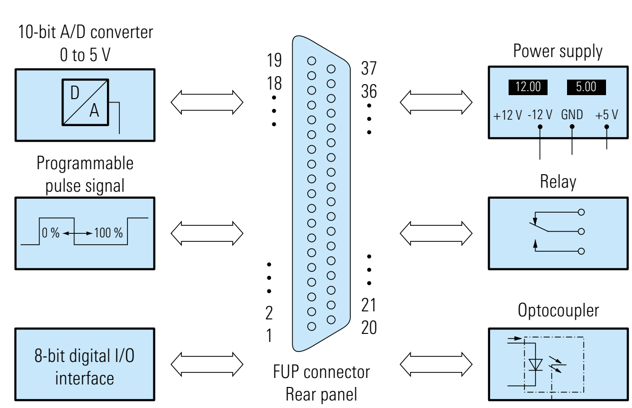
Safe investment thanks to modular concept

The high innovation rate in the com-puter industry results in short product lives. What is state-of-the-art today, will be at the bottom of the scale tomorrow. The possibility of boosting computer power is therefore of particular importance. This is one of the strong points of PSM. Modules like the CPU and graphics are accommodated on a separate card which can easily be replaced when greater performance is required.

This is important especially for industrial controllers, where the cost of integrated computer functionality makes up only a minor part of total costs, the principal share being attributable to measures taken for compliance with requirements relating to shock and vibration resistance, thermal loading capacity and electromagnetic compatibility.

A variety of interfaces are included in the basic unit: eg Ethernet, ultra/ultrawide SCSI, 16-bit GPIB. The factory user port adds versatile auxiliary functions

The factory user port (FUP) offers a variety of versatile auxiliary functions



Industrial Controller PSM

Specifications in brief

Processor	CPU slot, CPU performance: min. AMD-K6-2, 333 MHz; 64 Mbyte RAM (expandable to max. 256 Mbyte)
Display	
PSM 12	none
PSM 17	LCD colour, 10.4"
Mass storage	
Hard disk	15 Gbyte or more
Disk drive	1.44 Mbyte, 3 ½"
CD ROM drive	24 times or faster
Interfaces	
IEEE	IEEE 488.2, compatible with NI NAT
FUP (factory user port)	8 digital inputs/outputs 4 analog inputs: 0 to 5 V, 10-bit resolution 1 analog output: 0 to 5 V, 8-bit output via pulse width modulator optocouplers: 1 input, 1 output relays: 2 switches, SPS driving
Serial	RS-232, COM1, 2, 3, 4 (16550-compatible)
Parallel	Centronics LPT1 (ECP, EPP), LPT2
PC CARD	release 2.1, type III (slot 1), type II (slot 2)
SCSI	ultra, ultrawide (internal)
Ethernet	10 base T (10 Mbit/s)
Keyboard connector	5-pin DIN connector (on the rear) PS/2 connector (on the front)
Software	
Operating system	MS Windows 95 (free-of-charge option), MS Windows NT (option)
Measurement software	LabWindows/CVI (only with PSM-K10)
Graphics	
Video memory	4 Mbyte
Resolution with integrated LCD	VGA standard: 640 x 480 pixels
Resolution for external monitors	max. 1280 x 1024 pixels

General data

Rated temperature range	+5 to +45°C
Operating temperature range	0 to +50°C
Storage temperature range	–20 to +60°C
Power supply	
AC	100 to 120 V ±10%, 50 to 400 Hz ±5%, max. 4 A, 200 to 240 V ±10%, 50 to 60 Hz ±5%, max. 2 A
DC	10 to 28 V
Dimensions (W x H x D)	435 mm x 236 mm x 460 mm
Weight PSM12/PSM17	approx. 13 kg/14 kg

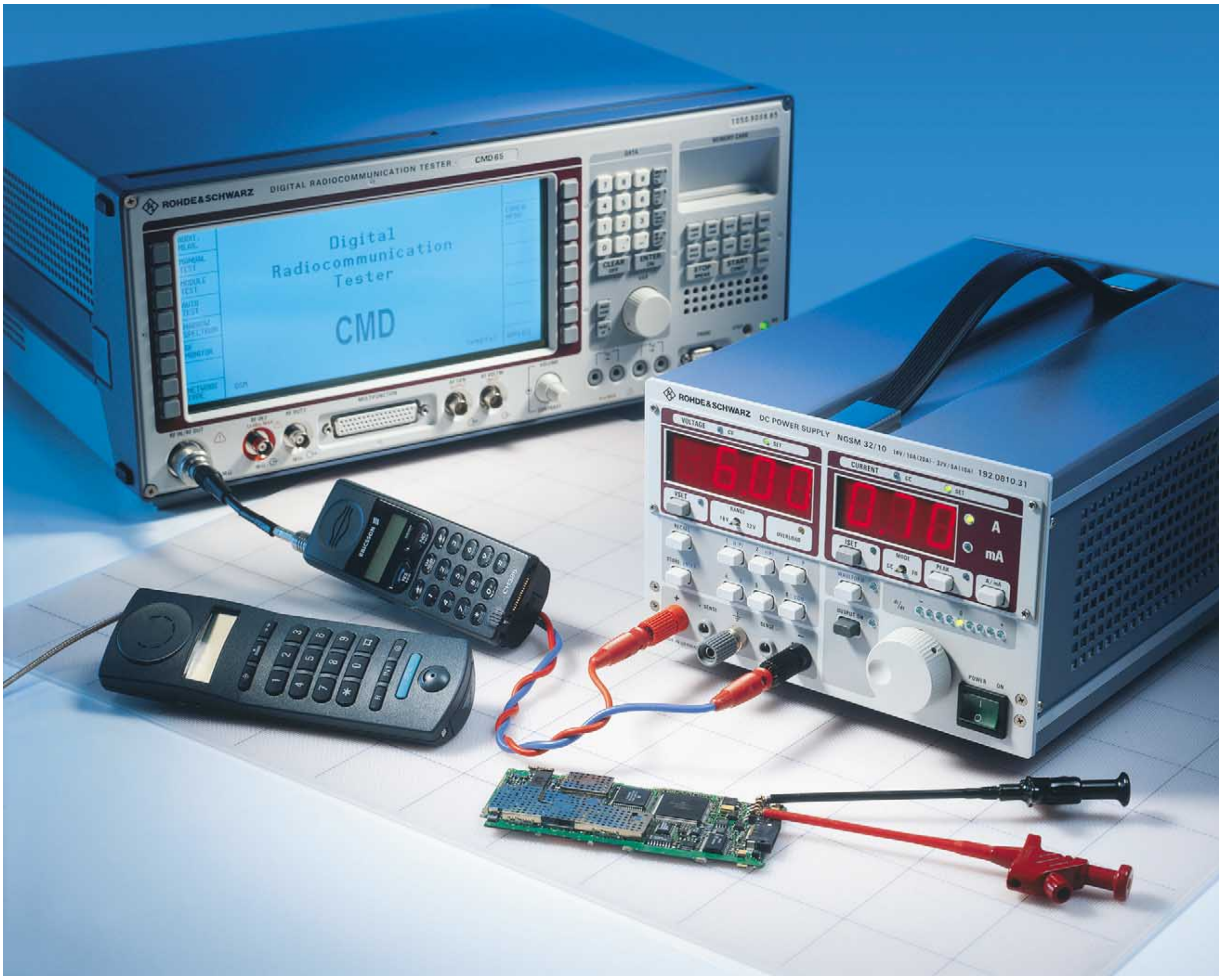
Ordering information

Industrial Controller	PSM12	1116.5004.20
	PSM17	1116.5004.70

Please state desired option PSM-K10 in your order.

Accessories supplied	pocket guide, power cable, LabWindows/CVI for Rohde & Schwarz	
Options		
Interfaces		
2nd IEEE/IEC Bus (AT-GPIB, 488.2)	PS-B4	1006.6207.04
TTL I/O Interface	PS-B11	
40 I/O ports, 8 relays, 8 optocouplers, 3 timers		1006.7303.02
without relays, optocouplers, timers		1006.7303.04
Analog I/O Interface	PS-B13	1006.6859.02
Memories		
PC CARD Exchangeable Hard Disk 260 Mbyte (minimum)	PSM-B9	1064.5700.02
32 Mbyte Memory Expansion	PSM-B2	1064.5880.04
Software (free-of-charge option)		
R&S System Software, Windows 95, German	PSM-K10 1)	1116.7507.31
R&S System Software, Windows 95, English	PSM-K10 1)	1116.7507.32
Windows NT, English	PSM-K11	1116.7607.31
Keyboards		
Rack-attachable Special Keyboard (English) with rollkey	PSA-Z1	1009.5001.32
Standard Keyboard (English)	PSA-Z2	1007.3001.32
Mouse	PS-B1	1006.6359.02
Pinwriter (24 pins, with graphics capabilities)	PDN	0351.4512.04
Monochrome Ribbon	PDN-Z2	0399.0917.03
Colour Ribbon	PDN-Z3	0399.1013.03
14" Colour Monitor	PMC1	1008.3005.03
17" Colour Monitor	PMC3	1082.6004.03
15" Industrial Monitor	PMC4	1034.8000.03
IEEE/IEC bus Cable	PCK	
0.5 m		0292.2013.05
1 m		0292.2013.10
2 m		0292.2013.20
4 m		0292.2013.40
Others		
19" Adapter	ZZA-95	0396.4911.00
Transit Case	ZZK-954	1013.9395.00

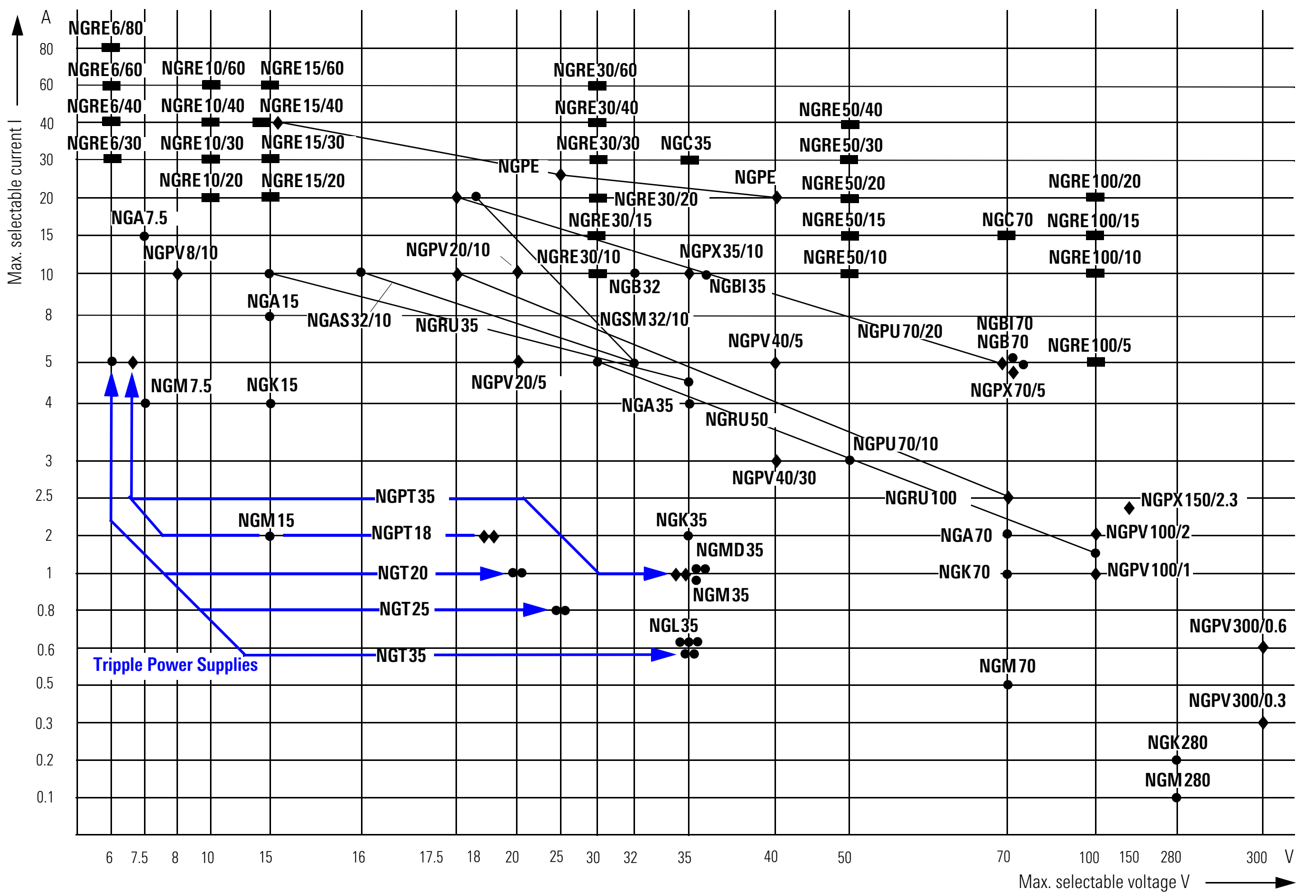
1) Factory-installed only.



DC Power Supply NGSM is a versatile supply and measuring unit for testing electronic car components by simulating real operating conditions (photo 42920)

Contents of Chapter 11

Range of Products, Introduction



- ● Compact bench model
- ●● Dual power supply (dual tracking)
- ●●● Triple power supply
- ■■ 19" model
- ♦ Programmable power supply (IEC 625-1/IEEE 488), 19" model
- ♦♦ Programmable power supply (IEC 625-1/IEEE 488) with multiple output, 19" model

Power supplies

- Selection guide to available line of power supplies (see above diagram)
- Overview of power supplies (page 412) with units classified according to
  – maximum output voltage,
  – maximum output current

The symbols in the above diagram provide information on the kind of unit: whether it is a bench model in the form of a single, dual or triple power supply, or a 19" unit (single or multiple output), as well as information on programmability.

The model nearest to the coordinates of the desired maximum voltage/current values will meet your requirements or even surpass them.

For more information on the unit of your choice please refer to the overview of power supplies.

The wide variety of Rohde&Schwarz power supplies falls into three main groups: bench models with output powers up to 350 W – eleven type series with a total of 29 basic models; 19" models with up to 2000 W output power – two type series with 29 basic models; system units/programmable power supplies with IEC625-1/ IEEE488 bus – five type series with 25 basic models.

Range of Products, Introduction

General technical features
All power supplies from Rohde& Schwarz are designed to offer essentially the same features: floating outputs, permissible voltage of the outputs with reference to chassis or ground – or with multiple output power supplies to one another – 1000 V.

Setting of voltage and current
Settings start from a threshold near zero. The rated values specified for current and voltage are the maximally settable levels. Almost all types of the available power supplies are constant-voltage/constant-current units, which means that they can also be used as current regulators. Pilot lamps or LEDs indicate whether the unit is operating in the constant-voltage/constant-
current mode or in the current limiting mode. All power supply units feature current limiting which can be continuously adjusted to any value between zero and the rated current. The current limiting of NGAS models can be set to 1.5 times the rated current.

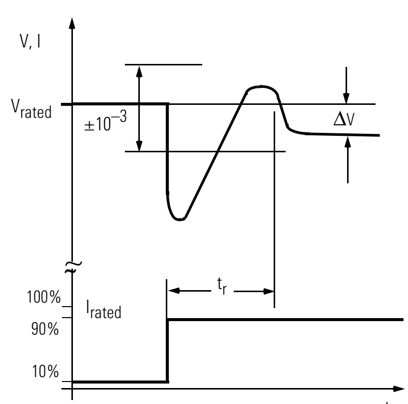
Parallel and series connection
If higher currents or voltages are required, all power supplies can be parallel- or series-connected. Protective circuits prevent the connected load or the power supply unit from being damaged.

The parallel connection capability is restricted for instruments with fast down programming (NGPV, NGPX, NGPE, NGSM).

Output impedance Z_{out}
The output impedance is specified in the tables to describe the effect of load variations on the output quantity. For instance, with constant-current operation of a 100 V/1 A unit, a specified output impedance of Z_{out}=30 kΩ means that a load variation between 0 and 100 Ω at a nominal current of 1 A will cause a current deviation of 3 mA corresponding to 0.3%.

Transient recovery time t_r
The value specified refers to a step change from 10% to 90% of the rated current in constant-voltage mode. After t_r the output voltage is again within tolerance. In constant-current mode t_r strongly depends on the load (<100 µs to 1 s).

Remote sensing
With models of >70 W output power, the voltage drop on the supply lead, which varies with the load current, can be corrected, if separate sensor leads are connected to the terminals of the load. A variation of 0.5 to 1 V on the positive and negative leads can be compensated for.



Transient recovery time t_r following step change in load

Remote control
NGRE power supplies can be equipped for remote control on request. NGRU models can be remote-controlled through external analog voltages.

Programming
Power Supplies NGPT, NGPV, NGPX, NGSM (with option), NGPU and NGPE are suitable both for manual operation and for control via IEEE/IEC bus, ie for use in automatic test systems.

Cooling
The power supplies cannot be damaged by thermal overloading. The models of the NGM, NGK, NGMD, NGT, NGL and NGRU series have rear-mounted convectional heatsinks. Models of higher output power rating use a two-stage (NGPT, NGSM, NGPX: continously variable) thermostat-controlled cooling fan. At low demands the fan is running at a speed that is hardly noticeable; only when high output is required is it switched to full power. The fans are driven by quiet, maintenance-free motors.

Overload protection
To provide protection against undesirably high voltages caused by maloperation or faults, the power supplies are fitted with independent crowbar circuits with an adjustable response threshold (exceptions see table). An external overvoltage protection is also available:

- Overvoltage Protection NG-Z,
  4.5 to 100 V/10 A,
  Order No. 0100.5103.02

Output capacitor
The output capacitor can be switch-selected to match the load: small capacitance with little energy content for sensitive semiconductor circuits, large capacitance for dynamic loads.

Overview of Power Supplies

Type	Designation/Uses	Order No.	V_{max}/V	I_{max}/A	P_{max}/VA	RS	OPV	RC_{DC}	IEC	Page
NGM 7.5	Universal	117.7110.12	7.5	4	30	–	●	–	–	414
NGM 15	constant-current	117.7110.13	15	2	30	–	●	–	–	414
NGM 35	and constant	117.7110.14	35	1	35	–	●	–	–	414
NGM 70	voltage sources	117.7110.15	70	0.5	35	–	●	–	–	414
NGM 280		117.7110.06	280	0.1	28	–	–	–	–	414
NGMD 35	Dual power supply	117.7127.02	2 × 35	2 × 1	70	–	●	–	–	414
NGK 15	Same as NGM,	192.0003.02	15	4	60	●	●	–	–	414
NGK 35	but	192.0003.03	35	2	70	●	●	–	–	414
NGK 70	double	192.0003.04	70	1	70	●	●	–	–	414
NGK 280	output current	192.0003.05	280	0.2	56	●	–	–	–	414
NGA 7.5	Constant-voltage-	192.0010.02	7.5	15	112	●	❍	–	–	414
NGA 15	sources with	192.0010.03	15	8	120	●	❍	–	–	414
NGA 35	adjustable	192.0010.04	35	4	120	●	❍	–	–	414
NGA 70	current limiting	192.0010.05	70	2	120	●	❍	–	–	414
NGAS 32/10	Same as NGA, high surge capability	192.0803.04	16/32	10 (15)	160	●	❍	–	–	414
NGB 32	Same as NGA, high	117.7210.90	32	10	320	●	●	–	–	414
NGB 70	surge capability	117.7227.90	70	5	350	●	●	–	–	414
NGBI 35		192.0910.31				●	●	–	–	414
NGBI 70		192.0910.71				●	●	–	–	414
NGL 35		192.0026.02	3 × 35	3 × 0.6	63	–	❍	–	–	414
NGT 20	Triple	117.7133.02	20/20/6	1/1/5	70	–	● (6 V)	–	–	414
NGT 25		192.0503.02	25/25/6	0.8/0.8/5	70	–	● (6 V)	–	–	414
NGT 35	power supplies	191.2019.02	35/35/6	0.6/0.6/5	72	–	● (6 V)	–	–	414
NGPT 35		192.0510.31	35/35/7	1/1/5	105	●	●	–	●	428
NGPT 18		192.0510.21	18/18/7	2/2/5	105	●	●	–	●	428
NGPT 7		192.0510.71	7/7/18	5/5/2	105	●	●	–	●	428

RS = remote sensing
OVP= overvoltage protection

RC_{DC} = remote control with DC voltage
* = fast on/off switching via TTL-compatible signal

IEC = IEC 625-2 bus (IEEE 488)

● = standard
❍ = option

Range of Products, Introduction

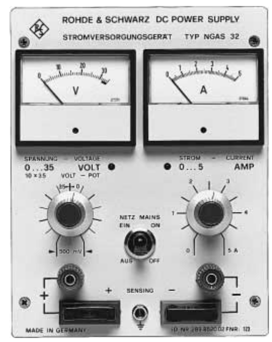
Type	Designation/Uses	Order No.	V_{max}/V	I_{max}/A	P_{max}/VA	RS	OPV	RC_{DC}	IEC	Page
NGRU 35	Precision	192.0210.03	35	10	150	●	●	●	–	417
NGRU 50	laboratory	192.0210.05	50	5	150	●	●	●	–	417
NGRU 100	power supplies	192.0210.08	100	3	150	●	●	●	–	417
NGC 35	Universal	192.0032.02	35	30	1050	●	❍	–	–	417
NGC 70	high-output	192.0032.03	70	15	1050	●	❍	–	–	417
NGRE 6 to 100	power supplies	100.8xxx.xx	6 to 100	5 to 80	180 to 2000	●	❍	❍	–	420
NGPU 70/10	Programmable	192.0049.92	70	10	175	●	●	–	●	422
NGPU 70/20	power supplies	192.0055.92	70	20	350	●	●	–	●	422
NGPV 8/10		192.0310.8x	7.99	9.99	80	●	●	–	●	423
NGPV 20/5		192.0310.2x	19.99	4.99	100	●	●	–	●	423
NGPV 20/10		192.0326.2x	19.99	9.99	200	●	●	–	●	423
NGPV 40/3		192.0310.4x	39.99	2.99	120	●	●	–	●	423
NGPV 40/5		192.0326.4x	39.99	4.99	200	●	●	–	●	423
NGPV 100/1	Programmable	192.0310.1x	99.99	0.99	100	●	●	–	●	423
NGPV 100/2	precision	192.0326.1x	99.99	1.99	200	●	●	–	●	423
NGPV 300/0.3	laboratory power supplies	192.0310.3x	299.99	0.299	90	●	●	–	●	423
NGPV 300/0.6		192.0326.3x	299.99	0.599	180	●	●	–	●	423
NGPE 40/40		192.0332.41	39.99	39.9	800	●	●	–	●	427
NGPT 35		192.0510.31	35/35/7	1/1/5	105	●	●	–	●	428
NGPT 18		192.0510.21	18/18/7	2/2/5	105	●	●	–	●	428
NGPT 7		192.0510.71	7/7/18	5/5/2	105	●	●	–	●	428
NGPX 35/10		192.0610.31	35	10	350	●	●	●*	●	425
NGPX 70/5		192.0610.71	70	5	350	●	●	●*	●	425
NGPX 150/2.3		192.0610.11	150	2.33	350	●	●	●*	●	425
NGSM 32/10	Progr. lab. model, arbitrary functions	192.0810.31	18/32	20/10	180	●	–	–	❍	430

RS = remote sensing
OVP= overvoltage protection
RC_{DC} = remote control with DC voltage
* = fast on/off switching via TTL-compatible signal
IEC = IEC 625-2 bus (IEEE 488)
● = standard
❍ = option

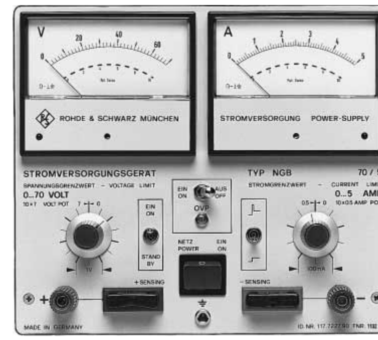
Single Power Supplies

NGM (photo 24541)

NGK (photo 24544)



NGAS (photo 29831-1)



NGB (photo 29832-1)

NGM, NGK: 30/70 W lab models

- Compact bench models
- High-resolution ten-turn potentiometer for voltage and current
- Single switchable meter on NGM, separate meters on NGK

The power supplies of the NGM series can be used either as constant-voltage or as constant-current sources, eg in the laboratory.

The power supplies of the NGK series provide twice the output current of the otherwise identical NGM models and are provided with remote-sensing sockets to compensate for voltage drops in the load leads.

NGA – 120 W compact models

- High-resolution ten-turn potentiometer for voltage
- Separate meters, remote-sensing sockets

The power supplies of the NGA series are constant-voltage sources with adjustable current limiting. They are mainly used for the supply of modules and systems in testshops and labs.

NGAS: 160 W compact model

- High surge capability, twice the rated current can be drawn for short periods
- Use as battery eliminators
- Separate meters for voltage and current

NGAS is suitable both for general lab applications and for the supply of loads with high surge or pulse-type current demands, eg test systems for car electronics or transceivers with switching power supplies.

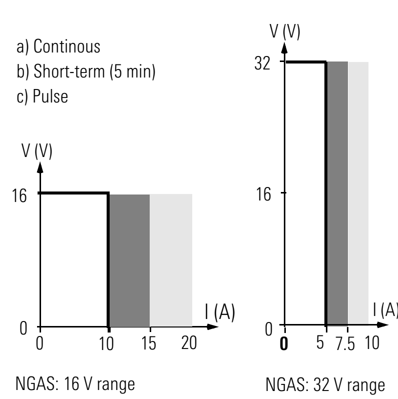
Thanks to its compact design, NGAS is suitable for mobile use. It is insensitive to RF voltages radiated by other equipment or a nearby antenna.

The current limiting threshold can be set to 1.5 times the rated current which may be drawn for up to 5 minutes. Due to the delayed response of current limiting, twice the rated current may be drawn for several milliseconds. The output voltage range can be set to 16 V or 32 V.

NGB, NGBI: 350 W bench models

- High-resolution ten-turn potentiometer for voltage and current
- Surge current capability – several times the rated current may be drawn for short periods

Suitable for use as constant-voltage/constant-current sources with automatic regulation of voltage-to-current transition (LED indication) and as battery eliminator with switch-selected delay for current regulation (higher surge current), eg for incandescent lamps, blinkers, voltage converters. Other features: large panel meters for voltage and current, voltage compensation on leads up to 1 V, adjustable overvoltage protection.

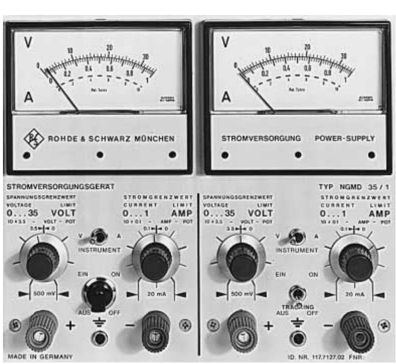


Current drain of NGAS as a function of selected output voltage

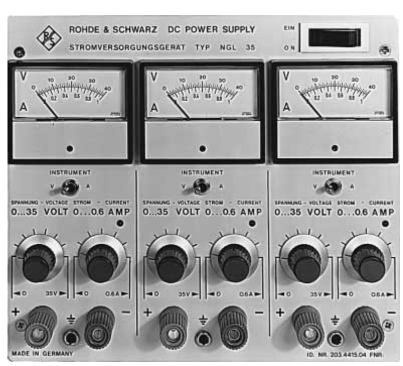
Specifications in brief of Single Power Supplies

Type	Order No.	Setting ranges Voltage V	Current A	Resolution V %	I %	Max. deviation of output for ΔV AC supply ±10% V(%)	I(%)	Δtamb –10 to +40 ×C V(%/×C)	I(%)	Z_{out} for V mΩ	I kΩ	t_r for V µs	Max. PARD V_{rms} mV	I_{rms} mA	Remote sensing S	OV protec. O	Dimens. WxHxD Weight mm (kg)
NGA 7.5	192.0010.02	0.01 to 7.5	0.2 to 15	0.02	0.5	0.01	0.2	0.01	0.1	0.25	0.25	75	0.15	–	S	–	129/172/ 330 (8)
15	192.0010.03	0.01 to 15	0.1 to 8	0.02	0.5	0.01	0.2	0.01	0.1	0.375	1	75	0.3	–	S	–	
35	192.0010.04	0.01 to 35	0.05 to 4	0.02	0.5	0.01	0.2	0.01	0.1	0.875	4.4	75	0.6	–	S	–	
70	192.0010.05	0.01 to 70	0.025 to 2	0.01	0.5	0.01	0.2	0.01	0.1	3.5	17.5	75	1	–	S	–	
NGAS 32/10	192.0803.04	0.01 to 32 0.01 to 16	0.1 to 10 (15)	0.02	0.5	0.01	0.2	0.01	0.1	0.16	1	75	0.6	–	S	–	129/172/ 330 (8)
NGB 32	117.7210.90	0.01 to 35	0.02 to 10	0.02	0.02	0.001	0.002	0.01	0.01	0.43	14	50	0.2	10	S	O	190/172/ 330 (10)
70	117.7227.90	0.01 to 70	0.01 to 5	0.02	0.02	0.001	0.002	0.01	0.01	1.75	56	50	0.5	5	S	O	
NGBI 35	192.0910.31	0.01 to 35	0.02 to 10	0.02	0.02	0.001	0.001	0.01	0.01	0.438	14	50	0.2	1	S	O	190/172/ 330 (10)
70	192.0910.71	0.01 to 70	0.01 to 5	0.02	0.02	0.001	0.001	0.01	0.01	1.75	56	50	0.5	1	S	O	
NGK 15	192.0003.02	0.01 to 15	0.01 to 4	0.02	0.02	0.001	0.002	0.01	0.01	0.75	37.5	50	0.2	0.1	S	O	190/172/ 278 (8)
35	192.0003.03	0.01 to 35	0.01 to 2	0.01	0.02	0.001	0.002	0.01	0.01	1.75	175	50	0.4	0.05	S	O	
70	192.0003.04	0.01 to 70	0.01 to 1	0.01	0.02	0.001	0.002	0.01	0.01	7	700	50	0.8	0.015	S	O	
280	192.0003.05	0.01 to 280	0.002 to 0.2	0.01	0.02	0.001	0.002	0.01	0.01	140	700	50	3	0.005	S	–	
NGM 7.5	117.7110.12	0.01 to 7.5	0.01 to 4	0.02	0.02	0.001	0.002	0.01	0.01	0.75	10	50	0.2	0.1	–	O	95/172/ 278 (4)
15	117.7110.13	0.01 to 15	0.01 to 2	0.02	0.02	0.001	0.002	0.01	0.01	1.5	40	50	0.2	0.05	–	O	
35	117.7110.14	0.01 to 35	0.01 to 1	0.02	0.02	0.001	0.002	0.01	0.01	3.5	175	50	0.4	0.02	–	O	
70	117.7110.15	0.01 to 70	0.01 to 0.5	0.01	0.02	0.001	0.002	0.01	0.01	14	700	50	0.8	0.001	–	O	
280	117.7110.06	0.01 to 280	0.002 to 0.1	0.01	0.02	0.001	0.002	0.01	0.01	280	1400	50	3	0.002	–	–	

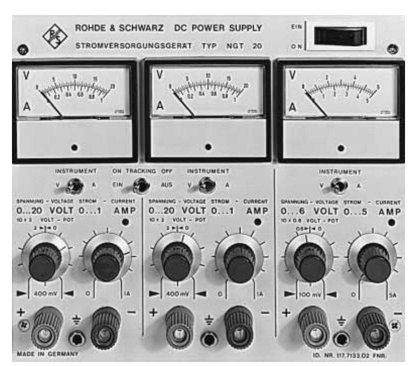
Dual and Triple Power Supplies



NGMD 35 (photo 24543)



NGL35 (photo 24547)



NGT20 (photo 24545)

NGMD 35 – 2 x 0 to 35 V/1 A

- Independent or tracking operation
- Isolated floating outputs, permanently shortcircuit-proof

Two NGM 35 power supplies are accommodated in one cabinet and can be used either separately or in tracking mode. In the tracking mode, unit II follows unit I. Relative to a common reference point, NGMD supplies a positive and a negative voltage of 0 to 35 V, which are concurrently and equally variable by a percentage of the voltage. The current limits can be set independently of each other.

Dual and Triple Power Supplies

NGL 35 – 3 x 0 to 35 V/0.6 A

- Three voltages at a time, series or parallel connection
- Thermal overload protection, automatic power-up

NGL 35 has three equal, separate and floating outputs. The voltages can be independently adjusted between 0 and 35 V and the current limiting threshold between 0 and 0.6 A. Voltage or current ratings can be tripled by parallel or series connection. A switchable panel meter is provided for each output.

NGT – 2 x 0 to 20/25/35 V 1/0.8/0.6 A; 1 x 0 to 6 V/5 A

- Independent or tracking operation of 20/25/35 V outputs
- Shortcircuit-proof, adjustable overvoltage protection (6 V output)

NGT models combine three independent voltage sources in one unit. A switchable panel meter is provided for each output. The 20 V, 25 V, 35 V outputs can be used separately, in series or parallel connection or in tracking mode. The independent 6 V output with its load rating of 5 A is especially designed for the supply of digital integrated circuits; overvoltage protection is adjustable.

Specifications in brief of Dual and Triple Power Supplies

Type	Order No.	Setting ranges Voltage V	Current A	Resolution V %	I %	Max. deviation of output for ΔV AC supply ±10% V(%)	I(%)	Δt_{amb} −10 to +40 °C V(%/°C)	I(%)	Z_{out} for V mΩ	I kΩ	t_r for V µs	Max. PARD V_{rms} mV	I_{rms} mA	Overvoltage protection	Dimensions WxHxD Weight mm (kg)
Dual Power Supplies																
NGMD35	117.7127.02	0.01 to 35 (2 x)	0.01 to 1	0.02	0.02	0.001	0.001	0.01	0.01	3.5	175	50	0.4	0.02	●	190/172/ 278 (8)
Triple Power Supplies																
NGL35	192.0026.02	0.01 to 35 (3 x)	0.01 to 0.6	contin.	1	0.01	0.2	0.1	0.1	3.5	15	75	0.2	–	–	190/172/ 278 (7)
NGT20	117.7133.02	0.01 to 20 (2 x) 0.01 to 6 (1 x)	0.01 to 1 0.01 to 5	0.02	1	0.01	0.2	0.01	0.1	2 1	9 0.4	75 75	0.15 0.2	–	– ●	190/172/ 278 (7)
NGT25	192.0503.02	0.01 to 25 (2 x) 0.01 to 6 (1 x)	0.01 to 0.8 0.01 to 5	0.02	1	0.01	0.2	0.01	0.1	2.5 1	10 0.4	75 75	0.2 0.2	– –	– ●	190/172/ 278 (7)
NGT35	191.2019.02	0.01 to 35 (2 x) 0.01 to 6 (1 x)	0.01 to 0.6 0.01 to 5	0.02	1	0.01	0.2	0.01	0.1	3.3 1	15 0.4	75 75	0.25 0.2	– –	– ●	190/172/ 278 (7)

Power Supplies NGRU

NGRU 35: 0 to 35 V/0 to 10 A

NGRU 50: 0 to 50 V/0 to 5 A

NGRU 100: 0 to 100 V/0 to 3 A

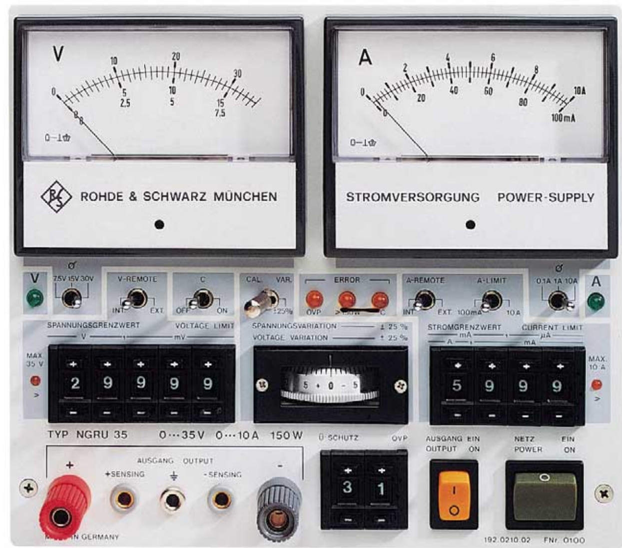


Photo 31460

Brief description

Power Supplies of the NGRU series are precision laboratory units providing high accuracy and repeatability of voltage and current settings via digital potentiometers.

The power supplies can be used as constant-voltage or constant-current sources. The maximum output power is 150 W and remains constant over a wide voltage range. The current loadability depends on the output voltage.

Main features

- Compact bench models
- High resolution and reproducibility through digital potentiometers
- Output voltage continuously variable with calibrated potentiometer
- Automatic power matching ensuring full power over wide output voltage range
- Digitally settable overvoltage protection
- Output voltage can be modulated – simulation of interference factors
- Remote programming of voltage and current
- Panel meter for voltage and current indication in three ranges
- Large LED indicators for overload, overtemperature, overvoltage protection and selected operating mode
- Switch-selectable output capacitor
- Remote sensing

Operation

The voltage can be set in five digits and continuously varied by ±25% with a calibrated potentiometer.

The current can be set in four digits within two ranges. The low range is 100 mA for all NGRU models so that even currents in the µA range can be reliably regulated.

The overvoltage protection is also set via digital potentiometer. In addition to manual operation, remote programming of voltage and current is possible by means of analog control signals.

Power Supplies NGRU

Specifications in brief

Voltage setting	NGRU 35	NGRU 50	NGRU 100
in 5 digits	<1 mV to 35 V	<1 mV to 50 V	<1 mV to 100 V
Resolution	1 mV	1 mV	1 mV
Max. error at 20°C	$\pm10^{-4}$ of set value ±20 mV		
analog (continuously)	±25% with ±0.5% setting error of scale		
Resolution	0.25%	0.25%	0.25%

Current setting			
(2 ranges in 4 digits)			
High range	<1 mA to 10 A	<1 mA to 5 A	>12 mA to 3 A
Resolution	1 mA	1 mA	1 mA
Max. error at 20°C	±2 x 10^{-3} of set value ±10 mA		
Low range	<10 µA to 100 mA		
Resolution	10 µA	10 µA	10 µA
Max. error at 20°C	±2 x 10^{-3} of set value ±0.2 mA		
Max. constant current (150 W)	up to 15 V: 10 A 20 V: 7.5 A 35 V: 4.3 A	up to 30 V: 5 A 40 V: 3.8 A 50 V: 3 A	up to 50 V: 3 A 75 V: 2 A 100 V: 1.5 A

Constant-voltage source			
Deviation of output voltage with			
±10% AC supply variation	$<\pm10^{-5}$		
between 0 and 40°C	$<\pm10^{-4}$/K		
with 10 to 90% load	$<10^{-4}$		
PARD (V_{rms})	<0.3 mV	<0.5 mV	<1 mV
Transient recovery time	<75 µs	<75 µs	<75 µs

Constant-current source			
Deviation of output current with			
±10% AC supply variation	<±2 x 10^{-5}		
between 0 and 40°C	<±2 x 10^{-4}/K		
from 10 to 90% load	<2 x 10^{-4}		
PARD			
in high range (I_{rms})	<2 mA	<1 mA	<0.3 mA
in low range (I_{rms})	<20 µA	<20 µA	<20 µA
Sensing sockets			
Max. voltage compens.	<0.5 V	<1 V	<1.5 V

Common data	
Modulation of output voltage (BNC female, floating)	V_{pp} = 10 V for 10 V modulation, 50 Hz to 1 kHz ±3 dB
Input impedance	approx. 3.5 kΩ
Overvoltage protection	
Setting range	1 to 99 V (response threshold approx. 5% higher)

Programming (external, analog)	
for output voltage	
0 to 100%´	0 to 10 V
for output current 0 to 100%	0 to 10 V
Setting time	<3 ms (to within ±1%)
Connector	5-contact Tuchel female
Input impedance	approx. 10 kΩ
Reference potential	positive terminal

General data	
Meter accuracy	±2.5% of full scale
AC supply	110/120/220/240 V ±10%, 47 to 63 Hz,
Dimensions (W x H x D); weight	190 mm x 180 mm x 330 mm; 9 kg

Ordering information

Power Supply	NGRU 35	0192.0210.03
	NGRU 50	0192.0210.05
	NGRU 100	0192.0210.08

1000 W Power Supplies NGC

NGC 35: **0 V to 35 V**
0.05 A to 30 A

NGC 70: **0 V to 70 V**
0.025 A to 15 A

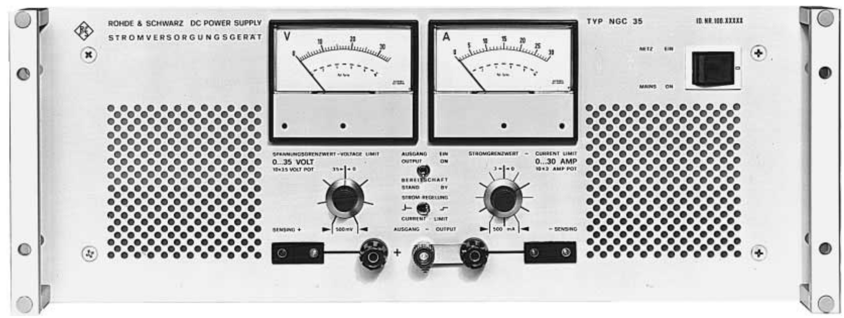


Photo 24536

Brief description

- Surge current capability – several times the rated current can be drawn for short periods
- High efficiency, 19" cabinet

The high efficiency of Power Supplies NGC is achieved through continuous pre-regulation. A series-pass regulator ensures for excellent static and dynamic characteristics. Special constructional measures allow use in RF systems.

Specifications in brief

	NGC 35	NGC 70
Voltage	<10 mV to 35 V	<10 mV to 70 V
Current	<50 mA to 30 A	<25 mA to 15 A
Resolution	<0.02%	<0.02%
Deviation of voltage		
with ±10% AC supply variation	$<\pm 10^{-5}$	
between 0 and 40°C	$<\pm 10^{-4}$/K	
from 10 to 90% current	$<10^{-4}$	
Deviation of current		
with ±10% AC supply variation	$<\pm 10^{-4}$	
between 0 and 40°C	$<\pm 10^{-3}$/K	
from 10 to 90% voltage	$<10^{-3}$	
PARD		
Voltage V_{rms}	<1 mV	<2 mV
Current I_{rms}	<20 mA	<20 mA
Transient recovery time (10 to 90% load)	<60 µs	
Sensing sockets		
Surge current for 1 ms/0.2 s	80/60 A	40/30 A
Max. voltage compensation	0.5 V per lead	

General data

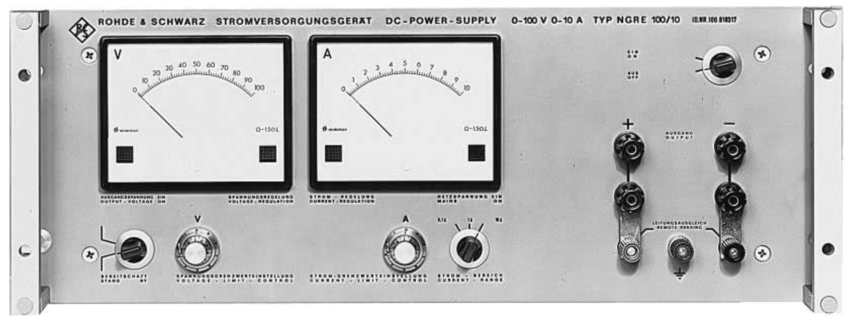
Rated temperature range	0 to +40°C
Meter accuracy	2.5 % of full scale
AC supply	220 V ±10%, 50 Hz, 2.4 kVA (other values on request)
Dimensions (W x H x D); Weight	484 mm x 194 mm x 509 mm; 40 kg

Ordering information

1000 W 19" Power Supply	NGC 35	0192.0032.02
	NGC 70	0192.0032.03

Power Supplies NGRE

19" models – from about 200 W to 2000 W



NGRE in design A and B: cabinet model or rackmount, design B without operating controls (photo 24537)

Brief description

Power Supplies NGRE provide high output power (from about 200 W). This type series is extremely versatile due to the use of standardized modules.

There are 27 basic versions (see table on next page), most of which come in five models. The basic versions only differ in the obtainable maximum voltage and current values and in the output impedance.

Each of these basic versions is equipped differently regarding meters, operating controls, connectors and available as a cabinet model or rackmount.

Power Supplies of the NGRE series are designed for operation from 220 V AC supply. The power supplies can be adapted to other voltages upon request and at no extra cost.

Main features

- Sustained shortcircuit-proof, thermal overload protection
- Series and parallel connection of several units possible
- Built-in overvoltage protection (optional)

Operation

Voltage and current are set by means of high-resolution ten-turn potentiometers and indicated on separate panel meters. On request the power supplies are available with digital displays instead of analog panelmeters (Ordering information NGRE MOD.DA). The power supplies are fitted with remote sensing sockets to compensate for voltage drops in the load leads. The two-stage cooling fan is thermostat-controlled and very quiet.

Setting the current ranges

NGRE models 16 and 17 for currents up to 30 A are available on request with decade current ranges, eg a 10 A unit can be set to 0.1/1/10 A.

Remote control

The following functions of models 12, 13, 16, 17 can be modified for remote control: output voltage, output current, power switch on/off/standby and control of power regulating element. Power supplies which have been modified for remote control may be operated in master-slave mode (optional). This mode, in which the output quantity is controlled by only one of the supplies involved, is especially recommended for equally splitting up the load current at high powers.

Surge current capability

Two to three times the rated current may be drawn from the NGRE Power Supplies. An external or internal (model code number …19) switch is provided for this purpose.

NGRE MOD.DA fitted with digital displays (photo 43344)

Power Supplies NGRE

Dimensions of different designs

	Cabinet model mm	Rackmount mm	Seated depth mm
Design A	484 x 194 x 436	483 x 177 x 425	347
Design B	484 x 194 x 509	483 x 177 x 498	420
Design C	608 x 394 x 284	–	–

Specifications in brief and order numbers

Setting ranges **Voltage** V	**Current** A	**Order number**	**Max. deviation of output for** ΔV AC supply ±10% V, I (%)	Δt_{amb} –10 to +40 °C V, I (%)	**Z_{out}** for V mΩ	(I) (kΩ)	**t_r** for V µs	**Max. PARD** V_{rms} µV	I_{rms} mA	**Power consumption** at 220 V/50 Hz kVA	**Available design**	**Weight** incl. case kg
0 to 6	0 to 30	100.8402.xx	±0.001	0.01	1	(1)	<50	300	9	0.9	A, C	22
	0 to 40	100.8419.xx	±0.001	0.01	0.1	(1)	<50	300	12	0.9	A, C	22
	0 to 60	100.8425.xx	±0.001	0.01	0.1	(1)	<50	300	18	0.9	A, C	28
	0 to 80	100.8431.xx	±0.001	0.01	0.1	(1)	<50	300	24	1.8	B, C	29
0 to 10	0 to 20	100.8354.xx	±0.001	0.01	1	(2)	<50	300	6	0.9	A, C	19
	0 to 30	100.8360.xx	±0.001	0.01	1	(2)	<50	300	9	0.9	A, C	28
	0 to 40	100.8377.xx	±0.001	0.01	0.1	(2)	<50	300	12	1.8	A, C	28
	0 to 60	100.8383.xx	±0.001	0.01	0.1	(1)	<50	300	18	1.8	A, C	37
0 to 15	0 to 20	100.8319.xx	±0.001	0.01	1	(2)	<50	300	6	0.9	B, C	28
	0 to 30	100.8325.xx	±0.001	0.01	1	(2)	<50	300	9	1.8	A, C	28
	0 to 40	100.8331.xx	±0.001	0.01	0.1	(2)	<50	300	12	1.8	A, C	37
	0 to 60	100.8348.xx	±0.001	0.01	0.1	(1)	<50	300	18	2.5	B, C	39
0 to 30	0 to 10	100.8254.xx	±0.001	0.01	1	(5)	<50	300	3	0.9	A, C	19
	0 to 15	100.8260.xx	±0.001	0.01	1	(5)	<50	300	4.5	0.9	A, C	28
	0 to 20	100.8277.xx	±0.001	0.01	1	(3)	<50	300	6	1.8	A, C	28
	0 to 30	100.8283.xx	±0.001	0.01	1	(2)	<50	300	9	1.8	A, C	37
	0 to 40	100.8290.xx	±0.001	0.01	0.1	(2)	<50	300	12	2.5	B, C	39
	0 to 60	100.8460.xx	±0.001	0.01	0.1	(2)	<50	300	18	3.5	C	50
0 to 50	0 to 10	100.8219.xx	±0.001	0.01	1	(5)	<50	300	3	0.9	A, C	28
	0 to 15	100.8225.xx	±0.001	0.01	1	(5)	<50	300	4.5	1.4	A, C	28
	0 to 20	100.8231.xx	±0.001	0.01	1	(5)	<50	300	6	1.8	A, C	37
	0 to 30	100.8248.xx	±0.001	0.01	1	(3)	<50	300	9	2.5	B, C	39
	0 to 40	100.8454.xx	±0.001	0.01	0.1	(2)	<50	300	12	3.5	C	50
0 to 100	0 to 5	100.8160.xx	±0.001	0.01	1	(10)	<50	500	1.5	0.9	A, C	28
	0 to 10	100.8183.xx	±0.001	0.01	1	(10)	<50	500	3	1.8	A, C	37
	0 to 15	100.8190.xx	±0.001	0.01	1	(5)	<50	500	4.5	2.5	A, C	39
	0 to 20	100.8448.xx	±0.001	0.01	1	(5)	<50	500	6	3.5	C	50

Completion of Order Numbers

Model code number (last two digits of Order No.)	Design	Voltage and current setting Precision potentiometer on front panel	Screwdriver adjustment on rear panel	Current range in three decades (up to 30 A) at extra cost	Four additional fixed voltages, pushbutton-selected	Large meters for voltage and current
13	19" cabinet		●			
17		●		●		●
12	19" rackmount		●			
16		●		●		●
19	Aluminium case	●			●	●

Programmable Power Supplies NGPU

NGPU 70/10: 175 W

(70 V/max. 10 A)

NGPU 70/20: 350 W

(70 V/max. 20 A)

Photo 26310

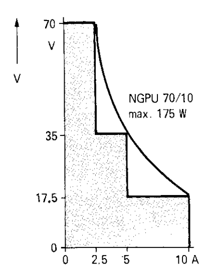
Brief description

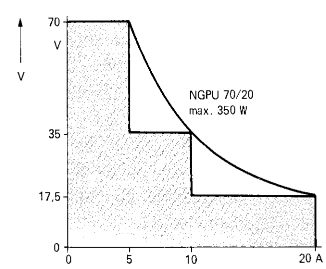
NGPU Power Supplies are constant voltage or constant-current sources, which can be programmed via IEEE/IEC bus or operated manually. Three selectable current ranges and one floating test output which can be switched between voltage and current make the NGPU ideal for use in IEEE/IEC bus test systems.

Graduated current loadability
Since the current drain of many loads – for instance of transceivers – is inversely proportional to the supply voltage, a graduated current loadability is fully compatible with practical requirements. The maximum continuous current drain for the selected output voltage is indicated on a scale of the panel voltmeter. Brief current surges exceeding this load limit are tolerable. If above 15 V a current exceeding this limit is permanently drawn, the power supply is disconnected from the AC supply via the built-in temperature monitor.

Main features

- Programming via IEEE/IEC bus or manual operation
- Three-digit programming of voltage and current (1000 steps), resolution: 10 mV to 100 mV, 10 mA to 20 mA
- Output current in three decade ranges





Current loadability is graduated as a function of the output voltage. Full output current can be derived over almost 80% of the voltage range. As the figure shows, the characteristic practically combines the curves, ie the performance, of three individual supplies

Specifications in brief

Output quantities	adjustable via ten-turn potentiometer or IEEE/IEC bus	
Resolution manual control	0.02%	
Resolution IEEE/IEC bus	1000 steps/range; for voltage adjustable 10 to 100 mV/step	
Voltage	<10 mV to 70 V	
Current	**NPGU 70/10**	**NPGU 70/20**
3 ranges	0.1/1/10 A	0.2/2/20 A
Deviation of output voltage/current		
with ±10% AC supply variation	$<10^{-5}$/$<5 \times 10^{-5}$	
between 0 and 40°C	$<(10^{-4}$/K+100 µV)/$<(10^{-4}$/K+100 µA)	
with 10 to 90% load	$<10^{-4}$/$<5 \times 10^{-4}$	
PARD		
Voltage, V_{rms}	<1.5 mV	<1.5 mV
Current, I_{rms}	<5 mA	<10 mA
Transient recovery time (10 to 90% load)	<60 µs	<60 µs

	NPGU 70/10	**NPGU 70/20**
Remote control	IEC 625-1 (IEEE 488)	
Remote sensing	compens. for 0.5 V per lead	
Test output		
for voltage	100 mV ±1% at 70 V	
for current	100 mV ±2% for full scale	
Overvoltage protection	adjustable from 4.5 to 80 V	
General data		
AC supply	110/220 V ±10%, 50 to 60 Hz	
Power consumption	600 VA	1250 VA
Dimensions (W x H x D) in mm	492 x 161 x 514	492 x 205 x 514
Weight	14 kg	19 kg

Ordering information

Programmable Power Supply	NGPU 70/10	0192.0049.92
	NGPU 70/20	0192.0055.92

Programmable Power Supplies NGPV

Power Supplies suitable for use in test systems and for general laboratory applications

Photo 431316-1

Brief description

Power Supplies of the NGPV series are suitable for use in test systems and for general laboratory applications.

Nine different models are available

NGPV 8/10	0 to 8 V/0 to 10 A
NGPV 20/5	0 to 20 V/0 to 5 A
NGPV 20/10	0 to 20 V/0 to 10 A
NGPV 40/3	0 to 40 V/0 to 3 A
NGPV 40/5	0 to 40 V/0 to 5 A
NGPV 100/1	0 to 100 V/0 to 1 A
NGPV 100/2	0 to 100 V/0 to 2 A
NGPV 300/0.3	0 to 300 V/0 to 0.3A
NGPV 300/0.6	0 to 300 V/0 to 0.6A

Each model comes in two versions

The version for use in systems and labs can be programmed via IEEE/IEC bus or operated manually. These power supplies are provided with the necessary operating controls, a digital LED display for indication of all input data including IEEE/IEC bus commands, and analog meters for indication of actual voltage and current values. The system version is without operating controls so that models for use in systems are lower-priced.

Main features

- Digital setting, high resolution
- No discrete output capacitance, true current source
- Programmable via IEEE/IEC bus and manual control
- Short setting time for down programming thanks to current sinking
- Two current ranges - high-resolution current monitoring output
- Display of operating status and faults
- Thermostat-controlled cooling fan
- 19" design

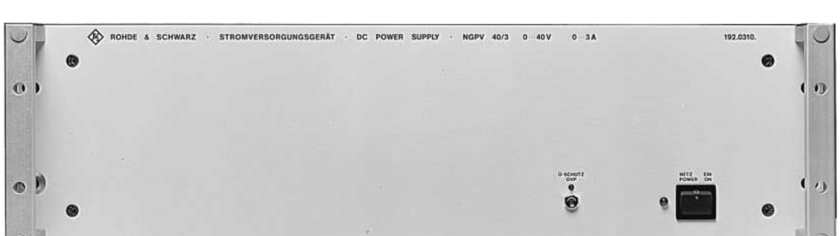
System use

Power Supplies NGPV are ideal for use in systems because of the short setting time of 2 ms which applies both to the rise time and thanks to controlled current sinking also to the fall time.

The NGPV models have no discrete output capacitance so that they can be used for regulating extremely low currents. Relay contacts will not be damaged by switching of current paths. A larger output capacitor can be switched into circuit manually or via the program.

Remote sensing

Remote sensing is a particularly system-friendly mode since it is set automatically with no sensing links involved. In the sensing mode, the maximum output voltage of the power supply exceeds the specified nominal voltage only by the amount of the voltage drop in the leads. The load is thus fully protected, even in the presence of a shortcircuit, wrong polarity or interruption of the sensing leads.



Power Supply NGPV for use in systems (photo 31924)

Programmable Power Supplies NGPV

Specifications in brief

Type	NGPV 8/10	NGPV 20/5	NGPV 20/10	NGPV 40/3	NGPV 40/5	NGPV 100/1	NGPV 100/2	NGPV 300/0.3	NGPV 300/0.6
A1 A2 A3	0 V to 7.99 V 10 mV/800 $<10^{-3}$	0 V to 19.99 V 10 mV/2000 $<10^{-3}$		0 V to 39.99 10 mV/4000 $<10^{-3}$		0 V to 99.9 V 100 mV/1000 $<10^{-3}$		0 V to 299.9 V 100 mV/300 $<10^{-3}$	
B1 B2 B3	0 A to 9.99 A 10 mA/1000 $<10^{-3}$	0 A to 4.99 A 10 mA/500 $<2 \times 10^{-3}$	0 A to 9.99 A 10 mA/1000 $<10^{-3}$	0 A to 2.99 A 10 mA/300 $<3 \times 10^{-3}$	0 A to 4.99 A 10 mA/500 $<2 \times 10^{-3}$	0 A to 0.999 A 1 mA/1000 $<10^{-3}$	0 A to 1.99 A 10 mA/200 $<4 \times 10^{-3}$	0 A to 0.299 A 1 mA/300 $<3 \times 10^{-3}$	0 A to 0.599 A 1 mA/600 $<2 \times 10^{-3}$
B11 B12 B13	0 A to 999 mA 1 mA $<10^{-3}$	0 A to 999 mA 1 mA $<10^{-3}$		0 A to 999 mA 1 mA $<10^{-3}$		0 A to 99.9 mA 0.1 mA $<2 \times 10^{-3}$		0 A to 99.9 mA 0.1 mA $<2 \times 10^{-3}$	
C	<200 µV	<250 µV		<400 µV		<600 µV		<900 µV	
D	500 pF/220 µF	500 pF/100 µF	750 pF/220 µF	500 pF/47 µF	750 pF/100 µF	500 pF/22 µF	750 pF/47 µF	500 pF/10 µF	750 pF/22 µF
E	4.5 V to 15 V	4.5 V to 25 V		4.5 V to 50 V		5 V to 110 V		5 V to 330 V	

Output voltage
A1: setting
A2: resolution (mV/steps)
A3: deviation (of fs)

Output current (A range)
B1: setting
B2: resolution (mA/steps)
B3: deviation (of fs)

Output current (mA range)
B11: setting
B12: resolution (1000 steps)
B13: deviation (of fs)

C: PARD, V_{rms}

D: output C (OFF/ON)

E: overvoltage protection (OVP)

Common data

Constant-voltage source

Deviation of output voltage	
with ±10% AC supply variation	$<10^{-5}$
between 0 and 50°C	$<2 \times 10^{-5}$/K
with 10 to 90% load	$<10^{-4}$
Transient recovery time (10 to 90%/90 to 10%)	<75 µs (to within $\pm 10^{-3}$)

Constant-current source

Deviation of output current	
with ±10% AC supply variation	$<10^{-5}$
between 0 and 50°C	$<5 \times 10^{-5}$/K
with 10 to 90% load	$<10^{-4}$
Transient recovery time, output C OFF/ON	<50 µs/<2 ms
PARD, I_{rms}	
in mA range	10 µA
in A range	100 µA/A

Remote control	IEC 625-1 (IEEE 488)
Interface functions	SH0, AH1, T0, TE0, L1, LE0, SR0, RL1, PP1, DC1, DT1, C0
Setting time (0 to 100%/100 to 0%)	<2 ms (to within $\pm 2 \times 10^{-3}$)
Remote sensing	compensation for 1 V per lead
Current monitoring output	
mA range	100 mV ±1% for full scale
A range	10 mV ±1%/A
General data	
Meter accuracy	±2.5% of fs
AC supply	110/120/220/240 V ±10%, 47 to 63 Hz

Order No.	192.0310...	192.0326...
Power consumption	approx. 250 VA	approx. 500 VA
Dimensions (W x H x D) in mm	492 x 161 x 392	492 x 161 x 420
Weight	12 kg	19 kg

Ordering information

Type	NGPV 8/10	NGPV 20/5	NGPV 20/10	NGPV 40/3	NGPV 40/5	NGPV 100/1	NGPV 100/2	NGPV 300/0.3	NGPV 300/ 0.6
F1	192.0310.80	192.0310.20	192.0326.20	192.0310.40	192.0326.40	192.0310.10	192.0326.10	192.0310.30	192.0326.30
F2	192.0310.81	192.0310.21	192.0326.21	192.0310.41	192.0326.41	192.0310.11	192.0326.11	192.0310.31	192.0326.31

F1: system version

F2: system and lab version

Programmable Power Supplies NGPX

NGPX 35/10: 0 to 35 V/0 to 10 A

NGPX 70/5: 0 to 70 V/0 to 5 A

NGPX 150/2.3:

0 to 150 V/0 to 2.3 A

High-speed power supply for power ramp simulation and high test throughput

Photo 42846

Brief description

Power Supplies NGPX are high-performance programmable laboratory units (350 W) using linear regulation. With their excellent regulation characteristics these 19" units are ideal for use in development labs. Thanks to convenient manual operation and IEEE/IEC bus control they can readily be integrated into production test systems. A rear trigger input allows fast on/off switching of the output voltage to support current-saving applications.

Main features

- 350 W output power
- Low PARD thanks to linear regulation
- Accurate return signalling of voltage and current values, also via IEEE/IEC bus
- Effective current measurement with dynamic loads
- Fast up and down programming (typ. 10 µs for NGPX35/10)
- Large alphanumeric LCD display for output of nominal and actual values as well as status information
- Nominal value input via numeric keypad; increment and decrement key
- Rear, isolated trigger input
- Rear isolating and polarity reversal relay (optional)
- Current monitor in 3rd current range with 25 µA resolution (optional)
- Nonvolatile storage of 10 complete instrument setups
- Selectable foldback function
- Temperature-controlled cooling fan
- Soft limits for current and voltage
- Hardware overvoltage protection
- Remote sensing
- 19" system unit with IEEE488.2

Programmable Power Supplies NGPX

Specifications in brief

Constant-voltage source	**35/10**	**70/5**	**150/2.3**
Voltage setting	0 to 35.00 V	0 to 70.00 V	0 to 150.00 V
Resolution (mV/steps)	10/3500	20/3500	50/3000
Deviation			
from nominal value (±1 LSB)	<25 mV	<50 mV	<125 mV
with ±10% AC supply variation	<±0.35 mV	<±0.7 mV	<±1.5 mV
with load variation (10% to 90% of fs)	<±1 mV	<±2 mV	<±3.5 mV
Transient recovery time with load variation (10% to 90% of fs) to ±0.15%	<75 µs	<75 µs	<75 µs
Rise/fall time of output voltage (fast mode)	typ. <10 µs	typ. <20 µs	typ. <20 µs
PARD, V_{rms} (C_{ON}/C_{OFF})	<0.25/<0.5 mV	<0.5/<1.0 mV	<1/<2 mV
Voltage measurement	0 to 40.95 V	0 to 81.9 V	0 to 204.75 V
Resolution (mV/steps)	10/4095	20/4095	50/4095
Deviation from measured value (±2 LSB)	<±35 mV	<±70 mV	<±150 mV
Current setting	0 to 10.00 A	0 to 5.00 A	0 to 2.30 A
Resolution (mA/steps)	2.5/4000	1.25/4000	1/2300
Deviation from nominal value[1]	<±10 mA±1 LSB	<±10 mA±1 LSB	<±5 mA±1 LSB
with ±10% AC supply variation	<±0.2 mA	<±0.2 mA	<±0.2 mA
with load variation (10 to 90% of fs)	<±1 mA	<±1 mA	<±0.5 mA
PARD, I_{rms} (C_{ON}/C_{OFF})	<0.2/<0.6 mA	<0.1/<0.3 mA	<0.05/0.15 mA
Current measurement in range 1	0 to 10.2375 A	0 to 5.1188 A	0 to 4.095 A
Resolution (mA/steps)	2.5[1]/4095	1.25[1]/4095	1/4095
Deviation from measured value ±2 LSB)	<±20 mA	<±10 mA	<±5 mA
Current measurement in range 2	0 to 1.02375 A	0 to 511.88 mA	0 to 409.5 mA
Resolution (µA/steps)	250/4095	125[2]/4095	100/4095
Deviation from measured value ±2 LSB)	<±2 mA	<±1 mA	<±0.5 mA
Current measurement in range 3 (option)		0 to 102.375 mA	
Resolution (µA/steps)	25[3]/4095	25[3]/4095	25[3]/4095
Deviation from measured value (±2 LSB)	<±30 µA[3] ±2.5 µA/°C	<±30 µA[3] ±2.5 µA/°C	<±30 µA[3] ±2.5 µA/°C
Overvoltage protection			
Operating range	4 to 99.95 V	4 to 99.95 V	4 to 200 V
Resolution	50 mV	50 mV	100 mV
Response accuracy	±4 V	±4 V	±4 V

General data	
Refresh rate of display	3 updates per second
Refresh rate of measured value	update on each query
Setting time (incl. command processing)	typ. 4ms (NGPX mode)
Outputs	floating, max. 250 V DC
AC supply	100/120/220/240 V; 47 to 63 Hz; 1400 VA
Dimensions (W x H x D); Weight	492 mm x 161 mm x 513 mm; 23 kg
Programming	IEC625-2/IEEE488.2

Ordering information

Programmable Power Supply	NGPX35/10	0192.0610.31
	NGPX70/5	0192.0610.71
	NGPX150/2.3	0192.0610.11
Options		
Rear isolating and polarity reversal relay for	NGPX 35/10	0192.0610.32
	NGPX 70/5	0192.0610.72
	NGPX 150/2.3	0192.0610.12
Current monitor in current range 3 for	NGPX 35/10	0192.0610.33
	NGPX 70/5	0192.0610.73
	NGPX 150/2.3	0192.0610.13

1) Readout roundet to full mA.

2) Readout roundet to full 100 µA.

3) Readout roundet to full 10 µA.

Programmable Power Supply NGPE 40/40

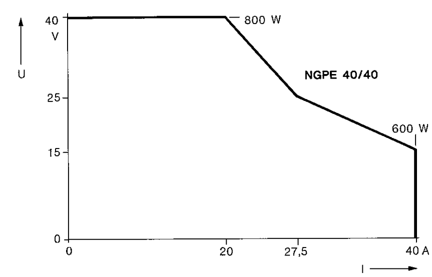
Photo 43554

Brief description

Programmable Power Supply NGPE is suitable for use in test systems and for general laboratory applications. The relatively small output capacitance, the short setting time even for down programming (thanks to built-in current sinking) as well as the voltage and current monitoring outputs are significant benefits in system use.

Main features

- 0 V to 40 V/0 V to max. 40 A
- Primary-switched regulator with high efficiency and low heat dissipation
- Low PARD, excellent EMC, RFI suppression grade B
- Good regulation characteristics even with partial loading thanks to push-push converter configuration using power FETs
- Wide AC supply regulation range: 190 V to 265 V/95 V to 135 V
- Clear front-panel layout and LED display for voltage and current as well as IEEE/IEC bus commands
- Manual setting or via IEEE/IEC bus
- Separate panel meters for voltage and current, each with two switch-selected ranges
- High resolution and reproducibility due to decade setting
- High setting speed (for up programming independent of preset current limit, for down programming due to current sinking)
- Current monitoring output (two ranges)
- Voltage monitoring output
- Overvoltage protection (OVP)
- Thermostat-controlled cooling fan
- Remote sensing similar to NGPV
- 19" system unit



The autoranging output characteristic shows that higher currents are available at lower voltages. At 15 V and 40 A the output power is still 600 W

Specifications in brief

Voltage setting, in 4 digits	0 to 39.99 V	
Resolution/Deviation	10 mV (4000 steps)/$<10^{-3}$ of full scale	
Current setting, in 3 digits	0 to 39.9 A	
Resolution/Deviation	100 mA (400 steps)/$<2x10^{-3}$ of full scale	
Constant-voltage source		
Deviation of output voltage		
with ±10% AC supply variation	$<10^{-4}$	
between 0 and 45°C	$<2 \times 10^{-5}$/°C	
with 10 to 90% nominal current	$<10^{-4}$	
Transient recovery time at 40 V,		
from 2 to 18 A or conversely	2.0 ms (to 150 mV)	
from 2 to 4 A or conversely	0.2 ms (to 50 mV)	
from 16 to 18 A or conversely	0.2 ms (to 50 mV)	
Setting time	without load	with load
from 0 to 39 V	50 ms	60 ms
from 39 to 0.4 V	100 ms	30 ms
from 39 to 0.1 V	120 ms	40 ms
PARD, V_{rms}/V_p	2 mV/20 mV	
Constant-current source		
Deviation of output current		
with ±10% AC supply variation	$<10^{-4}$	
between 0 and 45°C	$<10^{-4}$/°C	
with 10 to 90% nominal current	$<10^{-4}$	
PARD, I_{rms}	<40 mA	

Remote control	IEC 625-1 (IEEE 488)
Functions	SH0, AH1, T0, TE0, L1, LE0, SR0, RL1, PP1, DC1, DT1, C0
Remote sensing	compensation for 0.5 V per lead
Panel meters	
Voltmeter (2 ranges)	10/40 V ±2.5% of full scale
Ammeter (2 ranges)	4/40 A ±2.5% of full scale
Monitoring output	
for current	400 mV corresp. to 4 A, 2% of fs 400 mV corresp. to 40 A, 0.2% of fs
for voltage	0 to 40 V, 0.2% of fs
General data	
Overvoltage protection (OVP)	4.5 to 50 V
AC supply, selectable	95 to 135 V or 190 to 265 V, 47 to 63 Hz, 1600 VA
Dimensions (W x H x D); weight	492 mm x 161 mm x 420 mm; 14 kg

Ordering information

Programmable Power Supply	NGPE 40/40	0192.0332.41

Triple Power Supply NGPT

NGPT 35:

2 × 35 V/1 A and 1 × 7 V/5 A

NGPT 18:

2 × 18 V/2 A and 1 × 7 V/5 A

NGPT 7:

2 × 7 V/5 A and 1 × 18 V/2 A

Photo 40 649

Main features

- Insensitive to RF voltages radiated by device under test or nearby antenna
- Very low PARD (periodic and random deviation) due to linear regulation
- 14 bit resolution
- Precise and stable over wide temperature range
- Simultaneous readout of nominal and actual values of all channels
- Output voltage of all channels simultaneously variable by a percentage value
- Nonvolatile storage of up to six complete setups
- Software calibration via IEEE/IEC bus without potentiometer adjustment
- Coupled protection mode for DUTs which should not be supplied from an asymmetrical voltage source
- Floating outputs, max. 120 V DC
- Remote sensing (0.5 V per lead)
- Soft limits for defined voltage and current limiting
- Hardware overvoltage protection
- Quiet, temperature-controlled fan
- 19" system unit, full system capability via IEEE/IEC bus interface (IEC 625-1/ IEEE 488-2)

Operation

Setting and display

Three displays are provided for indication of the nominal and actual values. A separate display is provided for status information and menu-guided operation.

Variable by percentage

For module testing, NGPT 35 provides the possibility of varying the output voltage of all three channels simultaneously in percent. After selection of the channels to be included in this operating mode, the desired variation can either be set via the numeric keypad or in steps of 0.1%, 1% or 10% using the increment/decrement keys.

Triple Power Supply NGPT

Specifications in brief

Constant-voltage source	**35 V**	**18 V**	**7 V**
Voltage range	0 to 35 V	0 to 18 V	0 to 7 V
Resolution	2.5 mV	2.0 mV	0.5 mV
Deviation of full scale	<0.01%	<0.01%	<0.01%
with ±10% AC supply variation	<0.001%	<0.001%	<0.001%
from 0 to 45°C	<0.005%/°C	<0.005%/°C	<0.005%/°C
with 10 to 90% rated current	0.01%	0.01%	0.01%
Transient recovery time following load variation	75 µs	75 µs	150 µs
Programming time	35 ms	35 ms	35 ms
PARD (V_{rms})	200 µV	200 µV	100 µV

Constant-current source			
Current range	**0 to 1 A**	**0 to 2 A**	**0 to 5 A**
Resolution	0.1 mA	0.2 mA	0.5 mA
Deviation of full scale	<0.02%	<0.02%	<0.02%
with ±10% AC supply variation	<0.002%	<0.002%	<0.002%
from 0 to 45°C	<0.01%/°C	<0.01%/°C	<0.01%/°C
with 10 to 90% rated voltage	0.02%	0.02%	0.02%
Transient recovery time following load variation	10 ms	10 ms	5 ms
Programming time	60 ms	60 ms	60 ms
PARD (I_{rms})	20 µA	20 µA	100 µA

Display			
Voltage measurement	0 to 40 V	0 to 32.7660 V	0 to 8 V
Resolution	2.5 mV	2.0 mV	0.5 mV
Deviation of full scale	<0.01%	<0.01%	<0.01%
from 0 to 45°C	<0.005%/°C	<0.005%/°C	<0.005%/°C
Measurement rate	2 per s	2 per s	2 per s

Current measurement	0 to 1 A	0 to 3,2766 A	0 to 5 A
Resolution	0.1 mA	02 mA	0.5 mA
Deviation of full scale	0.02%	0.02%	0.02%
from 0 to 45°C	<0.01%/°C	<0.01%/°C	<0.01%/°C
Measurement rate	2 per s	2 per s	2 per s

Soft limits			
Voltage range	0 V to 35 V	0 V to 18 V	0 V to 7 V
Resolution	2.5 mV	2.0 mV	0.5 mV
Current range	0 to 1 A	0 to 2 A	0 to 5 A
Resolution	0.1 mA	0.2 mA	0.5 mA

Overvoltage protection			
Voltage range	1.5 to 40 V	1.5 to 25,55 V	1.5 to 10 V
Resolution	100 mV	50 mV	20 mV
Deviation of full scale	<2%	<2%	<2%
Response time	50 µs	50 µs	50 µs

Voltage variation			
Resolution	0.1%	0.1%	0.1%
Range	0 to 35 V	0 to 18 V	0 to 7 V

General data	
AC supply	100/120/220/40 V ±10%, 50 to 60 Hz, 350 VA
Dimensions (W x H x D); weight	492 mm x 161 mm x 514 mm; 16 kg

Ordering information

Triple Power Supply		
	NGPT35	0192.0510.31
	NGPT18	0192.0510.21
	NGPT7	0192.0510.71

DC Power Supply NGSM32/10

0 to 18 V/10 A (20 A)

0 to 32 V/5 A (10 A)

Designed for car electronics applications in service, laboratory and production

Photo 42945

Brief description

DC Power Supply NGSM 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 be used in mobile radio and car hifi applications. Due to its compact design, the unit 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 up to 12 device setups for short tests
- DUT protected against erroneous settings by ON/OFF output key
- IEEE/IEC bus or RS-232-C 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

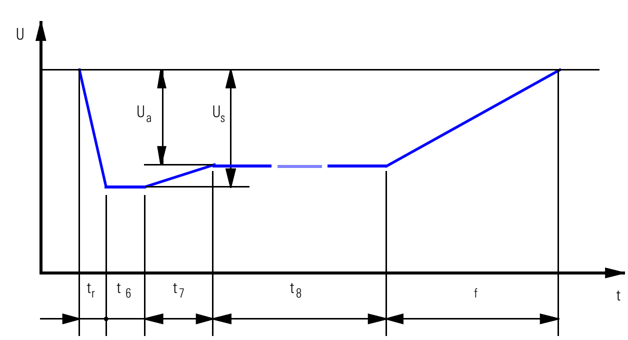
Car electronics
NGSM is a precise and, thanks to its versatility, an extremely economical tool for use in the production of electronics. With the aid of an IEEE/IEC bus or RS-232-C interface (optional), the power supply can readily be integrated into in-line production systems. The startup curve in line with DIN 40839 can be adapted to other factory standards by reprogramming it. High surge currents typically occur in applications such as central locking or ABS, but with a pulse current of up to 30 A, NGSM is ideally prepared for these applications.

Mobile radio systems
Mobile phones are either operated from theit own battery or from the car supply, thus placing specific requirements on the power supply:

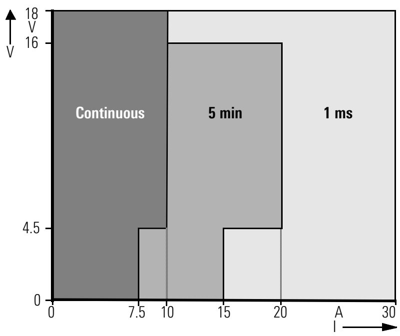
- Ready status should be very long in standby and in transmit/receive mode
- Reliable functioning, even in case of typical onboard supply fluctuations

The high resolution for current measurements allows the maximum operating time of a mobile phone to be accurately predicted; typical voltage drops during the startup of a car can be simulated. DC Power Supply NGSM is insensitive to the RF voltage conducted from a device under test or radiated from a nearby antenna.

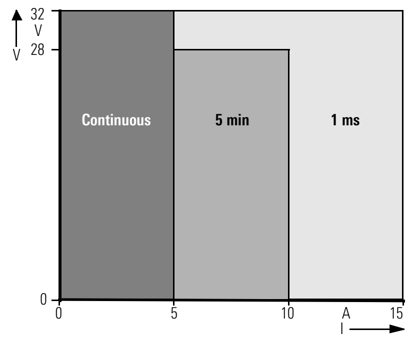
The trend indication of current can be used to check the transmit function of a mobile very simply. The experienced technician will for instance immediately recognize whether a Net-C phone has registered. The peak current measurement allows the achieved transmit power to be indirectly estimated and to detect any malfunctions of the mobile from the ratio of peak current to average value.



Startup curve to DIN 40839



Current loadability in 18 V range



Current loadability in 32 V range

The high power reserve of 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. Equipment for 12 V and for 24 V onboard supplies can 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.

Simple arbitrary generator

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.

NGSM automatically interpolates between two values.

Operation

DC 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 six settings as well as the data of the arbitrary generator can be stored for each voltage range and recalled whenever required. Any faults occurring during operation are immediately displayed and signalled by an acoustic alarm; 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 in brief

Constant-voltage source		
Voltage setting	0 to 18 V	0 to 32 V
Resolution	10 mV	10 mV
Deviation of full scale	<0.4%	<0.2%
with ±10% AC supply variation	<0.01%	<0.01%
between 0 and 45°C	<0.02%/°C	<0.02%/°C
with 10 to 90% nom. current	0.01%	0.01%
Transient recovery time after load variation	0.1 ms	0.1 ms
PARD, V_{rms}	1 mV	1 mV
Constant-current source		
Current setting	0 to 20 A	0 to 10 A
Resolution 0 to 9.99 A	10 mA	10 mA
10 to 20 A	100 mA	100 mA
Deviation of full scale	<0.5%	<1.5%
with ±10% AC supply variation	<0.02%	<0.02%
between 0 and 45°C	<0.05%/°C	<0.05%/°C
with 10 to 90% nom. voltage	0.2%	0.2%
PARD, I_{rms}	20 mA	20 mA
Current loadability		
Continuous current	0 to 10 A*	0 to 5 A
Surge current (max. 5 min)	0 to 20 A*	0 to 10 A
Impulse current (max. 1 ms)	0 to 30 A*	0 to 20 A
	*reduced output currents at V ≤4.5 V	
Display		
Voltage measurement	0 to 40 V	0 to 40 V
Resolution	10 mV	10 mV
Deviation of full scale	<0.2%	<0.1%
between 0 and 45°C	<0.02%/°C	<0.02%/°C
Measurement rate	6/s	6/s
Current measurement in mA range	0 to 199 mA	0 to 199 mA
Resolution 0 to 99.9 mA	0.1 mA	0.1 mA
100 to 199 mA	1 mA	1 mA
Current measurement in A range	0 to 40 A	0 to 40 A
Resolution 0 to 9.99 A	10 mA	10 mA
10 to 40 A	100 mA	100 mA
Deviation of current meas. (mA, A)	<0.5% ±1 LS of rdg	<0.5% ±1 LS of rdg
between 0 and 45°C	<0.1%/°C	<0.1%/°C
Peak current measurement	0 to 40 A	0 to 40 A
Resolution	100 mA	100 mA
Deviation of peak current meas.	<2% of fs	<2% of fs
between 0 and 45°C	<0.2%/°C	<0.2%/°C

General data	
Outputs	max. 120 V DC, floating
Voltage compensation	0.5 V per lead (remote sensing)
AC supply	100/120/220/240 V ±10%, 50 Hz to 60 Hz, 690 VA
Dimensions (W x H x D); weight	211 mm x 150 mm x 350 mm; 8 kg

Ordering information

DC Power Supply	NGSM 32/10	0192.0810.31
Options		
IEC-625/IEEE-488 Interface (listener/talker)	NGSM-B2	0192.0810.02
RS-232-C Interface	NGSM-B1	0192.0810.01
19" Adapter (3 HU, 2.8 kg)	NGSM-B0	0192.0810.00

RF Step Attenuator RSP up to 2.7 GHz (photo 37354)

Contents of Chapter 12

RF Step Attenuators RSP, RSG, RSH, DPSP, DPS

RSP (photo 36277)

Brief description

Attenuator sets are two-port networks providing adjustable attenuation and the same constant characteristic impedance at the input and output.

Switching characteristics (RSP, RSG)
During the switch-on routine the attenuators are set to DC and an attenuation of 40 dB. During switchover between two attenuation values it is ensured that there will be no reduction to lower attenuation values. During switching off the maximum attenuation value is always obtained.

Design (RSP, RSG)
RSP and RSG are accommodated in compact 19" cases. The connectors can be refitted from the front to the rear panel. Since the attenuator module is electrically isolated from the unit itself, the attenuator pads have no ground or AC supply connections.

Main features (RSP, RSG)

- Lifetime >5 x 10^6 switching operations per step
- Low input and output reflection coefficient
- Connectors electrically isolated from chassis ground
- High setting accuracy and switching reliability
- Short setting time of 20 ms
- Residual attenuation taken into account
- Frequency-dependent attenuation correction (RSP)
- Programmable via IEEE/IEC bus

RF Step Attenuator RSG
Attenuation can be set in 1 dB steps from 0 to 139 dB. The low residual attenuation with 0 dB setting can be determined by means of a special function. The attenuation accuracy can be improved by taking into account the correction values which are displayed on the front panel and can be recalled via IEEE/IEC bus.

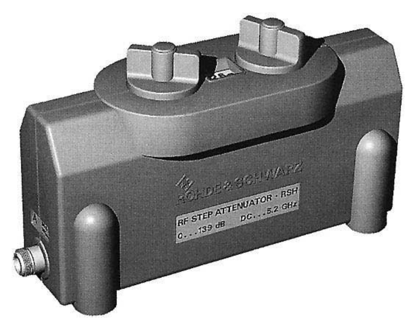
Precision Attenuator RSP
RSP provides attenuation values between 0 and 139.9 dB in the frequency range 0 to 2.7 GHz. Above 1 dB, the smallest step is 0.1 dB. RSP can be used as an attenuator pad from 1 dB to 139.9 dB.

RSH
The attenuation of RSH can be set manually from 0 to 139 dB in 10 dB and 1 dB steps. Operation of RSH is purely mechanical and the model is fully independent of any power supply.

DPSP
RF Step Attenuator DPSP allows manual settings with two rotary switches, the carry being executed automatically. For remote control, DPSP has an IEEE/IEC bus interface and can be used in automatic test systems.

DPSP can be mounted into 19" racks using an adapter. The connectors can be refitted from the front to the rear panel with no change of cables being involved.

DPS
RF Step Attenuator DPS features manual operation and the same electrical characteristics as the programmable DPSP. The desired attenuation is set with decade switches. Built-in batteries, which are charged during AC supply operation, make DPS ideal for all applications where a power cable would be troublesome, eg in servicing and in outdoor measurements.



RSH

DPSP (photo 26970)

DPS (photo 26972)

Specs in brief

Specs in brief	RSG	RSP	RSH	DPSP, DPS
Frequency range	0 to 5.2 GHz	0 to 2.7 GHz	DC to 5.2 GHz	0 to 2.7 GHz
Attenuation range	0 to 139 dB	0 to 139.9 dB	0 to 139 dB	0 to 139 dB
Smallest step	1 dB	0.1 dB (from 1 dB)	1 dB	1 dB
Residual attenuation (0 dB position)	DC ≤0.1 (typ. 0.05) dB ≤1 GHz ≤0.8 (typ. 0.5) dB ≤3 GHz ≤1.2 (typ. 0.8) dB ≤5.2 GHz ≤1.6 (typ. 1.3) dB	DC ≤0.12 (typ. 0.08) dB ≤1 GHz ≤1.2 (typ. 0.8) dB ≤2.7 GHz ≤1.8 (typ. 1.4) dB	DC ≤0.1 dB ≤1 GHz ≤0.7 dB ≤2.7 GHz ≤1 dB ≤5.2 GHz ≤1.6 dB	≤200 MHz ≤0.4 dB ≤1 GHz ≤0.8 dB ≤2.7 GHz ≤1.2 dB
Maximum attenuation error (in dB + % of attenuation value)	≤1 GHz ±(0.2 dB + 1%) ≤3 GHz ±(0.4 dB + 1%) ≤5.2 GHz ±(0.6 dB + 1.3%)	≤1 GHz ±(0.2 dB+ 1%) ≤2 GHz ±(0.3 dB+ 1%) ≤2.7 GHz ±(0.4 dB+ 1%)	≤1 GHz ±(0.2 dB + 1%) ≤2.7 GHz ±(0.4 dB + 1%) ≤5.2 GHz ±(0.6 dB + 1.3%)	±(0.2 dB + 1.3%), max. 1 dB typical: ±(0.1 dB + 0.6%), max. 0.5 dB
Maximum attenuation error with correction		≤0.5 GHz ±(0.05 dB + 0.5%) ≤1 GHz ±(0.1 dB + 0.5%) ≤2 GHz ±(0.15 dB + 1%)	–	–
Correction data stored for each attenuation setting	at 50 MHz intervals	at 50 MHz intervals	–	–
VSWR	≤3.5 GHz ≤1.1 + 0.2 f/GHz ≤5.2 GHz ≤1.8	≤2 GHz ≤1.2 + 0.15 f/GHz ≤2.7 GHz ≤1.5	≤3.5 GHz ≤1.1 + 0.2 f/GHz ≤5.2 GHz ≤1.8	≤1.5 GHz ≤1.1 + 0.2 f/GHz ≤2.7 GHz ≤1.4
Power-handling capacity				
Continuous	1 W	1 W	1 W	1 W
Pulse	200 W/10 µs, max. 150 V	200 W/10 µs, max. 150 V	200 W/10 µs, max. 150 V	200 W/10 µs, max. 150 V
Duty cycle				
Life	>5 x 10^6 switching operations/step	>5 x 10^6 switching operations/step	>1 x 106 switching operations	>5 x 10^6 switching operations/step
Switching time	≤20 ms (atten. not corrected)	≤20 ms (atten. not corrected)	–	≤20 ms
Selftest	checking of correction values	checking of correction values	–	
Power supply	100/120/220/240 V ±10%, 47 to 440 Hz	100/120/220/240 V ±10%, 47 to 440 Hz	–	115/125/220/235 V ±10%, 47 to 440 Hz
Dimensions (W x H x D)	435 mm x 103 mm x 359 mm	435 mm x 103 mm x 359 mm	248 mm x 135 mm x 76 mm	241 mm x 110 mm x 234 mm
Weight	5.5 kg	5.5 kg	1.2 kg	3 kg

Ordering information

	RSG	RSP	RSH	DPSP, DPS
RF Step Attenuator	1009.4505.02	0831.3515.02	1060.6518.02	DPSP: 0334.6010.02 DPS: 0334.7217.02

Extras

RSH	1046.2002.02	microwave cable and adapter set (DC to 26.5 GHz), 1 m, adapter for N male connector
	0358.5414.02	matching Pad RAM (50/75 Ω)

Relay Matrix PSN, RF Relay Matrix PSU

PSN: DC and AF Relay Matrix
for IEEE/IEC bus programming

PSU: DC to 6 GHz
RF Relay Matrix
for IEEE/IEC bus programming

Photo 25290

Photo 25289

Main features

- Six action reed relays and two power relays
- AF and control applications, high loadability
- Easy to operate, LED indication
- Remotely controllable via IEEE/IEC bus
- Fully isolated

Specifications in brief

	Relays 1 to 6	Relays 7 to 8
Connectors	telephone jacks on rear panel	
Contact/insulation resistance	150 mΩ/10^8 Ω	25 mΩ/10^8 Ω
Max. power-handling capacity	30 VA; 20 W (1 A, 110 V)	1 kVA; 100 W (5 A, 250 V)
Switching time	<1 ms	<5 ms

General data

Lifetime	>1000000 switching operations
Power supply	115/125/220/235 V ±10%, 47 to 420 Hz; max. 20 VA
Dimensions (W x H x D); weight	211 mm x 112 mm x 346 mm; 4 kg

Ordering information

Relay Matrix	PSN	0290.9210.02

Main features

- Six independent 50 Ω coaxial relays:
  – three with N connector up to 6 GHz,
  – three with BNC connector up to 500 MHz
- RF and pulse applications
- Easy to operate, LED indication
- Remotely controllable via IEEE/IEC bus

Specifications in brief

	Relays 1 to 3	Relays 4 to 6
Connectors	50 Ω N female on front panel	50 Ω BNC female on rear panel
Frequency range	DC to 6 GHz	DC to 500 MHz
VSWR	<1.22 to 1 GHz	<1.1 to 100 MHz
Insertion loss	0.3 dB to 1 GHz	0.2 dB to 100 MHz
Crosstalk attenuation	>80 dB to 1 GH	>40 dB to 100 MHz
Max. power-handling capacity	100 W at 0.1 GHz 50 W at 1 GHz	1 A at 28 V
Switching time	<25 ms	<7.5 ms

General data

Lifetime	>1000000 switching operations
Power supply	115/125/220/235 V ±10%, 47 to 420 Hz; max. 25 VA
Dimensions (W x H x D); weight	211 mm x 112 mm x 346 mm; 4.8 kg

Ordering information

RF Relay Matrix	PSU	0290.8014.02

Matching Pads, Attenuators, Terminations


DNF (photo 36389)


RBS 1000 (photo 31777)


RDL50 (photo 39853-1)


RNB (photo 27202)


RAU, 100W (photo 33901)


RNA (photo 36390-1)


RAD (RAD50, RAD600), photo 29356


RAM (RAZ), photo 34891-1

Brief description

Attenuators
Attenuators are ideal for use in test setups in which the attenuation values do not have to be frequently changed. Their compact design and ease of handling (easy to replace) makes them also highly suitable for use in mobile test setups.

High-power attenuators
These are used as dummy loads for transmitter and power amplifiers. They have a test output with exactly defined attenuation for the connection of a measuring instrument such as power meter, analyzer or counter.

Terminations
They provide reflection-free termination of instruments and cables and can also be used as a reference impedance for VSWR measurements. In contrast to high-power attenuators, terminations do not have a test output.

Matching pads, feedthrough terminations
Matching pads are used to provide the necessary matching between measuring instruments and transmission lines of different characteristic impedances or as feedthrough terminations for matching 50 Ω lines to measuring instruments of high input impedance.

Specifications in brief/Ordering information for attenuators, terminations, matching pads

Designation	Type Order No.	Characteristic impedance	Power rating	Nominal insertion loss	Frequency range	VSWR	Accuracy of insertion loss	Max. peak pulse voltage	Connectors	Dimensions, weight
Attenuators	DNF 0272.4010.50	50 Ω	2 W 1)	3 dB	0 to 12.4 GHz	≤1.1 (up to 4 GHz) ≤1.2 (up to 10 GHz) ≤1.25 (up to 12.4 GHz)	±0.3 dB up to 8 GHz 2) ±0.5 dB up to 12.4 GHz 2)		N male, N female	20.5 mm dia. x 55 mm, 69 g
	DNF 0272.4110.50			6 dB						
	DNF 0272.4210.50		1 W 1)	10 dB			±0.3 dB up to 8 GHz 2) ±0.6 dB up to 12.4 GHz 2)			
	DNF 0272.4310.50			20 dB			±0.5 dB up to 4 GHz 2) ±0.6 dB up to 8 GHz 2) ±0.8 dB up to 12.4 GHz 2)			
	DNF 0272.4410.50			30 dB			±1 dB up to 12.4 GHz 2)			
High-Power Attenuators	RBU 50 1073.8695.03	50 Ω	50 W 3)	3 dB	0 to 2 GHz	≤1.1	±0.5 dB up to 1.5 GHz ±0.75 dB up to 2 GHz	5 kW (1 µs, 1%)	N male, N female, to MIL-C39012	180 mm x 77 mm x 90 mm, 0.8 kg
	RBU 50 1073.8695.06			6 dB			±0.5 dB up to 1.5 GHz ±0.75 dB up to 2 GHz			
	RBU 50 1073.8695.10			10 dB			±1 dB up to 1.5 GHz ±1 dB up to 2 GHz			
	RBU 50 1073.8695.20			20 dB			±1 dB up to 1.5 GHz ±1 dB up to 2 GHz			
	RBU 50 1073.8695.30			30 dB			±1 dB up to 1.5 GHz ±1 dB up to 2 GHz			
	RBU 100 1073.8820.03	50 Ω	100 W 3)	3 dB	0 to 2 GHz	≤1.1	±0.5 dB up to 1.5 GHz ±0.75 dB up to 2 GHz	5 kW (1 µs, 1%)	N male, N female, to MIL-C39012	236 mm x 140 mm x 141 mm, 2.8 kg
	RBU 100 1073.8495.06			6 dB			±0.5 dB up to 1.5 GHz ±0.75 dB up to 2 GHz			
	RBU 100 1073.8495.10			10 dB			±1 dB up to 1.5 GHz ±1 dB up to 2 GHz			
	RBU 100 1073.8495.20			20 dB			±1 dB up to 1.5 GHz ±1 dB up to 2 GHz			
	RBU 100 1073.8495.30			30 dB			±1 dB up to 1.5 GHz ±1 dB up to 2 GHz			
	RDL50 1035.1700.52	50 Ω	50 W (input), 10 W (output)	20 dB	0 to 6 GHz	≤1.15 (up to 2 GHz)	±0.5 dB	2 kW/5 µs	N male, N female	114 mm x 89 mm x 68 mm, 0.5 kg
	RBS 1000 0207.4010.55	50 Ω	≤1000 W (≤600 W)	40 dB	0 to 0.4 GHz (1 GHz)	≤1.2 input	± 1 dB 4)	10 kW/1 µs	N female	500 mm x 285 mm x 152 mm, 12 kg

Designation	Type Order No.	Characteristic impedance	Power rating	Nominal insertion loss	Frequency range	VSWR	Accuracy of insertion loss	Max. peak pulse voltage	Connectors	Dimensions, weight
Terminations	RNA 0272.4510.50	50 Ω ±1%	1 W[1]		0 to18 GHz	≤1.02 (up to 1 GHz) ≤1.02 + 0.004 x f [GHz]			N male	21 mm dia. x 46 mm, 36 g
	RNA 1028.4994.72	75 Ω	1 W[1]		0 to 3 GHz	≤1.02			N male	21 mm dia. x 46 mm, 65 g
	RNB 0272.4910.50	50 Ω	1 W[1], 2 W peak		0 to 4 GHz	≤1.05 (up to 1 GHz) ≤1.1 (up to 2 GHz) ≤1.2 (up to 4 GHz)			N male	20.5 mm dia. x 35 mm, 36 g
	RAU 0200.0019.55	50 Ω	100 W[5]		0 to 2 GHz	≤1.05 (up to 1 GHz) ≤1.1 (up to 1.5 GHz) ≤1.4 (up to 2 GHz)		2 kV	N female	95 mm x 152 mm x 235 mm, 2 kg
Feedthrough terminations	RAD 0289.8966.00	50 Ω	500 mW[6]		0 to 1 GHz	≤1.05 (up to 0.1 GHz)[7] ≤1.1 (up to 0.5 GHz) ≤1.2 (up to 1 GHz)			BNC male, BNC female	14.5 mm dia. x 50.5 mm, 22 g
	RAD50 0844.9352.02	50 Ω	2 W		0 to 500 MHz	≤1.1 (up to 200 MHz) ≤1.25 (up to 500 MHz)			BNC male, BNC female	15.3 mm dia. x 50.5 mm, 22 g
	RAD600 0844.9452.02	600 Ω			0 to 10 MHz					
Matching pads	RAM 0358.5414.02	50 Ω → 75 Ω	2 W[8]	5.72 dB	0 to 2.7 GHz	≤1.06 (up to 2 GHz) ≤1.2 (up to 2.7 GHz), both terminals	+ 0.15/–0.05 dB		N male, N female on 75 Ω end	21 mm dia. x 73 mm, 105 g
	RAZ 0358.5714.02			1.76 dB		≤1.06 (up to 2 GHz) ≤1.2 (up to 2.7 GHz), at 75 Ω terminal	± 0.2 dB			

[1] At a max. ambient temperature of 30 °C; decreasing linearly to 0 W at 130 °C.
[2] Attenuation change at a temperature change of 1 K: ≤0.0001 dB/dB. At a load change of 1 W: ≤0.001 dB/dB.
[3] Continuous load up to a max. ambient temperature of 20 °C, decreasing linearly to 0 W at 125 °C; power-handling capacity at output up to 20 W.
[4] The frequency response of the insertion loss is specified on a label on RBS1000 as 0.1 dB measurement error.
[5] Overload capacity 100% (max. 5 s).
[6] Continuous load up to a max. ambient temperature of 70 °C; decreasing linearly to 0 W at 130 °C.
[7] Measured with open-circuit output.
[8] Ambient temperature 25 °C.

Junction Boxes/Power Splitters

Photo 27807

Photo 27603

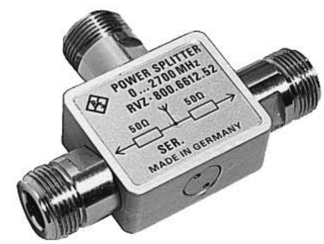


Photo 35789

Power Splitter/Combiner DVS

- Distribution or combination of signals
- High isolation between inputs
- Low insertion loss

Specifications in brief

Frequency range	0.1 to 400 MHz
Characteristic impedance	50 Ω
VSWR	typ. 1.2 dB
Insertion loss	typ. 3 dB
Isolation between inputs	20 to 40 dB
Max. continuous load	1 W = 7 V into 50 Ω
Dimensions	57 mm x 36 mm x 41 mm

Ordering information

Power Splitter/ Combiner	DVS 0342.1014.50

Four-Port Junction Box DVU4

- Four-port junction box for splitting up into or combining three channels with correct impedance matching
- For use eg in 3-signal measurements on radiotelephone equipment

Specifications in brief

Frequency range	0 to 1500 MHz
Characteristic impedance	50 Ω
VSWR	<1.1 (up to 1 GHz) typ. 1.2 (up to 1.5 GHz)
Insertion loss	9.5 dB
Max. load per connector	0.25 W
Max. permissible voltage spikes	300 V
Connectors	N female
Dimensions	120 mm x 120 mm x 35 mm

Ordering information

Four-Port Junction Box	DVU4 0201.4018.03

Power Splitter RVZ

- Power distribution to signal paths of exactly the same waves
- Measurement of correct transmission factor (reference: forward wave)

Specifications in brief

Frequency range	0 to 2700 MHz
Characteristic impedance	50 Ω
VSWR	≤1.1
Level deviation of outputs	≤0.1 dB
Phase deviation of outputs	≤2°
Insertion loss from input to each output	6 dB –0.1/ +0.5 dB
Power-handling capacity	1 W
Connectors	N female
Dimensions	47 mm x 70 mm x 16 mm

Ordering information

Power Splitter	RVZ 0800.6612.52

Adapters for RF Connectors

All RF connectors can be adapted for use in other systems by means of screw-in connectors, see table on the right. The maximum power values for frequencies other than 1000 MHz are obtained by means of the following formula:

$$P_{max} = P_{(1\,GHz)}/\sqrt{f_{(GHz)}}$$

Conversion to	Male connector	Female connector	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
7/16	017.9258.00	017.8739.00	1.0 kW

Coaxial Components

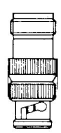
Brief description

Measuring instruments from Rohde & Schwarz are fitted with internationally used standard connectors. Depending on the requirements (frequency range, power rating, reflection characteristics, etc), connector systems N, PC-3.5 or BNC are used.

The following overview also shows the most frequently required couplings, angle junctions and T connectors.

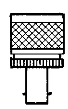
Note
Order numbers are bold-faced.

Adapters to systems of other make



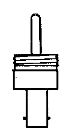
50 Ω
N female/
BNC male

0541.8030.00



50 Ω
N male/
BNC female

0118.2812.00

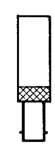


Screw-in connector
4/13 male/
BNC female

0017.5975.00

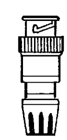
4/13 female/
BNC male

0408.4509.00



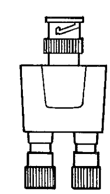
4/13 male/
BNC female

0408.4480.00



BNC male/
knurled terminal

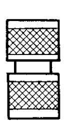
0541.8030.00



BNC male/
dual knurled terminal

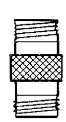
0017.6742.00

Couplings, angle junctions and T connectors, 50 Ω



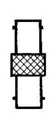
N
male/
male

0092.6581.00



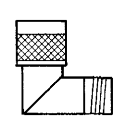
N
female/
female

0092.6700.00



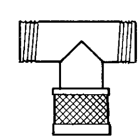
BNC
female/
female

0017.6559.00



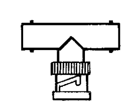
N
male/
female

0018.4495.00



N
female-female/
male

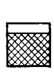
0018.4537.00



BNC
female-female/
male

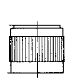
0017.6588.00

Shortcircuits



N connector
(male)

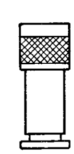
0017.8080.00

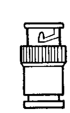


N connector
(female)

0017.8145.00

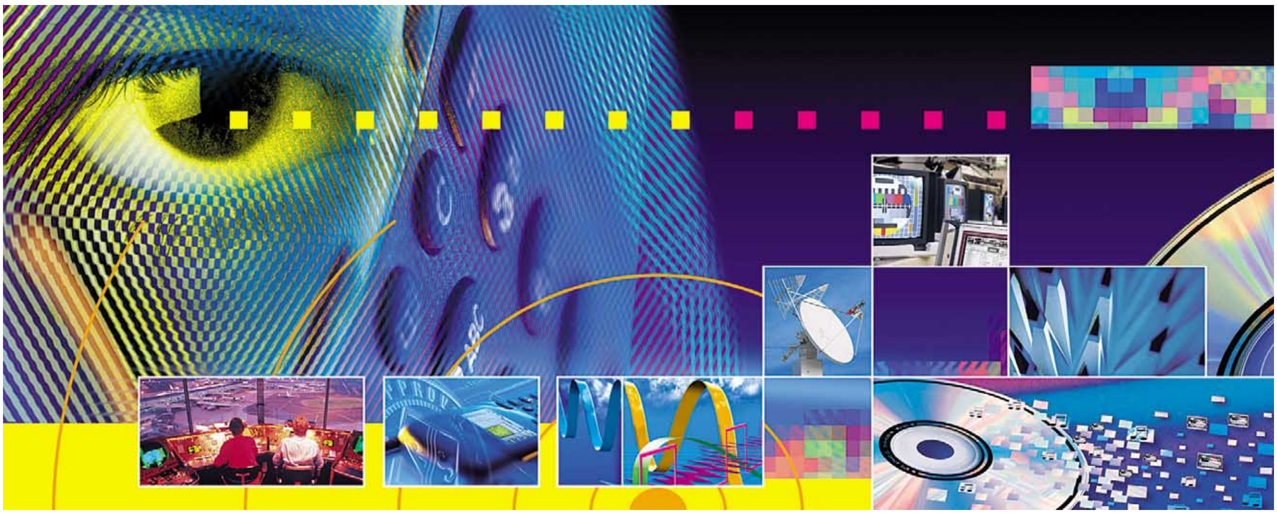
Cable-mounting connectors (male)





For cable	N, 50 Ω	BNC, 50 Ω
RG 58 C/U	**0472.9714.00**	**0017.6536.00**
RG 8/213/214U	**0415.9502.00**	**0017.6442.00**

Rohde & Schwarz Customer Service



Contents of Annex

Documentation – medium between man and technology

Technical documentation from Rohde & Schwarz prepared to customer's order - also for non-R&S products

- Review and appraisal of existing documentation for compliance with standards and guidelines
- Operating instructions and user's guides
- Maintenance instructions
- Service and calibration instructions
- Repair instructions
- Fault diagnosis instructions
- Leaflets
- Brochures
- Data sheets
- Materials management concepts
- Technical manuals
- Design drawings with 2D and 3D illustrations
- Spare parts catalogs and illustrated spare parts lists
- Program-controlled input and printout of modular documents
- Training documentation

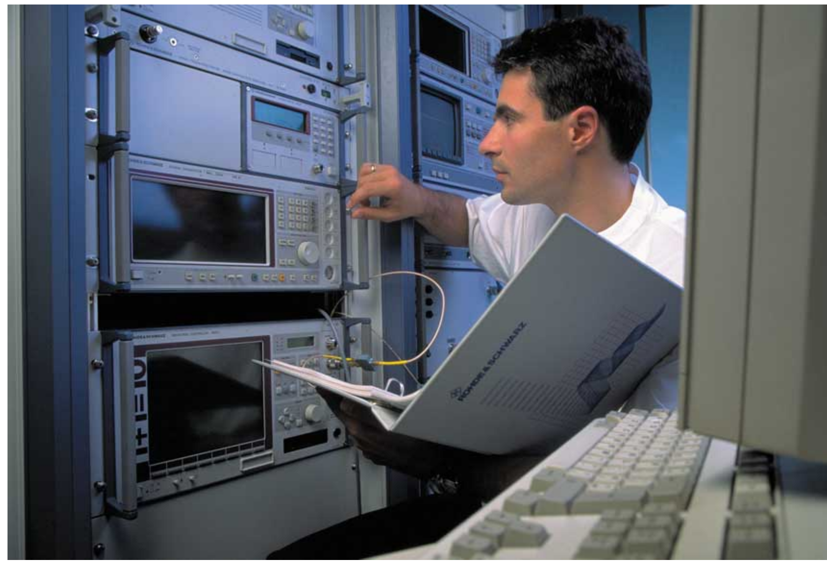


Photo 43499-III-1

Keeping pace with new requirements

Laws, standards and directives place high demands on technical documentation. We guarantee that the documentation prepared by us conforms to all relevant standards, directives, regulations and laws, including for instance the

- EU directives for
  - machinery
  - low voltage
  - EMC
- medical products law
- EN, ISO and VDI specifications
- DIN specifications
- product liability law
- product safety law
- multimedia law

New tools for your technical documentation

Your documentation will be tailored to your specific needs. We undertake the complete project handling through to the finished data medium.

More than just a translation

Our translations cover all fields of activity of our company. Technical documentation is translated into any desired language mainly by native speakers. The texts are translated technically correctly and edited. The result is a comprehensible, reliable and accurate match of your original documentation.

Drawing on qualified sources

Our staff at the Cologne Plant has a solid background of experience and know-how. This is the result of close cooperation with headquarters ranking among the market leaders worldwide in the fields of communications and test and measurement, as well as of numerous projects handled for other branches of industry. Benefits are also gained from the broad range of services provided by the Cologne Plant, including maintenance and repair, calibration, generation of special software, training and over 30 years of experience in documentation. We are always technically up to date. This is ensured by our participation in standardization bodies and joint ventures with leading international companies, by our intensive R&D work as well as by holding or attending lectures at universities and institutes of technology.

Documentation – medium between man and technology

This up-to-date technical know-how is of course also a benefit for product documentation where our staff can provide valuable information and recommendations.

Photo 43546-II-1

Documentation just in time

Market success is also determined by the "time to market". This means: if development and documentation take place simultaneously, time to market can be reduced substantially. Therefore we can make available on request an expert or whole team to support you on site in generating optimized documentation just in time in close cooperation with your specialists.

Documentation as you like it

You choose the hardware and software to be used for generating, storing and duplicating your documentation. The technical documentation furnished by us can easily be revised or completed – of course also by your staff. The documentation you receive is your individual solution: a manual, an illustrated catalog, detailed operating instructions – as a hardcopy, disk, tape, microfiche or CD-ROM.

Further support provided by Rohde & Schwarz

- Logistics concepts
- Material maintenance concepts
- Repair concepts
- Spare parts stockkeeping concepts
- Equipment layout diagrams
- Integrated logistics support
- Illustrated spare parts catalog (complying with B007, C-1-4, SPEC 2000, ATA DMKL, NATO guidelines)
- Electronic spare parts management, spare parts catalogs, materials lists
- Electronic information systems
- 3D illustrations, exploded views

Photo 43546-IV

- Generation of circuit diagrams, block diagrams to standard
- Design drawings to DIN
- Generation of home pages for Internet
- Generation of documentation in SMGL or HTML format
- Online documentation
- Database programming and design
- Multimedia productions eg for maintenance, service, marketing and sales
- Multimedia product presentations including trainer or simulator
- Storage on CD-ROMs

Get in touch with us

Call us and put our competence to the test. We shall be glad to provide you with any further information.

Rohde & Schwarz Cologne Plant
Telephone: +492203 49-51246
Telefax: +492203 49-51364

Photo 43546-II-2

Training

Committed cultivation of market and customer as well as the continuous training of your staff will ensure competitiveness of your company in the present and in the future

Photo 43544-I

Welcome to our training courses

Electronics as a basic technology calls for highly qualified staff. Rohde&Schwarz offers basic training, seminars, retraining, and training on instruments and systems in line with customer's requirements.

We provide our customers with what will be increasingly important in the future: practical training, transfer of know-how, helping you to help yourself. Our seminars are constantly being adapted to meet these objectives and to offer up-to-date solutions to your measurement problems.

Small groups for optimum results
The number of participants is limited for all seminars. This makes for enhanced receptivity and allows an intensive dialog between the trainees and the trainer. Thus, knowledge can be passed on at greater depth, and individual problems can be dealt with in greater detail. In most seminars, the emphasis is on practical exercises performed on modern test equipment, since this is the most efficient way of learning.

Photo 43544-IV

Training

Our training staff
Our communications, electrical and software engineers and physicists provide you with the knowledge you actually require. Having the latest know-how and many years of experience is one thing, being able to pass this on in an interesting and comprehensible way is another.

We therefore attach utmost importance to the qualified didactic training of our engineers picked to be your lecturers and trainers. Where appropriate and necessary, we call in lecturers from universities, authorities and from among users. We want to make sure that our customers have the best trainer available.

Photo 43544-III

Training courses kept up to date
All seminars are constantly reviewed and improved and new knowledge and relevant changes taken into account immediately. This guarantees that the technical know-how as well as the regulations and standard specifications presented to you are always up to date.

Rohde & Schwarz standard seminars
In our seminars your measurement problems, and not the Rohde & Schwarz test assemblies, are given top priority. Our training programs are structured so that both newcomers and specialists will find a seminar suiting their requirements.

Customer-specific seminars
We offer customized seminars for training tasks to be performed at your company. This starts with an analysis of the learning objectives and target group in the conceptual phase, which is followed by a proven methodical approach. This ensures an optimum benefit/cost ratio and avoids burdening the courses with unnecessary information. Within the framework of these seminars, we also offer special user and application courses for Rohde & Schwarz instruments to allow an even more time-saving and efficient use.

Training sites

Training courses are held at Rohde & Schwarz headquarters in Munich, at the Cologne Plant, our branch offices and representatives and at the customer's.

Training at Rohde & Schwarz
Highly qualified personnel and a complete range of measuring instruments and teaching aids make each seminar a success. Here you can get acquainted with state-of-the-art measurement and communications technology from Rohde & Schwarz.

Seminars at the customer's
You want to train several staff members at a time? To put learned matter into practice immediately? To solve specific problems within your own organization? To leave travelling to us? In this case we hold seminars at your company. These may be standard Rohde & Schwarz or customized seminars.

Ask for information on our seminars

Training Center Munich
Our brochure provides detailed information on the contents, dates, prices and other terms of our seminars.
Telephone: +4989 4129-13051
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Training Center Cologne
Our training brochure gives you an overview of the seminars held at the Cologne Plant.
Telephone: +492203 49-51271
Telefax: +492203 49-51285

For information on seminars held in other cities or at the customer's or seminars held in English please contact our sales offices (see address list on page 462).

Photo 43544-V

Worldwide Service Network

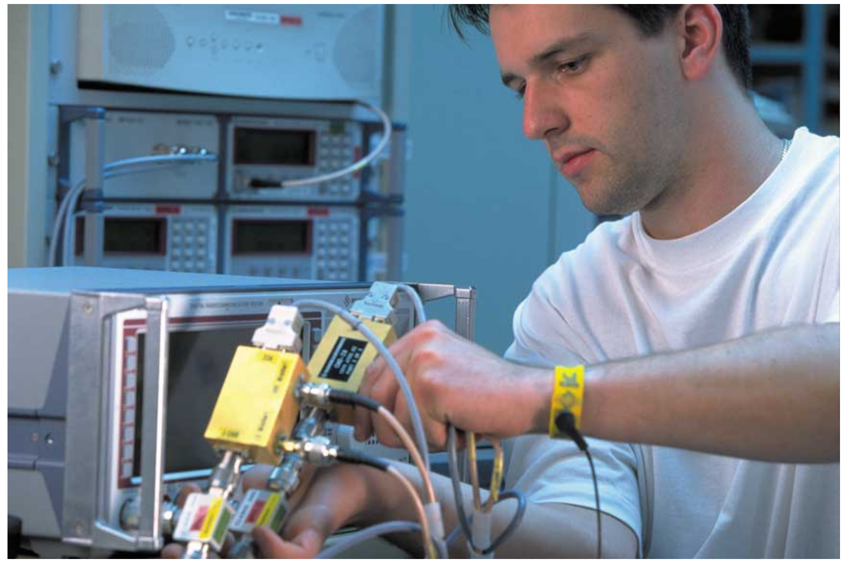

Photo 43498-IV-1

Rohde & Schwarz produces test & measurement equipment of the highest quality for a wide range of applications in research, development, production and service

International Service

To ensure the longterm quality of its equipment under extreme conditions of use, Rohde & Schwarz maintains a worldwide service network

A multi-level and decentralized concept ensures that all equipment and systems from Rohde & Schwarz can be fully serviced by local centers and only have to be sent elsewhere in exceptional cases. The concept is based on three hierarchical competence levels that are available to all Rohde & Schwarz customers.

Local Rohde & Schwarz service centers worldwide are the competent and easy-to-contact partners on the spot

Usually they are local Rohde & Schwarz representatives. And the services they offer primarily focus on local requirements.

The majority of these local service centers are equipped with standardized test and calibration systems of the ACS100 series to satisfy requirements for automatic diagnostics, fast repair and calibration.

Even where the use of automatic test and calibration systems is not yet economically attractive because too little equipment is in the field, all Rohde & Schwarz customers can still expect excellent service and utmost competence in the areas of video, RF and microwave technology. Because that is what the name Rohde & Schwarz stands for.

Efficient area support centers provide technical and logistics backup for local service centers

Located in the major industrial regions of the world, these area support centers can assist at virtually any level.

The two Rohde & Schwarz service centers in Cologne and Munich are the backbone of the worldwide service network

The tasks of these two centers include wide-ranging support, training at regular intervals and centralized stocking of spare parts. The Cologne and Munich service centers of course also provide on-site calibration, maintenance and repair of equipment and systems at the customer site.

Minimum downtimes

A large variety of services are offered by the worldwide centers of Rohde & Schwarz, with the aim of ensuring all customers maximum availability of Rohde & Schwarz equipment and systems. Especially in safety-critical fields (e.g. in medicine or aviation) or in cost-intensive production, Rohde & Schwarz customers have to rely on the precision of their products.

Qualified Service Staff

Rohde & Schwarz customers expect the same high standard from any Rohde & Schwarz service center worldwide

Rohde & Schwarz meets these expectations by extensive and continuous training of its staff and internal auditing of international service centers

Only those successfully meeting the stringent quality requirements may offer services in the name of Rohde & Schwarz.

Rohde & Schwarz service locations
The shortest distances mean the fastest response, so the worldwide Rohde & Schwarz service network features on the Internet. Our customers can find all facilities and services offered at www.rohde-schwarz. And when it is needed, the Rohde & Schwarz team is just a mouse click away.

Photo 43499-I-1

Service by contract
T&M equipment and systems from Rohde & Schwarz guarantee utmost precision to every user. To maintain this guarantee reliably and permanently under any conceivable conditions of use, equipment and systems have to be inspected and serviced at regular intervals.

Depending on the scenario and the environment in which the equipment and systems are used, Rohde & Schwarz offers services tailored to specific customer needs:

- Calibration contract
- Maintenance contract
- Repair service contract

For all Rohde & Schwarz customers this means service at its best as well as maximum operational reliability of their equipment and systems.

Local service centers are the competent partners to be contacted for determining and implementing service tailored to the customer's specific requirements.

Rohde & Schwarz service training
Rohde & Schwarz measuring instruments are high-tech products of outstanding precision. All Rohde & Schwarz service teams undergo continuous training so that they are able to properly service and repair complex equipment. In-house training covers the latest product developments, state-of-the-art technologies and procedures to ensure the best qualifications for all Rohde & Schwarz service staff worldwide. Rohde & Schwarz customers can be sure that only experienced and highly qualified personnel will service our products.

External participants may also profit from Rohde & Schwarz know-how. Customized training courses are available on the maintenance and repair of various products. This enables the user to carry out servicing and maintenance of instruments largely on his own. This is a special benefit if equipment is operated in remote regions of the world, for instance, without direct availability of a Rohde & Schwarz service engineer.

Quality Assurance through Calibration

Modern quality management systems such as DIN EN ISO 9000 ff require the use of traceable calibrated measurement systems in development, production and service

The use of traceable calibrated instruments is gaining in importance especially in production in view of more stringent product liability regulations

Calibration system ACS 100

Rohde & Schwarz calibration laboratories
The laboratories maintained worldwide by Rohde & Schwarz carry out calibration to customer order. Calibration certificates in line with international regulations or standards are issued to document this service. Traceability to nationally or internationally recognized standards is guaranteed. Test parameters for which national standards are not available are traced to basic parameters by means of approved methods.

Calibration carried out by Rohde & Schwarz is of the highest quality
In addition to its worldwide local service centers, Rohde & Schwarz maintains calibration laboratories of the German Calibration Service (DKD) on its premises in Cologne, Memmingen and Munich. These laboratories are accredited by the German Standards Laboratory (PTB) in line with DIN EN 45001 and are subject to continuous supervision by the accrediting authority.

With the aid of its mobile DKD calibration lab, the service center in Cologne also carries out on-site calibrations.

Standardized calibration systems
Since 1996 the global Rohde & Schwarz service centers have been using the standard calibration system ACS 100. About 50 of these systems are currently installed at all major service centers all over the world.

The ACS 100 calibration system features:

- Precision
- Suitability for mobile use
- Worldwide standard test and calibration methods
- Automatic test run
- Uniform test report
- Universal use

Fast Spare Parts Supply Service Addresses

Even the best equipment can fail sometime. And then you are thankful if replacement of faulty parts can be guaranteed fast. More than 30,000 different spare parts are centrally stored by Rohde&Schwarz in Munich

For the customer, this modern warehousing and logistics hub means extremely fast spare parts availability virtually anywhere in the world Rohde & Schwarz equipment is highly modular, which saves time and cuts costs if repair is needed. Rohde & Schwarz guarantees longterm spare parts availability also for older modules and systems.

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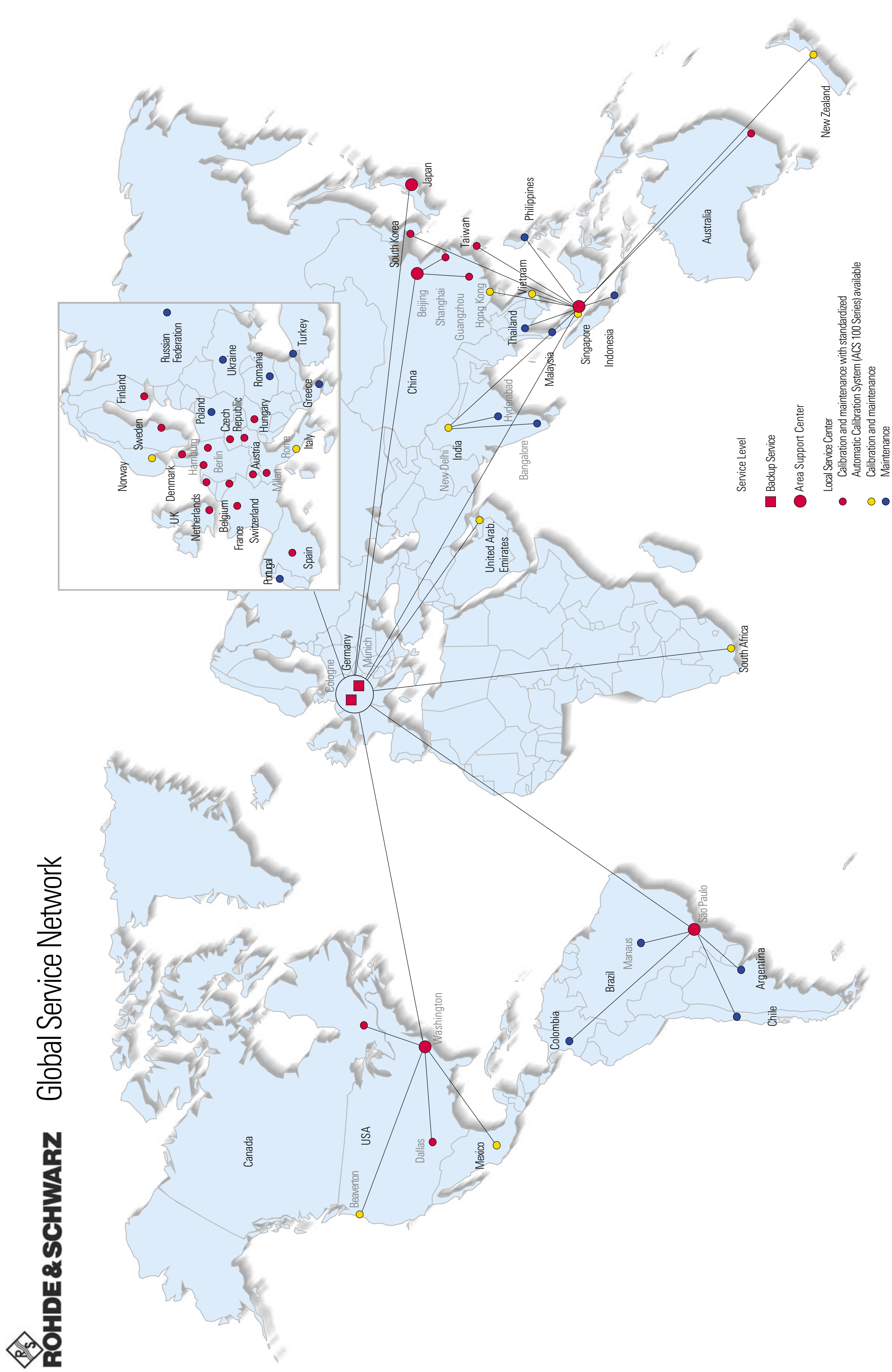
ROHDE&SCHWARZ
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Poland
Hungary
Rome
Italy
Greece
Romania
Ukraine
Russian Federation
Turkey
Service Level
Backup Service
Area Support Center
Local Service Center
Calibration and maintenance with standardized Automatic Calibration System (ACS 100 Series) available
Calibration and maintenance
Maintenance

Integrated customer support at Rohde&Schwarz

Financing

Rohde & Schwarz offers a variety of financing schemes based on rental and leasing contracts that allow the acquisition of test & measurement equipment at the time it is needed. Required T&M products are thus available fast and easily without any strain being placed on your liquidity.

Rental agreement with purchase option
You need an instrument only temporarily? Or you are not sure if an instrument is to be purchased at a later date? Or you have to bridge a momentary financial bottleneck? In such cases a rental agreement with purchase option is an ideal solution: you can rent an instrument for a period between six and 36 months, and buy the instrument after min. three and max. 30 months after the beginning of the rental agreement. If you buy the instrument, 75% of the paid rent will be credited against the price.

Leasing
Leasing is common practice in today's business transactions especially as far as medium-term investments are concerned. The lease of instruments expands your financial scope for implementing other, long-term investments, for instance a planned extension of your plant.

We are cooperating with well-established companies and can offer you a broad spectrum of leasing schemes. You can profit from state-of-the-art measuring equipment and systems from Rohde&Schwarz without binding your finances. This makes it possible to realize necessary investments immediately if budgets are tight and acquisitions would normally have to be postponed to the next fiscal period.

And, another important point: leasing is an interesting alternative also in terms of taxation since leasing payments are immediately and fully tax- deductible for example in Germany.

Service contracts

Repair service contract
Admittedly, not even equipment from Rohde&Schwarz is completely safe from failure. We therefore offer a repair service contract which you can conclude already at the time of purchasing your instrument so as to profit from this Rohde & Schwarz service right from the start and on the most favourable terms. The repair service contract extends the standard warranty period to three years. The contract price covers all services necessary to restore the instrument to proper operating condition.

Calibration and maintenance contract
In addition to the repair service contract for new equipment, Rohde & Schwarz offers a calibration and maintenance contract for the most common instruments and test antennas. Please direct your inquiry to:

Central Service Munich
Telefax: +4989 4129-13275

Application notes

Free-of-charge publications
Measuring instruments from Rohde & Schwarz are small, highly complex systems in themselves. They can be used for a variety of applications. The data sheets only cover a small selection of possible applications. Our application engineers are constantly working out solutions to new measurement problems and describing them in application notes. These notes are available to you free of charge. For some applications, we also offer a special software at a small nominal charge. Please contact your local Rohde & Schwarz representative.

Our hotline team (photo 43448)

Demo units

Rohde & Schwarz offers demo units at very favourable prices. These units have been in use very little, if at all, and are in an excellent condition. As a matter of course, the instruments are checked through before leaving our factory, and Rohde & Schwarz gives full warranty. Your local Rohde & Schwarz representative will be glad to inform you of available instruments.

Support center

Whatever your problem, our support center is there to help you. Your question will be dealt with fast and in detail, or a competent partner will be found for your problem. The staff of our support center is optimally trained to assist you in solving your problems.

- You are looking for a special type of instrument?
- You need competent support in the implementation of remote control concepts for test equipment for use in production?
- You have a question regarding the operation of equipment?
- Or you just want to find your local sales partner in order to take a look at our equipment?
- And so on ...

Just call our support center, and we will be glad to assist you. You can get in touch with us in the following ways:

Telephone
+49180 512 4242

Fax
+4989 4129-13777

E-mail
CustomerSupport@rohde-schwarz.com

The support center can work out a solution together with you for any aspect relating to the operation, programming and also applications of T&M equipment from Rohde & Schwarz or Advantest. You can rely on the technical expertise of our personnel.

In cases where an immediate answer is not possible, your time will not be wasted with unnecessary calls but the support center will record your problem and find a competent partner to get back to you.

Try us
Our support center can certainly help you. It is your hotline.

+49 180 512 4242

Your local partner remains
If you are already in contact with Rohde & Schwarz, your local sales office will of course remain the first partner to get in touch with as it is more familiarized with your specific requirements and applications than the support center, and will know right away how to give you the fastest support.

Cabinets, designs

Dimensions

The dimensions of Rohde & Schwarz instruments are specified as follows:

Overall width x height x depth in mm, looking onto the front panel (this also holds for pocket-size instruments). Dimensions generally refer to bench models.

Cabinet designs

Cabinet design must meet all the criteria that mature electronic packaging has to fulfill. Changing requirements regarding technology and environment call for new cabinet designs and systems.

Rohde & Schwarz uses the following two design forms for its products:

- design 2000 (BW2000)
- compact design 90 (KB90)

Rackmounting

Rohde & Schwarz instruments in the above cabinet design can be mounted into 19" racks with the aid of appropriate adapters. It may be necessary to retrofit the racks accordingly.

Design 2000 (BW2000)

Design 2000 is a standardized cabinet system suitable for bench models, for mobile use and for mounting in 19" racks. With only a few basic elements, a variety of cabinets can be implemented from one to five height units and in different widths and depths.

Design 2000 (photo 42980-3)

With the

- iF Product Design Award 1998

and

- iF Ecology Design Award 1998

DESIGN AWARD WINNER 1998
INDUSTRIE FORUM DESIGN HANNOVER

received from Industrie Forum Design Hanover, design 2000 has been attested excellent design that takes account of all environmental and recycling criteria for product design.

Construction

The sturdy construction of design 2000 essentially consists of a chassis, an enclosure, feet and front handles.

The chassis is made up of an aluminium-cast front frame and a sheet-metal module support including rear panel. To enclose the instrument, the enclosure is slid over the chassis from the rear and fixed by means of rear-panel feet with elastic pads. The bottom feet with anti-slide protection are screwed to the enclosure and serve at the same time as a locking device for stacking units.

Compared to previous designs, design 2000 features further improved shielding. The few interfaces between the cabinet parts can be sealed with braided cords and spring strips where required.

Options

The cabinets can optionally be fitted with side handles and tilt feet. Special shock-absorbing parts for the front and rear panel as well as a swivel carrying handle that can also be used as a stand are available for mobile use.

Cabinets, designs

Compact design 90 (KB 90)

Construction

The design 90 cabinet consists of a self-supporting aluminium-cast frame with front and rear panels and top and bottom covers which make up the panelling. The panelling is fixed and the instrument thus enclosed by screwing two feet (4 screws) to the rear panel. The cabinet is completed by attaching feet at the bottom and on the sides. Depending on the type of equipment, one or two carrying straps fixed on the sides make for portability of the instruments.

The tilt stands at the bottom allow the instrument to be set up in a position for convenient operation.

System compatibility

The compact units of design 90 can be stacked with each other as well as with 19" units of previous designs. The bottom feet serve for stacking the units to form a system.

Transit Cases ZZK-9x

Transit cases made of an aluminium composite material are available for all cabinet sizes of compact design 90. Reinforced rounded corners and edges ensure high stability and protection against knocks. Locks and handles are recessed for safety. The cases are dust-proof and splash-proof to DIN 40050 with IP54 type of protection and are suitable for airfreight and express freight.

Photo 38536-3

The compact cabinets of design 90 can be stacked not only with one another but also with19" cabinets of the preceding cabinet designs (photo 35053-4)

Dimensions, ordering information

Instrument size	Inner dimensions of case (mm) (H x W x D)			Weight (kg)	Type	Order No.
2HU, 1/2, 350	211	329	507	7.3	ZZK-973	1013.9143.00
2HU, 1/2, 460	211	329	619	8.5	ZZK-974	1013.9150.00
3HU, 1/2, 350	256	329	507	8.0	ZZK-983	1013.9172.00
3HU, 1/2, 460	256	329	619	9.3	ZZK-984	1013.9189.00
4HU, 3/4, 350	300	438	507	10.0	ZZK-993	1013.9237.00
4HU, 3/4, 460	300	438	619	11.6	ZZK-994	1013.9243.00
1HU, 1/1, 350	166	546	507	8.5	ZZK-913	1013.9266.00
1HU, 1/1, 460	166	546	619	9.8	ZZK-914	1013.9272.00
2HU, 1/1, 350	211	546	507	9.2	ZZK-923	1013.9295.00
2HU, 1/1, 460	211	546	619	10.7	ZZK-924	1013.9308.00
2HU, 1/1, 570	211	546	731	12.0	ZZK-925	1013.9314.00
3HU, 1/1, 350	255	546	507	10.0	ZZK-933	1013.9320.00
3HU, 1/1, 460	255	546	619	12.0	ZZK-934	1013.9337.00
3HU, 1/1, 570	255	546	731	13.0	ZZK-935	1013.9343.00
4HU, 1/1, 350	299	549	507	10.8	ZZK-943	1013.9350.00
4HU, 1/1, 460	299	549	619	12.4	ZZK-944	1013.9366.00
4HU, 1/1, 570	299	549	731	14.0	ZZK-945	1013.9372.00
5HU, 1/1, 350	343	549	507	11.6	ZZK-953	1013.9389.00
5HU, 1/1, 460	343	549	619	13.3	ZZK-954	1013.9395.00
5HU, 1/1, 570	343	549	731	14.5	ZZK-955	1013.9408.00
6HU, 1/1, 350	392	558	507	12.4	ZZK-963	1013.8682.00
6HU, 1/1, 460	392	558	619	14.2	ZZK-964	1013.8682.00
6HU, 1/1, 570	392	558	731	15.5	ZZK-965	1013.8682.00

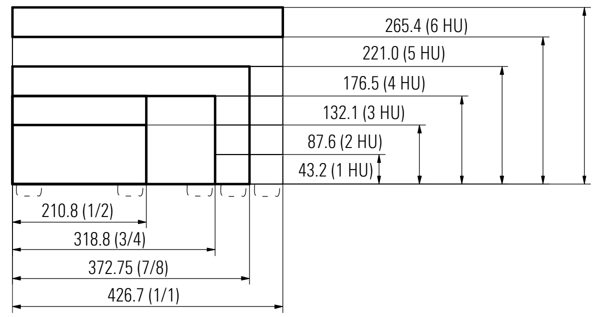
Cabinets, designs

Installation in 19" Racks

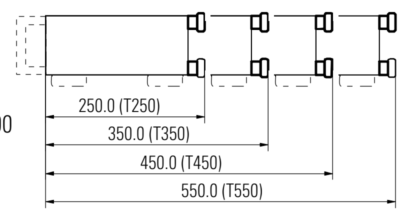
Rohde & Schwarz instruments of design 2000 or compact design 90 can be installed in 19" racks with the aid of appropriate adapters. It might be necessary to retrofit the racks accordingly.

With the 19" adapters from Rohde & Schwarz a wide variety of rackmounting combinations can be implemented, even different types of cabinet can be combined (1/2 width).

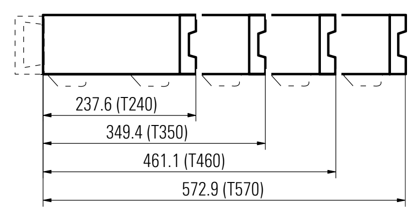
Additional adapter sets are available for rack-mounting by means of telescopic rails. For mounting the appropriate 19" adapter all that is required is to remove a few elements, e.g. the instrument's feet. The scope of supplies includes comprehensive mounting instructions plus the mechanical parts and fixing elements.



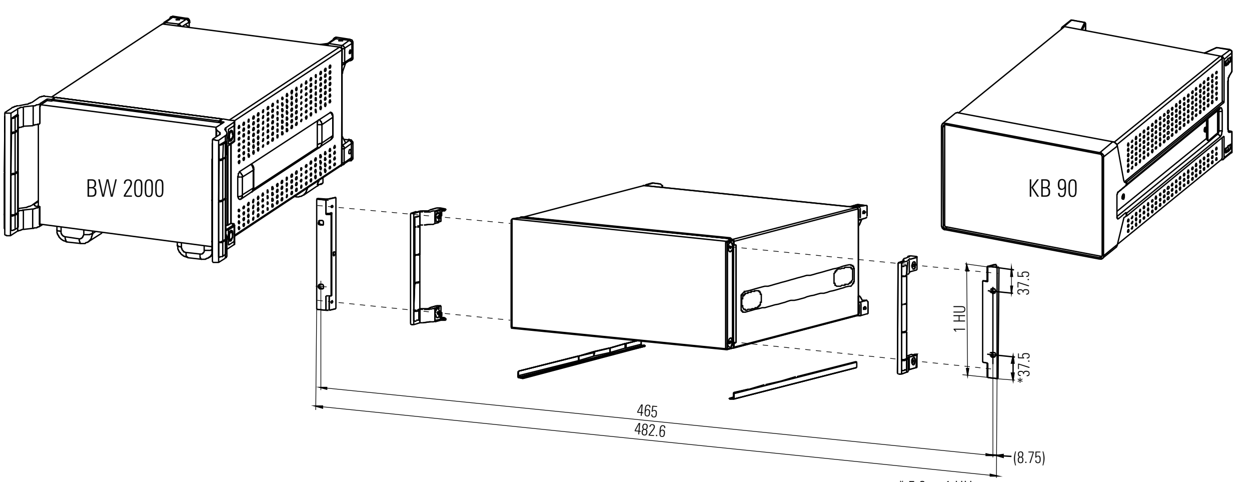
BW 2000



KB 90



19" adapter for 1/1 cabinets



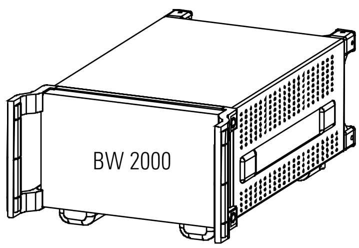
* 5.8 at 1 HU

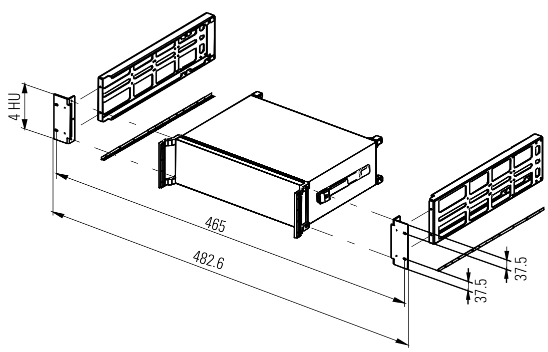
E	Type	Order number
1	ZZA-111	1096.3254.00
2	ZZA-211	1096.3260.00
3	ZZA-311	1096.3277.00
4	ZZA-411	1096.3283.00
5	ZZA-511	1096.3290.00

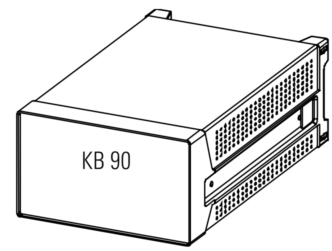
E	Type	Order number
1	ZZA-91	0396.4870.00
2	ZZA-92	0396.4886.00
3	ZZA-93	0396.4892.00
4	ZZA-94	0396.4905.00
5	ZZA-95	0396.4911.00
6	ZZA-96	0396.4928.00

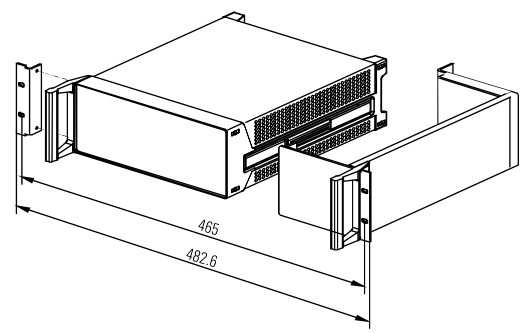
Cabinets, designs

19" adapter for 3/4 cabinets





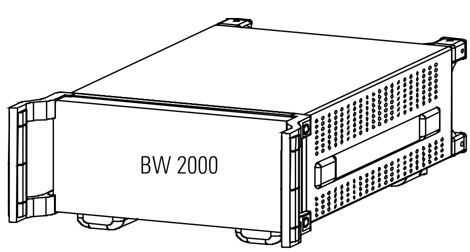


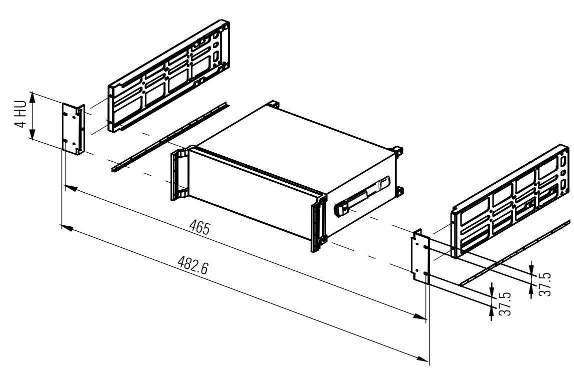


E	Type	Order number
3	ZZA-334	1096.3219.00

E	Type	Order number
4	ZZA-99	0839.5775.00

19" adapter for 7/8 cabinets



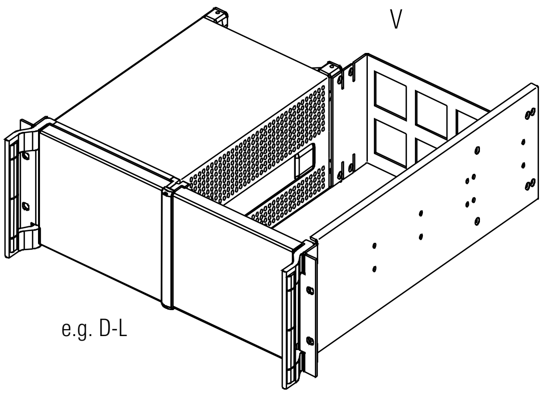


E	Type	Order number
4	ZZA-478	1096.3248.00

Cabinets, designs

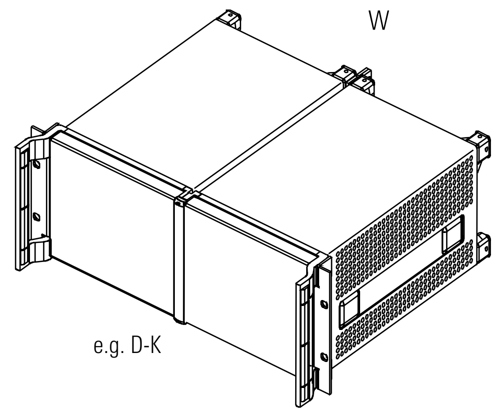
19" adapter for 1/2 cabinets

Possible combinations



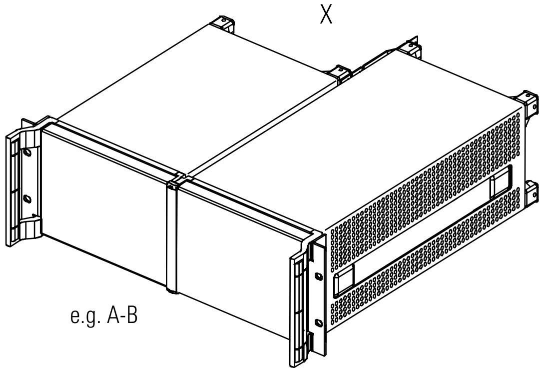
V

e.g. D-L



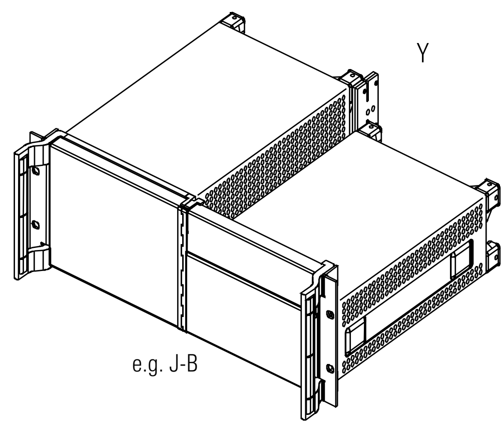
W

e.g. D-K



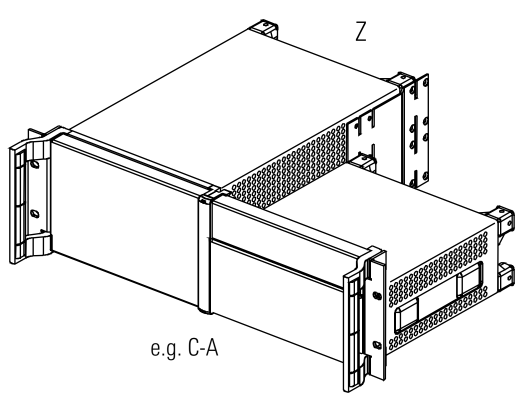
X

e.g. A-B



Y

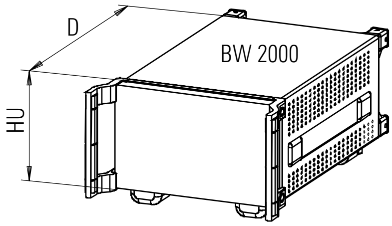
e.g. J-B

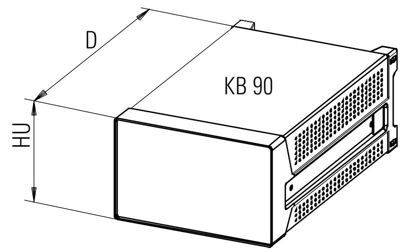


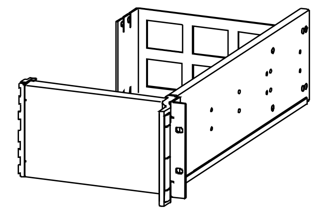
Z

e.g. C-A

Select cabinet combination







Height in mm (HU)	Depth in mm (T)	Cabinet
88 (2 HU)	222 (T250)	A
88 (2 HU)	322 (T350)	B
132 (3 HU)	322 (T350)	C
132 (3 HU)	422 (T450)	D
132 (3 HU)	422 (T460)	E

Height in mm (HU)	Depth in mm (T)	Cabinet
88 (2 HU)	209 (T240)	F
88 (2 HU)	321 (T350)	G
88 (2 HU)	433 (T460)	H
132 (3 HU)	321 (T350)	J
132 (3 HU)	432 (T460)	K

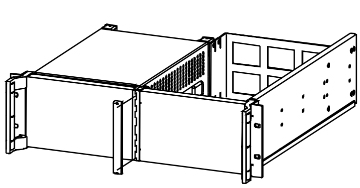
	Cabinet
Empty cabinet	L

	A	B	C	D	E	F	G	H	J	K	L
A	**3**	8	17	18	19	5	6	6	21	21	1
B	8	**3**	14	17	20	7	5	6	15	21	1
C	17	14	**4**	12	13	22	16	23	9	10	2
D	18	17	12	**4**	4	22	22	16	11	9	2
E	19	20	13	4	**4**	22	22	16	11	9	2
F	5	7	22	22	22	**24**	24	24	25	25	24
G	6	5	16	22	22	24	**24**	24	25	25	24
H	6	6	23	16	16	24	24	**24**	25	25	24
J	21	15	9	11	11	25	25	25	**25**	25	25
K	21	21	10	9	9	25	25	25	25	**25**	25
L	1	1	2	2	2	24	24	24	25	25	

e.g. combination C-L

Select #2 from table

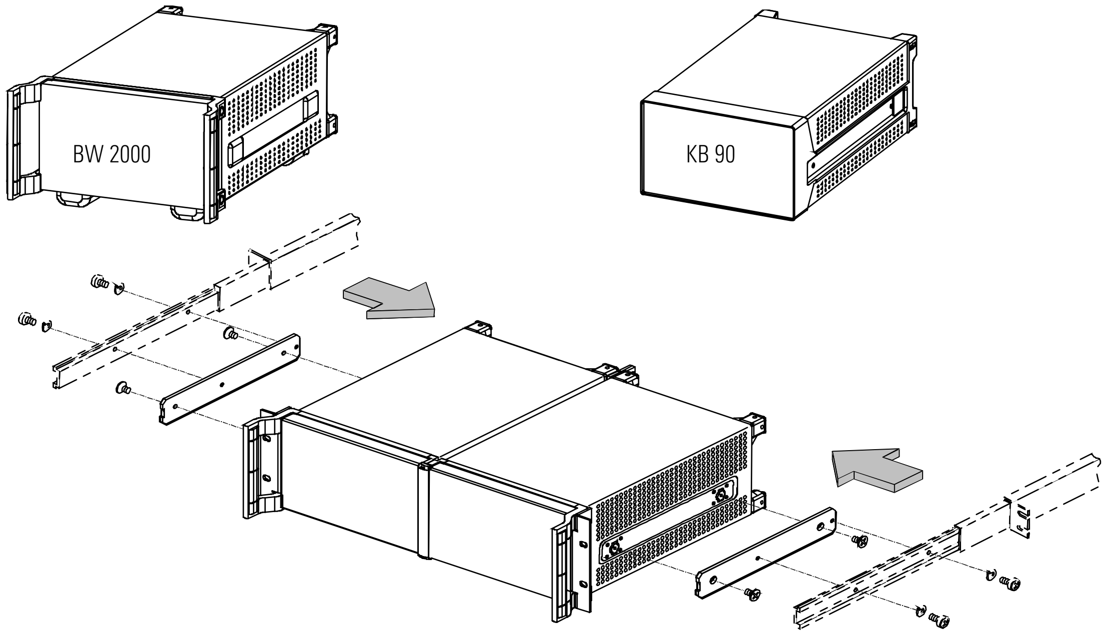
(Rohde&Schwarz Order number 1109.4164.00)



#	Rohde&Schwarz Order number	Description	See cabinets on page 459
1	1109.4158.00	19" adapter 1/2 Type 1	V
2	1109.4164.00	19"adapter 1/2 Type 2	V
3	1109.4170.00	19"adapter 1/2 Type 3	W
4	1109.4187.00	19"adapter 1/2 Type 4	W
5	1109.4193.00	19"adapter 1/2 Type 5	W
6	1109.4206.00	19"adapter 1/2 Type 6	X
7	1109.4212.00	19"adapter 1/2 Type 7	X
8	1109.4229.00	19"adapter 1/2 Type 8	X
9	1109.4235.00	19"adapter 1/2 Type 9	W
10	1109.4241.00	19"adapter 1/2 Type 10	X
11	1109.4258.00	19"adapter 1/2 Type 11	X
12	1109.4264.00	19"adapter 1/2 Type 12	X
13	1109.4270.00	19"adapter 1/2 Type 13	X
14	1109.4287.00	19"adapter 1/2 Type 14	Y
15	1109.4293.00	19"adapter 1/2 Type 15	Y
16	1109.4306.00	19"adapter 1/2 Type 16	Y
17	1109.4312.00	19"adapter 1/2 Type 17	Z
18	1109.4329.00	19"adapter 1/2 Type 18	Z
19	1109.4335.00	19"adapter 1/2 Type 19	Z
20	1109.4341.00	19"adapter 1/2 Type 20	Z
21	1109.4358.00	19"adapter 1/2 Type 21	Z
22	1109.4364.00	19"adapter 1/2 Type 22	Z
23	1109.4370.00	19"adapter 1/2 Type 23	Z
24	1109.4527.00	ZZA-97 19" adapter 2E 1/2	V/W/X
25	1109.4533.00	ZZA-98 19" adapter 3E 1/2	V/W/X/Y/Z

Cabinets, designs

Adapter for telescopic rails (only in conjunction with 19" adapter)



Height (HU)	Depth (T)	Type	Order number
1	T350	ZZA-T13	1109.3739.00
	T450	ZZA-T14	1109.3745.00
2 to 5	T350	ZZA-T35	1109.3768.00
	T450	ZZA-T45	1109.3774.00
	T550	ZZA-T55	1109.3780.00

Height (HU)	Depth (T)	Type	Order number
1	T350	ZZA-913	0396.5430.00
	T460	ZZA-914	0396.5460.00
2 to 6	T350	ZZA-923	0396.5476.00
	T460	ZZA-924	0396.5482.00
	T570	ZZA-925	0396.5499.00

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