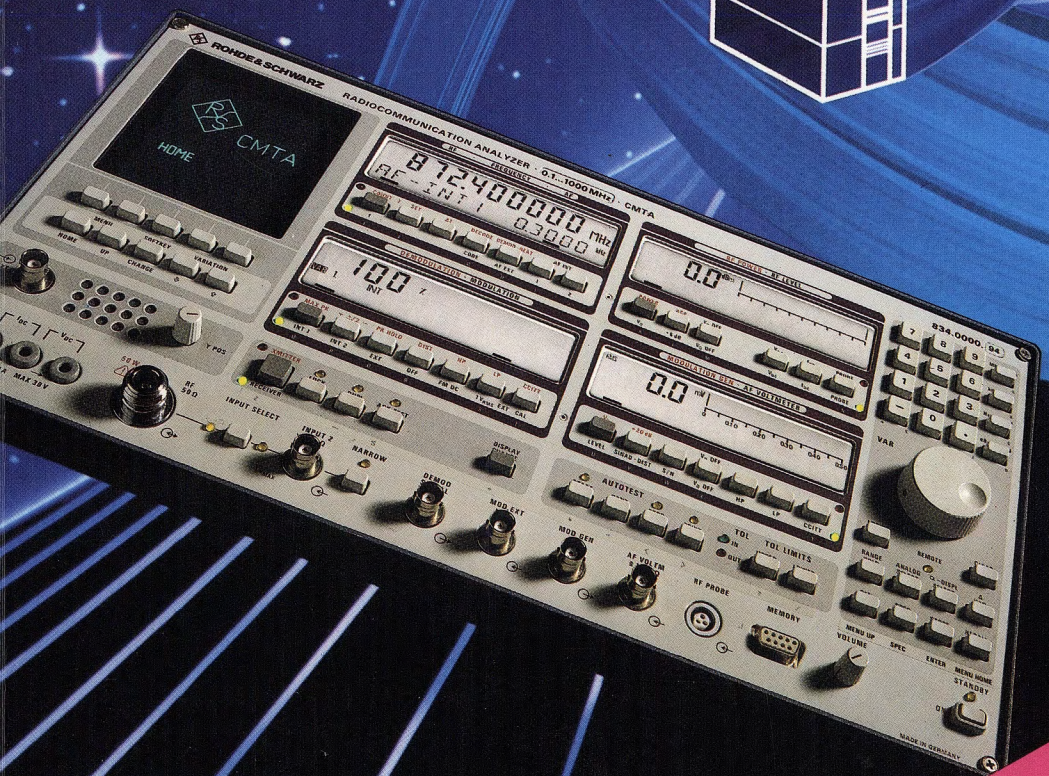
ROHDE&SCHWARZ

measuring equipment



supplement 91/92

ROHDE & SCHWARZ

This supplement to our measuring equipment catalog 1990/91 describes all new products (deadline March 1991) from the current line of Rohde & Schwarz measuring instruments. Our next catalog will appear in a completly new form in 1992, to coincide with the opening of the single European market.

Constantly growing complex demands in the field of measurements and communications mean that hardware and software have to be developed and redesigned at an ever faster rate.

Rohde & Schwarz has been developing, producing and selling measuring instruments, systems and communications equipment for almost sixty years.

The renowned high technological standard of our measuring instruments makes for their wide use in research, development and quality assurance in the field of electrical engineering as well as in the car industry. Moreover, we are also active in the field of long-distance shortwave communications, trunked radio and cellular radio networks. Our air-traffic control systems with communications and DF equipment are operated all over the world, and in many countries Rohde & Schwarz sound and TV transmitters are used for broadcasting.

The independent Munich company with about 5000 employees worldwide is represented in 80 countries, thus ensuring close contact to customers practically anywhere. Rohde & Schwarz invests a considerable share of its annual turnover in research and development to keep abreast with advanced technologies and to achieve the highest product precision and quality.

For many users, measuring instruments off the shelf are not good enough; they need custom-tailored instruments to **solve their problems**.

Apart from providing high precision, our aim is to maximize the benefits of our instruments for the user. To provide a quick, economical and efficient solution to user's problems is one of our foremost tasks.

The initial installation of computer-aided measuring systems, for instance, including interfacing with the customer-specific EDP, requires comprehensive and specialized know-how. Since this know-how is required only once, it is hardly profitable for the user to acquire this expertise. Thus, it makes more sense to use the services of an experienced specialist and to opt for turnkey systems. With more than 1000 highly qualified engineers, Rohde & Schwarz is the right partner to contact.

Information service Rohde & Schwarz supplies free of charge a wide variety of technical publications, like for instance NEWS FROM ROHDE & SCHWARZ, in wich you can find many equipment descriptions, reports on practical applications as well as articles on theoretical topics from renowned lecturers. The Rohde & Schwarz products are shown at some fourty to fifty fairs and exhibitions every year around the globe. Seminars, courses of instruction and service training courses are regularly held at Rohde & Schwarz in Munich and Cologne.

Our R&D center for microelectronics, measuring instruments and systems completed in 1990

Publisher:
Rohde & Schwarz GmbH & Co. KG
Editor: Gerhard Krätschmer
Translator: Ursula Renner
Printed in the Federal Republic of Germany

NEW PRODUCTS

contents

1	Automated testing	2 to 25
2	Signal generators	26 to 41
3	Radiocommunication testers	42 to 49
4	Analyzers	50 to 87
5	EMI testers	88 to 103
7	Network analyzers	104 to 113
9	Power meters	114 to 117

APPENDIX

A1	New products in the field of sound broadcast and TV measurements as well as communications	118 to 153
A2	Addresses, type index	154 to 156

You will find the following products only in the

CATALOG 90/91

6	Field-strength meters	284 to 317
8	Logic test equipment	354 to 381
10	Recorders, plotters, printers	444 to 457
11	Standard-frequency and standard-time systems	458 to 473
12	Power supplies	474 to 491
13	Other products	492 to 507

Test Workstation TSA
- benchtop test system for testing loaded printed circuit boards and modules in production and service
- custom-tailored test strategies

1

automated testing

		Page
Process Controller	PSA 12/15	4
Process Controller	PSA 17	12
Test Systems, cellular radio	TS 8100 TS 8200 TS 8400	14
Test System, field strength	TS 9955	16
Test Workstation	TSA	18

PSA Process Controllers

PSA 12 ♦ with external monitor
PSA 15 ♦ with built-in monitor

PSA 12

PSA 15

IEC 625 Bus

Process Controllers PSA 12 and PSA 15 are especially suitable for controlling measuring instruments and systems; they have evolved from the tried and tested Process Controllers PSA 2 and PSA 5 whose special features are compatibility with the industry standard and PCA software and a number of measurement extensions. Compared with their predecessors, they have considerably more computing power and are much versatile as far as hardware and software expansion is concerned. They have been designed to anticipate future developments in areas of use where large working memories, high mass storage capacity and fast computing are essential, eg parallel processing (multitasking) or controlling complex test systems in automated factories.

Main features

- Compatible with the industry standard (AT bus)
- Low RFI and EMI
- CPU 80386/20 MHz
- Programmable front-panel keyboard (optional)
- 5 slots for cards
- Integrated 9″ monitor with 8 softkeys (PSA 15 only)
- VGA colour graphics for external colour monitor
- 19″ cabinet suitable for rackmounting
- IEC-625/IEEE-488 controller
- R&S BASIC and Microsoft languages extended for measurement applications (optional)

Hardware and software compatibility with the industry standard ensures that a large number of standard programs can be run on the two models. The PSA 15 has a built-in 9″ monitor, while the PSA 12 is operated with an external monitor.

The hardware at a glance

Basic configuration

- CPU 80386/20 MHz
- VGA graphics, 640 × 480 pixels, a choice of 16 from over 256,000 colours
- 4 Mbyte RAM
- 3 1/2″ drive (1.44 Mbytes/720 Kbytes)
- 1 serial and 1 parallel interface
- Integrated 9″ monochrome monitor with 8 softkeys (PSA 15 only, program-controlled switch-off)
- IEC-bus interface
- Password facility
- Excellent RF shielding
- Temperature-controlled blower
- Realtime clock and calendar with battery backup
- 19″ cabinet suitable for rackmounting

Optional expansions and extras

- Programmable front-panel keyboard
- Keyboards compatible with industry standard for normal and special requirements, in various languages
- 5 1/4″ drive (1.2 Mbytes/360 Kbytes) **or:**
- Second 3 1/2″ drive (1.44 Mbytes/720 Kbytes)
- 40-Mbyte exchangeable hard disk
- 200-Mbyte hard disk
- 4-Mbyte memory expansion giving 8-Mbytes RAM
- TTL I/O interface
- Analog I/O interface
- Interface expansions giving a total of 4 serial and 2 parallel interfaces
- Second IEC bus interface
- Numeric coprocessor
- Serial mouse

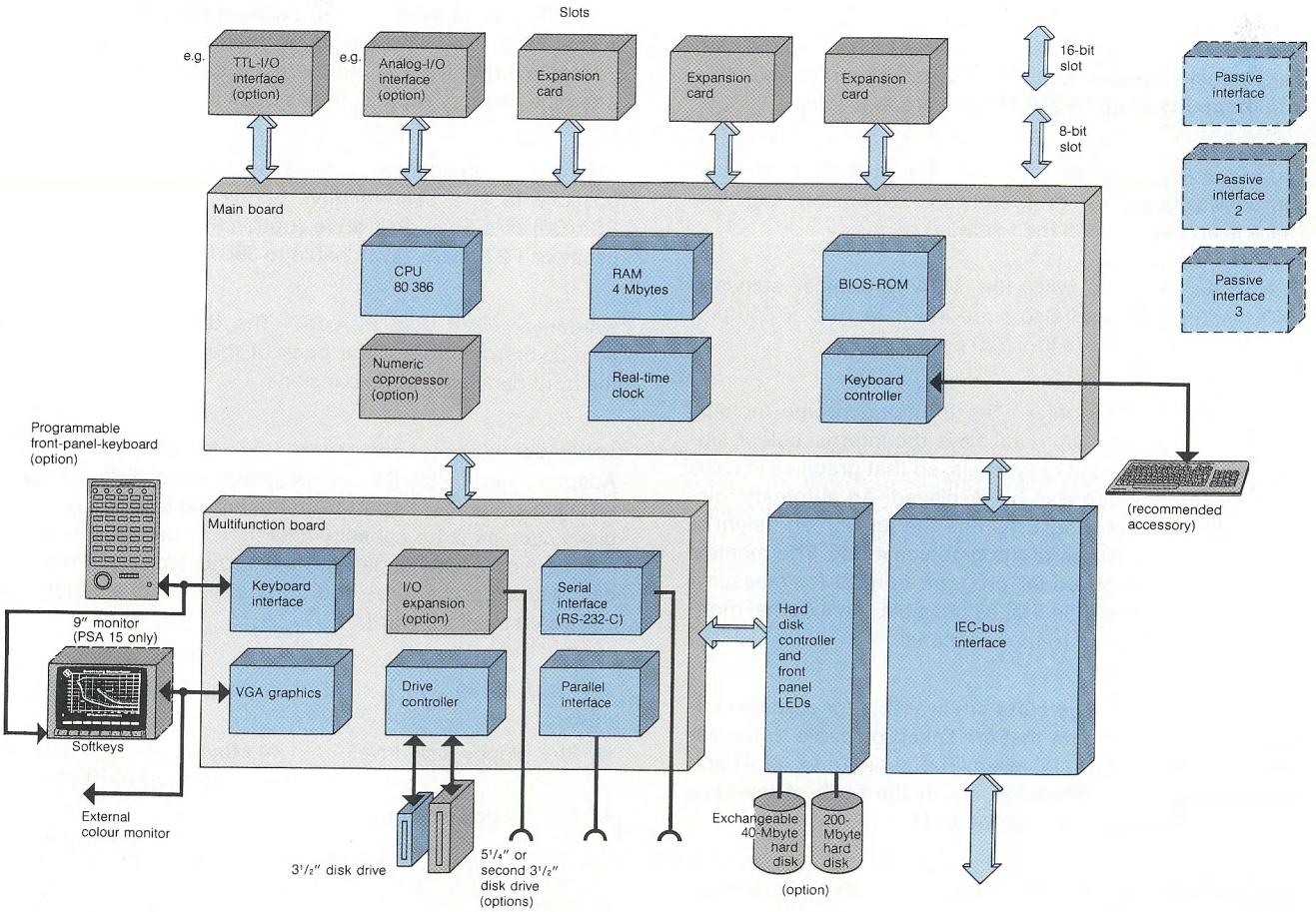
The software at a glance

Basic configuration

- MS-DOS 3.30
- Driver programs for interfaces
- R&S BASIC with expansions for measurement applications
- Many application programs
- Basic software for Rohde & Schwarz instruments

Optional expansions and extras

- Extended software for test applications:
  – Microsoft QuickBASIC/Pascal/C
- Calibration software
- Application software for measuring applications
- LabTest software package for data acquisition and processing (option)



Block diagram of Process Controllers PSA 12 and PSA 15

PSA 12/15

Characteristics

The PSA 12/15 controllers both contain a **20 MHz 80386 CPU.** This is operated in real mode under MS-DOS, ensuring compatibility with the industry standard. Their full power is only realized in the protected mode where linear addressing of virtual memories of up to 4 Gbytes can take place. In the virtual 8086 mode several programs, developed for the 8086 processor, can be run in a quasi-parallel mode.

A sufficiently large working memory and fast hard disks are essential if full advantage is to be taken of the 80386 CPU. The optional exchangeable hard disks for the PSA 12/15 make it easier to use various types of software.

In the basic version, the **working memory** of the PSA 12/15 has a capacity of 4 Mbytes which can be expanded to 8 Mbytes. Linear addressing can be used in the protected mode or it can be used as a 640-Kbyte working memory in the real mode, i.e. under MS-DOS. The 3 Mbytes at the top of the memory space can be used as extended or expanded memory under MS-DOS.

Hard disk capacity Programs or files that are several Mbytes in size, no problem with the 80386 CPU, often cannot be completely loaded in the working memory. For this reason, program sections that are not used frequently are exported to external mass storage using disk swapping and are loaded back into the working memory whenever they are required. The PSA 12 and PSA 15 have ample hard disk capacity to handle this – at present hard disks with a **total capacity of up to 240-Mbytes** are available.

Expandability The PSA 12 and the PSA 15 both have impressive hardware and software expansion facilities. There is an overview on the following page.

The PSA complies with the VGA **graphics** standard (640 × 480 pixels) and also supports EGA (640 × 350 pixels) and CGA modes (640 × 200 pixels).

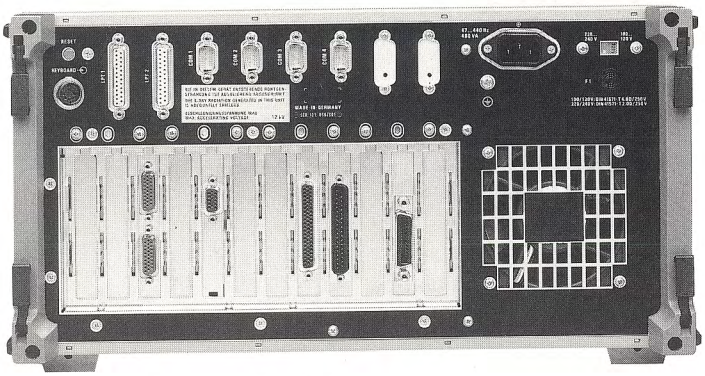
9″ monitor (PSA 15 only) The 9″ monochrome monitor integrated into the PSA 15 displays the internal colour signal in up to 64 different grey levels, so that graphics in CGA and EGA modes can also be displayed. An automatic display height corrector ensures that the full screen height is always used regardless of the graphics mode. The monitor can be switched off under program control for measurements calling for as little EMI as possible. An external monitor can be connected to the rear panel.

Expansion cards **Five slots** are available for cards. In addition, three connectors that are linked by cable to the associated cards can be installed. The serial (max. of 4) and parallel (max. of 2) interfaces are at the back of the controller and so do not take up any slots.

The **password facility,** which can be switched off, ensures that the operating system can only be loaded if a previously stored password is entered.

The built-in **IEC-bus interface** complies with IEC 625-1 (IEEE 488). The interface is programmed in R&S BASIC, QuickBASIC, MS-Pascal and MS-C using simple and convenient instructions.

Disk drives The controller has a 3½″ floppy disk drive with a capacity of 1.44 Mbytes (switchable to 720 Kbytes). The format of these disks complies with PS/2 standard.



Rear panel of Process Controller PSA

Hardware options

The **4-Mbyte Memory Extension PSA-B2** increases the working memory of the PSA to 8 Mbytes. There is therefore 7 Mbytes of extended or expanded memory available in the PSAs. The whole working memory is on the main memory card of the PSA so there are still 5 free slots even when the memory expansion has been installed.

Disk drives In addition to the **3½″ floppy disk drive,** it is possible to fit a second drive of the same type (option PSA-B6) or a **5¼″ disk drive** (option PSA-B16) with a capacity of 1.2 Mbytes (switchable to 360 Kbytes).

200-Mbyte Hard Disk PSA-B7 The drive (mean access time 25 ms) is fitted at the back of the PSAs, so keeping the front panel free for expansions.

40-Mbyte Exchangeable Hard Disk PSA-B9 Using the Adapter Frame PSA-B8, exchangeable hard disks can be installed in the PSA. Apart from the typical features of hard disks such as large capacity and short access times, they can be simply exchanged in next to no time. This makes data backup procedures and the installation of a variety of software straightforward.

The PSA 12/15 can be fitted with all of the following drives:

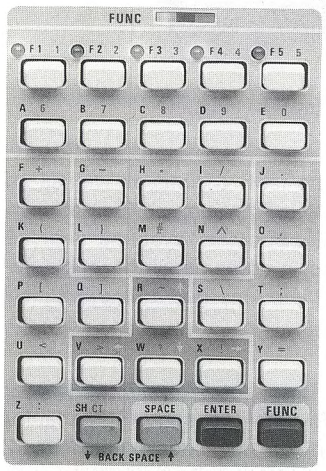
- 3½″ floppy disk drive: 1.44 Mbytes (switchable to 720 Kbytes)
- 5¼″ floppy disk drive: 1.2 Mbytes (switchable to 360 Kbytes)

  (or second 3½″ drive)
- Hard disk: 200 Mbytes
- Exchangeable hard disk: 40 Mbytes

The exchangeable hard disks for the PSA take the tedium out of installing software packages

Keyboard The keyboard is not supplied with the process controller and can be ordered separately in one of several national variants. Various keyboards are available for the PSA.

The favourably priced **keyboard** to the MF standard has alphanumeric keys, 12 function keys, an editor keypad, four cursor keys and a numeric keypad.

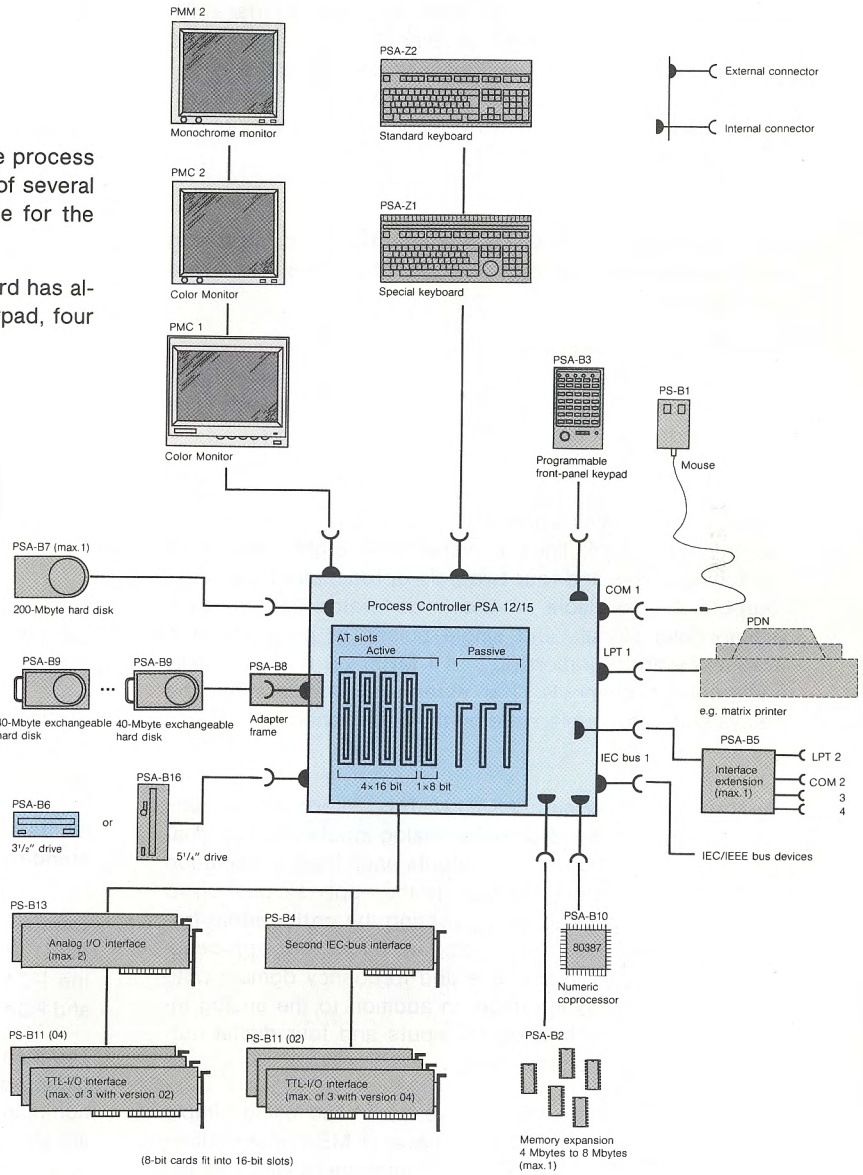


Programmable Front-panel Keypad PSA-B3

Programmable Front-panel Keypad PSA-B3
This keyboard can be integrated in the front panel. It can be used to input ASCII characters or program any string of characters and call them up with a single keystroke. It is primarily designed for controlling ready-to-run programs, especially when the controller is rack-mounted. This keyboard can fully replace the external keyboard. The supplied masks allow the user to re-assign the keys in any way he likes.

The PSA-B3 keypad can be programmed either with the aid of a menu or at the DOS level by calling up a configuration program. It can thus be installed for a specific application when the PSA is started, or the key assignment can be reprogrammed during the execution of a program.

The **Special Keyboard PSA-Z1** is suitable for mounting into 19″ racks. It can be fixed to the PSA and adjusted to give the angle the user requires for operation. In addition to the standard keyboard layout, it has a rollkey for generating the character codes of the four cursor keys. The special shielding of the keyboard makes it ideal for measurements calling for low EMI.



Configuration overview

2nd IEC-bus Interface PS-B4 It may be required to control large test systems or to ensure that two measuring instrument groups can be accessed separately.

PSA 12/15

The **Interface Extension PSA-B5** increases the number of PSA interfaces to a total of **four serial** and **two parallel interfaces.** This option can be mounted on the multifunction board of the process controller and therefore does not require an expansion slot. The additional interfaces are provided as separate back-panel connectors.

The four serial interfaces can easily be programmed with the aid of the driver software in R&S BASIC, QuickBASIC, MS-Pascal and MS-C, which already contain software handshakes like XON/XOFF or a hardware handshake.

An additional printer, for example, can be connected to the second parallel interface (LPT2). This interface can however also be used as a 8-bit input or output interface if a second printer is not required. Binary control information can be read via two further input lines. Thanks to the extensions in R&S BASIC, QuickBASIC, MS-Pascal and MS-C, the control lines can be conveniently addressed like the TTL I/O Interface PS-B11.

TTL I/O Interface PS-B11 This interface is for switching and interrogating external digital control lines. There are two versions:

Version 04 contains 40 digital I/O lines, which are easy to set or interrogate using the supplied driver software. Eight lines can be configured to recognize interrupt events. The interface does not require a back-panel connector.

Version 02 contains a group of floating control lines as well as the 40 control lines in version 04. Eight single-pole switching relays and four two-pole optocoupler inputs and outputs are available. A clock generator can produce squarewave signals and single pulses of programmable frequency and duration ($f_{max} \leq 4$ MHz) on three mutually independent channels. The external connectors for the relays and optocouplers are on the back panel.

Analog I/O Interface PS-B13 This interface contains eight differential or 16 unipolar analog inputs and two analog outputs. The inputs and outputs each have a resolution of 12 bits. The inputs can sample the applied signal up to 50,000 times a second, thus covering the **entire audio frequency range**. The PS-K21 software package for processing digital signals in the time and frequency domain optimally supports this interface. In addition to the analog inputs and outputs, four digital inputs and four digital outputs are provided on the card.

The PS-B13 and the PS-B11 are controlled using simple R&S BASIC, QuickBASIC, MS-Pascal or MS-C instructions in mnemonic form. For system programmers who use assembler or other languages, the driver programs have open software interfaces.

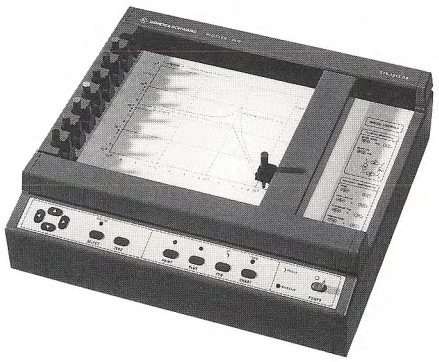
Numeric Coprocessor PS-B10 A socket is provided on the main board of the PSA for retrofitting a numeric coprocessor (Intel 80387). This coprocessor speeds up programs for long calculations.

User software supplied

Software for remote file access This is communication software for addressing a second controller via the IEC bus like a virtual DOS drive. This drive is accessed by means of the usual DOS commands (eg COPY, DIR, etc.). With the DOS command XCOPY, the hard disks including all subdirectories can be transferred from one controller to the other. In addition to the data transfer it is also possible to run programs on an external controller.

Software for digital signal processing (FFT transform) This software optimally supports the optional analog I/O interface for the Process Controller PSA: the ADC signal can be displayed and processed both in the frequency and in the time domain. The measured data to be transformed can also be input via the IEC bus, eg from an external storage oscilloscope.

Scientific graphics software Under R&S BASIC or Pascal, this software provides two- or **three-dimensional graphics,** Smith charts and polar diagrams as well as convenient plot routines with autoscaling. These routines can simply be configured for a wide variety of measurement requirements.



DIN A3 Plotter DOP from Rohde & Schwarz for result graphics
(see catalog 90/91, page 450)

Rohde & Schwarz BASIC has test routines as well as an editor for typing in and modifying programs. The software can be used to program IEC-bus test systems and the built-in measurement options. It contains all the ANSI elements and instructions that have emerged as the **industry standard**.

Compatibility with the software of Process Controller PCA Programs written in R&S BASIC and MS Pascal for the PCA Process Controller can be used on the PSA 12 and PSA 15 after minor modifications.

The standard VGA graphics for the PSA has the same resolution as the graphics for the PCA. The BASIC graphics commands for the PCA such as DRAW, DOT and LABEL are also available in unchanged form on the PSA.

Programs developed for the PCA only need modifying if the LABEL and PRINT commands were both used. The IEC-bus commands are identical to those of the PCA, and the graphics and interface commands are largely identical.

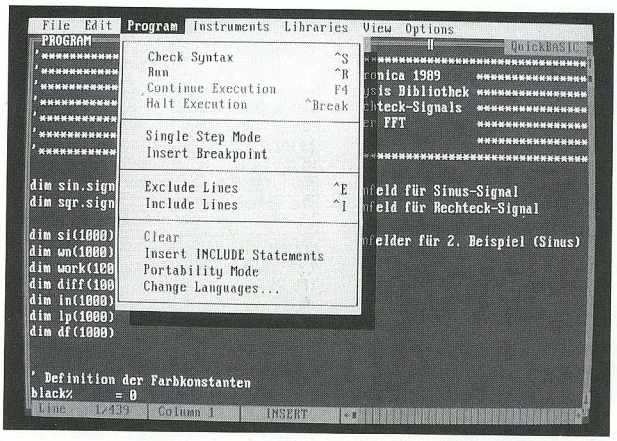
Compatibility with industry standard programs A large number of programs available for industry-standard computers have been tested on the PSA.

Software options

QuickBASIC PS-K1 Option The Microsoft QuickBASIC compiler is recommended for developing new software for measurement applications. It provides a convenient menu-driven environment with all the tools needed to develop compact, fast programs quickly: editor with syntax checking, compiler for immediate program execution and an integrated debugger with windows. The mouse (option PS-B1) is very well supported by QuickBASIC.

Thanks to the QuickBASIC learn program and the advisor which can help out with problems as they come up, the user will be able handle the **programming environment in no time at all.**

The QuickBASIC extensions to the IEC-bus driver and the TTL and analog I/O interfaces for measurements applications make it easy to program these interfaces both in the interactive QuickBASIC mode and in the EXE module which is generated by the QuickBASIC compiler.



QuickBASIC user interface

Pascal PS-K11 Option The Microsoft Pascal compiler is ideal for more sophisticated technical applications. Most programs for the PCA Process Controller are compatible. With its numerous language extensions, the compiler ensures **short development times, even for complex system software.**

Program testing is supported by the **CodeView debugger** which uses a window technique. For example, conditional and unconditional breakpoints and watch variables can be defined in a simple manner, or Pascal programs can be examined in source or machine code.

MS Pascal has been extended for the PSA Process Controller to include powerful procedures and functions for the IEC bus and all interfaces that are especially useful for measurement applications. Extensive commands are also available for colour graphics. The syntax of these extended commands is similar to that of R&S BASIC. These features, together with the straightforward Pascal call procedures from BASIC, provide a **unified language concept** within the PSA family.

MS-C Compiler PS-K12 Option The language C is available on numerous computer systems, from microcontrollers through to main frames. Many standard libraries are written in C. LabTest (see option PS-K3) can generate C code so that programs written with LabTest can be run on the MS-C compiler outside the LabTest environment.

C is a high-level language which provides for structured programming while at the same time featuring flexible data formats and high speed so that it has an advantage over other programming languages.

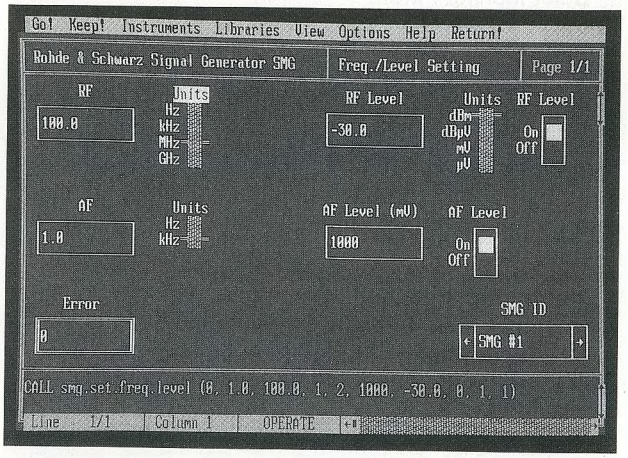
The **function library supplied** with the MS-C compiler comprises over 400 functions for memory management, character (string) processing, data conversion, file management, graphics, input and output of files and characters, floating and fixed decimal point arithmetic, search and sorting algorithms, MS-DOS system calls and program checks, etc.

For fast program development, an interactive, window-oriented C programming environment is supplied (Quick-C), which combines all the advantages of C and BASIC (convenient program generation and testing). Moreover, MS-C contains the **Debugger CodeView,** which is also included in the MS-Pascal PS-K11 Option.

LabTest PS-K3 Option With this programming environment (data sheet PD 756.8855), users **with no programming knowledge can control complex equipment,** evaluate results, produce result graphics and simulate instruments. Instrument libraries are supplied for the best known R&S units and those from other manufacturers.

LabTest displays the controls and displays of the instruments connected to the PSA's IEC bus on the screen, giving a **"virtual front panel".** The simulated instruments can then be operated like real instruments from the screen using a mouse or the keyboard. Each measurements can be programmed and then be executed automatically.

LabTest also has a comprehensive collection of procedures and functions for the professional programmer.



LabTest PS-K3 user interface

PSA 12/15

Standard models

Rohde & Schwarz has created the following standard models for three frequent fields of applications. This eliminates the need to configure the controller for the application on hand (see also table below):

Model PSA 12 P1/PSA 15 P1: Controlling test systems This model is for controlling medium to large test systems. It comprises:

- Programmable front-panel keyboard (simplifies handling of ready-to-run software when the PSA is accommodated in 19″ cabinets)
- Second IEC-bus interface
- TTL-I/O interface (version 04)
- Interface extension (4 serial, 2 parallel)
- 200-Mbyte hard disk
- Special keyboard (with rollkey, suitable for 19″ systems, EMI-proof)
- Color Monitor PMC 2 (only for PSA 12 P1)

Model PSA 12 P2/PSA 15 P2: Controller as test system This model is configured for direct analysis of analog and digital signals. It is also suitable for controlling small IEC-bus test systems. The internal generator/receiver and the external IEC-bus devices complement each other very well. This model contains:

- Programmable keyboard
- Analog I/O interface
- TTL-I/O interface (version 02)
- 200-Mbyte hard disk
- Numeric coprocessor
- Standard keyboard
- Color Monitor PMC 2 (only for PSA 12 P2)

Model PSA 12 P3: Software development Designed to optimize the development of test software. Based on the PSA 12 with an external Color Monitor PMC 2, this model comprises:

- Interface extension (4 serial, 2 parallel)
- 200-Mbyte hard disk
- 40-Mbyte exchangeable hard disk with adapter frame
- Standard keyboard (US English)
- 5¼″ disk drive
- Color Monitor PMC 2

Specifications

Central unit

CPU	80386
Clock rate	20 MHz
Data bus	8/16 bit
RAM	4 Mbytes (= 4096 Kbytes, of which 640 Kbytes under MS-DOS is for programs, 3 Mbytes for Extended/Expanded Memory)

Expansion slots

Free slots 16 bit	4
8 bit	1
Maximum dimensions of expansion cards (H × W)	112 mm × 334 mm

Operating system (loadable)	MS-DOS 3.30
BIOS	Setup and I/O functions

Programming languages

Supplied	Rohde & Schwarz BASIC
Options	Pascal PS-K11, QuickBasic PS-K1, C (MS-C-86) PS-K12 (others see recommended accessories)

Monitor (PSA 15 only)

CRT	9″
Screen size	8.6″ diagonal (124 mm × 180 mm)
Surface	anti-glare
Coating	phosphor P31 (green)
Refresh rate	60 to 70 Hz (depending on graphics mode)
Line frequency	31.5 kHz (non-interlaced)

Graphics interface

ASCII text mode	
Character matrix	8 × 14 or 9 × 16 dots
Graphics mode	
Resolution CGA	640 × 200 pixels
EGA	640 × 350 pixels
VGA	640 × 480 pixels
Grey shades	16 (monitor in PSA 15)
Colours displayed simultaneously	16 for 640 × 480 pixels 256 for 640 × 200 pixels
Number of colours available	262,144

3½″ Disk Drive PSA-B6 (option)

Format	double-sided, high density
Capacity formatted	1.44 Mbytes (720 Kbytes)
Tracks	160 (80)
Sectors per track	18 (9)
Bytes per sector	512

5¼″ Disk Drive PSA-B16 (option)

Format	double-sided, high density (double density)
Capacity formatted	1.2 Mbytes (360 Kbytes)
Tracks	160 (80)
Sectors per track	15 (9)
Bytes per sector	512

200-Mbyte Hard Disk PSA-B7 (option)

Capacity formatted	200 Mbytes
Disks	4
Heads	8
Cylinders	1334
Mean access time	25 ms
Data transfer rate	1.25 Mbytes/s
Storage format	1/7 RLL
Rated temperature range	+5 to +40 °C
Storage temperature range	−40 to +60 °C
Shock/non-operating	50 g, 10 ms
Average power consumption (standby)	7.8 W (3.5 W)

Overview

	Basic version		Keyboards			Drives			Interfaces				Coprocessors
	Monitor External	Monitor Internal	Progr. keyboard	Rollkey	Standard	200 Mbytes (fitted)	40 Mbytes (exchangeable)	5¼″ disk	Second IEC bus	4 × serial 2 × parallel	TTL I/O	Analog I/O	80387
Model	PSA 12 PMC 2	PSA 15	PSA-B3	PSA-Z1	PSA-Z2	PSA-B7	PSA-B8/B9	PSA-B16	PSA-B4	PSA-B5	PS-B11	PS-B13	PSA-B10
Controlling test systems													
Model PSA 15 P1		X	X	X		X			X	X	X (ves. 04)		
Model PSA 12 P1	X		X	X		X			X	X	X (ves. 04)		
Controller as test system													
Model PSA 15 P2		X	X		X	X					X (ves. 02)	X	X
Model PSA 12 P2	X		X		X	X					X (ves. 02)	X	X
Software development													
Model PSA 12 P3	X				X US Engl.	X	X	X		X			

Adapter frame for Exchangeable Hard Disk PSA-B8 (option)

Maximum no. of exchanges	≥ 10,000

40-Mbyte Exchangeable Hard Disk PSA-B9 (option)

Capacity formatted	40 Mbytes
Disks	1
Heads	2
Cylinders	1047
Mean access time	25 ms
Data transfer rate	1.25 Mbyte/s
Storage format	RLL
Rated temperature range	+5 to +45 °C
Storage temperature range	−40 to +60 °C
Shock/non-operating	50 g, 10 ms
Average power consumption (standby)	6.6 W (2.5 W)

Programmable Front-panel Keyboard PSA-B3 (option)

Number of keys	35 (5 × 7)
Character levels	3
Standard character set	US ASCII
Programming	interactive, command line

TTL I/O Interface PS-B11 (option)

Required slot width	16 bits
Max. No. of interface cards	3
TTL inputs/outputs	5 × 8 bits
Connector (with timer)	high-density; 62-contact D-sub connector
Timer[1])	3
Relais[1])	8
Optocouplers	4 inputs, 4 outputs

Analog I/O Interface PS-B13 (option)

Required slot width	8 bits
Max. No. of interface cards	2
Analog input	
Channels	8 differential or 16 unipolar inputs
Resolution	12 bits (successive approximation)
Conversion time	12 µs
Max. sampling rate	50 kHz
Input voltage range	±10 V, ±5 V, ±2.5 V, ±1 V, ±0.5 V or 0 to 10 V, 0 to 5 V, 0 to 2 V, 0 to 1 V
Input current	max. 250 nA
Trigger facilities	external signal, programmable timer, program-controlled
Analog output	
Channels	2 outputs
Resolution	12 bits
Output voltage range	< 0 to 5 V < 10 V (with external reference)
Output current	< 5 mA
Digital input/output (TTL)	4/4
Clock	
16-bit counters	1
Frequency	max. 2.5 MHz

Standard keyboards (recommended extras)

Number of keys	101/102
Keypads	alphanumeric/cursor/editor numeric/editor/cursor
Displays	Num Lock, Caps Lock, Scroll Lock
Connector	5-contact (DIN)

1st and 2nd IEC-bus interface

Required slot width	8 bits
Connector	IEC 625-1 (IEEE 488), 24-contact Amphenol
Interface functions	C1 to C5, T5, TE5, L3, LE3, SR1, RL1, PP1, PP2, AH1, SH1
Data rate	max. 300 Kbyte/s

General data (PSA)

Rated temperature range	+5 to +45 °C
Storage temperature range	−40 to +70 °C (basic version)
Relative humidity	20 to 80 % (no condensation)
RF shielding and RF immunity	VDE 0875, RFI suppression grade N, VDE 0871, limit class B
Mechanical strength	to IEC 359, class I
Safety specifications	to VDE 411 (IEC 348) and VDE 0804
Sinusoidal vibration	5 to 55 Hz, 1 octave/minute, 0,4 mm double amplitude, corresponding to a max. of 2,4 g at 55 Hz
Shock spectrum	at 40 g, transition frequency 45 Hz, from 12 to 1800 Hz (18 shocks in 6 axes)
Transport (packing)	1000 shocks 25 g/6 ms in 6 axes; free fall from 80 cm (PSA 12) or 60 cm (PSA 15) on all faces and corners
Power supply	100 to 120/220 to 240 V ±10 %, 47 to 440 Hz (max. 330 VA), equipment safety class I (VDE 0411 and IEC 348)
Dimensions (W × H × D)	435 mm × 236 mm × 570 mm
Weight (no options)	
PSA 12/15	14.5/16.5 kg

[1]) Only for PS-B11, version 02

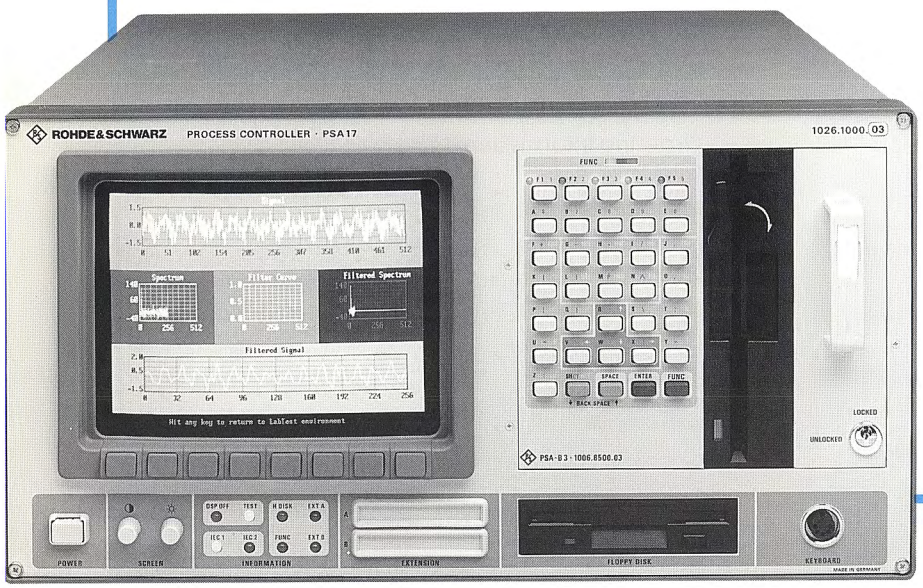
Ordering information

Order designation	▶ Process Controller	
PSA 12 (without monitor)	1012.0007.02	
PSA 15 (with built-in monitor)	1012.1003.02	
Accessories supplied	operating manual, BASIC manual, MS-DOS-User's Guide and User's Reference	
Software supplied	system disks with operating system, BASIC interpreter, demo software, user software, utilities, drivers for expanded memory	
Standard models		
Controlling test systems	PSA 15 P1	1008.2009.02
	PSA 12 P1	1008.2209.02
Controller as test system	PSA 15 P2	1008.2109.02
	PSA 12 P2	1008.2309.02
Software development	PSA 12 P3	1008.2409.02
Options		
Mouse German/English	PS-B1	1006.6359.02
Memory Extension 4 Mbytes	PSA-B2	1006.9506.03
Programmable Front-panel Keyboard	PSA-B3	1006.8500.03
2nd IEC-bus Interface	PS-B4	1006.6207.03
Interface Expansion	PSA-B5	1007.2705.02
3½″ Floppy Disk Drive	PSA-B6	1006.6659.03
200-Mbyte Hard Disk	PSA-B7	1006.7103.03
Frame Adapter for exchangeable disk	PSA-B8	1007.4008.03
40-Mbyte Exchangeable Hard Disk	PSA-B9	1007.3501.03
Numeric Coprocessor	PSA-B10	1006.6107.03
TTL-I/O Interface (version 04)	PS-B11	1006.7303.04
TTL-I/O Interface (version 02)	PS-B11	1006.7303.02
Connector for version 02	PS-Z11	1008.3305.02
Analog I/O Interface	PS-B13	1006.6859.02
5¼″ Floppy Disk Drive	PSA-B16	1007.4508.03
Recommended extras		
Monochrome Monitor	PMM 2	351.2832.02 (see catalog 90/91, page 40)
Color Monitor	PMC 2	1008.7500.02 (see catalog 90/91, page 40)
Color Monitor	PMC 1	1008.3005.02
Special Keyboard (with rollkey) German	PSA-Z1	1009.5001.31
Special Keyboard (with rollkey) English	PSA-Z1	1009.5001.32
Special Keyboard (with rollkey) French	PSA-Z1	1009.5001.33
Standard Keyboard German	PSA-Z2	1007.3001.31
Standard Keyboard US English	PSA-Z2	1007.3001.02
Standard Keyboard UK English	PSA-Z2	1007.3001.32
Standard Keyboard French	PSA-Z2	1007.3001.33
Standard Keyboard Country specific	PSA-Z2	1007.3001.90
Additional masks for PSA-B3 (10 pcs.)	PSA-Z3	1006.8851.02
Disks (10 pcs.)		
5¼″, formatted, high density	PCA-Z2	376.0210.02
3½″, unformatted, high density	PCA-Z3	351.2390.02
Cable for IEC-Bus 0.5 m	PCK	292.2013.05
Cable for IEC-Bus 1 m	PCK	292.2013.10
Cable for IEC-Bus 2 m	PCK	292.2013.20
Cable for IEC-Bus 4 m	PCK	292.2013.40
19″ Adapter	ZZA-95	396.4911.00
Transport Case (for PSA 12/15)	ZZK-995	1013.9408.00
Special Accessory Case (for PSA 12/15)	ZZT-98	396.9913.00
Pinwriter (220 V)	PDN	351.4512.02 (see catalog 90/91, page 454)
IEC bus for PDN	PDN-B4	1006.9706.02
Autom. Single-sheet Feed	PDN-B6	1006.9158.02
Centronics-Centronics cable	PDN-Z4	1006.9306.02
Plotter (DIN A3, colour)	DOP	375.1213.02 (see catalog 90/91, page 450)
Software		
QuickBASIC (3½″ disk)	PS-K1	1007.1009.04
IEC Bus Driver	PS-K2	1007.1750.32
LabTest (partly in German)	PS-K3	1007.1309.31
(English manual)	PS-K3	1007.1309.32
Pascal Compiler (3½″ disk)	PS-K11	1007.1909.04
MS C Compiler (3½″ disk)	PS-K12	1007.2105.04
CMT Basic Software	CMT-K1	351.0317.04
UPA Basic Software	UPA-K1	351.2432.04
Calibration Software	TS9000	on request

PSA 17

Process Controller PSA 17 ♦ With built-in colour monitor

- CPU 80386/25 MHz, 4-Mbyte RAM
- VGA graphics, 640 × 480 pixels, a choice of 16 from over 256,000 colours
- 3 1/2″ floppy disk drive (1.44 Mbytes/720 Kbytes)
- One serial and one parallel interface
- Integrated 8″ colour monitor with 8 softkeys
- IEC/IEEE-bus interface
- Password protection
- Excellent RF shielding, rackable 19″ enclosure
- Temperature-controlled, low-noise blower
- Realtime clock and calendar with battery backup



IEC 625 Bus

Characteristics, uses

Process Controller PSA 17 from Rohde & Schwarz features a **built-in, high-resolution 8″ colour monitor** and a CPU with 25-MHz clock frequency; otherwise it has the same features as the PSA 12 and PSA 15 models.

In the field of **automatic testing**, process controllers are mainly used as controllers. They coordinate all the measurements being made, control the measuring instruments and the DUT and also process and display the results in a clear form. In many cases, PCs can be used to solve test and measurement problems, but, generally speaking, the limitations of the PC for such applications become rapidly evident. This is particularly so in the case of measurement applications which require

– compatibility with the industry standard
– high computing power
– a large number of slots

and the following features which PCs are not able to provide:

- **Rackability** with low space requirements, with integral interfaces such as keyboard and monitor so that the controller can be used without any difficulties in all system environments.
- **Integrated measurement** technology in the form of plug-in cards so that a separate IEC-bus device is not required for every standard test (current/voltage measurements, FFT, digital signal measurements)
- **Universal software concept** with intelligent, language-independent interface drivers so that control and test procedures can be performed reliably and rapidly in any language
- **Rugged construction** for reliability that can be guaranteed even on the factory floor
- **Flexible LAN concept** for professional integration into existing computer networks
- **Low emission of EMI** so that the controller does not impair the accuracy of the results in critical EMC applications
- **Know-how and support from the manufacturer** in the fields of computers, control, LANs, measurement and system engineering which ensure that current or future problems of automated measurements are solved rapidly and economically

8″ colour display The monitor as the most important output device is built into the PSA 17. **VGA graphics** with a maximum of 256 colours can be displayed on the 8″ screen. The EGA and CGA modes are also supported, which means that a wide variety of common graphics programs can be used. The **automatic display-height correction** facility ensures that the full screen height is utilized whatever the graphics mode might be. The colour graphics are supported by all the programming languages that can be used with the PSA 17 and by LabTest. A colour monitor with a larger screen can be connected in parallel with the built-in monitor using the connector on the rear of the PSA 17.

Low EMI **Minimizing EMI** from instruments is essential when they are used for radiocommunication testing as well as testing in other fields and, of course, is absolutely vital for EMC measurements. **Specific measures** such as shielded enclosures, shielding bus connections and connecting filters to keyboard connectors mean that the PSA 17 has particularly favourable EMI emission characteristics. Open-site field-strength measurements show that emissions are typically 8 dBµV/m below the limit curves stated by VDE 0871, limit class B. The measurements were carried out with the following configurations: PSA 17 with PSA-B3, -B5, -B6, -B7, -B9, -B11 version 02, -B13 and Standard Keyboard PSA-Z2. To further reduce spurious emissions in the frequency range up to 10 MHz the built-in monitor can be turned off – even under program control.

The basic software package of the PSA 17 is very extensive:

MS-DOS and utility programs as well as driver programs for interfaces

R&S BASIC with expansions for measurement applications

PSA-K21 FFT/Cepstral transformation in conjunction with A/D converter PS-B13

PSA-K22 Field-strength monitoring using Test Receivers ESH 3/ESVP (catalog 90/91, pages 292 and 300)

PSA-K23 Scientific graphics software for 2D and 3D displays, Smith charts/polar diagrams and autoscaling routines

UPA-K1 Audio measurements using Audio Analyzer UPA (catalog 90/91, page 404)

CMT-K1 Radiocommunication measurements using Radiocommunication Tester CMT/CMTA (catalog 90/91, from page 178)

Optional expansions and extensions

Hardware

- Programmable front-panel keyboard
- Keyboards compatible with the industry standard, for standard and special requirements with lettering in a variety of languages
- 5¼″ floppy disk drive (1.2 Mbytes/360 Kbytes) **or:**
- Second 3½″ floppy disk drive (1.44 Mbytes/720 Kbytes)
- 40-Mbyte removable hard disk
- 200-Mbyte fixed hard disk
- Memory expansion to 8 Mbytes of RAM
- TTL I/O interface
- Analog I/O interface
- Interface expansion giving a total of 4 serial and 2 parallel interfaces
- Second IEC/IEEE-bus interface
- Numeric coprocessor
- Serial mouse
- Ethernet interface with PC-NFS software

Software

- Extended programming languages for automatic testing: Microsoft QuickBASIC, Pascal, C, BASIC compiler (PDS)
- Basic software for Rohde & Schwarz instruments
- Calibration software for all types of measuring equipment
- Application software for measurements
- LabTest for measurement data acquisition and processing
- Ready-to-use system software to customer specifications

Quality-assurance departments in production have to keep test data for many years. Storage may be decentralized, eg locally on floppy disks and removable hard disks, or centralized on large computer systems.

The **Ethernet adapter (option PSA-B21)** is used to hook up the PSA 17 with existing computer networks. The option comprises an 8-bit plug-in card which can be inserted into an 8 or 16-bit slot. The connection to Ethernet is either made via an Ethernet transceiver (Attachment Unit Interface, AUI) or via standard 50-Ω coaxial cable (Cheapernet).

Network operating software like Novell or PC-NFS is used to operate the Ethernet adapter in networks. The access technique used by the Ethernet adapter complies with ISO/OSI standard 802.3.

The **Ethernet kit (option PSA-B22)** comprises the Ethernet adapter and the PC-NFS network operating software. Using this kit, the PSA 17 can be connected to networks in which a file server operates with TCP/IP protocols and NFS software. This may be, say a DEC mainframe from the VAX series, a SUN workstation or even a powerful compatible under SCO Unix.

Specifications

Only the data that are additional to or differing from the specifications of PSA 12/15 (see page 4) are given below.

Central processing unit

CPU	Intel 80386
Clock frequency	25 MHz

Expansion slots

Max. board dimensions (height × width)

16 bit (2×)	112 mm × 312 mm
16 bit (2×)	112 mm × 200 mm
8 bit	112 mm × 170 mm

Operating system (loadable)	MS-DOS 3.30
BIOS	AWARD 3.05

Screen

CRT	8″
Screen size	7.6″ diagonal (120 mm × 160 mm)
Surface	non-glare
Refresh frequency	60 to 70 Hz (depending on graphics mode)
Dot pitch	0.26 mm
Line frequency	31.5 kHz (non-interlaced)

Optional Ethernet Adapter PSA-B21

Slot type	8 bit
Connectors	AUI (Attachment Unit Interface), thin wire Ethernet (coax)
Transmission speed	10 MB/s
Optional Ethernet Kit PSA-B22	like the PSA-B21 but with PC-NFS software for networking with a DEC-VAX, a SUN workstation or an SCO Unix file server

General data

EMI	to VDE 0875, radio interference level N; typ. 8 dBµV/m below VDE 0871, limit class B
Weight (without options)	19.2 kg

Ordering information

Order designation	▶ Process Controller PSA 17	1026.1000.03
Accessories supplied	operating manual, BASIC manual, application manual (on disk), MS-DOS user's guide and user's reference	
Software supplied	system floppy disk with operating system, BASIC interpreter, demo software, application software, utilities	

Options

Ethernet Adapter	PSA-B21	1028.9009.02
Ethernet Kit	PSA-B22	1028.9309.02

Recommended extras

Service Kit	PSA-Z12	1006.6507.02
Software Update	PS-U11	1008.2609.02

Software

MS BASIC Compiler PDS, English	PS-K10	1028.6297.02

CELLULAR RADIO MEASUREMENTS

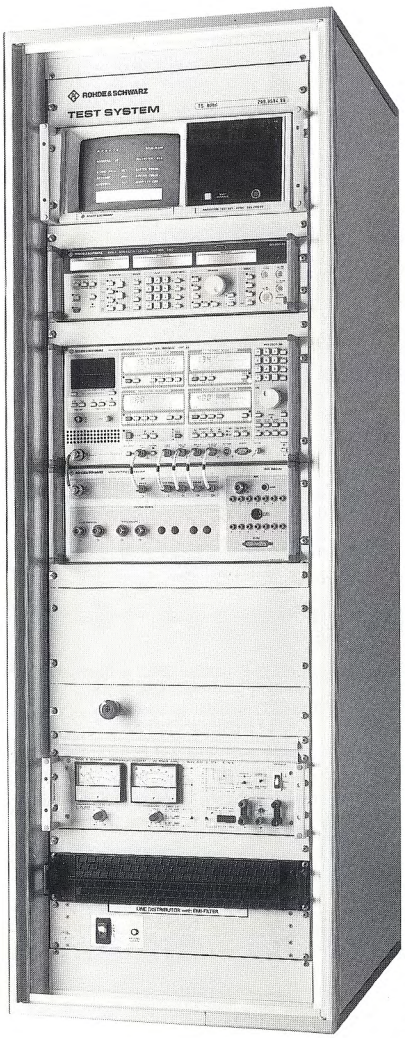
TEST SYSTEMS

TS 8100, TS 8200

These test systems can be used for all tests on single- or multichannel receivers as defined in **CEPT, ETSI and IEC** standards. Suitable software is available for measurements to selective-call standards **ZVEI 1 and 2, CCIR, EEA, CCITT, EIA, EUROFUNK, VDEW and NATEL.** Options allow simulation of the following cellular radio networks: **Network C, Radiocom 2000, NMT 900, AMPS and TACS**.

System panel

The universal system panel is tailored to the needs of **Radiocommunication Analyzer CMTA** (see main catalog 90/91, from page 178) for use in systems. It can be IEC/IEEE-bus-controlled and contains attenuators, highpass filters, timing boards, testpoint selectors and DUT connectors, allowing additional parameters of transmitters/receivers to be determined without having to change the test cables.



RT Test System TS 8200 for precision measurements on cellular radio equipment

Software

The **system software** is a menu-oriented user program than can be operated via mouse or keyboard. All test facilities provided in the test systems are fully independent of each other and can be called up in any sequence. In the password-protected **definition menu** DUT data sets can be defined, preset, individual input variables be modified or new test sequences be configured. All test results are recorded with date and time and stored for later processing. The **experiment mode** allows fast repeat measurements, eg when DUTs are being repaired. The **modular configuration of the control software** allows user-specific measurements to be added without any problem. It is not necessary to reinstruct the operator since the user-friendly environment is always the same.

System Panel TS-SP

Test System TS 8100 consists of:

CMTA – Radiocommunication Analyzer with option as required
NGPU – Programmable power supply for DUT
PSA – Process Controller with IEC/IEEE-bus interface
PDN – Universal Pinwriter
TS-SP – System Panel

System software package: user-friendly and menu-oriented, for all single-signal measurements.

Hardware integration in 19″ cabinet rack.

Test System TS 8200 consists of:

Measuring instruments as for TS 8100, plus
SMG/SMH/SWP – Signal Generator (synthesizer) as low-noise interference source for multi-signal measurements
TS-SP – System Panel

System software package: same as for TS 8100, plus multi-signal measurements.

Hardware integration in 19″ rack or in two desktop racks, mobile.

TYPE-APPROVAL TEST SYSTEM TS 8400

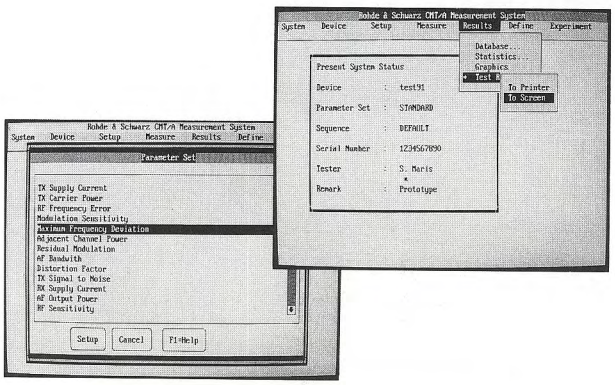
♦ 0.1 to 1000 MHz

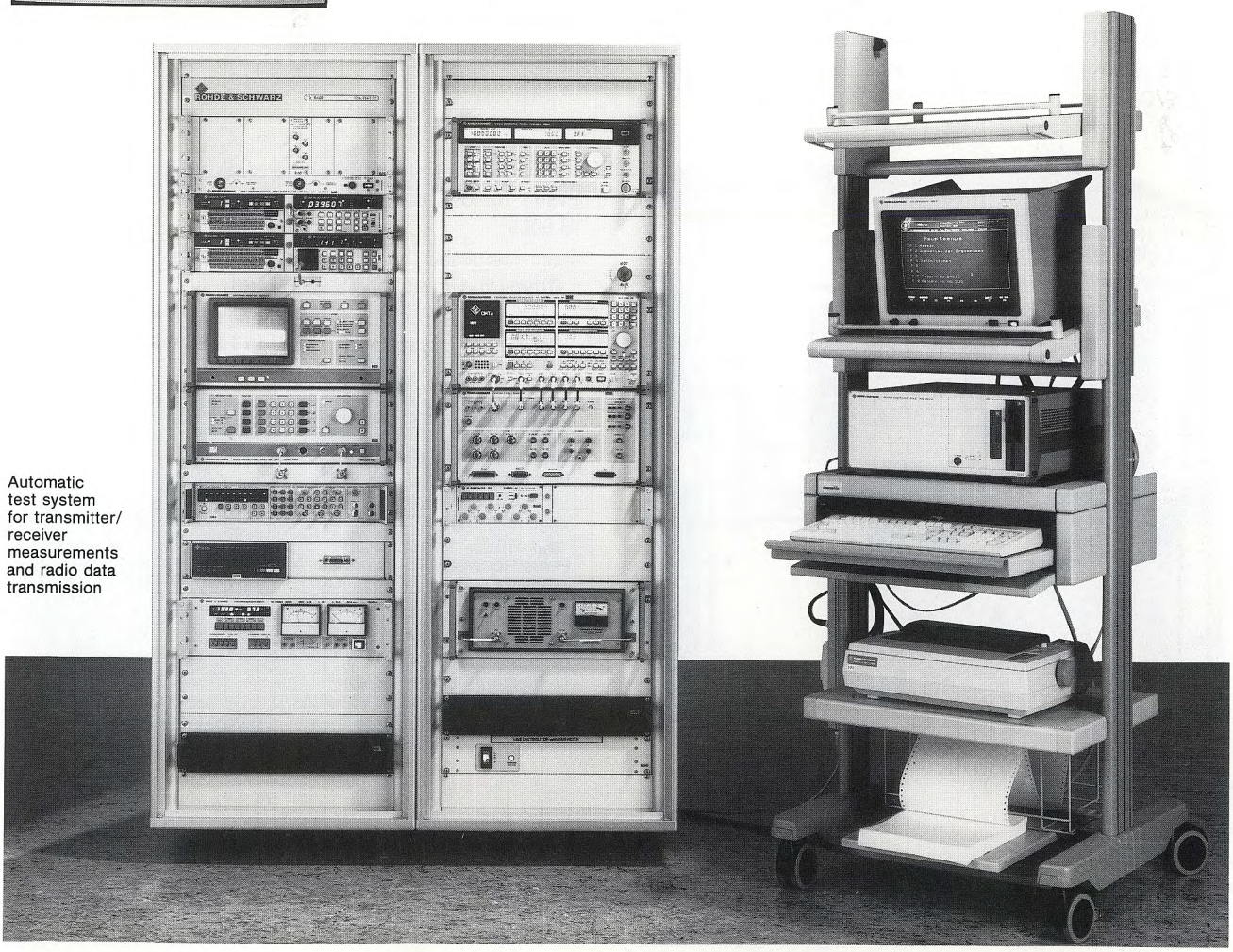
● For all AM/FM/φM/SSB transceivers, as well as for cellular radio and radio networks

This system is ideal for accurately reproducible measurements as are required in **type-approval testing, quality control and acceptance testing**. The **system software** is based on the same userfriendly software that is used in smaller systems with CMT/CMTA, but has expanded measurement capabilities and optional control of several instruments. The operator who is already familiar with the system, can easily make an upgrade himself. An abstract of all possible measurements is given in the brief specifications on the right, further user-specific applications can easily be generated.

Test system data in brief

Frequency range	0.1 to 1000 MHz
RF power measurement	up to 1000 W/50 Ω
Modulation types	AM/FM/φM/SSB
Selective call	Network C, Radiocom 2000, NMT 450, NMT 900, AMPS, TACS, ZVEI, CCIR, EEA, EIA, VDEW, NATEL and EURO
Standards tested	CEPT, ETSI, IEC/IEEE
Receiver measurements	S/N, SINAD, sensitivity for S/N or SINAD, limiting, image-frequency rejection, co-channel/adjacent-channel suppression, measurement of intermodulation and spurious responses, quieting, IF bandwidth, squelch level and hysteresis, AF bandwidth, AF output level, distortion, etc.
Transmitter measurements	RF power, frequency offset, modulation (deviation, sensitivity, limiting, frequency response, distortion), spurious modulation, S/N, adjacent-channel power, residual modulation, SSB spectrum analysis, etc.
AF/DC measurements	AF: frequency, level, voltage, distortion, multi-tone sequences; DC: current, voltage etc.





Automatic test system for transmitter/receiver measurements and radio data transmission

FIELD-STRENGTH MEASUREMENTS

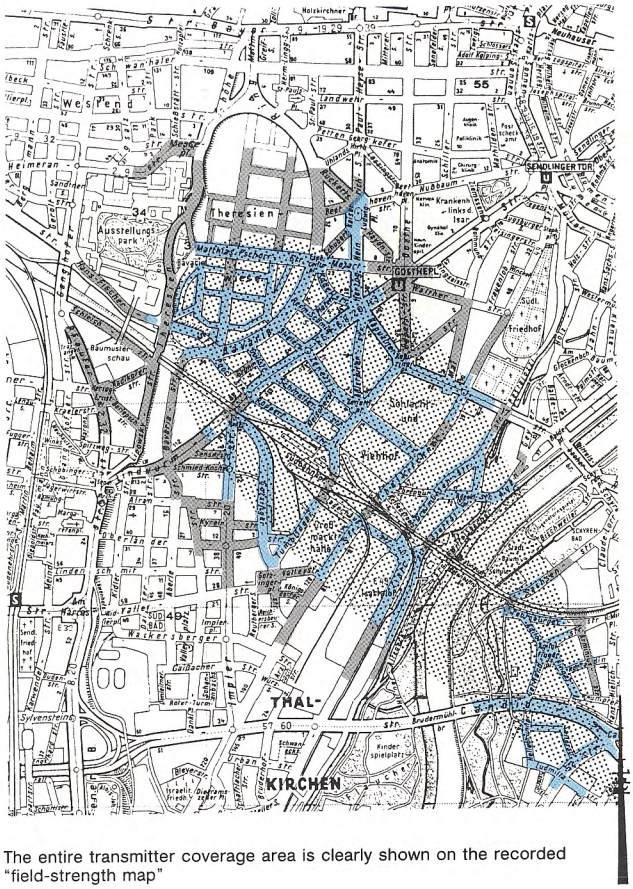
TEST SYSTEM TS 9955 ♦ Suitable for GSM

For **planning and checking** transmitter sites, **especially for cellular networks like the GSM**, a **mobile test system** is required to enable **measurements under operating conditions**. For a successful implementation of such projects it is absolutely necessary to exactly determine the required transmitter power, field-strength values and a variety of other parameters.

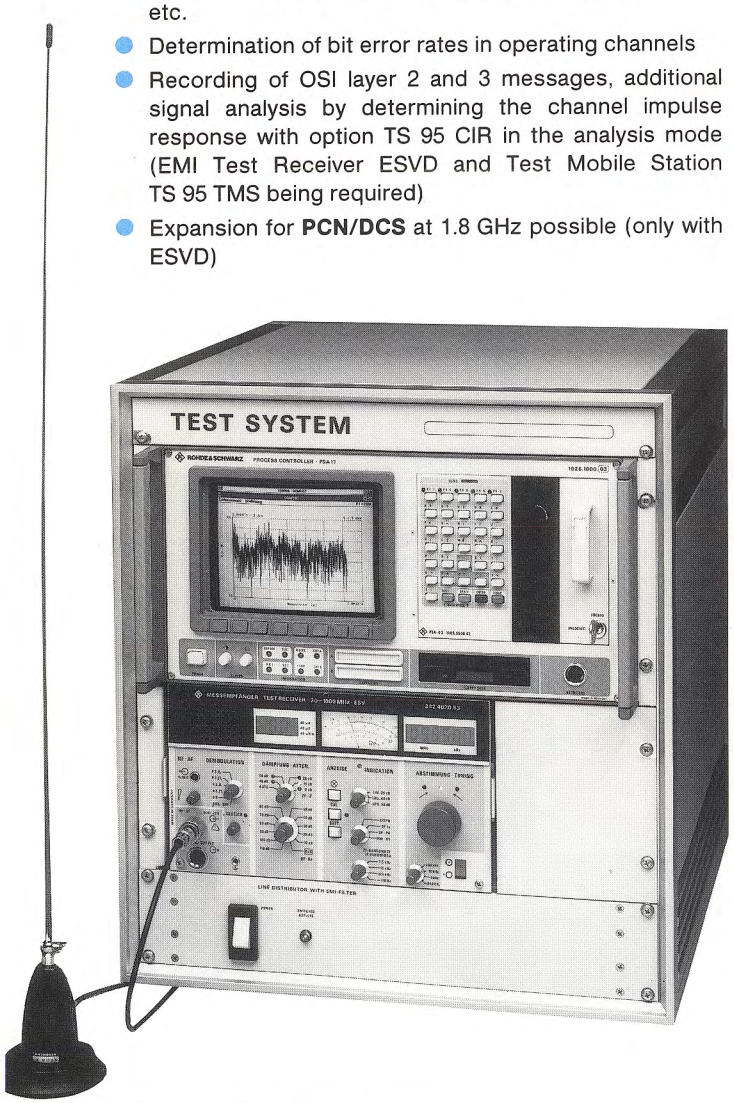
Test System TS 9955 from Rohde & Schwarz can optimally solve all these measurement problems. After evaluation of the data, the computer-aided system furnishes **comprehensive results** in the form of **level/path diagrams** and **cartographical representations**. This allows a realistic assessment of useful and interfering field strengths in the area surveyed.

Optional expansions for TS 9955 basic system for measurements in digital radio networks, **eg GSM:**

- Integration of test mobile stations (option TS 95 TMS) for recording system parameters like RXLEV, RXQUAL, etc.
- Determination of bit error rates in operating channels
- Recording of OSI layer 2 and 3 messages, additional signal analysis by determining the channel impulse response with option TS 95 CIR in the analysis mode (EMI Test Receiver ESVD and Test Mobile Station TS 95 TMS being required)
- Expansion for **PCN/DCS** at 1.8 GHz possible (only with ESVD)



The entire transmitter coverage area is clearly shown on the recorded "field-strength map"



Mobile test unit with Process Controller PSA 17 and Test Receiver ESV

For automation of **geographical data acquisition**, the following options can be integrated into the Test System TS 9955:

- self-contained navigation systems like **Travelpilot** or **Citypilot** with option TS 95 TP and
- externally supported navigation systems like **Global Positioning System with Option TS 95 GPS.**

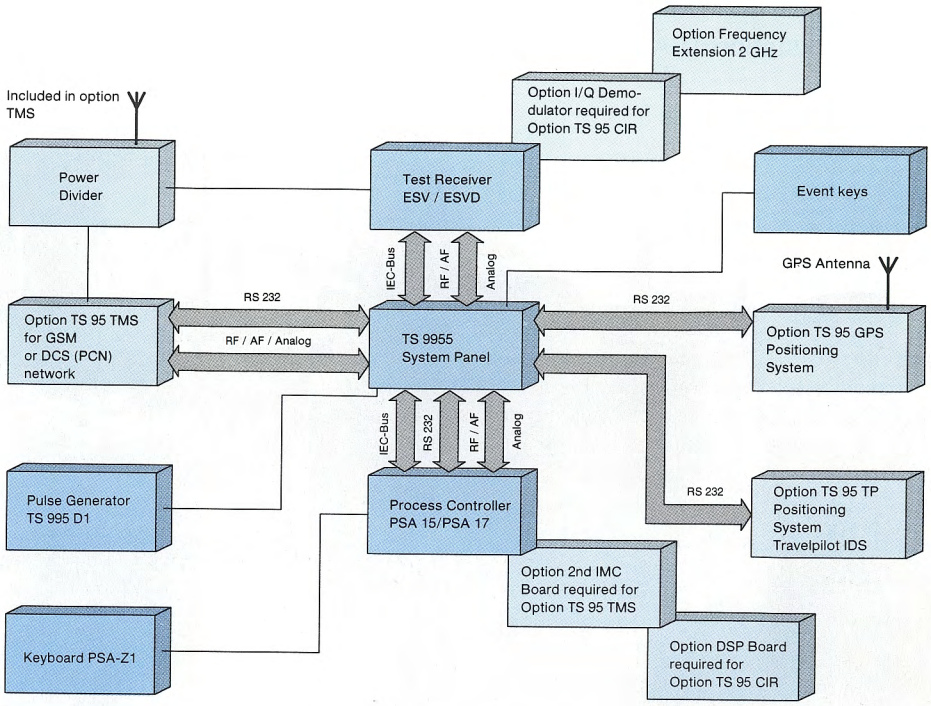
Test System TS 9955 consists of

a mobile test system with
Process Controller PSA 15 or PSA 17 (see pages 4, 12)
VHF-UHF Test Receiver ESV, ESVP (main catalog 90/91, from page 296) or EMI Test Receiver ESVD (modified ESVS 10, page 90)
Pulse Generator TS 995-D1
Software Package TS 995-SW

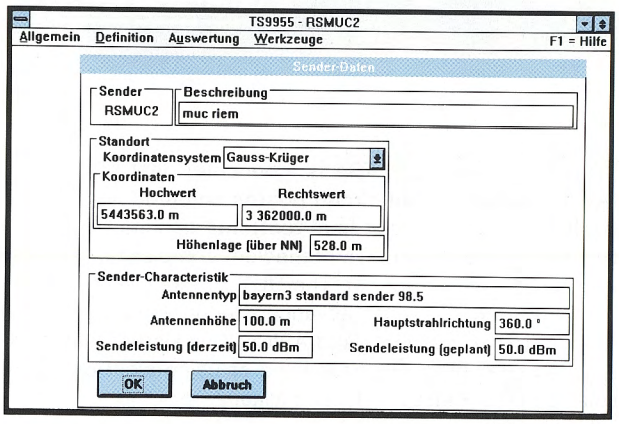
and a stationary evaluation system with
Process Controller PSA 15 or PSA 17
Digitizer TS 995-DC
Multicolour Plotter TS 995-PT
24-pin Pinwriter PDN (see catalog 90/91, page 454)
Colour Monitor PMC 2 (see catalog 90/91, page 40)

Explanation of abbreviations:

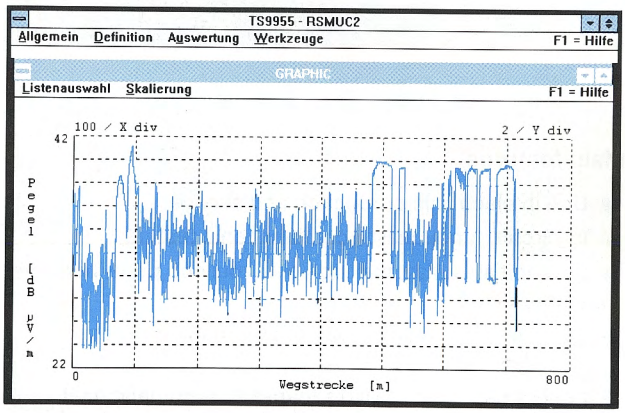
CIR	Channel Impulse Response
DCS	Digital Communication System
GPS	Global Positioning System
GSM	Groupe Spécial Mobile
OSI	Open System Interconnection
PCN	Personal Communication Network
RXLEV	Receive level
RXQUAL	Receive quality



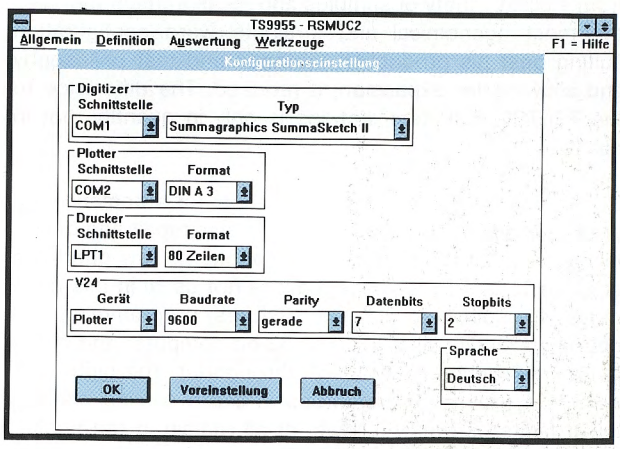
Block diagram and optional expansions for Test System TS 9955



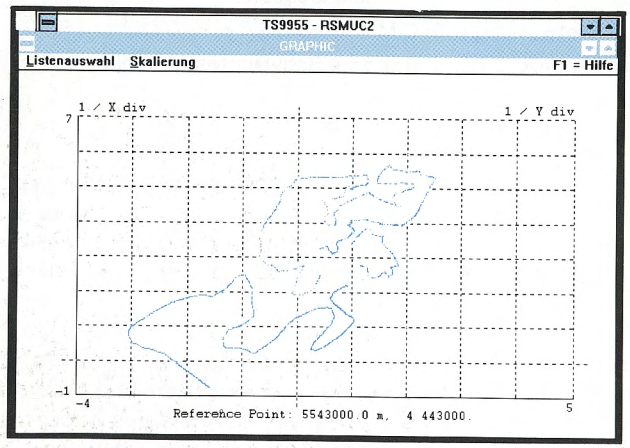
Input mask for general data of a transmitter under test



Output of results in a level/path diagram

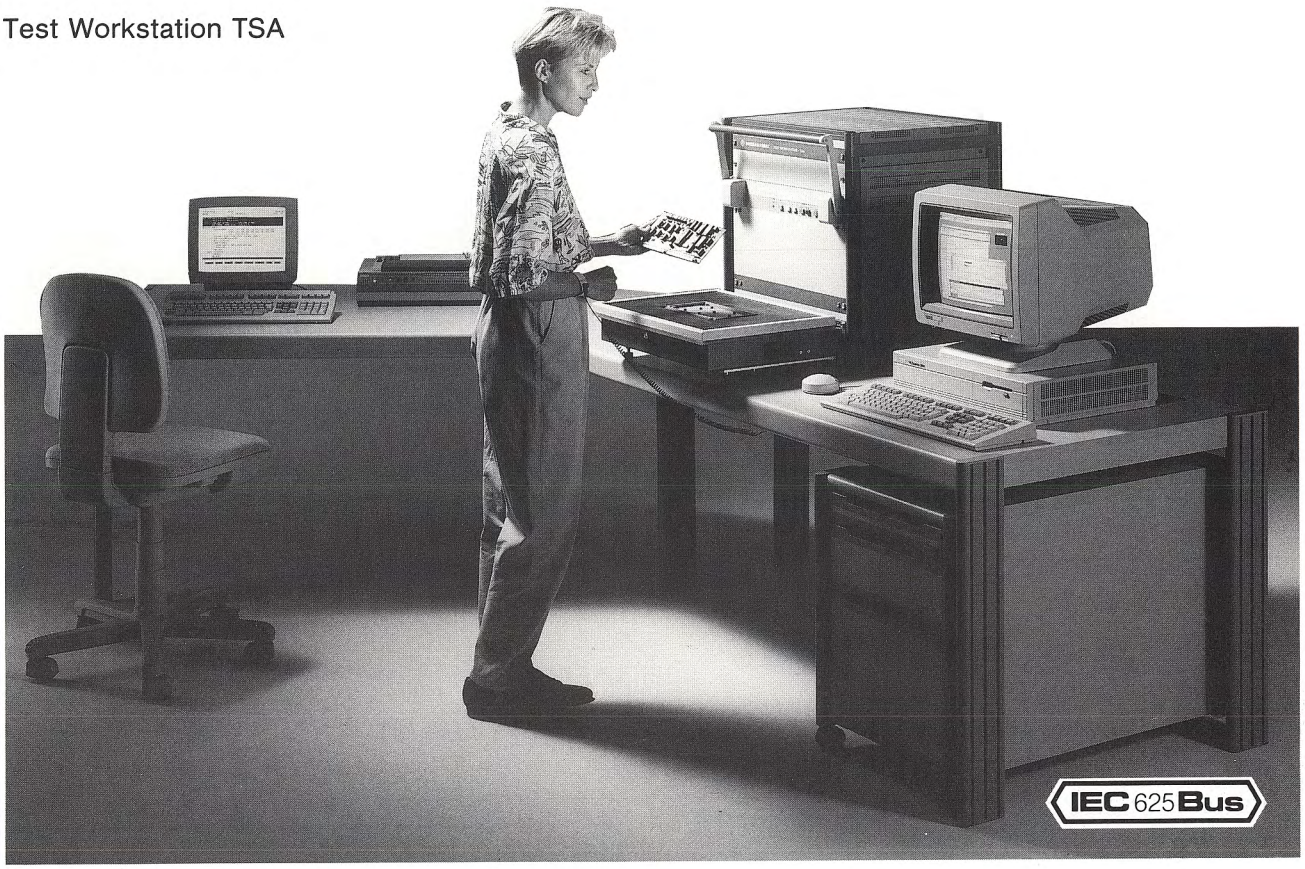


Setting mask for input/output peripherals



Cartographical representation of results

Test Workstation TSA



Main features

- Use in electronic production and service
- In-circuit, functional or combinational testing
- Low initial outlay making for excellent price/performance ratio
- Low costs of adaption 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
- Networking with CIM
- Compatible with Rohde & Schwarz tester family

Characteristics, uses

Automatic test stations like the TSI/TSIC/TSP have a key function in electronic production, since as a QA tool they are able to check the production quality and locate the problems as well as combine data from the development environment through to repair.

Test Workstation TSA complements the TSI/TSIC/TSP test system family in the lower price range. It is optimized for **medium-complexity UUTs.** The TSA features however the same test strategies, software tools and CIM integration capability like the "big ones".

Fields of application TSA is a benchtop test system for testing **loaded printed circuit boards and modules in production (board test and final test) and service.** The main field of application is UUTs of medium complexity, typically in double Eurocard format. The UUTs – like the TSA itself – incorporate the most advanced technologies such as SMDs, VLSI components and ASICs. This kind of testing is required in all branches producing or using electronics, in small-batch or mass production alike.

Economical solution to any test problem The TSA has the right test strategy for every test problem: **in-circuit, functional or combinational testing.** The user chooses from a great variety of stimulus and measurement modules the most economical and straightforward configuration suiting best his production methods and test philosophy and allowing for expansion, if required. The difference to the TSI/TSIC/TSP test stations is only in quantity, not in quality.

Due to **comprehensive software tools** for automatic program generation, fault location, paperless repair and quality management, the TSA provides, despite its **low purchase cost,** performance features that are not usual in this price range. The follow-up costs for fixtures, programming and operation remain also low. The 32-bit computer and distributed intelligence ensure high throughput. The high measurement precision guarantees in-depth testing so that fewer faults or even no faults at all remain in the subsequent production process. CAD and CAE data portability establishes the link to development.

TSA – a modular system

Test unit The test unit is the core of the system; it has 23 slots for accommodating the stimulus and measurement modules, an adapter interface and support plate and an UUT and system power supply. **Extremely short signal paths** ensure high-quality signal transmission between UUT and measurement modules. Due to its high integration density, the 19″ unit features on a minimum of space a **maximum of measurement capabilities** that were previously not attained. Moreover, the TSA is ergonomically designed and satisfies even the most stringent requirements regarding operating convenience.

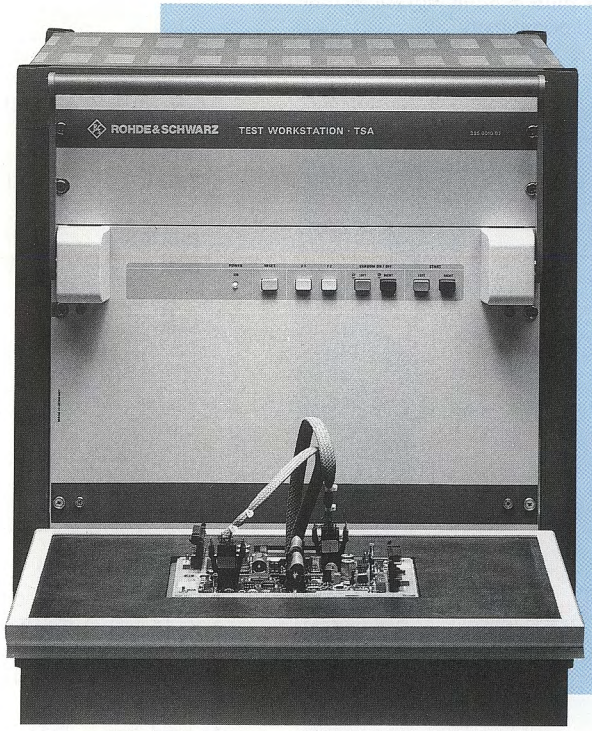
Fixture concept The proven fixture system, which is also employed with the **TSI, TSIC and TSP test stations,** transmits the signals between measurement modules and UUT. User-specific connectors can be plugged into three free ports of the adapter interface. The type of fixture is determined by the selected test strategy and the UUT. Two intergrated 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; analog stimulus and measurement modules, digital modules, switch and application modules can be inserted into the remaining 22 slots so that practically all requirements can be fulfilled.

Distributed intelligence achieved by integrating processors on different modules together with the 32-bit computer makes for a **high measurement speed.**

Computer There is a choice of two computers for the TSA: a **MicroVAX 3100** as a multiuser system with up to three terminals as standard, or a **VAXstation 3100** with 19″ monochrome monitor and **window, graphics and mouse,** enabling two-user operation with an additional terminal. Both computers use the **VAX/VMS operating system** and the TSS test operating system; both have a 209-Mbyte hard disk and a floppy disk drive (1.44 Mbyte) as well as interfaces to DEC 423, RS-232-C and IEC 625-1 (IEEE 488). The printer outputs both logs and lists; the standard Ethernet and Decnet software enables full networking. Additional terminals can be used to install further workstations for programming, paperless repair or quality management in parallel with the ongoing test mode.

Oberation Data input, programming and debugging is made via the alphanumeric keyboard of the computer and with the aid of the mouse. Programs, instructions or results are output on a terminal or graphics monitor. In batch testing, the control panel is used to start programs, answer queries, control the vacuum or reset the tester with the reset command. The program is automatically selected via barcode or by means of the fixture coding, so that even **untrained personnel is able to operate the test workstation.**



Test Workstation TSA:
start small – upgrade later

Expansions For special applications, external devices can be controlled via the **standard IEC bus** (IEEE 488). 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 TSA using a universal application module.

Compatibility within the tester family ranges from operation, language, software and computer through to direct portability of programs and adapters, enabling optimal utilization of the various test stations. The TSA provides a tester concept for production and service from the development environment through to repair and quality assurance. The result of all these features is **fast amortization.**

TSA – test strategies

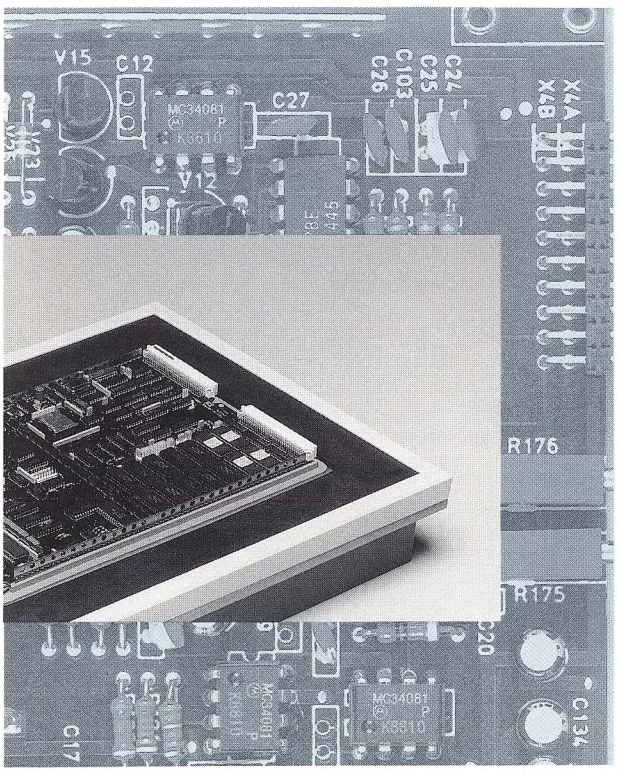
Analog in-circuit test

Field of application This method is ideal for in-production testing of printed circuit boards that are mainly fitted with analog components.

Method The analog in-circuit test of the TSA first checks **contact, shorts and opens** and then the **analog components** of loaded PCBs, such as resistors, capacitors, coils, diodes, Zener diodes and transistors. Multipin components such as potentiometers, relays optocouplers and operational amplifiers can also be checked for proper functioning. **Two-wire to six-wire guarding measurements** and quadrature measurements enable the effects of neighbouring components to be eliminated to a large extent. Typical production faults such as shorts, opens, soldering and insertion defects on boards mainly loaded with analog components are **diagnosed with high reliability** – much more reliably than with conventional prescreeners.

Program generation The automatic test generator (ATG) analyses the board description entered via keyboard or produced from CAD data regarding the attainable accuracy of the test, chooses the suitable test method and generates the test program.

Measurement configuration The analog in-circuit measurement unit (VMM, CMM, DCS modules) and switch modules (SMM) are required for this test method. The **maximum configuration of 912 pins** is sufficient for virtually all boards of medium size and complexity.



Vacuum fixture

Switch module	Pins/module	No. of modules	Max. No. of pins
SMM	48	max. 19	912

Hybrid in-circuit test

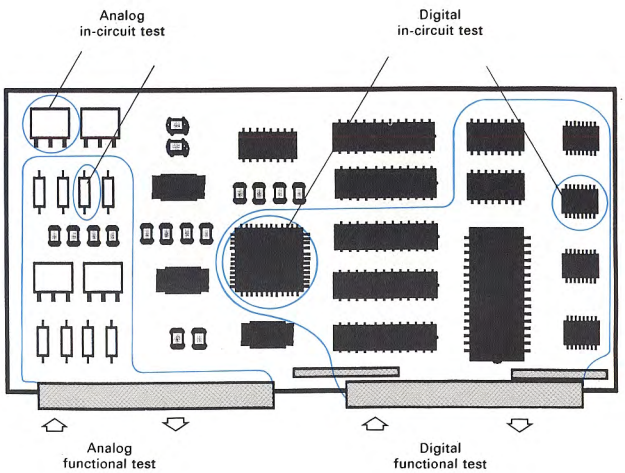
The **field of application** includes digital and hybrid (mixed analog/digital) loaded PCBs from simple complexity through to VLSI and microprocessor boards with RAMs, ROMs, ASICs and analog/digital components. This test method is mainly used in production.

Method This test comprises the analog in-circuit test facilities and also checks **each digital component** of a PCB for proper functioning and insertion. The influence of the component environment is eliminated by means of controlled backdriving, guarding and disabling. The TSA covers all technologies through to VLSI and processor boards: it generates up to **10 million patterns per second** with precise timing, levels up to ±15 V and flexible algorithmic sequence. Signature analysis and automatic bus tests are further methods.

For **program generation**, the automatic test generator uses the component library. The tests are matched to the component environment.

Measurement configuration This configuration comprises the analog in-circuit measuring unit (VMM, CMM, DCS modules), timing and address modules (TIM, ADM) for realtime control as well as driver/sensor/switch modules (see table below). The maximum configuration is **512 hybrid pins**.

Driver/sensor/ switch module	Test rate	Level	Pins/ module	Max. No. of pins
DSG	5 MHz	±5 V	64 hybrid	512 hybrid
DSA/DSF DSB	5 MHz 10 MHz	±5 V ±15 V	32 digital each	320 digital and
SMM	–	–	48 analog	320 analog



With in-circuit testing, each individual component of the board to be tested is checked independently; for functional testing, the TSA simulates the environment of the UUT.

Analog functional test

Field of application The analog functional test is used to check the **overall analog function** of mainly analog PCBs or modules in production or service and also allows adjustments. The measurement functions are implemented by means of high-speed measurement modules, some with own intelligence. Analog and digital signals can be synchronized with each other. The signals are available at fixed pins or via the switch equipment at any pin.

Stimulus and measurement modules

- **Digital multimeter module DVM** with $4^1/_2$-digit resolution for measuring voltage and current (DC, AC) and resistance
- **Timer/counter module TCM** for measuring period, time, pulsewidth and counting events up to 10 MHz, frequency measurement up to 200 MHz, programmable trigger threshold and sensitivity
- **Function generator module FGM** for generating precisely synthesized sine, triangular or squarewave pulses up to 1 MHz and with an amplitude up to 10 V_{PP}
- **Voltage source module VSM** with four floating sources up to 10 V
- **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
- **DC stimulus module DCS** as a four-quadrant current/voltage source up to 25.6 V and 200 mA
- Internal and external UUT power supply units of different ratings, fixed or programmable

Hybrid switch equipment Various switch modules provide for switching all types of signals from DC/AC through video to line voltages (380 V/8 A).

Application modules

- **Input/output module IOM** for switching and control tasks
- **Application module APM** for switching line voltages and for user-specific expansions with free space for additional circuits which must be integrated into the TSA
- **Application relay module ARM** with relays for analog and digital signals as well as line voltages

Digital functional test

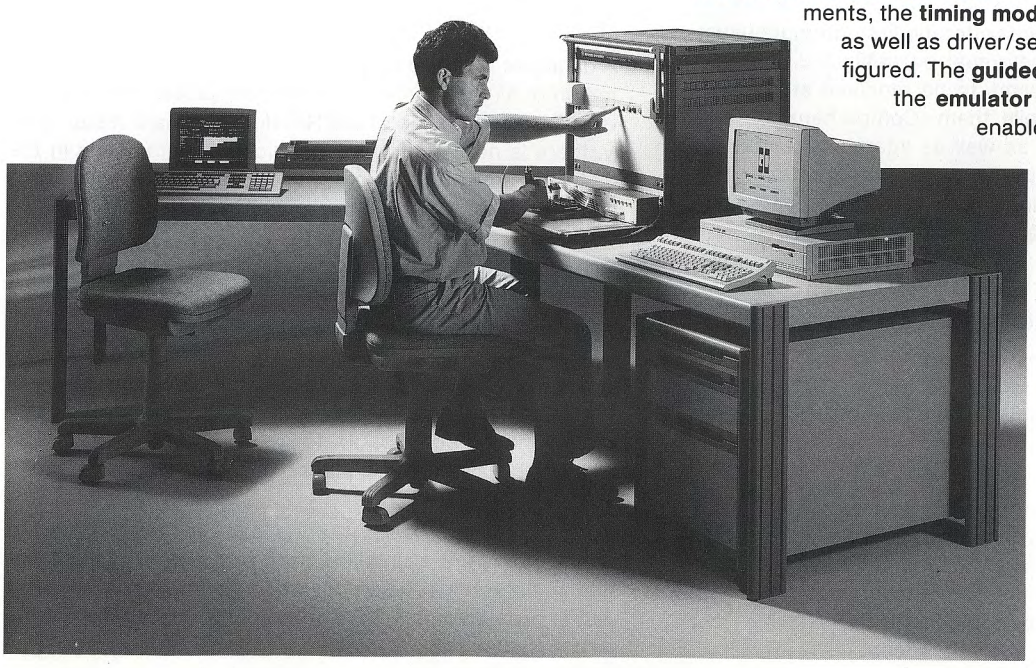
Field of application The digital functional test is used for checking the **overall digital function** of a PCB or module in production and service under operating conditions as close to reality as possible. Various driver/sensor modules satisfy the different requirements regarding timing and logic levels.

Functional test The **logic test equipment LTE** together with the driver/sensor modules DST and DSS provides up to **512 digital channels** (TTL or programmable up to ±30 V) as an economical solution where testing of the overall function is more important than the precise behaviour in time.

Realtime test In time-critical applications, dynamic driver/sensor modules (level range up to ±5 V or ±15 V) check the realtime behaviour of the UUT in addition to the function. At clock rates **up to 10 MHz,** timing resolution is further improved by clocks and timing sets. Programming can be simplified or adapted to UUT response by means of sequences with loops, subroutines and conditional branches.

In the **cluster test** mode, realtime testing is limited to sections of the circuit, making it more transparent. Signature analysis, logic-state display and an external microprocessor emulator provide further test and debugging facilities.

Measurement configuration Depending on the requirements, the **timing module TIM or TGM and ADM** as well as driver/sensor modules will be configured. The **guided-probe module GPM** and the **emulator** with more than 50 PODs enable in-depth measurements. Up to **136 dynamic channels with backdriving** are available to the user.



Combinational test

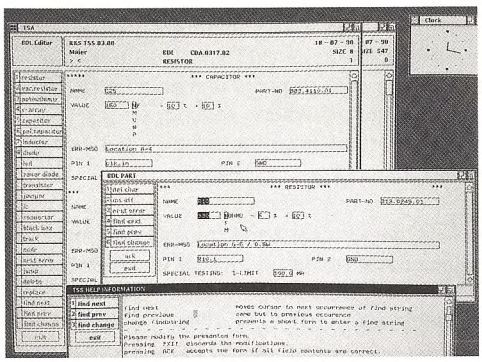
Due to its **modular design**, the TSA allows combinations of all test strategies within the potentials given by 23 slots. **Rohde & Schwarz will support the user** in finding an optimal configuration for his particular requirements.

TSA – software

Operation

Test Workstation TSA provides **menus and forms** which make for ease of operation without putting any restrictions on the advanced user. All permissible options are displayed on the terminal or workstation screen and selected using softkeys or the mouse. The **window technique** of VAXstation 3100 (X Windows) allows several pieces of information to be displayed on the screen simultaneously – just as if you were reading several books at a time. The help key provides assistance in case incorrect entries are made.

In the series test mode, settings and program selection are made automatically using barcode input or fixture codes. Operator inquiries are answered independent of the keyboard via the control panel keys of the test unit.



Form entry for in-circuit test

Programming

The **test language TSL** used by the TSI/TSIC/TSP/TSA test system family is a **high-level language for the test engineer** that is suitable for analog and digital in-circuit and functional testing. Standard terms like TEST, VOLTAGE or KHZ as well as node and signal names make it easy to follow the tests that have to be performed during program generation and updating.

Debugging Since programs after the first attempts usually do not run properly, they must be optimized. The TSA software allows the programs to be modified at any time without having to recompile them. Comprehensive start, stop and repeat facilities as well as interactive setting or reading of measuring instruments facilitate debugging. In the digital test mode, the logic state display is used to analyze patterns, timing sets and instruction sequence.

Automatic in-circuit test program generation

A major cost factor of test systems is the recurring expense for fixture and program generation. TSA reduces these costs through automatic test generation and diagnostics.

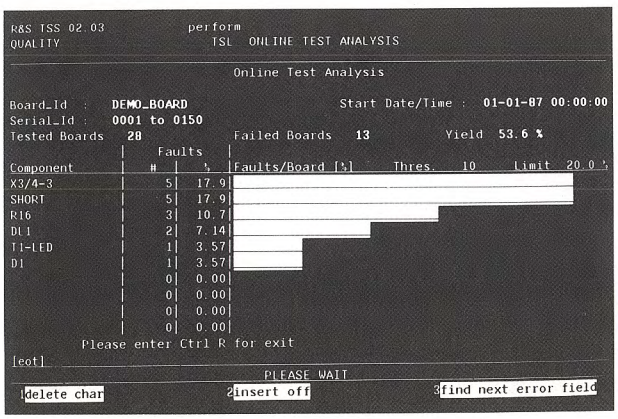
The **automatic test generator ATG** generates an in-circuit test program on the basis of the board description, which is either entered via menus or produced automatically from CAD data. After analyzing the circuit environment, the ATG chooses for each analog component the suitable test method with **guard points and tolerances**.

For digital component testing, the ATG uses the component **library containing more than 12000 components** to generate suitable tests and inserts tests to eliminate the effects of neighbouring components. The library contains MSI, LSI, VLSI and hybrid components and can be automatically updated with programmable logic devices **(PLD test generator).**

Automatic functional test generation and diagnostics

The **digital test generator CATE** uses simulation results from development and converts them into a functional test program with diagnostic data. TSA supports the simulators LASAR, CADAT and HILO. The **learn test generator** learns patterns or signatures of an unknown UUT to generate test programs and the diagnostic database. When the program thus generated is used for testing, a fault can be traced back to the faulty node or component using the **fault dictionary** or **guided-probe method.**

The **emulation test generator** is used for interactive generation of **turnkey tests** for buses, RAMs, ROMs or I/O devices by means of microprocessor emulation.



On-line quality analysis (histogram)

Paperless repair/quality management

A database is provided for paperless storage and administration of all test and repair data from production and service. For data logging of the Rohde & Schwarz tester family, there is no need for any additional programming in the test program. Testers from other manufacturers may also be integrated.

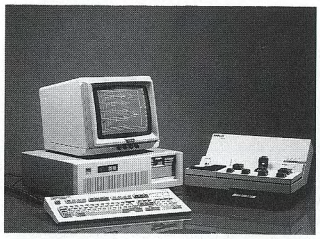
Repair station The data of the PCB to be repaired can be recalled via the barcode reader after identification. Following repair, the fault codes are entered into the repair form. In contrast to data logging on strip printer, **paperless repair** has the advantage that all data relating to the cause of fault are immediately available for repair and quality management. Connection to repair stations indicating faults in the layout on the screen or by cursor is possible.

Quality control Quality reports can be prepared on the basis of different evaluation criteria. In the form of **statistics and alarm messages** they provide current information on the production quality, so that corrective action can be taken in good time.

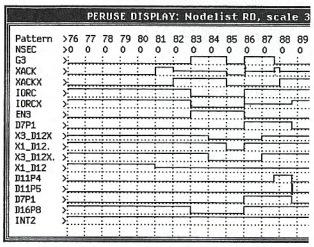
TSA – a complete system solution

Interfacing to development

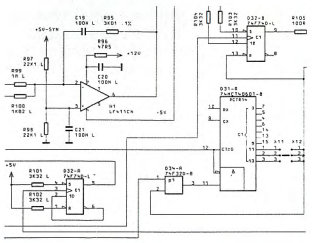
PLD test processor



Simulator interface

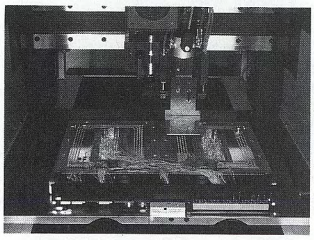


CAD interface

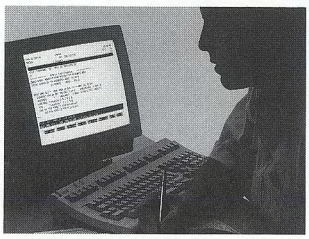


Test generation

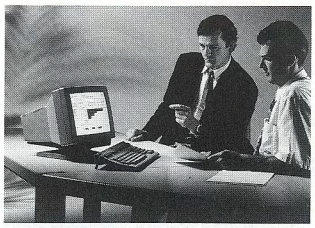
Fixture manufacture



Programming

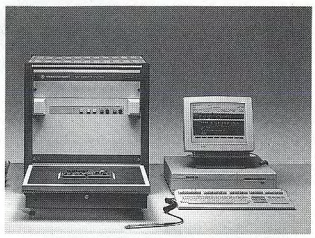


Quality control

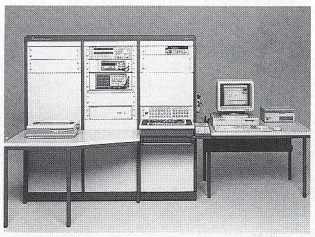


Production

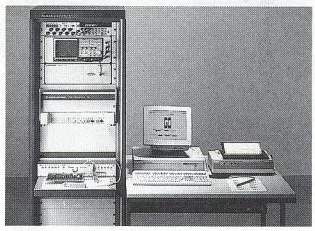
TSA (board test)



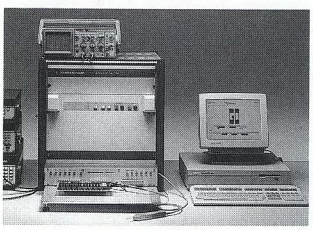
TSI TSIC TSP (board test)



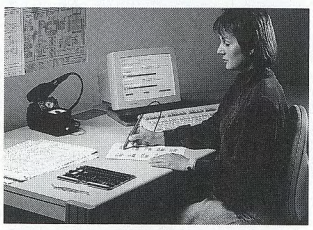
TSA (final test)



Service



Repair



Networking

TSA features a number of communication interfaces as standard. Serial lines on the basis of RS-232-C and DEC 423 enable point-to-point communications, using a modem also via the telephone network. Networking via **Ethernet** (thin-wire or thick-wire) using the network software DECnet is provided as standard. Software packages make it easy to communicate with UNIX or PC systems.

Service and support

Rohde & Schwarz supports the customer in finding a solution to his particular test requirements, works out the configuration and installs the TSA at the customer's premises. In addition to standard maintenance, individual maintenance concepts are also offered. A basic training course and optional in-depth courses provide the user with the knowledge required for optimal utilization of the test system. If desired, **complete fixtures and test programs** will be supplied or cooperation with test houses coordinated. Rohde & Schwarz can be reached at any time via the hotline.

Specifications

Test units (basic model)
Prepared for modular extension to analog or hybrid in-circuit tester, to analog or digital functional tester or to combinational tester

Number of slots	23, 22 of which are freely available for measurements or 19 for the pin extensions
Control module	for controlling all modules and internal power supplies, fixture coding, input/output ports
Control panel	keys: start, reset, vacuum on/off, 2 programmable function keys
Adapter interface	Pylon system, like TSI/TSIC/TSP family (see main catalog 90/91 from page 62)
Used blocks	7
Free blocks (for user extensions)	3 (for coax, high-voltage or high-current inserts)
Vacuum	2 integrated vacuum ports, 1 valve standard, 2nd valve optional, valves and control circuit incorporated in test station, external pump, vacuum coupler diameter 1 1/4"
Fixtures	single- and double-chamber fixtures (vacuum), two-stage fixtures, max. board size 410 mm × 310 mm, further fixtures on request

Internal UUT power supplies

Fixed voltage	5 V, max. 8 A
Error limits of voltage	±2 %
Programmable voltage UP1 (option)	2 × 12 to 15 V, max. 2 A
Ext. resistance-programmable	12 to 15 V each
Error limits of voltage	±(1 % + tolerance of resistor)
Voltage derating	max. 0.4 V (under full load)
Programmable voltage UP2 (option)	2 × 4.5 to 30 V, max. 1 A
Ext. resistance-programmable	12 to 30 V each
Error limits of voltage	±(1.5 % of fs + tolerance of resistor)
Ext. voltage-programmable	4.5 to 30 V each
Error limits of voltage	±0.5 % of fs
Voltage derating	max. 0.2 V (under full load)
Common features	floating, short-circuit-proof, can be cascaded, same types can be connected in parallel

External UUT power supplies

Programmable voltages/currents	0 to 7.99 V	0 to 9.99 A
(max. 4 units)	0 to 19.99 V	0 to 9.99 A
	0 to 39.99 V	0 to 4.99 A
Error limits of voltage	±(0.3 % + 30/40/60 mV) for 8-/20-/40-V units	
Error limits of current	±(0.5 % + 5 mA)	(range < 1 A)
	±(0.5 % + 20 mA)	(range ≥ 1 A)
Relay control	optional via input/output module IOM	
Power connection	signals applied to free special block	
Common features	floating, short-circuit-proof, electronic on/off switching	

Control unit

Computer	DEC MicroVAX 3100	DEC VAXstation 3100 graphic coproc.
Data memory	4 Mbyte	8 Mbyte
Hard disk	209 Mbyte	209 Mbyte
Floppy drive	1.44 Mbyte, 3.5"	1.44 Mbyte, 3.5"
Interfaces	IEC bus (IEEE 488)	IEC bus (IEEE 488)
	SCSI bus	SCSI bus
	Ethernet	Ethernet
	serial printer port	serial printer port
	2 free (DEC 423)	1 free (DEC 423)
VDU	DEC VT 420	graphic monitor 19", monochrome, 1024 × 864 pixels
Printer	DEC LA70	
Size	80 characters	
Printing speed	200 characters/s (draft quality) 40 characters/s (letter quality NLQ)	
Streamer tape (optional)	DEC TK50 (95 Mbyte)	

Software

Operating system	DEC VAX/VMS network software DECnet (further network software on request)
System software	test system software (TSS) for in-circuit and functional testing
TSS kernel with tools	form editors, editor/compiler, debugger for handling – test system language (TSL) – board description language (BDL) – component test language (CTL) – adapter descriptions (ADA) – text objects (TXT) standard TSL programs selftest (EST/OST), datalogging
Supplementary tools	automatic test generator (ATG), component library
Software options	PLD/CAD test processors digital test generator (CATE) for LASAR, CADAT, HILO emulation test generator (ETG) paperless repair software quality management system learn test generator (LTG)

Analog in-circuit test

Analog measurements	see catalog 90/91, from page 62
Analog stimuli	see catalog 90/91, from page 62

Pin configuration	SMM	DSG/SCM
Pins/module	48	64
Number of buses	6 and ground	6 and ground
Max. voltage/continuous current	100 V/1A	100 V/1A
Max. switch-on/off current	8 A/1 A	0.5 A/0.5 A
Max. number of pins	912	576

Hybrid in-circuit test

Analog measurements	see catalog 90/91, from page 62

Digital test (realtime test)

Measurement functions	digital in-circuit, cluster and realtime testing, logic analysis, signature analysis
Logic families	2
Pin memory capacity	4 K × 5 bit/channel 16 K × 5 bit/channel (virtual)
Each pin programmable	high-speed, birectional, signature analysis, trigger, low- or high-speed clock
Protection	backdriving control, overload protection, current limiting

Timing

Test rate	max. 10 MHz, depending on driver/sensor modules	
Type of modules	TIM	TGM
Number of clocks	4	7
Resolution	down to 10 ns	down to 100 ps
Events per clock	16 (with 1 clock)	256 (with 7 clocks)
Number of timing sets	1	16
External clock	max. 50 MHz	max. 100 MHz
Further features	interstep timing, multiclocking, synchr./asynchr. clocking, external trigger for all pins	
Command set	jumps, subroutines, loops, comparisons, conditional actions, delays, any vector execution, signature analysis start/stop, stop-on-fail mode, mixed mode analog/digital	

Driver/sensor modules	DSA/DSF	DSG	DSB
Multiplex channels: pins	1:4	1:8	1:4
Data rate max.	5 MHz	5 MHz	10 MHz
Drivers			
Standard level (High: 4.3 V, Low: 0 V)	TTL	TTL	TTL
Programmable level range[1]	–5 to +5 V	–5 to +5 V	–15 to +15 V
Difference	max. 5 V	max. 5 V	max. 20 V
Slew rate programmable (typ.)	250 V/µs to 80 V/µs	250 V/µs to 80 V/µs	350 V/µs to 80 V/µs
Output resistance	≤3.5 Ω (500 mA)	≤3.5 Ω (500 mA)	≤2.5 Ω (500 mA)
switchable to	–	–	50 Ω
Pulse width	min. 40 s		
Skew	≤±7 ns		
Driver format	non-return-to-zero/one, return-to-zero/one/off, complement, keep-previous-state, multiclocking		
Pullup/pulldown resistors	1.7 kΩ/900 Ω		
Resolution of driver level	10 mV[1])		
Static error limits	±150 mV[1])		
Max. current	500 mA (source/sink)		
Sensors	DSA/DSF	DSG	DSB
Level range	–5 to +5 V	–5 to +5 V	–15 to +15 V
Difference	max. 5 V	max. 5 V	max. 20 V
Static error limits			
5-V range	±40 mV	±40 mV	±0.3 % of rdg. ±50 mV
15-V range	–	–	±1 % of rdg, ±200 mV
Input resistance	≥35 kΩ	≥35 kΩ	≥100 kΩ
Thresholds	High and Low level independently programmable		
Resolution	2.5 mV		
Formats	measure, measure and compare, monitor driver, 0, 1, previous, complement state		

Pin configuration

	Driver/sens./ switch module DSG	Driver/sensor module DSA/DSF	DSB	Secondary matrix module SMM
Pins/module	64 hybrid	32 digital	32 digital	48 analog
max. number of pins	512 hybrid	320 digital + 320 analog = 320 hybrid		

Analog functional test

Digital multimeter module DVM
- DC voltage: 5 ranges 200 mV to 500 V
- AC voltage: 5 ranges 200 mV_{rms} to 400 V_{rms}
- DC current: 6 ranges 200 µA bis 10 A
- AC current: 6 ranges 200 $µA_{rms}$ to 10 A_{rms}
- Resistance: 6 ranges 200 Ω to 20 MΩ
- Resolution: 4 1/2 digits (3 1/2 at higher test rate)
- Switching: – via hybrid switch equipment; – special inputs for high current (10-A range) and high voltage (500/400-V range); – all inputs also accessible directly on adapter interface
- Other features: autorange, test sequences, averaging, ext. trigger, autocalibration

Timer/counter module TCM
- Channel A, B
  - Frequency range: DC to 10 MHz
  - Input sensitivity: 200 mV_{rms}
  - Resolution: 100 ns
  - Stability: 2×10^{-6}/year + 7×10^{-6}
  - Measurement functions: frequency/period, interval, pulse width, event counting, frequency ratio
  - Other features: AC/DC coupling, input sensitivity and trigger level programmable, 32-bit counter
  - Switching: – via hybrid switch equipment; – all inputs also accessible directly on adapter interface; – internal interface to digital test unit
- Channel C
  - Frequency range: 5 to 200 MHz
  - Input sensitivity: 200 mV_{PP} (f ≤ 100 MHz); 300 mV_{PP} (f ≤ 150 MHz); 400 mV_{PP} (f ≤ 200 MHz)
  - Input impedance: 50 Ω

Function generator module FGM
- Frequency: 1 Hz to 1 MHz
- Stability: 2×10^{-6}/year + 7×10^{-6}
- Waveform: sine, square, triangle
- Distortion: 2% (f = 1 kHz)
- Symmetry: 10 to 90%
- Amplitude: 0 to 10 V_{PP}/5 V_{PP} into 50 Ω
- Error[2]: ±(2.5% + 40 mV) (f ≤ 10 kHz); ±(6% + 40 mV) (f ≤ 100 kHz); ±(8% + 40 mV) (f ≤ 1 MHz) (sine, triangle)
- Offset[3]: –10 to +10 V
- Error: 2% (f = 1 kHz)
- Trigger: internal/external, single, continuous
- Other features: autocalibration
- Switching: – via hybrid switch equipment; – all outputs also accessible directly on adapter interface

Voltage source module VSM
- Number of sources: 4
- Voltage range/max. current: 0 to 10 V/5 mA, short-circuit-proof
- Resolution: 12 bit
- Error: 0.2% of fs
- Other features: floating, can be cascaded

DC stimulus module DCS[4]
(included as standard in analog in-circuit measuring unit)
- DC voltage/DC current: see analog in-circuit test
- Switching: via hybrid switch equipment

Digital functional test (low speed)

Driver/sensor modules	DSS	DST
Channels per module (pins/module)	32 (32)	32 (32)
Logic families	2	1
Max. number of channels	512	512
Drivers		
Family X	TTL	TTL
Family Y	–30 to +30 V[1]) max. 35 V difference	–
Max. current/output resistance	25 mA/50 Ω	50 mA/50 Ω
Driver format	0, 1, tristate	0, 1, tristate
Sensors		
Family X	TTL	TTL
Family Y	–30 to +30 V max. 35 V difference	–
Sensor formats	measure, measure and compare, monitor driver	
Driver/sensor delay	≥ 60 ns, resolution ≥ 30 ns	
Clock rate	depending on pattern, max. 50 kHz	
Other features	control by relays	

Realtime test: see hybrid in-circuit test (digital test)

Channel configuration for digital realtime test

	Driver/sensor/ switch module DSG	Driver/sensor module DSA/DSF	DSB
Channels/module	8	8	8
Max. number of channels	64	136	64

Guided probe module GPM: see TSP, catalog 90/91, from page 62

Emulator measurement system: see TSP, catalog 90/91, from page 62

Hybrid switch equipment

Secondary matrix SMM, SCM: see analog in-circuit test (pin configuration)
- DC resistance per line: < 2.5 Ω
- 3-dB bandwidth (50 Ω): ≥ 3 MHz

Instrument multiplexer module IMM (primary matrix)
- Number of ext. inputs/module: 16 (coaxial)
- Outputs/module: 6 buses + 6 video pins
- Number of modules with 3-dB bandwidth (50 Ω): max. 3
  - Standard pins: ≥ 3 MHz
  - Video pins: ≥ 25 MHz

The stimuli and measurement modules contain the primary matrix component and do not require IMM.

Other modules

Input/output module IOM
- Relays (adapter interface): 4 (1 × single-throw), 2 (1 × double-throw)
  - Max. voltage/current: 100 V/1 A
- Birectional ports (TTL): 2 × 8 bit
- Input ports (TTL): 2 × 8 bit

On rear of module, max. 2 external UUT power supplies up to 10 A can be connected for control by relays at free connector blocks.

Applications relay module ARM
- Relays (adapter interface): 24 (1 × single-throw)
- Relays on rear of module: 8 (1 × double-throw)
  - Max. voltage/current: 100 V/1 A
- Power relays (rear of module): 3 (2 × single-throw), 1 (1 × single-throw)
  - Max. voltage/current: 250 V AC (380 V AC)/8 A

Application module APM
- Birectional ports (TTL): 4 × 8 bit, 2 × 8 bit of which optionally optocoupled (input or output)
- Terminal area for DIL, SIL, SMD: 250 cm^2
- Pins to adapter interface: 48
- Pins to rear of module: 96 (DIN 41612)
- Power supply: +5 V/4 A, +12 V/1 A, –12 V/1 A
- Power relays (rear of module): 3 (2 × single-throw), 1 (1 × single-throw)
  - Max. voltage/current: 250 V AC (380 V AC)/8 A

General data

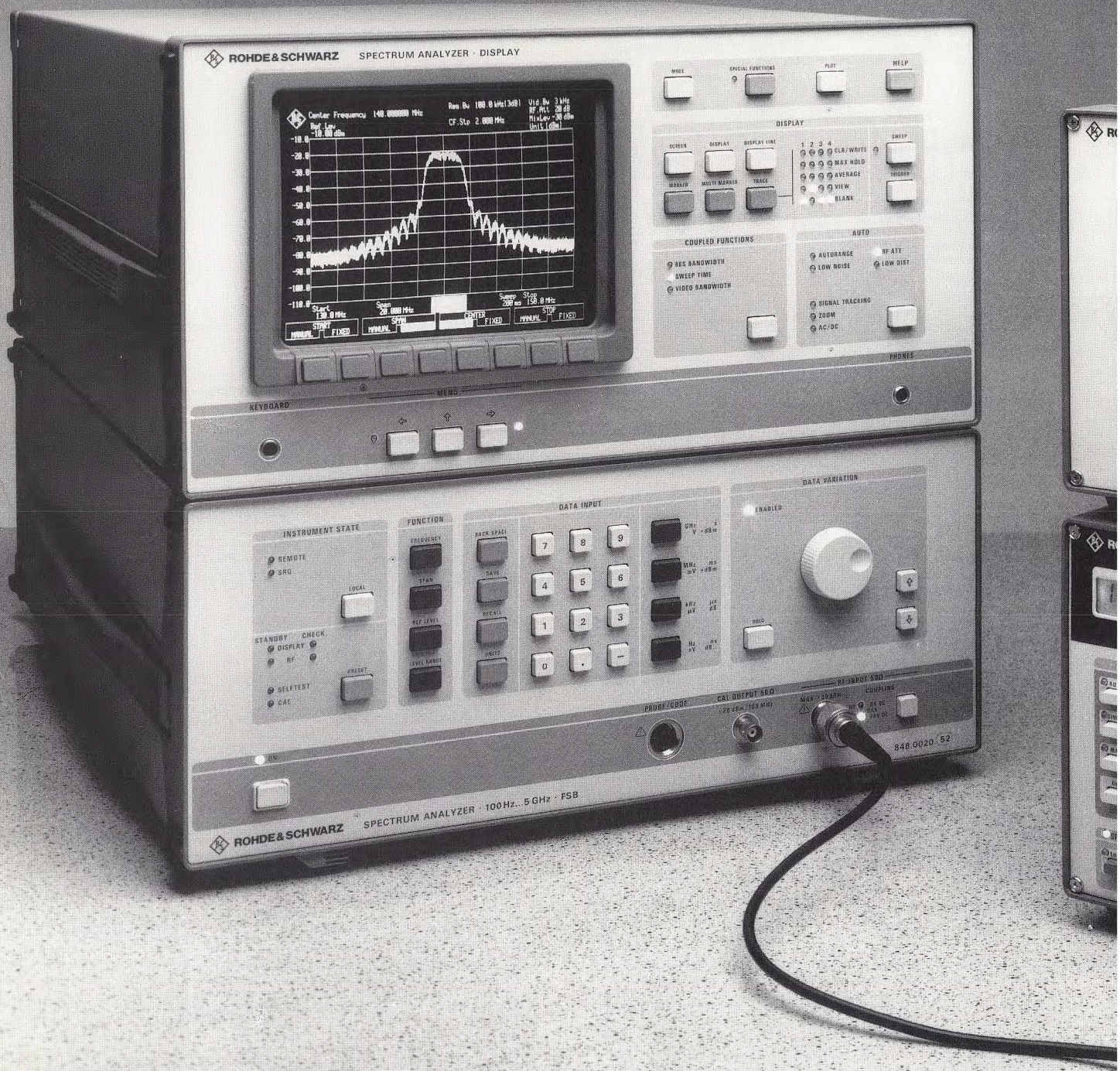
- Storage temperature range: –40 to +65 °C
- Rated temperature range: +13 to +33 °C
- Max. humidity: 20 to 80 %, without condensation
- Safety regulations
  - Test unit: meets VDE 0411 and IEC 0348 requirements, satisfies VDE 0871 class B requirements for radiated and conducted interference
  - Computer: meets safety regulations to VDE 0805/IEC 435, RFI suppression to DBP regulation 523/1969 and VDE 0871 class A
- Power supply: 230 V ±10%, 47 to 63 Hz, safety class I, to VDE 0411 (IEC 348) max. 1300 VA (test unit) max. 190 VA (computer) other voltages on request
- Dimensions
  - Test unit (19″ benchtop model) including fixture support plate (W × H × D): 555 mm × 595 mm × 890 mm
  - Computer (W × H × D): 462 mm × 103 mm × 400 mm
- Weight of test unit: max. 90 kg
- Weight of computer: 7.7 kg

Ordering information

Order designation
- Test Workstation TSA 382.7320.02
- Digital Functional Tester TSA 90 382.7420.02
- Analog/Digital Functional Tester TSA 92 382.7520.02
- Analog In-circuit Tester TSA 94 382.7620.02
- Combinational Tester TSA 96 382.7720.02
- Hybrid In-circuit Tester TSA 98 382.7820.02

[1]) With external level references.
[2]) Accuracy specified for outputs directly on adapter interface.
[3]) Sum of offset and amplitude: ±10 V
[4]) Specifications only valid in conjunction with VMM/CMM modules.

Three top-class instruments in use:
– Dual Arbitrary Waveform Generator ADS
– Signal Generator SMHU 58
– Spectrum Analyzer FSB (chapter 4)



		Page
Arbitrary Waveform Generators	ADS/AMS	28
Arbitrary Waveform Designer	AWD-K1	34
Signal Generator	SMHU 58	36

signal generators

AMS/ADS

Arbitrary Waveform Generator AMS/ADS ♦ User-programmable waveforms

- 12-bit amplitude resolution
- 16-Kpoint waveform memory per channel
- Sine synthesis with high spectral purity (0.1 Hz to 5 MHz)
- Generation of triangular waves with high linearity (0.1 Hz to 100 kHz)
- User-programmable frequency sweep converting a maximum of 8191 arbitrary frequencies
- ARB sequence mode for generating signals with extremely long periods
- 25-MHz clock frequency
- 320-Kbyte memory

IEC 625 Bus

Arbitrary waveform generation (ARB) is a key feature of the most up-to-date function generators. Because they can generate signals with any shape and repeat them as often as required, this new class of electronic tools has become indispensable in many areas of research and engineering. The AMS and the ADS are two examples of this type of instrument form Rohde & Schwarz. They combine excellent characteristics with an operating convenience that sets new standards.

Characteristics, uses

User-programmable waveforms and sequences, the precision of digital sinewave and triangular wave synthesis combined with extraordinary sweep characteristics make the **Arbitrary Waveform Generator AMS** a general-purpose signal source.

The **Dual Arbitrary Waveform Generator ADS** adds two independently programmable synthesis channels to the capabilities of the ADS. Thanks to its simple channel synchronization facility and its precise phase setting, the ADS is ideal for generating complex signals.

A programmable clock generator, a trigger generator whose period and symmetry can be set with crystal accuracy, an IEC/IEEE bus, RS-232-C intferface and digital waveform outputs are standard for both instruments.

ARB generators are essential tools for

- Digital modulation
- Communication engineering
- Navigation engineering
- Automatic test equipment
- Component testing
- Audio engineering
- Acoustics
- Material testing
- Ultrasound engineering
- Filter design
- Video engineering
- Control engineering
- Sensor engineering
- Automotive engineering

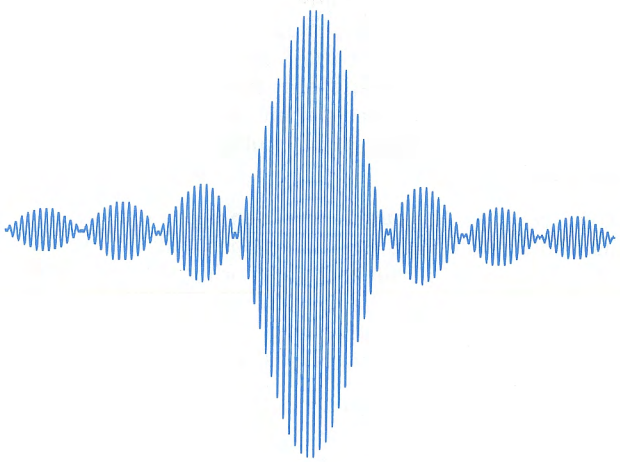
Further main features

- Easy-to-use editor functions for creating user-programmable waveforms, ARB sequences and ARB sweeps
- 25-MHz read clock (overrange to 30 MHz)
- Output voltage of 0.1 mV to 10 V (V_{pp}) into 50 Ω
- −5 V to +5 V DC offset
- 320 Kbyte nonvolatile memory for
  - 20 front-panel setups
  - up to 99 ARB signals
  - up to 99 ARB sequences
  - up to 99 ARB sweeps
- Memory card
- ARB application software

Applications

Precise signal simulation: ARB The signals required for effective tests on highly sophisticated electronics – from ICs to complete systems – either cannot be produced by conventional function generators, or if they can, only in an approximate form. The AMS and ADS with their synthesis facilities now give development engineers the means of generating exact replicas of those signals which their products will encounter under real conditions. This means that **problems** which would otherwise be missed **can be ironed out in the design stage**.

Thanks to its second independent channel, the ADS is more flexible than instruments with just one channel. It is ideal for developing and testing modern communication equipment which uses digital modulation requiring two precise signals for **driving I/Q modulators**. For these applications, the ADS is the ideal signal source as it has a high clock frequency, high amplitude resolution and precise channel synchronization. Application software provides flexible digital filtering making the provision of hardware filters superfluous.



Carrier with $\frac{\sin x}{x}$ modulation

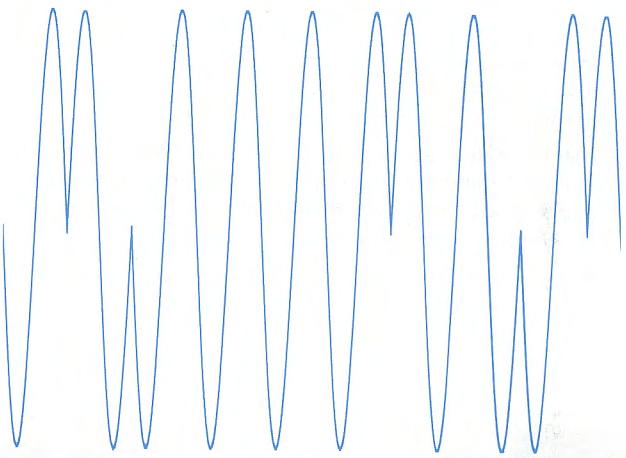
The newly developed **waveform editor** is a **highly convenient** way of handling synthesis and modifying any waveform or application-specific sweep. Previously, this could only be done using external computers with the appropriate software. The complete **waveform library** stored in the internal memory by the user can be accessed and is available for editing.

In the **sequence mode**, ARB signals can be joined up to give one continuous programmed sequence which can contain **up to 8191 elements**. By assigning a repetition rate (1 to 65535) to any element in the sequence, it is possible to create sequences that use a fraction of the memory required for conventional ARB synthesis.

Each element in the sequence can be assigned an individual read clock frequency. In this way, "stretched" ARB signals can be included in the sequence. The SEQ editor, like the ARB editor, is used to program and modify ARB sequences.

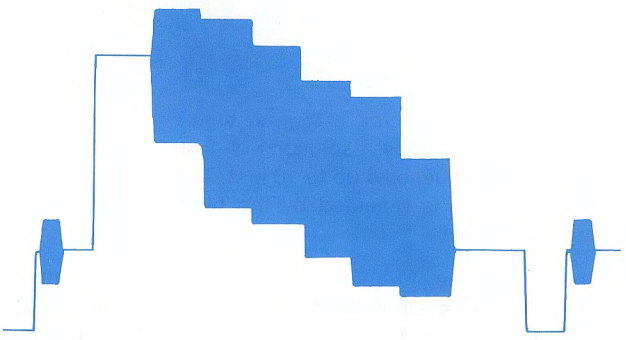
Many signals that are frequently required and which can only be generated by a great deal of programming, if at all, are easy to generate using ARB sequences.

In the sequence mode, the AMS and ADS are ideal for **generating long data sequences for testing digital communication systems**. When the waveform memory is appropriately programmed, 12 different data streams can be simultaneously output via the 12-bit digital output.



The AMS and ADS are ideal signal sources for modem tests as it is easy to generate PSK and FSK modulated sine signals with the sequence function

Thanks to the **high clock frequency**, the **large waveform memory** and the **flexible programming facilities** for the sequence mode, the AMS and ADS can be used as **video signal sources** for generating signal patterns laid down in current standards, or likely to be specified in the standards of the future. The separately programmable channels of the ADS are particularly useful for carrying out tests on display units with separate video and sync inputs.



Generating video signals with the AMS/ADS

AMS/ADS

Applications

Sine and triangular signals are important basic functions which are pre-programmed and can be called by simply pressing a key.

As the **sine signal has a high spectral purity** and high resolution (1 Hz, switchable to 0.1 Hz for frequencies less than 500 kHz) over a **large frequency range** (0.1 Hz to 5 MHz), the AMS and ADS are ideal sine signal sources for a wide range of applications:

- the **extremely flat frequency response** and harmonic distortion of typically –70 dB are essential for audio measurements
- the ADS is the right instrument for tests on phase detectors and PLLs as it has a **fine phase resolution** of 0.02 degrees
- internal superimposition of the two ADS channels provides two-tone signals for intermodulation measurements
- thanks to its **precise phase, level and offset setting**, the ADS can generate SSB signals with a sideband suppression of typ. 70 dB, when used with the I/Q modulator of the Signal Generator SMHU 58
- PSK, FSK and pulse modulation applications

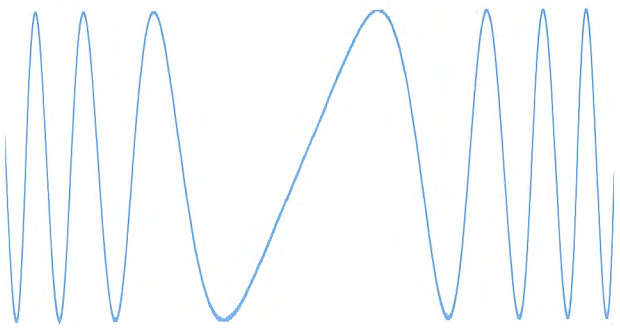
ADS used with SMHU 58 to generate digitally modulated signals; Spectrum Analyzer FSB provides spectral display

The frequency range for **triangular signals** covers 0.1 Hz to 100 kHz. Frequency resolutions of 1 and 0.1 Hz can be selected for frequencies up to 10 kHz. The precision of the signal synthesis is reflected by the **high linearity** of the triangular signals.

In the sine mode, **frequency sweeps** comprising a maximum of 8191 discrete, uper-programmable frequencies are available. The sweep editor can be used to create linear and log sections of the sweep so that standard sweeps can be generated with a minimum of entries.

The minimum step time with internal triggering is 1 µs. Applications where extremely fast sweeps are required can be handled with external triggering which provides a **step time of down to 100 ns**.

Both the frequency and phase of each sweep step can be defined so that user-programmable **phase sweeps** for testing phase-sensitive circuits can be generated.

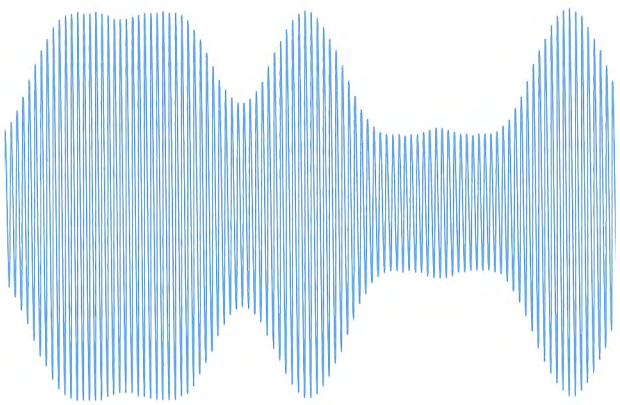


There are no phase discontinuities when a frequency is changed. Frequency changes can be made by the internal trigger generator, external pulses or manually

The AMS and ADS are ideal for generating tone signalling sequences to a variety of standards. This is because they have **fine frequency resolution** and a precisely settable trigger generator in sweep mode. Thanks to internal superimposition of the synthesis channels in the ADS, it can generate **DTMF (Dual Tone Multiple Frequency) sequences**.

Level control The **output level can be controlled externally** to simulate rapid level fluctuations (fading), for amplitude modulation, pulse modulation or for testing ALCs. In the case of the ADS, the two channels can be controlled separately. The input impedance of the control paths is 50 Ω, the bandwidth is typically 50 MHz.

Internal level setting can be provided via electronic setting circuits which, in contrast to the built-in mechanical attenuators, do not interrupt the signal path. This is important for determining the trigger threshold of electronic detectors, ALCs and other level-sensitive circuits.

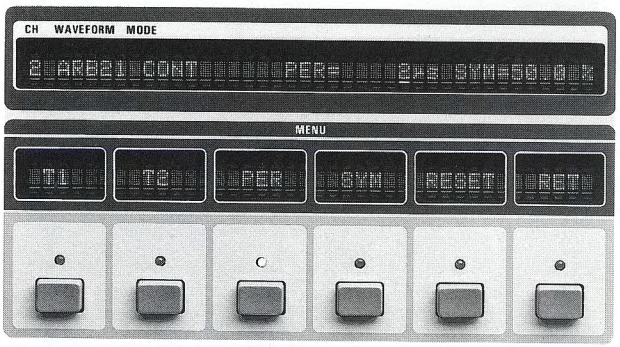


Controlling the amplitude of channel 1 with channel 2

Operation

Trigger functions A range of trigger functions (SINGLE, GATE, RESET, HOLD and HOLD/RESET in ARB mode, SINGLE and STEP in sequence mode) provide flexible control for signal generation.

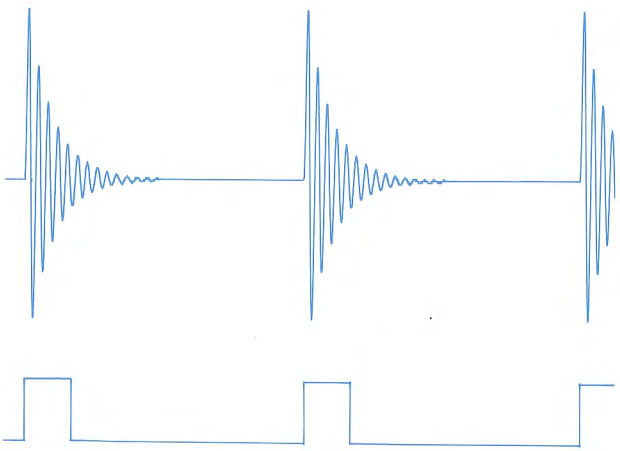
In the sine mode, the modulation modes frequency shift keying (FSK), **phase shift keying** (PSK) and **pulse modulation** (PM) can be selected as well as the trigger functions HOLD and HOLD/RESET. Triggering can be carried out with the internal trigger generator, using an external source or manually.



Menu for setting trigger parameters

Using the **trigger generator,** whose period and on/off ratio are adjustable, the trigger operating modes can be controlled with crystal accuracy. The period can be varied between 1 µs and 2000 s and the on/off ratio with a maximum resolution of 500 ns can be obtained. The signal is available at the trigger input/output connector of the synthesizer channel.

The input impedance and the trigger threshold are selectable (50/600 Ω, 0.2/2 V) for **external trigger signals.** The trigger input is electronically protected against overloads. The ADS has separate trigger inputs/outputs for independent control.



Single mode: triggered sequence of an exponentially decaying sine signal

Clock supply An internal or an external clock can be used for signal synthesis, the latter being used for frequencies up to 30 MHz (overrange). The clock period of the internal generator can be adjusted over a range of 40 ns to 2.5 ms with a resolution of down to 40 ns.

Filters Six switchable lowpasses per channel ensure that the output signals are filtered in a way appropriate for the waveform. **Four modified Bessel filters of the 3rd order** (10 kHz, 100 kHz, 1 MHz and 2.5 MHz) and **two modified Chebishev filters of the 7th order** (500 kHz, 5 MHz) are available.

Digital output Digital waveform outputs, fitted as standard, mean that the AMS and ADS can be used as flexible, digital word-generators with a word width of 12 bits per channel. As well as the data signals, the clock signals for both channels are also output.

Memory configuration Each synthesis channel is assigned a fast **waveform memory** with a capacity of 16384 points (with an amplitude resolution of 12 bits). This memory stores the current curve or curve sequence.

Both models have 320 Kbytes of **non-volatile memory** which can be used in a flexible way. As well as 20 complete front-panel setups, 99 different ARB signals, 99 ARB sequences and 99 sweeps can be stored. They are assigned to different pools, the ARB pool, the SEQ pool and the SWP pool, for ease of handling. This means that in addition to the standard sine and triangular functions a large number of waveforms programmed by the user can be called by simply pressing a button.

Accessories

The **memory card**, which is available as an option, allows application-specific waveform libraries to be set up.

Memory card

ARB software (on request) To define new waveforms, another effective software tool, the **Arbitrary Waveform Designer AWD-K2,** complements the ARB editor. It operates in conjunction with an industry-standard controller and supports the graphical creation of waveforms on the screen, the generation of waveforms by entering mathematical formulae or signal transfer from a storage oscilloscope. Stored signals can also be modified in a variety of ways.

AMS/ADS

Option

The **Clock Generator Option ADS-B1** replaces the standard clock generator with a high-resolution clock synthesizer. The synthesizer doubles the period that can be obtained from the standard generator, giving a maximum value of 5 ms. The main advantage, however, is the resolution which is increased by a factor of 4000 (10 ps). The clock generator makes it thus possible to set the period of the ARB signals more accurately. The reference input/output of the option, which can be switched between 5 and 10 MHz, can be used to synchronize the AMS and ADS with other equipment.

Specifications

The ADS contains two independently settable channels. All specifications apply without restriction to both channels.

Signal output

Output impedance ..... 50 Ω

Output voltage (AC)
Range (V_{PP}) ..... 0 to 20 V (EMF, I_{max} = ±100 mA), 0 to 10 V (into 50 Ω)
Resolution ..... $3^1/_2$ digits, min. 0.1 mV
Error at 1 kHz, V_{PP} > 10 mV ..... < ±0.2 dB (typ. ±0.1 dB)
Non-interrupting level setting ..... with special function
Setting range ..... typ. > 40 dB
External level control ..... with special function
Internal superimposition of channels (ADS only) ..... with special function

DC offset
Setting range ..... −5 V to +5 V (into 50 Ω), not affected by level setting
Resolution ..... 3 digits, min. 10 mV
Error ..... < ±0.2 dB + residual offset
Residual offset ..... < ±20 mV ±1 % of level setting

Waveforms

Standard waveforms ..... Sine, triangular
User-definable waveforms ..... single ARB curves or composite ARB sequences

Sine
Frequency range ..... 0.1 Hz to 5 MHz
Frequency resolution
1 Hz to 5 MHz ..... 1 Hz
0.1 Hz to 500 kHz ..... 0.1 Hz (special function)
Frequency error
after 20 min warm-up ..... < 4 × 10^{-5} + aging error
Aging error ..... < 1 × 10^{-5} per year
Frequency-response flatness (referred to 1 kHz)
20 Hz to 100 kHz, offset 0 V .... < 0.1 dB
100 kHz to 5 MHz ..... < 0.5 dB
THD
20 Hz to 100 kHz, offset 0 V .... < −60 dB (typ. −70 dB)
Harmonic and nonharmonic spurious signals
100 kHz to 2 MHz, offset 0 V .... < −60 dB
100 kHz to 5 MHz, offset 0 V < −50 dB

Triangular
Frequency range ..... 0.1 Hz to 100 kHz
Frequency resolution
1 Hz to 100 kHz ..... 1 Hz
0.1 Hz to 10 kHz ..... 0.1 Hz (special function)

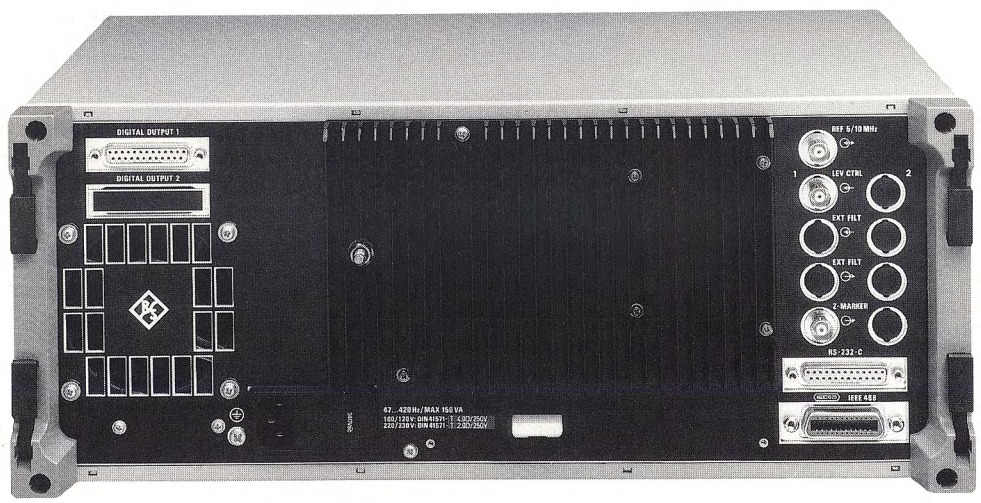
Phase setting (ADS only)
Setting range CH1/CH2 ..... −180° to +180°
Resolution ..... min. 0.02°

Operating modes
Continuous mode ..... CONT
Trigger operating modes
Frequency shift keying (FSK) ... no phase discontinuities over whole frequency range
Phase shift keying (PSK) ..... setting range −180° to +180°, resolution 0.02°
Pulse modulation (PM)
Reset (RESET) ..... triggered phase-reset to 0°
Hold ..... triggered stop
Hold/reset (HD/RS) ..... triggered stop and restart

Sweep mode
Digital, user-programmable frequency and phase sweeps, triggered internally, externally or manually
Frequency range ..... 1 Hz to 5 MHz
Step width ..... user-selectable, min. 1 Hz
Phase range ..... −180° to +180°
Step width ..... user-selectable, min. 0.02°
Step time
Internal ..... 1 µs to 2000 s
External ..... min. 100 ns
Sweep marker ..... user-selectable within sweep limits

User-selectable waveforms
Curve length ..... 2 to 16 384 points
Amplitude resolution ..... 12 bits
Rise/fall time ..... < 9 ns (10/90 %)
Setting time ..... typ. < 30 ns (1 %)
Overshoots ..... < 5 % (filter off)
Glitch energy ..... typ. < 40 pVs (V_{out} = 1 V_{PP})

Clock source (CLK) ..... internal or external
Internal
Output impedance ..... 50 Ω
Signal ..... HCT/TTL compatible
Read frequency ..... 400 points/s to 25 Mpoints/s
Resolution ..... min. 40 ns
Frequency error
after 20 min warm-up ..... < 4 × 10^{-5} + aging error
Aging error ..... < 1 × 10^{-5} per year
External
Input impedance ..... 50/600 Ω, selectable
Input signal ..... ±0.5 V to ±5 V
Frequency range ..... DC to 25 MHz (typ. 30 MHz, depending on operating mode)



Rear-panel connectors of AMS and ADS

Filters
Modified Bessel filters
(3rd order) ..... 10 kHz, 100 kHz, 1 MHz, 2.5 MHz
Modified Chebishev filters
(7th order) ..... 500 kHz, 5 MHz

Operating modes
Continuous mode ..... CONT
Trigger modes ..... SINGLE, GATE, RESET, HOLD, HOLD/RESET

ARB sequences

Sequence length ..... 2 to 8191 ARB curves
Repetition rate for single ARB curves ..... 1 to 65535, programmable for each curve
Expansion factor ..... (1 to 65535) × clock period, programmable for each ARB curve

Operating modes
Continuous mode ..... CONT
Trigger modes ..... SINGLE, STEP

Trigger mode

Trigger source ..... internal, external, manual

Internal trigger generator
Output impedance ..... 50 Ω
Signal ..... HCT/TTL compatible
Trigger period ..... 1 µs to 2000 s
On/off ratio ..... adjustable, 1:6500 to 6500:1
Resolution, ON/OFF time ..... min. 500 ns

External trigger
Input impedance ..... 50/600 Ω, selectable
Trigger threshold ..... 0.2 V/2.0 V, selectable
Trigger edge ..... rising or falling edge can be selected
Trigger state ..... switchable to active low or active high
Frequency ..... DC to 25 MHz

Manual triggering ..... with MAN key

Memory

Internal memory
Memory size ..... 320 Kbytes, nonvolatile
For storing ..... – 20 complete front-panel setups
– max. 99 ARB curves[1])
– max. 99 ARB sequences[1])
– max. 99 sweeps[1])

Memory card
Memory size ..... 128 Kbytes for storing front-panel setups, ARB curves, ARB sequences and sweeps

Clock generator (option ADS-B1)

Read frequency ..... 200 points/s to 25 Mpoints/s
Resolution ..... 0.01 %, min. 10 ps

Reference frequency
Input/output frequency ..... 5 or 10 MHz, selectable
Aging ..... $< 1 \times 10^{-5}$/month
Temperature effect ..... $\leq 5 \times 10^{-6}$/°C
Output level ..... > 0.2 V into 50 Ω
Input level ..... 0.2 V to 2 V into 50 Ω or HCT/TTL

Inputs/outputs

Front panel
OUTPUT 1 ..... signal output (ADS: CH1), 50 Ω, overvoltage protection to ±40 V DC
OUTPUT 2 (ADS only) ..... signal output CH2, data same as OUTPUT 1
MARK 1 ..... marker output (ADS: CH1), BNC, 50 Ω, HCT/TTL compatible
MARK 2 (ADS only) ..... marker output CH2, same data as for SYNC/MRK 1
CLK 1 ..... clock input/output (ADS: CH1): BNC, input for ext. clock signal, 50/600 Ω, output for int. clock signal, 50 Ω, HCT/TTL compatible, overvoltage protection to ±40 V DC
CLK 2 (ADS only) ..... clock input/output CH2, same data as for CLK 1
TRIGGER 1 ..... trigger input/output (ADS: CH1), BNC, input for external trigger signal, 50/600 Ω, output for internal and manual trigger signal, 50 Ω, HCT/TTL compatible, overvoltage protection to ±40 V DC
TRIGGER 2 (ADS only) ..... trigger input/output CH2, same data as for TRIGGER 1

Rear panel
DIGITAL OUTPUT 1 ..... digital waveform output (ADS: CH1), 25-contact connector, 12 bit + CLK, HCT/TTL compatible
DIGITAL OUTPUT 2 (ADS only) ... digital waveform output CH2, same data as for DIGITAL OUTPUT 1
Z-MARKER 1 ..... Z-marker output (ADS: CH1), BNC, output voltage ±15 V nom., 1 kΩ
Z-MARKER 2 (ADS only) ..... same data as for Z-MARKER 1
LEV CTRL 1 ..... input for ext. level control signal (ADS: CH1), BNC, 50 Ω, input voltage −1 to +1 V DC
LEV CTRL 2 (ADS only) ..... level control input CH2, same data as for LEV CTRL 1
REF 5/10 MHz (only with ADS-B1) reference input/output, BNC
RS-232-C ..... serial interface, DCE
IEEE 488 ..... IEC-bus interface to IEEE 488.2

Remote control

Remote control facility via IEC bus (IEEE 488.2) to SCPI[2]) or via serial interface (RS-232-C).

Remote-controllable functions .... all functions that can be set manually from the front panel, except EDIT, power on/off and variation knob

IEC bus (IEEE 488.2)
Connector ..... 24-contact connector
IEC-bus-address ..... 00 to 30, set from keypad
Interface functions ..... listener and talker, SH1, AH1, T6, L4, SR1, LR1, PP0, DC1, DT0, C0

RS-232-C interface
Connector ..... 25-contact connector (DCE)
Baud rate ..... 1200, 2400, 4800, 9600, 19200, selectable via special function
Parity ..... odd or even

General data

Rated temperature range ..... 0 to +55 °C
Storage temperature range ..... −40 to +70 °C
Power supply ..... 100/230 V −10/+15 %, 120/220 V −15/+10 %, 47 to 420 Hz, safety class I to VDE 0411 (IEC 348)
Power consumption ..... max. 150 VA
Mechanical stress ..... shock-tested to DIN 40046, part 7 (30 g, 11 ms) and vibration-tested to DIN 40046, part 8 (5 to 55 Hz, 2 g), meets IEEE Publ. 68-2-27 and 68-2-6
Dimensions ..... 435 mm × 192 mm × 350 mm
Weight AMS ..... 12.5 kg
ADS ..... 14 kg

Ordering information

Order designation AMS ..... ▶ Arbitrary Waveform Generator AMS 1013.0000.02
Order designation ADS ..... ▶ Dual Arbitrary Waveform Generator ADS 1012.4002.02

Accessories supplied ..... power cable, protective cover, manual

Option
Clock Generator ..... ADS-B1 ..... 1013.5748.02

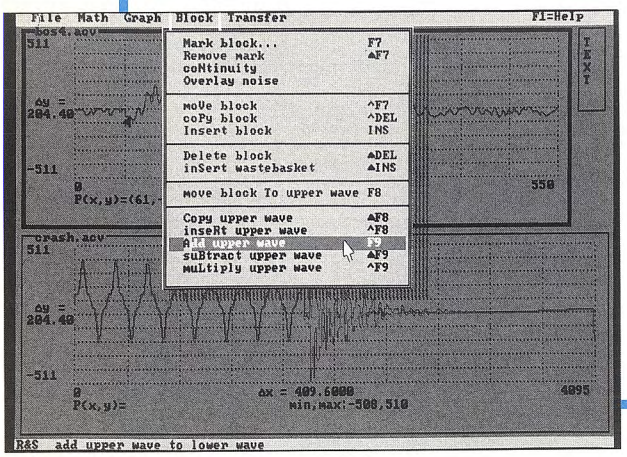
Recommended extras
Memory Card ..... CMS-Z2 ..... 841.1509.02
ARB Application Software ..... AWD-K2 ..... on request
Service Kit ..... ADS-Z2 ..... 1013.1494.02
19" Rack Adapter ..... ZZA-94 ..... 396.4905.00
Front Handles ..... ZZG-94 ..... 396.5160.00
Service Manual AMS/ADS 1012.9779.00

[1]) No. depends on free memory space.
[2]) SCPI = Standard Commands for Programmable Instruments.

AWD-K1

Software ♦ Arbitrary Waveform Designer AWD-K1

- Convenient design of arbitrary waveforms
  - Signal definition by means of mathematical formulas
  - Graphical entry of line segments
  - Signals from a digital storage oscilloscope
  - Support through waveform library
  - Modular signal construction
- Powerful tool for programming Function Generator AFGU



IEC 625 Bus

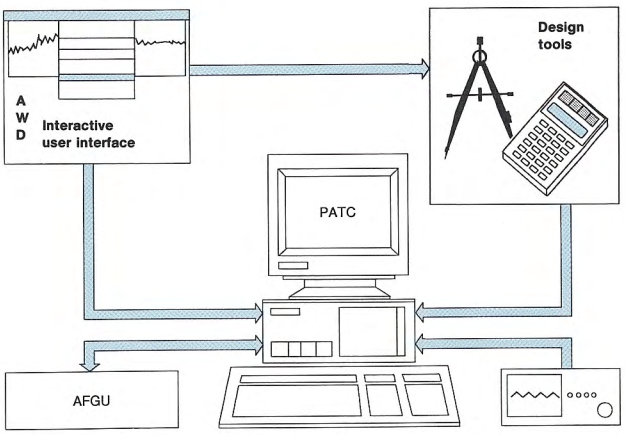
The task

Freely programmable waveform generators deliver signals of any shape. They are used to simulate real signals, eg those from sensors. Further fields of application are the generation of **complex modulation signals** and stimuli for materials and design testing.

In many cases, the requirements of such applications cannot be met using standard functions such as sine, triangle or sawtooth, but only with the aid of **user-defined waveforms.**

The solution

The **Arbitrary Waveform Designer AWD-K1** from Rohde & Schwarz is an application software that enables the user to generate **any kind of signal** on a computer without special programming. Via an IEC/IEEE-bus interface, the waveforms generated by the user can be transferred to the AFGU and output. The AWD-K1 ensures **convenient, flexible** and **customized** definition, transfer and output of arbitrary signals.



Application example with PATC and AFGU

Waveform generation

The AWD-K1 allows the **modular construction of curves** in three different ways that are closely linked to each other and also support one another.

Mathematical interpreter system The mathematical interpreter system generates the appropriate waveform within a defined range from a formula entered. The formula is entered in the usual infix notation (parentheses) using a **built-in text editor.** In addition, user-defined constants and variables can be used.

The user can choose from a large number of mathematical functions and operations such as sine, cosine, tangent, etc., as well as addition, subtraction, multiplication and division.

Graphics editor The graphics editor ensures easy entry of **any kind of line segment,** for instance, by the mouse. Curve sections (blocks) can be shifted, copied, inserted, or erased. When a block is erased, it is simultaneously stored in a **buffer** so that it can be reinserted into the generated curve any time. Data can be exchanged and linked between two **graphics windows.** It is thus possible to combine curve sections or to add, subtract and multiply them with one another. A **zoom function** allows the signal to be displayed with optimal resolution.

Transfer interface The signals from a digital storage oscilloscope can be transferred to the controller. The AWD-K1 can be used subsequently to manipulate the waveform or superimpose other signals such as noise.

By exchanging data with **Function Generator AFGU,** the waveforms generated can be stored and are available at the AFGU output.

File management

The **file manager** handles formulas and signal data. The waveforms can also be logged on a printer. Approximately 190 different makes of printers are supported. The AWD-K1 is able to use both monochrome and colour monitors; a **palette of colours can be selected.**

Easy operation

The graphics and mathematical tools of AWD-K1 make for simple stepwise generation of arbitrary waveforms. A user interface that is adapted to the SAA (Systems Application Architecture) Standard in line with the latest findings enables easy use of the application software. The **self-explanatory menus** display and activate the numerous functions of AWD and can be operated conveniently by means of keyboard and/or mouse. A **context-sensitive help system** furnishes information about the current menu item or dialog any time.

Specifications

System features

User interface	automatic adaptation to the graphics mode used, easy-to-operate menu, context-sensitive help system, interactive dialog boxes, DOS access, selectable colour palettes
Data types	INTEGER, Y axis: −511 to +511, X axis: 0 to 4095, internal formula computation: REAL with double precision

Mathematical interpreter system

Arithmetic operations	addition, subtraction, multiplication, division, raising to a power
Mathematical functions	sine, cosine, tangent, arc tangent, exponential function, natural logarithm, decadic logarithm, hyperbolic sine, hyperbolic cosine, hyperbolic tangent, square-root function, absolute value, unit step, square function, sign function
Notation	algebraic
Evaluation	definition of formula range
Standardization	automatic quantization (REAL/INTEGER conversion), option: automatic amplitude matching (autoranging), setting of autorange interval
Formula editor	text input, insert/overwrite mode, extensive erase functions (wastebasket), comfortable cursor control, automatic line feed

Graphics

Display	linear with automatic scaling
Coordinate system	automatic decadic setting
Display mode	X axis: time Y axis: voltage
Resolution	zoom and scroll function in X direction
Graphics windows	two graphics windows for simultaneous processing of two waveforms

Graphics editor

Generation of line segments	graphical determination of origin and end point of a straight line, line fixing
Block commands	marking, shifting, copying, insertion of a block
Extended block commands	erasure of a block, ie storage in a buffer (wastebasket), reinsertion into the waveform as often as desired

Data exchange

Combining of waveforms	insertion, copying, extraction of complete signals
Linking of waveforms	addition, subtraction and multiplication of waveforms
Linking of blocks and curve sections	1:1 ratio, continuously joined on the left
Additional functions	superposition of noise of variable level

Transfer interface

Setting functions	IEC/IEEE-bus address of generator
Communication with generator	transmission and reception of waveforms
Interaction with any kind of storage oscilloscope	transferring real signals, defined interface with a storage oscilloscope, driver library

File management, documentation

Files, I/O	convenient input and output of waveforms and formulas
Documentation	output of waveforms on all common printers

Hardware

Controller	controller family PSA, PATC, PAT or XT/AT compatible with the industry standard (AT with a minimum clock of 8 MHz recommended)
Operating system	MS-DOS 3.0 upwards
Main memory	minimum storage capacity 512 Kbytes
Monitor and monitor adapter	Hercules graphics card and monochrome screen, Enhanced Graphics Adapter (EGA) with monochrome or colour screen, Video Graphics Adapter (VGA) and monochrome or colour screen
Drives	hard disk drive with an available storage capacity of at least 2 Mbytes and $3^1/_2''$ or $5^1/_4''$ disk drive
IEC-bus card (IEEE 488)	R&S IEC-bus card (included in PSA, PAT-B1 being required for PAT and PATC), IEEE-488 Instrumentation Interface PCIIA from National Instruments or 100% compatibles
IEC-bus driver	Rohde & Schwarz IEC-bus Driver PS-K2, National Instruments GPIB-PC software
Mouse	Rohde & Schwarz PS-B1, serial Microsoft mouse or compatibles
Numeric coprocessor	Rohde & Schwarz PS-B10, Intel 8087 and compatibles
Printer	all common graphics or laser printers, from Acer, Alps, Anadex, Apple, Brother, C. Itoh, Canon, Centronics, Citizen, DEC, Epson, Fujitsu, Hewlett Packard, IBM, Kyocera, Mannesmann, NEC, Nissho, Okidata, Panasonic, Printronix, Ricoh, Rohde & Schwarz, Seikosha, Star, Texas Instruments, Tandy, Tektronix, Toshiba

Generator	Function Generator AFGU
Resolution of X axis	4096 points
Resolution of Y axis	1024 points
Step width	100 ns to 327 s

Storage oscilloscope	Digital Storage Oscilloscope BOS, Hewlett Packard 54200A, Hewlett Packard 54200D, Philips PM 3350 A, PM 3365 A, PM 3355, PM 3375

Ordering information

Order designation	▶ Arbitrary Waveform Designer AWD-K1, 6 disks of 360 Kbytes each with manual 1026.4500.02

Hardware

Function Generator	AFGU	377.5000.02
Process Controller*)	PATC	1011.8991.02
Mouse (multilingual manual)	PS-B1	1006.6359.02
IEC-bus Interface/BASIC	PAT-B1	1007.1150.02
IEC-bus Driver German	PS-K2	1007.1750.31
English	PS-K2	1007.1750.32
Numeric Coprocessor	PS-B10	1006.6107.02

*) As regards features, see relevant specifications.

SMHU 58

Signal Generator SMHU 58 ♦ 1 kHz to 4.32 GHz

- All SMGU and SMHU applications in the frequency range 1 kHz to 4.32 GHz
- Additional modulation modes in the frequency range 5 MHz to 1.95 GHz
  - I/Q modulation
  - Broadband AM, bandwidth 50 MHz
  - Broadband FM, bandwidth 20 MHz
  - GMSK for GSM mobile radio

IEC 625 Bus

Uses, characteristics

The **Signal Generator SMHU 58** is used for generating complex test signals for modern **communications and radar systems.** Its high versatility is based on the great variety of modulation capabilities in conjunction with high spectral purity and frequency hopping.

The I/Q and the broadband FM modulators of the SMHU 58 make all digital and analog modulation modes for directional radio and satellite communications possible. Modern radio networks, like the GSM mobile radio network and also DECT, PCN and ADC, use digital modulation methods, for which the SMHU 58 is ideally suited due to the high accuracy of its I/Q modulator. For modulation using serial data signals, coders can be integrated for the necessary signal processing and filtering to relevant standards. The optional GMSK coder produces from a serial data stream filtered analog signals for driving the I/Q modulator. The accuracy of the resulting phase modulation meets all requirements placed on a reference signal for GSM receiver testing.

The SMHU 58 configuration also provides all the features of a **top-class signal generator** for conventional applications.

Main features at a glance

- I/Q modulator for any phase and amplitude modulation modes (PSK, QAM, ASK, etc.) in modern communications systems, modulation bandwidth DC to 200 MHz
- Second, coherent carrier for simple I/Q demodulation
- Broadband amplitude modulation for TV applications, modulation bandwidth DC to 50 MHz, minimum incidental φM
- Broadband frequency modulation for satellite communications, radar and video applications, modulation bandwidth 20 Hz to 20 MHz, deviation 20 MHz
- Optional GMSK modulation for GSM mobile radio and PCN applications
- Frequency hopping, 4800 stored frequency and level settings; parallel bus interface for external addressing of memories; setting time <1 ms
- High spectral purity for out-of-channel measurements and LO applications
- High output power, adjustable up to +19 dBm
- High frequency accuracy and drift-free FMDC for FSK and VCO modes
- Fast AMDC for generating level bursts
- RF, AF, level and memory sweeps for automatic test runs, built-in AF generator

GMSK = Gaussian Minimum Shift Keying
GSM = Groupe Spécial Mobile
DECT = Digital European Cordless Telephone
PCN = Personal Communication Network
ADC = American Digital Cellular

The table shows which types of modulation can be combined

Modulation	AM	FM (φM)	Pulse	I/Q	BB-AM	GMSK	BB-FM
AM		●				●	●
FM (φM)	●		●	●	●	●	
Pulse		●		●	●	●	●
I/Q		●	●				●
BB-AM		●	●				●
GMSK	●	●	●				
BB-FM	●		●	●	●		

The **modulation facilities** of the SMHU 58 include the usual modes of top-class generators, ie **AM, FM, φM and pulse modulation**, which can be utilized over the entire frequency range from 1 kHz to 4.32 GHz, plus the additional facilities for **I/Q modulation** and its special applications GMSK and broadband AM (BB-AM) as well as for **broadband FM** (BB-FM). These modulation modes can be used between 5 MHz and 1.95 GHz, ie within the TV satellite IF band and the transmission bands of present and future radio networks.

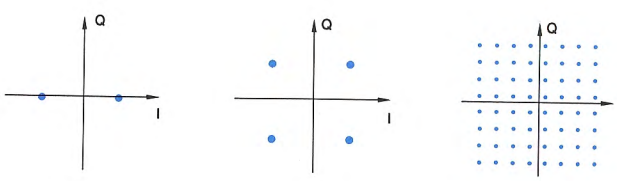
Simultaneous modulation is required for simulating the complex signals of modern communications and radar systems. Simultaneous use of GMSK and AMDC, for instance, allows power ramping in the generated bursts like in time division multiplex operation of GSM mobile radio. I/Q or GMSK modulation with simultaneous FMDC makes Doppler shifting possible. The combination of pulse modulation and I/Q modulation or BB-FM enables the generation of complex radar signals, the pulsed signal being additionally phase-coded or frequency-modulated.

Applications of I/Q modulation

Digital modulation methods are based on phase, amplitude and combined phase/amplitude shift keying. To enable these types of modulation, bipolar signals with stepped amplitude are applied to the I/Q modulator of the SMHU 58.

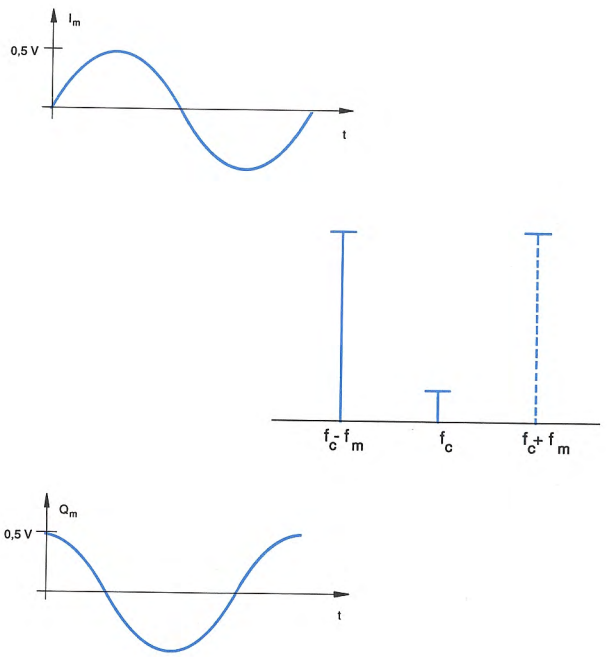
The diagrams below show three common modes of carrier keying. The end points of the carrier vectors represent the possible phase and amplitude states of the RF output signal.

- **BPSK:** Bipolar Phase Shift Keying
- **QPSK:** Quadrature Phase Shift Keying
- **64-QAM:** 64-stage Quadrature Amplitude Modulation



BPSK QPSK 64-QAM

Frequency shifting and FSK When applying sinusoidal, 90° phase-shifted I and Q modulation signals to the I/Q modulator, its input frequency is shifted by the frequency of the modulation signals. Varying the phase offset of the two modulation signals by 180° causes a polarity reversal of the frequency offset. Using this method, the SMHU 58 allows very fast frequency shift keying with shifts of up to 400 MHz. A further advantage of this method is the shift accuracy which only depends on the frequency accuracy of the modulation source.



90° phase-shifted I and Q modulation signals

Broadband AM The I/Q modulator is also used for broadband amplitude modulation within a modulation bandwidth of 50 MHz. There are no limiting effects up to a level of +7 dBm; between +7 and +13 dBm, the characteristics depend on the magnitude of the modulation.

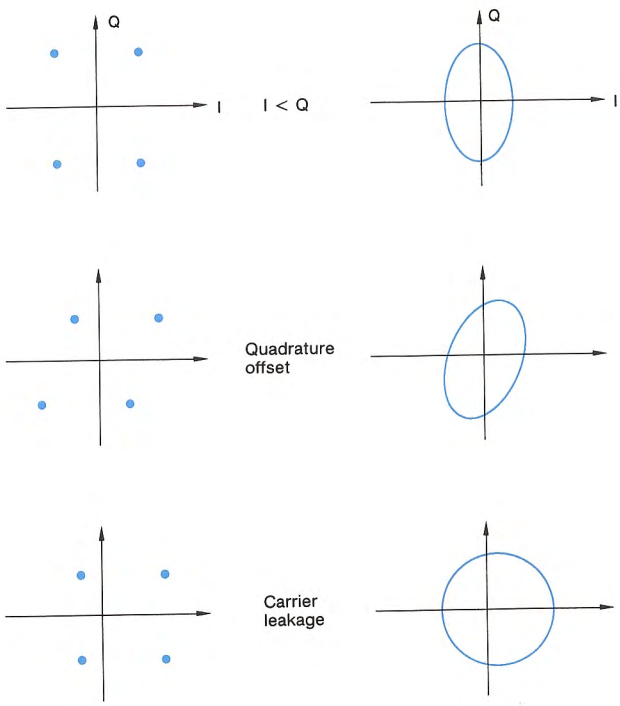
The modulation depth is a linear function of the modulation signal amplitude; an input voltage of 1 V_p causes 100% modulation.

Modulation range, linearity and bandwidth make the SMHU 58 an ideal instrument for TV applications.

SMHU 58

Autocalibration and error simulation The I/Q modulator is adjusted for minimum amplitude and phase error in an automatic calibration routine. As a result, equal gain is adjusted in the I and the Q branch (I/Q balance), the phase offset set to exactly 90° (quadrature) and the carrier leakage minimized to typically –60 dBc.

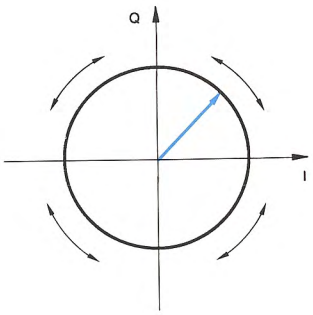
These three settings can also be varied to simulate a non-ideal behaviour of the modulator. In all cases, this will result in phase and amplitude errors of the modulated signal (see diagrams); with phase-continuous modulation, there is an additional spurious deviation. With the aid of **selectable defined modulation distortion,** effects on bit error rates can be determined and demodulator maladjustments corrected.



Simulation of modulation distortion

Optional GMSK Coder

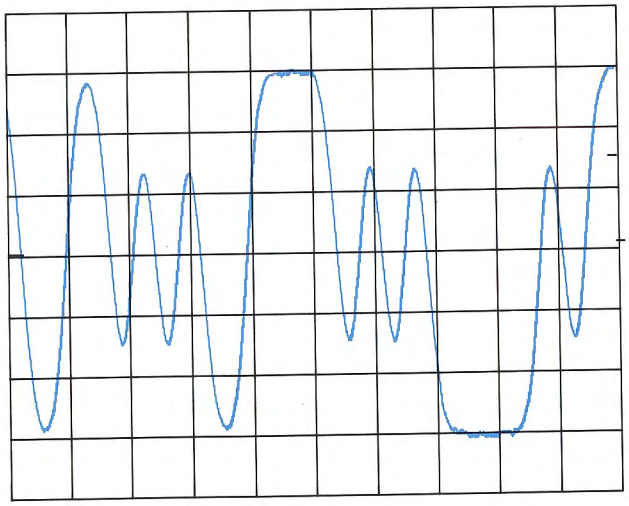
MSK and GMSK are phase-continuous modulation methods, with the I/Q vector continuously moving on a circle of constant amplitude.



Phase-continuous modulation

The GMSK coder filters the data signal according to the specified Gaussian function and generates precise I and Q modulation signals for phase modulation in the I/Q modulator. The rms error of the phase response produced referred to the nominal response is less than 1°.

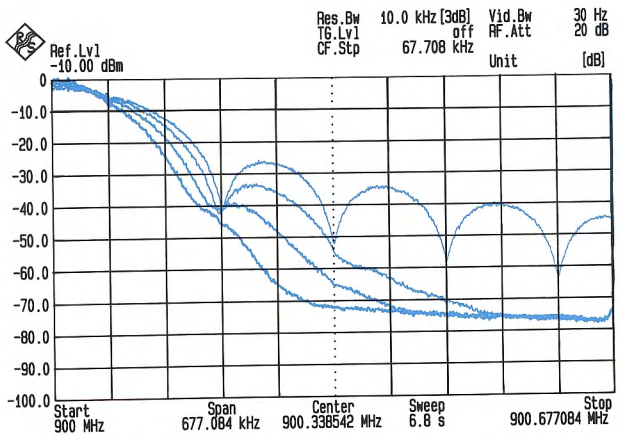
When equipped with the **optional GMSK coder**, the SMHU 58 provides a 0.3 GMSK modulation in line with the GSM specifications. An internal PRBS (Pseudo Random Binary Sequence) data generator with sequences of 2^9-1 and $2^{15}-1$ as well as crystal-accurate clock makes the SMHU 58 independent of external signal sources. When external signal sources are used, a data signal and a clock of 270.833 kHz must be applied.



GMSK frequency response → 10 µs or ↑ 22.5 kHz/div

The I/Q signals generated in the GMSK coder can be picked up at the I and Q sockets. They can be used, for instance, as reference signals for comparison with the I/Q signals that are available after demodulation in the receiver.

For varying the modulation spectrum, other standard filter bandwidth values can be selected in addition to the 0.3 value (see diagram on the left).



GMSK modulation spectra for B × T = 0.2/0.3/0.5/∞

Further applications

Level control and ASK (Amplitude Shift Keying) For Level control or level keying, the control signal must be applied to the I input and the Q input terminated with 50 Ω. In the input voltage range from 0 to 0.5 V, there is a linear level control over 60 dB from the minimum value to the set nominal output level. The input frequency range is from DC to 200 MHz.

Broadband FM allows modulation frequencies up to 20 MHz. The lower 3-dB cutoff frequency can be set to 20 Hz or 100 kHz; switching to 100 kHz reduces the residual φM.

The frequency deviation can be adjusted in fine steps in the range from 1 kHz up to the carrier-frequency-independent maximum value of 50 MHz.

Through the simultaneous use of pulse modulation and BB-FM, the SMHU 58 can generate **radar chirps** with a frequency variation up to 100 MHz in less than 100 ns.

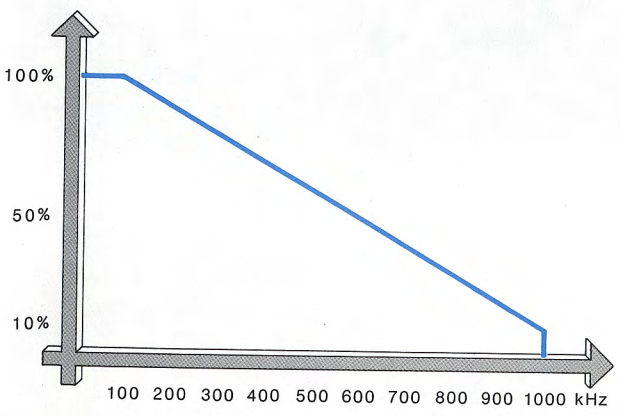
Further applications of the top-class frequency modulator are in the field of **video measurements** and also in **satellite reception**, where the first IF band (950 to 1750 MHz) and the low intermediate frequencies are within the frequency span of the SMHU 58 for BB-FM.

Frequency modulation The modulation frequency range for FM extends from DC to 1 MHz. The maximum deviation that can be set for modulation frequencies above 100 kHz decreases linearly down to 10 % at 1 MHz.

The FM applications range from high-quality stereo modulation to fast FSK.

The maximum deviation usually decreases with the carrier frequency. This is different when FM is simultaneously used with I/Q, GMSK or BB-AM. The maximum deviation then has a constant value of 3.2 MHz in the range between 5 MHz and 1.95 GHz.

In FMDC mode, high carrier frequency accuracy is ensured by a novel frequency control circuit. When FMDC is selected, the frequency offset remains smaller than $10^{-7} \times f_c$ (f_c = carrier frequency) and smaller than 400 Hz for I/Q modulation, BB-AM and GMSK. There is **practically no drift**. This is particularly useful for receivers with digital signalling.



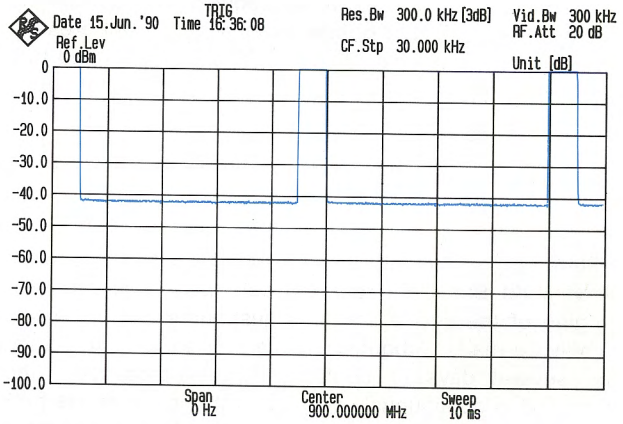
Characteristic of maximum deviation adjustable for FM

Power reserve and dynamic range

- Level range from −140 to +13 dBm
- Overrange up to +19 dBm

With GMSK, the output level can be controlled over a range of 40 dB using AMDC. Level bursts can thus be produced such as used in modern communication networks.

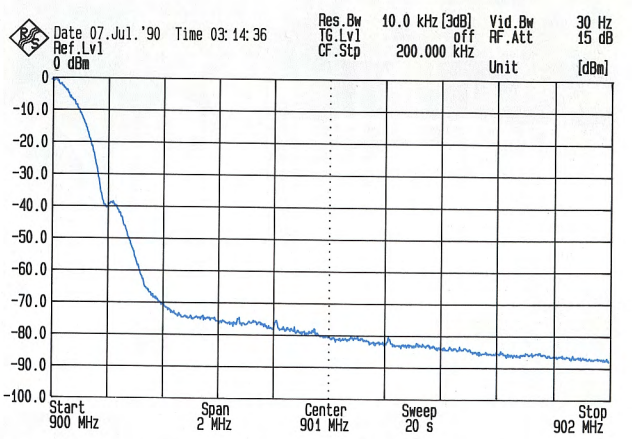
The rise/fall times are 2 µs. Extremely short rise/fall times and an on/off ratio of greater than 80 dB can be achieved by pulse modulation. Use of the I/Q modulator provides another possibility of very fast level control.



Power ramping in AM EXT mode

Spectral purity The SMHU 58 phase noise and spurious characteristics are influenced by the operating mode. Highest spectral purity is ensured in CW and AM mode, where up to 1 GHz nonharmonic spuriae are below −100 dBc. The SSB phase noise 20 kHz from a 1 GHz carrier is −134 dBc, the noise floor far from the carrier is below −145 dBc.

In the **I/Q modulation, GMSK, BB-AM and BB-FM** modes, the signal quality exceeds the standard required even for the most demanding measurements like for instance determination of the **intermodulation rejection** in line with the GSM specifications.



GMSK modulation spectrum for B × T = 0.3, measured with a carrier offset of up to 2 MHz

SMHU 58

Self-diagnostics

For maintenance and calibration, precise data on the instrument status are required. Using built-in test equipment, the SMHU 58 provides these data without any extra equipment.

Self-test enhances reliability The signal generator status is continuously monitored. The SMHU 58 signals malfunctions and deviations from nominal values by a status indication with error code on the display and by a service request via the IEC/IEEE bus.

Built-in test equipment The signal generator can be fully checked without any extra test equipment and without opening it up. **85 test points** cover all important areas in the signal generation section like RF signal level and tuning/check voltage in the control circuits. When a test point is called up via the keyboard or the IEC/IEEE bus, its number and value are displayed. The source of a fault can thus easily be identified if there is a problem.

A **diagnostic and adjustment program** for process controllers compatible with the industry standard (included in Service Kit SMGU-Z2) enables automatic evaluation and logging of the device status. Adjustments can easily and rapidly be made without any extra test equipment. During the several days of burn-in following production, the SMHU 58 is continuously checked with the aid of this program. This ensures that an extremely reliable instrument tested over a wide temperature range will be delivered to the customer.

Specifications

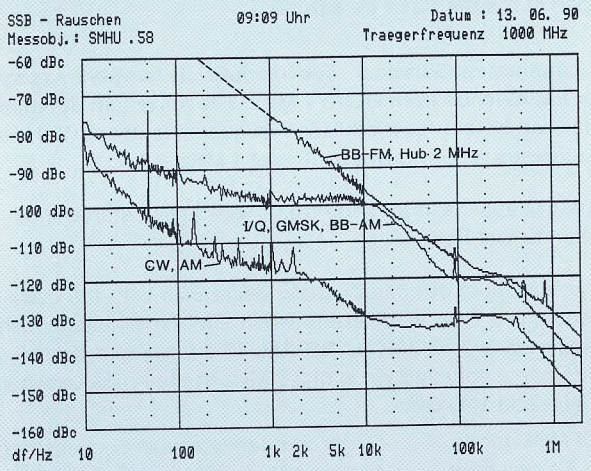
valid for I/Q modulation, GMSK, BB-FM and BB-AM; supplementary data to basic data of SMHU (see catalog 1990/91, page 122)

Frequency

Range	10 to 1900 MHz
Overrange (specs not guaranteed)	5 to 1950 MHz
Setting time for frequency change (phase drift <4° within one 577-µs time slot)	<4 ms in fast mode

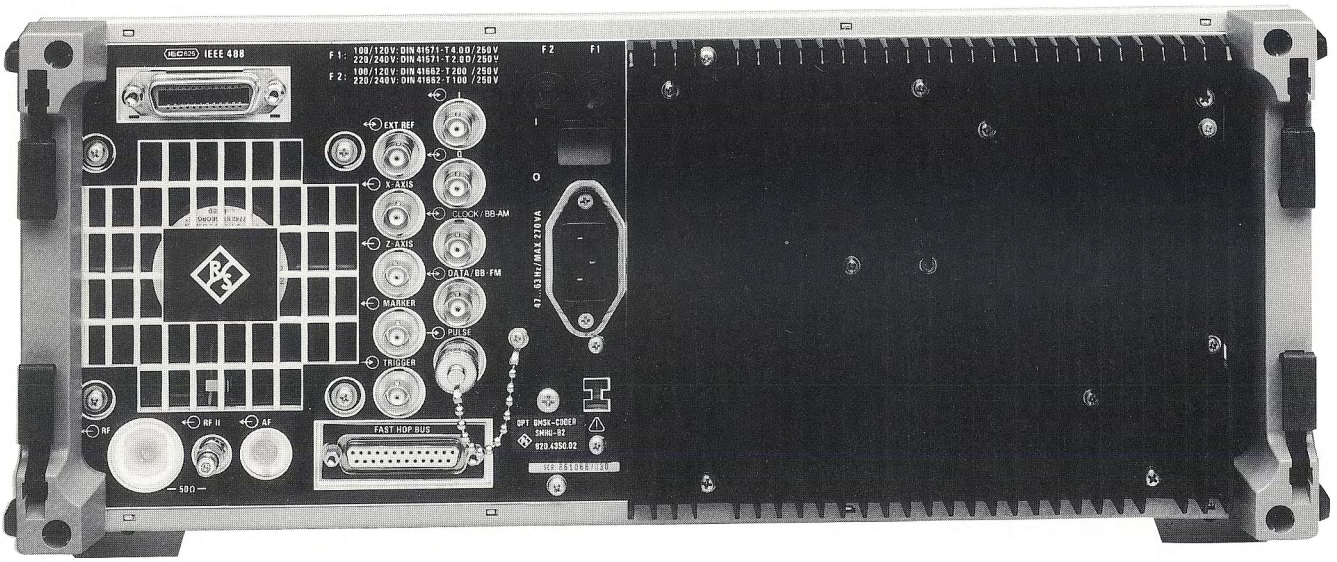
Spectral purity

Spurious signals	
Harmonics	<–30 dBc
Nonharmonics at >10 kHz from carrier[1]) in frequency range 10 to 250 MHz	<–74 dBc
845 to 1005 MHz	<–74 dBc
1650 to 1900 MHz	<–74 dBc
10 to 1900 MHz	–45 dBc
Broadband noise with I/Q modulation, GMSK and BB-FM (deviation <2 MHz), carrier offset >2 MHz, 1-Hz bandwidth	typ. <–135 dBc[1])
Single-sideband phase noise with I/Q modulation, GMSK and BB-AM, 1-Hz bandwidth, carrier offset 1 kHz	<–94 dBc
20 kHz	<–98 dBc
100 kHz	<–112 dBc



Typical single-sideband phase noise at 1000 MHz

Rear view of SMHU 58



Residual FM, rms at 1000 MHz

Operating mode	Weighting bandwidth 0.3 to 3 kHz (CCITT) (Hz)	0.03 to 20 kHz (Hz)
I/Q, GMSK, BB-AM	<8	<40
BB-FM, deviation <0,4 MHz	<20	<50
BB-FM, deviation 0,4 to 2 MHz	<40	<100
BB-FM, deviation 2 to 10 MHz	<100	<500
BB-FM, deviation >10 MHz	<400	<2000

2nd RF output (RF II)
Unmodulated coherent carrier if /I/Q, GMSK or BB-AM is selected.
The output level is unregulated.
Frequency range ..... 10 to 1900 MHz
Output level ..... typ. −3 to +3 dBm
Output impedance ..... 50 Ω

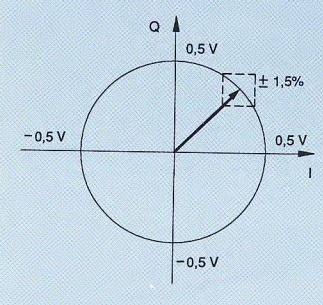
Broadband AM
Operating mode ..... EXT DC
Level range ..... up to +7 dBm
(overrange up to +13 dBm)
Modulation frequency response at
140 MHz and m = 60%
DC to 50 MHz ..... <3 dB
AM distortion at
f_{mod} = 1 kHz and m = 60% ..... <0.5%
Incidental φM at 30% AM,
f_{mod} = 1 kHz ..... typ. 0.003 rad

Modulation input BB-AM
Input impedance ..... 50 Ω
Input voltage V_p for
100% modulation ..... 1 V ±4%

Frequency modulation
Normal FM with I/Q,
GMSK and BB-AM
Maximum deviation ..... 3200 kHz

Broadband FM (BB-FM)
Operating modes ..... INT, EXT AC
Deviation range ..... 50 kHz to 50 MHz,
adjustable from 1 kHz
Resolution ..... <1%, min. 1 kHz
Setting error at f_{mod} = 1 kHz,
deviation ≤25 MHz ..... <5% of reading
FM distortion at f_{mod} = 1 kHz,
deviation = 25 MHz, carrier
frequency 100 to 1800 MHz ..... <0.5%
Modulation frequency
BB-FM, INT ..... 20 Hz to 100 kHz
BB-FM, EXT AC ..... 20 Hz to 20 MHz
Modulation frequency response at
a carrier frequency of 100 to 1800 MHz,
deviation <25 MHz,
20 Hz to 20 MHz ..... <3 dB
50 Hz to 10 MHz ..... typ. <1 dB
Modulation input BB-FM
Input impedance ..... 50 Ω, link-selectable to 75 Ω
Input voltage for
selected deviation (V_p) ..... 1 V

I/Q modulation
Vector DC accuracy, referred
to full-scale I input,
fed from 50-Ω source
input voltage range $\sqrt{I^2+Q^2} \leq 0.5$ V
carrier 140 MHz ..... <1.5%[2])
10 to 1900 MHz ..... typ. <1.5%[2])



Magnitude worst-case error ..... $\leq 20 \log \left(\frac{\sqrt{I^2+Q^2} \pm 10.6\ mV}{\sqrt{I^2+Q^2}}\right)$ dB[2])

Phase worst-case error ..... $\leq \pm \arctan \left(\frac{10.6\ mV}{\sqrt{I^2+Q^2}}\right)$ degree[2])

Modulation frequency response
f_{mod} = DC to 200 MHz
carrier 1000 MHz ..... <3 dB
250 to 1500 MHz ..... typ. <3 dB
Residual carrier at 0 V input voltage,
fed from 50-Ω source (I and Q),
ref. to full-scale input
carrier 140 MHz ..... <0.3%[2])
10 to 1900 MHz ..... typ. <0.3%[2])
I/Q impairment
Carrier leakage
Setting range ..... 0 to 50%
Resolution 1%
I ≠ Q
Setting range ..... −12 to +12%
Resolution up to 10% 0.1%
above 10% 1%
Quadrature offset
Setting range ..... −9.9 to +9.9°
Resolution ..... 0.1°
Modulation inputs I und Q
Input impedance ..... 50 Ω
VSWR (DC to 200 MHz) ..... <1.4
Input voltage for
full-scale magnitude ..... ±0.5 V (±1 V EMF, 50-Ω source)

GMSK modulation (option SMHU-B2)
Operating mode ..... internal with pseudo-random binary sequence, external
PRBS (pseudo-random
binary sequence) ..... 2^9-1 sequence length to CCITT Rec. V52 or $2^{15}-1$ to CCITT Rec. 0.151, selectable via special function
Differential coding ..... to GSM Rec. 05.04, selectable via special funktion

Selectable filters

Filter No.	Modulation, filter
1	GMSK, B×T = 0.2
2	GMSK, B×T = 0.25
3	GMSK, B×T = 0.3
4	GMSK, B×T = 0.4
5	GMSK, B×T = 0.5
6	GMSK, B×T = 0.7
7	GMSK, B×T = 1
9	MSK, 0.7 MHz (3 dB)
10	TFM

Data rate ..... 270.833 kHz ±13.5 Hz
Modulation phase error[2])
rms ..... <1°
peak ..... <3°
Modulation inputs DATA, CLOCK
Input levels ..... TTL
Input impedance ..... 1 kΩ
The polarity of the active clock edge and of the modulation deviation can be selected via special functions

Ordering information

Order designation ..... ▶ Signal Generator SMHU 58 835.8011.58
Accessories supplied ..... power cable, manual

Option
GMSK Coder ..... SMHU-B2 ..... 820.4350.02

Recommended extras
Rear-panel connectors
for RF and AF ..... SMGU-Z9 ..... 820.4415.02
19″ Rack Adapter ..... ZZA-94 ..... 396.4905.00
Service Kit ..... SMGU-Z2 ..... 820.4515.02
Transport Case ..... ZZK-944 ..... 1013.9366.00
Trolley ..... ZZK-1 ..... 1014.0510.00

[1]) Does not apply to special function "non-interrupting level setting".
[2]) Applies after 1 hour warmup and recalibration using special function "calibration routine for I/Q modulation" for 4 hours operation and temperature variations of less than 5 °C.

ROHDE&SCHWARZ
COLOR MONITOR · PMC2
1008.7500.02
File Edit Run Compile Project Options Debug Break/watch
Load F3
Pick Alt-F3
New
Save F2
Write to
Directory
Change dir
OS shell
Quit Alt-X
Message
F1-Help F5-Zoom F6-Switch F7-Trace F8-Step F9-Make F10-Menu
OFF
ON
POWER

3

radiocommunication testers

CRTS 02/04 GSM Radiocommunication Test Set CRTS 02/04 ♦ GSM network in 900-MHz band

- CRTS 02: Simulation of a GSM base station (cell site) and measurement on a mobile station
- CRTS 04: Simulation of a GSM mobile station and measurement on a base station

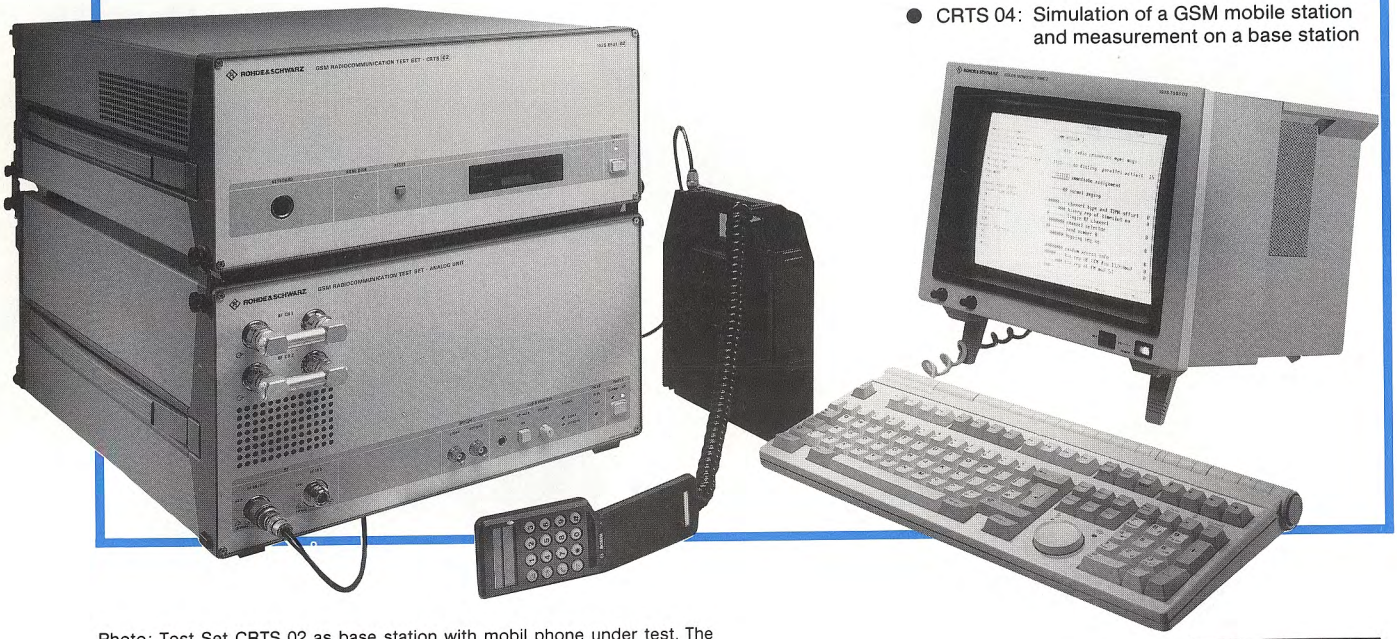
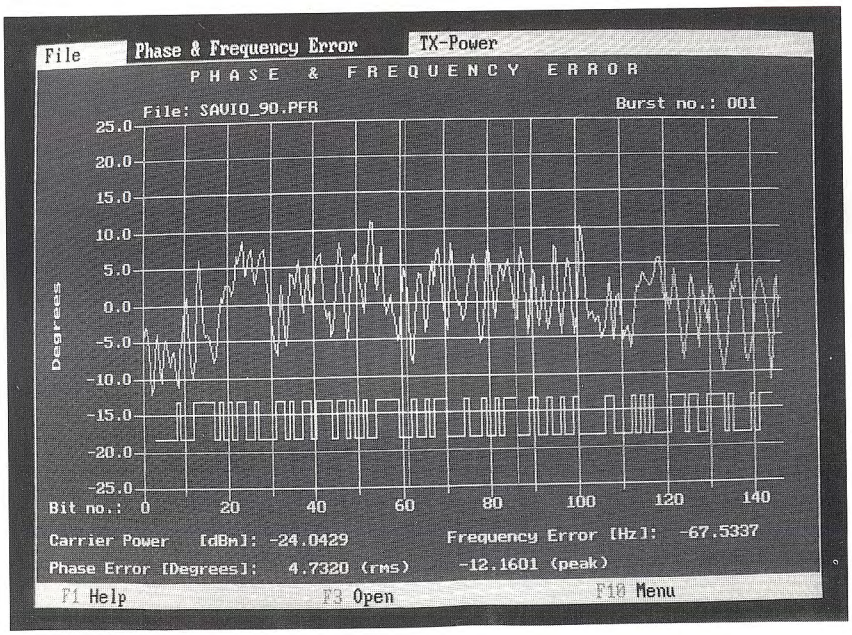


Photo: Test Set CRTS 02 as base station with mobil phone under test. The hardware of CRTS 02 and CRTS 04 is identical.

IEC 625 Bus

Main features

- Simulation of a GSM base/mobile station with call set-up, data transfer and all signalling procedures between the CRTS and the station under test
- Logging of all signalling activities in OSI layers 1, 2 and 3 for protocol analysis. Mnemonic display of message content for protocol troubleshooting
- Checks the error-correction facilities of the base/mobile station by implanting errors in the data stream
- Measurements on the transmitter signal:
  - power ramp and phase trajectory
  - burst delay
  - frequency error
- Measurements on the receiver:
  - realtime bit-error-rate measurements
  - receiver sensitivity
- Tests on speech coder and decoder
- Numerical and graphical output of results on screen or printer
- Automatic synchronization of CRTS 04 with clock frequency of base station under test
- Versatile audio measurement unit (option CRTS-B1)



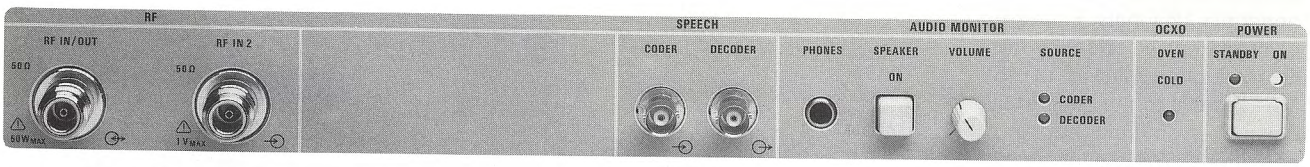
Graphic and numerical presentation of the results of a phase and frequency error measurement on a GSM burst

Applications

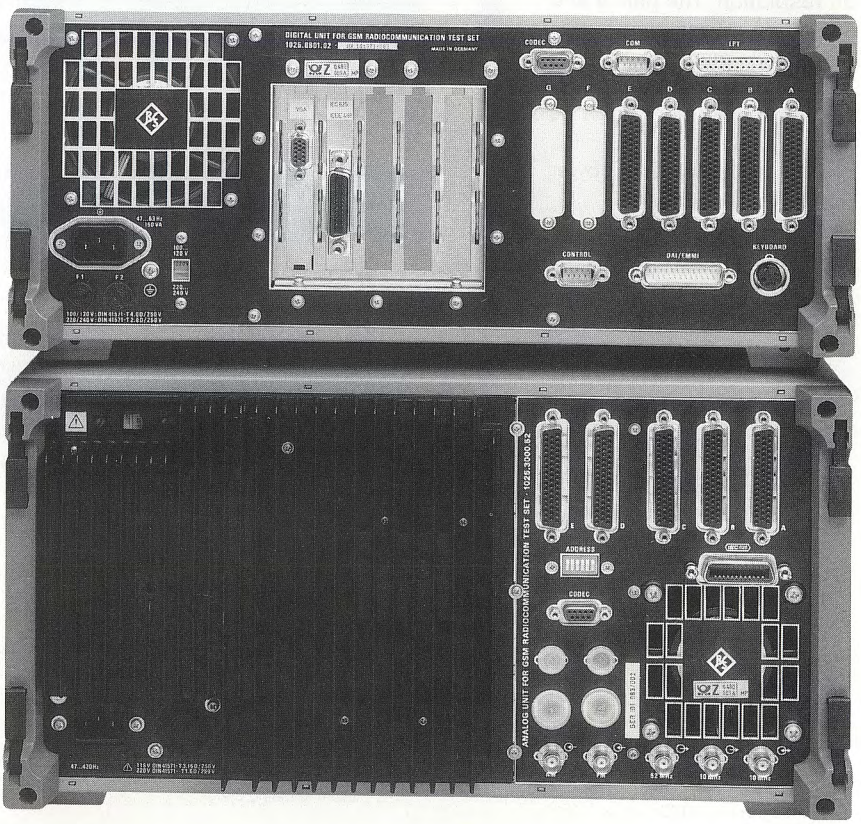
- **Development**
  - Test of all signalling functions and validation of data transmission protocols and timing
  - Measurements on GSM-modulated RF signals and receiver testing
  - Simple generation of customized test procedures
- **Type approval and quality assurance**
  Complete conformance testing as described in GSM Recommendation 11.10 with respect to
  - Channel coding (OSI layer 1),
  - Data link protocols (OSI layer 2),
  - Network signalling (OSI layer 3), and all GSM-specific in-channel RF parameters

Automatic measurements and logging using test procedures supplied

- **Production**
  - Fast and reliable testing of modules and complete GSM mobile radios with CRTS 02
  - CRTS 02: Rational production and high output thanks to short test times
  - The CRTS 02 can be easily integrated into existing local area networks in the factory environment
  - CRTS 04: comprehensive and reliable testing of signalling functions and of base-station RF parameters
- **Repair and maintenance**
  - Automatic test sequences ensure reliable evaluation of the GSM base/mobile station, even by non-technical operators
  - Extensive troubleshooting features easy fault-finding on defective radios



Front panel of the Analaog Unit



Rear panel of CRTS

CRTS 02/04

Characteristics

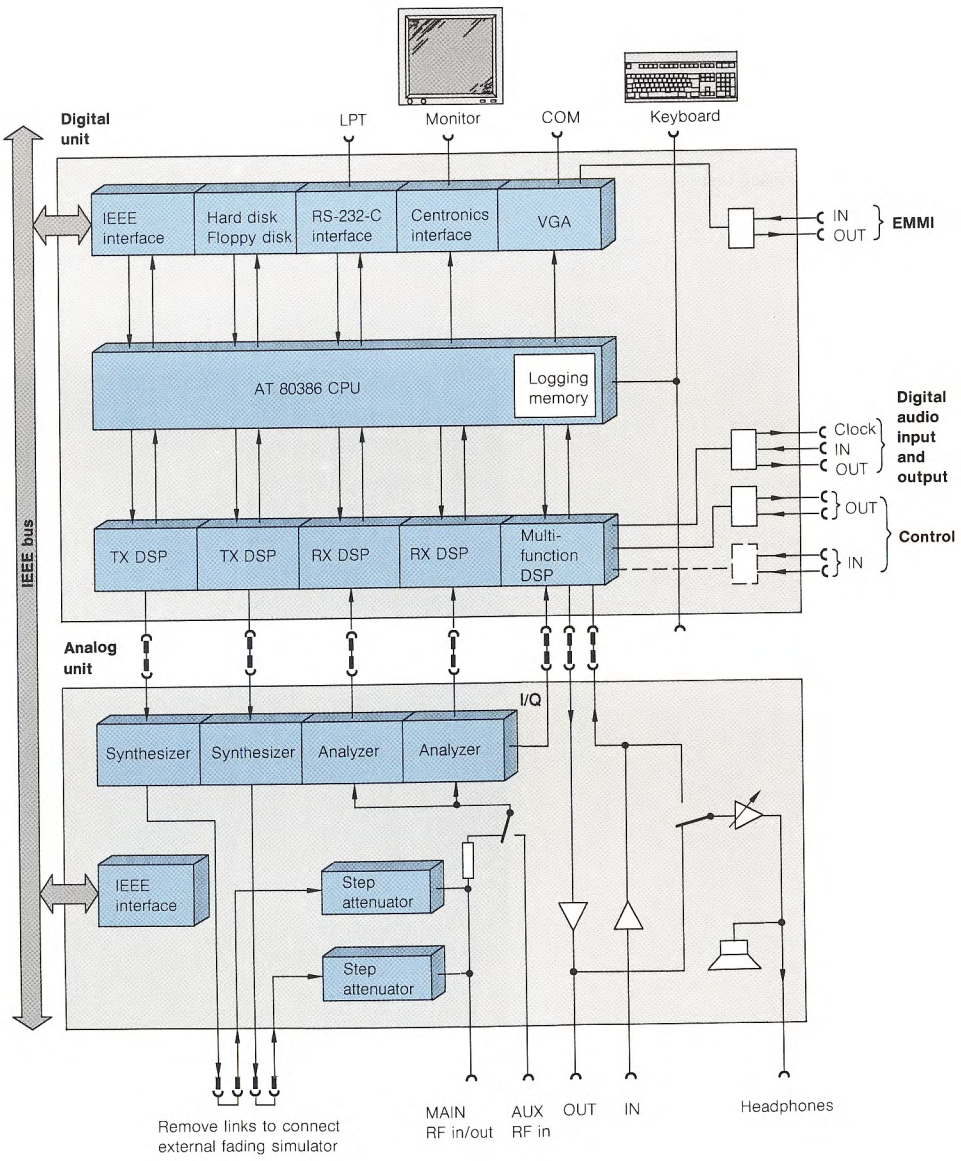
Generation of GSM signals The Analog Unit provides two independent RF generator channels. These permit transmission with or without frequency hopping on all GSM RF channels. Both signals are GMSK modulated (Gaussian Minimum Shift Keying) and are timed as bursts to occupy exactly one or all of the 8 GSM timeslots. The timing of the bursts relative to the ideal timebase can be varied in fine steps by up to 4.6 ms in each channel independently. The amplitude can be varied dynamically over a 40-dB range. Using these two channels, the test set can simulate and test at the base/mobile station simultaneously a control channel (BCCH + FCCH + SCH + CCCH)*) and a traffic channel (TCH + SACCH)*). In addition to the dynamic control, the output level can be adjusted in steps with high precision over a wide range. For measuring the receiver sensitivity, a fading simulator can be connected into each of the output circuits.

Measurements on GSM signals A receive channel is associated with each of the generator channels. Each receive channel is offset by the GSM duplex spacing of 45 MHz relative to the generator channel, even under hopping conditions. The digital signal is recovered by a precise GMSK demodulator. In addition, the signal in one of the receive channels is sampled at a rate of 1.083 MHz (4 samples per bit) and 12-bit resolution. The phase and amplitude samples are stored in memory for the computation of the GSM-specific parameters such as burst delay of CRTS 02, phase trajectory and power ramp.

CRTS 04 Separate connectors are provided for testing the transmitter and the receiver unit of a base station (BTS). For transmitter testing, an external attenuator must be connected for matching the input sensitivity.

AF and DC measurements The optional AF Measurement Unit CRTS-B1 allows a wide range of audio measurements. The built-in AF generator provides single or double tones, the low source impedance ensuring that no problems arise in coupling the signal into the test fixture. The following audio test facilities are provided:

- AF voltmeter with RMS and peak detectors
- tunable distortion meter/SINAD meter
- AF counter
- wide choice of filter functions, including CCITT weighting and programmable notch, highpass and lowpass characteristics
- Also included is a floating-input DC ammeter/voltmeter.



Operation

Signalling The CRTS performs all channel coding and layer 2 signalling functions automatically in realtime. The detailed signalling sequence is determined by the user, by defining which messages have to be transmitted and in which sequence. The user further specifies the behaviour of layer 2 during the test. For all tests on the base/mobile stations, the CRTS simulates the functions of an ideal station at the other end. A built-in speech coder/decoder also permits voice transmission tests.

Protocol analysis Every transmitted or received layer 2 or layer 3 message, or even the bits of a burst, can be marked with a frame number and recorded in the log memory. Depending on whether everything is logged or just selected logical channels, the log can cover a time interval between 10 seconds and 15 minutes.

In order to test the layer 2 functions of a base/mobile station, the layer 2 performance of the CRTS can be modified. In particular, it is possible to ignore a certain number of layer 2 messages, wait for the arrival of a specific message, or modify the layer 2 status variables V(R), V(S) and V(A).

It is also possible to invert bits at the physical burst level in order to simulate transmission errors and to test the reaction of the base/mobile station.

CRTS 02 In the loop-back mode of the mobile station, the BER of the receiver can be determined in realtime for sensitivity measurements. To check the timing-advance function of the mobile station, the time of arrival of the burst is measured and the reaction of the mobile station to timing advance commands in the CRTS 02 generator channels monitored.

CRTS 04 BER measurements in realtime for determining the receiver sensitivity of a base station can be performed in two different ways:

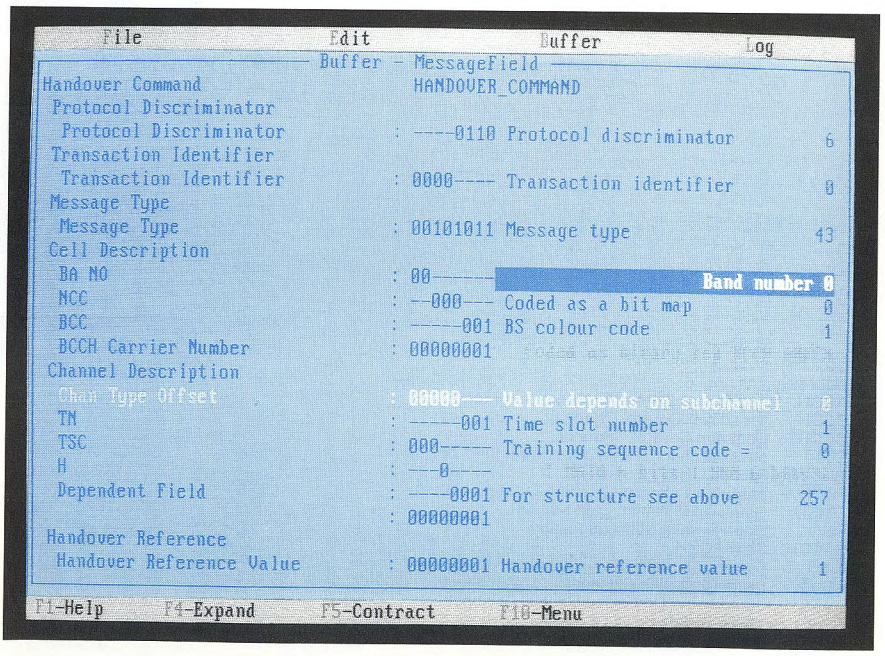
- in loop-back mode
- via the Y interface of the base station

To check the delay measurement function of the base station, sending of the bursts can be delayed and the reaction of the base station be monitored. To permit synchronization of external measuring instruments (eg spectrum analyzer), both CRTS models have a trigger output for starting measurement at the beginning of a burst.

A comfortable, **window-oriented user interface** simplifies the operation of the CRTS and the generation of test sequences.

Test programs are written in Borland Turbo C++. The use of such a popular standard language eliminates the long training periods needed for special test languages and offers the user high flexibility in creating test sequences for individual applications. The user is well supported by an **extensive library** of prepared messages and programs, including

- Receiver BFI performance (bad frame identification)
- Receiver sensitivity in speech channel TCH/FS*) and in user-data and control channels
- Usable receiver input level range
- Complete layer 2 signalling test of base/mobile station
- MS originated and terminated call
- Absolute delay and timing advance (CRTS 02)
- Delay measurement function (CRTS 04)
- Reception time tracking speed (CRTS 02)
- Intra-cell channel change
- TX power control
- Phase/frequency error
- Power ramp of burst



A comfortable editor permits messages to be defined simply by filling out a table

CRTS 02/04

Operation

Using these starter programs, the most important tests can be performed without any programming effort at all. The starter package at the same time forms the basis for further programs to be defined or modified by the user.

A **menu-driven editor**, in which the GSM coding rules described in recommendation 4.08 have been taken into account, allows the definition of new messages and the entry of system information simply by filling out tables.

A further software environment permits the display of logged messages in the form of a **protocol analysis.** All messages are shown in mnemonic form, using the same basic mask as the message editor. All measured parameters of GSM signals, such as phase trajectory, burst delay etc., can be displayed graphically or numerically and may be documented on a printer as required.

The Digital Unit of the CRTS may further be used as an **IEEE-488 controller**, allowing extension of the test set by including external instruments. The CRTS contains both the IEEE-488 interface and the necessary software drivers.

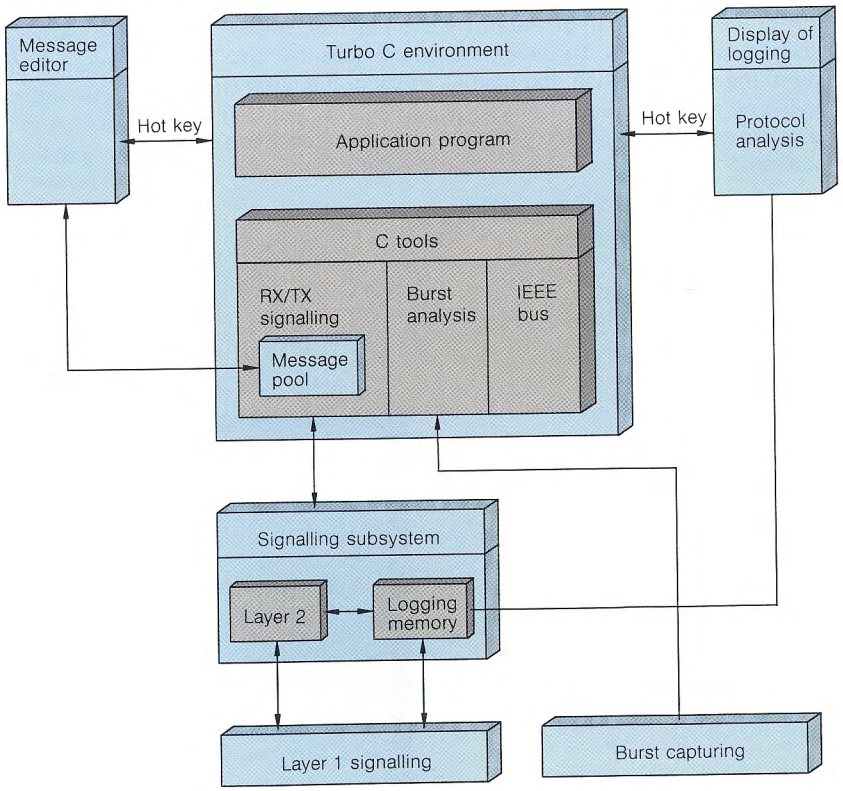
CRTS 02 To permit speech coder/decoder tests, the CRTS 02 also supports the **digital audio interface (DAI)** of the mobile station as defined in GSM Recommendation 11.10.III.6.4. For remote control of the mobile station, a serial electrical man-machine interface (EMMI) in accordance with GSM Recommendation 11.10.III.6.3. is provided, together with the required software.

CRTS 04 To permit BER tests, the CRTS 04 has a software-supported **Y interface** in line with GSM Recommendations.

The complete software, including message library, control programs and test results, is stored on hard disk. The built-in floppy drive permits easy backup and transfer operations.

Using a commercially available LAN interface (not supplied with CRTS) in one of the free AT slots of the CRTS, the test set can readily be linked to an existing factory **LAN**. This network link may be used for transferring files containing either programs or test results.

Software structure of the CRTS



*) Abbreviations unsed:
ACCH: Associated Control CHannel.
BCCH: Broadcast Control CHannel.
CCCH: Common Control CHannel.
C0: physical channel used for control functions
FACCH: Fast ACCH.
FCCH: Frequency Control CHannel.
GMSK: Gaussian Minimum Shift Keying.
OSI: Open System Interconnection.
SACCH: Slow ACCH.
SAPI: Service Access Point Indicator.
SCH: Synchronization CHannel.
SDCCH: Stand-alone Dedicated Control CHannel.
TCH: Traffic CHannel.
TCH/FS: Traffic Channel/Full Speech.

Specifications

Analog Unit

Signal generator

Frequency range (CRTS 02)	GSM-band 935.2 to 959.8 MHz
Frequency range (CRTS 04)	GSM-band 890.2 to 914.8 MHz
Hop size	any frequency step within the GSM band
Frequency fine tuning	0 to 60 kHz, resolution about 2 Hz
Frequency setting time	<500 µs to within <4° of final phase
Spurious phase modulation	<1° rms, <4° peak
Frequency aging	$<2 \times 10^{-9}$/day (after 30 days operation)
Frequency drift	$<2 \times 10^{-9}$/°C
Maximum output level	16 dBm
Static attenuation setting	0 to 135 dB
Resolution	5 dB
Dynamic attenuation	0 to 40 dB (electronic)
Level error	<1.5 dB from −127 to 13 dBm, (with dynamic attenuation at 0 dB)
Modulation	GMSK, bit rate 270 833 bit/s acc. to GSM Rec. 05.04
Burst delay	−4.6 to +4.6 ms, variable in steps of 0.46 µs

Analyzer

Frequency range (CRTS 02)	GSM-band 890.2 to 914.8 MHz
Frequency range (CRTS 04)	GSM-band 935.2 to 959.8 MHz
Reference level for full dynamik range	19 to 47 dBm ($RF_{in/out}$) −21 to +9 dBm (RF_{IN2}), in steps of 2 dB
Level error	<1.5 dB
Duplex spacing	45 MHz
Sampler	two 12-bit A/D converters (for I and Q signals), sampled at 1.083 MHz (4 samples per bit)

Synchronization	10-MHz output, 10-MHz input/output, 52-MHz output
Inputs/outputs	
for fading simulator	2 N-type connectors, 50 Ω in each channel (output level 8 to 16 dBm)
for $RF_{IN/OUT}$ and RF_{IN2}	N-type connectors, 50 Ω

Speech coder input

Input voltage for full dynamic range	20 mV to 2 V (R_i = 100 kΩ)

Speech decoder output

Output voltage at full dynamic range	2 V (R_o <3 Ω)

Audio monitor	built-in loudspeaker, headphone connector, volume control
Modes	voltmeter, AF generator, speech decoder, speech coder

AF Measurement Unit (Option CRTS-B1)

Signal source	single or dual tone
Frequency range	20 Hz to 20 kHz
Output level (rms)	10 µV to 5 V
Output impedance	<3 Ω
AF voltmeter	
Modes	RMS, +Peak, −Peak
Frequency range	50 Hz to 20 kHz
Level range (rms)	0.1 mV to 30 V
Weighting filters	
CCITT filter	acc. to CCITT 0.41
Programmable highpass filter	107 Hz to 10.6 kHz
Programmable lowpass filter	235 Hz to 21 kHz
Programmable notch filter	100 Hz to 5 kHz (notch frequency)
Distortion meter/SINAD meter	
Fundamental frequency range	100 Hz to 5 kHz
Measurement range	0 to 50 %, 1 to 50 dB
AF frequency counter	
Frequency range	20 Hz to 500 kHz
Resolution	0.1 Hz/1 Hz
Input level	10 mV to 30 V (up to 20 kHz)
DC measurements	
Voltage	0 to ±30 V
Current	0 to ±10 A

Digital Unit

Processor unit	80386 AT, 25 MHz, arithmetic coprocessor 80387
RAM size	8 MByte
Hard disk	40 MByte
Floppy disk drive	3½", 1.44 MByte
Graphics	VGA
Interfaces	IEC-625 bus, (IEEE-488), RS-232-C, parallel Centronics, keyboard connector on front and rear speech codec input/output control interface, digital audio interface (DAI), EMMI interface (CRTS 02), Y interface (CRTS 04)

Layer 1 functions

Channels supported	C0 channel with FCCH + SCH + BCCH + CCCH + SDCCH/4 + SACCH/C4; TCH/SDCCH channel with TCH + FACCH + SACCH or SDCCH/8 + SACCH/C8 (TCH is TCH/FS or TCH/F9.6, TCH/F4.8, TCH/F2.4, TCH/H4.8, TCH/H2.4)
Cyphering and frequency hopping	with or without on all channels

Layer 2 functions

Signalling	all logical channels for SAPI = 0 and 3
User data	transparent mode

Layer 3 functions	defined by user programs
Programming	language Turbo C++
Program examples	for the most important test sequences are delivered with the CRTS

GSM-specific measurements

Bit error rate	for measurement of receiver sensitivity – acc. to GSM Rec. 11.10.II.4.2 in loop-back mode (CRTS 02) – acc. to GSM Rec. 11.20.2.1.7.1 via Y interface (CRTS 04)
Phase/frequency error	acc. to GSM Rec. 11.10. II.3.1 (CRTS 02) and 11.20.2.1.6.2 (CRTS 04)
Peak transmitter carrier power	acc. to GSM Rec. 11.10. II.3.3.2.1 (CRTS 02) and 11.20.2.1.6.4 (CRTS 04)
Burst delay	acc. to GSM Rec. 11.10. II.6.1.2.1 (CRTS 02)
Simulation of delay in downlink	acc. to GSM Rec. 11.10. II.6.1.2.2 (CRTS 02) and 11.20.2.1.8.6 (CRTS 04)

Presentation of results

for GSM-specific measurements	graphical or numerical
for messages and signalling sequences (content of log memory)	alphanumeric in mnemonic form

General data

Rated temperature range	0 to 45 °C
Environmental conditions	to IEC 359, class 1 (no condensation)
Storage temperature range	−40 to +70 °C
Power supply	110/220 V ±10 %, 47 to 63 Hz, (max. 500 VA), safety class I (acc. to IEC 348 and VDE 0411)
Dimensions (W × H × D)	
Analog Unit	435 mm × 236 mm × 570 mm
Digital Unit	435 mm × 192 mm × 570 mm
Monitor	357 mm × 304 mm × 397 mm
Keyboard	446 mm × 42 mm × 210 mm
Weight	
Analog Unit	28 kg
Digital Unit	18 kg
Monitor	14 kg
Keyboard	1.7 kg

Ordering information

Order designation	▶ GSM Radiocommunication Test Set	
	CRTS 02	1025.8501.02
	CRTS 04	1025.8501.04
Equipment supplied	Analog Unit, Digital Unit, connecting cables, Color Monitor PMC 2, Keyboard PSA-Z1 (English), operating system MS-DOS with manual (English), Turbo C++ Compiler with editor and development environment with manual (English), GSM software with message editor, log and program examples, but without cyphering	

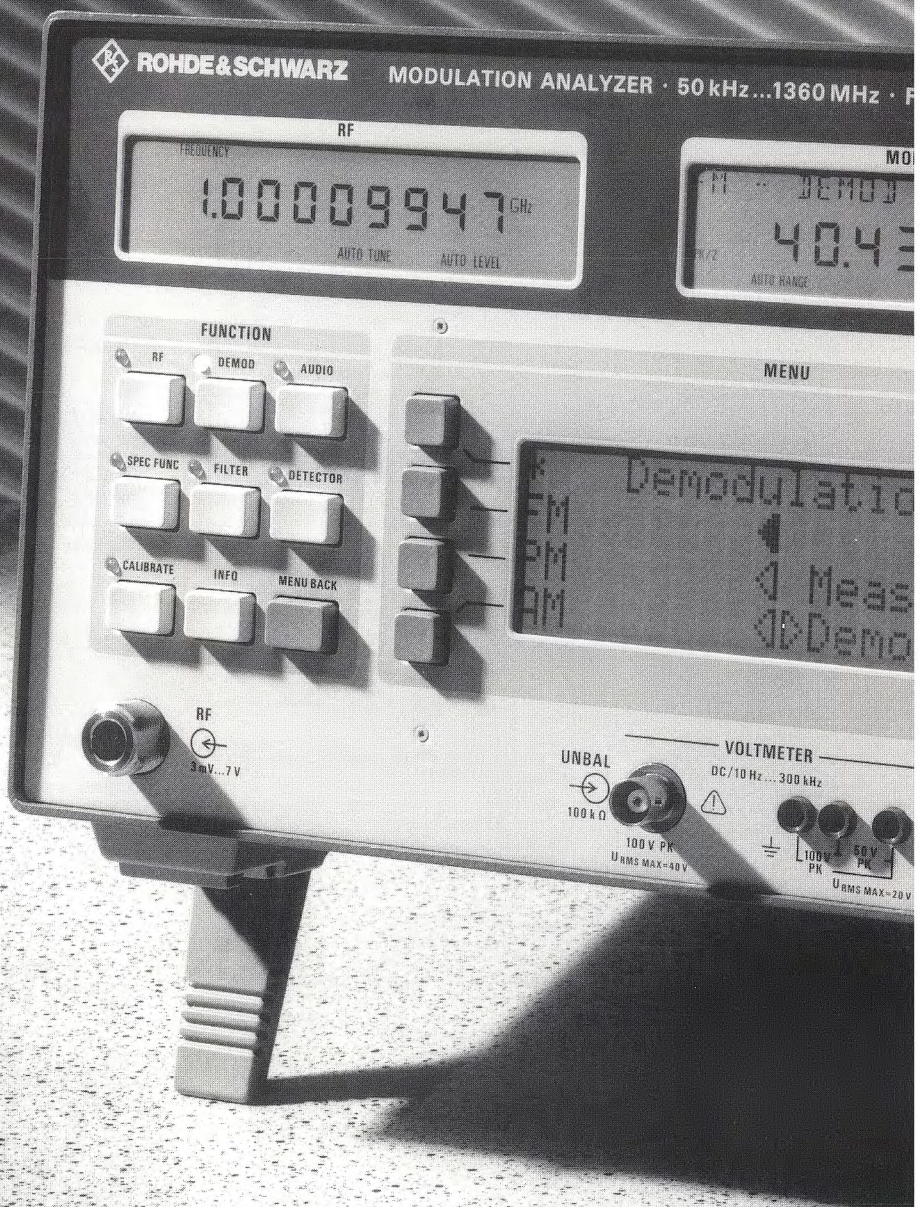
Options

AF Measurement Unit	CRTS-B1	1025.7005.02
Software for Cyphering CRTS 02	CRTS-K2	1034.4105.02
Software for Cyphering CRTS 04	CRTS-K4	1034.4140.02

			Page
Modulation Analyzer	FMA	50 kHz to 1360 MHz	52
Communications & Spectrum Analyzer (special model for radiomonitoring)	FSAD	100 Hz to 2.0 GHz	58
Spectrum Analyzer	FSB	100 Hz to 5.2 GHz	62
Communications & Spectrum Analyzer	FSBC	100 Hz to 5.2 GHz	70
Spectrum & Network Analyzer	FSBS	100 Hz to 5.2 GHz	74
Spectrum Analyzer	FSM	100 Hz to 26.5 GHz	78
S-Parameter Test Set	FS-Z5	5 MHz to 2.7 GHz	86

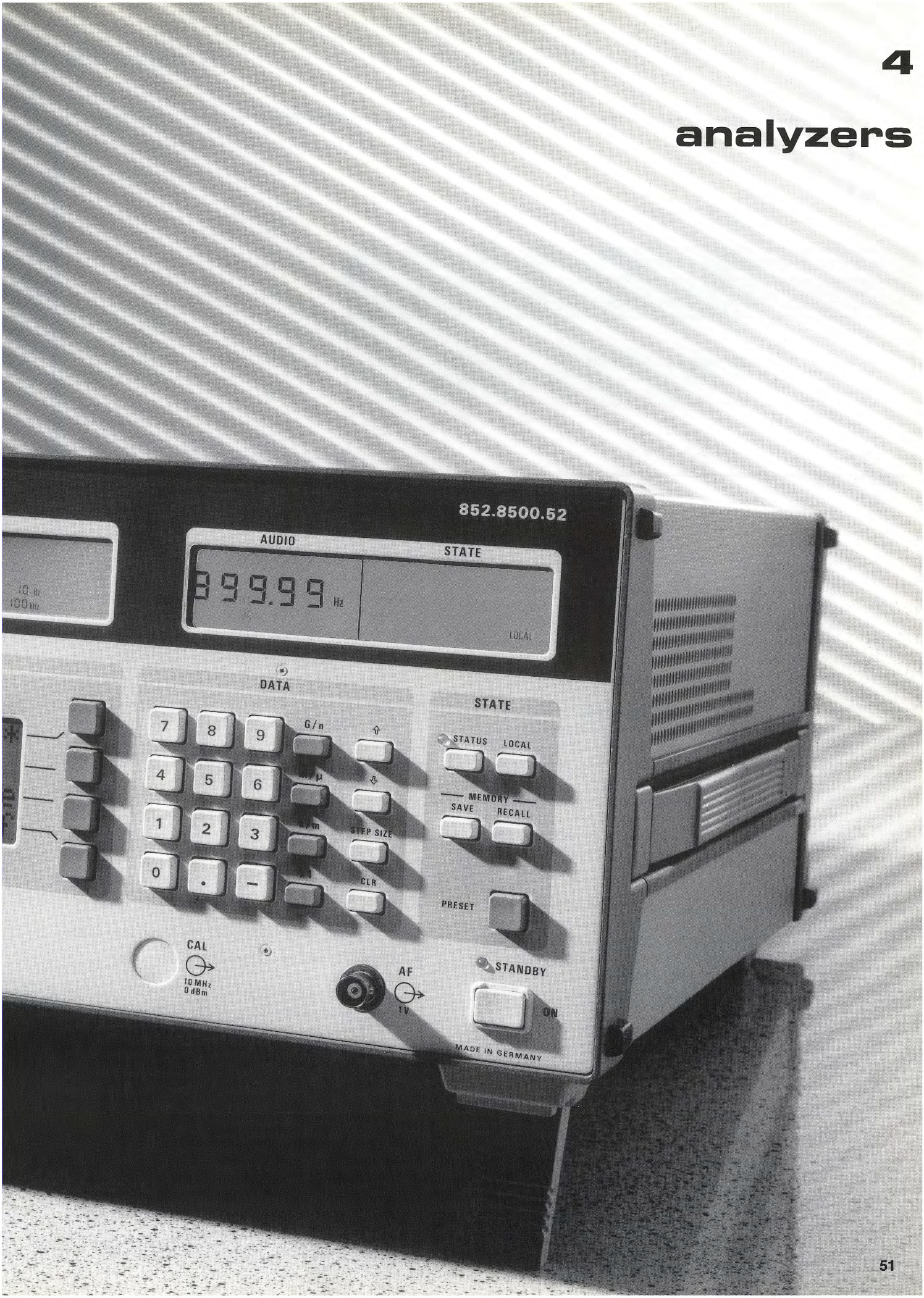
Modulation Analyzer FMA

– whether modulation, high-frequency or AF measurements: top-class performance throughout



4

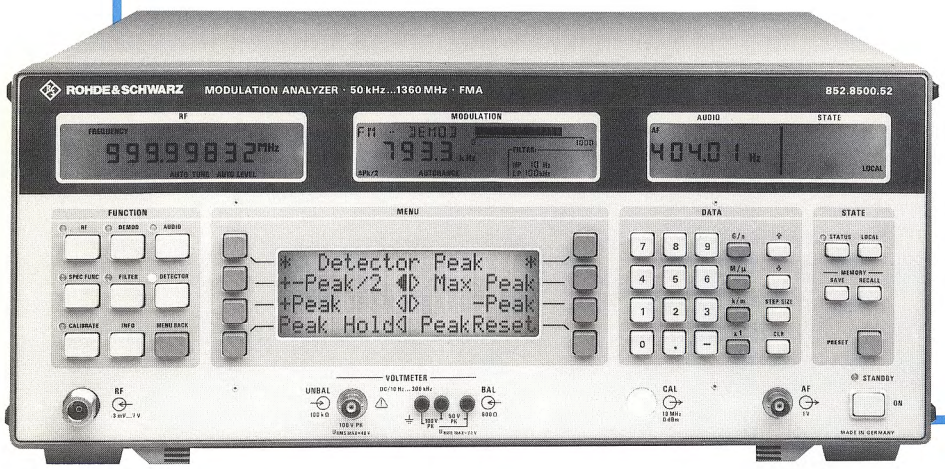
analyzers


852.8500.52
AUDIO
STATE
899.99 Hz
LOCAL
DATA
STATE
7
8
9
G/n
4
5
6
1
2
3
STEP SIZE
0
.
–
CLR
STATUS
LOCAL
MEMORY
SAVE
RECALL
PRESET
CAL
10 MHz
0 dBm
AF
1 V
STANDBY
ON
MADE IN GERMANY

FMA

Modulation Analyzer FMA ♦ 50 kHz to 1360 MHz

- RF frequency measurement with 10-digit readout
- High-precision AM, FM and φM measurement over a wide modulation frequency range
- Audio-frequency measurement with 5-digit readout
- Universal filter capabilities, psophometric weighting filters
- AF voltage measurement AC/DC
- High-accuracy power measurement (typ. error <0.5 dB)
- Distortion measurement down to <0.005 %, continuously from 10 Hz to 100 kHz (optional)
- Built-in stereodecoder for the highest requirements, for internal and external use (optional)



IEC 625 Bus

Characteristics

The **Modulation Analyzer 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 stereodecoder.

The 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. Its **unrivalled measuring accuracy** ensures high reliability.

The low residual FM, the **psophometer functions** using CCIR and CCITT filters (filter option FMA-B1) and the integrated FM stereodecoder (option FMA-B3) are a great help in testing and designing oscillators, transmitters, transposers and receivers.

Result display Three large illuminated LCD displays simultaneously read out the measured carrier frequency, modulation and modulation frequency values, plus additional information about device status and settings. The clear front-panel layout, with softkeys and a few main function keys, makes for user-friendly operation.

Uncompromised further development of measuring instruments is the answer to steadily increasing quality requirements in complex communication measurements.

The FMA features **modulation analysis** with **unrivalled precision** and a large variety of measurement functions at great ease of operation:

- **Fast, fully automatic adjustment to input frequencies** from 50 kHz to 1360 MHz at levels from 3 mV to 7 V
- **RF frequency measurement** with 10-digit readout and resolution down to 0.1 Hz; modern technology enables correct frequency measurement even with high AM depth
- **AM modulation depth, FM and φM deviation** with error of less than 0.5 %, wide dynamic range and 3-dB bandwidth of >300 kHz; FM and φM deviation measurement range 700 kHz (700 rad); AM, FM and φM demodulation from 50-kHz carrier frequency upwards
- **Audio frequency measurements** with 5-digit readout and resolution as fine as 1 mHz
- **Distortion** (THD) and SINAD **measurement** over the whole range from 10 Hz to 100 kHz with a dynamic range of >80 dB (option FMA-B2))
- **Psophometric weighting filters**
  - highpass filters 10/20/300 Hz
  - lowpass filters 3/23/100 kHz
  - CCIR, CCITT and other special weighting filters with filter option FMA-B1
- **Precision detectors**
  - separate +PK and −PK detector with extremely short response time
  - true RMS detector
  - quasi-peak detector to CCIR 468-4 with filter option
- **AC and DC voltage measurement and power measurement**
  - DC measurement from 10 µV to 20 V, error 0.5 %
  - AC measurement from 30 µV to 20 V, error <1 %
  - RF power measurement from 0.18 µW to 1 W or −37.5 to +30 dBm in the entire frequency range with a measurement error of typically 0.5 dB. External attenuators are taken into account in the result readout. An overload protection circuit for up to 5 W input power is included as standard.
- **FM stereodecoder** (option FMA-B3) for internal and external use. Able to measure crosstalk of more than 60 dB and with a weighted S/N ratio of ≥80 dB, it allows precise measurement of all quality parameters even of high-grade FM transmission equipment.
- **RDS demodulator** The FM stereodecoder option contains a full-featured radio data signal demodulator.

The FMA is designed for **high measurement speed**:

- Fast, automatic frequency adjustment by direct frequency measurement up to 1.36 GHz
- Two independent frequency counters for simultaneous RF and AF measurement
- 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, eg for extremely fast modulation measurement with preset RF level and preset RF frequency. In this way, 10 modulation values can be measured per second.

Measuring accuracy With a measurement error of less than 0.5 % at frequencies up to 20 kHz and 1 % in the range between 20 and 100 kHz, the FMA features a modulation measurement precision that is unrivalled and fulfills the requirements of calibration services. This high accuracy can be even further enhanced to values better than 0.1 % by using the optional AM/FM calibrator.

Dynamic range An extremely low-noise local oscillator (typ. −135 dBc at 1 GHz, 20 kHz from carrier) ensures for FM or φM demodulation negligible residual FM or φM up to the highest carrier frequencies. This makes the FMA suitable both for spurious and wanted modulation analysis.

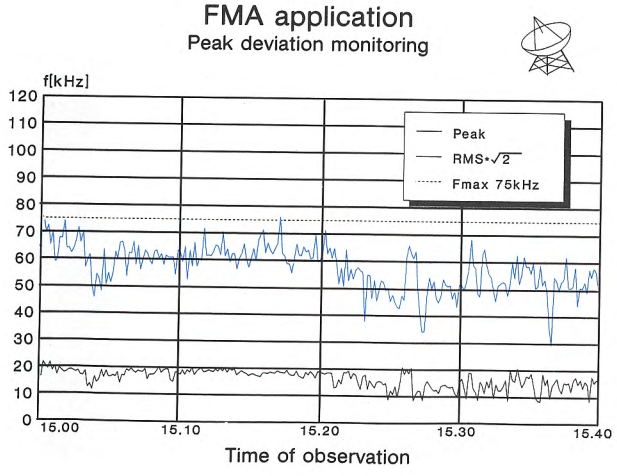
S/N ratio A weighted FM stereo S/N ratio of typically 78 dB for carrier frequencies up to 170 MHz allows in conjunction with the integrated stereodecoder (option) precise and convenient S/N ratio measurements on FM broadcast transmitters, channel transposers and sound processing units.

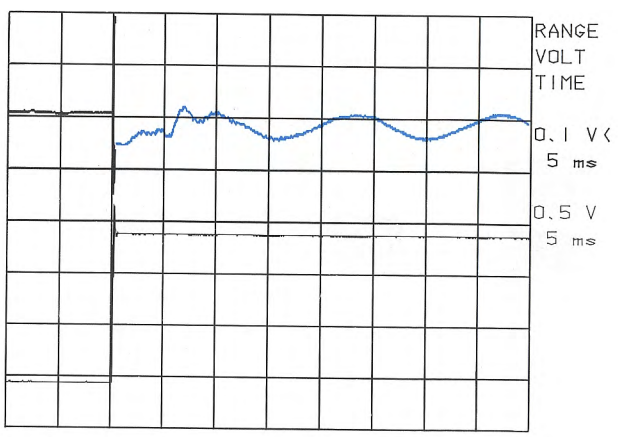
Future-oriented design With its low-noise synthesizer of 0.1 Hz resolution, broadband IF connectors and a number of free slots, the FMA is exceptionally well prepared for future applications. The frequency range can be extended up to 5.2 GHz. The built-in firmware can easily be updated via a serial interface using a PC compatible with the industry standard.

Applications

Peak deviation monitoring In conjunction with a process controller, eg the PSA from R&S, the FMA is ideal for monitoring the peak deviation of VHF broadcast transmitters. In the PK hold mode, +PK and −PK detectors operating in parallel and featuring a very short response time ensure precise measurement of all, even the narrowest of modulation peaks. The monitoring intervals can be from ≤100 ms up to any duration. The values measured by all detectors such as +PK, −PK, RMS and quasi-peak can be read out per interval.

The DC coupling of the AM and FM demodulator outputs in conjunction with the high DC stability and short settling time of the FM demodulator (<100 µs for a frequency error <500 Hz) as well as the use of a storage oscilloscope connected to the AM and FM output enable the measurement of **on/off transients of radio equipment to FTZ 17R2028.** The AM output signal, whose DC voltage component is proportional to the RF input level, is used as a trigger signal.





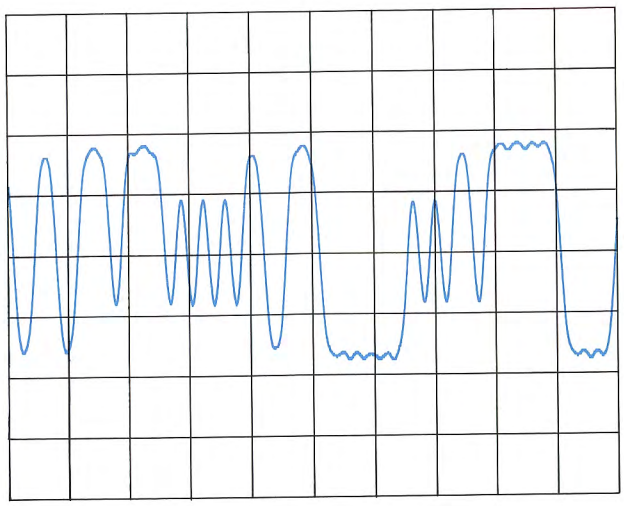
▲ Transient measurement on radio equipment
– Upper curve: FM output signal
– Lower curve: trigger signal at AM output (DC-coupled)

◀ With the aid of an external PC, the FMA is also suitable for longtime monitoring of peak deviation measured at intervals of <100 ms up to any length

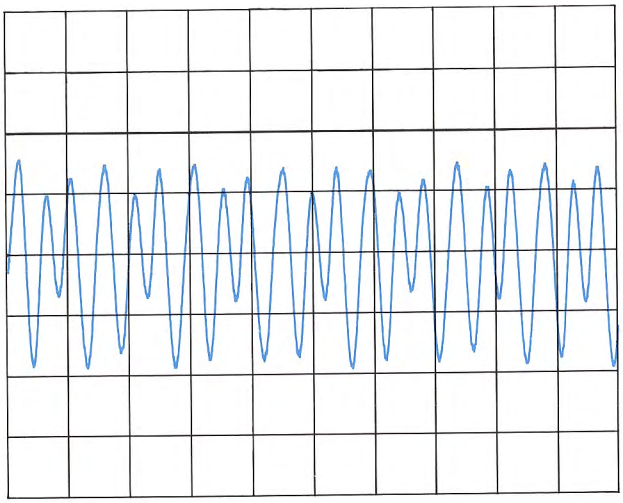
FMA

Applications

The built-in FM demodulator has a 3-dB bandwidth of 330 kHz and measures deviations up to 700 kHz. It allows digital modulators, eg GMSK (Gaussian Minimum Shift Keying) modulators, as will be used in the future GSM network, to be fully analyzed.



GMSK signal FM-demodulated by the FMA (bandwidth × bit period = 0.3, f_{bit} = 270,833 baud, pseudo-random bit sequence); the high demodulation bandwidth of 330 kHz ensures an undistorted signal at the FM or AM output; the frequency deviation can be precisely measured ▶



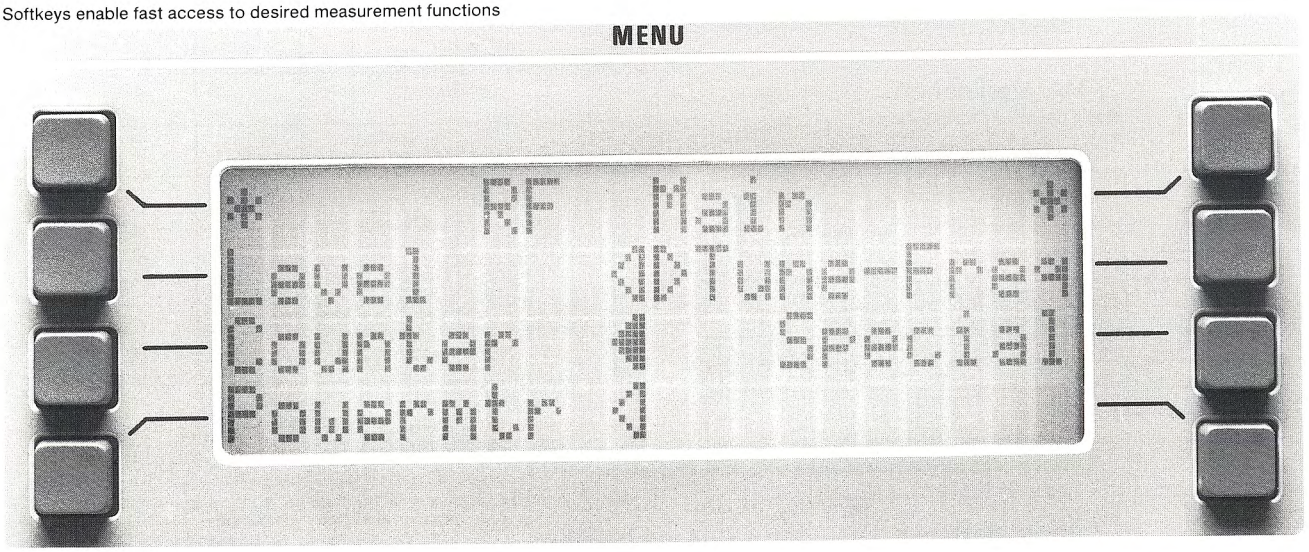
◀ GMSK signal as above, but modulated with constant 1; the residual FM of 2.9 kHz produced by the non-ideal GMSK modulator can be measured with the FMA at the required bandwidth

Operation

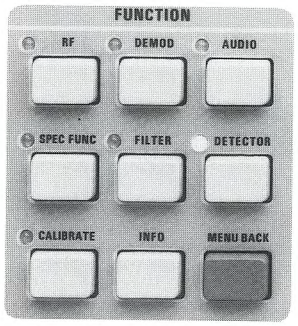
To handle its **numerous measurement functions**, the FMA is menu-controlled to avoid needing a great number of individual keys. All essential test parameters can be read at a glance on clearly arranged LCDs.

Remote control The modulation Analyzer FMA features full remote-control capability. The IEC-bus interface fully complies with the new IEEE 488.2 standard and enables **plain-text programming,** which greatly facilitates program writing.

Softkeys enable fast access to desired measurement functions

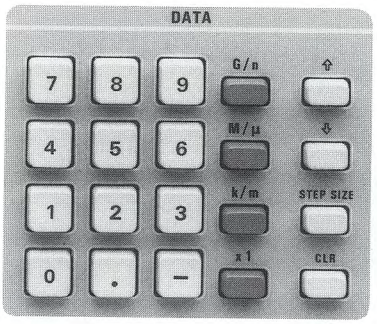


A minimal number of **main function keys** as well as an alphanumeric menu display with four softkeys down each side make for clear front-panel layout and fast access to the desired measurement functions. Important functions are at the top of the menu hierarchy, the number of submenu levels being limited to a maximum of three.



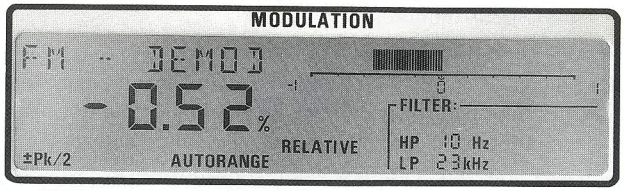
A minimal number of main function keys makes the FMA user-friendly

Parameters, like for instance a reference value for relative display, can be entered via the numeric keyboard and are terminated with entry keys (unit/multiplier keys). Up to 20 complete setups can be stored and as a result measurement reliability in complex applications can be considerably enhanced.



Convenient parameter entry using ergonomically configured keypad

Result display Frequency or level, deviation or modulation depth as well as frequency or distortion are read out independently of one another on three LCD displays. All essential device settings, such as operating mode, type of detector, weighting filter, etc are displayed.

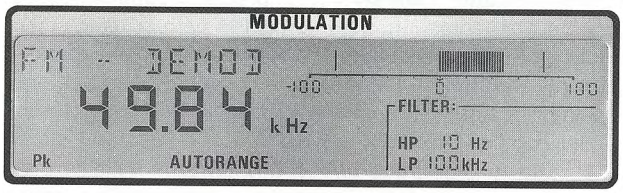


Quasi-analog bargraph indicator

A **quasi-analog bargraph indicator** with a high resolution of one hundred divisions is ideal for adjustments.

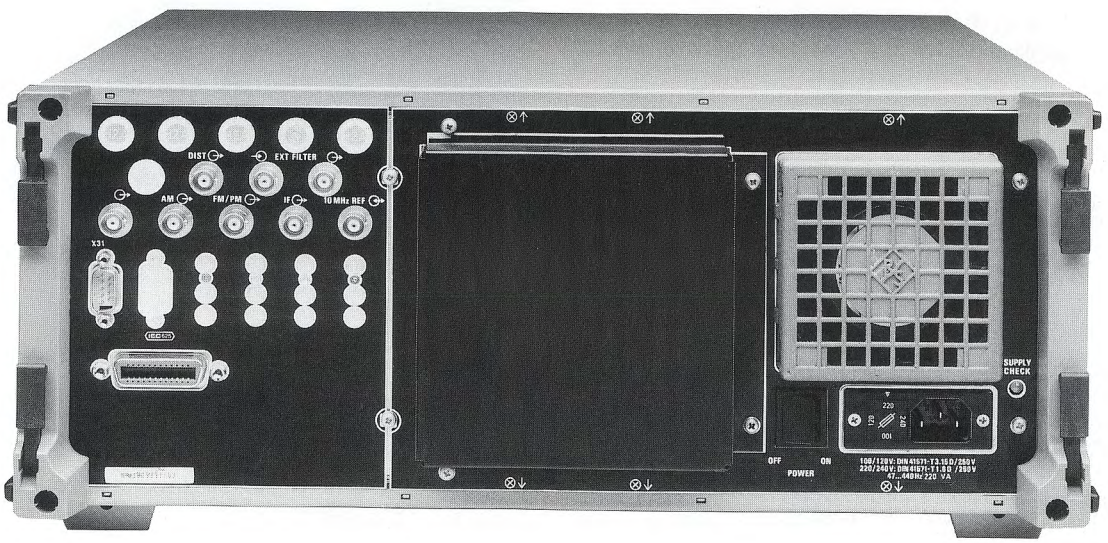
If **relative measurement** (% or dB) is selected, the bargraph indicator automatically switches to plus/minus indication when minor deviations are measured. This ensures fast and easy adjustment to a defined reference value.

A special **min/max hold display** shows the current result in analog form and the defined minimum and maximum values simultaneously.



In min/max hold mode the current result can be displayed in analog form between minimum and maximum value

Rear view of FMA



FMA

Options

Filter FMA-B1 The filter option contains the following universal weighting filters:

- Psophometric filter to CCIR 468-4 with associated quasi-peak detector
- CCITT filter P53
- Lowpass filters 30 kHz, 120 kHz with Bessel characteristic; highpass filter can be switched in for correct peak measurements on squarewave modulation signals
- 5-Hz lowpass filter for hum suppression in DC voltmeter mode
- Special φM filter; allows correct φM demodulation with modulation frequencies of 10 Hz and above
- 4.5-kHz lowpass with steep skirts, especially for residual modulation measurements on AM broadcast transmitters (ARD Specifications No. 5/4.1)

DIST/SINAD Meter FMA-B2 This measuring facility can be continuously tuned from 10 Hz to 100 kHz either automatically or manually and used internally or via the voltmeter function of the FMA. Able to measure distortion down to typically <0.005 %, the DIST/SINAD meter fulfills the requirements of high-quality audio measurements. The result can be read out in percent or as a SINAD value in dB.

Stereodecoder FMA-B3 This precision stereodecoder can be connected into the internal FM path or used separately via the external input. The FMA can thus be expanded to form a **complete FM stereo test system**. All FM stereo quality parameters, such as crosstalk, stereo distortion (using option FMA-B2), unweighted and weighted stereo S/N ratio (using option FMA-B1), pilot tone deviation, etc can conveniently and precisely be measured. This option forms a package together with the built-in RDS demodulator with external evaluation facility.

AM/FM Calibrator FMA-B4 High-accuracy AM/FM calibration source with an error of less than 0.1 %.

10-MHz Reference Oscillator FMA-B10 Highly stable 10-MHz reference oscillator with aging of $< 1 \times 10^{-9}$/day.

5.2-GHz Frequency Range Extension FMA-B12 extends the field of applications of the FMA into the microwave range.

Specifications

Frequency range	50 kHz to 1360 MHz	
Frequency tuning	automatic[1]) or manual	
Display	10-digit readout	
Resolution	0.1/1/10/100 Hz selectable	
Frequency error and drift	±1 digit + error of reference frequency	
Reference oscillator	**standard**	**option FMA-B10**
Aging	2×10^{-6}/year	1×10^{-7}/year
after 30 days of operation	–	1×10^{-9}/day
Temperature effect	2.5×10^{-6} (0 to 55 °C)	2×10^{-9}/°C
Warmup time	15 min	15 min
External reference input/output	manual or remote-controlled switchover	

RF input ... Z_{in} = 50 Ω, N connector, VSWR <1.4 with 10 dB attenuation
Overload protection ... up to 5 W (15 V RMS)
Maximum peak voltage ... 25 V (including DC)

RF power measurement
Frequency range ... 50 kHz to 1360 MHz
Power measurement range ... 0.18 µW to 1 W (−37.5 to +30 dBm)
Measurement error
0.18 µW ≤P <0.1 mW ... ≤±1.5 dB ±0.05 µW
P ≥0.1 mW ... ≤1 dB (typ. 0.5 dB)

Amplitude modulation measurement
Modulation frequency range ... 10 Hz to 200 kHz
Resolution ... 0.1 % of rdg; max. 0.001 % AM
Measurement error[2]) with peak detection (% of rdg, plus peak residual AM)

f_{in}:	50 to 300 kHz	>0.3 to 10 MHz	≥10 MHz
	f_{mod}	f_{mod} meas. error	f_{mod} meas. error
m ≤80 %	30 Hz to 3 kHz	30 Hz to 10 kHz ≤0.8 %	30 Hz to 20 kHz ≤0.8 %
m ≤95 %	–	30 Hz to 20 kHz ≤1 %	30 Hz to 100 kHz ≤1 %
	10 Hz to 8 kHz	10 Hz to 20 kHz ≤2 %	10 Hz to 100 kHz ≤2 %
	–	10 Hz to 50 kHz ≤5 %	10 Hz to 200 kHz ≤5 %

Residual AM[3])
to CCITT ... ≤0.01 %
20 Hz to 23 kHz, RMS ... ≤0.03 %
to CCIR ... ≤0.05 %
Incidental AM in FM mode (f_{mod} = 1 kHz, meas. bandwidth 20 Hz to 3 kHz)
f_{in} = 50 kHz to 10 MHz, deviation = 5 kHz ... ≤0.2 %
f_{in} ≥10 MHz, deviation = 50 kHz ... ≤0.1 %
AF distortion for f_{mod} = 10 Hz to 20 kHz
m = 40 % ... ≤0.2 %
40 % ≤m ≤80 % ... ≤0.4 %

Frequency modulation measurement
Modulation frequency range ... 10 Hz to 200 kHz

Max. measurable dev. for f_{in}:	50 to 300 kHz	300 kHz to 10 MHz	≥10 MHz
	f_{in}/10	150 kHz	700 kHz

Measurement error[2]) with peak detection (plus peak residual FM)

f_{in}: 50 to 300 kHz		300 kHz to 10 MHz		≥10 MHz	
f_{mod}	error	f_{mod}	error	f_{mod}	error
30 Hz to 5 kHz	≤0.5 %	30 Hz to 10 kHz	≤0.5 %	30 Hz to 20 kHz	≤0.5 %
10 Hz to 8 kHz	≤2 %	30 Hz to 20 kHz	≤1 %	30 Hz to 100 kHz	≤1 %
		10 Hz to 50 kHz	≤2 %	10 Hz to 200 kHz	≤2 %

Resolution ... better than 0.1 % of rdg (min. 0.1 Hz)

Residual FM[3]) for f_{in} ...	≤340 MHz	≤680 MHz	≤1360 MHz
to CCITT, RMS	≤0.5 Hz	≤0.7 Hz	≤1 Hz
20 Hz to 23 kHz, RMS	≤2 Hz	≤3 Hz	≤5 Hz
CCIR, quasipeak +50 µs deemph.	≤3 Hz	≤4 Hz	≤6 Hz

Stereo S/N ratio[3])
weighted to CCIR, 40 kHz deviation, at FM output (with noise filter)
f_{in}: 10 to ≤170 MHz ... ≥76 dB
170 to ≤340 MHz ... ≥73 dB
340 to 680 MHz ... ≥68 dB
Stereo crosstalk
(f_{in} ≥10 MHz, without noise filter)
f_{mod} = 1 kHz ... ≥56 dB down
30 Hz ≤f_{mod} ≤15 kHz ... ≥50 dB down
AF distortion for

	deviation of ... 75 kHz	500 kHz
f_{in} ≥10 MHz		
f_{mod} = 30 Hz to 20 kHz[4]) ...	≤0.05 %	≤0.2 %
= 20 kHz to 100 kHz ...	≤0.15 %	≤0.5 %
f_{in} >500 kHz		
f_{mod} = 30 Hz to 20 kHz ...	≤0.1 %	–

Incidental FM
(m = 50 %, f_{mod} = 1 kHz, B = 20 Hz to 3 kHz, plus peak residual FM) ... ≤10 Hz
Deemphasis ... 50/75/750 µs selectable, effective at AF output and, if selected, for readout of results

Phase modulation measurement
Modulation frequency range ... 200 Hz to 200 kHz
Max. measurable deviation (up to max. 1 kHz AF, −6 dB/octave for f >1 kHz)

f_{in}: 50 to 300 kHz	300 kHz to 10 MHz	≥10 MHz
1/10 × f_{in}/kHz × 1 rad	150 rad	700 rad

Error[2]) of peak detection (plus peak residual φM)

f_{mod}: 300 Hz to 5 kHz	300 Hz to 10 kHz	300 Hz to 100 kHz
≤2 %	≤2 %	≤2 %

Resolution	<0.1 % (minimum 0.0001 rad)	
Residual φ[3]) for f_{in}	≤680 MHz	>680 MHz
CCITT weighting	≤0.002 rad	≤0.004 rad
300 Hz to 23 kHz	≤0.005 rad	≤0.01 rad
AF distortion (at AF output) (f_{mod} 200 Hz to 20 kHz, φ = 4 rad, f_{in} ≥ 500 kHz)	≤0.1 %	

AF voltmeter

DC voltage measurement		
Range	±10 µV to 20 V	
Offset voltage[5])		
unbalanced input	≤1 mV	can be corrected to ≤30 µV using offset function
balanced input	≤3 mV	
Resolution	<0.1 %	
Error		
3-kHz lowpass filter	±0.5 % ±100 µV ± offset voltage	
5-kHz lowpass filter (with filter option)	±0.5 % ±10 µV ± offset voltage	
AC voltage measurement		
Frequency range	10 Hz to 300 kHz	
Measurement range	30 µV to 20 V	
Resolution	0.1 % of rdg	
Error (RMS detektor)		
30 Hz to 20 kHz	≤1 % ±30 µV (100-kHz lowpass filter)	
10 Hz to 100 kHz	≤2 % ±100 µV (without lowpass filter)	
10 Hz to 200 kHz	≤3 % ±100 µV (without lowpass filter)	
Weighting facilities	all AF measuring facilities, such as detector, filter, frequency counter and distortion meter can also be used in voltage measurements	
Inputs		
unbalanced	input impedance 100 kΩ ‖ 80 pF, BNC connector	
balanced	input impedance 600 Ω, threecontact connectors to DIN 41628	

AF detector

Peak detector	positive or negative peak of AF or their arithmetic mean
RMS detector	true RMS-responding rectifier, readout as RMS value or converted to peak for sinewave
Quasi-peak detector (with filter option)	detector to CCIR Rec. 468-4

Weighting filters

Highpass filters	10 Hz (2nd order) 20 Hz (3rd order) 300 Hz (2nd order)
Lowpass filters	3 kHz (4th order) 23 kHz (4th order), combined with 20-Hz highpass filter meets CCIR 468-4, unweighted 100 kHz (4th order)
Filter option	CCIR 468-4 (unweighted) CCITT P53 5-Hz lowpass (for DC measurement) 30-kHz Bessel lowpass, 4th order 120-kHz Bessel lowpass, 4th order 4.2-kHz Cauer lowpass special φM filter (phase demodulation for modulation frequency ≥ 10 Hz) external filters possible

AF frequency display	5 digits
Frequency range	10 Hz to 300 kHz
Resolution	1 mHz to 10 Hz
Error	±0.005 % ±3 mHz ±1 digit

Distortion measurement (optional)

Readout either in % or SINAD in dB, automatic adjustment for S/N ≥ 20 dB	
Measurement range	10 Hz to 100 kHz
Display range	
THD	0.005 to 50 %
SINAD	6 to 86 dB
Maximum error	
10 Hz to 100 kHz (harmonics up to 300 kHz)	±2 dB ±0.08 % THD
20 Hz to 20 kHz (with 100-kHz lowpass filter)	±1 dB ±0.015 % THD

Stereodecoder FMA-B3 (option)

Crosstalk from L to R, R to L (30 Hz to 15 kHz)	≥60 dB down
Frequency response L, R, M, S (30 Hz to 15 kHz)	≤±0.1 dB
Level difference between L and R	≤0.1 dB
Nonlinear distortion (with input level 6 dBm and 12.5 dBm, L, R, M, S output)	
THD (30 Hz to 15 kHz)	≤0.1 %
Intermodulation distortion to DIN 45403	d2 ≤0.05 %, d3 ≤0.1 %

S/N ratio (referred to +6 dBm at 500 Hz, deemphasis 50 µs)	
CCIR unweighted	≥ 80 dB
CCIR weighted	≥ 80 dB
Switch-selectable deemphasis	50 or 75 µs
External decoder input	balanced, 3-contact connector to DIN 41628
Common-mode rejection	
f≤ 1 kHz	≥60 dB
1 kHz <f ≤15 kHz	≥50 dB
15 kHz <f ≤ 100 kHz	≥36 dB
Input impedance	≥40 kΩ
Input level range	−12 to +12.5 dBm into 600 Ω, nominal +6 dBm/40 kHz
Resolution of level setting	≤0.2 dB
Stereodecoder outputs	
L, R, M	balanced, 3-contact connectors to DIN 41628, +6 dBm; Z_{out} ≤30 Ω, Z_l ≥300 Ω
S	unbalanced, BNC connector, Z_l ≥600 Ω
RDS demodulator outputs	9-contact Cannon connector
Signals available	data, clock, quality signal, TP information, 57-kHz carrier (TTL)

Measuring time

Automatic tuning; RF, modulation and modulation frequency measurement with 10 Hz RF resolution

(HP filter and PK detector switched on)	typ. 1 s
Fast modulation measurement (RF, modulation range and level already programmed)	≤120 ms
DIST measurement f_{mod} ≥30 Hz	typ. 2.5 s
≥300 Hz	typ. 1 s

Outputs

IF output	max. 200 mV into 50 Ω
AM output	max. 1 V into 600 Ω (can be DC-coupled)
FM/φM output	
for FM	+6 dBm (1.545 V) into 600 Ω, 40 kHz deviation (DC-coupled)
for φM	+6 dBm (1.545 V) into 600 Ω, 40 rad
Distortion output (with optional DIST/SINAD meter)	max. 1 into 600 Ω
AF output	1 to 4 V into 600 Ω

Remote control

Interface	IEC 625-1/625-2 (IEEE 488.1/488.2), connector: 24-contact Amphenol; all device functions including Serial Poll and Parallel Poll
Interface functions	SH1, AH1, L4, T5, SR1, RL1, DC1, DT1, PP1, C0

General data

Environmental conditions	to IEC 359, class I
Rated temperature range	0 to +55 °C
Storage temperature range	−40 to +70 °C
RFI suppression	complies with VDE 0871, limit B and PTT regulations 527/1979
Power supply	100/120/220/240 V ±10 %, 47 to 440 Hz (170 VA), safety class I to VDE 0411 (IEC 348)
Dimensions (W × H × D)	435 mm × 192 mm × 460 mm
Weight	25 kg

Ordering information

Order designation	▶ Modulation Analyzer FMA 852.8500.52
Accessories supplied	manual, power cable, spare fuses

Options

Filter	FMA-B1	855.2002.52
DIST/SINAD meter	FMA-B2	855.0000.52
Stereodecoder	FMA-B3	856.0003.52
AM/FM Calibrator	FMA-B4	855.6008.52
Reference Oszillator	FMA-B10	856.3502.52
5.2-GHz Frequency Extension	FMA-B12	855.8500.52

Recommended extras

Service Kit	FMA-Z1	856.4009.52
19″ Adapter	ZZA-94	396.4905.00
Transport Case	ZZK-944	1013.9366.00
Attenuator, 20 dB, 50 W	RDL 50	1035.1716.00

---

[1]) For amplitude-modulated signals: P_{in} ≥ −27 dBm, m ≤80 %.
[2]) In temperature range 20 to 30 °C, additional error of ±0.5 % over entire temperature range; error of RMS detection may be up to twice as high as of peak detection.
[3]) For input level ≥20 dB above specified minimum input level.
[4]) 100-kHz lowpass filter switched in.
[5]) Input attenuator switched on: value × 10.

FSAD Communications & Spectrum Analyzer FSAD ♦ 100 Hz to 2 GHz

- Top-class instrument for radiomonitoring
- Continuous frequency range and wide usable level range from –160 dBm to +30 dBm with selectable low-noise preamplifiers
- Excellent frequency accuracy
- Low phase noise
- Selectable preselection with 14 RF filters; seven steep-sided channel filters additionally in IF section
- Frequency response smaller than ±0.6 dB
- Tracking generator
- Variable tolerance and frequency lines
- Multimarker (32 functions!), autozoom and autoranging functions
- Easy-to-learn and convenient operation

Computer function (hardware and software)

- Further processing of results
- Use of specific application software

IEC 625 Bus

Characteristics, uses

Communications & Spectrum Analyzer FSAD from Rohde & Schwarz is yet another top-class instrument of the **FSA analyzer family** and especially suitable for signal analysis. Based on

- **Spectrum Analyzer FSA** (see catalog 90/91, page 234),
- **Network & Spectrum Analyzer FSAS** (see catalog 90/91, page 242) and
- **Communications & Network Analyzer FSAC** (see catalog 90/91, page 246),

the FSAD is able to handle practically all **radiomonitoring** measurements, measurements on antennas and cables, as well as selective scalar network analysis.

High-performance components such as tracking generator, RF filters, RF preamplifiers with wide dynamic range and steep-sided channel filters in the IF section are the **particularly strong features** of the FSAD.

The FSAD sets new standards for use in monitoring systems and in the laboratory. Typical features are high sensitivity (inherent noise level < –160 dBm), low phase noise, wide dynamic range and variable resolution bandwidths from 6 Hz to 3 MHz.

Operation

All analyzers of the FS.. family use the same **operating concept**. Convenient controls and indicators as well as **automatic test routines** allow even highly complex measurements to be performed with high speed and precision. A 'cleaned-up' front panel with **ergonomic controls and indicators** and a **well thought-out operating software** allow the user to concentrate fully on the measurement problem rather than on the instrument.

Any problems about the operating sequence can easily be solved by referring to the **help menu** that is accessible in any mode and often does away with the need to consult the operating manual.

Help-Menu	HELP Press Back or ↑ to exit...	Mode Comm. Analyzer

Filter	Frequency range	Type
1	0 to 9 kHz	Lowpass
2	9 to 150 kHz	Lowpass+ Highpass
3	0.15 to 2 MHz	
4	2 to 10 MHz	
5	10 to 30 MHz	
6	30 to 50 MHz	Bandpass
7	50 to 80 MHz	
8	80 to 110 MHz	
9	110 to 140 MHz	

Filter	Frequency range	Type
10	140 to 260 MHz	Tuned Bandpass
11	260 to 450 MHz	
12	450 to 700 MHz	
13	700 to 1000 MHz	
14	> 1 GHz	Highpass

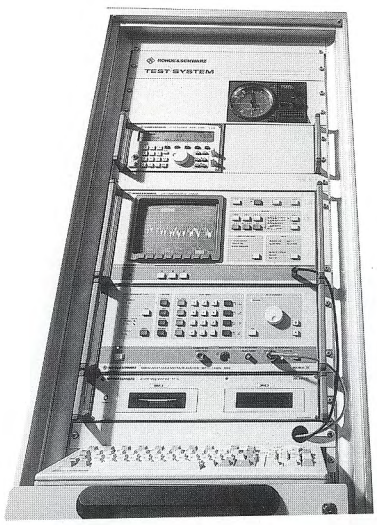
PRE-SELECTION FILTER TABLES

Help functions provide additional explanations for the current softkey menu

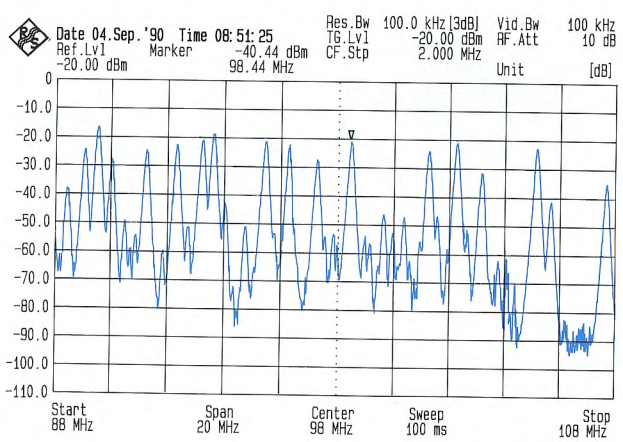
Applications

Radiomonitoring Fast, clear display of frequency bands is possible in a single sweep. The FSAD allows **field-strength and frequency-band occupancy measurements** as well as precise measurement of unknown signals with the built-in frequency counter. The FSAD is able to detect even **very weak interfering sources** by comparison with known sources (system application). An additional channel filter module with **steep-sided crystal IF filters** is tailored to the specific needs of radiomonitoring.

A typical field of application of the FSAD is the use in an unattended, intelligent radio test station. The test station allows demodulation of signals, remote-controlled measurements of level, frequency and modulation parameters as well as of frequency spectra in the radio bands.

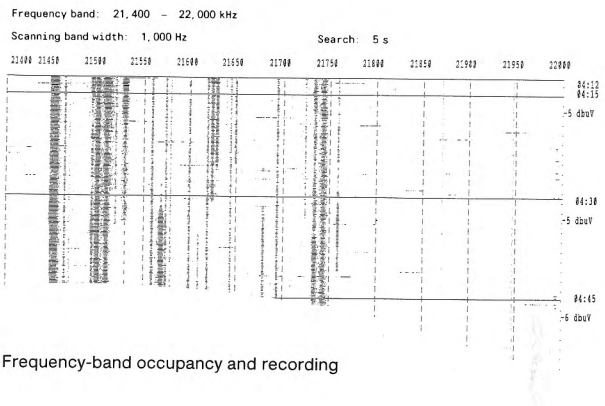


FSAD in unattended radio test station



Use of built-in frequency counter for accurate determination of signals in VHF FM band

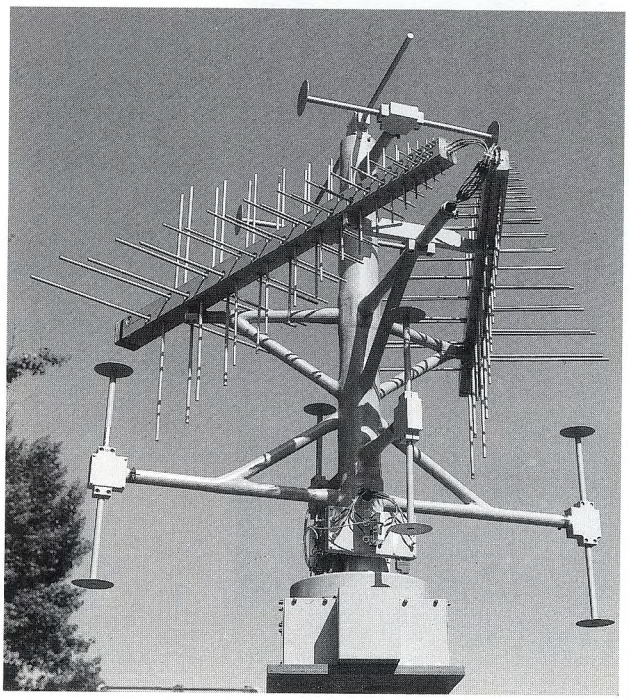
Frequency-band occupancy and recording The occupancy of a frequency band is determined by the FSAD in conjunction with the Computer Function FS-Z4. A frequency band defined by the start and stop frequencies of the analyzer is monitored continuously. After each sweep, the collected data are read and further processed by a program in the computer function. All signals exceeding a defined threshold are recorded on the fanfold printout, with the axis being marked by the time of the day at regular intervals.



Frequency-band occupancy and recording

Antenna measurements can be performed optimally with the FSAD, as for instance measurement of VSWR, gain and radiation pattern of an antenna under real operating conditions, ie not in a shielded room. Unlike broadband systems, the FSAD features a high immunity to overloading thanks to automatically selected input attenuators and RF filters.

Antenna measurements under operating conditions

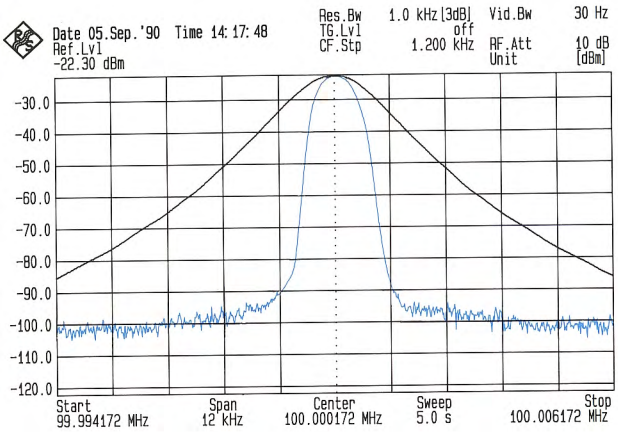


FSAD

Applications (continued)

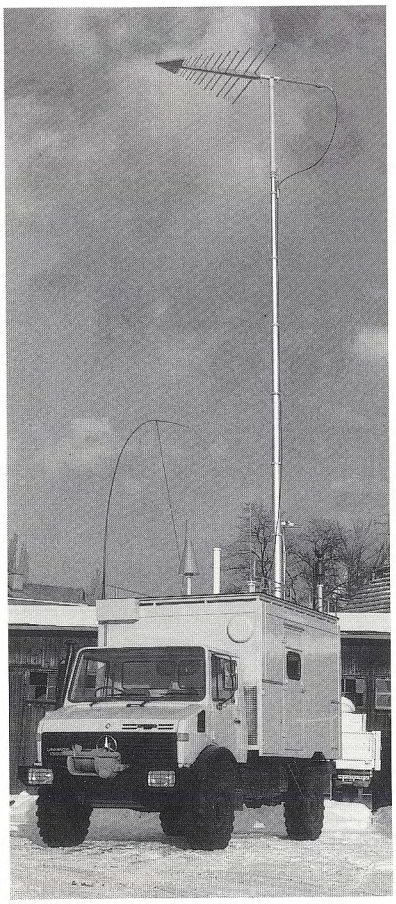
Receiver mode The FSAD differentiates between different types of signals using separate, calibrated demodulators. In-service measurements and measurements on receiving systems can be made conveniently using the built-in tracking generator.

Cable measurements The FSAD provides fast and accurate results even with extremely high shielding values (eg video cables with multiple shielding).



Additional channel filters improve the selectivity of the FSAD

Rear view



The FSAD from Rohde & Schwarz proving to be an ideal radiomonitoring instrument for the radiomonitoring services

Specifications

The data given below are supplementary to those of the Spectrum Analyzer FSA (catalog 90/91, page 238) and apply to the modified dynamic characteristics of Communications & Spectrum Analyzer FSAD.

Frequency, spectral purity: see FSA

Filters: see FSA; additional:

Channel filters

Type of filter	7 crystal filters, 1 free slot
Bandwidths (–6 dB)	1/2.4/6/8/15/100/235 kHz, other bandwidths on request
Setting	by special function
Shape factor –60 dB/–6 dB	between 2 and 3

Spurious responses

Third-order intermodulation
(f > 100 kHz, measured at
IF OUTPUT 21.4 MHz,
f < 140 MHz, RF filter on)
mixer level ≤ –30 dBm,
RF attenuation ≥ 10 dB

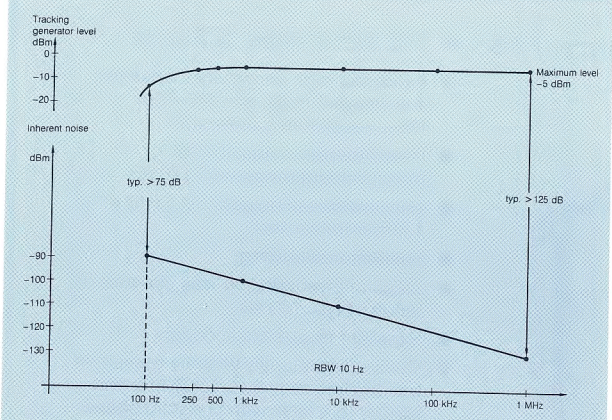
f < 30 MHz	< –75 dBc → TOI > +10 dBm, TOI = Third Order Intercept Point
30 MHz ≤ f ≤ 1.7 GHz	< –100 dBc → TOI > +20 dBm
1.7 GHz < f ≤ 1.8 GHz	< –90 dBc → TOI > +15 dBm

Sweep: see FSA

Scalar network analysis

Frequency range

(DC coupling, normalization)	100 Hz to 2 GHz
Span (continuously adjustable)	10 Hz to 2 GHz
Gain measurement range	130 dB
Loss measurement range	
f > 1 MHz, RBW = 1 kHz	> 120 dB
f < 1 MHz	see diagram



Typical loss measurement range at low frequencies

Inherent frequency response
(start frequency >5 × resolution bandwidth in default coupled mode)
without normalization ..... <1.1 dB, typ. <0,8 dB
with normalization,
without noise ..... display range/360
Display range
without normalization, LIN ..... 0 to100 %, 0 to −40 dB
without normalization, LOG .... 1/10/20/50/100/110 dB
with normalization ..... display range minus the frequency response to be normalized

Tracking generator
Output connector ..... N female
Output impedance ..... 50 Ω
VSWR for output level <−15 dBm ≤1.5
Output level ..... adjustable from −81 to −0 dBm (electronically in in 0.1-dB steps, mechanically in 1-dB steps)
Level deviation at −20 dBm output level and 100 MHz ..... ±0.5 dBm
Additional error on level change, referred to −20 dBm
mechanical ..... 0.3 dB +1.3 % of level change, max. 1 dB
electronic ..... 0.05 dB/0.1 dB
Additional error on switching level control time constant
RF detector → AF detector .... <0.3 dB

Frequency response for f_{start} >5 × RBW in default coupled mode, referred to level at 100 MHz (RF det.) or 1 MHz (AF det.)
500 Hz to 1.8 GHz ..... <0.5 dB
250 to 500 Hz ..... <+0.5 dB, <−3 dB
100 to 250 Hz ..... <−9 dB
1.8 to 2 GHz ..... +1 dB, <−10 dB (typ.)
Harmonics f >1 kHz ..... >25 dB down
Spurious ..... >30 dB down
Level control (softkey-selected) ... int./ext.
Modulation ..... AM (<30 %)
Frequency (ext. AF source, softkey-selected) ..... 10 Hz to 20 kHz

RF filters and RF preamplifiers

RF preamplifier		RF filter off 0 dB	10 dB	20 dB	RF filter on 0 dB	10 dB	20 dB	Unit
Inherent noise[1]	max.	−150	−155	−156	−143	−149	−150	dBm
Noise figure	typ.	13	7	6	16	10	9	dB
Freq. response[2]	max.	+1/ −1	+2/ −3	+2.5/ −3.5	+1/ −8	+2/ −9	+2.5/ −9.5	dB
	typ.	+0.3/ −0.3	+1/ −1.5	+1.5/ −2.0	+0/ −4	+0.5/ −5	+1/ −5.5	dB
VSWR, 0-dB RF attenuation. 10 MHz to 1 GHz	max.	2.8	2.8	2.8	2.8	2.8	2.8	
	typ.	1.5	1.5	1.5	1.5	1.5	1.5	
VSWR, 0-dB RF attenuation. 1 to 1.8 GHz	min.	2.8	2.8	2.8	3.5	3.5	3.5	
	typ.	1.6	1.6	1.6	2.0	2.0	2.0	
Input level for 1-dB compression[3]	min.	0	−15	−25	+1	−14	−24	dBm
	typ.	+5	−10	−20	+8	−7	−17	dBm
3rd-order intercept point T.O.i.[4] at input[4]	min.	+8	−5	−15	+5	−5	−15	dBm
	typ.	+11	0	−10	+10	0	−10	dBm
2nd-order intercept point H.S.O.i.[4] at input	min.	+50	+12	+2	+45	+12 (+42)[5]	+2 (+32)[5]	dBm dBm
	typ.	+60	+17	+7	+52	+17 (+52)[5]	+7 (+42)[5]	dBm dBm

Typical noise characteristics for f <20 MHz
RF attenuation ..... 0 dB
LO feedthrough ..... −20 dBm
Resolution bandwidth ..... 6 Hz
Video bandwidth ..... 1 Hz
DC coupling ..... for f<50 kHz
RF filter ..... off

Frequency range (RF filter off)

Preamplifier	0 dB	10 dB	20 dB
200 Hz <f < 1 kHz	−125 dBm	−133 dBm	−133 dBm
1 kHz <f < 10 kHz	−133 dBm	−138 dBm	−139 dBm
10 kHz <f <100 kHz	−138 dBm	−146 dBm	−149 dBm
100 kHz <f < 1 MHz	−138 dBm	−146 dBm	−153 dBm
1 MHz <f < 20 MHz	−145 dBm	−154 dBm	−158 dBm

Max. input level

Coupling of input	AC RF	AC DC	DC RF	DC DC
RF attenuation				
0 to 9 dB	+20 dBm	20 V	+20 dBm	0 V
10 to 19 dB	+30 dBm	20 V	+30 dBm	0 V
≥20 dB	+30 dBm	20 V	+30 dBm	0 V

Max. pulse energy ..... 1 mWs (= 100 Watt for 10 µs)

Level measurement error
The following data apply when using the FSAD with RF filters and/or RF preamplifier:
Frequency range ..... 500 Hz <f <1.8 GHz:
(following level calibration at centre frequency with reference level of −10 dBm)
Permissible deviation ..... typ. <0.8 dB
max. <1.5 dB
Frequency range ..... <500 Hz
(following level calibration at f = 500 Hz with reference level of −10 dBm)
Permissible deviation ..... typ. <1 dB
max. <1.5 dB
Frequency range ..... >1.8 GHz
In the frequency range >1.8 GHz an absolute calibration is best performed using an external calibration signal.

Demodulation, VDU, inputs and outputs and computer function: see FSA

General data same as FSA; except:

Weight ..... 64 kg

Ordering information

Order designation ..... ▶ Communications & Spectrum Analyzer FSAD 1005.7000.54
Accessories supplied ..... same as for FSA
Recommended extras ..... same as for FSA, plus the following

SWR Bridge (see catalog 90/91, p. 352) 50 Ω, 5 to 2500 MHz	ZRB2	373.9017.53
SWR Bridge (see catalog 90/91, p. 352) 75 Ω, 5 to 2000 MHz	ZRB2	802.1018.73
RF Current Probe; 10 kHz to 30 MHz	ESH2-Z1	338.3516.52
VHF Current Probe 20 to 300 (600) MHz	ESV-Z1	353.7019.02
Active Probe; 9 kHz to 30 MHz, high impedance	ESH2-Z2	299.7210.52
Precision Termination 50 Ω, N	RNA	272.4510.50
Termination 50 Ω, N	RNB	272.4910.50
Calibration Kit; 0 to 3 GHz, N	ZCAN	800.8515.52
Rod Antenna	HFH2-Z1	335.3215.52
Loop Antenna	HFH2-Z2	335.4711.52
Loop Antenna	HFH2-Z3	335.6214.52
Tripod	HFU-Z	100.1114.02
Mast (for tripod)	HFU-Z	100.1220.02
Antenna Roof-mounting Kit	HFH2-Z5	335.5718.02
Inductive Probe	HFH2-Z4	338.3016.52
Broadband Dipole; 20 to 80 MHz ..	HUF-Z1	358.0512.52
Log-periodic Antenna 80 to 1300 MHz	HL023A1	577.8017.02
RF connecting cable (7 m)	HFU2-Z5	252.0055.55
Probe; BNC connector	HFV-Z	204.1010.02
Adapter BNC female to N male	NAB11-23	118.2812.00

[1] RF attenuation 0 dB, resolution bandwidth 6 Hz, video bandwidth 1 Hz
[2] Frequency-dependent error in level display with reference to level at 100 MHz, filter switched off and 0-dB preamplification
[3] Measured at IF output 21.4 MHz (broad)
[4] Frequency 20 MHz to 1.8 GHz
[5] Frequency (fundamental) 15 MHz <f <500 MHz

FSB

Spectrum Analyzer FSB

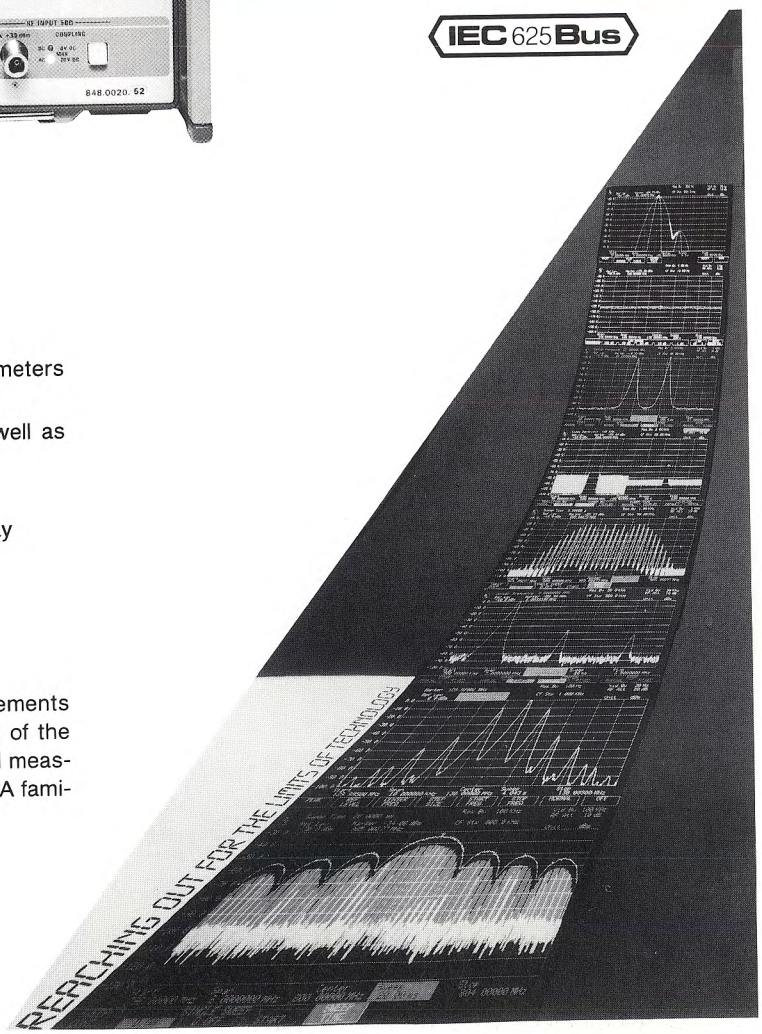
♦ 100 Hz to max. 5.2 GHz

- Extremely high sensitivity thanks to low inherent noise of –145 dBm (6-Hz resolution bandwidth)
- Useful display range 105 dB for measurement range of > 170 dB
- Very low phase noise of –110 dB at 1 kHz from carrier
- Fundamental mixing
- Large intermodulation-free dynamic range of typ. 100 dB
- Excellent frequency accuracy
- Quasi-continuously variable resolution bandwidths from 6 Hz to 30 kHz and 80 kHz to 3 MHz with constant shape factor
- Calibrated AM/FM demodulators

Computer function (option)

- Further processing of results
- Use of specific application software

IEC 625 Bus



Further main features

- Numerous automatic test routines
- Clear display of all essential functions and parameters on colour screen
- Level, frequency and bandwidth correction as well as selftest immediately after switch-on
- Optional logarithmic scaling of frequency axis
- Four trace memories with functional status display

Uses

Spectrum Analyzer FSB for high-precision measurements from AF through to microwaves is the basic model of the 5-GHz analyzer family. It is ideal for all selective level measurements; in addition to the uses covered by the FSA family, its main fields of applications are:

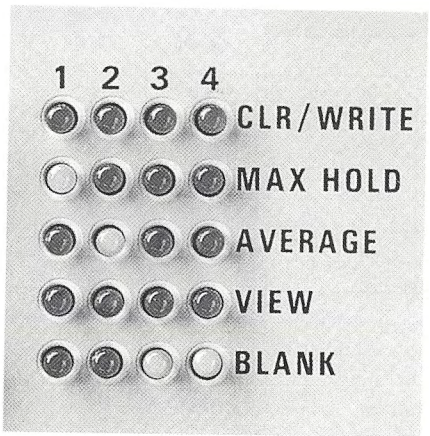
- mobile radio
- directional radio
- satellite communications
- radioastronomy
- development and production of receivers, amplifiers, filters and oscillators

Easy operation

- Single-knob operation
- Monofunction keys
- Softkey-controlled menus
- Convenient parameter entry, either via numeric keypad, step keys and/or spinwheel
- Status display

A single spinwheel, a clearly arranged front panel – **each key being assigned a single function only** – and softkeys along the bottom edge of the screen whose function depends on the menu selected make for the operating convenience of the FSB. Parameters are entered via the numeric keypad. The parameters can be varied quickly and precisely using the step keys for coarse adjustment and the spinwheel with magnetic latching for fine adjustment.

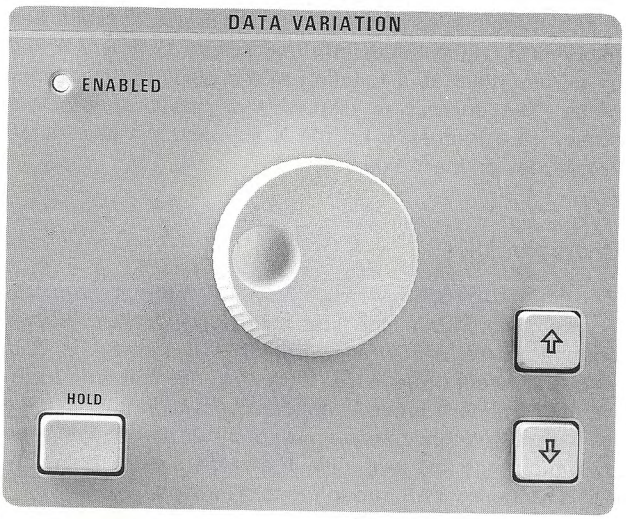
The **LED panel** clearly indicates the current status of four trace memories. The five operating modes of the **four trace memories** can all be seen at a glance. This is very useful when operating with different evaluation criteria.



LED panel

Hardkeys and softkeys The hardkeys being single-function keys are assigned fixed functions for calling menus (eg markers), selecting parameters (frequency) or entering values. The softkeys are assigned varying functions depending on the menu selected.

Spectrum Analyzer FSB is **easy to operate even for complex measurements**. This includes entries made by the user, readout of results on the screen as well as automatic detection of overloads even outside the displayed frequency range. **Basic settings** for repeated measurements can be **stored and recalled**. Test sequences can be executed automatically when using the optional computer function.



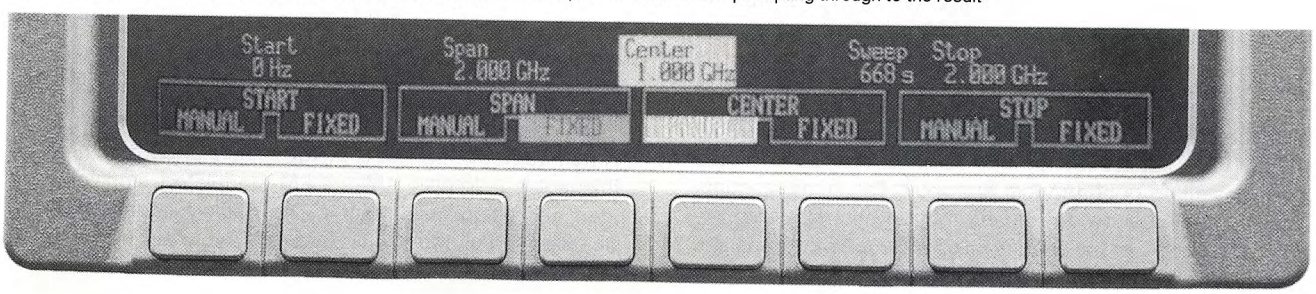
Parameter variation using step keys and spinwheel

Setting parameters can be coupled for signal analysis, so that only one value need to be changed and all others – like the ratio between resolution bandwidth and video bandwidth – are adapted automatically.

The **9″ colour screen** with display of all functions and parameters important for the measurement provides the user with a clear overview even in the case of highly complex applications, in particular when **several traces are displayed simultaneously**. An external keyboard allows entry and readout of additional information.

The **screen menus** lead directly to the result. There are no complicated tree structures with the FSB. If more than eight functions are offered, the menu is extended horizontally to the left or right. The status display in the **help menu** provides a current overview of the active settings in form of a list; both the list and the complete display can be output as a hardcopy.

Eight softkeys at the bottom edge of the screen with varying functions provide reliable user prompting through to the result



FSB

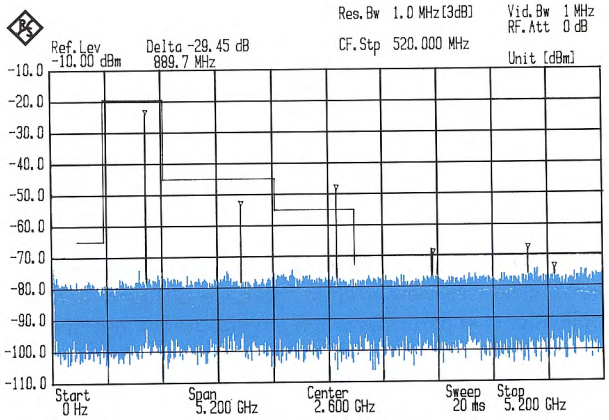
Description

Spectrum Analyzer FSB operates on the principle of search tone analysis. This means that the frequency range to be analyzed can be scanned by varying the internal oscillator frequency with the aid of an analysis filter with matched resolution bandwidth. The scan can be defined by any combination of start, center and stop frequency as well as span.

The parameters required for the analysis, ie **resolution bandwidth, video bandwidth and sweep time**, are linked by an algorithm as a function of the displayed frequency range. The analysis is displayed on the built-in colour screen: the frequency on the X axis and the associated amplitudes on the Y axis.

Characteristics

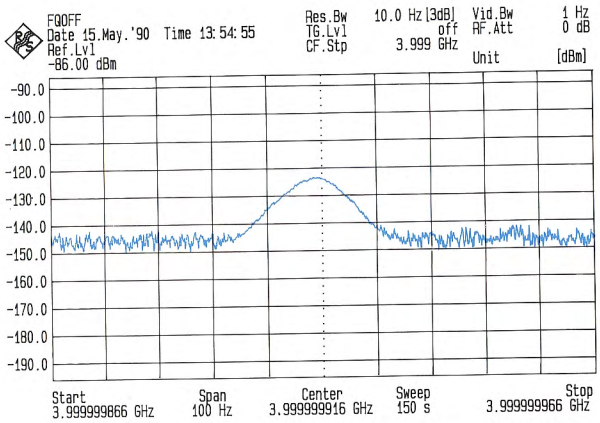
Continuous frequency range from AF through to microwaves The FSB is the first microwave analyzer with a continuous frequency range from 100 Hz to max. 5.2 GHz whose inherent noise is less than −145 dBm for 6 Hz bandwidth. A modern receiver concept with high intermediate frequency and fundamental mixing, mixer stages with wide dynamic range and low-noise IF amplifiers extends the analysis range from AF through to microwaves.



Harmonics measurement: the FSB operates with a continuous frequency range from 100 Hz to 5.2 GHz

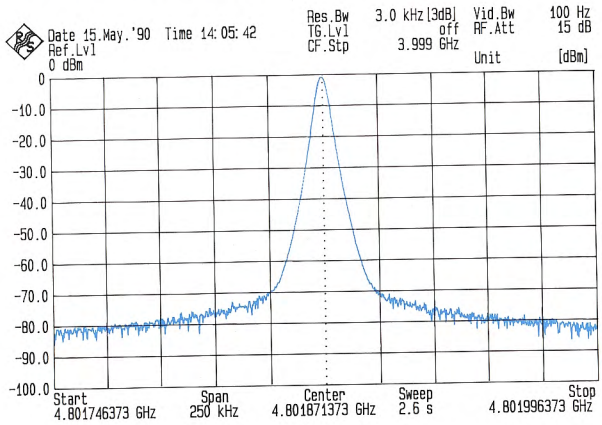
High frequency accuracy and spectral purity The synthesizer concept of the FSB allows a frequency resolution of 0.1 Hz with **extremely low phase noise**. The quasi-continuous frequency characteristic for spans up to 5 MHz enables frequency variation in steps of as small as 0.003 Hz. Frequency spans above 5 MHz are synchronized with the start and stop frequencies of the **YIG oscillator**, which due to its bipolar transistor provides exceptionally good phase noise data for the first conversion.

The **smallest resolution bandwidth of 6 Hz** of the FSB means that line-frequency interference can be detected just as well as nonharmonic spurious. The quasi-continuously variable bandwidth means that an optimum compromise can be found between resolution, frequency span and sweep time whatever the measuring task.



The FSB provides highest sensitivity right into the medium microwave range

Large level display range Measurement of **extremely weak signals in the GHz range** is no problem for the FSB thanks to its sensitivity of −145 dBm. The dynamic range is manifested by the intermodulation-free range of more than 100 dB. A logarithmic precision amplifier and the **high-resolution A/D converter** provide a display variable from the finest level resolution (0.1 dB per division of graticule) up to a display range of 110 dB.



Low phase noise and high attenuation of spurious in the FSB provide ideal prerequisites for the analysis of microwave oscillators

Computer-calculated optimization of the RF and IF stages and the use of a balanced mixer with wide dynamic range as well as of a low-noise GaAs-FET amplifier make for a **very good thermal noise characteristic**. This however does not affect the dynamic range at large signal levels. An attenuator adjustable in 1-dB steps enable optimum matching of the input level to the most favourable mixer level. The balanced design of this mixer makes for excellent suppression of even-numbered harmonics (eg 2nd harmonic).

The conversion loss which is practically idependent of frequency in conjunction with an **electronic frequency response correction** yields a steady amplitude display over the entire frequency range.

A **demodulator module** is included as standard in the FSB. It enables unknown AM- or FM-modulated signals to be identified using headphones. The demodulated signal can be displayed on the colour screen with high level resolution in the frequency range up to 20 kHz.

High measuring convenience The FSB has a variety of useful measurement tools:

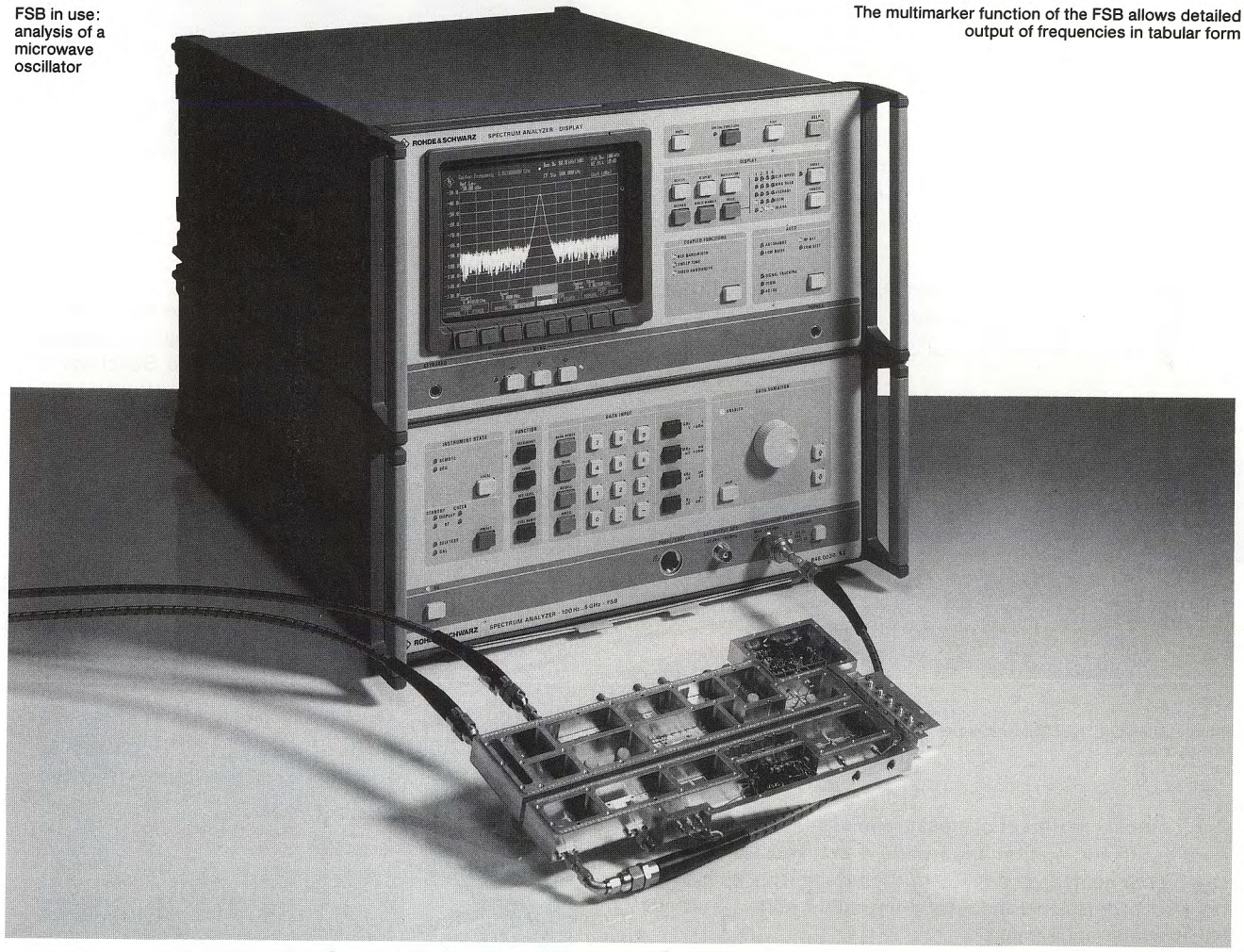
- multimarker function with up to eigth markers
- level, frequency and bandwidth correction
- adaption to signal type
- LOW NOISE and LOW DISTORTION operating modes.

The FSB thus provides an exceptionally high operating convenience which largely precludes errors and speeds up measurements considerably.

	INSTRUMENT STATE	
	FREQUENCY / TIME	LEVEL
REF. MARKER	889.77777777 MHz	-24.04 dBm
DELTA MARKER		
MULTI MARKER 1	5.77777777 MHz	-25.08 dBm
MULTI MARKER 2	889.77777777 MHz	-24.04 dBm
MULTI MARKER 3	1.779555555555 GHz	-53.49 dBm
MULTI MARKER 4	2.680888888888 GHz	-48.36 dBm
MULTI MARKER 5	3.582222222222 GHz	-67.66 dBm
MULTI MARKER 6	4.495111111111 GHz	-67.97 dBm
		TRIGGER FREE
DISPLAY LINE 1		
DISPLAY LINE 2		
THRESH. LINE		
LEVEL LINE		
N dB DOWN LINE		
FREQUENCY LINE 1		
FREQUENCY LINE 2		

The multimarker function of the FSB allows detailed output of frequencies in tabular form

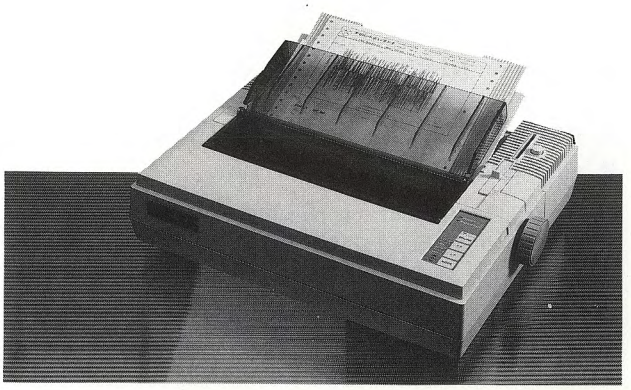
FSB in use: analysis of a microwave oscillator



Options

Useful result outputs

- Hardcopy on printer, video printer or plotter (labelling via external keyboard)
- Display also possible on external (colour) monitor or oscilloscope
- Remote-control capability via IEC bus (IEC 625-2, IEE 488.2) or programmable user port
- Expandable to form a process controller



24-pin Pinwriter PDN from Rohde & Schwarz with colour graphics, see catalog 90/91, page 454

FSB

The FSB enables direct connection of a number of useful options for the **output of measurement results**

- Hardcopy output of the screen display on a printer, video printer or IEC-bus plotter. In conjunction with the external Keyboard PCA-Z1, **convenient screen documentation** is ensured with optimum resolution and display size.
- Connection of several colour monitors for special workstations as well as for training and demonstration purposes
- Connection of an oscilloscope to the video output for (realtime) investigation of signals whose frequency is above 20 kHz.

Computer function

The **optional Computer Function FS-Z4** enables test routines to be automatically executed without the use of an external process controller. It consists of the following hardware and software components:

- Keyboard PCA-Z1
- External Floppy Disk Station PZ-11; can be optionally fitted with $3^1/_2$″ or $5^1/_4$″ drives.
- Software FS-K1 with MS-DOS, R&S-Basic and manual

The individual parts can also be ordered separately. Together with the CPU fitted as standard the FSB can be upgraded to a process controller with IEC-bus connector

For **complex automatic measurements**, a powerful process controller, eg from the **Rohde & Schwarz PSA family**, can be connected via the IEC-bus interface. This opens the door to professional **industry-compatible** software which fulfills every requirement.

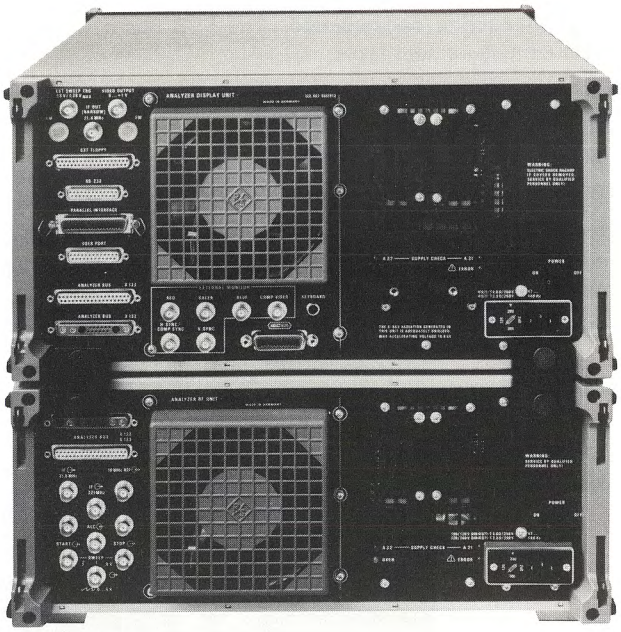
Design

Spectrum Analyzer FSB is built in design 90 and made up of the

- **RF unit** (4 height units of 19″ system) and the
- **display unit** (5 height unit).

For normal operation, the two units of the FSB are fastened together. They can be separated for ease of transport.

The electrical connection between the two units is established by means of two multicore screw-on cables. Each unit has its own power supply and AC supply connector.



Rear view of FSB

Future-oriented design

Thanks to excellent RF characteristics, versatile measurement capabilities, IEC-bus control as well as extendable hardware and software configuration, the Spectrum Analyzer FSB is well equipped to meet any future requirements.

The **modular design** – the display unit can also be combined with any other RF unit from the FS.. family – ensures the **flexibility** that is required for solving today's and tomorrow's measurement problems.

Specifications

Frequency

Frequency range	
DC coupling	100 Hz to 5.0 GHz (5.2 GHz)
AC coupling	100 kHz to 5.0 GHz (5.2 GHz)
Frequency offset	can be entered up to ±500 GHz
Frequency resolution	1 Hz
Step keys	span/10
Spinwheel	span/900
Selectable frequency display	
LIN	linear display of 11 vertical frequency lines (corresp. to 10 divisions)
LOG	linear measurement and log display of result (10/5 divisions per decade) (stop frequency/start frequency > 1.4)
Frequency reference	
Internal	R.A. = frequency reference accuracy
Mechanical settability	$<1 \times 10^{-8}$
Aging	$<5 \times 10^{-10}$/day (after 30 days) $<1 \times 10^{-7}$/year
Temperature drift	$<5 \times 10^{-8}$ (0 to 55 °C)
Run-in response	$<1 \times 10^{-7}$ after 10 min. at +25 °C
External (switch-selected)	10 MHz
Frequency display	
Evaluation aids	markers and cursor lines
Resolution	span/900
Error	
Span > 5 MHz	$<8 \times 10^{-3} \times$ span; $<5 \times 10^{-3} \times$ span (sweep time ≥ 100 ms)
Span 10 Hz to 5 MHz	$<2.5 \times 10^{-3} \times$ span ±RBW ±freq. × R.A.; $<2.5 \times 10^{-3} \times$ span ± freq. × R.A. (sweep time ≥ 100 ms); RBW = resolution bandwidth

Additional frequency error ..... resulting from centre frequency offset of IF filter

Without calibration
RBW < 3 kHz ..... < 700 Hz
3 kHz ≤ RBW ≤ 30 kHz ..... < 15% RBW
80 kHz ≤ RBW ≤ 150 kHz ..... < 35% RBW
150 kHz < RBW ..... < 15% RBW
With calibration ..... < 10% RBW or < 10 Hz (the higher value applies)

Drift of filter centre frequence at constant ambient temperature after 1-h warmup period
RBW < 1 kHz ..... < 10 Hz/min

Frequency drift ..... at constant ambient temperature, after 1-h warmup period

Span > 5 MHz (frequency drift occurring only during sweep, not added from sweep to sweep) ..... < ±200 kHz per minute of sweep time
Span ≤ 5 MHz ..... corr. to ref. frequency drift

Frequency counter ..... measures the frequency of the signal on which the marker is placed; marker to be at least 20 dB from noise and from point of intersection with adjacent signal
Counter resolution ..... 10 kHz to 0.1 Hz
Error ..... (freq. × R.A.) ± 2 × resolution

Frequency span
Setting range ..... 0 Hz/10 Hz to 2 GHz
Resolution ..... 2 Hz
Step key increments ..... 0.5 × span or 1 × span
Spinwheel span/900
Error
Span ≤ 5 MHz ..... $\pm 2 \times 10^{-3} \times$ span
Span > 5 MHz ..... $\pm 5 \times 10^{-3} \times$ span
Frequency steps per span ..... ≥ 1000

Spectral purity

Phase noise
At f ≤ 100 MHz ..... phase noise in dBc (1 Hz)

Frequency span	≤ 100 kHz	> 100 kHz to 5 MHz	> 5 MHz
Frequency offset			
> 100 Hz	≤ − 95	–	–
> 1 kHz	≤ −105	–	–
> 10 kHz	≤ −110	≤ −107	≤ − 90
> 30 kHz	≤ −113	≤ −110	≤ −105
> 100 kHz	≤ −115	≤ −115	≤ −115
> 300 kHz	≤ −115	≤ −120	≤ −120

At f > 100 MHz
Frequency offset
< 1 kHz ..... phase noise linearly increasing with f up to ≤ +12 dB at 5 GHz
> 1 kHz ..... phase noise linearly increasing with f up to ≤ +6 dB at 5 GHz
(applies to ambient temperature from +10 to +35 °C)

Sidebands ..... at discrete frequencies (in dBc)
Frequency offset
n × AC supply frequency ..... > 70, if mesurable by phase noise
m × line frequency (29.4 kHz) .. > 80
100 kHz (span ≤ 5 MHz) ..... > 90
−10.7 MHz ..... > 90
Other ..... > 75, for f > 1 MHz

Residual FM
Span > 5 MHz ..... < 10 kHz PP/2 in 0.1 s (test bandwidth 10 kHz)
Span ≤ 5 MHz ..... < 3 Hz PP/2 in 10 s (RBW = 10 Hz; VBW = 10 Hz; VBW = video bandwidth)

Filters

Resolution filters
Type of filter ..... 5 decoupled circuits
Bandwidths (−3 dB) ..... < 10 Hz (typ. 6 Hz) to 3 MHz
Error
Uncalibrated (in the range 10 to 300 kHz, the specified bandwidth error does not apply at a relative humidity of > 50%) . < ±30%
Calibrated ..... < ±10% (RBW ≥ 10 Hz), < ±1.5 Hz (RBW < 10 Hz)
Selection ..... with step keys in increments of 1/3/10 and with spinwheel and keyboard in increments of typ. 5% (except from 30 to 80 kHz)

Shape factor
−60 dB/−3 dB ..... < 12
−80 dB/−3 dB ..... < 20

Video filter ..... 1st-order RC lowpass filter following IF rectifier
Bandwidths (−3 dB) ..... 1 Hz to 3 MHz
Error (VBW = 1 Hz to 1 MHz) ..... ±20%
Selection ..... in increments of 1/3/10

Amplitude

Amplitude range
(at RBW of 10 Hz) ..... < −140 to +30 dBm

Maximum input power
DC ..... 0 V with DC coupling, ±20 V with AC coupling
AC ..... +30 dBm (RF attenuation ≥ 10 dB), otherwise +20 dBm
Max. pulse spectral density ..... 61 dBµV/MHz (RF attenuation > 10 dB)
Max. pulse energy (τ = 10 µs)
RF attenuation ≥ 10 dB ..... 1 mWs
Max. pulse voltage ..... 150 V

Level compression
RF level at input mixer (measured at 21.4-MHz IF OUTPUT)
f ≤ 36 MHz; ≤ −15 dBm ..... < 1 dB
f > 36 MHz; ≤ −10 dBm ..... < 1 dB

Displayed inherent noise level ... spurious excepted
RF attenation 0 dB, RBW 10 Hz, VBW 1 Hz
200 Hz < f < 1 kHz ..... < − 85 dBm
1 kHz < f < 10 kHz ..... < −105 dBm
10 kHz < f < 100 kHz ..... < −110 dBm
100 kHz < f < 1 MHz ..... < −115 dBm
1 MHz < f < 40 MHz ..... < −130 dBm
40 MHz < f < 4.8 GHz ..... < −140 dBm
4.8 GHz < f < 5.0 GHz ..... < −137 dBm

Indication of measured value .... internal electronic graticule with 11 to 13 (horizontal) level lines (top line corresp. to reference level)

Measurement ranges ..... linear or logarithmic 110/100/50/20/10/1 dB

Resolution
Markers ..... measurement range/4096, min. 0.01 dB
Display
110 dB ..... 352 steps (341 for log. frequency axis)
other ..... 360 steps (340 for log. frequency axis)
A/D converter ..... 12 bits

Setting range of reference level ..... the reference level can be set and measured values displayed in all common units. A level offset of −116 to +120 dB can be selected.
LOG scale ..... −90 to +30 dBm
LIN scale ..... −130 to +30 dBm
Resolution
Keyboard, spinwheel ..... 0.1 dB
Step keys
LIN, 100 dB, 110 dB ..... 10 dB
other ..... 0.1 × measurement range

Measurement error
Internal calibration source (CAL OUTPUT)
Level ..... −20 dBm ±0.2 dB
Frequency ..... 100 MHz $\pm 10^8 \times$ R.A.
RF frequency response (RF attenuation = 10 dB and DC coupling, ref. to 100 MHz, reference level > −30 dBm) ..... < ±1.0 dB
Level drift ..... typ. < 0.1 dB/°C (RF attenuation 10 dB, RBW 3 kHz reference level −20 dBm). The effect of this error can be avoided by calibration.

Resolution bandwidth switching
Reference bandwidth = 3 kHz (applicable for RBW < 10 Hz and ambient temperature +20 to +30 °C)
Uncalibrated ..... +2 dB, −3 dB
Calibrated
RBW ≥ 10 Hz ..... < ±0.3 dB
RBW < 10 Hz ..... < ±1.0 dB

If gain switching referred to ref. level −20 dBm (RF attenuation 10 dB)

	without	with calibration
Ref. level 0 to −60 dBm	< ±1 dB	< ±1.0 dB, typ. < ±0.4 dB
Ref. level −60.1 to −120 dBm	< ±2 dB	< ±1.3 dB, typ. < ±0.6 dB

FSB

RF attenuator ..... adjustable in range from 0 to 81 dB
Setting increments
  Keyboard, spinwheel ..... 1 dB
  Step keys ..... 5 dB
f < 2 GHz
  Error per 5-dB increment ..... < ±0.2 dB
  Total error ..... < ±(0.3 +1.3% of attenuation) dB
  Max. ..... 1 dB
f ≥ 2 GHz
  Error per 5-dB increment ..... < ±0.5 dB
  Total error ..... < ±(0.5 +2.5% of attenuation) dB
  Max. ..... 2 dB
The data on the total error apply to attenuation values deviating from the basic 10-dB setting, taking into consideration the frequency-dependent transmission loss incorporated in the calibration at the 10-dB setting.

AC/DC switching of input coupling
  RF attenuation ≥ 10 dB,
  1 MHz < f ≤ 3 GHz ..... < ±0.5 dB
Measurement range switching .... referred to LOG 100 dB at ref. level
  LOG 110/100/50/20/10 dB ..... < ±0.2 dB
  LOG ↔ LIN/LOG 1 dB
    Uncalibrated ..... < ±1 dB
    Calibrated ..... < ±0.2 dB
Scaling
  LOG scale (reference: 10 dB below ref. level)
    Display
      0 to −20 dB
        RBW ≥ 30 Hz ..... < ±0.1 dB/dB
        RBW ≥ 10 Hz ..... < ±0.2 dB/dB
        RBW < 10 Hz ..... < ±0.5 dB/dB
      −20 to −90 dB ..... < ±0.2 dB/dB
    Total error 0 to 100 dB ..... < ±1.5 dB
  LIN scale
    RBW ≥ 10 Hz ..... < ±5% of ref. level
    RBW < 10 Hz ..... < ±10% of ref. level
Error of calibration routine ..... < ±0.2 dB

Spurious responses
  Internal (without input signal, input terminated with 50 Ω, RF attenuation 0 dB)
    f > 1 MHz ..... < −110 dBm
    f ≤ 1 MHz ..... < −100 dBm
  LO feedthrough
    at f = 0 Hz ..... < −15 dBm
Second-order harmonic distortion
  Mixer level ≤ −30 dBm,
  RF attenuation ≥ 10 dB
    f < 40 MHz ..... < −60 dBc → HSOI ≥ +30 dBm, (HSOI = Harmonic Second Order Intercept Point)
    f ≥ 40 MHz ..... < −70 dBc → HSOI ≥ +40 dBm
Third-order intermodulation distortion (Δf > 100 kHz)
  Mixer level ≤ −30 dBm,
  RF attenuation ≥ 10 dB
    f < 40 MHz ..... < −75 dBc → TOI > +7 dBm, (TOI = Third Order Intercept Point)
    f ≥ 40 MHz ..... < −80 dBc → TOI > +10 dBm; with a mixer level of −40 dBm, this corresponds to an intermodulation suppression of 100 dBc
Other
  Mixer level ≤ −40 dBm,
  RF attenuation ≥ 10 dB
    f < 40 MHz ..... < −70 dBc
    f ≥ 40 MHz ..... < −75 dBc

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

Sweep

Sweep time
Span > 0 Hz

Setting ranges	Step size
20 ms to 2 s	20 ms
2 to 20 s	200 ms
20 to 1980 s	2 s
Error	$< \pm 10^{-3}$

Span = 0 Hz

Setting ranges	Step size
200 µs to 10 ms	1/2/4/8/10
20 ms to 1980 s	see span > 0 Hz

Error
  200 µs to 10 ms ..... < ±2%
  20 ms to 1980 s ..... $< \pm 10^{-3}$
Sampling rate ..... 1/8.9 µs
Time measurement ..... with the aid of markers and cursor lines
  Resolution ..... sweep time/900

Sweep mode ..... repetitive/single

Trigger
Operating modes ..... free run, line, video, external
Voltage range ..... ±5 V with external trigger
Trigger treshold resolution ..... 64 steps

Demodulation

Receiver mode ..... demodulation of received RF signal
Display of demodulated signal .... vertically on a 10-line graticule as a function of horizontal time base
Marker function for measuring .... modulation depth in %, frequency deviation, centre frequency offset
Resolution
  AM 0.1%
  FM ..... frequency deviation range/4096
  Time ..... sweep time/900

FM demodulator ..... values applicable to signal levels 0 to −30 dB below ref. level; VBW 10 kHz; S/N ratio > 60 dB
Centre frequency offset after AF calibration (AF calibration not before 5 minutes after FM demodulation is switched on)
  FM deviation
    2 kHz, 20 kHz, 200 kHz ..... < 2% of deviation
    200 Hz ..... < 40 Hz
  Drift at constant ambient temperature ..... < 10 Hz/min
FM deviation display error
  Deviation 2 kHz, 20 kHz, 200 kHz
    Modulation frequency
      100 Hz to 5 kHz ..... < 3% of rdg
      DC to 15 kHz ..... < 5% of rdg
FM linearity error (deviation < 20 kHz, modulation frequency < 5 kHz) ... < 1%
Residual FM (PP/2), averaged over 5 sweeps ..... < 20 Hz
Incidental FM at 50% AM, modulation frequency 1 kHz, VBW 3 kHz ..... < 500 Hz, typ. < 100 Hz

AM demodulator ..... values applicable to signal levels −6 to −35 dB below reference level
Centre offset of unmodulated signal
  Measurement range
    100% AM ..... < 2% of fs
    10% AM ..... < 5% of fs
Error of displayed mod. depth, AM < 80% (plus residual AM), mod. frequency 0.4 to 10 kHz ..... < 6% of rdg (with measurement range 10% AM < 8% of rdg)
Residual AM
  PP/2 ..... < 1%
  weighted to CCITT (VBW 3 kHz, RBW 30 kHz, averaged over 5 sweeps) ..... typ. < 0.1%
Incidental AM, RBW 3 MHz, FM deviation 50 kHz, modulation frequency 1 kHz ..... < 3%

VDU

Monitor ..... 9″ in-line colour CRT with 0.29-mm dot pitch
Useful area ..... 157 mm × 118 mm
Brightness ..... adjustable in 64 steps
Colours ..... selectable (16 from 4096)
Number of display memories 4
X resolution (electrical) ..... 1024 points
Y resolution (electrical) ..... 512 points

Scaling	electronically superimposed, calibrated graticule
Additional information	alphanumeric display of essential parameters as well as hints in English
Output to plotter	R & S Plotter DOP; HP-GL
Functions	curve arithmetric (swap, subtract, frequency axis logarithmation), averaging, peak hold
Markers	reference marker + delta marker +6 multimarkers
Functions	signal track, marker to peak, marker to ref. level, marker to center freq., step size, marker to center, marker to start/stop freq., marker to peak/next peak/min/next. min, marker zoom, noise marker with normalization in dBm/Hz, delta marker to span, delta marker with noise normalization in dBc (Hz), N dB down, shape factor measurement 60/3 dB and 60/6 dB, multimarker peak, search, multimarker set/clear/clear all, marker to next/previous multimarker; receiver mode: delta marker (measurement of (AM) modulation depth, (FM) frequency deviation and offset)

Inputs and outputs

Front panel, RF section

RF INPUT 50 Ω		
(100 Hz to 5.0 GHz)	N female	
Impedance	50 Ω	
VSWR	**f ≤2.7 GHz**	**f >2.7 GHz**
RF attenuation = 0 dB	≤3.0	≤3.0
RF attenuation ≥10 dB	≤1.5	≤1.8
CAL OUTPUT		
(100 MHz, −20 dBm)	BNC female	
Impedance	50 Ω	
VSWR	<1.1	
PROBE/CODE (supply and coding connector, e.g. for active or passive probes and antennas)	12-contact Tuchel female	
Supply voltage	+10 V, max. 100 mA, −10 V, max. 100 mA	

Front panel, display section

PHONES	JK 34 jack
Frequency range (−3 dB)	100 Hz to 15 kHz
EMF	10 V_{PP}
Source impedance	30 Ω
KEYBOARD	JK 34 jack (for PCA-Z1)

Rear panel, RF section

IF OUTPUT, 221.4 MHz	BNC female
Impedance	50 Ω
VSWR	<2
Gain referred to level at input mixer	−3 dB, ±6 dB
Bandwidth (10 dB)	>36 MHz
IF OUTPUT, 21.4 MHz	BNC female
Impedance	50 Ω
VSWR	≤2
Gain referred to level at input mixer, ref. level −10 dBm, att. 20 dB, normal	+8 dB, ±2 dB
Bandwidth (−6 dB)	>10 MHz
10-MHz REFERENCE	BNC female
Output level with internal reference (Z_S = 50 Ω)	+10 dBm +3/−1 dB
Input level with external reference (Z_{in} = 500 Ω)	0.1 to 1 V_{rms}
SWEEP OUTPUT	BNC female
Output voltage (Z_L >500 Ω)	0 to +5 V
START-SWEEP-STOP	BNC female; positive TTL pulse (τ = 1.4 µs) occuring upon sweep start and stop

Rear panel, display section

IF OUTPUT (narrow), 21.4 MHz	BNC female
Impedance	50 Ω
VSWR	<2
Level with reference level up to −90 dBm	−15 dBm ±3 dB
Bandwidth	corresp. to resolution bandwidth
EXT SWEEP TRIG	BNC female
Input impedance	>8 kΩ
Voltage range	±5 V; max. ±20 V
VIDEO OUTPUT	BNC female
Source impedance	75 Ω
Output voltage	0 to +0.5 V into 75 Ω, proportional to vertically displayed measured value

EXTERNAL MONITOR	
Outputs	BNC female
RED, GREEN, BLUE, COMP VIDEO	
Clock frequency	40 MHz
Impedance	75 Ω
Output voltage	0.3 to +1.4 V into 75 Ω
V SYNC (vertical synchronization)	TTL levels, fan-out 20 LS-TTL, polarity selectable by internal jumpers
Repetition frequency	50 Hz ±2%
Sync pulse	0.8 ms
H SYNC/COMP SYNC (horizontal synchronization)	TTL levels, fan-out 20 LS-TTL, function and polarity selectable by internal jumpers
Line frequency	29.4 kHz ±2%
Sync pulses	2 µs
EXT FLOPPY	37-contact Cannon D female, for PZ-11
RS 232	25-contact Cannon D female
PARALLEL INTERFACE (Centronics)	36-contact Amphenol female
USER PORT	25-contact Cannon D female, function definable in setup mode
KEYBOARD	JK 34 jack for PCA-Z1
IEC-625 bus (IEEE 488.2)	24-contact Amphenol female
Bus functions	AH1, SH1, T6, L4, SR1, RL1, PP1, DC1, DT1, C1 to C4, C11
Data transfer rate	≤350 Kbyte/s

General data

Note	unless otherwise specified, all values applicable to continuous sweep with coupled functions in default coupling and calibrated; based on IEC 714
Ambient conditions	to IEC 359, class I
Rated temperature range	0 to +55 °C
Storage temperature range	−40 to +70 °C; the unit contains a lithium battery for buffering the CMOS RAMs. The battery capacity and service life will be considerably reduced at low or high temperatures, respectively.
Max. relative humidity	20 to 90% (without condensation)
EMC	VDE 0871, limit class B; postal regulation 526/527.79; CISPR publication 11, 22; FCC DOC 20780: Part 15, Subpart 5
Warmup period (0 to 55 °C), time required to attaining operating temperature after cold start	1 h
Internal thermal equilibrium (at constant outside temperature)	4 hours
Power supply	100/120/220/240 V ±10%, 47 to 440 Hz (500 VA), safety class I (to IEC 348 and VDE 0411)
Dimensions (W × H × D)	435 mm × 413 mm × 590 mm
Weight	58 kg

Ordering information

Order designation	▶ Spectrum Analyzer FSB	848.0020.52
Frequency span max. 2 GHz		848.0020.54
Accessories supplied	power cable, connecting cable, manual	

Recommended extras

Service Kit	FS-Z1	811.0010.02
Connection Cable Set (for servicing, 1 m)	FS-Z2	811.0304.02
Filter Element	FS-Z3	805.7900.02
Software for Computer Function	FS-K1	811.0610.02
Computer function (FS-K1 + PCA-Z1 + LAS-Z11)	FS-Z4	811.0810.02
Keyboard	PCA-Z1	375.7511.02
Ext. Floppy Disk Station	PZ-11	350.8514.02
Plotter	DOP	375.1213.02
24-pin Pinwriter		
220 V	PDN	351.4512.02
117 V	PDN	351.4512.03
Colour option	PDN-B3	351.4912.02
IEC-bus Cable (1 m)	PCK	292.2013.10
19″ Adapter	ZZA-941	396.9471.00
	ZZA-951	396.9488.00

Accessories for current, voltage and field-strength measurements: see accessories for Test Receivers ESH 2/ESH 3 catalog 90/91, page 276) and ESV/ESVP catalog 90/91, page 280)

FSBC Communications & Spectrum Analyzer FSBC

♦ 100 Hz to 5.2 GHz

- Universal instrument for selective level measurements, scalar network analysis through to radiomonitoring tasks
- Continuous frequency range and wide level range from −154 dBm to +30 dBm with selectable low-noise preamplifier
- Separately switchable preselection circuit with 12 RF filters affording large dynamic range
- Tracking generator with offset capability for quasi-realtime measurements on frequency-converting DUTs
- Wide dynamic range for measurements on high-gain two-ports up to the microwave range
- Variable tolerance and frequency lines
- Great variety of multimarker, autozoom and autoranging functions
- Easy-to-learn and convenient operation

Computer function
(hardware and software)

- Further processing of results
- Use of specific application software

IEC 625 Bus

Uses

Communications & Spectrum Analyzer FSBC is another innovative model of the **FS.. analyzer family**. Developed from the

- **basic FSB model** (see page 62) and the
- **Network & Spectrum Analyzer FSBS** (see page 74),

the FSBC ist able to handle practically all **radiomonitoring** measurements in a continuous frequency range from AF through to microwaves thanks to integrated switch-selectable modules, such as **low-noise preamplifier** and **RF preselection.**

The FSBC covers nearly all applications of the FSA and FSB families. When **operated directly with antennas**, this analyzer allows measurement of field strength, frequency band occupancy and of antenna parameters as well.

Operation

The **great operating convenience** of the FS.. analyzer family is continued with the FSBC:

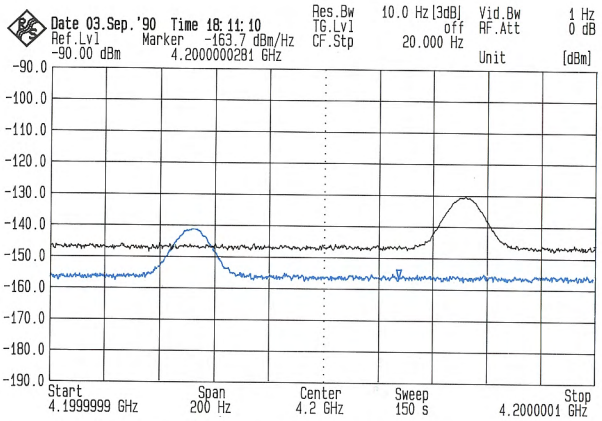
- Single-knob operation
- Colour-coded single-function keys
- Softkey-controlled menus
- Many automatic test routines and marker functions
- Autocalibration
- Four trace memories
- High-resolution, clear colour display
- Brief operating instructions shown on display (help functions)

Outstanding features of FSBC

- Wide frequency range 100 Hz to 5 (5.2) GHz
- Switchable preselection 12 built-in RF filters
- Useful level range display section
  < −142 to +30 dBm or
  < −151 to +30 dBm
  with preamplifier,
  generator section
  −81 to 0 dBm
- High frequency resolution
  – synthesizer 0.0032 Hz
  – frequency counter 0.1 Hz
- High level resolution
  – display section 0.01 dB
  – tracking generator 0.1 dB
- Wide range of resolution bandwidths 6 Hz to 3 MHz
- High frequency and level stability
- High accuracy resulting from normalization
- Low inherent frequency response: typ. < ±1.0 dB (generator + display, without normalization)

Characteristics

The characteristics of the FSB and FSBS models have been further enhanced to take account of the special applications of the FSBC: in the field of **communications measurements**, very weak signala and signals frequently subjected to noise are an everyday occurrence. An integrated, selectable **preamplifier** improves the **high sensitivity** of this analyzer even further in the entire frequency range. As a result of densely occupied frequency bands, the requirements regarding selectivity and dynamic range are extremely stringent; the FSBC is ideally suited for these task thanks to an automatically controlled **filter assembly** comprising up to 12 filters.



The high sensitivity is improved even further by the selectable preamplifier of the FSBC

The **AM and FM demodulators** fitted as standard in all analyzers of the FS.. family have a special task in the FSBC: unknown signals — whether amplitude- or frequency-modulated — can easily be identified using the built-in loudspeaker or headphones and displayed on the high-resolution colour screen for closer examination.

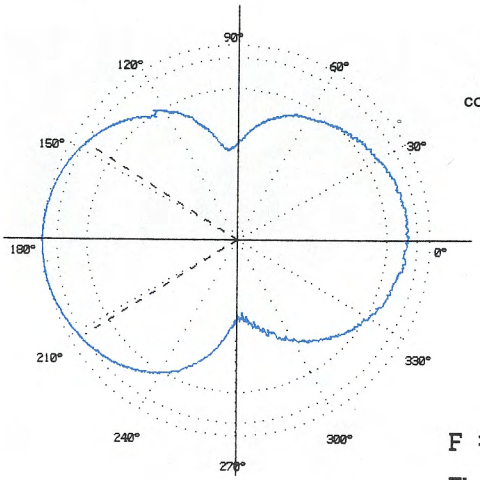
- A separate IF amplifier with AGC provides an AF signal of constant volume — irrespective of the signal level — in the AM mode
- A limiting amplifier with PLL discriminator ensures that the typically high S/N ratio of an FM signal can be fully utilized
- A software-controlled squelch with adjustable response level enables noise-free reception of transmitters that operate intermittently

Applications

In addition to the applications of the FSA series as well as those of the FSB and FSBS, this analyzer provides great advantages for **special applications** — right through to the **microwave range:**

Radiomonitoring Fast, clear display is possible after a single sweep. The FSBC allows field-strength and frequency band occupancy measurements as well as precise measurement of unknown signals by means of the built-in frequency counter. The FSBC is able to detect even very weak interfering sources by comparing them with known sources.

Antenna measurements These can be carried out optimally with the FSBC and Computer Function FS-Z4 (see FSB). Measurement of VSWR, gain and directional characteristic (lobe pattern) under operating conditions, ie not in shielded rooms, are typical applications. Other than with broadband analyzer systems, measurements are highly reliable as a result of suitably selected input attenuators and RF filters.



Antenna pattern shown in polar coordinates (conversion by computer function)

Receiver mode The FSBC differentiates between different types of signal by using separate, calibrated AM and FM detectors. Inservice measurements and measurements on receiving systems can conveniently be made using the built-in tracking generator.

The excellent dynamic characteristics of the basic FSB model are extended in many ways by optionally adding RF filters and a preamplifier. Loop-in RF filters suppress interfering signals and reduce the level range of the input mixer by preselection. The loop-in, low-noise preamplifier optimizes the dynamic range and significantly improves sensitivity.

Individual selection of the configuration has the advantage that thanks to the low noise figure of the preamplifier an extremely high sensitivity can be achieved when bypassing the RF filters. With computer control, the configuration can also be changed automatically as a function of frequency.

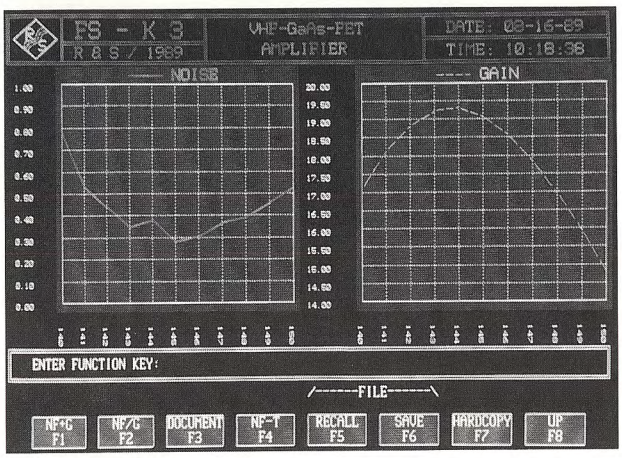
Modulation measurement Two AM and four FM measurement ranges make for high resolution and accuracy. Frequency offsets can be determined by DC coupling of the FM demodulator; the frequency offset can also be calibrated in the FM range. A precise trigger facility and averaging enable even extremely small signals buried in noise to be detected and measured. Superimposed markers and cursors make modulation measurements fast and convenient.

Computer function

The **optional computer function** enhances the measurement capabilities and operating convenience of the FSBC. The computer function is available as a system floppy disk FS-K1 with MS-DOS 3.1, R&S BASIC and documentation or as a complete hardware and software kit FS-Z4 with software FS-K1, keyboard and an external floppy disk station; for details see FSB.

FSBC

Application Software FS-K3 In conjunction with the computer function, this application software allows **automatic noise measurement** on tuners, RF amplifiers, etc. In view of the high signal purity and precision of the FSBC, quality can be evaluated **even of extremely narrowband and low-noise devices under test.**



User interface of Software FS-K3

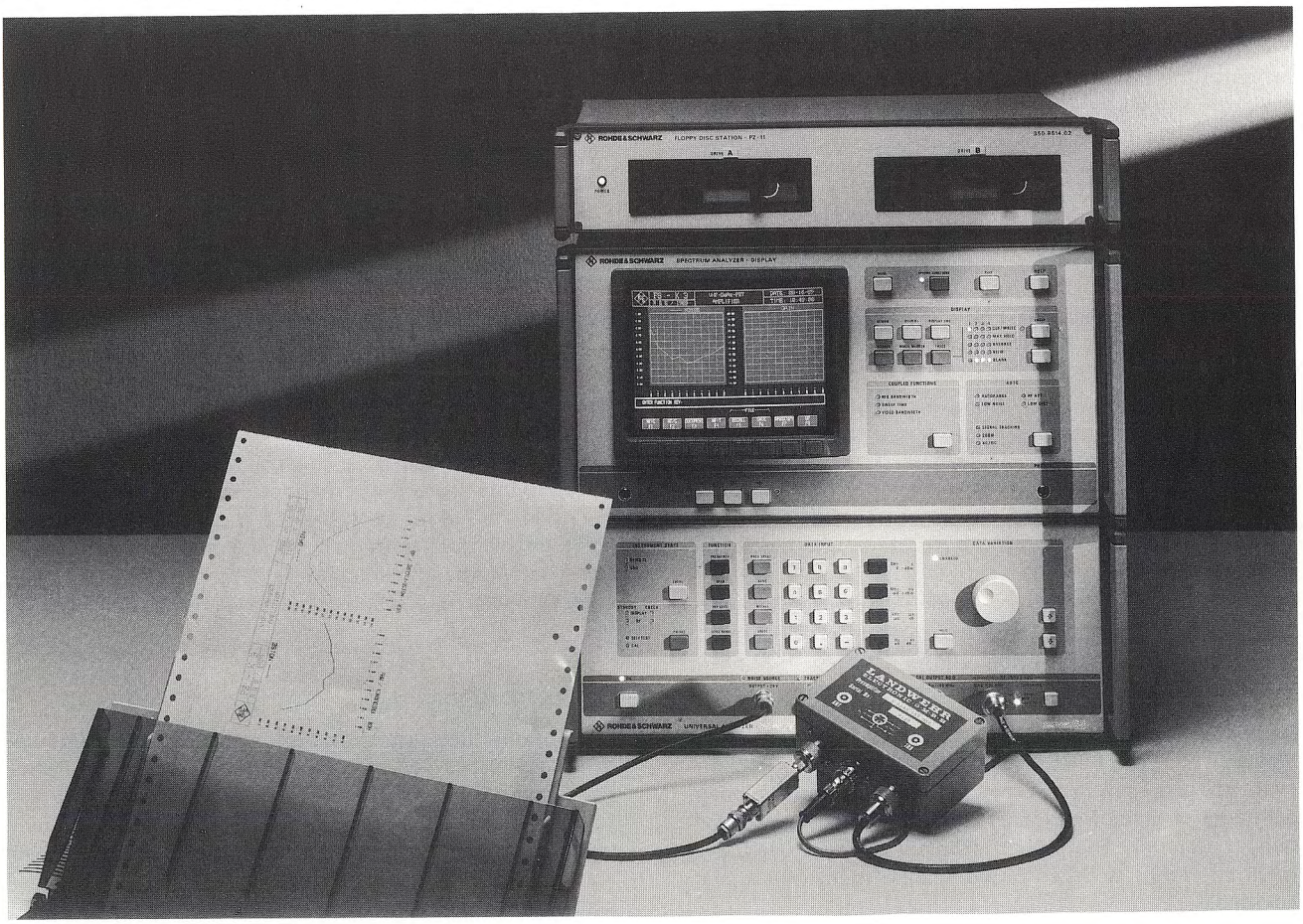
For this kind of measurements, an external noise source is required (eg NOISE COM, Type NC 3101), which receives the necessary supply voltage (28 V/100 mA) via a BNC socket factory-fitted on the front panel of the FSBC (optional).

The convenient and uncomplicated operation has equally been applied to the software:

- Control via softkeys and interactive user prompting
- Display of results in form of graphics and tables
- Easy handling of even complex processes in noise measurements with the aid of ENR (excess noise ratio) tables as well as measurement with or without SSC (second stage calibration)
- Hardcopy output on printer for reliable documentation
- Direct screen switchover between analyzer and test program

The **measurement and display capabilities** are highly versatile: whether permanent measurement at one frequency or sweep mode with selectable step size, the result is displayed as noise figure or noise temperature. For routine measurements, eg adjustment and final inspection in production, settings as well as graphics and tables produced can be stored on floppy disk.

FSBC + FS-K3 + FS-Z4 (drive with system disk): a spectrum analyzer is turned into an automated noise measurement system



Specifications

The data given below are supplementary to those of the Spectrum Analyzer FSB (page 66) and refer to the modified dynamic characteristics of Communications & Spectrum Analyzer FSBC.

Frequency, spectral purity, filters: see FSB

Amplitude

Only the data differing from the FSB are specified.

Amplitude range
(RBW = 10 Hz) ..... <−149 to +30 dBm

Max. input level

Coupling of input	AC		DC	
RF attenuation	RF	DC	RF	DC
0 to 9 dB	+20 dBm	20 V	+20 dBm	0 V
10 to 19 dB	+30 dBm	20 V	+30 dBm	0 V
≥20 dB	+30 dBm	20 V	+30 dBm	0 V

Max. pulse energy ..... 1 mWs (= 100 W for 10 µs)

		RF filter off		RF filter on		
RF preamplifier		0 dB	10 dB	0 dB	10 dB	Unit
Inherent noise[1])						
40 MHz <f<4.8 GHz	max.	−142	−151	−136	−145	dBm
4.8 GHz ≤f<5 GHz	max.	−139	−148	−133	−142	dBm
Frequency response[2])	max.	+1/−1	+2/−3	+1/−8	+2/−9	dB
	typ.	+0.3/−0.3	+1/−2.0	+0/−4	+0.5/−5	dB
VSWR,						
0-dB RF attenuation.	max.	2.5	2.2	2.8	2.8	
10 MHz to 1 GHz	typ.	1.6	1.5	1.6	1.5	
VSWR,						
0-dB RF attenuation.	max.	3.0	2.2	3.5	3.5	
1 to 2 GHz	typ.	2.2	1.6	2.5	2.0	
VSWR,						
0-dB RF attenuation.	max.	3.0	3.0	3.0	3.0	
2 to 5 GHz	typ.	1.7	2.2	2.0	2.4	
Input level for	min.	−10	−21	−10	−21	dBm
1-dB compression[3])	typ.	−5	−16	−5	−16	dBm
3rd-order intercept point	min.	+7	−4	+5	−5	dBm
TOI[4]) at input	typ.	+10	−1	+10	0	dBm
2nd-order intercept point	min.	+40	+15	+40	+15	dBm
HSOI[4]) at input	typ.				(+40)[5])	dBm
	typ.	+50	+20	+50	+17 (+50)[5])	dBm

Typical noise characteristics

RF attenuation ..... 0 dB
LO feedthrough ..... −20 dBm
Resolution bandwidth ..... 6 Hz
Video bandwidth ..... 1 Hz
DC coupling ..... for f<50 kHz
RF filter ..... off

Frequency range (RF filter off)

Preamplifier	0 dB	10 dB
200 Hz ≤ f < 1 kHz	−116 dBm	−124 dBm
1 kHz ≤ f <10 kHz	−123 dBm	−131 dBm
10 kHz ≤ f < 100 kHz	−129 dBm	−138 dBm
100 kHz ≤ f < 1 MHz	−131 dBm	−140 dBm
1 MHz ≤ f <40 MHz	−141 dBm	−150 dBm
40 MHz ≤ f < 4.8 GHz	−145 dBm	−154 dBm
4.8 GHz ≤ f < 5.0 GHz	−142 dBm	−151 dBm

Level measurement error
The following data apply when using the FSBC with RF filters and/or RF preamplifier:
Frequency range ..... 500 Hz<f<5.0 GHz
(following level calibration at centre frequency with reference level of −10 dBm)
Permissible deviation
typ. ..... <0.8 dB
max. ..... <1.5 dB

Frequency range ..... < 500 Hz
(following level calibration at f = 500 Hz with reference level of −10 dBm)
Permissible deviation
typ. ..... <1 dB
max. ..... <1.5 dB

Frequency range ..... >5 GHz
In the frequency range >5 GHz an absolute calibration is best performed using an external calibration signal.

Scalar network analysis: see FSBS page 77

Sweep, demodulation, VDU, inputs and outputs: see FSB

General data, same as FSB, except:
Weight ..... 64 kg

Ordering information

Order designation	▶ Communications & Spectrum Analyzer FSBC	851.5007.52
Frequency span max, 2 GHz		851.5007.54
Accessories supplied	same as for FSB	
Recommended extras	same as for FSB, plus the following	
SWR Bridge (main catalog page 352) 50 Ω, 5 to 2500 MHz	ZRB2	373.9017.53
SWR Bridge (main catalog page 352) 75 Ω, 5 to 2000 MHz	ZRB2	802.1018.73
SWR Bridge (see page 112) 50 Ω, 10 MHz to 18 GHz	ZRMD	831.7010.xx
RF Current Probe 10 kHz to 30 MHz	ESH2-Z1	338.3516.52
VHF Current Probe 20 to 300 (600) MHz	ESV-Z1	353.7019.02
Active Probe 9 kHz to 30 MHz, high-impedance	ESH2-Z2	299.7210.52
Precision Termination 50 Ω, N	RNA	272.4510.50
Termination 50 Ω, N	RNB	272.4910.50
Calibration Set 0 to 3 GHz, N	ZCAN	800.8515.52
Rod Antenna	HFH2-Z1	335.3215.52
Loop Antenna	HFH2-Z2	335.4711.52
Loop Antenna	HFH2-Z3	335.6214.52
Tripod	HFU-Z	100.1114.02
Mast (for tripod)	HFU-Z	100.1120.02
Roof-mounting Kit	HFH2-Z5	335.5718.02
Inductive Probe	HFH2-Z4	338.3016.52
Broadband Dipole 20 to 80 MHz	HUF-Z1	358.0512.52
LP Broadband Antenna 80 to 1300 MHz	HL023A1	577.8017.02
RF Connecting Cable, 7 m	HFU2-Z5	252.0055.55
Probe, BNC connector	HFV-Z	204.1010.02
Adapter BNC female/N male	NAB11-23	118.2812.00

[1]) RF attenuation 0 dB, resolution bandwidth 6 Hz, video bandwidth 1 Hz
[2]) Frequency-dependent error in level display with reference to level at 100 MHz, filter switched off and 0 dB preamplification
[3]) Measured at IF output 21.4 MHz
[4]) Frequency 40 MHz to 5.0 GHz
[5]) Frequency (fundamental) 15 MHz <f <500 MHz and 2 GHz <f <5 GHz

FSBS Spectrum & Network Analyzer FSBS ♦ 100 Hz to 5.2 GHz

- Continuous frequency range
- Selective scalar network analysis for measuring transmission and reflection parameters as well as voltage and power
- Tracking generator with frequency offset capability for quasi-realtime measurements on frequency converting DUTs
- Wide dynamic range for measurements on high-impedance two-ports up to the microwave range
- Measurement of high stopband attenuation (eg of image-frequency rejection filters)
- Variable tolerance and frequency lines
- Great variety of multimarker, autozoom and autoranging functions
- Easy-to-learn and convenient operation

Computer function (hardware and software)

- Further processing of results
- Use of specific application software

IEC 625 Bus

Uses

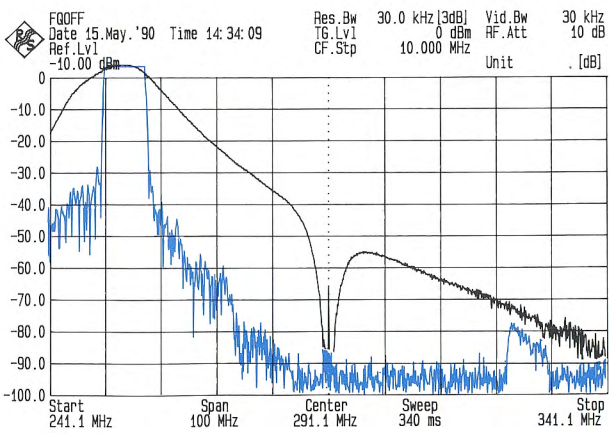
Spectrum & Network Analyzer FSBS is the second model of yet another new series belonging to the **FS.. analyzer family**. Developed from the **basic FSB model** (see page 62), the FSBS features a built-in tracking generator which enables selective scalar network analysis in a continuous range from AF through to microwaves.

The FSBS covers nearly all applications of the FSA family and of the FSB. In addition, this analyzer allows **quasi-real-time** measurement of the following parameters on **frequency converting devices**, such as tuners, channel transposers, etc:

- conversion loss/gain
- LO feedthrough
- isolation
- image-frequency rejection
- mixer compression

In addition to measuring the conversion characteristics, this selective, frequency-converting measuring system is particularly strong in measuring the above parameters in an **unusually wide dynamic range**.

This is illustrated in the diagram below, using a TV IF converter as an example. The high image-frequency rejection (>85 dB) and conversion gain of the DUT can be read off at a glance, allowing easy checking and adjustment of the data guaranteed by the manufacturer.



Measurement on TV IF converter: diagram showing up-converted IF in inverted position, unwanted sideband in normal position and LO feedthrough

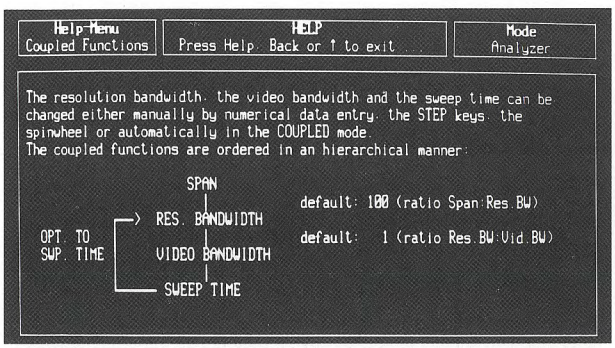
Outstanding features of FSBS

- Wide frequency range 100 Hz to 5 (5.2) GHz
- Large dynamic range gain 100 dB
  loss > 120 dB
- Useful level range display section
  < −140 to +30 dBm
  generator section
  −81 to 0 dBm
- High frequency resolution
  Synthesizer 0.0032 Hz
  Frequency counter 0.1 Hz
- High level resolution
  Display section 0.01 dB
  Tracking generator 0.1 dB
- Wide range of resolution bandwidths 6 Hz to 3 MHz
- High accuracy resulting from normalization
- Low inherent frequency response: typ. < ±1.0 dB (generator + display, without normalization)

Operation

Due to the **high operating convenience** of the FSBS, the user can fully concentrate on the measurement problem rather than on the measuring instrument.

- Single-knob operation
- Single-function keys
- Softkey-controlled menus with minimum menu depth
- Many automatic test routines and marker functions
- Autocalibration of display and generator section
- Two independent active trace memories and memory for two additional traces
- High-resolution, clear colour display
- Brief operating instructions shown on display (help functions)



Help menu often does away with the need to consult the operating manual

Computer function

The **optional computer function** enhances the measurement capabilities and the operating convenience of the FSBS. It is available as a system floppy disk FS-K1 with MS-DOS 3.1, R&S BASIC and documentation or as a complete hardware and software kit FS-Z4 with Software FS-K1, keyboard and an external floppy disk station; for details see FSB.

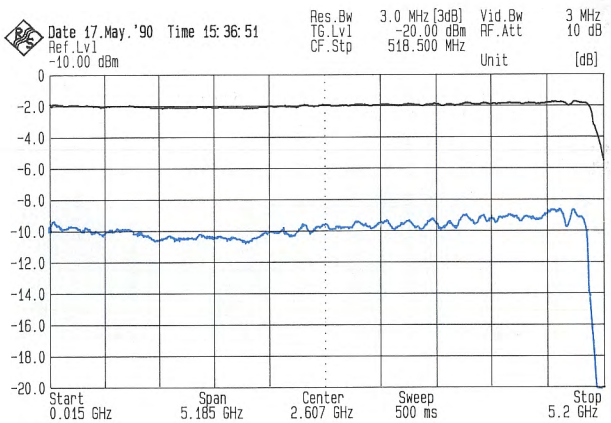
Characteristics

The **built-in tracking generator** allows a frequency offset of up to ±1 GHz from the receive frequency without any additional signal source. Thus, the FSBS is the first analyzer showing the normal and inverted position of a converter including the LO feedthrough **at a glance and in quasi-realtime.**

The tracking generator can be optimally used thanks to a great variety of softkey-controlled supporting functions:

- High accuracy of transmission measurements due to graphical elimination of residual frequency response of FSBS and test cables
- Reflection measurement taking into account the reflection in open-circuit and/or short-circuit mode
- Selection of reference-line position, ie of 0-dB line for transmission and reflection measurements

Frequency stability The tracking generator has the same frequency stability as that of the frequency processor of the analyzer section. Since the generator signal is tuned to the nominal frequency of the display section, there is no loss in time due to synchronization which is not required in this case.



Tracking generator output signal of FSBS with maximum frequency sapn and without normalization

Tracking generator level/modulation The level of the tracking generator can be varied in 0.1-dB or 1-dB steps in a wide range from −81 dBm to max. 0 dBm; a level offset can also be selected. The reference level of the tracking generator, and hence the output level, can be modulated by means of an external AF generator (eg SPN from Rohde & Schwarz).

High output level If the tracking signal is required with a level of greater than 0 dBm in the large-signal range, a power amplifier can be connected, whose frequency response is linearized by the tracking generator by means of level variation after an external ALC voltage has been applied.

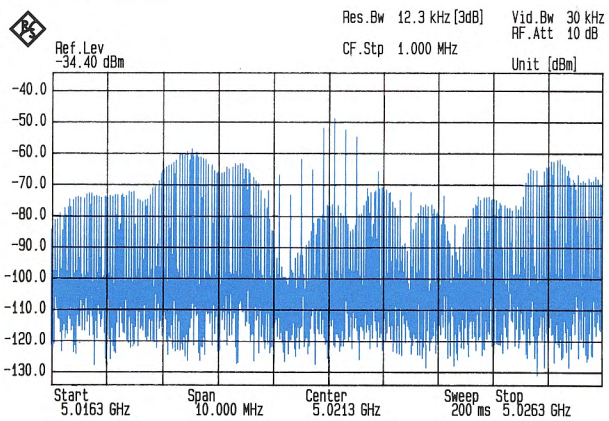
FSBS

Basic functions The FSBS has a great variety of basic functions like the FSB, a few of which are mentioned here:

- AUTORANGE — Automatic setting of reference level (= full-scale deflection)
- COUPLED FUNCTIONS — Span-dependent, automatic coupled function of resolution/video bandwidth and sweep time
- MARKER — Difference marker and multimarker, crystal-accurate reading, automatic determination of shape factor 60/3 dB and 60/6 dB
- TRACE — Display of four traces
- SAVE/RECALL — Storage of nine instrument setups, ie up to four traces plus the relevant settings

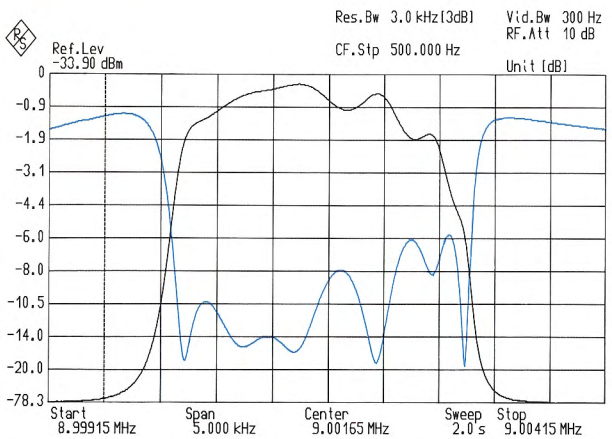
Application examples

Pulse spectrum



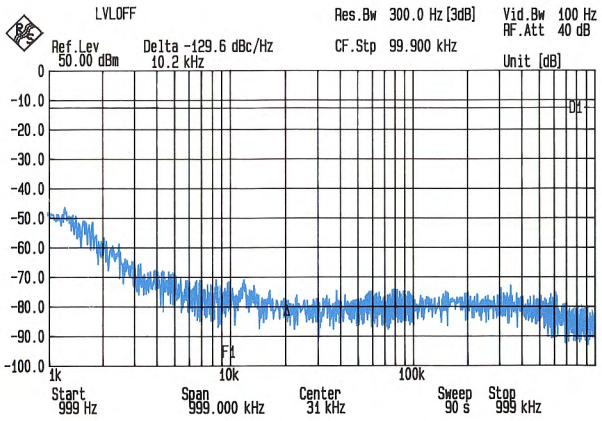
Spectrum of two radar systems at same center frequency

Network analysis



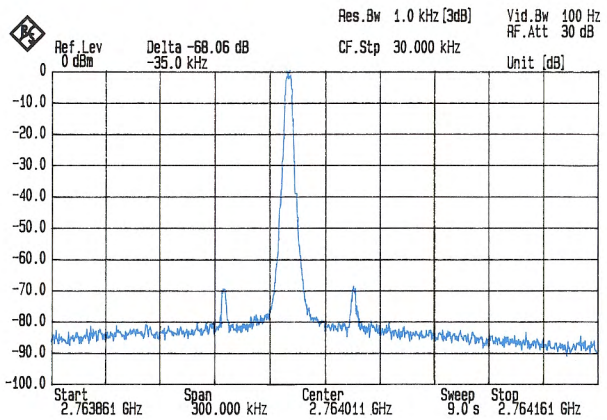
Transmission and reflection measurement on a mismatched filter using SWR Bridge ZRB 2

Phase noise measurement



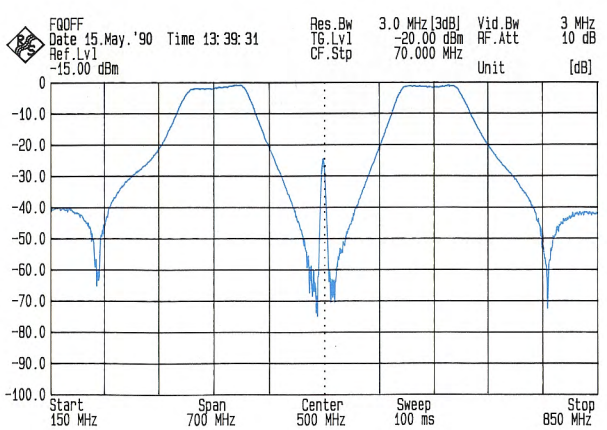
Phase noise measurement with logarithmic display

Spurious measurement



Measurement of spurious emissions of a YIG oscillator

Mixer measurement



Conversion loss of a mixer stage

Specifications

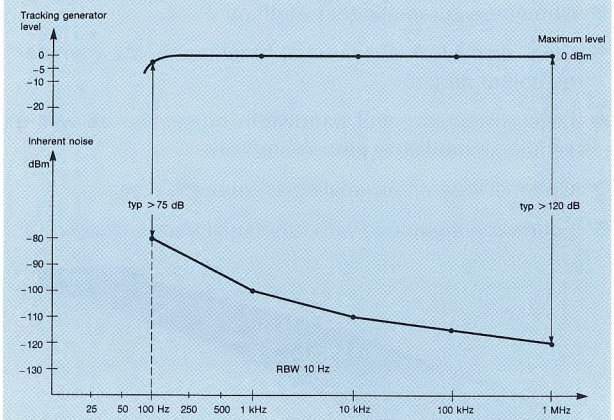
Spectrum analysis
For detailed specifications and recommended extras please refer to the data of the FSB from page 66 onwards.

FSBS specifications:

Frequency
Frequency range
DC coupling ..... 100 Hz to 5.0 GHz
AC coupling ..... 100 kHz to 5.0 GHz
Frequency drift
Aging ..... $<1 \times 10^{-7}$/year
Temperature effect ..... $<5 \times 10^{-8}$ (0 to 55 °C)
Frequency resolution
3-dB bandwidht ..... 6 Hz to 3 MHz
Fine adjustment ..... typ. 5% (except 30 to 80 kHz)
Increments 1/3/10
Shape factor
−60 dB/−3 dB ..... <12
−80 dB/−3 dB ..... <20
Spectral purity
Frequency offset (>100 kHz) ... typ. 115 dBc (1 Hz)
Frequency response
(RF attenuation 10 dB,
DC coupling)
f = 100 MHz (ref. level > −30 dBm) $<\pm 1.0$ dB
Frequency span
Settable range ..... 0 Hz/10 Hz to 5.2 GHz
Error
Span ≤5 MHz ..... $\pm 2 \times 10^{-3} \times$ span
Span >5 MHz ..... $\pm 5 \times 10^{-3} \times$ span
Frequency steps per span ..... ≥1000

Amplitude
Measurement range with smallest
resolution and video bandwidth,
f >20 MHz ..... <−140 to +30 dBm
Result display ..... internal electronic graticule with
11 to 13 horizontal level lines
Measurement ranges ..... linear or logarithmic
1/10/20/50/100/110 dB
Resolution
Markers ..... measurement range/4096,
min. 0.01 dB
Display (110-dB range) ..... 352 steps (41 for log frequency axis)

Scalar network analysis
Frequency range
(DC coupling, normalization) ..... 100 Hz to 5.0 GHz
Span (continuously adjustable) ... 10 Hz to 5.2 GHz
Frequency offset
Setting range ..... up to ±1 GHz
Resolution ..... 1 Hz
Step keys ..... 100 kHz
Spinwheel ..... 10 kHz
Gain measurement range ..... 110 dB
Loss measurement range
f <10 MHz ..... see diagram
10 MHz < f <4.8 GHz,
RBW = 1 kHz ..... >120 dB
4.8 GHz < f <5.0 GHz,
RBW = 1 kHz ..... >117 dB



Typical loss measurement range at low frequencies

Amplitude
Inherent frequency response
(start frequency >5 × resolution bandwidth in default coupled mode)
without normalization ..... <2.0 dB, typ. <1.5 dB
with normalization,
without noise ..... display range/360
Display range
without normalization, LIN ..... 0 to 100%, 0 to −40 dB
without normalization, LOG .... 1/10/20/50/100/110 dB
with normalization ..... display range minus frequency
response to be normalized

Tracking generator
Output connector ..... N female
Output impedance ..... 50 Ω
VSWR for output level <−10 dBm
f ≤2.7 GHz ..... ≤1.5
f ≥2.7 GHz ..... ≤1.8
Output level ..... adjustable from −81 to 0 dBm
(electron. in 0.1-dB steps,
mechan. in 1.0-dB steps)
Level deviation with −20 dBm
Output level at 100 MHz ..... ±0.5 dBm
Additional error on level variation,
referred to −20 dBm
mechanical by RF attenuator
f <2 GHz ..... $<\pm$(0.3 +1.3% of attenuation) dB,
max. 1 dB
f >2 GHz ..... $<\pm$(0.5 +2.5% of attenuation) dB,
max. 2 dB
electronical ..... 0.05 dB/0.1 dB, max. 0.2 dB/0.5 dB
Additional error on switching
level control time constant
RF detector → AF detector ..... <0.3 dB
Frequency response at f_{start}
>5 × RBW
in default coupled mode, ref. to
level at 100 MHz (RF detector)
or 1 MHz (AF detector)
500 Hz to 5 GHz ..... <1.0 dB
100 Hz to 500 Hz ..... <+0.5 dB, <−3 dB
Level control
(softkey-selectable) ..... int./ext.
Modulation ..... AM (<30%)
Frequency (ext. AF source,
softkey-selectable) ..... 10 Hz to 20 kHz
Additional error by frequency
offset switching
positive offset 0 to 860 MHz .. <1 dB
860 to 1000 MHz . <2 dB
negative offset 0 to 1000 MHz . <1 dB

Spurious suppression
f_{offset} = 0 Hz
Harmonics 3 kHz < f <2 GHz ..... >25 dB
f >2 GHz ..... >20 dB
Nonharmonic mixture products .... >30 dB
Other (carrier offset 20 kHz) ..... >30 dB
Residual FM, rms
Meas. bandwidth 30 Hz to 3 kHz . <300 Hz
Meas. bandwidth 30 Hz to 20 kHz <1 kHz

General data

Data not specified same as FSB, p. 69

Rated temperature range ..... 0 to 55 °C
Storage temperature range ..... −40 to +70 °C
Dimensions (W × H × D) ..... 435 mm × 413 mm × 590 mm
Weight ..... 61 kg

Ordering information

Order designation ..... ▶ Spectrum & Network Analyzer FSBS 851.2008.52
Frequency span max. 2 GHz 851.2008.54

Accessories supplied ..... same as for FSB

Recommended extras ..... same as for FSB

Additionally

SWR Bridge (50 Ω, 5 to 2500 MHz)	ZRB 2	373.9017.53
SWR Bridge (75 Ω, 5 to 2000 MHz)	ZRB 2	802.1018.73
RF Current Probe (10 kHz to 30 MHz)	ESH2-Z1	338.3516.52
VHF Current Probe (20 to 300 (600) MHz)	ESV-Z1	353.7019.02
Active Probe (9 kHz to 30 MHz, high-impedance)	ESH2-Z2	299.7210.52
Precision Termination (50 Ω, N)	RNA	272.4510.50
Termination (50 Ω, N)	RNB	272.4910.50
Calibration Kit (N, 0 to 3 GHz)	ZCAN	800.8515.52
Accessories for current, voltage and field-strength measurements .	see accessories for Test Receivers ESH 2/ESH 3 (catalog 90/91, page 276) and ESV/ESVP (catalog 90/91, page 280)	

FSM

Spectrum Analyzer FSM ♦ 100 Hz to 26.5 GHz

- Continuous sweep from 100 Hz to 26.5 GHz
- Fast sweep rates for full span (100 ms for 26.5 GHz)
- Extremely high sensitivity due to low inherent noise of –145 dBm (6-Hz resolution bandwidth)
- Useful display range 105 dB with measuring range > 170 dB
- Very low phase noise of –110 dBc at 1 kHz from carrier
- Fundamental mixing
- Large intermodulation-free dynamic range of typ. 100 dB
- Exceptional frequency accuracy
- Quasi-continuously variable resolution bandwidths from 6 Hz to 30 kHz and from 80 kHz to 3 MHz with constant shape factor
- Calibrated AM/FM demodulators

Computer function (option)

- Further processing of results
- Use of specific application software

IEC 625 Bus

The Rohde & Schwarz spectrum analyzer family is based not only on the same hardware and firmware, but also uses the same underlying philosophy: to achieve extraordinary performance data for each instrument and to be only satisfied with the best.

Uses

Spectrum Analyzer FSM is a top-class instrument for microwave measurements. A continuous frequency range from 100 Hz to 26.5 GHz, without using electronic or mechanical switchover, extremely high sensitivity and very low phase noise are exactly on the track of the basic models FSA (see catalog 90/91, page 234) and FSB (see page 62).

The wide dynamic range and the fast sweep rates underline the **toprank position of the FSM in the class of microwave analyzers** A clear operating concept ensures high operating convenience. The flexible software guarantees that the instrument can be integrated into any modern laboratory now and in the future. Selective level measurements are performed by the Spectrum Analyzer FSM with high precision.

Further main features

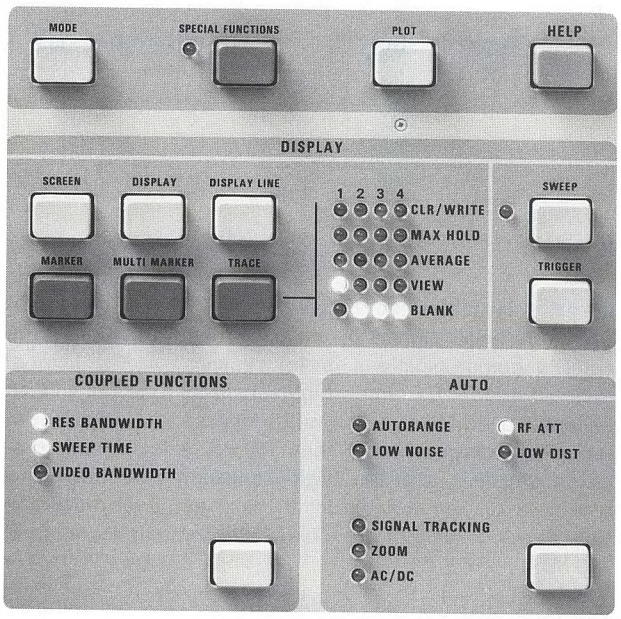
- Numerous automatic test routines
- Clear display of all essential functions and parameters on colour monitor
- Level, frequency and bandwidth correction as well as selftest immediately after switch-on
- Optional logarithmic scaling of frequency axis
- Four trace memories with functional status display

Easy operation

- Single-knob operation
- Monofunction keys
- Softkey-controlled menus
- Convenient parameter entry, either via numeric keypad, step keys and/or spinwheel
- Status display

A single spinwheel, a clearly arranged front panel – **each key being assigned a single function only** – and softkeys along the bottom edge of the screen whose function depends on the menu selected make for the operating convenience of the FSM. Parameters are entered via the numeric keypad. The parameters can be varied quickly and precisely using the step keys for coarse adjustment and the spinwheel with magnetic latching for fine adjustment.

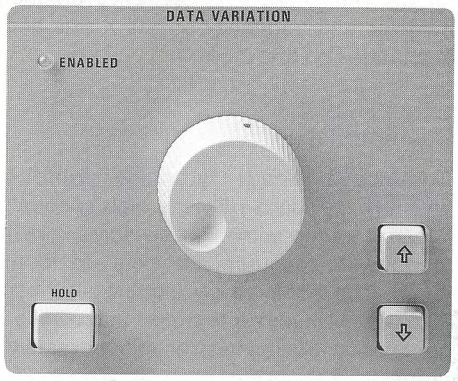
The **LED panel** clearly indicates the current status of four trace memories. The five operating modes of the **four trace memories** can all be seen at a glance. This is very useful when operating with different evaluation criteria.



Control panel on display unit of FSM

Hardkeys and softkeys The hardkeys being single-function keys are assigned fixed functions for calling menus (eg markers), selecting parameters (frequency) or entering values. The softkeys are assigned varying functions depending on the menu selected.

Spectrum Analyzer FSM is **easy to operate even for complex measurements** This includes parameter entry, readout of results on the screen as well as automatic detection of overloads even outside the displayed frequency range. **Basic settings** for repeated measurements can be **stored and recalled**. Test sequences can be executed automatically when using the optional computer function.



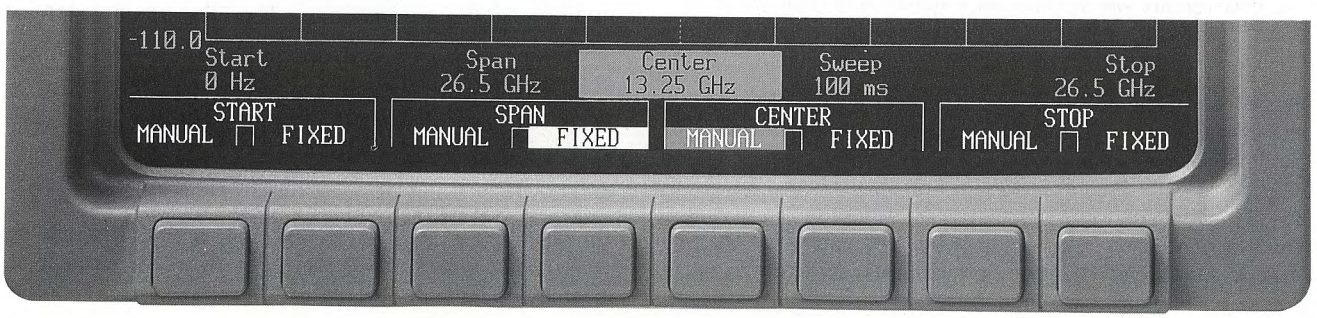
Parameter variation using step keys and spinwheel

Setting parameters can be coupled for signal analysis, so that only one value need to be changed and all others – like the ratio between resolution bandwidth and video bandwidth – are adapted automatically.

The **9″ colour screen** with display of all functions and parameters important for the measurement provides the user with a clear overview even in the case of highly complex applications, in particular when **several traces are displayed simultaneously**. An external keyboard allows entry and readout of additional information.

The **screen menus** lead directly to the result. There are no complicated tree structures with the FSM. If more than eight functions are offered, the menu is extended horizontally to the left or right. The status display in the **help menu** provides a current overview of the active settings in form of a list; both the list and the complete display can be output as a hardcopy.

Eight softkeys at the bottom edge of the screen with varying functions provide reliable user prompting through to the result



FSM

Description

Spectrum Analyzer FSM operates on the principle of search tone analysis. This means that the frequency range to be analyzed can be scanned by varying the internal oscillator frequency with the aid of an analysis filter with matched resolution bandwidth. The scan can be defined by any combination of start, center and stop frequency as well as span.

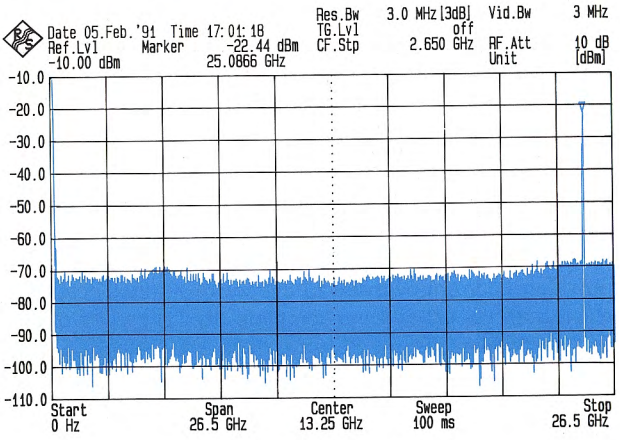
The parameters required for the analysis, ie **resolution bandwidth, video bandwidth and sweep time**, are linked by an algorithm as a function of the displayed frequency range. The analysis is displayed on the **built-in colour monitor**: the frequency on the X axis and the associated amplitudes on the Y axis.

Characteristics

Continuous frequency range from AF through to 26.5 GHz Wide bandwidth, high spectral purity and large dynamic range with high sensitivity previously were only found with spectrum analyzers up to the medium GHz range. The FSM is now offering all these features up to 26.5 GHz. A **highly integrated microwave front end** allows continuous sweeping over this extremely wide frequency range.

Switchover between the receiving bands is distortion-free via a built-in diplexer. The characteristic data of the preselector are stored for correction purposes so that the preselector peak function is no longer required.

An **attenuator with built-in calibration input** is an integral part of the microwave front end. The 5-dB step adjustment of the attenuator and software-controlled level matching optimize the 1st LO for minimum spurious products.



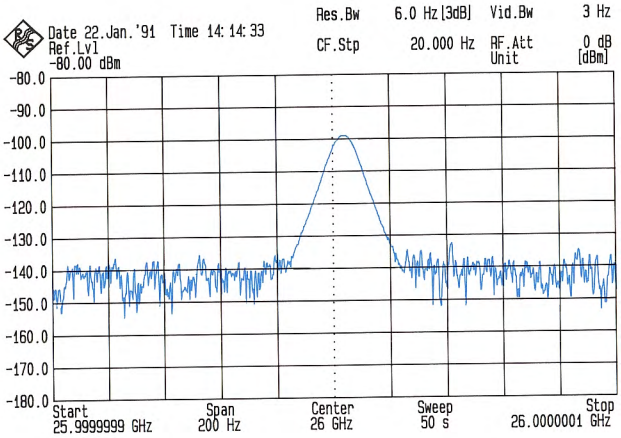
The FSM operates with a continuous frequency range from 100 Hz to 26.5 GHz

High frequency accuracy and spectral purity The synthesizer concept of the FSM is tailored to typical measurement problems: frequency spans up to 5 MHz are fully synchronized with a high resolution. For spans above 5 MHz, the excellent accuracy is achieved by synchronization with the start and stop frequencies of the **YIG oscillator** which due to its bipolar transistor provides exceptionally good phase noise data for the first conversion.

Since the parameters of this microwave synthesizer set new standards close to the carrier, the FSM is the ideal instrument for assessing the spectral purity from multiplexed reference signals right through to dielectric stabilized microwave oscillators.

The **smallest resolution bandwidth of 6 Hz** of the FSM means that line-frequency interference can be detected just as well as nonharmonics. The quasi-continuously variable bandwidth means that an optimum compromise can be found between resolution, frequency span and sweep time whatever the measuring task.

A **six-section YIG filter** forms the core of the RF unit. An integrated diplexer and mixer are the key components in providing **high amplitude precision** of the continuous sweep from 100 Hz to 26.5 GHz. Measurements with **extremely high sensitivity** are possible in the entire frequency range, eg –140 dBm at 26 GHz.



The FSM provides highest sensitivity right through to 26.5 GHz

Large, selectable level display range Measurements of even very weak signals in the GHz range are required in satellite communications or for research in the field of radioastronomy. Extremely high sensitivity together with an exceptionally wide dynamic range make for an **intermodulation-free range of more than 100 dB**. A logarithmic precision amplifier and the **high-resolution A/D converter** provide a display variable from the finest level resolution (0.1 dB per division of graticule) up to the display range of 110 dB.

The FSM also contains a **detector module** as standard thus enabling unknown signals, which are amplitude- or frequency-modulated, to be identified easily using headphones. The demodulated signal can be displayed on the colour screen at the same time with high level resolution in the frequency range up to 20 kHz.

High measuring convenience The FSM has a variety of useful measurement tools:

- multimarker function with up to eight markers
- level, frequency and bandwidth correction
- adaptation to signal type
- LOW NOISE and LOW DISTORTION operating modes.

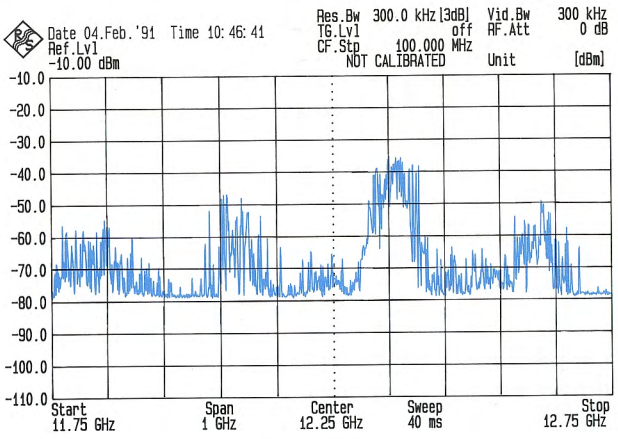
The FSM thus provides an exceptionally high operating convenience which largely precludes errors and speeds up measurements considerably.

INSTRUMENT STATE			
Ref. Marker	26.44111111111 GHz	-68.78 dBm	Trigger Free
Delta Marker			
Multi Marker 1	5.47666666666 GHz	-64.46 dBm	
Multi Marker 2	10.9533333333 GHz	-52.02 dBm	
Multi Marker 3	16.4300000000 GHz	-49.69 dBm	
Multi Marker 4	22.02444444444 GHz	-19.16 dBm	
Multi Marker 5			
Multi Marker 6			
Display Line 1			
Display Line 2			
Threshold Line			
Reference Line			
N dB down Line			
Frequency Line 1			
Frequency Line 2			
Ref. Lvl. Offset 0 dB			
Frequency Offset 0 Hz			
T.G. Lvl. Offset 0 dB			
T.G. Freq. Offset 0 Hz			

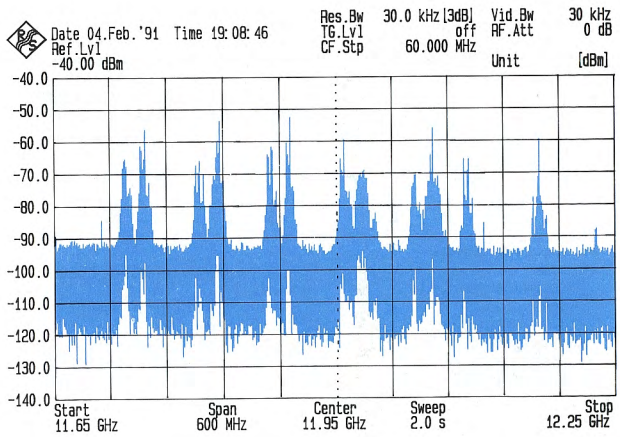
The multimarker function of the FSM allows detailed output of frequencies in tabular form.

Applications

The consequent use of modern technologies is the basis for solving measurement tasks encountered in development through to production. The FSM is able to perform a great variety of tasks in **satellite communications** as well as in **microwave module and component testing**.

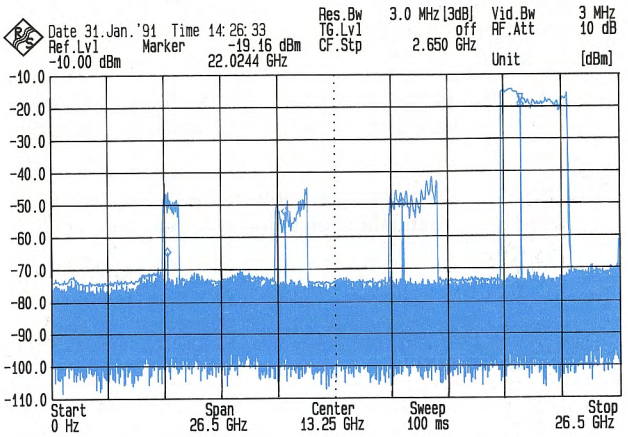


RFI emission of a microwave oven at its 5th harmonic



Measurement on a satellite receiving system

Directional and mobile radio are typical fields of application of the FSM, as well as measurements in the **submillimeter range** which are made with the aid of input mixers. The built-in microwave synthesizer features excellent spectral purity (eg < -105 dBc, δf = 100 kHz, f = 20 GHz). This allows **phase noise measurements** to be conveniently performed even in the microwave range.



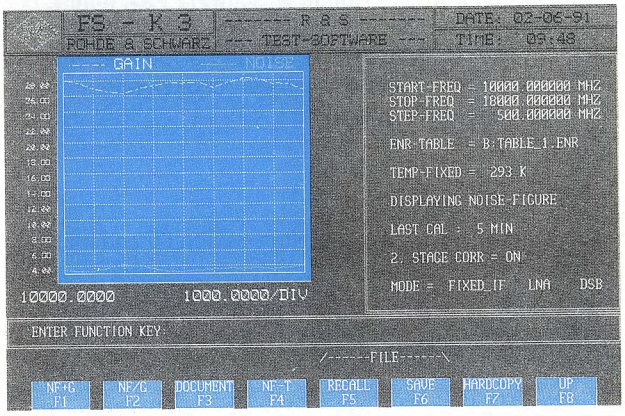
Measurement on a frequency multiplier TRACE 2 in MAX HOLD

Broadband measurements are supported by **extremely fast sweep rates** (typ. 80 ms for 26.5 GHz sweep width), dynamic correction of the preselector tuning voltage being the necessary precondition. The excellent RF and system characteristics make the FSM an allround measuring instrument for use in every RF and microwave laboratory.

Automatic noise measurement system Use of the **Computer Function FS-Z4** (see next page) and of the **Application Software FS-K3** for noise measurements allows another special application of the FSM.

Through the use of a separate preamplifier, the FSM is turned into an automatic noise measurement system. An interesting feature is that measurement up to 26.5 GHz can be made without additional conversion.

The FSM provides the features required for this application:
- fundamental mixing,
- high amplitude measuring accuracy,
- extremely high sensitivity.



Software FS-K3: measurement on a low-noise amplifier

FSM

Options

The FSM enables direct connection of a number of useful options for the **output of measurement results**

- Hardcopy output of the screen display on a printer, video printer or IEC-bus plotter. In conjunction with the external Keyboard PCA-Z1, **convenient screen documentation** is ensured with optimum resolution and display size.
- Connection of several colour monitors for special workstations as well as for training and demonstration purposes
- Connection of an oscilloscope to the video output for (realtime) investigation of signals whose frequency is above 20 kHz.

Computer function

The **optional Computer Function FS-Z4** enables test routines to be automatically executed without the use of an external process controller. It consists of the following hardware and software components:

- Keyboard PCA-Z1
- External Floppy Disk Station PZ-11; can be optionally fitted with $3^1/_2$″ or $5^1/_4$″ drives.
- Software FS-K1 with MS-DOS, R&S-BASIC and manual

The individual parts can also be ordered separately. Together with the CPU fitted as standard the FSM can be upgraded to a process controller with IEC-bus interface

For **complex automatic measurements**, a powerful process controller, eg from the **Rohde & Schwarz PSA family,** can be connected via the IEC-bus interface. This opens the door to professional software complying with the **industry standard** which satisfies the highest requirements.

Design

Spectrum Analyzer FSM is built-in design 90 and made up of the

- **RF unit** (4 height units of 19″ system) and the
- **display unit** (5 height units).

For normal operation, the two units of the FSM are fastened together. They can be separated for ease of transport.

The electrical connection between the two units is established by means of two multicore screw-on cables. Each unit has its own power supply and AC supply connector.

Rear view of the two units

Future-oriented design

Thanks to excellent RF characteristics, versatile measurement capabilities, IEC-bus control as well as extendable hardware and software configuration, the Spectrum Analyzer FSM is well equipped to meet any future requirements.

Specifications

Frequency

Frequency range	100 Hz to 26.5 GHz
Preselector	5.0 to 26.5 GHz
Frequency offset	can be entered up to ±500 GHz
Frequency resolution	1 Hz
Step keys	span/10
Spinwheel	span/900
Selectable frequency display	
LIN	linear frequency response displayed on a linear frequency axis with a relative scale (10 divisions with span/10)
LOG	n linear sweeps displayed on a logarithmic frequency axis with an absolute scale (10/5 divisions per decade). Variable oversampling ensures that all displayed values are backed up by measured values. A continuously adjustable interpolation mode is available for fast measurements (stop frequency/start frequency > 1.4)
Frequency reference	
Internal	R.A. = frequency reference accuracy
Mechanical settability	$< 1 \times 10^{-8}$
Aging	$< 5 \times 10^{-10}$/day (after 30 days) $< 1 \times 10^{-7}$/year
Temperature drift	$< 5 \times 10^{-8}$ (0 to 55 °C)
Run-in response	$< 1 \times 10^{-7}$ after 10 min. at +25 °C
External (switch-selected)	10 MHz
Frequency display	
Evaluation aids	markers and cursor lines
Resolution	span/900

Error 100 Hz to 12.91 GHz	12.91 to 26 GHz	
Span > 5 MHz	> 10 MHz	< 8 × 10^{-3} × span < 5 × 10^{-3} × span (sweep time ≥ 100 ms)
Span 10 Hz to 5 MHz	20 Hz to 10 MHz	< 2.5 × 10^{-3} × span ± RBW ± frequency × R.A., < 2.5 × 10^{-3} × span ± frequency × R.A. (sweep time ≥ 100 ms) RBW = resolution bandwidth

Additional frequency error ..... resulting from centre frequency offset of IF filter

Without calibration
- RBW < 3 kHz ..... < 700 Hz
- 3 kHz ≤ RBW ≤ 30 kHz ..... < 15 % RBW
- 80 kHz ≤ RBW ≤ 150 kHz ..... < 35 % RBW
- 150 kHz < RBW ..... < 15 % RBW

With calibration ..... < 10 % RBW or < 10 Hz (the higher value applies)

Drift of filter centre frequency at constant ambient temperature after 1-h warmup period
- RBW < 1 kHz ..... < 10 Hz/min

Frequency drift ..... at constant ambient temperature, after 1-h warmup period

Span > 5 MHz/10 MHz*) (frequency drift occurring only during sweep, not added from sweep to sweep) ..... < ±200 kHz per minute of sweep time

Span ≤ 5 MHz/10 MHz*) ..... corresponding to ref. frequency drift

Frequency counter ..... measures the frequency of the signal on which the marker is placed; marker to be at least 20 dB from noise and from point of intersection with adjacent signal

Counter resolution ..... 10 kHz to 0.1 Hz

Error ..... (freq. × R.A.) ±2 × resolution

Frequency span

Setting range ..... 0 Hz/10 Hz/20 Hz to 26.5 GHz

Resolution ..... 2 Hz
- Step key increments ..... 0.5 × span or 1 × span
- Spinwheel span/900

Error
- Span ≤ 5 MHz ..... ± 2 × 10^{-3} × span
- Span > 5 MHz ..... ± 5 × 10^{-3} × span

Frequency steps per span ..... ≥ 1000

Spectral purity

Phase noise in dBc (1 Hz)

Frequency offset		> 0.1	> 1.0	> 10	> 100	> 1000 kHz
Frequency	**Span**					
100 MHz	≤ 100 kHz	**95**	**105**	**110**	**115**	**120**
	> 100 kHz to 5 MHz .			107	115	120
	> 5 MHz				117	120
5 GHz	≤ 100 kHz	83	102	110	115	120
	> 100 kHz to 5 MHz .			107	115	120
	> 5 MHz				117	120
13.3 GHz	≤ 100 kHz	75	94	102	107	114
	> 100 kHz to 5 MHz .			99	107	114
	> 5 MHz				111	114
20 GHz	≤ 100 kHz	71	**90**	98	**103**	113
	> 100 kHz to 5 MHz .			95	103	113
	> 5 MHz				110	113
26 GHz	≤ 100 kHz	**69**	**88**	96	**101**	108
	> 100 kHz to 5 MHz			93	101	108
	> 5 MHz				105	**108**

Bold-type values are guaranteed. Typical values are approx. 3 to 6 dB better.

Sidebands (f < 5 GHz) ..... at discrete frequencies (in dBc)

Frequency offset
- n × AC supply frequency ..... > 70, if measurable by phase noise
- m × line frequency (29.4 kHz) .. > 80
- 100 kHz (span ≤ 5 MHz/10 MHz*)) ..... > 90
- Other ..... > 75, for f > 1 MHz

Residual FM

Span > 5 MHz/10 MHz*) ..... < 10 kHz/20 kHz*) PP/2 in 0.1 s (test bandwidth 10 kHz)

Span ≤ 5 MHz/10 MHz*) ..... < 3 Hz PP/2 in 10 s (RBW = 10 Hz; VBW = 10 Hz; VBW = video bandwidth) residual FM increases by 0.6 Hz/6 Hz × f [GHz] for f > 5 GHz

Filters

Resolution filters

Type of filter ..... 5 decoupled single circuits

Bandwidths (−3 dB) ..... < 10 Hz (typ. 6 Hz) to 3 MHz

Error
- Uncalibrated (in the range 10 kHz to 300 kHz, the specified bandwidth error does not apply at a relative humidity of > 50 %) . < ±30 %
- Calibrated ..... < ±10 % (RBW ≥ 10 Hz), < ±1.5 Hz (RBW < 10 Hz)

Selection ..... with step keys in increments of 1/3/10 and with spinwheel and keyboard in increments of typ. 5 % (except from 30 to 80 kHz)

Shape factor
- −60 dB/−3 dB ..... < 12
- −80 dB/−3 dB ..... < 20

Video filter ..... 1st-order RC lowpass filter following IF rectifier

Bandwidths (−3 dB) ..... 1 Hz to 3 MHz

Error (VBW = 1 Hz to 1 MHz) ..... ±20 %

Selection ..... in increments of 1/3/10

Amplitude

Amplitude range

(at RBW of 10 Hz) ..... < −140 to +30 dBm

Maximum input power ..... 30 dBm, 0 V DC

Max. pulse spectral density ..... 61 dBµV/MHz (RF attenuation > 10 dB)

Max. pulse energy (τ = 10 µs)
- RF attenuation ≥ 10 dB ..... 1 mWs

Max. pulse voltage ..... 150 V

Level compression

RF Level at input mixer (measured at 21.4 MHz IF OUTPUT)

f ≤ 36 MHz; ≤ −15 dBm ..... < 1 dB

f > 36 MHz; ≤ −10 dBm ..... < 1 dB

f > 5 GHz; ≤ −5 dBm ..... < 1 dB

Displayed inherent noise level ... spurious excepted

RF attenuation 0 dB, RBW 10 Hz, VBW 1 Hz

200 Hz	≤ f <	1 kHz	< − 85 dBm
1 kHz	≤ f <	10 kHz	< −105 dBm
10 kHz	≤ f <	100 kHz	< −110 dBm
100 kHz	≤ f <	1 MHz	< −115 dBm
1 MHz	≤ f <	40 MHz	< −130 dBm
40 MHz	≤ f <	4.8 GHz	< −140 dBm
4.8 GHz	≤ f <	6.0 GHz	< −135 dBm
6.0 GHz	≤ f <	21.0 GHz	< −138 dBm
21.0 GHz	≤ f <	26.5 GHz	< −135 dBm

Indication of measured value .... internal electronic graticule with 11 to 13 (horizontal) level lines (top line corresp. to reference level)

Measurement ranges ..... linear or logarithmic 110/100/50/20/10/1 dB

Resolution

Markers ..... measurement range/4096, min. 0.01 dB

Display
- 110 dB ..... 352 steps (341 for log. frequency axis)
- other ..... 360 steps (340 for log. frequency axis)

A/D converter ..... 12 bits

Setting range of reference level ..... the reference level can be set and measured values displayed in all common units. A level offset of −116 to +120 dB can be selected.

LOG scale ..... −90 to +30 dBm

LIN scale ..... −130 to +30 dBm

Resolution
- Keyboard, spinwheel ..... 0.1 dB
- Step keys
  - LIN, 100 dB, 110 dB ..... 10 dB
  - other ..... 0.1 × measurement range

Measurement error

Internal calibration source (CAL OUTPUT)
- Level ..... −20 dBm ±0.2 dB
- Frequency ..... 100 MHz ± 10^{8} × R.A.

Frequency response (RF attenuation 20 dB, reference level 0 dBm)

100 Hz	≤ f <	5.0 GHz	< ±1 dB
5 GHz	≤ f <	26.5 GHz	< ±2.5 dB

Level drift ..... typ. < 0.1 dB/°C (RF attenuation 20 dB, RBW 3 kHz, reference level 0 dBm). The effect of this error can be avoided by calibration.

FSM

Resolution bandwidth switching
- Reference bandwidth = 3 kHz (applicable for RBW < 10 Hz and ambient temperature +20 to +30 °C)
  - Uncalibrated ..... +2 dB, −3 dB
  - Calibrated
    - RBW ≥ 10 Hz ..... < ±0.3 dB
    - RBW < 10 Hz ..... < ±0.1 dB

IF gain switching referred to ref. level −20 dBm (RF attenuation 10 dB; RBW ≥ 10 Hz, f > 40 MHz)

	without	with calibration
Ref. level 0 to −60 dBm	< ±1 dB	< ±1.0 dB, typ. < ±0.4 dB
Ref. level −60.1 to −120 dBm	< ±2 dB	< ±1.3 dB, typ. < ±0.6 dB

RF attenuator ..... adjustable in range 0 to 75 dB in 5-dB steps using keyboard, spinwheel or step keys

Error when changing attenuation (referred to max. error at 26.5 GHz)
- 5 dB ..... 0.7 dB
- 10 dB ..... 0.8 dB
- 20 dB ..... 0.8 dB
- 40 dB ..... 2.5 dB

Measurement range switching .... referred to LOG 100 dB at ref. level
- LOG 110/100/50/20/10 dB ..... < ±0.2 dB
- LOG ↔ LIN/LOG 1 dB
  - Uncalibrated ..... < ±1 dB
  - Calibrated ..... < ±0.2 dB

Scaling
- LOG scale (reference: 10 dB below ref. level)
  - Display
    - 0 to −20 dB
      - RBW ≥ 30 Hz ..... < ±0.1 dB/dB
      - RBW ≥ 10 Hz ..... < ±0.2 dB/dB
      - RBW < 10 Hz ..... < ±0.5 dB/dB
    - −20 to −90 dB ..... < ±0.2 dB/dB
  - Total error
    - 0 to −100 dB ..... < ±1.5 dB
- LIN scale
  - RBW ≥ 10 Hz ..... < ±5% of ref. level
  - RBW < 10 Hz ..... < ±10% of ref. level

Error of calibration routine ..... < ±0.2 dB

Spurious responses

Internal (without input signal input terminated with 50 Ω, RF attenuation 0 dB)
- f > 1 MHz ..... < −110 dBm
- f ≤ 1 MHz ..... < −100 dBm

LO feedthrough at f = 0 Hz ..... < −15 dBm

Second-order harmonic distortion
- Mixer level ≤ −30 dBm, RF attenuation ≥ 10 dB
  - f < 40 MHz ..... < −60 dBc → HSOI ≥ +30 dBm, (HSOI = Harmonic Second Order Intercept Point)
  - 40 MHz ≤ f ≤ 5 GHz ..... < −70 dBc → HSOI ≥ +40 dBm
  - f > 5 GHz ..... < −95 dBc → HSOI ≥ +65 dBm

Third-order intermodulation distortion (f > 100 kHz)
- Mixer level ≤ −30 dBm, RF attenuation ≥ 10 dB
  - f < 40 MHz ..... < −70 dBc → TOI > +5 dBm, (TOI = Third Order Intercept Point)
  - f ≥ 40 MHz ..... < −75 dBc → TOI > +7 dBm;

Other
- Mixer level ≤ −40 dBm, RF attenuation ≥ 10 dB
  - f < 40 MHz ..... < −70 dBc
  - f ≥ 40 MHz ..... < −75 dBc

Immunity to interference

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

IF rejection ..... referred to reference level
- 221.4 MHz ..... > 100 dB, typ. 110 dB
- 21.4 MHz ..... > 100 dB, typ. 110 dB
- 4.194 MHz ..... > 100 dB, typ. 110 dB

Sweep

Sweep time

Span > 0 Hz

Setting ranges	Step size
20 ms to 2 s	20 ms
2 to 20 s	200 ms
20 to 1980 s	2 s
Error	< ±10⁻³

Span = 0 Hz

Setting ranges	Step size
200 µs to 10 ms	1/2/4/8/10
20 ms to 1980 s	see span > 0 Hz
Error	
200 µs to 10 ms	< ±2%
20 ms to 1980 s	< ±10⁻³
Sampling rate	1/8.9 µs
Time measurement	with the aid of markers and cursor lines
Resolution	sweep time/900

Sweep mode ..... repetitive/single

Trigger
- Operating modes ..... free run, line, video, external
- Voltage range ..... ±5 V with external trigger
- Trigger threshold resolution ..... 64 steps

Demodulation

- Receiver mode ..... demodulation of received RF signal
- Display of demodulated signal .... vertically on a 10-line graticule as a function of horizontal time base
- Marker function for measuring .... modulation depth in %, frequency deviation, centre frequency offset
- Resolution
  - AM 0.1%
  - FM ..... frequency deviation range/4096
  - Time ..... sweep time/900

FM demodulator ..... values applicable to signal levels 0 to +30 dB below ref. level; VBW 10 kHz; S/N ratio > 60 dB

Centre frequency offset after AF calibration (AF calibration not before 5 minutes after FM demodulation is switched on)
- FM deviation
  - 2 kHz, 20 kHz, 200 kHz ..... < 2% of deviation
  - 200 Hz ..... < 40 Hz
- Drift at constant ambient temperature after 1-hour warmup ..... < 10 Hz/min

FM deviation display error
- Deviation 2 kHz, 20 kHz, 200 kHz
  - Modulation frequency
    - 100 Hz to 5 kHz ..... < 3% of rdg
    - DC to 15 kHz ..... < 5% of rdg

FM linearity error (deviation < 20 kHz, modulation frequency < 5 kHz) ... < 1%

Residual FM (PP/2), averaged over 5 sweeps ..... < 20 Hz

Incidental FM at 50% AM, modulation frequency 1 kHz, VBW 3 kHz ..... < 500 Hz, typ. < 100 Hz

AM demodulator ..... values applicable to signal levels 6 to 35 dB below reference level

Centre offset of unmodulated signal
- Measurement range
  - 100% AM ..... < 2% of fs
  - 10% AM ..... < 5% of fs

Error of displayed mod. depth, AM < 80% (plus residual AM), mod. frequency 0.4 to 10 kHz ..... < 6% of rdg (with measurement range 10% AM < 8% of rdg)

Residual AM
- PP/2 ..... < 1%
- weighted to CCITT (VBW 3 kHz, RBW 30 kHz, averaged over 5 sweeps) ..... typ. < 0.1%

Incidental AM, RBW = 3 MHz, FM deviation 50 kHz, modulation frequency 1 kHz ..... < 3%

VDU

- Monitor ..... 9″ in-line colour CRT with 0.29-mm shadow mask pitch
- Useful area ..... 157 mm × 118 mm
- Brightness ..... adjustable in 64 steps
- Colours ..... selectable (16 from 4096)
- Number of display memories 4
- X resolution (electrical) ..... 1024 points
- Y resolution (electrical) ..... 512 points
- Scaling ..... electronically superimposed, calibrated graticule
- Additional information ..... alphanumeric display of essential parameters as well as hints in English

Output to plotter	R&S Plotter DOP; HP-GL
Functions	curve arithmetic (swap, subtract), comparison with tolerance curves, averaging peak hold
Markers	reference Marker + delta marker + 6 multimarkers
Functions	signal track, marker to peak, marker to ref. level, marker to centre freq., step size, marker to start/stop freq., marker to peak/next peak/min/next min, marker zoom, noise marker with normalization in dBm/Hz, delta marker to span, delta marker with noise normalization in dBc (Hz), n dB down, shape factor measurement 60/3 dB and 60/6 dB, multimarker peak search, multimarker set/clear/clear all, marker to next/previous multimarker receiver Mode: delta marker (measurement of modulation depth, frequency deviation and offset)

Inputs and outputs

Front panel, RF section

1st LO	SMA female
Frequency range	5.1 to 13.14 GHz
Output level	> −5 dBm, typ. > 0 dBm
VSWR	< 2.5
RF INPUT 50 Ω	
(100 Hz to 26.5 GHz)	N female
Impedance	50 Ω
VSWR	

(for 3.5 mm female adapter)	f ≤ 5.0 GHz	5.0 < f ≤ 26.5 GHz
RF attenuation 0 dB	≤ 3.0	≤ 3.0
RF attenuation ≥ 20 dB	≤ 1.5	≤ 2.0

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

Front panel, display section

PHONES	JK 34 jack
Frequency range (−3 dB)	100 Hz to 15 kHz
EMF	10 V_{PP}
Source impedance	30 Ω
KEYBOARD	JK 34 jack (for PCA-Z1)

Rear panel, RF section

IF OUTPUT, 221.4 MHz	BNC female
Impedance	50 Ω
VSWR	< 2
Gain referred to level at input mixer	−3 dB, ±6 dB
Bandwidth (10 dB)	> 36 MHz
IF OUTPUT, 21.4 MHz	BNC female
Impedance	50 Ω
VSWR	< 2
Gain referred to level at input mixer (ref. level −10 dBm, f_{in} = 100 MHz, RF att. 20 dB, normal)	+8 dB ±2 dB
Bandwidth (−6 dB)	> 10 MHz
10-MHz REFERENCE	BNC female
Output level with internal reference (Z_s = 50 Ω)	+10 dBm +3/−1 dB
Input level with external reference (Z_{in} = 500 Ω)	0.1 to 1 V_{rms}
SWEEP OUTPUT	BNC female
Output voltage (Z_L > 500 Ω)	0 to +5 V
START-SWEEP-STOP	BNC female; positive TTL pulse (τ = 1.4 µs) occurring upon sweep start and stop

Rear panel, display section

IF OUTPUT (narrow), 21.4 MHz	BNC female
Impedance	50 Ω
VSWR	< 2
Level with reference level up to −90 dBm	−15 dBm ±3 dB
Bandwidth	corresp. to resolution bandwidth
EXT SWEEP TRIG	BNC female
Input impedance	> 8 kΩ
Voltage range	±5 V; max. ±20 V
VIDEO OUTPUT	BNC female
Source impedance	75 Ω
Output voltage	0 to +0.5 V into 75 Ω, proportional to vertically displayed measured value

EXTERNAL MONITOR	
Outputs	BNC female
RED, GREEN, BLUE, COMP VIDEO	
Clock frequency	40 MHz
Impedance	75 Ω
Output voltage	0.3 +1.4 V into 75 Ω
V SYNC	
(vertical synchronization)	TTL level, fan-out 20 LS-TTL, polarity selectable by internal jumpers
Repetition frequency	50 Hz ± 2%
Sync pulse	0.8 ms
H SYNC/COMP SYNC	
(horizontal synchronization)	TTL level, fan-out 20 LS-TTL, function and polarity selectable by internal jumpers
Line frequency	29.4 kHz ± 2%
Sync pulses	2 µs
EXT FLOPPY	37-contact Cannon D female, for PZ-11
RS-232	25-contact Cannon D female
PARALLEL INTERFACE	
(Centronics)	36-contact Amphenol female
USER PORT	25-contact Cannon D female, function definable in setup mode
KEYBOARD	JK 34 jack for PCA-Z1
IEC 625.2 bus (IEEE 488)	24-contact Amphenol female
Bus functions	AH1, SH1, T6, L4, SR1, RL1, PP1, DC1, DT1, C1 to C4, C11
Data transfer rate	≤ 350 kbyte/s

General data

Note:	Unless otherwise specified, all values applicable to continuous sweep with coupled functions in default coupling and calibrated; based on IEC 714
Ambient conditions	to IEC 359, class I
Rated temperature range	0 to +55 °C
Storage temperature range	−40 to +70 °C; the unit contains a lithium battery for buffering the CMOS RAMs. The battery capacity and service life will be considerably reduced at low or high temperatures, respectively.
Max. relative humidity	20 to 90% (without condensation)
EMC	VDE 0871, limit class B; postal regulation 526/527.79; CISPR publication 11, 22; FCC DOC 20780: Part 15, Subpart 5
Warmup period (0 to +55 °C), time required for attaining operating temperature after cold start	1 h
Internal thermal equilibrium (at constant outside temperature)	4 hours
Power supply	100/120/220/240 V ±10%, 47 to 440 Hz (500 VA), safety class I (to IEC 348 and VDE 0411)
Dimensions (W × H × D)	435 mm × 413 mm × 590 mm
Weight	62 kg

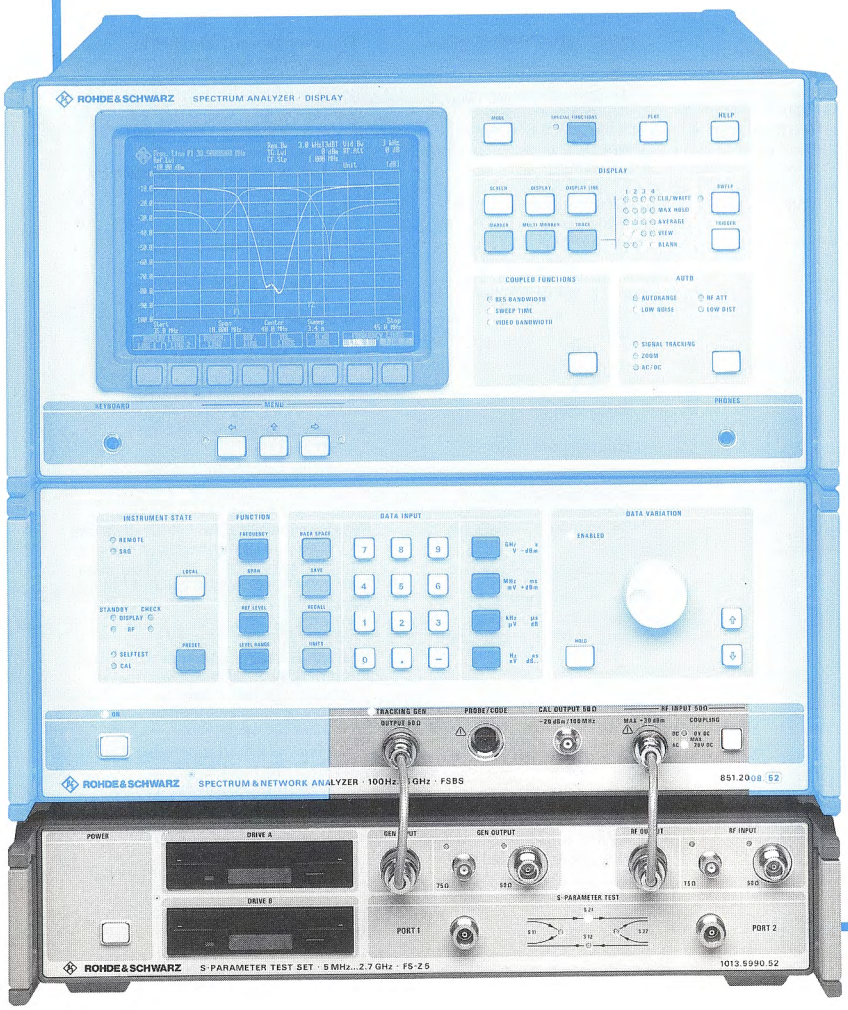
Ordering details

Order designation	▶ Spectrum Analyzer FSM 1020.7020.52	
Accessories supplied	power cables (2 of), connection cables (2 of), adapter 3.5 mm female (1021.0512.00), adapter N female (1021.0535.00), manual	
Recommended extras		
Service Kit	FS-Z1	811.0010.02
Connection Cable Set (for servicing, 1 m)	FS-Z2	811.0304.02
Software for Computer Function	FS-K1	811.0610.02
Computer Function (FS-K1 + PCA-Z1 + PZ11)	FS-Z4	811.0810.02
Application Software	FS-K3	811.1117.02
Keyboard	PCA-Z1	375.7511.02
Ext. Floppy Disk Station	PZ-11	350.8514.02
Plotter	DOP	375.1213.02
24-pin Pinwriter (220 V)	PDN	351.4512.02
Colour Option	PDN-B3	351.4912.02
IEC-bus Cable (1 m)	PCK	292.2013.10
19″-Adapter	ZZA-941	396.9471.00
	ZZA-951	396.9488.00
Accessories for current, voltage and field-strength measurements	see accessories for Test Receivers ESH 2/ESH 3 (catalog 90/91, page 276) and ESV/ESVP (catalog 90/91, page 280)	

*) For receive frequencies ≥ 12.91 GHz

FS-Z5

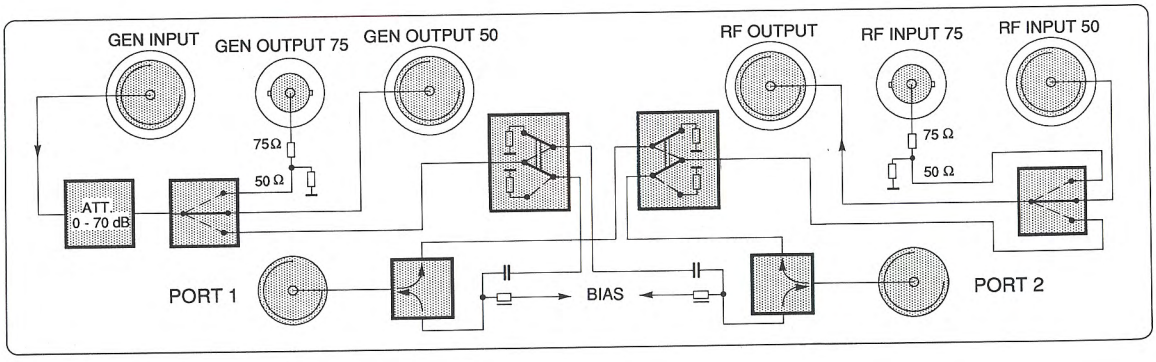
S-Parameter Test Set FS-Z5 ♦ 5 MHz to 2.7 GHz



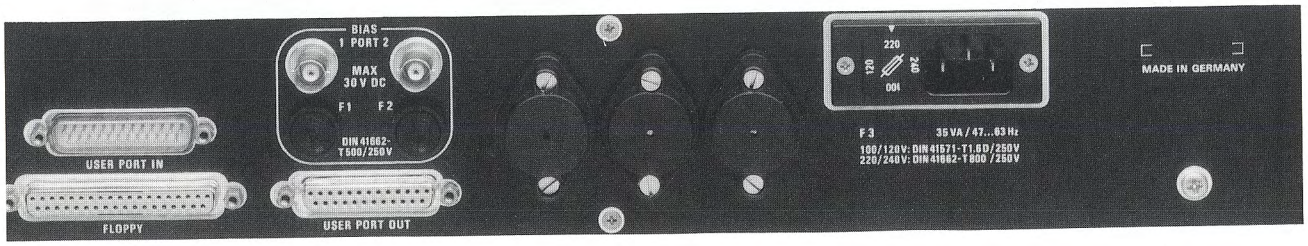
- Wide frequency range
- Compact test setup
- User-friendly operation
- High directivity of typically >46 dB
- Return loss at testport typically >26 dB
- DC bias for DUTs (max. 30 V, ±200 mA)
- Extremely high crosstalk attenuation between testports (typ. >120 dB)
- Five operations modes
  - S-parameter measurement
  - Transmission measurement 50 Ω
  - Transmission measurement 75 Ω
  - Spectrum analysis 50 Ω
  - Spektrum analysis 75 Ω

Computer function

- Using Keyboard PCA-Z1 and Software FS-K1 (R&S BASIC, MS-DOS), two built-in 3½" floppy disk drives can be expanded to form a computer function, which is identical with FS-Z4, see Spectrum Analyzers FSA and FSB



▲ Block diagram of FS-Z5 and rear-panel connectors ▼



Characteristics, uses

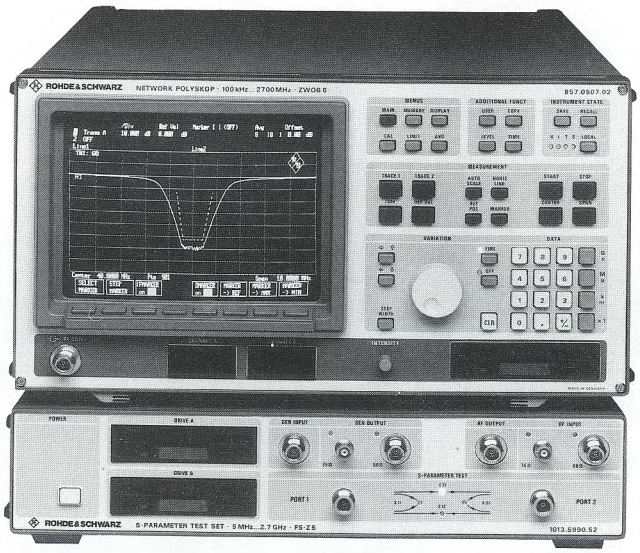
The **S-Parameter Test Set FS-Z5** in conjunction with suitable R&S analyzers provides a convenient test facility for automatic network analysis. The following instruments are suitable for scalar measurements:

- Spectrum analyzers with tracking generator of the FS.. family
- Scalar network analyzers of the ZWOB family

A variety of operating modes allows versatile application in the laboratory and production:

S-parameter measurement The usable frequency range extends from 5 MHz to 2.7 GHz and enables broadband measurements, eg on RF amplifiers. The directivity of typically >46 dB of the SWR bridge as well as the return loss of typically >26 dB at the testports allow even very small reflection coefficients to be measured. DC supply for active DUTs (max. 30 V, ±200 mA) is ensured via an integrated DC bias.

Transmission measurement and spectrum analysis 75 Ω Built-in matching pads allow these measurements to be carried out also on DUTs in 75-Ω systems. Separate, switchable inputs with BNC connectors are provided for this purpose. In test setups using both 75 Ω and 50 Ω impedances, the inputs can easily be selected via the USER-PORT of the analyzer without having to make any time-consuming modifications.



S-Parameter Test Set FS-Z5 in conjunction with Network Polyskop ZWOB 6

Transmission measurement and spectrum analysis 50 Ω In this operating mode, direct connections to the analyzer are established. The RF connection between the S-Parameter Test Set FS-Z5 and the analyzer can be left in.

Specifications

Frequency range . . . . . 5 MHz to 2.7 GHz
Directivity . . . . . ≥40 dB
Input and output crosstalk attenuation with testports shorted . ≥100 dB

Inputs and outputs

Front-panel connectors

GEN INPUT (100 Hz to 2.7 GHz) . . N female, max. +30 dBm
Impedance . . . . . 50 Ω
Return loss . . . . . ≥14 dB
VSWR . . . . . ≤1.5
GEN OUTPUT
50 Ω (100 Hz to 2.7 GHz) . . . . . N female, max. +30 dBm
Impedance . . . . . 50 Ω
Return loss . . . . . ≥14 dB
VSWR . . . . . ≤1.5
GEN OUTPUT
75 Ω (100 Hz to 1 GHz) . . . . . BNC female, max. +30 dBm
Impedance . . . . . 75 Ω
Return loss . . . . . ≥14 dB
VSWR . . . . . ≤1.5
RF OUTPUT (100 Hz to 2.7 GHz) N female, max. +30 dBm
Impedance . . . . . 50 Ω
Return loss . . . . . ≥14 dB
VSWR . . . . . ≤1.5
RF INPUT 50 Ω (100 Hz to 2.7 GHz) N female, max. +30 dBm
Impedance . . . . . 50 Ω
Return loss . . . . . ≥14 dB
VSWR . . . . . ≤1.5
RF INPUT 75 Ω (100 Hz to 1 GHz) . BNC female, max. +30 dBm
Impedance . . . . . 75 Ω
Return loss . . . . . ≥14 dB
VSWR . . . . . ≤1.5
PORT 1 and 2 (5 MHz to 2.7 GHz) . N female, max. +10 dBm
Impedance . . . . . 50 Ω
Return loss . . . . . ≥23 dB
VSWR . . . . . ≤1.15

Rear-panel connectors

BIAS PORT 1 and 2 . . . . . BNC female, max. 30 V, ±200 mA DC
USERPORT IN . . . . . Cannon D, 25-contact male
USERPORT OUT . . . . . Cannon D, 25-contact female
FLOPPY . . . . . Cannon D, 37-contact female

Insertion loss

GEN INPUT to GEN OUTPUT 50 Ω ≤0.5 dB + 0.5 dB × f[GHz]
GEN INPUT to GEN OUTPUT 75 Ω ≤6.7 dB + 0.5 dB × f[GHz]
GEN INPUT to PORT 1 and 2 . . . . . ≤11 dB + 1.0 dB × f[GHz]
RF INPUT 50 Ω to RF OUTPUT . . . . ≤0.5 dB + 0.3 dB × f[GHz]
RF INPUT 75 Ω to RF OUTPUT . . . . ≤6.7 dB + 0.3 dB × f[GHz]
PORT 1 and 2 to RF OUTPUT . . . . . ≤10 dB + 1.0 dB × f[GHz]
Measurement error caused by inherent reflection . . . . . 0.01 + 0.05 $|r|^2$
r = reflection coefficient of connected DUT

Mechanical RF switch and attenuator

Service life . . . . . ≥10^7 switching operations
Switching time . . . . . ≤20 ms
Attenuation range . . . . . 0 to 70 dB, 10-dB steps
Max. attenuation error . . . . . ±(0.2 dB +1.3 % of attenuation), max. 1 dB
Typical attenuation error . . . . . ±(0.1 dB +0.6 % of attenuation), max. 0.5 dB

Floppy-disk drives . . . . . 2×3½″, double-sided, high density
Tracks per disk 160
Sectors per track 18
Bytes per sector 512
Formatted capacity . . . . . 1.44 Mbyte
Recording format . . . . . IBM-compatible

General data

Environmental conditions . . . . . to IEC 359, class I
Rated temperature range . . . . . +5 to +50 °C
Storgage temperature range . . . . . −20 to +60 °C
Max. relative humidity . . . . . 20 to 80 % (non-condensing)
EMC . . . . . VDE 0871, limit class B
Power supply . . . . . 100/120/220/240 V ±10 %, 47 to 63 Hz, 36 VA, safety class I to VDE 0411 (IEC 348)
Dimensions (W × H × D) . . . . . 435 mm × 103 mm × 590 mm
Weight . . . . . 9 kg

Ordering information

Order designation . . . . . ▶ S-Parameter Test Set FS-Z5 1013.5990.52

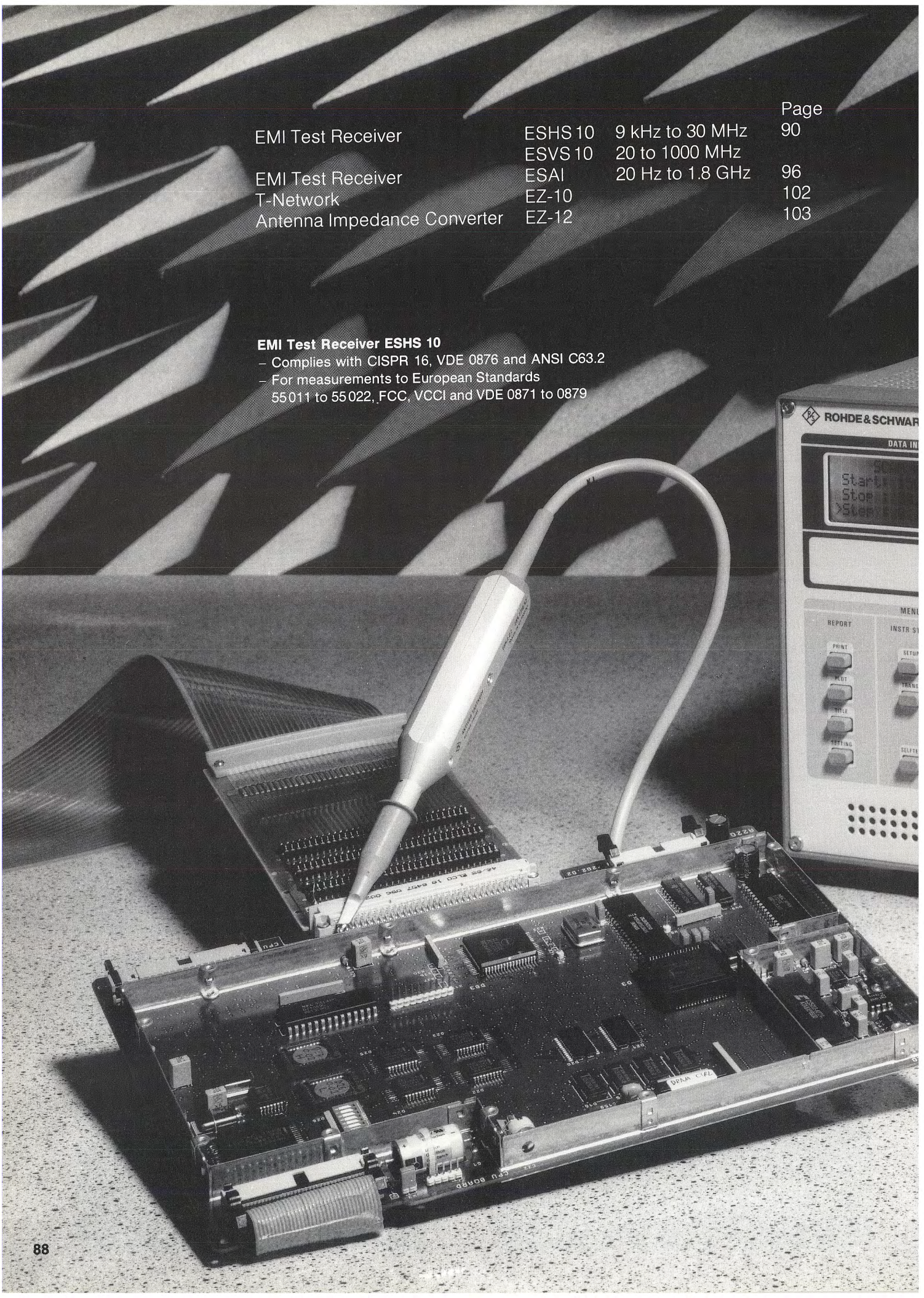
Accessories supplied . . . . . power cable, 2 × N connecting cables, USERPORT connecting cable, FLOPPY connecting cable, set of front handles, manual

Recommended extras

Pair of Test Cables	ZPV-Z4	335.1012.50
50-Ω Termination	RNB	272.4910.50
50-Ω Precision Termination	RNA	272.4510.50
50-Ω Calibration Kit	ZCAN	800.8515.52

			Page
EMI Test Receiver	ESHS 10 ESVS 10	9 kHz to 30 MHz 20 to 1000 MHz	90
EMI Test Receiver	ESAI	20 Hz to 1.8 GHz	96
T-Network	EZ-10		102
Antenna Impedance Converter	EZ-12		103

EMI Test Receiver ESHS 10
- Complies with CISPR 16, VDE 0876 and ANSI C63.2
- For measurements to European Standards 55011 to 55022, FCC, VCCI and VDE 0871 to 0879



5
emi testers

ESHS 10/ESVS 10

EMI Test Receiver ESHS 10 ♦ 9 kHz to 30 MHz
ESVS 10 ♦ 20 to 1000 MHz

- Complies with CISPR 16, VDE 0876 and ANSI C63.2
- For measurements to European Standards 55011 to 55022, FCC, VCCI and VDE 0871 to 0879
- Level measurement range
  ESHS 10: −36 to +137 dBµV
  ESVS 10: −14 to +137 dBµV
- Field-strength measurements using test antennas
- Frequency resolution
  ESHS 10: 10 Hz, ESVS 10: 100 Hz
- Manual operation or automatic test with report on printer or plotter
- Battery (int./ext.) or AC supply

Characteristics

EMI Test Receivers ESHS 10 and ESVS 10 are **double-conversion and triple-conversion heterodyne** receivers covering the frequency range 9 kHz to 30 MHz and 20 to 1000 MHz.

The number of measurements required to ensure electromagnetic compatibility is continuously increasing. Thanks to the **built-in intelligence** of Test Receivers ESHS 10 and ESVS 10, the time required for measurements is reduced considerably. Being specialists for EMI measurements to CISPR, CENELEC, FCC, VCCI and VDE standards, these test receivers furnish **results at a speed and accuracy** not possible previously.

Both test receivers can be manually operated, featuring **high frequency resolution** and **accurate level indication,** equally so in average and quasi-peak detection. Their real strength, however, is the automatic measurement of RFI parameters. The ESHS 10, for example, controls an artificial mains network, detects the line with the highest RFI level and compares the results with the permissible limits. Both test receivers furnish a **comprehensive test report** with all the necessary information which is output on a printer or plotter.

Special features

- Average, peak and quasi-peak detectors operating in parallel; highly linear envelope detector with more than 70-dB dynamic range
- Macros for automatic test runs
- Crystal-stabilized fast synthesizer (any frequency step in less than 10 ms (ESHS 10) or 30 ms (ESVS 10)) with high frequency resolution and sweep mode for fast frequency scanning
- High pulse loading capacity of input attenuator
- High measuring accuracy: error typ. ≤0.5 dB
- Wide dynamic range: noise figure typ. 6 dB (ESHS 10) or 7 dB (ESVS 10) with preamplifier, 10 dB (ESHS 10) or 12 dB (ESVS 10) without preamplifier, third-order intercept point typ. 20 dBm without preamplifier
- Automatic level calibration
- Measurement of voltage, field strength, current and pulse spectral density with **full indication of units**
- Automatic consideration of frequency-dependent transducer factors
- Indication of level on analog meter and digital display with 0.1-dB resolution
- 60-dB operating range also for quasi-peak and average indication
- Output of results on printer or plotter including limit lines and user-definable labelling
- Nonvolatile storage of 10 complete instrument settings and 22 different transducer factors and limit lines

The **clear arrangement of the controls** – all keys being assigned one function only – and the LC display of the selected parameters such as attenuation, bandwidth and detector ensure **great ease of operation.** The display is easy to read in any ambient light.

Uses

ESHS 10 and ESVS 10 each combine three instruments in one:

- a compact, manually tunable and battery-operated test receiver
- an automatic test receiver which automatically performs measurements and reports the results
- a system-compatible test receiver

Manual operation 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. Both instruments feature the conventional test receiver operation with tuning knob, indication of results on a meter and built-in loudspeaker.

Comprehensive shielding measures and a circuit design strictly following EMC rules enable the test receivers to be operated in a shielded room next to the device under test.

Automatic operation The input keys for automatic measurements are arranged on the left part of the front panel. Three groups of menu keys are provided below a four-line LCD window to enter frequency scans, limits, transducer factors, configuration data and **complex test routines**. In a frequency scan (lin or log), up to five subscans are covered; each subscan can be assigned a specific test receiver setting. **Nonvolatile storage of 22 limit lines** and transducer factors with up to 50 values is possible.

The results of a frequency scan are output on a printer with parallel interface as a list and on a plotter with IEC/IEEE-bus interface in graphical form. Time can be saved by simultaneous printing of the lists and plotting of the graphs.

Plotting is also possible during the frequency scan so that a **preview of the interference spectrum** can already be obtained during the measurement. Any relevant information can be added to the test report, either by entering it via a line editor or, more conveniently, via an MF keyboard that can be connected. Information is automatically added to the parameters known to the test receiver such as date, time and receiver settings.

Macros for automatic test runs (ANALYSIS OPTIONS) match the ESHS 10 and ESVS 10 to the specific configuration, device under test and measurement specification. Being thus prepared, the ESHS 10, for example, performs the following sequences automatically:

- fast prescan measurement using the peak and/or average detector
- determination of critical frequencies by means of limit lines with data reduction to shorten the measuring time
- final measurement at critical frequencies – for RFI voltage measurements on all phases of the artificial mains network (LISN) – using the average and/or quasi-peak detector
- report of results on printer or plotter

The minimum configuration consisting of ESHS 10, artificial mains network (LISN) and plotter is already a powerful and cost-effective test set.

Remote control The IEC/IEEE-bus interface complies with the latest standard IEEE 488 Part 2. The measured values are output with a resolution of 0.01 dB.

ESHS 10 measuring the RFI emission of a monitor

ESHS 10/ESVS 10

Description

The service-friendly modular design of the test receivers in conjunction with a consequent design to EMC rules ensures excellent characteristics regarding RFI emission and immunity.

A faulty module is easily found by the built-in selftest and replaced with a minimum of effort and without affecting the other modules.

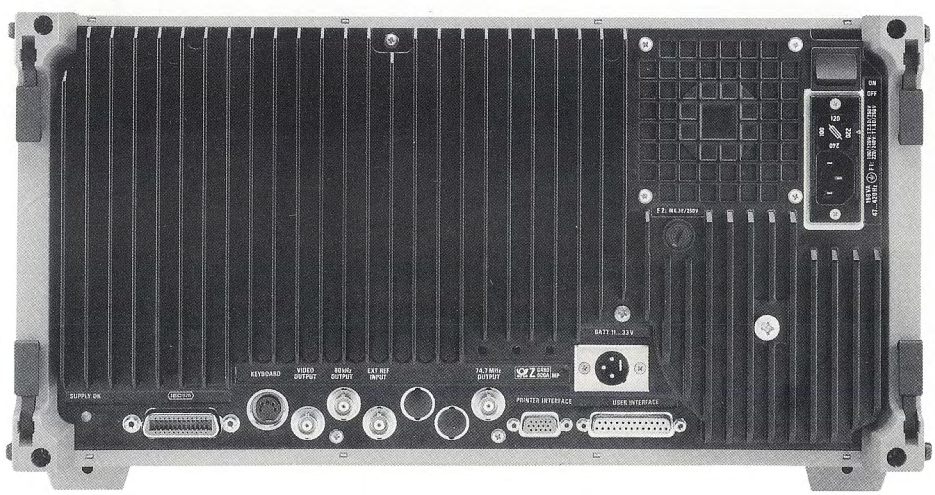
Further main features

- Pulse-resistant RF attenuator switchable in 10-dB steps in the range 0 to 120 dB
- Preselection filter
- Preamplifier with wide dynamic range, can be switched between preselection filter and 1st mixer
- High-level input mixer
- Filters with low delay distortion in the IF stage
- Peak indication with automatic consideration of IF bandwidth correction factors for measuring broadband interference (PK/MHz)
- Automatic overload detection by permanently active peak detectors
- Logarithmic amplifier with more than 70-dB dynamic range
- 12-bit A/D converter with short conversion time
- Measurement time selectable between 1 ms and 100 s
- 16-bit processor; flash EPROMs allowing convenient and fast firmware updating
- Demodulator circuits for A3E (AM) and N0N, for ESVS 10 also F3E (FM); headphones connector and built-in loudspeaker
- Automatic monitoring of all synthesizer loops and supply voltages during operation

Interfaces

For further signal evaluation and for driving or supplying addon units, the ESHS 10 and ESVS 10 have the following interfaces:

- Coding and supply socket (ANTENNA CODE) for active antennas and other accessories
- IF output 74.7 MHz for connection to a panoramic display
- IF output 80 kHz/10.7 MHz for evaluating the IF signal eg with an oscilloscope
- Envelope detector output (VIDEO OUTPUT) for evaluating the detected IF signal eg with an oscilloscope
- USER INTERFACE with
  - 6 TTL ports for driving external devices, eg for phase selection of Artificial Mains Networks ESH2-Z5 and ESH3-Z5
  - input for external triggering of measurements
  - outputs for the analog display voltage with and without simulation of the meter response for connecting a discontinuous interference analyzer
- – RS-232 interface for reprogramming the built-in Flash EPROMs when updating the firmware via an AT-compatible computer
- Parallel interface (PRINTER INTERFACE) for connecting a printer
- IEC/IEEE-bus interface
- Connector for an MF-compatible keyboard for text entry
- Input for an external reference frequency (5 or 10 MHz, automatic detection by ESHS 10)
- Connector (11 to 33 V) for battery-powered operation, eg in a vehicle



Rear-panel connectors (ESHS 10)

Specifications of ESHS 10

Frequency range . . . . . 9 kHz to 30 MHz
Frequency setting
with tuning knob . . . . . in 10-Hz, 10-kHz steps or any step size (switch-selected)
numerical . . . . . via keyboard
in steps . . . . . any selectable size
automatic scanning . . . . . for RF analysis
Display . . . . . 7-digit, LCD
Resolution . . . . . 10 Hz
Setting error . . . . . $< 3 \times 10^{-6} + 30$ Hz

RF input . . . . . $Z_{in} = 50\ \Omega$, N connector, female
VSWR . . . . . < 1.2 with ≥ 10 dB RF attenuation, < 2 with 0 dB RF attenuation

Oscillator reradiation
at RF input (0 dB RF attenuation)
w/o preamplifier . . . . . < 20 dBµV
with preamplifier . . . . . < 10 dBµV
Preamplifier . . . . . switchable between input filter and 1st mixer
Gain . . . . . 10 dB
Preselector . . . . . five bandpass filters

9 kHz	to < 150 kHz
150 kHz	to < 4.05 MHz
4.05 MHz	to < 12.8 MHz
12.8 MHz	to < 21.55 MHz
21.55 MHz	to 30 MHz

Maximum input level (with and w/o preamplifier)
RF attenuation 0 dB
DC voltage . . . . . 7 V
Sinewave AC voltage . . . . . 130 dBµV
Pulse spectral density . . . . . 97 dBµV/MHz
RF attenuation ≥ 10 dB (DC-coupled)
DC voltage . . . . . 7 V (= 1 W)
Sinewave AC voltage . . . . . 137 dBµV
Max. pulse voltage (10 µs) . . . . . 700 V
Max. pulse energy (10 µs) . . . . . 100 mWs

Interference rejection, non-linearities

Image-frequence 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	−10 dBm	−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

RF shielding
Voltage indication at a field strength of 10 V/m with 0 dB RF attenuation ($f \neq f_{in}$) . . . . . < −10 dBµV
Additional error in quasi-peak indication range . . . . . < 1 dB

Intermediate frequencies
1st IF . . . . . 74.7 MHz
2nd IF . . . . . 80 kHz

IF bandwidths

Nominal bandw.	−3 dB (±20%)	−6 dB	Shape factor
200 Hz[1])	140 Hz	200 Hz +20/−30 Hz	B_{6dB}/B_{50dB} = 1:8 (typ.)
10 kHz[2])	7 kHz	9.5 kHz ±0.5 kHz	B_{6dB}/B_{60dB} = 1:3.5 (typ.)

Noise indication

	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	< −30 dBµV typ. −35 dBµV	< −36 dBµV typ. −41 dBµV
Average value, BW = 10 kHz,		
f_{in} > 50 kHz	< −14 dBµV typ. −17 dBµV	< −20 dBµV typ. −25 dBµV
Peak value (typ. increase as against average value)	+ 11 dB	
Quasi-peak band A (9 to 50 kHz)	typ. −24 to −30 dBµV	typ. −30 to −36 dBµV
(50 to 150 kHz)	typ. −32 dBµV	typ. −38 dBµV
band B (≥ 150 kHz)	typ. −13 dBµV	typ. −19 dBµV
PK/MHz (BW = 10 kHz)	typ. 34 dBµV/MHz	typ. 28 dBµV/MHz

Voltage measurement range (f > 50 kHz)
Lower limit (additional error caused by inherent noise < 1 dB)

Average indication (AV)	Preamplifier off	Preamplifier on
B_{ZF} = 200 Hz	< −26, typ. −31 dBµV	< −32, typ. −37 dBµV
B_{ZF} = 10 kHz	< −6, typ. −10 dBµV	< −12, typ. −18 dBµV
Peak indication (Pk)		
B_{ZF} = 200 Hz	typ. −8 dBµV	typ. −14 dBµV
B_{ZF} = 10 kHz	typ. 10 dBµV	typ. 4 dBµV
Quasi-peak indication (QP)		
CISPR Band A (pulse freq 25 Hz)	typ. −30 dBµV	typ. −36 dBµV
CISPR Band B (pulse freq 100 Hz)	typ. −11 dBµV	typ. −17 dBµV
Spectral density (Pk/MHz)	typ. 50 dBµV/MHz	typ. 44 dBµV/MHz

Lower limits with preamplifier . . . . . all values 6 dB lower
Upper limit
AV, PK, QP . . . . . 137 dBµV (RF attenuation ≥ 10 dB)
Inherent spurious response . . . . . < −10 dBµV (equiv. input voltage)
Level display
digital[3]) . . . . . 3½ digits, 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, 60 dB
Display modes . . . . . average (AV), peak (PK), spectral density measurement, (PK/MHz) quasi-peak (QP)
averaging, hold and measuring times . . . . . 1 ms to 100 s (1/2/5 steps)
Measuring error (level indication)
AV for S/N > 16 dB . . . . . < 1 dB (digital display), typ. < 2 dB (analog display)
Level calibration . . . . . harmonics generator
Demodulation modes . . . . . N0N (zero beat) A3 (for A3E emissions)
Date, time of day . . . . . internal clock, permanently operated from internal battery

Connectors and interfaces

Remote control . . . . . to IEC 625-2 (IEEE 488)
Remote-control connector . . . . . 24-contact Amphenol connector
Interface functions AH1, L4, SH1, T6, SR1, PP1, RL1, DC1, DT1, C1, C2, C3, C11
Plotter language . . . . . HP-GL

Front-panel outputs
Supply and coding connector for antennas etc. . . . . 12-contact Tuchel connector
AF output . . . . . Z_{out} = 10 Ω, jack JK34
EMF . . . . . adjustable up to 2 V

Rear-panel outputs
IF 74.7 MHz . . . . . Z_{out} = 50 Ω, BNC connector, female
Gain ref. to RF input
RF attenuation 0 dB . . . . . typ. 10 dB without preamplifier, typ. 20 dB with preamplifier
Bandwidth (−3 dB) . . . . . > 2 MHz or bandwidth of preselector
IF 80 kHz . . . . . Z_{out} = 50 Ω, BNC connector, female
EMF in range of analog level display for unmod. sinewave signal:
Operating range 30 dB . . . . . 1 to 30 mV
60 dB . . . . . 1 mV to 1 V
Bandwidth = IF bandwidth
Envelope detector output . . . . . BNC connector, female
EMF in range of analog level display:
Operating range 30 dB . . . . . 4 to 126 mV
60 dB . . . . . 4 mV to 4 V
User interface . . . . . 25-contact Cannon connector; includes 6 control lines for an external device (eg artificial mains network), display voltage (analog) with and without simulation of meter response, input for external triggering, RS-232-C interface for firmware updating
Printer connection . . . . . parallel interface, 15-contact Cannon connector
Keyboard connection . . . . . DIN connector (5-contact)

Rear-panel inputs
Ext. reference frequency . . . . . BNC connector
Required level . . . . . EMF ≥ 1 V from 50 Ω
Frequency . . . . . 5/10 MHz
Ext. battery . . . . . 3-contact connector
Required voltage . . . . . 11 to 33 V

ESHS 10/ESVS 10

General data

Rated temperature range	−10 to +55 °C (no condensation allowed)
Storage temperature range	−25 to +70 °C
Mechanical resistance	shock-tested to MIL STD 810 D (shock-spectrum 40 g), vibration-tested to MIL-T-28800 D, Class 5; IEC-Publ. 68-2-6
RFI suppression	complies with VDE 0876, Part 1a, Regulation 527/1979 and MIL-STD-461B (CE03 and RE02)
Power supply	
AC supply	100/120/220/240 V ±10%, 50 VA 47 to 440 Hz safety class I to VDE 0411 (IEC348)
Battery	
Internal	12 V, 10 Ah
Operating time	approx. 4 h
External	11 to 33 V, 1.2 A at 24 V, 2.3 A at 12 V
Dimensions (W × H × D)	435 mm × 236 mm × 363 mm
Weight	21 kg/18 kg with/without batteries

Ordering information

Order designation	▶ EMI Test Receiver ESHS 10 1004.0401.10
Accessories supplied	power cable, connector for external battery, operating manual

Recommended extras

For interference measurements:		
RF current probe 20 Hz to 100 MHz	EZ-17	816.2063.02
RF current injection probe 20 Hz to 100 MHz	EZ-17	816.2063.03
RF Current Probe (9 kHz to 30 MHz)	ESH2-Z1	338.3516.52
Active Probe (9 kHz to 30 MHz, high-impedance)	ESH2-Z2	299.7210.52
Passive Probe (9 kHz to 30 MHz, VDE 0876)	ESH2-Z3	299.7810.52
Four-line Artificial Mains Network (9 kHz to 150 kHz/30 MHz, VDE 0876)	ESH2-Z5	338.5219.52
T-Network	ESH3-Z4	800.1510.52
Four-wire T-Network	EZ-10	816.1215.02
Antenna Impedance Converter	EZ-12	1026.4800.02
Two-line V-Network	ESH3-Z5	831.5518.52
V-Network 5 µH ‖ 50 Ω	ESH3-Z6	836.5016.52
Attenuator (20 dB, 10 W)	ESH2-Z11	349.7518.52
Rod Antenna	HFH2-Z1	335.3215.52
Rod Antenna (MIL)	HFH2-Z6	837.1866.54
Loop Antenna (9 kHz to 30 MHz)	HFH2-Z2	335.4711.52
Loop Antenna (9 kHz to 1 MHz)	HFH2-Z3	335.6214.52
Inductive Probe	HFH2-Z4	338.3016.52
Tripod	HFU-Z	100.1114.02
Wooden Tripod (for HFH2-Z6)	HZ-1	837.2310.02
Roof-mounting Kit (for Loop Antenna HFH2-Z2)	HFH2-Z5	335.5718.02
Other accessories		
6-V Lead Acid Storage Battery, maintenance-free, 10 Ah (2 required)		338.4012.00
Keyboard	PSA-Z1	1009.5001.32
Headphones		110.2959.00
Service Manual		1004.0553.24
Service Kit	EZ-8	816.1067.02
19″ Rack Adapter		
with front handles	ZZA-95	396.4911.00
without front handles	ZZA-951	396.9488.00
Set of Front Handles	ZZG-95	396.5176.00
2nd Set of Handles		396.9588.00
Pinwriter (24-pin), 220 V	PDN	351.4512.02
Pinwriter (24-pin), 120 V	PDN	351.4512.03
Plotter (DIN A4)	DOP	375.1213.02
Modification Kit HP-GL	DOP-U1	350.9010.02
Transit Case	ZZK-953	1013.9389.00
Trolley	ZZK-1	1014.0510.00
Cables		
IEC-bus Connecting Cable 1 m	PCK	292.2013.10
2 m	PCK	292.2013.20
Printer Cable	EZ-11	816.1767.02
Control cables for artificial mains networks in shielded cabins from ESHS 10 to ESH3-Z5		
Control Cable 2 m	EZ-14	1026.5341.02
from ESHS 10 to ESH2-Z5		
Control Cable 2 m	EZ-13	1026.5293.02
Control cables for artificial mains networks in shielded cabins from ESHS 10 to ESH3-Z5 (both cables required)		
Control Cable 2 m	EZ-14	1026.5341.02
10 m	EZ-6	816.0683.02
from ESHS 10 to ESH2-Z5 (both cables required)		
Control Cable 2 m	EZ-13	1026.5293.02
10 m	EZ-5	816.0625.02
Feeder cables for active antennas in shielded cabins (2 required)		
Feeder Cable 3 m	HZ-3	837.3469.02
10 m	HZ-4	816.0519.02

[1]) Meets tolerances to CISPR 16
[2]) Meets tolerances to CISPR 16 (min. 8 kHz, max. 10 kHz) and complies with MIL tolerance (10 kHz ±10%)
[3]) Units: dBµV, dBµA, dBm, dBµV/m, dBµA/m, dBpW

Specifications of ESVS 10

Frequency range	20 to 1000 MHz
Frequency setting	
with tuning knob	in 100-Hz, 100-kHz steps or any step size (switch-selected)
numerical	via keyboard
in steps	any size selectable
automatic scanning	for RF analysis
Display	8-digit LCD
Resolution	100 Hz
Setting error	$< 3 \times 10^{-6}$
RF input	Z_{in} = 50 Ω, N connector, female
VSWR	<1.2 with ≥10 dB RF attenuation, <2 with 0 dB RF attenuation
Oscillator reradiation at RF input (0 dB RF attenuation)	
w/o preamplifier	<20 dBµV
with preamplifier	<10 dBµV
Preamplifier	switchable between input filter and 1st mixer
Gain	10 dB
Preselector	
1 filter with fixed tuning	20 to <51.3 MHz
5 tracking filters	51.3 to <125.3 MHz
	125.3 to <273.3 MHz
	273.3 to <495.3 MHz
	495.3 to <717.3 MHz
	717.3 to 1000 MHz
Maximum input level (with and w/o preamplifier)	
RF attenuation 0 dB (AC-coupled)	
DC voltage	50 V
Sinewave AC voltage	130 dBµV
Pulse spectral density	97 dBµV/MHz (100 V for 0.5 ns)
RF attenuation ≥10 dB (AC-coupled)	
DC voltage	50 V
Sinewave AC voltage	137 dBµV = 1 W
Max. pulse voltage	150 V
Max. pulse energy (20 µs)	10 mWs
RF attenuation ≥10 dB with option ESVS-B1 (DC-coupled)	
DC voltage	7 V
Sinewave AC voltage	137 dBµV = 1 W
Max. pulse voltage	1500 V
Max. pulse energy (10 µs)	100 mWs

Interference rejection, non-linearities

	Preamplifier off	Preamplifier on
Image-frequence rejection 1st IF	>90, typ. 100 dB	
2nd IF	>90, typ. 100 dB	
IF rejection	>90, typ. 100 dB	

Intercept point d3, with $\lvert f_1-f_2 \rvert \geq 5$ MHz, Level (f_1, f_2) at receiver	−10 dBm	−20 dBm
	>15 dBm, typ. +20 dBm	>5 dBm, typ. +10 dBm
Intercept point k2	>35 dBm	>25 dBm

RF shielding	
Voltage indication at a field strength of 10 V/m with 0 dB RF attenuation ($f = f_{in}$)	<0 dBµV
Additional error in quasi peak indication range at 10 V/m	<1 dB
Intermediate frequencies	
1st IF	1354.7 MHz
2nd IF	74.7 MHz
3rd IF	10.7 MHz

IF bandwidths

Nominal bandw.	–3 dB (±20 %)	–6 dB (±10 %)	Shape factor BW_{6dB}/BW_{60dB}
10 kHz[1])	7 kHz	9.5 kHz ±0.5 kHz	1:4 typ.
120 kHz[2])	90 kHz	120 kHz	1:5,5 typ.

Noise indication

	Preamplifier off	Preamplifier on
Average value, BW = 10 kHz	–12, typ. –15 dBµV	< –16, typ. –21 dBµV
Average value, BW = 120 kHz	< –1, typ. –4 dBµV	< –5, typ. –10 dBµV
Peak value, BW = 10 kHz	typ. –4 dBµV	typ. –9 dBµV
Peak value, BW = 120 kHz	typ. +7 dBµV	typ. +1 dBµV
Quasi-peak band C/D	typ. +2 dBµV	typ. –4 dBµV
Spectral density measurement Pk/MHz, BW = 120 kHz	typ. 25 dBµV/MHz	typ. 21 dBµV/MHz

Voltage measurement range

Lower limit (additional error caused by inherent noise < 1 dB

Average indication (AV)	Preamplifier off	Preamplifier on
BW = 10 kHz	< –8, typ. –11 dBµV	< –12, typ. –17 dBµV
BW = 120 kHz	< 3, typ. 0 dBµV	< –1, typ. –6 dBµV
Peak indication (Pk)		
BW = 10 kHz	typ. 12 dBµV	typ. 7 dBµV
BW = 120 kHz	typ. 23 dBµV	typ. 17 dBµV
Quasi-peak indication (QP) CISPR band C/D (100 Hz plus repitition freq)	< 10, typ. 6 dBµV	< 4, typ. 0 dBµV

Upper limit
AV, PK, QP, ... 137 dBµV (RF attenuation ≥ 10 dB)
Inherent spurious response ..... < –5 dBµV (equiv. input voltage)
Level display[3])
digital ..... 3½ digits, 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, 60 dB
Display modes ..... average (AV), peak (PK), pulse spectral density, (PK/MHz) quasi-peak (QP)
averaging, hold and measuring times ..... 1 ms to 100 s (1/2/5 steps)
Measuring error (level indication)
AV for S/N > 16 dB ..... < 1 dB (digital display), typ. < 2 dB (analog display)
Level calibration ..... sinewave and harmonics generator
Demodulation modes ..... A0 (zero beat), A3 (for A3E emissions), F3 (for F3E emissions)
Date, time of day ..... internal clock, permanently operated from internal battery

Connectors and interfaces

Remote control ..... to IEC 625-2 (IEEE 488)
Remote-control connector ..... 24-contact Amphenol connector
Interface functions AH1, L4, SH1, T6, SR1, PP1, RL1, DC1, DT1, C1, C2, C3, C11
Plotter language ..... HP-GL

Front-panel outputs

Supply and coding connector for antennas etc. ..... 12-contact Tuchel connector
AF output ..... Z_{out} = 10 Ω, jack JK34
EMF ..... adjustable up to 2 V

Rear-panel outputs

IF 74.7 MHz ..... Z_{out} = 50 Ω, BNC connector, female
Gain ref. to RF input
RF attenuation 0 dB ..... typ. 10 dB without preamplifier, typ. 20 dB with preamplifier
Bandwidth (–3 dB) ..... > 2 MHz or bandwidth of preselector
IF 10.7 MHz ..... Z_{out} = 50 Ω, BNC connector, female
EMF in range of analog level display for unmod. sinewave signal:
Operating range 30 dB ..... 1 to 30 mV
60 dB ..... 1 mV to 1 V
Bandwidth = IF bandwidth
Envelope detector output ..... BNC connector, female
EMF in range of analog level display:
Operating range 30 dB ..... 4 to 126 mV
60 dB ..... 4 mV to 4 V
User interface ..... 25-contact Cannon connector; includes 6 control lines for an external device, display voltage (analog) with and without meter simulation, input for external triggering, RS-232-C interface for firmware updating
Printer connection ..... parallel interface, 15-contact Cannon connector
Keyboard connection ..... DIN connector (5-contact)

Rear-panel inputs

Ext. reference frequency ..... BNC connector (female)
Required level ..... EMF ≥ 1 V from 50 Ω
Frequency ..... 5/10 MHz
Ext. battery ..... 3-contact connector
Required voltage ..... 11 to 33 V

General data

Rated temperature range ..... –10 to +55 °C (no condensation)
Storage temperature range ..... –25 to +70 °C
Mechanical resistance ..... shock-tested to MIL STD 810 D (shock-spectrum 40 g), vibration-tested to MIL-T-28800 D, Class 5; IEC-Publ. 68-2-6
RFI suppression ..... complies with VDE 0876, Part 1a, PTT Decree 527/1979 and MIL-STD-461B (CE03 and RE02)

Power supply

AC supply ..... 100/120/220/240 V ±10 %, 60 VA 47 to 440 Hz safety class I to VDE 0411 (IEC348)
Battery
Internal ..... 12 V, 10 Ah
Operating time ..... approx. 2.5 h
External ..... 11 to 33 V, 1.9 A at 24 V, 3.3 A at 12 V
Dimensions (W × H × D) ..... 435 mm × 236 mm × 363 mm
Weight ..... 23.7 kg/20.4 kg with/without batteries

Ordering information

Order designation ..... ▶ EMI Test Receiver ESVS 10 1011.2006.10
Accessories supplied ..... power cable, connector for external battery, operating manual

Option

Pulse Power Attenuator	ESVS-B1	816.1815.02

Recommended extras

For interference measurements:

RF current probe 20 Hz to 100 MHz	EZ-17	816.2063.02
RF current injection probe 20 Hz to 100 MHz	EZ-17	816.2063.03
VHF Current Probe 20 to 300 MHz	ESV-Z1	353.7019.02
Absorbing Clamp 30 to 1000 MHz	MDS-21	194.0100.50
Adapter (BNC female to N male)		118.2812.00
Broadband Dipole 20 to 80 MHz	HUF-Z1	358.0512.52
Log-periodic Broadband Antenna 80 to 1300 MHz	HL 023A1	577.8017.02
Tripod	HFU-Z	100.1114.02
Mast (for tripod)	HFU-Z	100.1120.02
Biconical Antenna 20 to 300 MHz	HK 116	4000.7752.02
Log-periodic Antenna 200 to 1300 MHz	HL 223	4001.5501.02
Conical Log Spiral Antenna 200 to 1000 MHz	HUF-Z4	837.2210.52
Wooden Tripod (for HK 116, HL 223, HUF-Z4)	HZ-1	837.2310.02
RF Connecting Cable (12 m)	HFU2-Z4	252.0090.56
RF Connecting Cable (7m)	HFU2-Z5	252.0055.56
RF Probe (BNC connector)	HFV-Z	204.1010.02
Adapter (BNC female to N male)		118.2812.00
V-Network 5 µH/50 Ω	ESH3-Z6	836.5016.52
Preamplifier 10 dB	ESV-Z3	397.7014.52

Other accessories

6-V Lead Acid Storage Battery, maintenance-free, 10 Ah (2 required)		338.4012.00
Keyboard	PSA-Z1	1009.5001.32
Headphones		110.2959.00
Service manual		1011.2441.24
Service Kit	EZ-8	816.1067.02
19″ Rack Adapter		
with front Handles	ZZA-95	396.4911.00
without front Handles	ZZA-951	396.9488.00
Set of Front Handles	ZZG-95	396.5176.00
2nd set of Handles		396.9588.00
Pinwriter (24-pin), 220 V	PDN	351.4512.02
Pinwriter (24-pin), 120 V	PDN	351.4512.03
Printer Cable	EZ-11	816.1767.02
Plotter (DIN A4)	DOP	375.1213.02
Modification Kit HP-GL	DOP-U1	350.9010.02
Transit Case	ZZK-953	1013.9389.00
Trolley	ZZK-1	1014.0510.00
IEC-bus Connecting Cable 1 m	PCK	292.2013.10
2 m	PCK	292.2013.20

[1]) Meets tolerances to CISPR 16
[2]) Meets tolerances to CISPR 16 (min. 8 kHz, max. 10 kHz) and complies with MIL tolerance (10 kHz ±10 %)
[3]) Units: dBµV, dBµA, dBm, dBµV/m, dBµA/m, dBpW

ESAI

EMI Test Receiver ESAI ♦ 20 Hz to 2 GHz

- EMC measurements in the frequency range 20 Hz to 1.8 (2) GHz to CISPR, VDE, NAMUR, FCC, EN, MIL, DEF STAN, GAM EG 13
- Parallel detectors for peak, average, rms and quasi-peak weighting
- Impulse-resistant second input for frequency range 20 Hz to 200 MHz
- Wide dynamic range and high measuring accuracy
- Overload-protected by built-in preselector
- Sensitivity can be increased by switch-selectable low-noise preamplifier
- IF bandwidths to CISPR and MIL as well as quasi-continuously adjustable IF resolution bandwidths
- Built-in pulse reference source for checking CISPR weighting curve
- Automatic overload detection
- Built-in AM/FM demodulators
- Versatile tracking generator for twoport measurements
- Computer function (optional)

IEC 625 Bus

Uses

EMI Test Receiver ESAI combines the top-class performance features of Rohde & Schwarz EMI test receivers with the speed of R&S spectrum analyzers. The ESAI is both a **specialist instrument for EMC measurements** in the frequency range 20 Hz to max. 2 GHz **and a top-class spectrum analyzer** with all the advantages of the FSA analyzer family (see chapter 4 and catalog 90/91). Its distinguishing features are high sensitivity, wide dynamic range and high measuring accuracy.

The integrated measurement and analysis functions simplify and speed up all measurements to the relevant industrial and military standards such as **CISPR, VDE, NAMUR, FCC, EN, VCCI, MIL, DEF STAN, BS, DO 160, GAM EG 13.**

Characteristics

A test receiver which enables **weighted measurements on interference pulses to CISPR** has to meet extremely stringent requirements. The ESAI's integral **preselector with 14 filters** provides the required large dynamic range for wideband signals. A **low-noise preamplifier** (gain 10 dB/20 dB), which **can be switched** after the preselector, is used to increase sensitivity.

To **measure high-energy pulses**, the ESAI has a **second impulse-resistant input** in the frequency range from 20 Hz to 200 MHz. An automatic overload detector checks crucial points in the signal path.

Parallel detectors EMI Test Receiver ESAI has a variety of maximum, minimum, mean, rms and quasi-peak detectors for simultaneous signal analysis, which considerably speeds up test routines.

EMI test sets often use audio facilities to identify the type of interference. In this respect, the ESAI's integral **AM/FM demodulators** prove very useful.

In addition to the built-in sine calibration source, the ESAI provides a **pulse calibration source** that allows CISPR weighting curves to be checked. The ESAI is also equipped with a **tracking generator** which facilitates all kinds of EMC measurements.

Documentation on printers and plotters **Printers and plotters** can be **directly connected** to provide clear documentation of the measurement results as the ESAI supports a wide range of commercially available monochrome and colour hardcopy devices including laser printers.

RF dynamic range

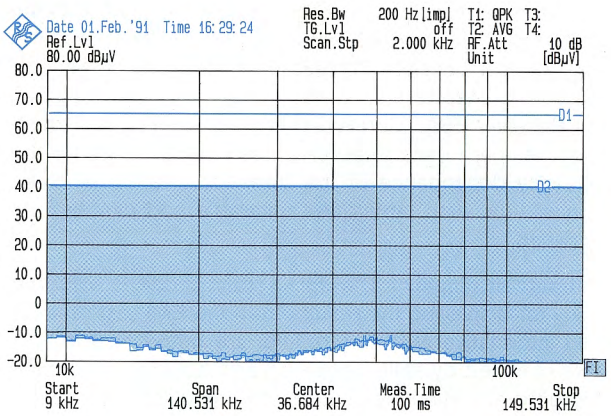
The **large dynamic range and excellent sensitivity of the ESAI** can be seen from the four diagrams. The linear CISPR operating range for weighted measurements on single pulses, which is a function of the preselector bandwidth and the intrinsic sensitivity, is marked as a blue-coloured area.

It should be stressed that the ESAI settings **completely conform to CISPR** requirements, ie the figures given apply to an RF attenuation of 10 dB. This means that sensitivity can be raised by 10 dB, if necessary (see Table). Even with a preamplification of 10 dB, **CISPR band C/D** still has an ample dynamic range.

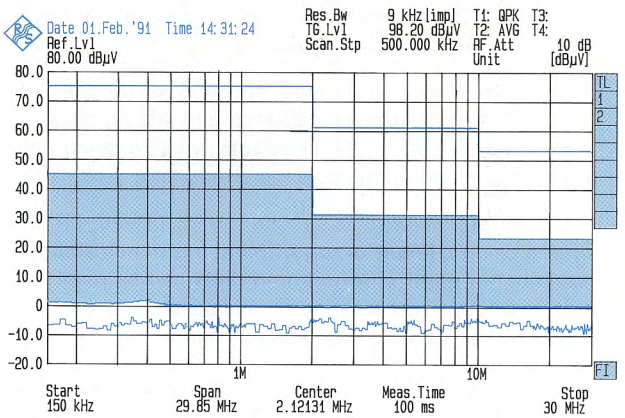
Frequency range	Resolution bandwidth	Average (RF attenuation 0 dB)	Quasi-peak (RF attenuation 0 dB)
10 to 150 kHz CISPR A*)	200 Hz (6 dB)	−17 dBµV −20 dBµV typ.	−15 dBµV −18 dBµV typ.
150 kHz to 30 MHz CISPR B*)	9 kHz (6 dB)	− 7 dBµV −10 dBµV	−0 dBµV −3 dBµV
30 to 1000 MHz CISPR C/D	120 kHz (6 dB)	RF pre-amplifier 0 dB 10 dB 20 dB	 +5 dBµV −3 dBµV −4 dBµV	 +12 dBµV + 4 dBµV + 3 dBµV
1 to 1.8 GHz	6 Hz (3 dB)	RF pre-amplifier 0 dB 10 dB 20 dB	 −150 dBm (without preselection) −155 dBm (without preselection) −156 dBm (without preselection)	

*) Temperature range 15 to 35 °C, SCAN mode. In the range 0 to 15 °C and 35 to 55 °C, sensitivity can differ from the specified value by 1 dB.

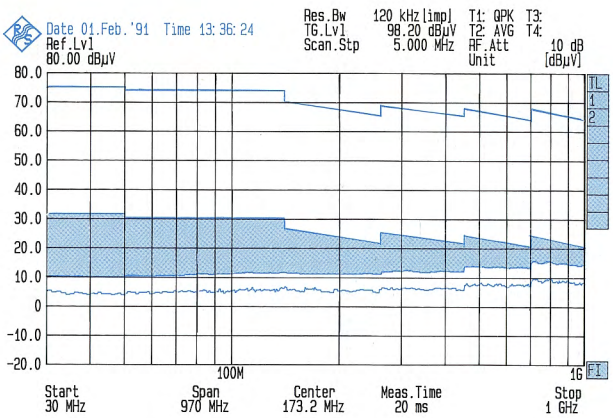
The diagrams show actual and not nominal maximum sensitivities, ie the measurable difference of 6 to 7 dB between the mean and quasi-peak detectors is shown.



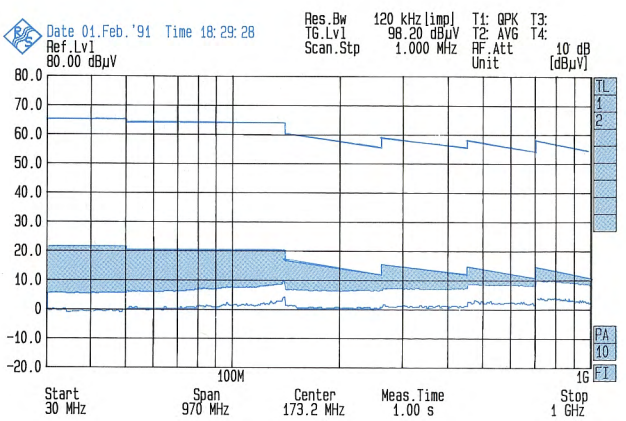
CISPR A



CISPR B



CISPR C/D



CISPR C/D with RF preamplifier

ESAI

High measuring convenience

Thanks to its high measuring convenience, **EMI Test Receiver ESAI** is able to solve **all EMC measurement problems**

- Linear or logarithmic scaling of frequency axis and superimposed limit lines with automatic limit check
- Fast scan mode with manual adjustment during scan and optional subscan measurement
- Automatic consideration of cascaded, frequency-dependent transducer factors
- Split-screen display
- Documentation on printer and plotter
- Optional computer function for programming test sequences and for storing device setups and test results on floppy disks
- Help functions
- Remote control via IEC 625.2/IEEE 488.2 bus

Time-saving **Fast overview measurements** are essential at the development stage. It is precisely in this context that the ESAI with its spectrum analyzer capabilities can cut down on development times:

- In the **OVERVIEW mode,** the whole interference spectrum is displayed on the high-resolution colour monitor.
- Apart from the IF resolution bandwidths required by CISPR (200 Hz, 9 kHz and 120 kHz) and MIL (in decades from 10 Hz to 1 MHz), the IF selectivity has a **quasi-analog** setting mode to optimize the sweep time.
- The interference spectrum can be displayed on the screen using a **linear or logarithmic frequency scale.** A maximum of **eight different limit lines** can be displayed on the screen. The ESAI automatically detects and displays any values outside specified limits.

Fast scan mode In the SCAN mode, the ESAI functions in a way that can be compared with a conventional test receiver:

- In addition to measurements at the selected frequency, automatic scans between a start and a stop frequency with measurements at an adjustable step are possible.
- **Manual adjustments** which can be made while the scan is in progress and optional **subscan measurements** reduce the time required for complete EMI measurements.

To conform with relevant standards, measurements over various frequency ranges and bandwidths have to be made. For this purpose, the user can define a variety of frequency ranges in a **configuration table.** Measurements are then made over these subranges using the selected bandwidth, measurement time, step size, etc.

TABLE 1 of 2 CONFG TABLES — SELECT TABLE - Enter No. 2

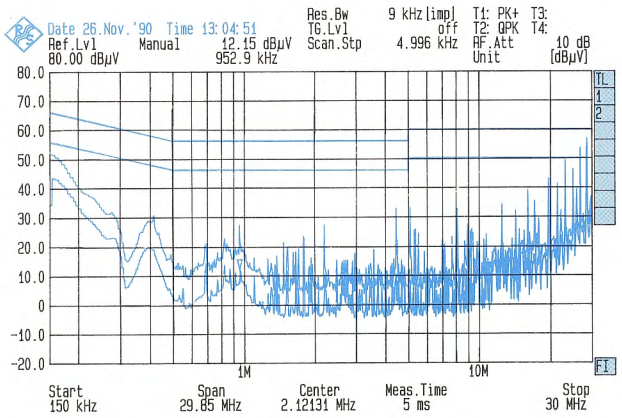
i	F1 MHz	F2 MHz	Res-BW	Time s	PrAmp	PrSel	Li/Lo	Step MHz/%
1	0.009000	0.150000	200Hz	0.005	0	ON	LIN	0.000100
2	0.150000	30.000000	9KHz	0.005	0	ON	LIN	0.005000
3	30.000000	1000.000000	120KHz	0.005	0	ON	LIN	0.050000
4								
5								
6								

Measurement according to CISPR

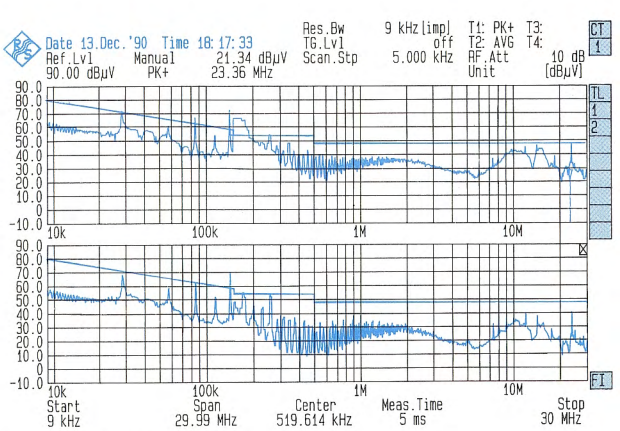
Configuration table

Automatic compensation for transducers The ESAI always displays results with correct units (dBµV, dBµV/m, dBµA, etc.). The transducers designed for the Rohde & Schwarz test receiver families ESV and ESH (see catalog 90/91, chapter 5) are also suitable for use with EMI Test Receiver ESAI. Correction factors entered in a transducer table are used to automatically compensate for the frequency dependence of the transducer factor. A maximum of four such tables are auvailable and can also be combined.

Split-screen display The split-screen mode is a further facility for displaying the results from the EMI test receiver in an informative way. The results are output in two windows obtained by splitting the screen display horizontally. Different trace memories, and so the results from different detectors, can be displayed in the upper and the lower windows. This facility is ideal for separately displaying narrowband and broadband signals.



Display of interference signal spectrum with logarithmic frequency axis and two of a maximum of eight limit lines



Split-screen display

Operation

EMI Test Receiver ESAI is **easy to operate even for complex measurements.** The operating convenience includes simple entry of parameters, readout of results on the screen as well as automatic detection of overloads even outside the displayed frequency range. **Basic settings** for repeated measurements can be **stored and recalled.**

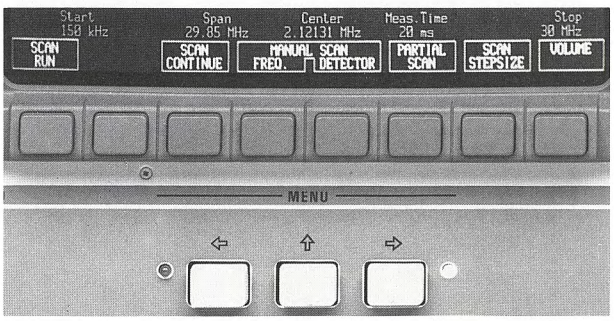
Hardkeys and softkeys The hardkeys being monofunction keys are assigned fixed functions for calling menus (eg markers), selecting parameters (frequency) or entering values. The softkeys are assigned varying function depending on the menu selected. A single spinwheel, a clearly arranged front panel – **each key being assigned a single function only** – and softkeys along the bottom edge of the screen whose function depends on the menu selected make for the operating convenience of the ESAI. Parameters are entered via the numeric keypad. The parameters can be varied quickly and precisely using the step keys for coarse adjustment and the spinwheel with magnetic latching for fine adjustment.

Setting parameters can be coupled for signal analysis, so that only one value need to be changed and all others – like the ratio between resolution bandwidth and video bandwith – are adapted automatically.

The **LED panel** clearly indicates the current status of **four trace memories.** The five operating modes of the four trace memories can all be seen at a glance. This is very useful when operating with different evaluation criteria.

The **9″ colour monitor** with display of all function and parameters important for the measurement provides the user with a clear overview even in the case of highly complex applications, in particular when **several traces are displayed simultaneously.** An external keyboard allows entry and readout of additional information.

The **screen menus** lead directly to the result. There are no complicated tree structures with the ESAI. If more than eight functions are offered, the menu is extended horizontally to the left or right. The status display in the help menu provides a current overview of the active settings in form of a list; both the list and the complete display can be output as a hardcopy.



Screen menus

Computer function

The **optional Computer Function FS-Z4** enables test routines to be automatically executed without the use of an external process controller. It consists of the following hardware and software components:

- Keyboard PCA-Z1
- External Floppy Disk Station PZ-11; can be optionally fitted with $3^1/_2$″ or $5^1/_4$″ drives
- Software FS-K1 with MS-DOS, R&S Basic and manual

The individual parts can also be ordered separately. Together with the CPU fitted as standard the ESAI can thus be upgraded to a process controller with IEC-bus interface

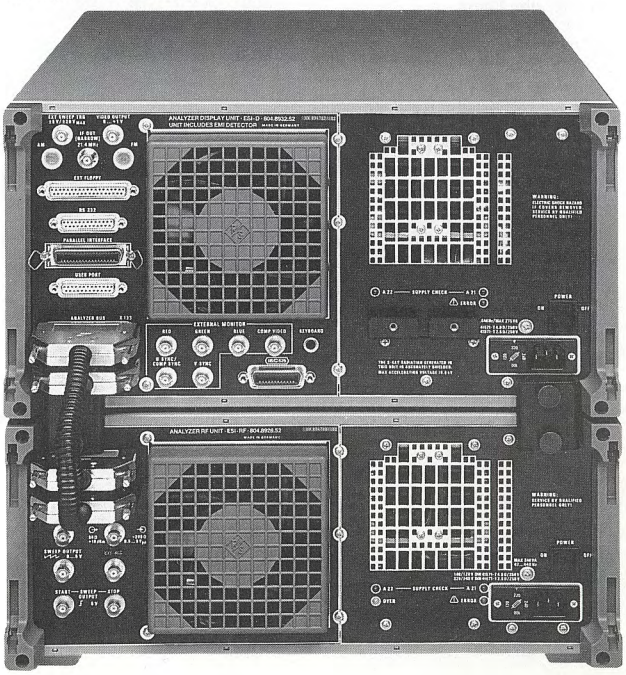
For **complex automatic measurements,** a powerful process controller, eg from the **Rohde & Schwarz PSA family,** can be connected via the IEC-bus interface. This opens the door to professional software to **industry standard** which satisfies the highest requirements.

Design

EMI Test Receiver ESAI is built in design 90 and made up of the

- **RF unit** (4 height units of 19″ system) and the
- **display unit** (5 height units).

Rear-panel connectors of ESAI



ESAI

Specifications

Frequency

Frequency range

DC coupling	20 Hz to 1.8 GHz (2 GHz)
Frequency offset	can be entered up to ±500 GHz
Frequency resolution	1 Hz
Step keys	span/10
Spinwheel	span/900
Frequency display	selectable: LIN/LOG
Frequency reference (aging)	$<1 \times 10^{-7}$/year

Frequency display

Evaluation aids	markers and cursor lines
Resolution	span/900
Error	
Span >5 MHz	$<8 \times 10^{-3} \times$ span
	$<5 \times 10^{-3} \times$ span (sweep time ≥100 ms)
Span 10 Hz to 5 MHz	$<2.5 \times 10^{-3} \times$ span ± RBW ± frequency × reference accuracy

Frequency span

Setting range	0 Hz/10 Hz to 2 GHz
Error	
Span ≤5 MHz	$\pm 2 \times 10^{-3} \times$ span
Span >5 MHz	$\pm 5 \times 10^{-3} \times$ span

Spectral purity

Phase noise

At f ≤100 MHz	phase noise in dBc (1 Hz)		
Frequency span	≤100 kHz	>100 kHz to 5 MHz	>5 MHz
Frequency offset			
>100 Hz	≤−100	–	–
> 1 kHz	≤−110	–	–
> 10 kHz	≤−115	≤−112	–
> 30 kHz	≤−118	≤−115	–
>100 kHz	≤−118	≤−120	≤−120
>300 kHz	≤−118	≤−125	≤−125

At f >100 MHz	
Frequency offset <1 kHz	phase noise linearly increasing with f up to ≤+10 dB at 1.8 GHz
>1 kHz	phase noise linearly increasing with f up ≤+6 dB at 1.8 GHz

Residual FM

Span >5 MHz	<10 kHz PP/2 in 0.1 s (test bandwidth 10 kHz)
Span ≤5 MHz	<1 Hz PP/2 in 10 s (RBW = 10 Hz; VBW = 10 Hz; VBW = video bandwidth)

Filters

Resolution filters

Type of filter	5 decoupled crystal filters
Bandwidths (−3 dB)	<10 Hz (typ. 6 Hz) to 3 MHz

Spurious responses

Internal (without input signal)	
Input terminated with 50 Ω	
RF attenuation 0 dB	<−110 dBm
Oscillator feedthrough	
at f = 0 Hz	≤−22 dBm (T = 15 to 35 °C) ≤−15 dBm (T = 0 to 15 °C, 35 to 55 °C)
Second-order harmonic distortion	
Mixer level ≤−30 dBm, RF attenuation ≥10 dB	
f <20 MHz	<−65 dBc → HSOI ≥+35 dBm HSOI = harmonic second order intercept point
f ≥20 MHz	<−80 dBc → HSOI ≥+50 dBm
Third-order intermodulation distortion (Δf >100 kHz)	
Mixer level ≤−30 dBm, RF attenuation ≥10 dB	
f <20 MHz	<−75 dBc → TOI >+7 dBm, TOI = third order intercept point
f ≥20 MHz	<−80 dBc → TOI >+10 dBm; corresp. to an intermodulation suppression of 100 dBc at a mixer level of −40 dBm
Other	
Mixer level ≤−40 dBm, RF attenuation ≥10 dB	
f <20 MHz	<−70 dBc
f ≥20 MHz	<−75 dBc

Immunity to interference (preselection ON)

Image frequency rejection	referred to reference level
f +(2 × 2221.4 MHz)	>90 dB, typ. 100 dB
f −42.8 MHz	>100 dB, typ. 115 dB
f +8.388 MHz	>100 dB, typ. 115 dB
IF rejection	referred to reference level
2221.4 MHz	>75 dB, typ. 90 dB
21.4 MHz	>100 dB, typ. 110 dB
4.194 MHz	>100 dB, typ. 110 dB

Demodulation

Receiver mode	demodulation of received RF signal
Display of demodulated signal	vertically on a 10-line graticule as a function of horizontal timebase
Marker functions for measuring	modulation depth in %, frequency deviation, centre frequency offset
Resolution	
AM	0.1 %
FM	frequency deviation range/4096
Time	sweep time/900
FM demodulator	values applicable to signal levels 0 to −30 dB below reference level; VBW = 10 kHz; S/N ratio >60 dB
AM demodulator	values applicable to signal levels −6 to −35 dB below reference level

Scalar network analysis

Frequency range (DC coupling, normalization)	100 Hz to 2 GHz
Span range (continuously adjustable)	10 Hz to 2 GHz
Gain measurement range	130 dB
Attenuation range (f >1 MHz, RBW = 1 kHz)	>120 dB
Inherent frequency response (500 Hz to 1.8 GHz, start frequency >5 × RBW in default coupled mode)	
Without normalization	<1.1 dB, typ. <0.8 dB
With normalization, without noise influence	display range/360
Output level	adjustable from −100 to −5 dBm (elecronically in 0.1-dB steps, mechanically in 1-dB steps)
Level accuracy	≤±0.5 dBm (level of tracking generator −20 dBm at bei 100 MHz)

Sweep

Sweep time

Span >0 Hz	
Setting ranges	Step size
20 ms to 2 s	20 ms
2 to 20 s	200 ms
20 to 1980 s	2 s
Error	$<\pm 10^{-3}$
Span = 0 Hz	
Setting ranges	Step size
200 µs to 10 ms	1/2/4/8/10
20 ms to 1980 s	see span >0 Hz
Error	
200 µs to 10 ms	±2 %
20 ms to 1980 s	$<\pm 10^{-3}$
Sampling rate	1/8.9 µs

Trigger

Operating modes	free run, line, video, external
Voltage range	±5 V with external trigger
Trigger treshold resolution	64 steps

Inputs and outputs

Front panel, RF unit

RF input 1	BNC connector, 50 Ω
Frequency range	20 Hz to 200 MHz, 9 kHz to 200 MHz
Maximum input level	
DC, RF attenuation 0 dB	0 V
AC, RF attenuation >10 dB	+7 V DC/+30 dBm/137 dBµV
Pulse signals	
RF attenuation 0 dB	+36 dBm/<0.2 s
RF attenuation >10 dB	<1 mWs
VSWR	
RF attenuation 0 dB	<2
RF attenuation >10 dB	<1.2
RF input 2	N connector, 50 Ω
Frequency range	20 Hz to 1.8 GHz

Maximum input level
- DC, RF attenuation 0 dB ..... 0 V
- AC, RF attenuation > 10 dB .... +7 V DC/+30 dBm/137 dBµV

Pulse signals
- RF attenuation 0 dB ..... +10 dBm/ < 0.2 s
- RF attenuation > 10 dB ..... < 1 mW s

VSWR	f < 1 GHz	1 GHz < f < 1.8 GHz
RF attenuation 0 dB	< 2	< 3
RF attenuation > 10 dB	< 1.2	< 1.5

Protection ..... fuse + surge arrester

Amplitude accuracy*)
- Frequency response 20 Hz to 1.8 GHz (RF filter on) ..... < 2.0 dB (RF attenuation < 10 dB, S/N ratio > 15 dB)
  < 1.5 dB (RF attenuation > 10 dB, S/N ratio > 15 dB)

RF attenuator
- Range ..... 0 to 120 dB
- Step size ..... 2 dB

Overload detection ..... detector for RF, 1st IF, 2nd IF

RF preamplifier ..... gain 0 dB/10 dB/20 dB

RF preselector ..... 14 selectable filters with automatic switching

Filters 10 to 13 can be tuned, all others are fixed

Filter	$f_{cutoff(lower)}$	$f_{cutoff(upper)}$	Type
1	DC	9 kHz	LP
2	9 kHz	150 kHz	BP
3	150 kHz	2 MHz	BP
4	2 MHz	10 MHz	BP
5	10 MHz	30 MHz	BP
6	30 MHz	50 MHz	BP
7	50 MHz	80 MHz	BP
8	80 MHz	110 MHz	BP
9	110 MHz	140 MHz	BP
10	140 MHz	260 MHz	BP
11	260 MHz	450 MHz	BP
12	450 MHz	700 MHz	BP
13	700 MHz	1000 MHz	BP
14	1000 MHz	2000 MHz	BP

TRACKING GEN
- Connector type ..... N female
- Impedance ..... 50 Ω
- VSWR at < −15 dBm output .... < 1.5

CAL OUTPUT ..... BNC female; 100 MHz, −20 dBm ±0.2 dB; pulsed signals: pulse repetition frequency 1 Hz to 10 kHz
- Impedance ..... 50 Ω
- VSWR ..... < 1.1

PROBE/CODE (supply and coding connector, eg for active or passive probes and antennas) ..... 12-contact Tuchel female
- Supply voltage ..... +10 V, max. 100 mA
  −10 V, max. 100 mA

Front panel, display unit

PHONES ..... JK 34 jack
- Frequency range (−3 dB) ..... 100 Hz to 15 kHz
- EMF ..... 10 V_{pp}
- Source impedance ..... 30 Ω

KEYBOARD ..... JK 34 jack (for PCA-Z1)

Rear panel, RF unit

IF-OUTPUT 21.4 MHz ..... BNC female
- Impedance ..... 50 Ω
- VSWR ..... ≤ 2
- Gain referred to level at input mixer
- Ref. level − RF attenuation
  - ≤ −20 dBm ..... +10 dB ±2 dB
  - > −20 dBm ..... 0 dB ±2 dB
- Bandwidth (−6 dB) ..... > 10 MHz

10-MHz REFERENCE ..... BNC female
- Output level with internal reference (Z_s = 50 Ω) ..... +10 dBm +3/−1 dB
- Input level with external reference (Z_{in} = 500 Ω) ..... 0.1 to 1 V_{rms}

EXT ALC ..... BNC female
- Input voltage ..... 0 to −1 V

SWEEP OUTPUT ..... BNC female
- Output voltage (Z_L > 500 Ω) .... 0 to +5 V

START-SWEEP-STOP ..... BNC female; positive TTL pulse (t ≈ 1.4 µs) occurring upon sweep start or stop

Rear panel, display unit

IF-OUTPUT (narrow) 21.4 MHz .... BNC female
- Impedance ..... 50 Ω
- VSWR ..... < 2
- Level with reference level up to −90 dBm ..... −15 dBm ±3 dB

EXT SWEEP TRIG ..... BNC female

VIDEO-OUTPUT ..... BNC female

EXTERNAL MONITOR
- Outputs ..... BNC female for RED, GREEN, BLUE, COMP VIDEO, V SYNC, H SYNC
- Line frequency ..... 29.4 kHz ±2%
- Sync pulses ..... 2 µs

EXT FLOPPY ..... 37-contact Cannon D female (for PZ-11)

RS-232-C ..... 25-contact Cannon D female

PARALLEL INTERFACE (Centronics) ..... 36-contact Amphenol female

USER-PORT ..... 25-contact Cannon D female

PHONES ..... JK 34 jack
- Frequency range (−3 dB) ..... 100 Hz to 15 kHz
- EMF ..... 10 V_{pp}
- Source impedance ..... 30 Ω

IEC-625 bus (IEEE 488) ..... 24-contact Amphenol female
- Interface functions ..... AH1, SH1, T6, L4, SR1, RL1, PP1, DC1, DT1, C1 to C4, C11

VDU

Monitor ..... 9″ in-line colour CRT/ 1024 × 512 pixels

Number of display memories 4

Output to plotter/printer ..... R&S: Plotter DOP, HP-GL, HP-Laser Jet

Functions ..... curve arithmetic (swap, subtract), comparison with tolerance curves, averaging, peak hold

General data

Note ..... unless otherwise specified, all values applicable to continuous sweep with coupled functions in default coupling and calibrated; based on IEC 714

Ambient conditions ..... according to IEC 359, class I

Rated temperature range ..... 0 to +55 °C

Storage temperature range ..... −40 to +70 °C

Max. relative humidity ..... 20 to 90% (without condensation)

EMC ..... VDE 0871, limit class B; postal regulation 526/527.79; CISPR publication 11, 22; FCC DOC 20780: Part 15, Subpart 5

Warmup period (0 to +55 °C), time required for attaining operating temperature after cold start ..... 1 h

Power supply ..... 100/120/220/240 V ±10%, 47 to 440 Hz (500 VA), safety class I to VDE 0411 and IEC 348

Dimensions (W × H × D) ..... 435 mm × 413 mm × 590 mm

Weight ..... 64 kg

Ordering information

Order designation ..... ▶ EMI Test Receiver ESAI 804.8910.52

Recommended extras

Service Kit	FS-Z1	811.0010.02
Connection Cable Set (for servicing, 1 m)	FS-Z2	811.0304.02
Filter Element	FS-Z3	805.7900.02
Software for Computer Function	FS-K1	811.0610.02
Computer Funktion (FS-K1 + PCA-Z1 + PZ-11)	FS-Z4	811.0810.02

EMI accessories

Probes/antennas/ artificial mains network 9 kHz to 30 MHz ..... see catalog, page 276

Probes/antennas 30 MHz to 1 GHz ..... see catalog, page 280

*) Temperature range 15 to 35 °C, SCAN mode. In the temperature range 0 to 15 °C/35 to 55 °C the specified value can increase by 1 dB.

EZ-10 4-wire T-Network for balanced inputs/outputs EZ-10 ♦ 9 kHz to 150 MHz

- High decoupling rejection and high unbalance rejection in the whole frequency range
- Large bandwidth for handling balanced signals (up to 10 MHz)

Characteristics, uses

The **4-wire T-Network EZ-10** is used for EMC measurements on devices and systems with two symmetrical twin-pair lines with and without phantom-powering facilities, eg ISDN communications equipment with S0-bus interface. The current-compensated decoupling choke required for phantom-powered circuits is built in with the EZ-10. For asymmetrical voltages model 02 covers the frequency range from 9 kHz to 150 MHz, and model 03 the range from 150 kHz to 150 MHz. Model 03 is also suitable for EMC measurements on high-impedance interfaces (eg x- and y-interfaces in ISDN networks). The EZ-10 also meets FTZ regulation 12TR1 and replaces the T1 and T2 networks (2 of each) including the additional decoupling choke for phantom-power circuits specified in this regulation.

T-networks are used as artificial mains networks for two purposes. One is to **measure the asymmetrical RFI voltage** in the range from 9 kHz to 150 MHz from devices with symmetrically driven communication, data, audio-frequency and control lines; the other is as coupling unit to **measure the immunity** of such devices to conducted asymmetrical RFI voltage.

The T-network represents a load impedance of 150 Ω in an asymmetrical circuit, and couples the asymmetrical interference voltage with an attenuation of 10 dB to the test receiver, or in the case of immunity tests to the device under test. High unbalance rejection reduces the crosstalk of symmetrical (wanted) voltages into the asymmetrical circuit. The high isolation provides effective suppression of interference from the balanced line. The low capacitance of the T-networks in the symmetrical circuit results in a wide passband for wanted signals. When measuring the immunity of a device under test to conducted EMI, the **high RF power-handling capability of R&S T-networks** is a great advantage.

Specifications

Frequency range of asymmetrical RFI voltage	
Model 02	9 kHz to 150 MHz
Model 03	150 kHz to 150 MHz
Load impedance for asymmetrical RFI voltage	150 Ω ±20 %
Voltage attenuation in measurement circuit	
Model 02	9 kHz to 100 MHz: 10 ±1 dB 100 to 150 MHz: <13 dB
Model 03	150 kHz to 100 MHz: 10 ±1 dB 100 to 150 MHz: <13 dB
Passband (BW_{6dB} for $Z_{balanced}$ = 100 Ω)	>10 MHz
Unbalance rejection	
at 10 kHz (model 02)	>80 dB
at 150 kHz (model 03)	>68 dB
at 1 MHz	>53 dB
at 10 MHz	>40 dB
at 150 MHz	>25 dB
Isolation	
at 10 kHz (model 02)	>20 (typ. 25) dB
at 150 kHz (model 03)	>37 dB
at 1 MHz	>45 dB
at 20 MHz	>60 dB
at 150 MHz	>60 dB
Maximum input voltage (rms) at input for asymmetrical voltages	17 V
Maximum DC/low-frequency voltage between line and ground	200 V
Maximum phantom current	150 mA (current to and from on single or different line pairs)
Input/output connectors for	
signal generator/test receiver	BNC female
DUT and AC line	4-mm telephone jacks

General data

Rated temperature range	−10 to +55 °C
Storage temperature range	−25 to +70 °C
Dimensions (W × H × D)	196 mm × 115 mm × 41 mm
Weight	1 kg

Ordering information

Order designation	▶ 4-wire T-Network EZ-10
Model 02 (9 kHz to 150 MHz)	816.1244.02
Model 03 (150 kHz to 150 MHz)	816.1244.03

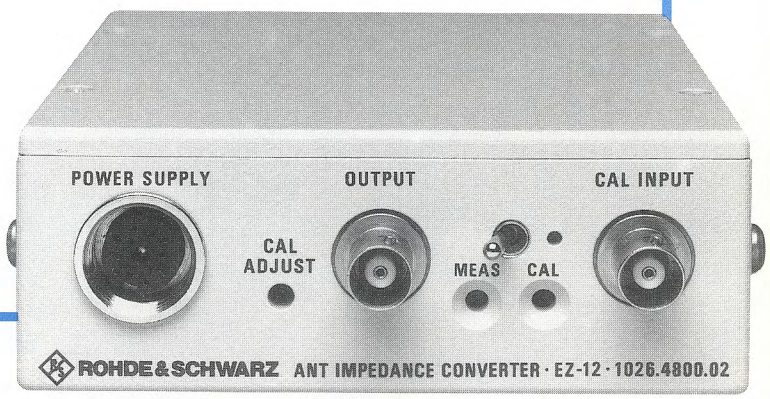
Accessories supplied

Coding plug for automatic display correction of R&S test receivers	800.1833.00

Antenna Impedance Converter EZ-12
♦ 9 kHz to 30 MHz

EZ-12

- Flat frequency response
- High sensitivity
- High overload capability
- Calibration input



Characteristics, uses

The **Antenna Impedance Converter EZ-12** is a wideband matching unit for test receivers and spectrum analyzers that have low-impedance inputs. It is used for **high-impedance measurements of interference voltage** in the long-, medium- and short-wave bands at the output of a vehicle-mounted antenna. Its flat frequency response plus high sensitivity and overload capability guarantee reliable results.

For an unimpaired signal reception, in a car for example, the interference coming from the various sources in the vehicle must not exceed specified values at the output of the antenna cable. Measures taken at the vehicle to ensure this are referred to as RFI suppression with respect to on-board receivers. The measurement of interference voltages at the antenna is called a complete vehicle test in contrast to direct measurements of emissions from the vehicle components. Limits for interference levels at the vehicle antenna output are specified in DIN/VDE draft 0879 part 2, and in a draft from CISPR Subcommittee D (CISPR/D/WG2-Secretariat 25).

Description

With a gain of 0 dB and an input impedance of 350 kΩ || 10 pF (at 1 MHz), the EZ-12 permits the measurement of the open-circuit voltage at the output of a vehicle antenna using a test receiver or spectrum analyzer. The antenna cable is connected to the input socket of the EZ-12, and the output socket (BNC female) is connected to the test receiver or spectrum analyzer. The EZ-12 can be powered from R&S test receivers or R&S spectrum analyzers. When the EZ-12 is used together with other test receivers and spectrum analyzers, it is fed from the Power Supply HZ-9.

The EZ-12 has a calibration input with a circuit that simulates a vehicle antenna to DIN IEC 315, part 1. This input in conjunction with a tracking generator is used to check that the EZ-12 is operational and to measure the frequency response.

The Impedance Converter is built into a rugged metal case with threaded holes on each side. This makes it easy to fit the EZ-12 in a dummy radio and to wire an electrical connection to the chassis of the vehicle.

Specifications

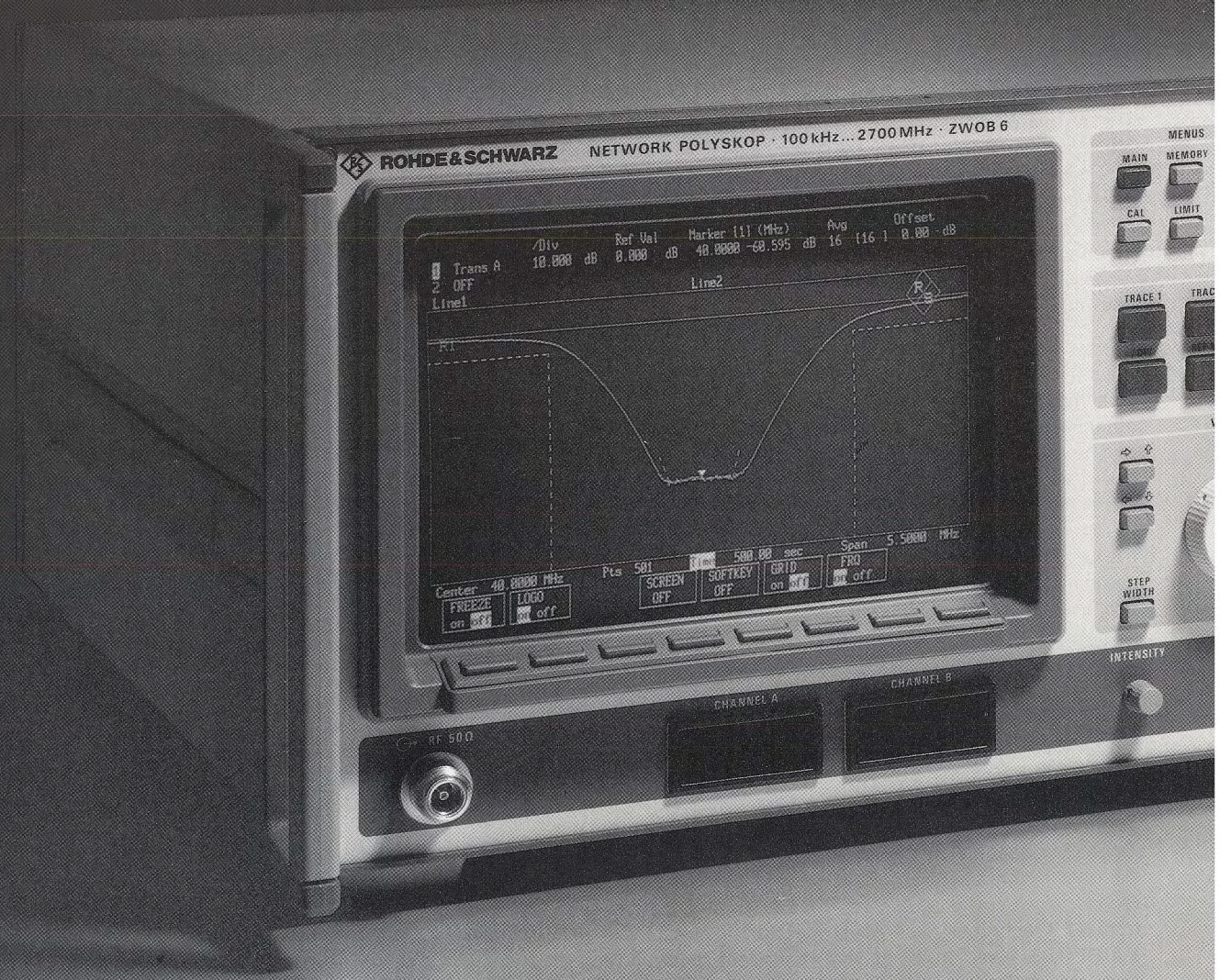
Frequency range	9 kHz to 30 MHz
RF input	connector meeting DIN 41 585, part 1 draft 11.89 and ISO/DIS 10599/part 1
Input impedance	approx. 350 kΩ || 10 pF (at 1 MHz)
Gain factor	
for direct input to antenna socket	0 ±1 dB
for input via antenna simulator (CAL input)	−14 ±1 dB
RF output	BNC female, 50 Ω
VSWR	< 2
Noise voltage at output (input terminated with antenna simulator)	typ. −10 dBµV (average detector, B = 10 kHz, f > 100 kHz)
1-dB compression point	> 107 dBµV
Calibration input	BNC female, 50 Ω
General data	
Rated temperature range	−10 to +55 °C
Storage temperature range	−25 to +70 °C
Mechanical stress	
Shock	meets DIN 40046, part 7 (30 g, 11 ms)
Vibration	meets DIN 40046, part 8 (5 to 55 Hz, 2 g); corresponds to IEC 68-2-27 and 68-2-6
Power supply	12-contact Tuchel-type female connector
Supply voltages	+10 V ±0.1 V/−10 V ±0.1 V
Current drain	50 mA (max.) each
Dimensions (W × H × D)	125 mm × 110 mm × 40 mm
Weight	0.6 kg

Ordering information

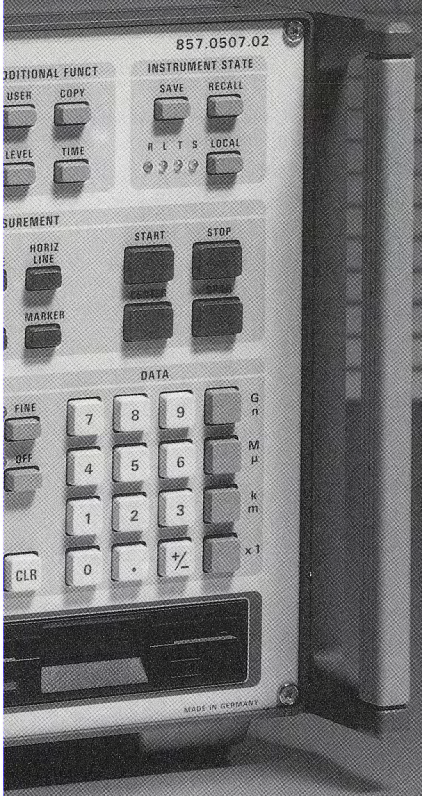
Order designation	▶ Antenna Impedance Converter EZ-12 1026.4800.02	
Accessories supplied	power cable (3 m) 837.3475.00, manual	
Recommended extras		
Power Supply for active antennas (only required when EZ-12 not supplied from receiver)	HZ-9	816.1045.02

			Page
Network Polyskop	ZWOB 2	100 kHz to 1.6 GHz	106
	ZWOB 4	100 kHz to 2.7 GHz	
	ZWOB 6	100 kHz to 2.7 GHz	
SWR Bridge	ZRMD	10 MHz to 18 GHz	112
Computer Function	ZAM-Z3		113

Network Polyskop ZWOB 6
– Scalar transmission and reflection measurements, even on frequency-converting devices under test



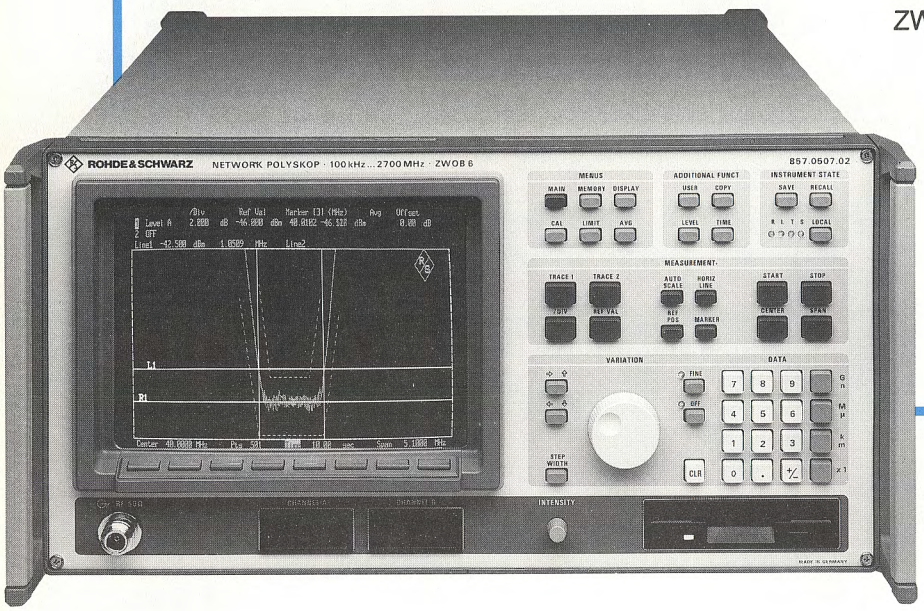
7
network analyzers



ZWOB

Network Polyskop ZWOB 2 ♦ 100 kHz to 1.6 GHz
ZWOB 4 ♦ 100 kHz to 2.7 GHz
ZWOB 6 ♦ 100 kHz to 2.7 GHz

- High frequency and level measuring accuracy
- Fast go/nogo test
- IF markers
- Floppy disk drive (option, ZWOB 6 standard)
- Computer function (option)
- Group-delay measurement (option)

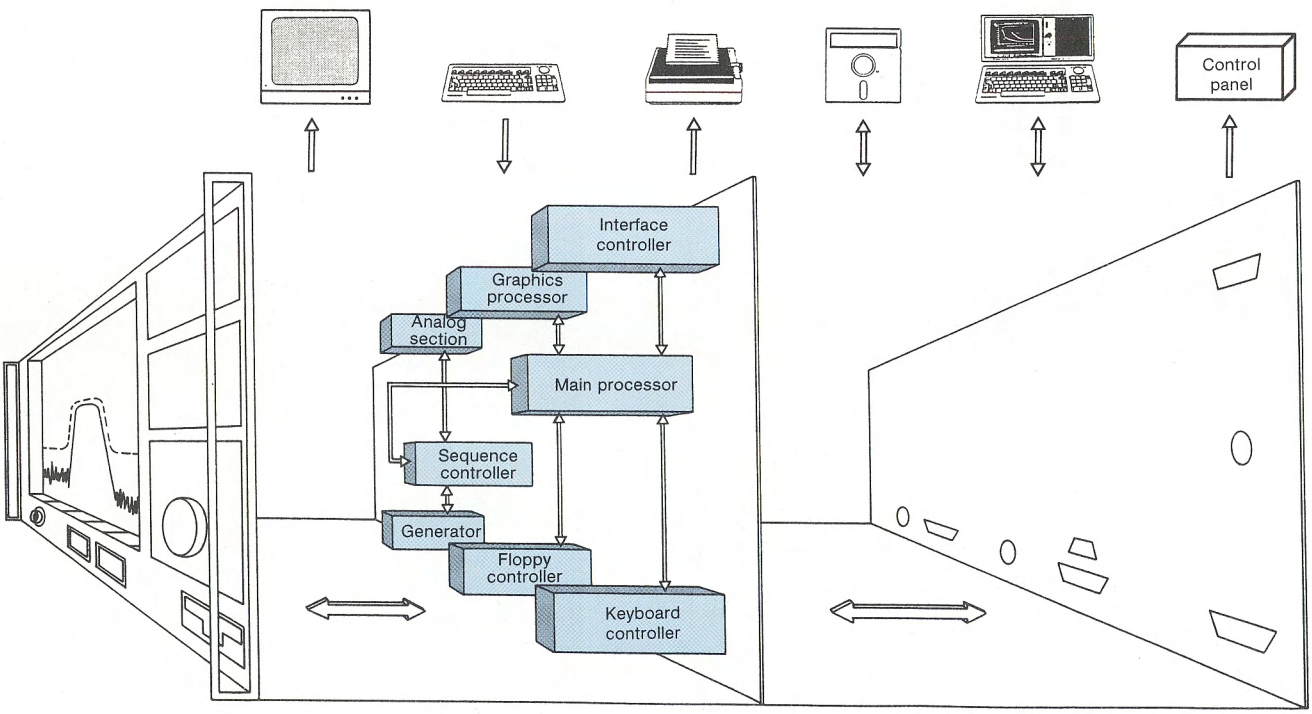


IEC 625 Bus

Network Polyskop ZWOB (models 2, 4 and 6) is a scalar network analyzer with **extraordinary capabilities.** There is hardly a problem associated with **production, quality control and service** checks on one or two ports that cannot be solved with the ZWOB. As important features, it offers **high operating convenience** and simplified measuring concepts all combined in a compact unit.

The ZWOB combines a variety of electronic measuring and control instruments in one **compact unit** thanks to its **precision measuring capability,** fast data processing and evaluation, programmable test routines, numerous control and evaluation features and controller facilities. All this makes the Network Polyskop **indispensable** for setting up test and control systems, above all for the production and testing of advanced components in communications technology.

Basic design and external equipment that can be connected



The Network Polyskop features up-to-date technology:

- for signal generation – a generator with counter correction and filter unit (optional harmonics filter for ZWOB 2/4)
- for signal detection – calibrated and temperature-controlled measuring heads
- for signal evaluation – **precision amplifiers** and a 14-bit A/D converter
- for processing and representation of the signals – two 16-bit processors supported by a **numeric coprocessor** for **increased speed**

Characteristics

ZWOB 6 features the following state-of-the-art **characteristics:**

The wide **frequency range** covering 0.1 to 2700 MHz and the high measuring accuracy allow for a wide range of applications in development, production, quality control and service.

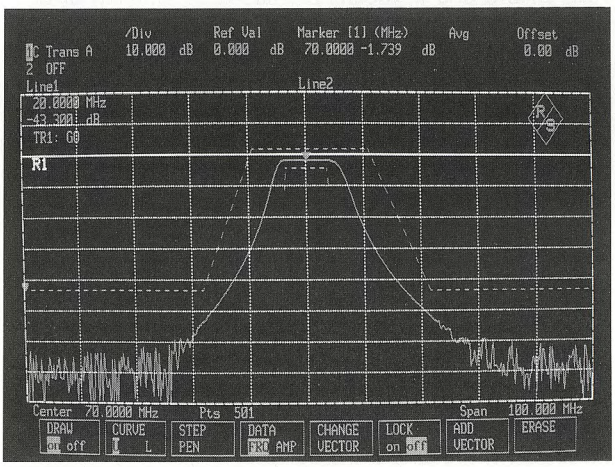
The high **harmonic suppression** of typically 70 dB reduces measurement errors in wideband sweeping to a negligible degree. In particular, the measurement accuracy is considerably improved when testing filters with high stopband attenuation.

The low **spurious FM** in the narrowband mode of typically < 100 Hz in the lower frequency range guarantees a sharp display even of very steep filter edges.

The **accuracy** required, for instance, for adjusting cable repeaters is ensured by precise amplitude measurement of the Polyskop. Adjustment procedures are no longer a chore thanks to the high **measuring speed** of the ZWOB.

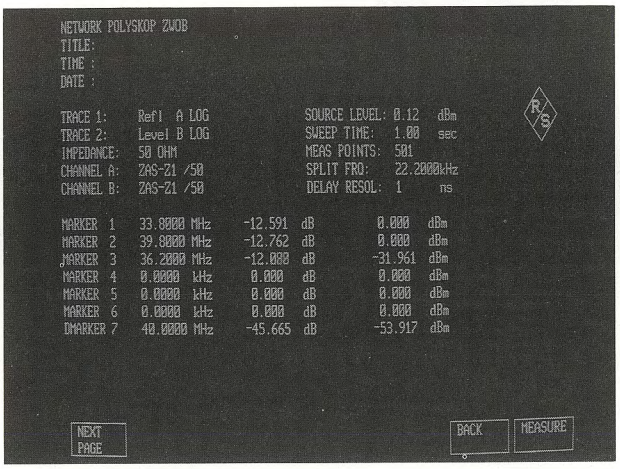
Efficient handling of the test run is ensured by a variety of **evaluation functions and operating aids:** The **autoscale function** presents the user with an optionally scaled display at all times.

Easy-to-enter **tolerance curves** and automatic measurement evaluation accelerate adjustment procedures and **go/nogo tests,** which is of particular importance in production and quality control.



User-definable tolerance curves are displayed together with the transmission characteristic measured

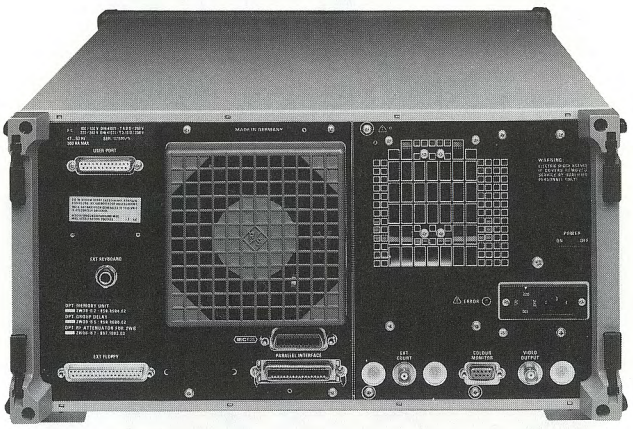
IF markers, ie markers referred to the output frequency, can be generated to facilitate measurements on converters or tuners.



Display in form of a list

Plain text At the push of a button, Polyskop ZWOB displays the selected parameters and IF markers in the form of a software-produced list on the screen. The screen content can of course also be easily output on printer, videoprinter or plotter.

With a **variety of external equipment** that can be connected (see diagram on page opposite), the ZWOB forms the core of an advanced test system. The programmable **user port,** for instance, allows remote control of external switching functions such as the setting of RF switches on the device under test.



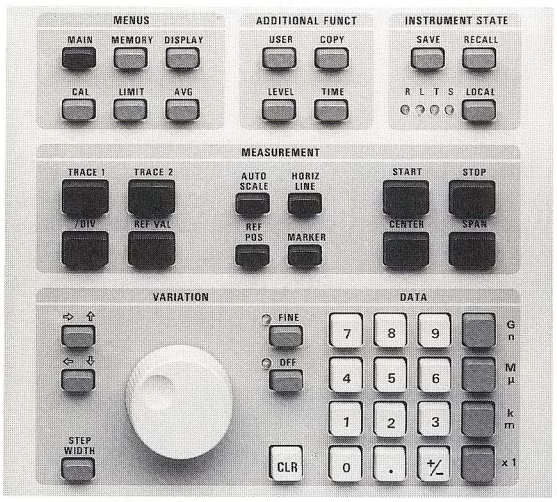
Rear view

Modern measuring instruments feature system compatibility and ease of configuration to meet user-specific requirements. The wide variety of additional units that can be connected to Network Polyskop ZWOB demonstrates how the product philosophy of Rohde & Schwarz has paid off in the development of powerful and sophisticated measuring systems.

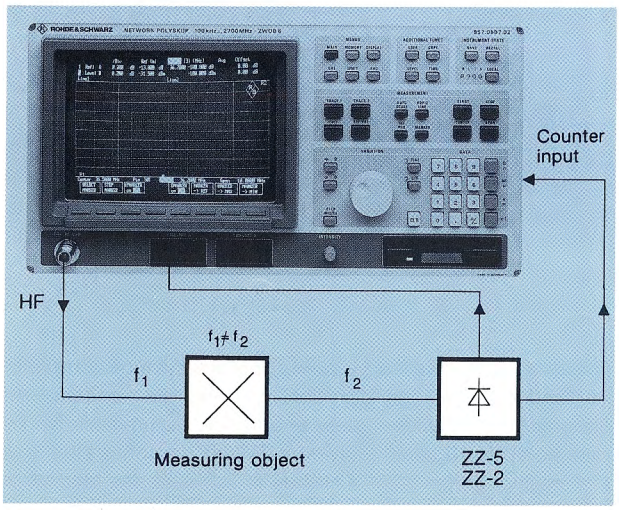
ZWOB

ZWOB 6 as the core of a modern sweep test assembly

The **ergonomic layout of the front-panel controls** and the 9″ screen enable unstrained working even for long periods of time. Frequently used functions can be selected from a keypad which is marked in different colours for ease of distinction.

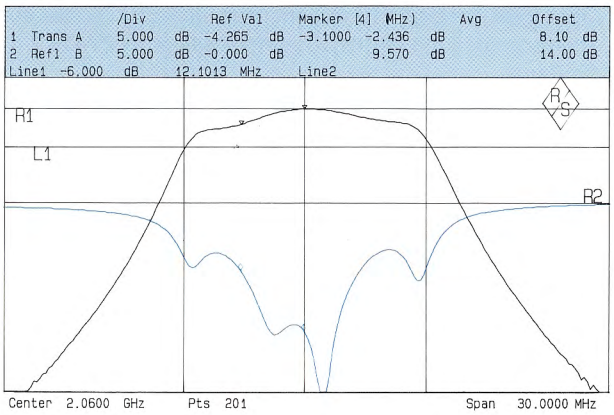


User-friendly keypad



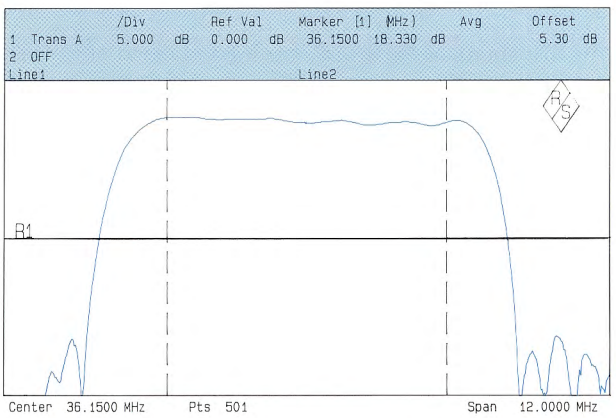
Test setup for measuring the transmission characteristics of a channel converter

Applications



Simultaneous display of transmission and return loss of a bandpass filter

The highly **flexible evaluation functions** of the ZWOB allow time-saving adjustment procedures. In the case of a bandpass filter, for instance, transmission and return loss can be adjusted in one step (see above). Characteristic features such as the 6-dB points on the transmission curve are labelled by **markers**.



Transmission curve of a channel converter: IF (center frequency 36.15 MHz, span 12 MHz) on channel 7 (vision carrier 189.25 MHz, sound carrier 194.75 MHz). Dashed vertical lines in diagram are IF markers.

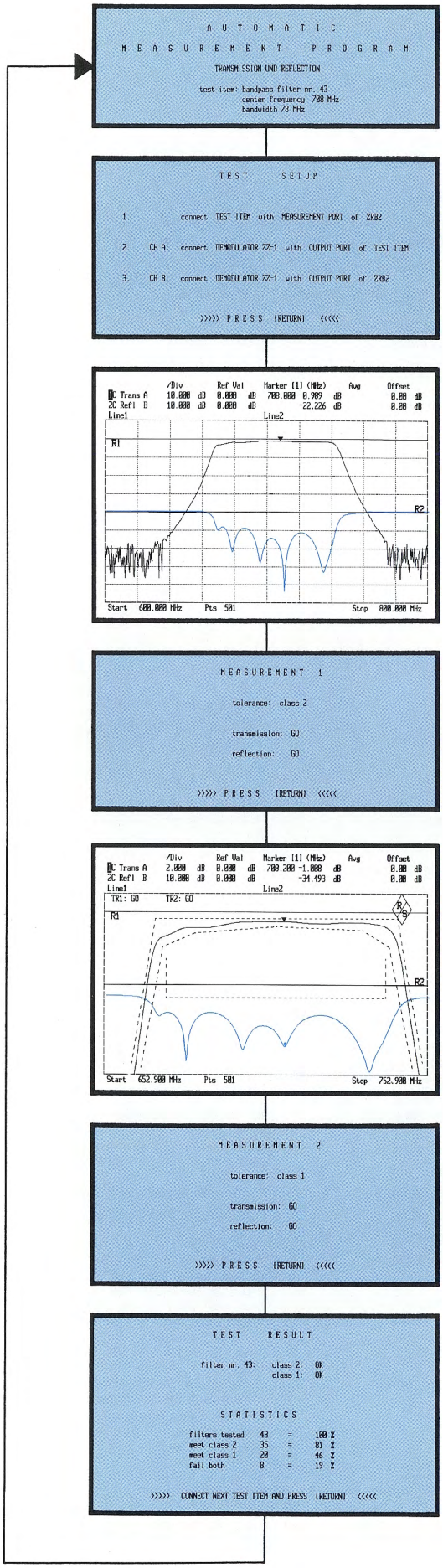
Options

The optional **Computer Function** consisting of MS-DOS, R&S BASIC and keyboard permits programming of complete test runs and their execution in a dialog with the user. This is ideal for use in test and production departments as well as for quality control and incoming inspection. Apart from **saving time** and preventing operating errors, the operator is guided through test programs by **screen prompts**, so that he need not familiarize himself with equipment in any detail.

Thanks to the **memory facilities** provided as standard, complete setups, measurement results and test programs can easily be stored and recalled.

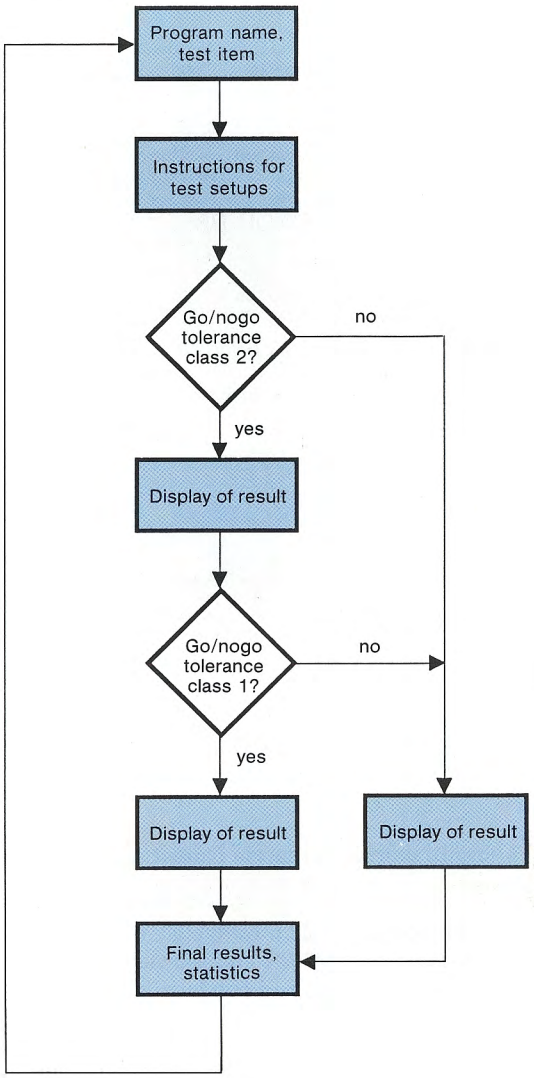
Setups and measurements:
- 10 complete setups in battery-backed CMOS-RAM
- more than 200 per 3½″ floppy disk (HD, 1.44 Mbyte)

Measurement results and programs:
- as many as required using the built-in or an external floppy disk station



◀ Display sequence of a dialog-controlled two-part measurement on a bandpass filter

▼ Flowchart for sequence on left



Group Delay Option ZWOB-B5 Numerous electronic components in communications technology require **delay differences** between various frequencies in the transmission bandwidth **to be measured** in addition to amplitude response and reflection characteristic. This is particularly important in **TV technology** where a very wide signal spectrum is transmitted and the resulting delay differences cause picture distortions.

The Group Delay Option fitted in the Network Polyskop ZWOB allows delay differences to be measured and easily evaluated. The test method, which uses amplitude modulation for determining time differences between zero crossings of demodulated signals before and after the DUT, has the great advantage that measurements can also be carried out on frequency converting modules. Even if the DUT comprises a demodulator, the delay can be measured with the AF Measuring Head ZZ-6 (model 05) so that **complete TV receiver modules** through to the video output can be tested.

ZWOB

Configuration	3½" Disk Drive	Computer Function	Harmonics Filter	Group Delay Option	Attenuator Set 0 to 139 dB
Model	ZWOB-B2	ZWOB-Z3	ZWOB-B4	ZWOB-B5	ZWOB-B7
ZWOB 2	option	option	option	option	option
ZWOB 4	option	option	option	option	option
ZWOB 6	standard	option	standard	option	standard

Specifications of Option ZWOB-B5:

Split frequency ..... 9.9 kHz
Modulation depth ..... 17 to 25 %
Measurement range ..... 0 to 50 µs
Resolution ..... 10 or 1 ns[1])
Input voltage range of demodulator (ZZ-1 or ZZ-5) .... 50 mV to 1 V

Measurement error
(carrier frequency range 1 to 2700 MHz, span ≤ 100 MHz)[2])
Error with constant level at the measuring head in the range 100 mV to 1 V ..... < ±3 ns[1])
Error for level changes at the measuring head in the range 1 V to 316 mV ..... < ±10 ns[1])
316 to 100 mV ..... < ±20 ns[1])
Noise (level > 50 mV) ..... typ. 4 ns peak
Temperature error (10 to 40 °C) ... < ±2 ns/ °C
Additional measurement error caused by generator phase modulation ..... 2 × slope [dB/MHz] in ns for f ≤ 1600 MHz, 4 × slope [dB/MHz] in ns for f > 1600 MHz

[1]) AVG factor 16.
[2]) With ZWOB 6 or models ZWOB 2 and 4 with harmonics filter option, a delay offset of up to 30 ns occurs with frequencies ≤ 400 MHz upon switchover between narrowband (span ≤ 5 MHz) and wideband (span > 5 MHz) operation.

Extras

A **large variety of extras** can tackle almost any measurement problem:

The **Passive Demodulator ZZ1** with built-in termination (50 Ω or 75 Ω), very good VSWR and a dynamic range of more than 76 dB provides full and continuous coverage of the frequency range from 100 kHz to 2.7 GHz.

For testing active DUTs such as cable repeaters, antenna amplifiers and tuners, the **Active Demodulator ZZ-2** is available for the frequency range from 5 MHz to 1.3 GHz. It is used, for instance, for measuring the input matching at low input voltage. Since the demodulator has its own RF output, it can also be used for displaying IF markers.

In addition to the Active Demodulator ZZ-2, the **Insertion Unit ZZ-5** is used for displaying IF markers for measurements on frequency-converting modules.

If the DUT has its own demodulator, the **AF Measuring Head ZZ-6** can be used.

Precision **SWR Bridges ZRB 2 and ZRMD**, available as 50-Ω and 75-Ω models with a directivity of up to 46 dB can be used for determining VSWR values (ZRB 2: catalog 90/91, page 352; ZRMD: page 112).

The output impedance of the ZWOB generator is 50 Ω. Applications in the 75-Ω range are enabled by the **Matching Pads RAM and RAZ** (see catalog 90/91, page 497).

Calibration Set ZCAN (50 or 75 Ω, see catalog 90/91, page 353) serves for checking and calibrating the test setup for VSWR measurements.

Specifications

Generator section

Frequency
Range
ZWOB 2 ..... 100 kHz to 1.6 GHz
ZWOB 4 and 6
Model 02 ..... 100 kHz to 2.7 GHz
Model 04 ..... 100 kHz to 2.3 GHz
Span
ZWOB 2 ..... 0 to 1599.9 MHz
ZWOB 4 and 6 ..... 0 to 2699.9 MHz
Resolution ..... 1 kHz

Error (23 ±5 °C)[1]) — ZWOB 6:

	span ≤ 5	> 5 MHz
f ≤ 2700 MHz (ZWOB 4 and 6) ..	0.003 × span + 50	50 kHz
	ZWOB 4: +50 kHz	
f ≤ 1595 MHz (ZWOB 2: f ≤ 1600 MHz)	0.003 × span + 25	25 kHz
	ZWOB 2 and 4: +25 kHz	
f ≤ 400 MHz	0.003 × span + 10	25 kHz
	ZWOB 2 and 4: +25 kHz	
f ≤ 95 MHz	0.003 × span + 5	25 kHz
	ZWOB 2 and 4: +25 kHz	

Temperature effect (0 to +50 °C) ..... additional error < 1 kHz per degree above or below 23 °C
Spurious FM[1]) ..... < 5 kHz
(meas. bandwidth 30 Hz to 3 kHz, CCIR weighting, quasi-peak) ..... < 3 kHz for f ≤ 1.6 GHz (ZWOB 6 only)
< 600 Hz for f ≤ 400 MHz and span ≤ 5 MHz (ZWOB 6 only)
< 150 Hz for f ≤ 100 MHz and span ≤ 5 MHz (ZWOB 6 only)
Harmonic suppression[1]) ..... > 60 dB (> 30 dB) for f > 300 MHz
(values in parentheses for ZWOB 2/4) ..... > 55 dB (> 30 dB) for f > 30 MHz
> 30 dB (> 30 dB) for f ≤ 30 MHz
Nonharmonic suppression ..... > 50 dB (> 500 kHz from carrier)

Level
Range ..... ZWOB 2 and 4: 2 to 16 dBm[2])
ZWOB 6: −110 to +10 dBm
Resolution ..... 1 dB
Deviation ..... < 1.0 dB for f = 100 MHz (< 0.5 dB at 23 ±5 °C)
Frequency response ..... ≤ ±1 dB, referred to 100 MHz (≤ ±3 dB for f < 0.5 MHz)

Output
Impedance ..... 50 Ω
Return loss ..... ≥ 15 dB (VSWR ≤ 1.4)
Connector ..... N female

Display section

Measurement accuracy ..... up to ±0.1 dB (calibrated)
Test parameters ..... transmission, reflection (VSWR), power, voltage
Test channels ..... A and B
Dynamik range and measuring error see Measuring Heads
Voltage slew rate ..... up to 5 V/ms

Screen
Screen size ..... 9" diagonal
Line frequency/refresh rate ..... 29.4 kHz ±2%/50 Hz ±2%
Resolution (X × Y) ..... 1024 × 512 pixels

Display
Display modes ..... for absolute or relative measurement either linear or logarithmic display can be selected. Additionally two tolerance curves per channel can be displayed.
Frequency markers ..... 6, user-adjustable; 3 RF and 3 IF markers in IF marker mode

Evaluation
Amplitude display ..... max. resolution 0.001 dB, display range from +100.00 to −100.00 dB
Frequency display ..... max. resolution 10 Hz
Horizontal lines ..... 1 line and 1 delta line per test trace for direct bandwidth measurement
Markers ..... 1 marker and 1 delta marker per test trace
Auxiliary functions ..... automatic positioning of marker to minimum or maximum, setting of reference value by directly taking over the value of the marker or the line amplitude

[1]) With built-in harmonics filter option, ZWOB 6 specifications also apply to ZWOB 2 and 4.
[2]) With built-in attenuator set option (without harmonics filter): −110 to +16 dBm; plus harmonics filter option: −110 to +10 dBm.

AUTO functions	maximum to center frequency, maximum transferred as reference value, minimum transferred as reference value, marker as reference value
Calibration memory	2 calibration traces with max. 501 points; each can be stored. When changing the frequency within the calibrated range, sample points can be interpolated
Reference memory	2 additional memories for 501 points each
Averaging (AVG)	digitally over 2 to 256 sweeps
Step width	continuously adjustable for frequency and amplitude

Compensation of spurious signals

(error ≤1 dB with test level 50 mV)	
with Demodulator ZZ-1 or Insertion Unit ZZ-5	50 mV
with Active Demodulator ZZ-2	5 mV

Sweep times and number of test points

for level, transmissions and reflection measurements

sweep time	test points
50 to 100 ms	51
101 to 200 ms	101
201 to 500 ms	201
>500 ms	501

for group-delay measurements ... sweep time × 1.7

Inputs and outputs

Front panel	
Generator output	N female
Demodulator connectors	two 12-contact female
Rear panel	
Centronics interface	36-contact female connector
IEC-bus interface (IEEE 488)	24-contact female connector
Bus functions	SH1, AH1, T6, L4, SR1, RL1, PP1, DC1, DT1, C1 to C3, E2
User port	D-connector, 25-contact, 16 progr. outputs (TTL), 1 input
External floppy disk	37-contact female connector
Frequency-counter input	BNC, input for IF marker generation
Frequency range	100 kHz to 400 MHz (optionally up to 1 GHz)
Input level required	in selectable range <100 MHz: 13 mV to 1 V; in selectable range >20 MHz: 23 mV to 1 V

Measuring heads

Demodulator ZZ-1

Frequency range	0.1 to 2700 MHz
Frequency response (1 to 2700 MHz)	≤±0.5 dB (referred to 100 MHz)
Dynamic range	≥76 dB
Max. measurement level	+13 dBm
Noise level	≤−63 dBm
Impedance	50 Ω/75 Ω
VSWR	≤1.1/≤1.15
Measurement error (at 100 MHz and 23 ±2 °C)	
1 V to 10 mV	≤±0.2 dB
10 to 1 mV	≤±0.5 dB
Temperature effect	≤±0.2 dB additionally
Max. input voltage (rms)	5 V (AC+DC)
Connector	N male

Active Demodulator ZZ-2

Frequency range	5 to 1300 MHz
Dynamic range	≥96 dB
Max. measurement level	+13 dBm
Noise level	≤−83 dBm
Impedance	50 Ω/75 Ω
VSWR	≤1.3
Measurement error (at 10 MHz and 23 ±2 °C)	
1 V to 10 mV	≤±0.5 dB
1 mV to 100 µV	≤±1 dB
Temperature effect	≤±0.5 dB additionally
Frequency response (referred to 500 MHz)	<2 dB
Max. input voltage (rms)	2.5 V (AC+DC)
Connector	N male

Insertion Unit ZZ-5

Frequency range	0.1 to 2700 MHz
Frequency response	≤±1 dB (referred to 100 MHz)
Dynamic range	≥69 dB
Max. measurement level	+13 dBm
Noise level	≤−56 dBm
Impedance	50 Ω
VSWR	
≤1000 MHz	≤1.2
≤2000 MHz	≤1.3
≤2500 MHz	≤1.4
>2500 MHz	≤1.6
Measurement error (at 100 MHz and 23 ±2 °C)	
1 V to 10 mV	≤±0.2 dB
10 V to 2 mV	≤±0.5 dB
Temperature effect	≤±0.2 dB additionally
Insertion loss	≤2 dB
≤1000 MHz	≤1 dB
Max. input voltage (rms)	5 V (AC+DC)
Connector	N, male and female

AF Measuring Head ZZ-6

for high-impedance measurements in combination with the Demodulator Probe SWOB3-Z; model 05 is designed for group-delay measurements and has an input impedance of 10 kΩ

Frequency range	0 to 3 kHz
Dynamic range	60 dB (typically)
Max. test voltage	+1 V (internally switchable to −1 V)
Input impedance	100 kΩ/10 kΩ
Max. input voltage	±10 V DC
Connector	BNC female

The data stored in the EPROM are either detector data for SWOB3-Z or for linear mode.

General data

Rated temperature range	0 to +50 °C
Storage temperature range	−40 to +70 °C
Power supply	100/120/220/240 V ±10 %, 47 to 63 Hz (max. 300 VA), safety class I, to VDE 0411 (IEC 348)
Dimensions (W × H × D)	450 mm × 221 mm × 620 mm
Weight	30 kg

Ordering information

Order designation	▶ Network Polyskop ZWOB 2	
100 kHz to 1600 MHz	857.0007.02	
	▶ Network Polyskop ZWOB 4	
100 kHz to 2700 MHz	857.0259.02	
100 kHz to 2300 MHz	857.0259.04	
	▶ Network Polyskop ZWOB 6	
100 kHz to 2700 MHz	857.0507.02	
100 kHz to 2300 MHz	857.0507.04	
Accessories supplied	power cable, manual	

Options

3½" Disk Drive	ZWOB-B2	856.8504.02
Computer function	ZWOB-Z3	857.1255.02
Harmonics Filter (factory-fitted only)	ZWOB-B4	857.1455.02
Group delay Option	ZWOB-B5	856.9000.02
Attenuator Set	ZWOB-B7	857.1003.02
Ext. Counter up to 1 GHz	ZWOB-B8	857.1555.02

Measuring heads

Demodulator 0.1 to 2700 MHz	ZZ-1	
50 Ω	1010.0000.52	
75 Ω	1010.0000.72	
Active Demodulator 5 to 1300 MHz	ZZ-2	
50 Ω	1010.0500.52	
75 Ω	1010.0500.72	
Insertion Unit 0.1 to 2700 MHz	ZZ-5	
50 Ω	1010.1006.52	
75 Ω	1010.1006.72	
AF Measuring Head 0 to 3 kHz	ZZ-6	
with correction data for SWOB3-Z	1010.1506.02	
with linear correction data	1010.1506.03	
for group-delay measurement, input impedance 10 kΩ	1010.1506.05	

Recommended extras

Calibration Kit 0 to 3000 MHz	ZCAN	
50 Ω	800.8515.52	
75 Ω	800.8515.72	
SWR Bridge	ZRB 2	
5 to 3000 MHz, 50 Ω, N female	373.9017.52	
N male	373.9017.55	
5 to 2500 MHz, 50 Ω, N female	373.9017.53	
N male	373.9017.56	
5 to 2000 MHz, 75 Ω, N female	802.1018.73	
N male	802.1018.76	
SWR Bridge 0.01 to 18 GHz	ZRMD	
50 Ω, N female	831.7010.53	
N male	831.7010.55	
PC 7	831.7010.57	
Power Splitter 0 to 2700 MHz	RVZ	
50 Ω	800.6612.52	
Matching Pad 50/75 Ω, 0 to 2700 MHz		
Matching on both sides	RAM	358.5414.02
With 25-Ω series resistor	RAZ	358.5714.02
Plotter (DIN A4)	DOP	375.1213.02
24-pin Pinwriter (220 V)	PDN	351.4512.02
Color Monitor (14")	PMC 2	1008.7500.02
Video Printer	Model SE 640 manufactured by ABB Metrawatt is recommended	
Accessory Bag Standard	ZZT-97	396.9936.00
Special	ZZK-98	396.9913.00
Transport Case	ZZK-955	1013.9408.00
Trolley	ZZK-1	1014.0510.00

ZRMD

SWR Bridge ZRMD ♦ 10 MHz to 18 GHz

- Test port PC-7 or N connector
- Calibration standard included
- High measurement accuracy
- Great operating convenience in conjunction with intelligent display units, eg Network Analyzer ZAM 52 from Rohde & Schwarz:
  - automatic correction of diode characteristic
  - indication of reflection coefficient in %
    or return loss in dB
    or standing wave ratio SWR
- Also available with BNC output connector for universal applications

Characteristics, uses

The **SWR Bridge ZRMD** is used to measure the magnitude of the reflection coefficient of RF circuits and components. The output signal from the test generator — e.g. **Synthesized Sweep Generator SWM** by Rohde & Schwarz (see catalog 90/91, page 136) — is applied to the device under test via the SWR Bridge. Part of the signal is reflected to the bridge where it is detected, the amount depending on the reflection coefficient.

If the ZRMD model fitted with indicator cable is used together with a R&S display unit (e.g. **Scalar Network Analyzer ZAM 52,** see catalog 90/91, page 331), correction for the characteristic of the detector diode used in the bridge is made automatically. To this end, the diode characteristic is stored in an EPROM in the connector housing. As a result, the magnitude of the reflection coefficient can be indicated in % or, by conversion, the return loss can be given in dB or as the standing wave ratio SWR.

As an alternative, a **ZRMD model with BNC female output connector** is available. This enables the connection of any indicator such as a voltmeter or an oscilloscope. However, the non-linear level dependence of the indication must be considered separately.

The **accuracy of the bridge** is limited by its finite directivity as well as by multiple reflections between the device under test and 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. With measurements of large reflection coefficients, the accuracy depends primarily on the matching of the test port of the bridge. With a directivity of D = 38 dB and a test port return loss of S = 20 dB, the maximum absolute error as a function of the reflection coefficient to be measured is $0.013 + 0.1\,|r|^2$.

Specifications

	N Standard	N Precision	PC-7
Frequency range	10 MHz to 18 GHz		
Characteristic impedance	50 Ω		
Directivity D			
up to 12 GHz	≥36 dB	≥38 dB	≥40 dB
up to 18 GHz	≥34 dB	≥36 dB	≥38 dB
Return loss S at test port			
up to 12 GHz	≥18 dB	≥18 dB	≥20 dB
up to 18 GHz	≥16 dB	≥16 dB	≥18 dB
Measurement error (r: magnitude of measured reflection coefficient)			
up to 12 GHz	$0.016+0.13\,\|r\|^2$	$0.013+0.13\,\|r\|^2$	$0.01+0.1\,\|r\|^2$
up to 18 GHz	$0.02+0{,}16\,\|r\|^2$	$0.016+0.16\,\|r\|^2$	$0.013+0.13\,\|r\|^2$
Return loss at the input			
up to 12 GHz	≥20 dB		
up to 18 GHz	≥18 dB		
Insertion loss			
Input → test port	6.4 dB + 0.008 dB × $(f/GHz)^2$ ±1 dB		
Power-handling capacity	0.5 W		

General data

Rated temperature range	0 to +50 °C
Storage temperature range	−40 to +70 °C
Connectors	
Input	N female
Test port	N female, N male or PC-7
Output	indicator cable or BNC female

Dimensions without connectors (L × W × H)	46 mm × 79 mm × 20 mm
Length of connectors	
N female	17 mm
N male	18 mm
PC-7	5 mm
Length of indicator cable	1.3 m
Weight	320 g

Ordering information

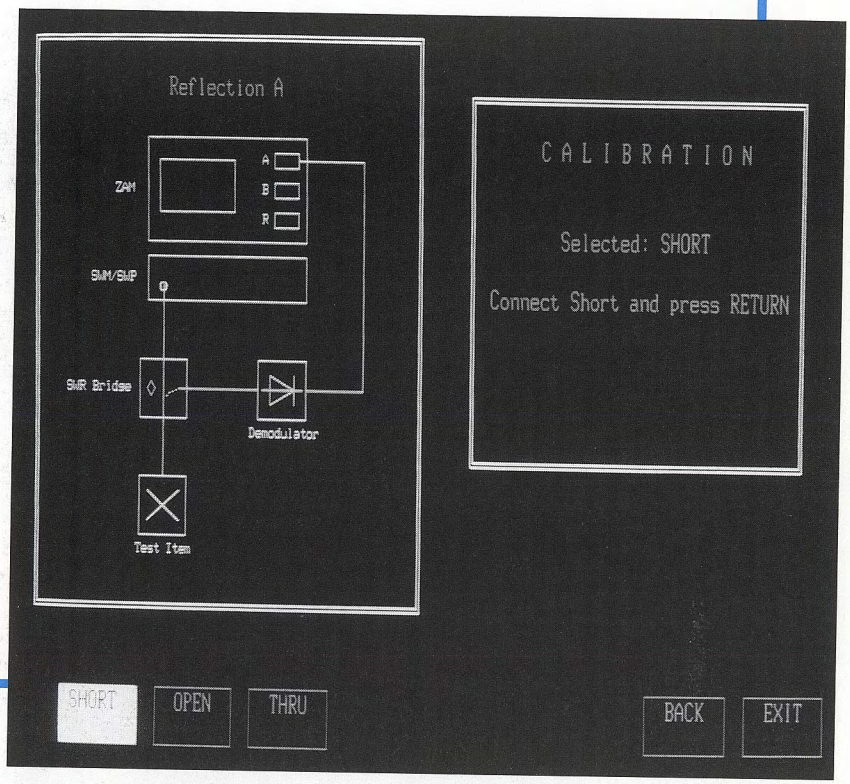
Order designation	▶ SWR Bridge ZRMD		
		Output R&S indicator cable	Output BNC female
Test port connector			
N Standard	female	831.7010.53	831.7010.63
	male	831.7010.55	831.7010.65
N Precision	female	831.7010.52	831.7010.62
	male	831.7010.56	831.7010.66
PC-7		831.7010.57	831.7010.67
Accessories supplied	Calibration standard open-circuit/short-circuit (phase difference open-circuit/short-circuit: 180° ±5°)		

Computer Function ZAM-Z3 for Network Analysis System ZPM

ZAM-Z3

♦ Software

- Further processing of results
  - statistical analysis
  - limit checks
  - result-dependent control of measurement and test runs
- Controlling the measurement path via IEC/IEEE bus using a relay matrix
- Storing results and device setups on floppy disks for subsequent processing on external controllers or for checking measurements using relevant stored setups
- Dialog mode for selecting and influencing test runs



Characteristics, uses

When fitted with the **Computer Function ZAM-Z3** and using suitable application software, **Network Analysis System ZPM** is upgraded to an automatic test system for handling complex measurement tasks. The optional Computer Function ZAM-Z3 further enhances the **high operating convenience** of Scalar Network Analysis System **ZPM** by adding the capability of writing measurement, control and evaluation programs in BASIC and conveniently filing data.

With the Computer Function in operation, **Network Analyzer ZAM 52** behaves like an independent process controller, ie the ZPM system functions like an external instrument regarding addressing and remote control. The built-in IEC/IEEE bus is the interface between the computer function software and the analyzer, so that the ZPM and the system equipment connected can be addressed in the same way.

The optional Computer Function **includes** the MS-DOS 3.1 operating system, the R&S BASIC interpreter as well as Keyboard PCA-Z1 with rollkey. In addition, Floppy Disk Station PZ-11 fitted with two 5¼″ drives is required for operation with the Computer Function.

Specifications

Computer Function ZAM-Z3

Includes	MS-DOS 3.1, R&S BASIC interpreter, Keyboard PCA-Z1

Keyboard PCA-Z1

Function keys	59 keys, international layout
	10 keys, can be labelled with overlay code, selectable with SHIFT and CONTROL
Separate numerical keypad	14 keys, can be switched to cursor functions
Rollkey	24 characters per revolution, code change with SHIFT and CONTROL
Data transfer	8 bit serial, ASCII character set, 2400 baud

Floppy Disk Station PZ-11

Drives (to be ordered separately)	5¼″, double-sided, HD
Tracks per disk	160
Sectors per track	15
Bytes per sector	512
Disk capacity (formatted)	1.2 Mbytes

Ordering information

Order designation	▶ Computer Function ZAM-Z3 for Network Analysis System ZPM	1009.9859.02

Required extras

Floppy Disk Station (basic model)	PZ-11	350.8514.02
5¼″ disk drives for PZ-11 (2 ea. required)	PCA-B6	376.0710.02

Recommended extras

5¼″ disks (HD), 10 ea.	PCA-Z2	376.0210.02

Directional Power Meter NAS
– precise power and VSWR measurements in the entire field of radiotelephony

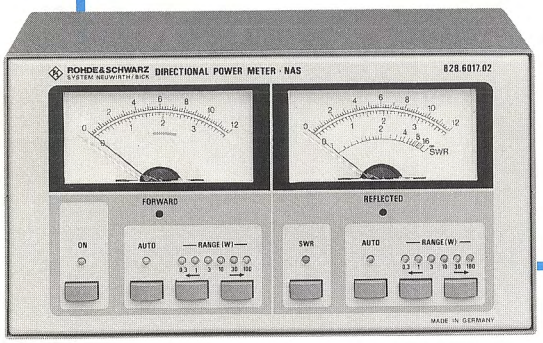
power meters

		Page
Directional Power Meter	NAS	116
Power Sensors	NRV-Z6/-Z7/-Z8	117

NAS

Directional Power Meter NAS ♦ 1 to 1000 MHz/10 mW to 120 W

- Convenient power measurement in the entire field of radiotelephony
- Wide frequency range
- Large power measurement range
- High EMI immunity
- Excellent price/performance ratio
- Direct VSWR readout



Scale 1:3

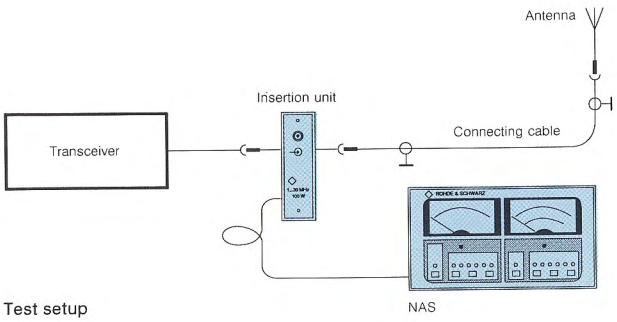
Characteristics, uses

The **Directional Power Meter NAS** from Rohde & Schwarz enables precise power and VSWR measurements in the entire field of radiotelephony.

With its **large frequency range** from 1 to 1000 MHz the NAS covers practically all RT bands and can be used in a wide field of applications. Thanks to battery supply and **high EMI immunity**, the NAS can be used even when subjected to strong ambient interference. Three different insertion units, which can be directly attached to the instrument or also be operated in detached mode via the connecting cable NAS-Z9, allow power and VSWR measurements from 10 mW to 120 W to be performed anywhere.

Operation

Two analog displays are provided for easy reading of results which is especially useful when adjustments are made. At a single keystroke the NAS indicates either VSWR and forward power or forward and reflected power. **Microprocessor control** does away with inconvenient correction tables and automatically ensures selection of the right power range. If not in use, the instrument is automatically switched off after 5 min, thus avoiding inadvertent discharge of batteries.



Test setup

The NAS enables precise measurements by reading the calibration data of a measuring head connected and taking them into account in the display. **Linearization** and **absolute calibration** of the moving-coil meters is **software-controlled**. In view of accuracy and operating convenience, the **price/performance ratio** is **unequalled**.

Specifications

Basic unit

Display	two moving-coil meters for forward and reflected power or forward power and VSWR indication
Power measurement ranges (Insertion Units NAS-Z1/-Z3/-Z5)	0.3/1/3/10/30/100 W (+20 % overflow)
Measurement range selection	automatic or manual, separate for forward and reflected power
Error limits (18 to 28 °C)	±1.5 % of selected range + error of insertion unit
Additional error at temperatures >28 °C and <18 °C	≤0.25 % of rdg./°C
Automatic switchoff	approx. 5 min. after keys have been actuated last

Insertion units

Characteristic impedance	50 Ω
Connectors	N female

	NAS-Z1	NAS-Z2	NAS-Z5
Measurement range	0.01 to 120 W	0.01 to 120 W	0.01 to 120 W
Frequency range	1 to 30 MHz	25 to 200 MHz	100 to 1000 MHz
Error limits	±4.5 % of rdg	±5.5 % of rdg	±5.5 % of rdg
VSWR	<1.07	<1.07	<1.07 f ≤500 MHz <1.1 f >500 MHz
Directivity	>30 dB	>30 dB	>30 dB f ≤500 MHz >26 dB f >500 MHz
Insertion loss	<0.2 dB	<0.2 dB	<0.3 dB

General data

Operating temperature range	0 to +50 °C
Power supply	5 dry batteries IEC R20 (single cell)
Lifetime	>150 h (alkalinemanganese batteries)
Dimensions (W × H × D)	
Basic unit	210 mm × 145 mm × 90 mm
Insertion units	55 mm × 120 mm × 90 mm
Weight	
Basic unit	2 kg (incl. batteries)
Insertion units	0.7 kg

Ordering information

Order designation	▶ Directional Power Meter NAS	828.6017.02
Measuring heads		
Insertion Unit (1 to 30 MHz)	NAS-Z1	828.6317.02
Insertion Unit (25 to 200 MHz)	NAS-Z3	828.6517.02
Insertion Unit (100 to 1000 MHz)	NAS-Z5	828.6717.02
Connection Cable (1.5 m) for detached operation of insertion units	NAS-Z9	828.6969.02
Accessories supplied	manual	

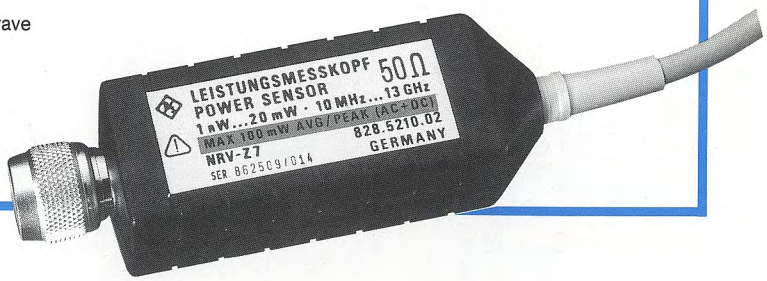
Note:
Error limits refer to power indication in W. The total error is the error of the display section plus the error of the insertion unit. As usual with power meters, error limits are calculated as RSS (Root Sum Square) value of the individual error components. The RSS value can be considered as an error that will not be exceeded in 95 % of the readings.

Power Sensors NRV-Z6/-Z7/-Z8

♦ 50 MHz to 26.5 GHz (-Z6)
10 MHz to 13 GHz (-Z7/-Z8)

- Precise power measurement right into the upper microwave range (26.5 GHz) using NRV-Z6
- NRV-Z7 and -Z8 as value-for-money alternatives to the well-proven Power Sensors NRV-Z1/NRV-Z2 for applications up to 13 GHz

NRV-Z6/-Z7/-Z8



Characteristics, uses

Rohde & Schwarz is offering three new **Power Sensors NRV-Z6, NRV-Z7 and NRV-Z8** to complement the Dual-channel Power Meter NRV and RF Millivoltmeter URV 5 (see catalog 90/91, pages 438 and 422). NRV-Z7 and NRV-Z8 are **value-for-money alternatives** to the well-proven Power Sensors NRV-Z1 and NRV-Z2 for all applications up to 13 GHz and provide the same features.

Power Sensor NRV-Z6 enables power measurements even in the upper microwave range up to 26.5 GHz with the high precision of R&S instruments.

Specifications

Power sensor	**NRV-Z6**	**NRV-Z7**	**NRV-Z8**
Power meas. range	1 nW to 20 mW	1 nW to 20 mW	100 nW to 500 mW
Frequency range	50 MHz to 26.5 GHz	10 MHz to 13 GHz	10 MHz to 13 GHz
Characteristic impedance	50 Ω	50 Ω	50 Ω
Power-handling capacity (AC + DC)			
Average value	100 mW	100 mW	2 W
Peak value	100 mW	100 mW	10 W
Zero error[1]	±0.2 nW	±0.1 nW	±10 W

Linearity error (NRV-Z6)	f in GHz	0.05 to 0.2	0.2 to 14	14 to 26.5
	1 nW to 20 µW	±1%	±0.5%	±0.5%
	20 µW to 2 mW	−3 to +1%	±1%	−1 to +2%
	2 to 20 mW	−5 to +2%	±2%	−1 to +5%

Linearity error (NRV-Z7)	f in GHz	0.01 to 4	4 to 8	8 to 13
	1 nW to 20 µW	±0.4%	±0.4%	±0.4%
	20 µW to 2 mW	±0.4%	−0.4 to +2.4%	−0.4 to +5.4%
	2 to 20 mW	±0.4%	0 to +4.4%	0 to +10.4%

Linearity error (NRV-Z8)	f in GHz	0.01 to 4	4 to 8	8 to 13
	100 nW to 2 mW	±0.3%	±0.3%	±0.3%
	2 to 200 mW	±0.3%	−0.3 to +2.3%	−0.3 to +5.3%
	200 to 500 mW	±0.3%	0 to +3.8%	0 to +8.3%

Measurement rate and indication noise[2]):

Filter	0	1	2	3	4	5
Change of display[3])	910 ms	480 ms	250 ms	140 ms	85 ms	45 ms
Computer control[4])	15 s	3.6 s	1 s	260 ms	90 ms	52 ms
Noise in nW[5])						
NRV-Z6	0.08	0.16	0.32	0.64	1.3	4
NRV-Z7	0.04	0.08	0.16	0.32	0.64	2
NRV-Z8	4	8	16	32	64	200

RSS[6]) error of calibration factor[7]):

Frequency	0.05 to 2	>2 to 8	>8 to 12.4	>12.4 to 18	>18 to 26.5 GHz
NRV-Z6	1.3%	1.8%	2.9%	3.2%	2.8%

Frequency	0.01 to 0.1	>0.1 to 2	>2 to 4	>4 to 8	>8 to 13 GHz
NRV-Z7	1.6%	2.1%	2.6%	3.8%	4.0%
NRV-Z8	0.8%	1.5%	1.8%	2.0%	2.8%

Calibration frequencies
(Linear interpolation between calibration frequencies. The large number of calibration points makes interpolation errors negligible.)
NRV-Z6 ..... approx. 30 points from 0.05 to 26.5 GHz
NRV-Z7, NRV-Z8 ..... approx. 30 points from 0.01 to 13 GHz

Calibration power
NRV-Z6, NRV-Z7 ..... 10 µW
NRV-Z8 ..... 1 mW

Temperature effect	max.	typ.
18 to 28 °C	1%	0.3%
10 to 40 °C	3%	1%
0 to 50 °C	7%	2%

Reflection coefficient, VSWR, NRV-Z6

f in GHz	0.05 to 0.1	>0.1 to 18	>18 to 26.5
r in %	13	9	16.5
VSWR	1.3	1.2	1.4

Reflection coefficient, VSWR, NRV-Z7

f in GHz	0 to 0.001	0.001 to 1	1 to 2	2 to 4	4 to 13
r in %	5	3	6	12	17
VSWR	1.11	1.06	1.13	1.27	1.41

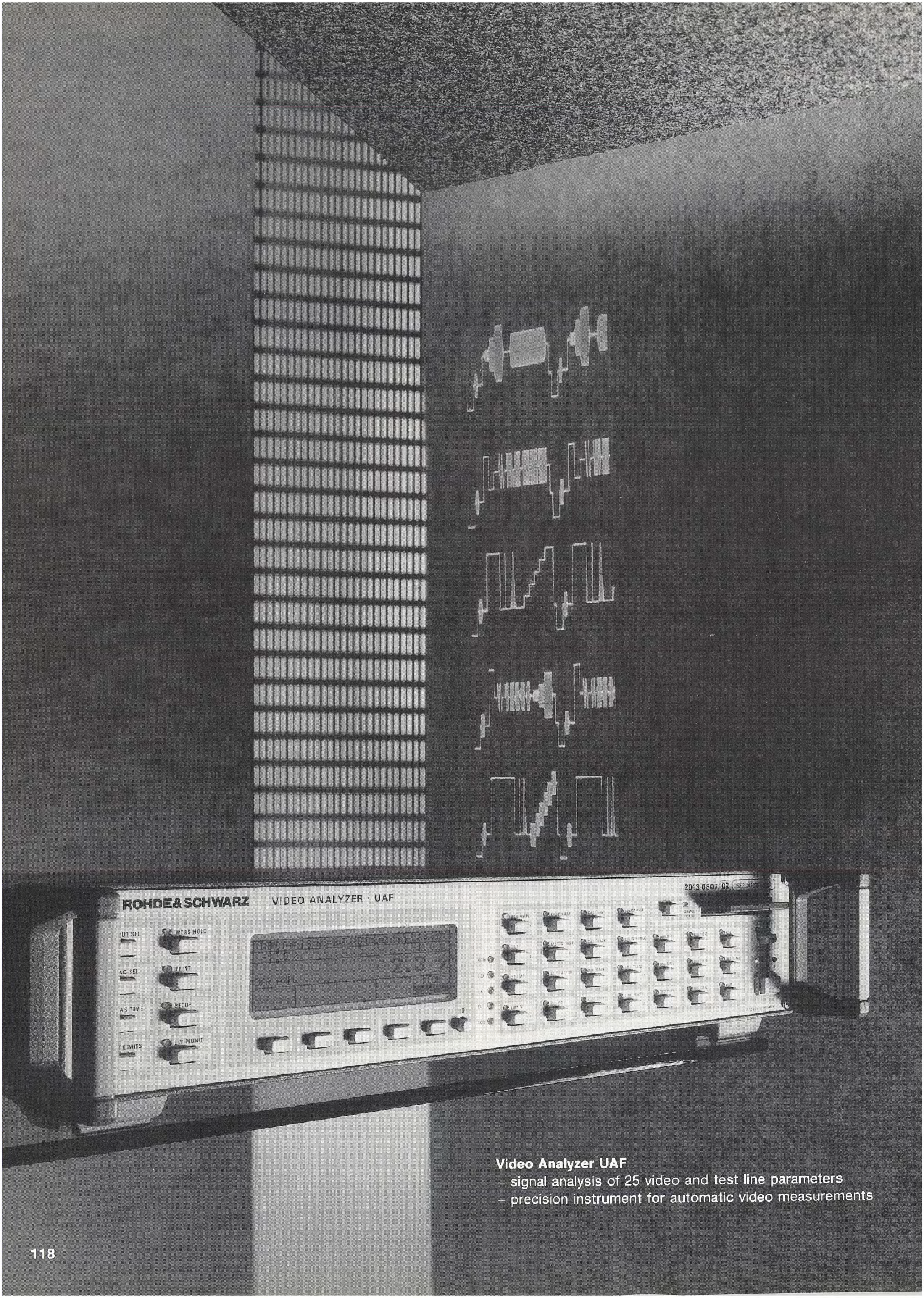
Reflection coefficient, VSWR, NRV-Z8

f in GHz	0 to 4	4 to 8	8 to 13
r in %	2.4	4.8	7.0
VSWR	1.05	1.1	1.15

Ordering information

Order designation .....
- Power Sensor NRV-Z6 828.5010.02
- Power Sensor NRV-Z7 828.5210.02
- Power Sensor NRV-Z8 828.5410.02

[1]) 1 hour after zeroing, ±1 °C; after warm up of 2 hours.
[2]) Observation time 1 min, 2 standard deviations, temp. 18 to 28 °C.
[3]) With untriggered measurements. No indication of intermediate values in the case of triggered measurements.
[4]) Period between triggering and output of first byte.
[5]) Noise power measured for filter 2, other values calculated.
[6]) RSS (root sum square) value of the individual error components.
[7]) Frequency-response correction enabled; without frequency-response correction, the correction factor for 50 MHz is assumed for NRV-Z7, -Z8 and for 500 MHz for NRV-Z6.



Video Analyzer UAF
– signal analysis of 25 video and test line parameters
– precision instrument for automatic video measurements

A1

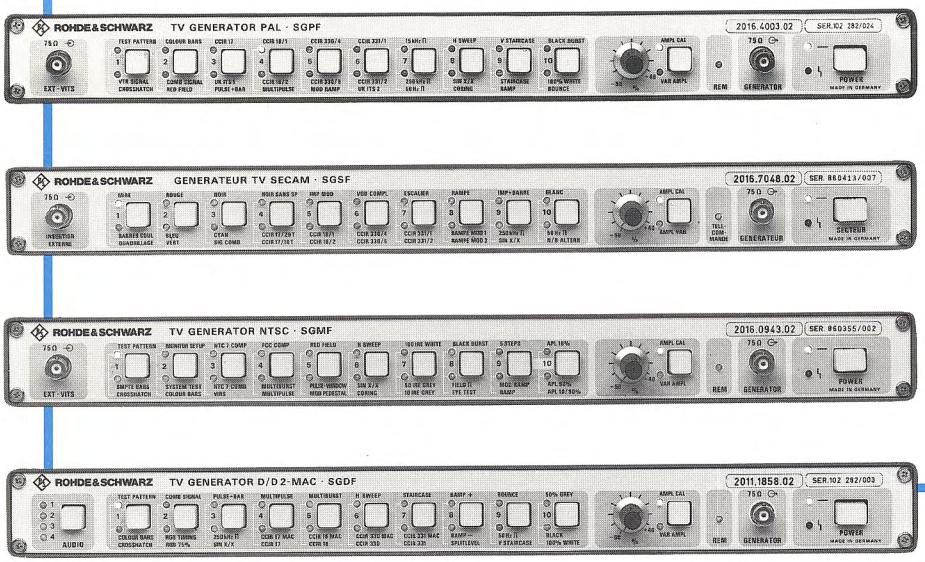
appendix

New products in the field of TV measurements and communications

			Page
TV Generators	SGPF	(PAL)	120
	SGSF	(SECAM)	
	SGMF	(NTSC)	
	SGDF	(D2-MAC)	
	SDMF	(D2-MAC)	126
	SFZ	(SAT-IF)	128
Video Analyzer	UAF		130
Video Timing Analyzer	TIF		134
TV Digital Oscilloscope	ODFA		138
TV Demodulator	AMFS		140
TV Demodulator, NICAM	AMFN		144
TV Test Receiver	EMFP		146
NF-IF Selector	ZS 101		149
VLF-HF Receiver	EK 890		150

SG.F

TV-Generators SGPF ♦ PAL
SGSF ♦ SECAM
SGMF ♦ NTSC
SGDF ♦ D-MAC, D2-MAC



- Each more than 30 baseband signals
- Insertion test signals included in every signal
- FuBK or general-purpose test pattern with SGPF
- 4 sound configurations with SGDF

With options:

- Source identification
- Test signal insertion (not with SGDF)
- Energy dispersal signal (not with SGSF)
- Aspect ratio 4:3 or 16:9 (with SGPF and SGDF)
- Increased crystal accuracy (with SGDF)

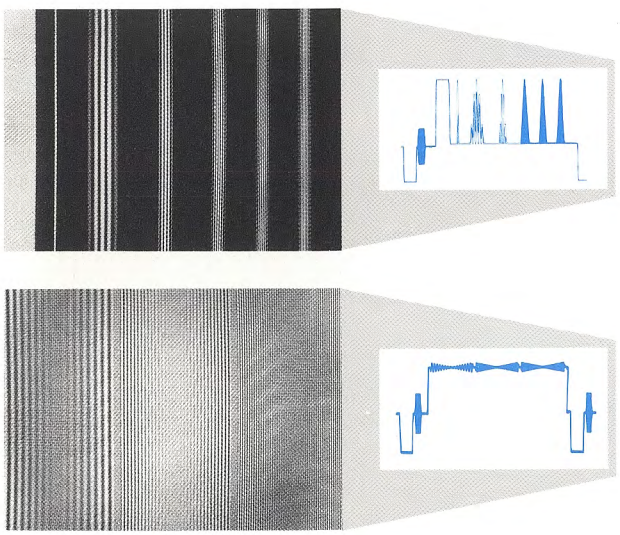
IEC 625 Bus

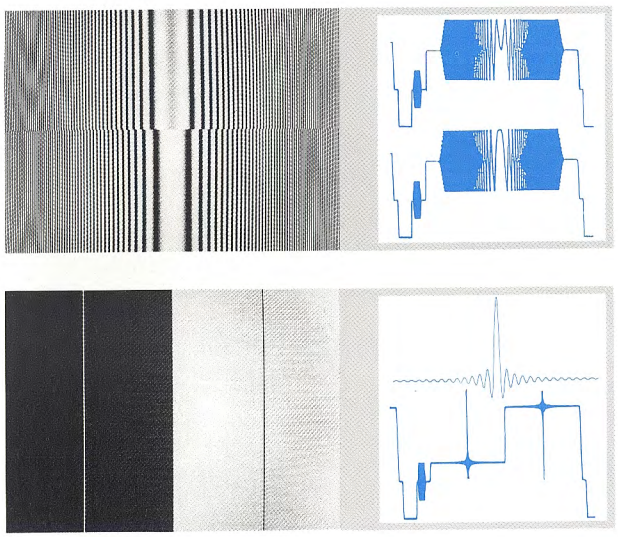
With its **TV Generators SG.F** for the traditional colour standards and the newly introduced D-MAC/D2-MAC system, Rohde & Schwarz has the right unit for any production, studio and service requirements.

As far as the different standard specifications allow, the instruments are of identical design and offer the same functions featuring the following **common characteristics**:

- more than 30 baseband signals available at the push of a button or via remote control
- signal output on the front and on the rear panel
- bus control (IEC 625/IEEE 488) of all generator functions
- 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 region (not with SGDF)
- use as test signal inserter with the genlock option fitted (not with SGDF)

Digital picture generation With the PAL generator, the three components Y, C_B and C_R are stored and used for digital generation of the real-time composite colour video signal (CCVS).





Test signal examples: multipulse and H sweep (top), coring (not with SGDF) and $\frac{\sin x}{x}$ signals (bottom)

For generation of the test signals to NTSC, SECAM and D-MAC/D2-MAC, about 1000 different video lines are stored digitally and can be combined to obtain the desired pattern under program control.

Test lines are included in every picture. For the SGDF the test signals are preset in accordance with the CCIR-MAC standard whereas the assignment of a test signal to a specific line can be freely programmed via DIP switches for the other three generators. Eight complete test signal configurations can be stored and recalled from the front panel or via the IEC/IEEE bus so that any measurement task occurring in practice can be suitably tackled.

A separate memory is provided for the test line region and yields information as to the line of the test pattern into which the signal (eg a teletext signal) applied to input EXT · VITS is to be inserted or regarding the line of the generator signal which is to be added to a program signal (with the genlock option fitted, not applicable for the SGDF).

Output signal The signal amplitude can be set via the IEC/IEEE bus or manually by a potentiometer. On all models separate output amplifiers ensure excellent decoupling between the front and the rear outputs.

Options (see preceding page) cannot be retrofitted and should be ordered together with the basic unit. For the possible combinations see ordering information.

Design The extremely compact design of the generators (one height unit at a width of 19″) is the result of the fully digital concept and state-of-the-art technology.

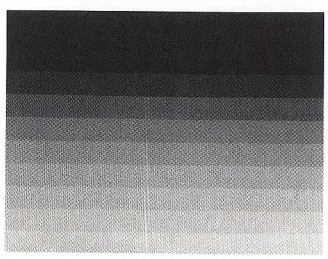
TV Generator SGPF for PAL

The SGPF digitally generates a PAL composite colour video signal (CCVS) coded over an eight-field sequence with a resolution of 12 bits. Two LSI gate arrays convert the Y, C_B and C_R components into the digital CCVS which features an accurately defined colour-subcarrier/sync-pulse (SC/H) phase. For identification of the beginning of the eight-field sequence, the PAL identification pulse can be inserted into line 7 of the first field.

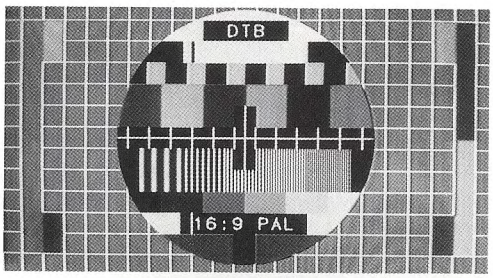
With the genlock option fitted, the SGPF offers the possibility of inserting test signals into a program signal. If no program signal is available, the selected video test pattern is through-connected to the program output.

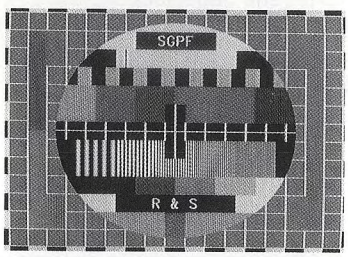
The more than 30 test signals comprise the following groups:

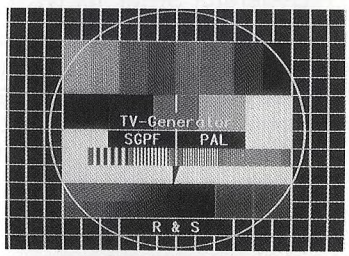
- test pattern to German FuBK standard or general-purpose test pattern with optional source identification, crosshatch pattern and VTR signal
- CCIR insertion test signals
- squarewave signals (50 Hz, 15 kHz, 250 kHz)
- sawtooth signals
- multipulse, H sweep, $\frac{\sin x}{x}$ and coring signals
- black burst, vertical staircase, white field and bounce signals



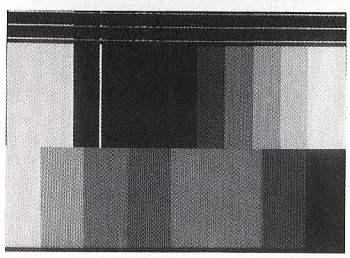
Vertical grey scale







The signal assortment can optionally include a general-purpose test pattern of aspect ratio 16:9 or 4:3 (top) or a FuBK test pattern (right)



VTR signal

TV Generator SGSF for SECAM

The SGSF delivers the video signals to SECAM standard in a twelve-field sequence with the (disconnectible) chrominance synchronization signals in the field blanking interval. The genlock option permits insertion of test signals into a program signal; moreover, it is possible to switch over to a substitution signal in the case of program failure.

In addition to

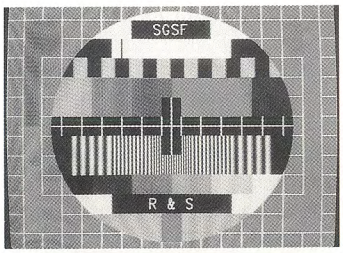
- the general-purpose test pattern with optional text insertion for source identification, the colour bars, crosshatch pattern, red, blue, green and black fields, a signal for chroma noise measurement and a test signal for chrominance-to-luminance delay,

the following purely monochrome test signals are available:

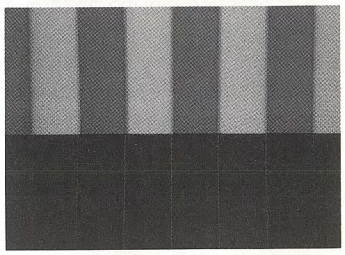
- CCIR insertion test signals
- multipulse, H sweep, $\frac{\sin x}{x}$
- squarewave signals (50 Hz, 15 kHz, 250 kHz, pulse-and-bar signal)
- sawtooth and staircase signals
- pluge and coring signals
- black, white and bounce signals

Thus it is possible to use the well-known Video Analyzers UAF and UVF, the Video Distortion Analyzer UPF and the Video Noise Meter UPSF 2 from Rohde & Schwarz for automatic SECAM measurements.

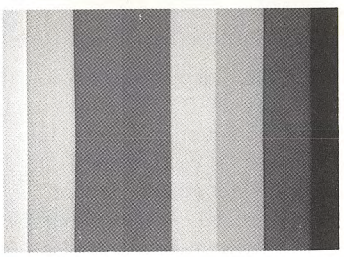
(UAF: see page 130)
(UVF, UPF, UPSF 2: see sound and TV broadcasting catalog PD 756.7294.21)



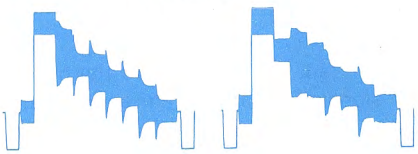
General-purpose test pattern



Combined signal

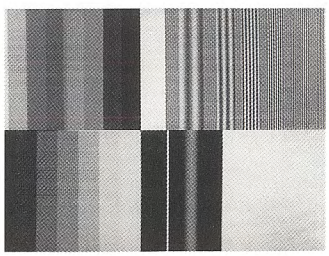


Colour bars



TV-Generator SGMF for NTSC

The SGMF produces NTSC baseband signals of studio quality complying with the stringent requirements of the RS-170 A standard as regards SC/H phase, burst timing reference and burst width. It is possible to insert the NTSC identification pulse into the first field of the NTSC sequence.

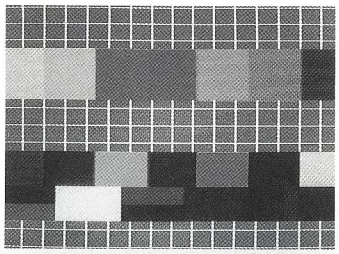


System test pattern

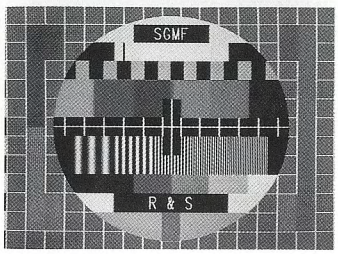
Over 30 video signals are available:

- general-purpose test pattern with optional source identification as well as different, combined test signals for adjusting convergence, brightness and colour during monitor setup
- NTC7 and FCC test signals
- crosshatch-and-dot pattern
- signals for measuring amplitude and group delay responses (multiburst, multipulse, H sweep, $\frac{\sin x}{x}$
- squarewave signals (bounce, 60 Hz, 15 kHz, 250 kHz, pulse-and-bar signal)
- ramp and staircase signals
- colour-bar signal and red field
- special signals (pluge, coring, VIRS, eye test) and black burst

Using the genlock option it is possible to insert any of these signals into the field blanking interval of a program signal; all generator functions including level setting can be remote-controlled via the IEC/IEEE bus.



Monitor setup pattern



General-purpose test pattern

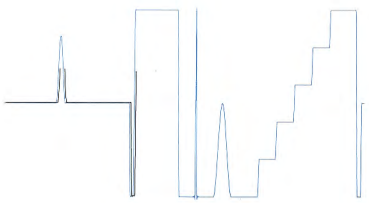
TV Generator SGDF for D-MAC/D2-MAC

The SGDF delivers a baseband signal of 8.6-MHz bandwidth in accordance with the "Spécification du système D/D2-MAC/paquet". More than 30 full-field signals are produced, ie:

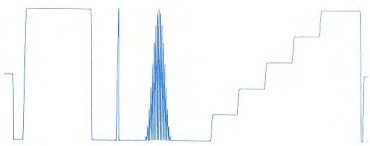
- MAC test pattern with optional source identification, EBU colour-bar signal, crosshatch pattern, a combined test signal and signals for measuring delay and colour errors in the RGB channels
- newly defined MAC test signals such as multiburst, multipulse, H sweep signals for measuring amplitude and group-delay responses
- staircase and sawtooth signals essential for A/D-D/A conversion testing
- 50% grey pedestal without chrominance and CCIR ramp for measuring the S/N ratio with the Video Noise Meter UPSF 2
- black and white fields as well as squarewave signals for determining level, streaking and tilt
- CCIR insertion test signals both in MAC and composite form for automatic assessment of signal distortions using conventional PAL video analyzers
- $\frac{\sin x}{x}$ pulse at full bandwidth for checking group delay and evaluating the amplitude/frequency response on a spectrum analyzer
- V sweep signal up to 8.6 MHz

Since the D-MAC/D2-MAC signal is not only composed of the multiplexed analog components but also includes up to eight audio channels in the baseband, the SGDF also generates audio and data signals which feature duobinary coding at half the clock rate (D2 = 10.125 MHz). Four different sound configurations can be called up at the push of a button.

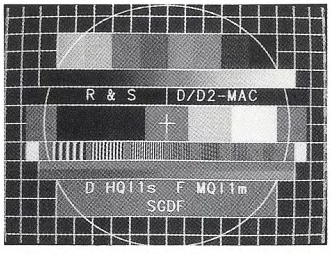
Internal jumpers allow audio and data coding at the full clock rate (20.25 MHz) to obtain the D-MAC signal. In this case the number of audio channels is doubled.



MAC-coded CCIR 17 test signal



CCIR 17 test signal in composite form for assessment using conventional PAL video analyzers



D-MAC/D2-MAC test pattern

Specifications

SGPF/SGSF/SGMF – Signal characteristics

	PAL SGPF	SECAM SGSF	NTSC SGMF
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 pulse	nominal ±7 mV	nominal ±7 mV	–
12.5T pulse	–	–	nominal ±7 mV
Amplitude setting	on front panel or via IEC/IEEE bus between –50 and +40% of calibrated value		
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
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	–
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	–
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 colourdifference signal preemphasis	–	±0.2 dB	–
Tolerance of subcarrier preemphasis	–	±0.15 dB	–
Waveforms	–	to CCIR Rep. 624-3	–
S/N ratio	rms, weighted, 0.2 to 5 MHz	rms, weighted, 0.2 to 5 MHz	rms, weighted 0.2 to 4.2 MHz
measured on all-black picture	≥74 dB	≥74 dB	≥74 dB
measured on sawtooth signal	≥70 dB	≥70 dB	≥70 dB
Clock frame	sync frame and burst phase to CCIR Rep. 624-3	sync frame and colour subcarriers D_R and D_B to CCIR Rep. 624-3	sync frame and burst phase to RS-170 A
SC/H phase	0 ±5°	–	±5°
V component	can be disabled	can be disabled	can be disabled

Specifications

SGPF/SGSF/SGMF – Additional data

Inputs/outputs BNC, 75 Ω
Return loss ≥34 dB (up to 6 MHz)
Sync pulse output 2 V into 75 Ω
EXT · VITS input (for insertion of external signals into test line region or for application of a sweep signal to the active picture range)
- Connector BNC, 75 Ω
- Gain 0 ±0.1 dB
- Amplitude/frequency response ±0.1 dB (up to 6 MHz)
- Differential gain ≤0.3%
- Differential phase ≤0.3°

Option genlock with test signal insertion
for coupling the generator clock with the sync pulse and the burst/colour subcarrier (with PAL/NTSC) of the applied CCVS to permit test signal insertion into the latter
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 allblack line or other signal
  - NTSC both fields lines 10 to 21

Remote control IEC-625/IEEE-488.2 bus

Manual setting output amplitude, field-repetitive/line-repetitive operation, application of sweep signal to active picture range, coding and selection of 8 test line blocks, front panel disabled by 6th bit of IEC/IEEE-bus switch

SGDF

D2-MAC outputs ..... one each on front and rear panel, BNC, 75 Ω
Return loss 0 to 6 MHz ..... ≥34 dB
6 to 10 MHz ..... ≥30 dB

Signal data
Squarewave pulses, staircase, sawtooth and sweep signals ..... nominal ±5 mV
Amplitude/frequency response ... ≤0.2 dB (ripple)
Multipulse
Amplitude/frequency response . ≤0.2 dB
Blackman pulse (luminance and chrominance)
Amplitude ..... nominal ±7 mV
Half-amplitude duration ..... 120 ±7 ns
Rise time to D2-MAC specification
Luminance ..... 105 ±7 ns
Chrominance ..... 105 ±7 ns
Rise time and half-amplitude duration of compressed MAC signal to CCIR
Luminance ..... 133 ±7 ns, 154 ±10 ns, 1.33 µs ±30 ns
Chrominance ..... 105 ±7 ns, 333 ±20 ns, 667 ±30 ns
S/N ratio, rms, weighted to D2-MAC, 0.2 to 7.5 MHz
measured with 50 % grey pedestal ..... ≥74 dB (referred to 1 V)
measured on sawtooth ..... ≥68 dB (referred to 1 V)
D2 sound and data signals ..... duobinary coding (optionally coded with D clock)
Basic amplitude ..... 800 ±10 mV
Peak-to-peak amplitude ..... 945 ±10 mV

TTL outputs ..... 75 Ω
Line-repetitive pulse ..... 4.7 µs ±50 ns
2-field-repetitive pulse ..... line 625 (or composite sync)

Configuration of sound and data signals with D2-MAC
Two subsequent frames contain:
80 packets (address 224) HQI1 stereo
1 BI packet with address 224
20 packets (address 129) MQI1 mono
1 BI packet with address 129
2 information packets (address 0)
60 dummy packets (address 1023)

Sound coding with D2-MAC (1st data frame)

	Address	Coding	Frequency/level (0 dB equal to12 dB below clipping level) Left	Right	Mono
Audio 1	224	HQI1s	1 kHz/0 dB	5 kHz/0 dB	–
	129	MQI1m	–	–	0.5 kHz/0 dB
Audio 2	224	HQI1s	1 kHz/+12 dB	Silence	–
	129	MQI1m	–	–	5 kHz/–3 dB
Audio 3	224	HQI1s	Silence	1 kHz/+12 dB	–
	129	MQI1m	–	–	0.25 kHz/+6 dB
Audio 4	224	HQI1s	Silence	Silence	–
	129	MQI1m	–	–	Silence

Configuration of sound and data signals with D-MAC
Two consecutive frames contain:

1st data frame	2nd data frame
80 packets (address 224)	80 packets (address 225)
HQI1 stereo	HQI1 stereo
1 BI packet with address 224	1 BI packet with address 225
20 packets (address 129)	20 packets (address 130)
MQI1 mono	MQI1 mono
1 BI packet with address 129	1 BI packet with address 130
2 information packets (address 0)	2 information packets (address 0)
60 dummy packets (address 1023)	60 dummy packets (address 1023)

2nd data frame

	Address	Coding	Frequency/level (0 dB equal to 12 dB below clipping level) Left	Right	Mono
Audio 1	225	HQI1s	5 kHz/0 dB	1 kHz/0 dB	–
	130	MQI1m	–	–	7.5 kHz/0 dB
Audio 2	225	HQI1s	15 kHz/0 dB	Off	–
	130	MQI1m	–	–	1 kHz/–3 dB
Audio 3	225	HQI1s	Off	15 kHz/0 dB	–
	130	MQI1m	–	–	1 kHz/0 dB
Audio 4	225	HQI1s	Silence	Silence	–
	130	MQI1m	–	–	Silence

Configuration of line 625
The following data are stored in an EPROM:

		No. of bits	Contents
LSW	Line sync word	6	to standard
CRI	Clock run-in	32	to standard
FSW	Frame sync word	64	to standard
UDT	Unified data and time	5	10101 bin
CHID	Channel identification	16	5A5A hex
SCR	Service configuration reference	8	00 hex
MVSCG	Multiplex and video scrambling control group	8	0011 1111 bin
CAFCNT	Conditional access frame count	20	FFFFF hex
	Unallocated	5	11111 bin
	Error control	14	to Golay code
RDF	Repeated data frame (5 identical blocks)	5 × 94	90/91 hex, 0 bin, 01 hex
TDMCTL	Time division multiplex control		4 × 3FFH (10 bits) 2 × 7FFH (11 bits) 14 bits data protection to Golay code

General data

Rated temperature range ..... +5 to +45 °C
Remote-control interface ..... to IEC 625-2 (IEEE 488), control of all functions
Power supply ..... 100/120/220/240 V +15/–10 %, 47 to 63 Hz (50 VA), safety class I, to VDE 0411 (IEC 348)
Dimensions (W × H × D) ..... 450 mm × 59 mm × 510 mm
Weight ..... 6 kg

Ordering information

	PAL	SECAM	NTSC	D-MAC/D2-MAC
Order designation for				
Basic unit	▶ TV-Generator SGPF 2016.4049.02	▶ TV-Generator SGSF 2016.7048.02	▶ TV-Generator SGMF 2016.0943.02	▶ TV-Generator SGDF 2011.1858.02
Options	FuBK or general-purpose test pattern source identification test signal insertion energy-dispersal signal[1]) aspect ratio 4:3 or 16:9[2])	source identification test signal insertion English or French front-panel labelling	source identification test signal insertion energy-dispersal signal[1])	source identification energy-dispersal signal increased crystal accuracy aspect ratio 4:3 or 16:9

[1]) not possible together with test signal insertion [2]) not possible with FuBK test pattern

The options cannot be retrofitted and should be ordered with the basic unit. When requesting a quotation, also ask for the options order form (please enter texts for source identification).

Accessories supplied ..... power cord, fuses, handles and screws

Recommended extras

Junction Panel SGDF-Z	–	–	–	2011.2177.02
with Bypass SG.F-Z	2016.1679.02	2016.1679.02	2016.1679.02	–

SDMF

D2-MAC Generator SDMF ♦ All sound and data configurations

- More than 50 test patterns
- BI and SI packets
- Menu-guided operation

IEC 625 Bus

The **D2-MAC Generator SDMF** delivers TV signals in accordance with the D2-MAC/packet standard. In addition to the vision information, all sound and data configurations are made available.

Thanks to its high flexibility, SDMF can be used in **all fields of D2-MAC transmission**: as a test-signal source in the studio, for checking satellite and cable links through to measurements on domestic receivers. It can be controlled from an external computer, so it is ideal for testing in the lab and for measurements during production.

The **more than 50 test patterns** of SDMF include:

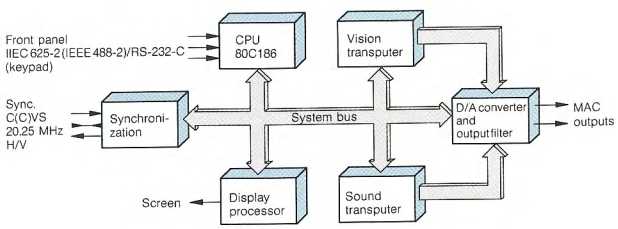
- the D2-MAC test pattern with the possibility of text insertion, the EBU colour-bar signal, signals for measuring group delay and colour errors in the RGB channels,
- the newly specified MAC test signals such as multiburst, multipulse, line- and field-repetitive sweep signals for measuring amplitude and group-delay frequency response,
- staircase and sawtooth signals for A/D and D/A converter testing,
- grey pedestals and CCIR ramp signals for noise-voltage measurement,
- all-black, all-white and squarewave signals for determination of level, streaking and tilt,
- $\frac{\sin x}{x}$ pulses for measuring group delay and frequency response on the spectrum analyzer,
- zone-plate signals for determination of system-dependent distortion and evaluation of resolution,
- circle and crosshatch signals for evaluation of monitor geometry,
- CCIR test signals in MAC and composite coding for measurement using conventional video analyzers.

The pattern descriptions and the calculating programs are stored in the PROM, ie the patterns can be varied by changing certain parameters. Thus it is possible to select the luminance value in 1 % steps for the grey pattern and the maximum frequency for the $\frac{\sin x}{x}$ or zone-plate signals. Text insertion is possible from the front panel or an external keypad. With the FuBK test pattern to German standard, it is possible to insert the selected sound channels. For testing the vertical colour-filtering facility can be disconnected. In accordance with the standard, switchover of the aspect ratio from 4:3 to 16:9 and of the compression factors of the luminance signals and the colour-difference signals is possible.

The strength of SDMF is its **high flexibility regarding sound and data services**. All service addresses can be selected or calculated by the instrument (see Specifications). The characteristics of each sound channel can be set separately. In addition, each channel can be assigned to television main sound, television additional sound, radio main sound, radio additional sound, teletext or data.

In accordance with the D2-MAC standard, **SDMF** automatically **generates** the following elements from the set data and codings:

- coding blocks of 90 or 120 bytes,
- interpretation blocks (BI)



Block diagram of D2-MAC Generator SDMF

- packets of the service identification channel (SI) with consecutive packets and various data groups (address 0),
- dummy packets (address 1023),
- line 625.

Line 625 is fully to standard and includes the following: LSW (line sync word), CRI (clock run-in), FSW (frame sync word), UDT (unified date and time), SDF (static data frame) and RDF (repeated data frame) with frame counter and configuration data essential for the system.

Operation Although SDMF offers comprehensive and very complex facilities, it is extremely easy to operate thanks to **menus.** Four keys are provided to set the modes: vision, sound, data and setup. Everything else can be selected or entered in these four basic menus and the submenus. If texts have to be modified frequently, it is best to add a keypad to the front panel. All settings can also be performed via the two remote-control interfaces.

Nine **memories for complete front-panel setups** are available, the configuration of memory 1 being the default setting upon power up. Comprehensive, multi-level **error-detection mechanisms** ensure secure and error-free operation in spite of the complexity of the D2-MAC standard.

Description SDMF could be thought of as a computer with specialized, high computing power, its auxiliary and peripheral modules being fitted with innovative VLSI circuits such as LCAs (logic cell arrays) or transputers and making it suitable for use as a test generator (see block diagram). This explains the high flexibility and adaptability of SDMF.

Specifications

Sound and data

Addresses	1 to 1022, either as desired or as calculated internally according to the "rules of operation"
Mode	mono/stereo
Quality	MQ/HQ (medium/high quality)
Type of protection	parity/Hamming
Coding	linear/NICAM
Coding blocks	90/120 bytes
Frequency (in 5-Hz steps)	40 Hz to 15 kHz
Level	+12 dB to < −72 dB
Preemphasis	can be disabled
Silence	can be enabled
Automixing	identification can be enabled
BI packets	can be disabled
Service (channel characteristics)	television and radio main sound (adjustable: service and program name, type code, etc.); television and radio additional sound; news flash sound; teletext; data (external)
Dummy packet (address 1023)	automatic generation
SI packet	automatic generation with update function
Line 625 (to standard)	with UDT and frame counter
VPS data	can be enabled, contents of bytes 5/11/12/13/14 selectable
Network parameters (adjustable)	satellite data, transmitter data, commentaries, language code
Error simulation	bit error mask for BC,BI, SI, dummy; amplitude

Vision

Full field (with static signals, time and text insertion is possible)	D2-MAC test pattern to German FuBK standard, all white signal, all-black signal, all-grey signal (in 1 % steps), grey staircase (horizontal/vertical), crosshatch, crosshatch + clamping fields, colour-bar signal (horizontal/vertical), RGB ramps (horizontal/vertical), $\frac{\sin x}{x}$ (maximum frequency adjustable), sweep signal (RGB, black/white), 50-Hz or 250-kHz squarewave, bounce signal (time adjustable), zone-plate signals of 1st and 2nd order frequency)
Test lines and full field	
MAC format	pulse-and-bar signals, rising ramp/falling ramp, complex sweep signal (phase: 0°/90° and 0°/90°/180°/270°), multipulse, staircase, multiburst
MAC and PAL formats	CCIR 17, CCIR 18, CCIR 18 (DBP), CCIR 330, CCIR 331, 2T pulse
Lines for test signals	1, 311, 312, 313, 623, 624, 10, 17, 18, 19, 330, 331, 332
Aspect ratio	4:3 or 16:9
Compression ratio	C_Y = 3:2 and C_U = 3:1 or C_Y = 5:4 and C_U = 5:1
Panning	can be enabled
Verticale colour filtering	can be disabled
Teletext	two pages

Output signals

Amplitude	1000 mV
adjustable	total level, Y, U, V, test lines, reference pulse, data level
System clock	20.25 MHz $\pm 2.5 \times 10^{-7}$
Signal generation	10-bit resolution
Tolerances	
Amplitudes	±0.5 % ±1 mV
Frequency response	
flatness up to 8.5 MHz	±0.2 dB
Risetimes (10 %/90 %)	±1 % ±5 ns
Half-amplitude duration (50 %)	±1 % ±5 ns
Overshoot	≤ ±1 %
S/N ratio (weighted in accordance with D2-MAC, 200 kHz to 7.5 MHz, measured with all-grey signal or ramp)	> 72 dB (referred to 1 V)

Inputs/outputs

D2-MAC outputs	BNC, front panel and rear panel
Return loss up to 8.5 MHz	> 34 dB (Z_{out} = 75 Ω)
Synchronization input (CVS)	BNC, loop-through circuit, rear panel
Return loss up to 6 MHz	> 36 dB
Pull-in range	15.625 kHz $\pm 2.5 \times 10^{-6}$
Clock output/input	BNC, rear panel, $Z_{out/in}$ > 1 kΩ
Output	20.25 MHz
Input	20.25 MHz $\pm 2.5 \times 10^{-6}$
Trigger output	BNC, rear panel, Z_{out} approx. 75 Ω
Line-repetitive signal	TTL level
Field-repetitive signal	TTL level

Operation	from front panel or extra keyboard
Memory	9 complete setups
Display	7″ screen, menu in German, English or French
Remote control	IEC-625/IEEE-488 bus and RS-232-C

General data

Rated temperature range	+5 to +45 °C
Power supply	100/120/220/240 V −10 %/+15 %, 47 to 63 Hz (150 VA)
Dimensions (W × H × D)	435 mm × 192 mm × 460 mm
Weight	19 kg

Ordering information

Order designation	▶ D2-MAC Generator SDMF 2000.0003.02

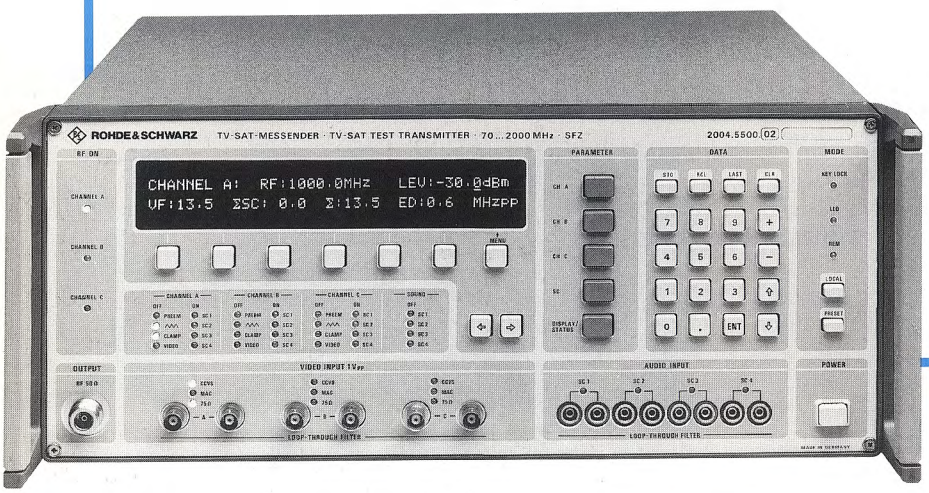
D-MAC/D2-MAC generator including scrambling test on request.

Recommended extra

Keyboard PCA-Z1	375.7511.02

SFZ

TV-SAT Test Transmitter SFZ ♦ 70 to 2000 MHz



- Customized configuration
  - can be fitted with max. 3 IF channels and 4 FM sound subcarrier modules
  - baseband processing to PAL, SECAM, NTSC or D/D2-MAC
- Continuous tuning
- RF control switchable to clamped or average mode
- Sound subcarrier adjustable from 5.0 to 9.0 MHz in 10-kHz steps
- Standard energy dispersal signal (25/30 Hz)

IEC 625 Bus

Uses, characteristics

TV-SAT Test Transmitter SFZ delivers all IF carrier signals which are required in the development and production of receiving equipment handling TV programs transmitted via broadcast and telecommunications satellites.

Moreover, the SFZ can be used as a continuously tunable FM modulator in transmission and distribution systems for servicing and for standby operation as well. The TV-SAT Test Transmitter handles external video signals to PAL, SECAM or NTSC as well as D/D2-MAC baseband signals in accordance with the standard used.

Modular design allows customized configuration of the SFZ. Retrofitting or later modification is possible without any problem by adding or exchanging the corresponding modules.

For intermodulation measurements in line with the three-carrier method, a module comprising two additional attenuators is available and can be inserted instead of one of the four sound subcarrier modules, thus permitting individual level adjustment of the IF carrier signals.

Combined **hardkey and softkey control** makes the SFZ **user-friendly** and allows simple, rapid entry of all relevant signal data. The **status menu** gives a clear overview of the most important parameters for each channel, ie frequency, level, deviation of video signal, subcarrier and energy dispersal signal. Operating states which do not meet the standard, for instance disconnected preemphasis, energy dispersal signal, clamping or video input, are promptly revealed by front-panel LEDs. The selected parameters can be locked by a keystroke, eg for continuous operation and thus protected against inadvertent modification. All functions of the SFZ are menu-guided and can be remote-controlled via the IEC/IEEE bus.

Configuration examples

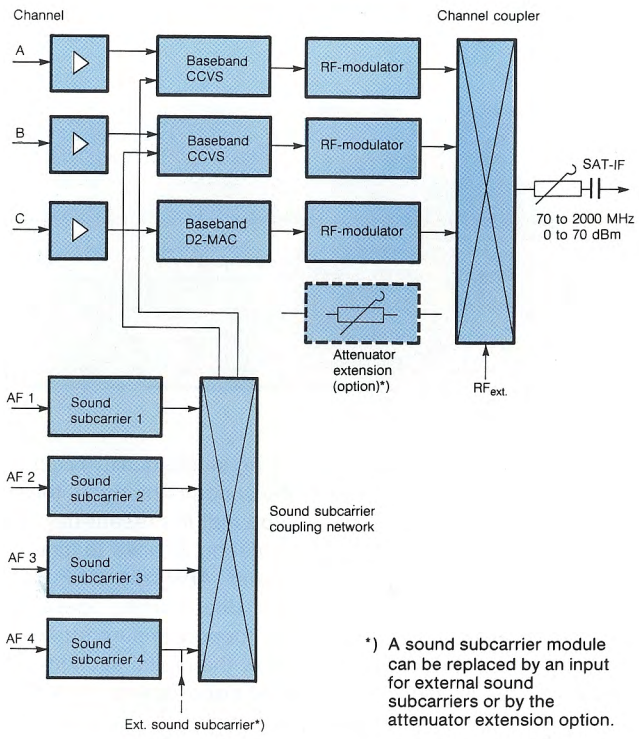
SFZ mainframe, fitted with: Order No.	**CCVS basic module** 1 channel 70 to 2000 MHz, PAL CCVS with one sound subcarrier 2004.5500.11	**D/D2-MAC basic module** 1 channel 70 to 2000 MHz, D/D2-MAC, no FM sound subcarrier 2004.5500.81	**Customized configuration** 3 channels 70 to 2000 MHz, 2 × PAL CCVS, 1 × D/D2-MAC 4 × FM sound subcarrier 2004.5500.xx
RF modulator Order No.: 2004.6206.02	●	●	●●●
CCVS processing module Order No.: 2004.6306.02	●	–	●●
D/D2-MAC baseband processing module Order No.: 2004.6406.02	–	●	●
FM sound subcarrier module Order No.: 2004.6506.02	●	–	●●●●
Sond subcarrier coupling network Order No.: 2004.6606.02	–	–	●

Description

SFZ produces up to 3 frequency-modulated carrier signals in the satellite IF range from 70 to 2000 MHz. The IF carriers are added via a coupling network to obtain a common output signal. The IF carriers can be modulated with external PAL or NTSC or D/D2-MAC baseband signals in accordance with the baseband module used. Frequency control at the RF is either to signal average value or clamped to grey level (MAC signals) and the back porch (CCVS).

A mixed configuration of SFZ for composite and component signals is possible (see examples). In the CCVS processing module, a disconnectible lowpass filter with group delay equalization limits the video signals to a transmission bandwidth of 5 MHz. A switchable clamping circuit permits suppression of superimposed low-frequency noise signals. It is also possible to connect a standard energy dispersal signal and a preemphasis.

Each IF carrier (PAL, NTSC) can be modulated with a maximum of 4 FM sound subcarriers which are tunable in 10-kHz steps over the range from 5.0 to 9.0 MHz and can be added separately. The sound subcarriers can be modulated with internal or external AF signals; it is possible to select three different preemphases.



Block diagram of a customized configuration

Specifications

Frequency range	70 to 2000 MHz	
Frequency error of RF carriers	≤250 kHz	
RF frequency control	clamped or average value	
Output level	0 dBm	
Setting range	0 to −70 dBm in 1-dB steps	
Source impedance Z_s	50 Ω	
Connector	N female	
Energy dispersal signal		
Type	25- or 30-Hz triangular signal coupled with field repetition frequency (625/525 lines)	
Adjustable deviation*)	0 to 5 MHz, doubled automatically if the video or baseband signal is disconnected	
Resolution of deviation setting	100 kHz	
Video transmission characteristics		
Modulation type	frequency modulation (F3)	
Nominal video input level	1 V_{PP}	
Video input (per channel)	BNC female, 75 Ω	
Adjustable video deviation		
Input signal 1 V_{PP}	7.5 to 30 MHz	
Resolution	100 kHz	
Hum suppression with level clamping on	≥40 dB	
Linear distortion		
Frequency response flatness (ref. to 1.5 MHz)		
without preemphasis and without lowpass	10 Hz to 5 MHz	≤±0.3 dB
	5 MHz to 12 MHz	≤±0.7 dB
with preemphasis and lowpass	10 Hz to 4,8 MHz	≤±0.5 dB
with preemphasis, without lowpass	10 Hz to 5 MHz	≤±0.4 dB
	5 MHz to 12 MHz	≤±0.8 dB
Group delay		
without lowpass	200 kHz to 5 MHz	≤±5 ns
	5 MHz to 12 MHz	≤±10 ns
with lowpass	200 kHz to 4.8 MHz	≤±20 ns
Transients (streaking) with 200-ns rise and fall time	≤±2%	
Nonlinear distortion (measured with standard video signal and switched on preemphasis and deemphasis)		
Differential gain		
at 13.5-MHz deviation*)	≤±1.5%	
at 25.0-MHz deviation*)	≤±2.0%	
Differential phase		
at 13.5-MHz deviation*)	≤±1.5°	
at 25.0-MHz deviation*)	≤±2.0°	
Video-frequency S/N ratio referred to 21.5 MHz deviation*), with preemphasis and deemphasis,		
100 kHz to 5 MHz	≥70 dB rms, weighted to CCIR	
Sound subcarriers		
Frequency range	5.0 to 9.0 MHz	
Deviation*)	1 to 4 MHz	
Resolution	10 kHz	
External audio signal input		
Frequency range	30 Hz to 100 kHz	
Nominal level	+9 dBm (600 Ω)	
Impedance	≥5 kΩ, balanced	
Connector	female Lemo Triax	
Internal modulation signals	40 Hz, 100 Hz, 400 Hz, 1 kHz, 5 kHz, 10 kHz, 15 kHz	
AF deviation*) (adjustable)	0 to 600 kHz	
Resolution	1 kHz	
Modulation distortion	<0.5%	
Preemphasis (switchable)	50 µs, 75 µs, J17, off	

General data

Rated temperature range	+5 to +45 °C
Power supply	100/120/220/240 V +15/−10%, 47 to 63 Hz (150 VA), safety class I, to VDE 0411 (IEC 348)
Dimensions (W × H × D)	435 mm × 192 mm × 460 mm
Weight	19 kg

Ordering information

Order designation	▶ TV-SAT Test Transmitter SFZ
PAL CCVS basic module	2004.5500.11
D/D2-MAC basic module	2004.5500.81
Options	
RF modulator	2004.6206.02
CCVS processing module	2004.6306.02
D/D2-MAC baseband processing module	2004.6406.02
FM sound subcarrier module	2004.6506.02
Sound subcarrier coupling network	2004.6606.02
Attenuator extension	2004.6806.02

*) Peak-to-peak deviation

UAF

Video Analyzer UAF ♦ Standard B/G

- 3 signal inputs
- 25 video parameters
- Limit monitoring
- Full-field measurements
- Freely selectable test signal
- Memory card
- Printer interface

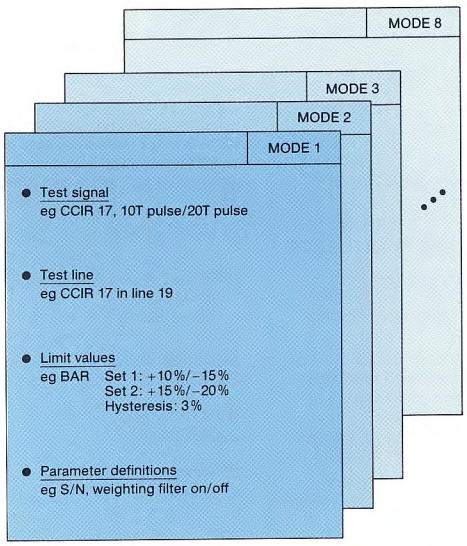
IEC 625 Bus

Measurement accuracy for satisfying studio quality requirements and measuring times in the seconds range — these are the standards which have to be met in present-day automatic video measurement engineering. Thanks to its outstanding characteristics, the **Video Analyzer UAF** fully complies with these requirements. User-friendly operation and a clear display with graphics support ensure straightforward measurements. The core of the digital section is a microprocessor plus an **arithmetic coprocessor**. It rapidly calculates the results from the samples averaging them over the integration time.

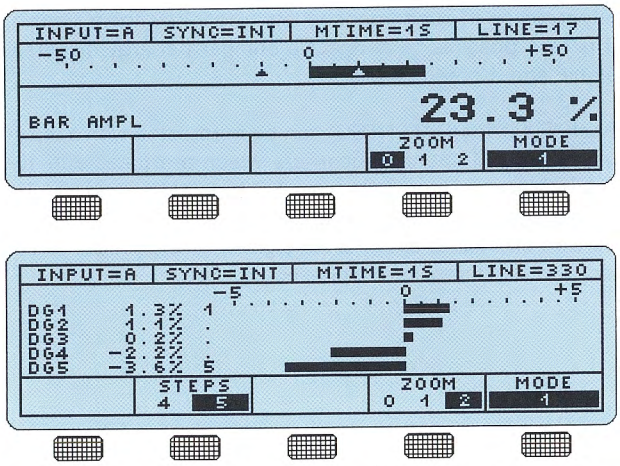
Characteristics, uses

The signal analysis comprises **25 video and test line parameters** and covers all important levels as well as linear and nonlinear distortions such as 2T K rating, frequency response and hum. 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, be it in the studio or in production. In the case of very noisy VTR signals, on long transmission links or at the end of a long line of transposers, increasing the integration time to 2.5, 5 or 10 s always yields stable results.



For rapid recall, for instance within a fest routine, the UAF is able to store up to 8 test configurations (modes 1 to 8).



The test results are displayed either in the form of numerical values or as a bar

For use in quality and production control of video recorders, the UAF also handles the **S-VHS component signals Y/C.** Distorted test signals due for instance to jitter or head switchover do not affect the operation of the UAF.

Memory card Using a plug-in memory card, customer-defined test and data-logging programs can be loaded and the test results also stored on the card. For measurements in the field, on cable networks or at inaccessible points in transmitter, it is not necessary to bring along a computer or printer to log data.

Moreover, the memory card permits **storage of complete instrument setups**: limit values, test parameter definitions, filter settings in the case of noise voltage measurements as well as line numbers of the eight test configurations. Thus any measurement can be reproduced.

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. Thus all parameters can be checked at a glance for adherence to set limits.

The illuminated **LC display** shows the result in large figures which are easy to read even from some distance. Several parameters can be displayed at the same time in small characters. For certain applications, eg alignment, the **bar indication** proves useful.

The complete device setup and the selected limit values are contained in the upper lines of the display. The lower part shows the function of the unlabelled keys. These softkeys offer user prompting with respect to the displayed measured value or the called function.

The small 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 selected input, synchronization or printer mode.

The function **"option"** permits further test parameters, eg an external level or future extensions, to be called up.

For integration into computer-controlled test systems, all functions of the UAF can be remote-controlled via an IEC/IEE-bus interface. The UAF can also be used as the controller. If parameter logging is required for acceptance test measurements, a **printer** can be connected directly to the Centronics interface.

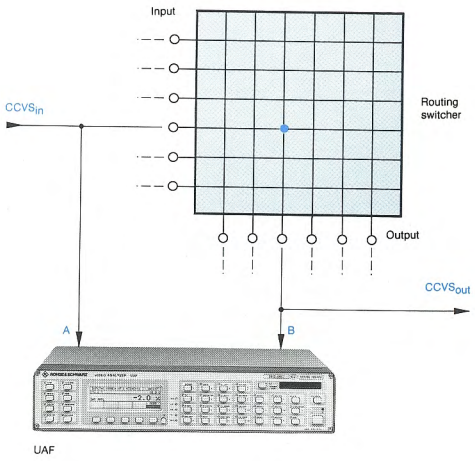
Special modes The **difference measurement** mode permits signal errors at the input of the device under test to be eliminated. For this purpose the input signal of the DUT is applied to channel A and the output signal to channel B of the UAF (righthand column, top). In this way it is possible to perform measurements on a transposer system or a cable headend receiving incorrect input signals.

Thanks to the high display accuracy of the UAF, the difference measurement mode is also suitable for high-precision studio measurements on components such as routing switchers which feature stringent tolerances.

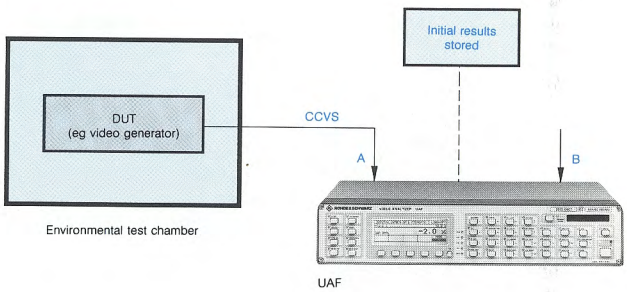
Reference measurement In this mode only one input of the UAF is connected to the DUT (righthand column, bottom), the first test cycle being stored as the reference. This mode facilitates determination of the effect of the environment (EMC, climate, etc.) on video generators in the lab and in servicing.

Automatic test sequence The AUTORUN menu allows test sequences to be programmed on the UAF front panel; these sequences are executed automatically and can be repeated cyclically using the built-in real-time clock. An AUTORUN routine may for instance ensure input switchover, mode variation, limit monitoring and result logging.

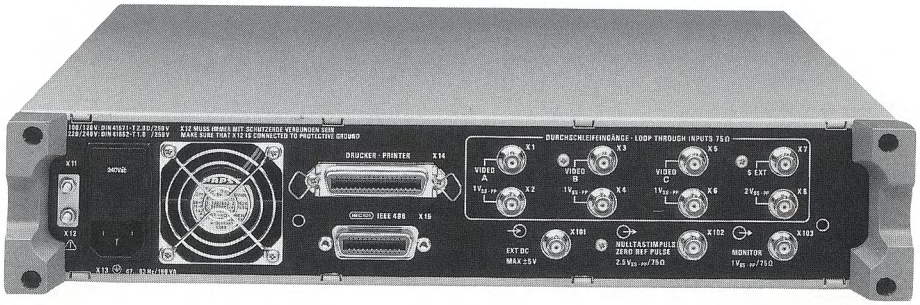
Difference measurement



Reference measurement

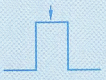
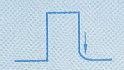
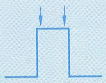
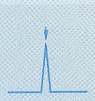
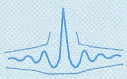
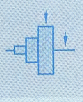
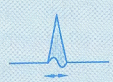


Since the UAF is able to act as a controller via the IEC/IEEE bus, its controller functions can be included in an AUTORUN routine. Thus it is for instance possible to send commands to the IEC/IEEE-bus-compatible TV Test Receiver EMFP (see page 146) in order to set the receive channel. Without the use of a controller, the UAF and EMFP are able to set all channels of a cable network, monitor the signal quality and print error logs in the AUTORUN mode. This capability can even be extended when using the Video Selector VSF (see catalog 90/91, page 535).



Rear panel of UAF

Specifications UAF

Test parameter		Key label	Measurement range	Resolution	Error limits[1]) at nominal	Additional max. error per 1% (1°, 1 ns) departure from nominal
Luminance bar amplitude		**BAR AMPL**	−100 to +100%	0.1%	±0.3%	0.015%
Black level distortion		**BASELINE DIST**	−20 to +40%	0.1%	±0.3%	0.045%
Tilt of luminance bar		**TILT**	−40 to +40%	0.1%	±0.3%	0.045%
2T pulse amplitude		**2T AMPL**	−50 to +50%	0.1%	±0.5%	0.03%
2T K factor		**2T K FACTOR**	0 to +10%	0.1%	±0.7%	0.03%
Luminance nonlinearity		**LUM NL**	0 to +50%	0.1%	±0.5%	0.01%
Residual picture carrier		**RES PC**	0 to +30%	0.1%	±0.3%	0.015%
Sync pulse amplitude Reference = signal Reference ≈ nominal		**SYNC AMPL**	−50 to +50% −80 to +100%	0.1% 0.1%	±0.5% ±0.5%	0.01% 0.01%
Colour subcarrier gain CCIR 331 CCIR 17		**C/L GAIN**	−50 to +50% −50 to +50%	0.1% 0.1%	±1.0% ±1.0%	0.02% 0.02%
Chrominance/luminance intermodulation CCIR 331 CCIR 17		**C/L INTERMOD**	−50 to +50% −50 to +50%	0.1% 0.1%	±0.3% ±1.0%	0.01% 0.02%
Chrominance/luminance delay		**C/L DELAY**	−500 to +500 ns	1 ns	±5 ns	0.01 ns
Differential gain positive/negative peak-to-peak		**DIFF GAIN**	−50 to +50% 0 to ±100%	0.1%/0.01%[2]) 0.1%/0.01%[2])	±0.3% ±0.5%	0.025% 0.015%
Differential phase positive/negative peak-to-peak		**DIFF PHASE**	−50 to +50° 0 to +100°	0.1°/0.01°[2]) 0.1°/0.01°[2])	±0.3° ±0.5°	0.025° 0.015°
Nonlinearity of colour subcarrier gain positive/negative peak-to-peak		**C NL GAIN**	−50 to +50% 0 to +100%	0.1% 0.1%	±0.7% ±1.0%	0,025% 0.02%
Nonlinearity of colour subcarrier phase positive/negative peak-to-peak		**C NL PHASE**	−50 to +50° 0 to +100%	0.1° 0.1°	±0.7° ±1.0°	0.025° 0.02°

Test parameter		Key label	Measurement range	Resolution	Error limits[1] at nominal	Additional max. error per 1% (1°, 1 ns) departure from nominal
Burst amplitude Reference = signal Reference = nominal		**BURST AMPL**	 −50 to +50% −80 to +80%	 0.1% 0.1%	 ±1% ±1%	 0.02% 0.02%
Multiburst amplitude		**MULTIB 1 to 6**	−80 to +50%	0.1%	±1%	0.02%
Luminance signal/noise ratio		**S/N**	25 to 80 dB	0.1 dB	±1 dB	–
Intermodulation between colour subcarrier and sound carrier		**C/SND INTERMOD**	30 to 70 dB	0.1 dB	±1 dB	–
Hum		**HUM**	6 to 60 dB	0.1 dB	±1 dB	–
DC measurement			−5 to +5 V	5 mV	±10 mV	–

Signal inputs ..... 3 video inputs, 75-Ω loop-through filters, 3 × CCVS or 1 × Y/C and 1 × 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 ..... 1 input, loop-through filter
Nominal level ..... 2 V/4 V into 75 Ω (V_{PP})
SIS ..... permissible

Parameters ..... 25 test parameters, direct key selection
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 ..... setting of test signal, test lines, ON state display mode, limit values, IEC/IEEE-bus address, printer type, date and time
MEAS TIME ..... measuring time 1/2.5/5/10 s, selectable
MEAS HOLD ..... measured values of all parameters are simultaneously frozen
PRINT ..... measured value output via printer (Centronics interface)
MONITORING ..... limit monitoring of single parameters, parameter groups or all parameters; out-of-limit indication by blinking of associated LED, acoustical alarm can be switched on, result logging; two upper and two lower parameter limits freely adjustable for every mode
AUTORUN ..... entry and recall of user-defined test routine
Difference measurements ..... selectable between two inputs (measuring time doubled)
Reference measurement ..... on test cycle stored as reference

Indication ..... LC display
Display mode (selectable) ..... numerical, 1 parameter
numerical, 3 parameters
numerical with bar display
Types of indication ..... measured value, limit values, major modes, prompting
Language ..... German, English, French or Italian

Interfaces and outputs
IEC/IEEE bus ..... interface to IEC 625-2/IEEE 488-2
Printer ..... Centronics interface
Memory card ..... storage of measured values, limit values and parameter definitions, devices setups and user-defined test routines
Monitor output ..... clamped test signal, also for display of measurement timing, level same as input signal ±1%, 75 Ω
Zero reference control ..... 2.5 V_{PP} ±10% into 75 Ω, position and duration adjustable

General data

Rated temperature range ..... +5 to +45 °C (application class I to IEC 359)
Power supply ..... 100/120/220/240 V ±10%, 47 to 63 Hz, 115 VA, safety class I, to VDE 0411 (IEC 348)
Dimensions (W × H × D) ..... 435 mm × 103 mm × 460 mm
Weight ..... 10 kg

Ordering information

Order designation ..... ▶ Video Analyzer UAF 2013.0807.02
Standard B/G
Other standards on request.
Accessories supplied ..... power cord, spare fuses, manual four 75-Ω Terminations RMF 2, 32-kbyte memory card

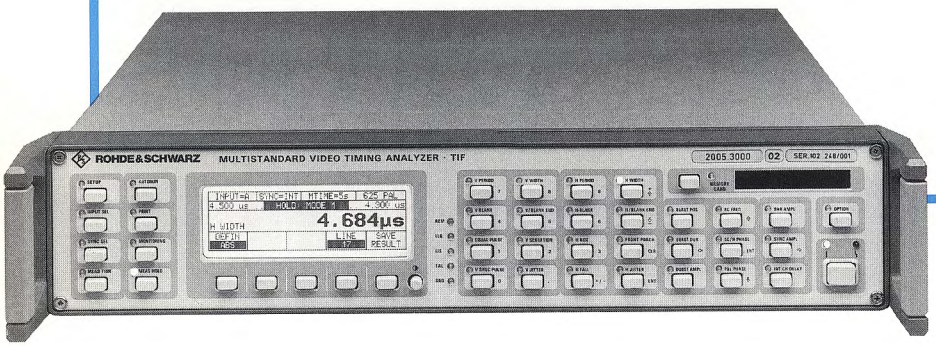
Recommended extras
Memory card 32 kbyte ..... ZZM-32 ..... 2005.4394.02
128 kbyte ..... LZ-50 ..... 852.6507.02
512 kbyte ..... ZZM-512 ..... 2005.4388.02
Service manual 2013.1684.24

[1]) With the difference and reference measurement modes, the attainable error limits are ±2 digits for all parameters.
[2]) Higher resolution for difference and reference measurements.

TIF

Multistandard Video Timing Analyzer TIF ♦ All Standards

- CCVS and analog components
- 25 test parameters
- High measuring speed
- Memory card
- Printer interface

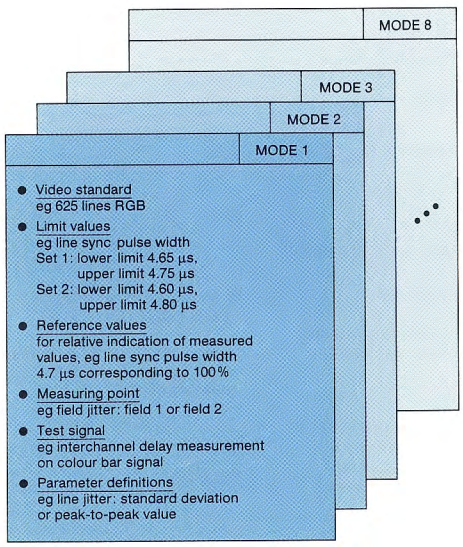


IEC 625 Bus

Uses, characteristics

Use in the **studio** is a typical application of the **Multistandard Video Timing Analyzer TIF**. Problems related to measurement during generation, processing and synchronization of video signals as well as to standards conversion can be solved by this device with maximum precision in the minimum of time. Signal processing is fully digital using **state-of-the-art transputer technology**. The TIF copes even with the most complex signals and handles **all current video standards**.

The variety of signal sources in the studio, from the film scanner via studio VRTs through to the video recorder, from the substitution signal via microwave links through to the satellite receiving system, give rise to signals of very different quality exhibiting typical errors. Moreover, the variety of standards – 625 and 525 lines, PAL, SECAM, NTSC and different component signal forms — in no way facilities measurements in the studio.



For quick recall, eg within a test routine, the TIF is able to store internally up to eight configurations (modes 1 to 8)

For quality assessment of **VTRs**, jitter measurement is of particular importance. During postprocessing, synchronization errors may easily occur and cause malfunction of special-effect devices, test or data line inserters.

If, when **cutting and recording** on a VTR, the SC/H phase, ie the phase relation between colour subcarrier and sync signal, is not taken into account, this causes for instance a malfunction of the **time base corrector** upon reproduction and thus a horizontal shift of the picture. This means that the two aspects – the SC/H phase as the cause and the disturbance of the sync frame as the result – have to be monitored. If measurements to this effect are made ahead of the time base corrector, the measuring device has to cope with the uncorrected signal of a **B- or C-format VTR**.

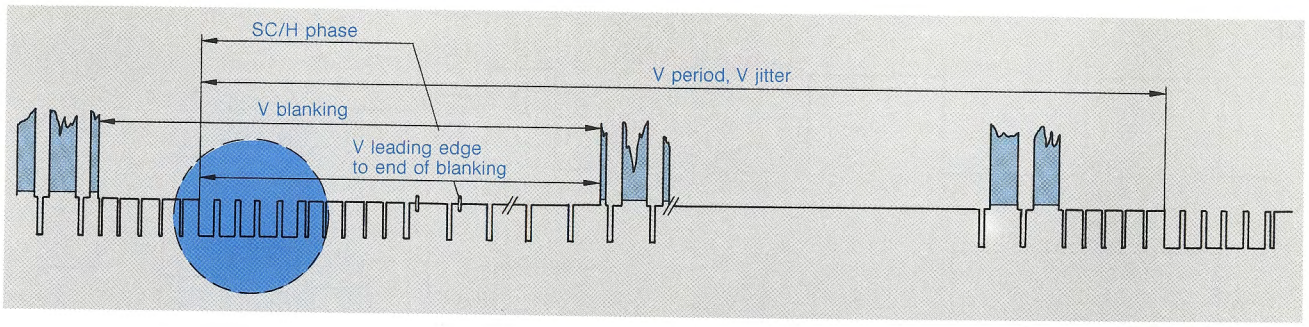
When distributing video signals in the studio, the tolerances of the permissible interchannel delay at the inputs and outputs of **routing switchers** and **mixers** are particularly stringent. **Component signals** are critical as regards timing errors of the individual components. The TIF permits measurement of interchannel delay without any problem while the equipment is in service, ie during the ongoing program.

The Multistandard video Timing Analyzer TIF is equipped to handle all tasks with maximum precision and speed regardless of whether measurements on coded composite colour video signals (CCVSs), Y/C or component signals such as RGB and YC_BC_R are to be performed.

Operation

Internal processing in the TIF is up to 80% digital – all test parameters are determined by digital processing. However, the operator has the impression of using a test set and not a computer. Many important features ensure **ease of operation** of the device:

- clear results on a large, easy-to-read LCD
- prompting by user-defined softkeys
- one key per test paramter



The different test parameters of the TIF: vertical parameters and SC/H phase; horizontal parameters shown for CCIR-17 test signal (PAL system)

- limit monitoring of all parameters
- language selectable for displayed messages (eg German, English, French, Italian)
- storage of device setups and results in the device or on a memory card
- portable thanks to light weight and small dimensions
- IEC/IEÉE-bus and Centronics interfaces

The **memory card** is a storage medium and enhances the flexibility and range of applications of the TIF considerably. Using the memory card it is for instance possible to store autorun programs, measured data and device setups.

Test parameters

All parameters which are **important for video signal assessment** can be measured with the TIF (see diagrams to the right).

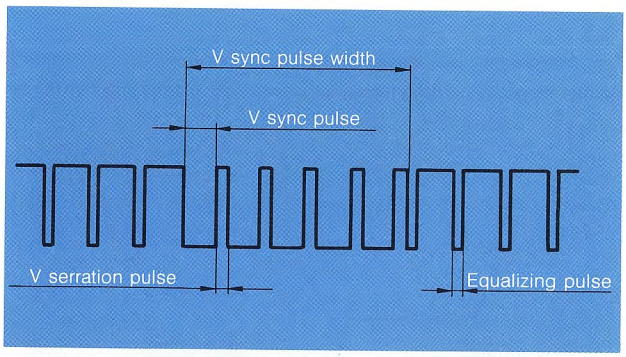
The **vertical parameters** are used for checking all sync and blanking signals within the field blanking interval for adherence for the relevant standards; this group covers for instance the field sync pulse as such, the serration and the equalizing pulses and the interval up to the beginning of the picture contents.

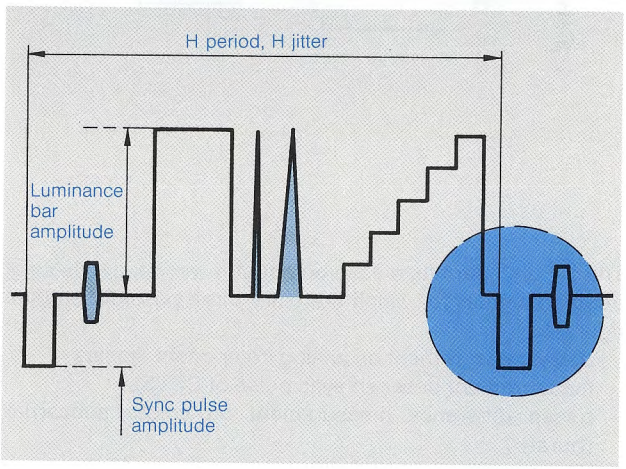
The second important group covers the **horizontal parameters**. In this case, the TIF determines the sync pulse width, the rise and fall times of the sync pulse edges and the line period.

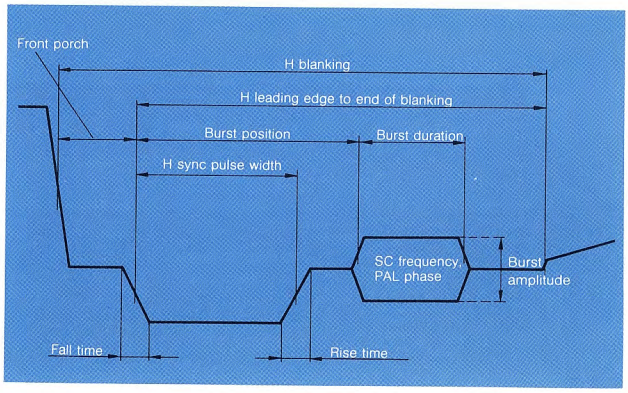
Jitter measurement is a special feature of the TIF. In this mode variations of the line period, which occur in particular with video recorders, can be measured.

Naturally the **burst** as the sync signal for colour transmission is measured. In addition to the frequency of the burst, its position, duration and amplitude can be determined.

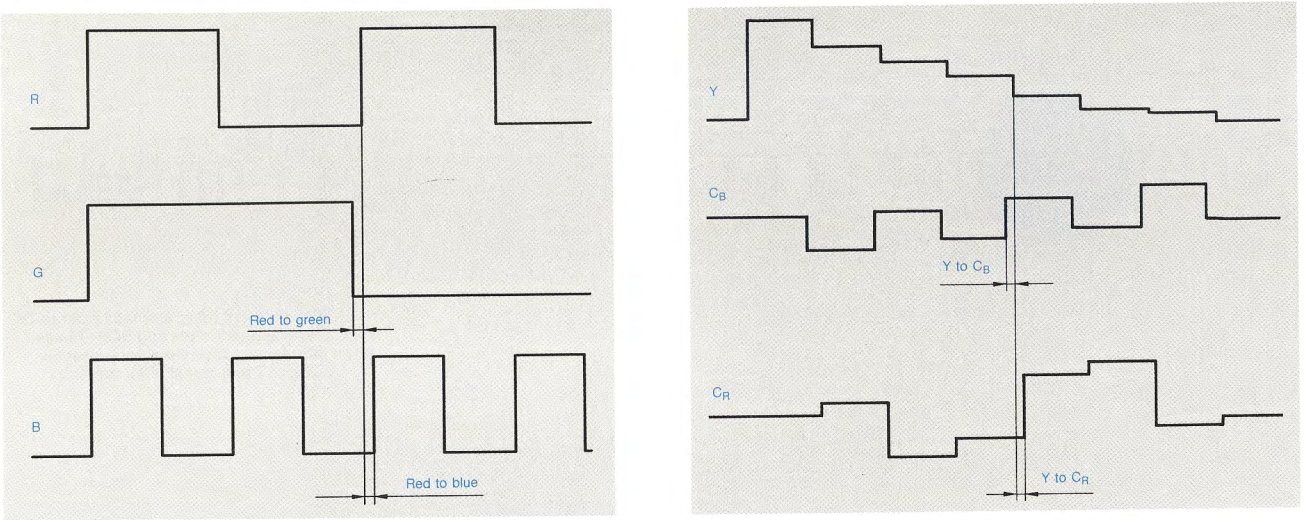
A parameter which cannot be assessed on a conventional oscilloscope is the **colour subcarrier phase**. The TIF measures the SC/H phase and the PAL burst phase, two important quality criteria. With the SECAM colour system, these criteria are the two carrier frequencies for the colour difference signals.



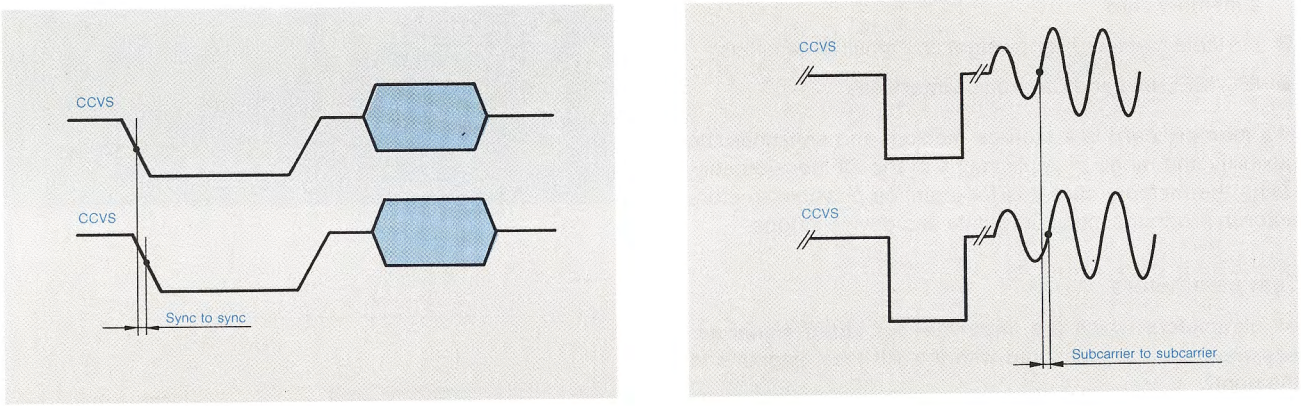




TIF



Top: interchannel delay measurement for component signals using colour bar signal.
Bottom: interchannel delay measurement on CCVS; measurement on the sync pulse edge (left), measurement of phase difference on colour subcarrier (right).

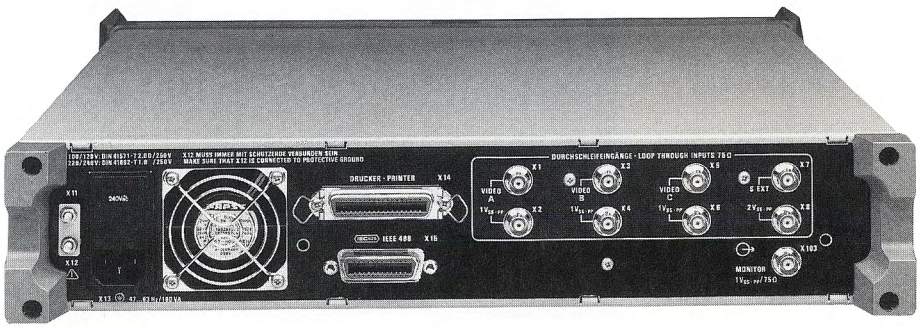


The TIF also permits measurement of **interchannel delay** of coupled signals for which there are three possibilities (see figures):

- delay measurement on analog component signals
- measurement between sync pulse of CCVSs
- phase difference measurement on colour subcarrier (burst)

Although the paramters **luminance bar** and **sync pulse** are not really timing parameters, they are necessary for assessment of the values measured and can therefore also be determined with the TIF.

The TIF is fitted with three video inputs and a sync signal input. Thus three CCVSs or one component signal can be monitored.



TIF rear panel

Specifications

Test parameters	Key label	Measurement range 525 lines	Measurement range 625 lines	Resolution	Error limits[1] ±1 digit
Vertical parameters					
Field period	**V PERIOD**	16683 ±30 µs	20000 ±30 µs	1 ns	±5 ns
Field sync pulse width	**V WIDTH**	190.666 ±40 µs	160 ±40 µs	1 ns	±5 ns
Field blanking	**V BLANK**	1.15 to 3.7 ms	1.41 to 4 ms	10 ns	±50 ns
Field leading edge to end of blanking	**V/BLANK END**	1.15 to 3.7 ms	1.41 to 4 ms	10 ns	±50 ns
Equalizing pulse	**EQUAL PULSE**	2.3 ±1 µs	2.35 ±1 µs	1 ns	±2 ns
Field serration pulse	**V SERRATION**	4.7 ±2 µs		1 ns	±2 ns
Field sync pulse	**V SYNC PULSE**	27 ±4 µs		1 ns	±2 ns
Field jitter	**V JITTER**	0 to 30 µs		1 ns	±5 ns
Horizontal parameters					
Line period	**H PERIOD**	63.556 ±4 µs	64 ±4 µs	1 ns	±2 ns
Line sync pulse width	**H WIDTH**	4.7 ±2 µs		1 ns	±2 ns
Line blanking	**H BLANK**	7 to 65 µs		1 ns	±50 ns
Line leading edge to end of blanking	**H/BLANK END**	6 to 60 µs		1 ns	±50 ns
Rise time	**H RISE**	80 ns to 1 µs		1 ns	±5 ns
Fall time	**H FALL**	80 ns to 1 µs		1 ns	±5 ns
Front porch	**FRONT PORCH**	1 to 5 µs		1 ns	±50 ns
Line jitter	**H JITTER**	0 to 4 µs		1 ns	±5 ns
Chroma Parameters					
Burst position	**BURST POS**	4.7 to 6 µs		1 ns	±10 ns
Burst duration	**BURST DUR**	1.5 to 3 µs		1 ns	±10 ns
Burst amplitude	**BURST AMPL**	150 to 450 mV		1 mV	±10 mV
Subcarrier frequency	**SC FREQ**	PAL 4433618 ±100 Hz		0.05 Hz	±1 Hz
		M-PAL 3575611 ±100 Hz		0.05 Hz	±1 Hz
		N-PAL 3582056 ±100 Hz		0.05 Hz	±1 Hz
		NTSC 3579545 ±100 Hz		0.05 Hz	±1 Hz
		SECAM 4.1 to 4.5 MHz		50 Hz	±200 Hz
SC/H phase	**SC/H PHASE**	±90°		1°	±4°
PAL phase	**PAL PHASE**	90° ±90°		1°	±4°
Miscellaneous					
Luminance bar amplitude	**BAR AMPL**	350 to 1050 mV		1 mV	±10 mV
Sync pulse amplitude	**SYNC AMPL**	150 to 450 mV		1 mV	±10 mV
Interchannel delay between two inputs	**INT CH DELAY**				
Edge measurement		±2 µs		1/0.1 ns[2]	±5/±1 ns[2]
Colour subcarrier measurement		±180°		1°/0.1°[2]	±5°/±1°[2]

Inputs ..... 3, 75-Ω loop-through filters
Level ..... 1 V_{PP} ±50%
Return loss
  up to 6 MHz ..... ≥40 dB
  from 6 to 10 MHz ..... ≥36 dB
TV standard ..... 625 and 525 lines, PAL, NTSC, SECAM, RGB, YC_BC_R
Synchronization
  Internal ..... optional from 1 of 3 inputs, sync level 300 mV +100/−50%
  External ..... 1 input, loop-through filter, nominal level 2 V/4 V into 75 Ω (V_{PP})
Parameters ..... 25, direct key selection

Special functions
SETUP ..... setting of ON state, limit values, IEC/IEEE-bus address, printer type, date/time
MEAS TIME ..... measurement time 1/2.5/5/10 s, adjustable
MEAS HOLD ..... measured values of all parameters are simultaneously frozen
PRINT ..... measured value output via printer (Centronics interface)
MONITORING ..... limit monitoring of single parameters, parameter groups or all parameters, indication by blinking of associated LEDs, acoustical alarm can be switched on; two upper and two lower parameter limits freely adjustable for every mode
AUTORUN ..... entry and recall of user-defined test sequence

Indication ..... LCD
Scope of indication ..... measured, value, limit values, important modes, prompting

Language ..... selectable: German, English, French or Italian

Interfaces and outputs
IEC/IEEE bus ..... interface to IEC 625-2/IEEE 488-2
Printer ..... Centronics interface
Memory card ..... storage of measured values, limit values and parameter definitions, device setups and user-defined test routines
Monitor output signal ..... 1 V_{PP} ±10% into 75 Ω, clamped test signal for display of measurement timing in HOLD mode

General data
Rated temperature range ..... +5 to +45 °C (application class I to IEC 359)
Power supply ..... 100/120/220/240 V ±10%, 47 to 63 Hz (80 VA), safety class I, to VDE 0411 (IEC 348)
Dimensions (W × H × D) ..... 435 mm × 103 mm × 460 mm
Weight ..... 10 kg

Ordering information

Order designation ..... ▶ Multistandard Video Timing Analyzer TIF 2005.3000.02

Accessories supplied ..... Power cord, spare fuses, manual, four 75-Ω Terminations RMF 2, 32-kbyte memory card

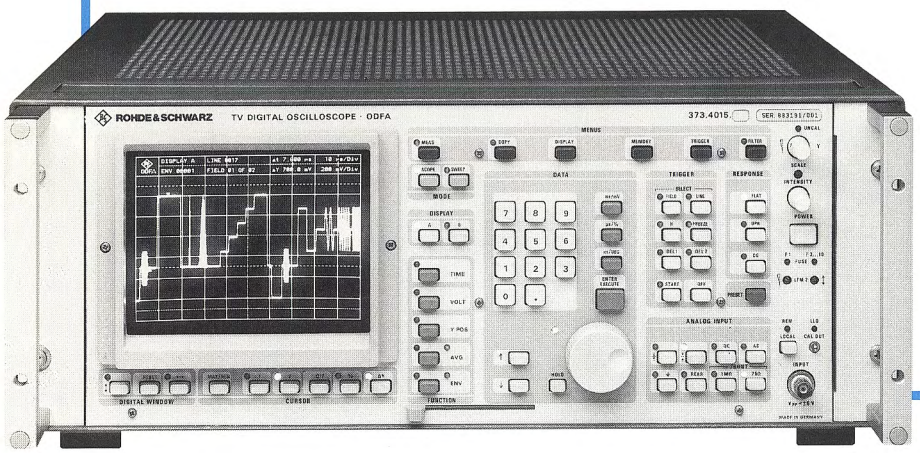
Recommended extras

Memory Card	32 kbyte	ZZM-32	2005.4394.02
	128 kbyte	LZ-50	852.6507.02
	512 kbyte	ZZM-512	2005.4388.02
Service manual		.....	2005.3269.24

[1] Values apply to undistorted video signal.
[2] Increased accuracy in case of single measurement.

ODFA

TV Digital Oscilloscope ODFA ♦ 0 to 10 MHz



- High measurement accuracy due to 10-bit A/D converter and digital signal processing
- Easy operation through softkeys
- Automatic test routines for test line evaluation
- Cursors for timing, amplitude and frequency-response measurements (sweep mode)
- Teletext analysis
- Graticule and tolerance-mask insertion
- Storage of settings and test curves

IEC 625 Bus

Uses, characteristics

The **TV Digital Oscilloscope ODFA** is a 10-bit analyzer for high-precision digital signal processing; it is based on the well-proven technology of its predecessor ODF. The signals on the screen feature a resolution of 0.1% of the display height and width. For use in automatic test systems, the ODFA is fitted with an IEC/IEEE-bus interface.

Uses The TV Digital Oscilloscope can be used wherever video signals are produced and transferred, and quality has to be kept at the required high standard. This applies to TV studios as well as to TV transmitters and TV transmitting and receiving equipment.

Selected quality parameters are being increasingly monitored automatically but often there are impairments which cannot be detected by automatic monitoring. In these cases, the best solution is additional signal analysis with the aid of a high-resolution digital oscilloscope.

The ODFA is used for both display and automatic analysis of the video signals and individual measurements using the cursors.

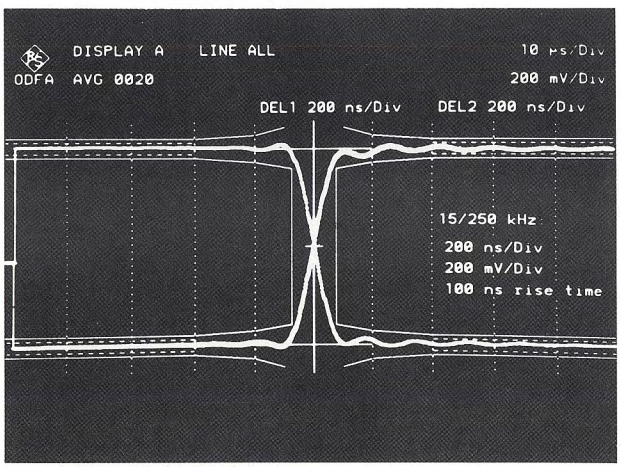
Operation

The **operational concept** of the ODFA is such that when the scope mode is selected, only a few keys are needed to set up the required display. The most important settings such as time and amplitude scales, Y adjustment and triggering are accessible in clear form and can be selected via a numerical keypad and a spinwheel. Expansion displays with two independent delay time bases can be selected and adjusted using an intensify bar. The measuring facility for differential phase and gain can also be operated from the front panel.

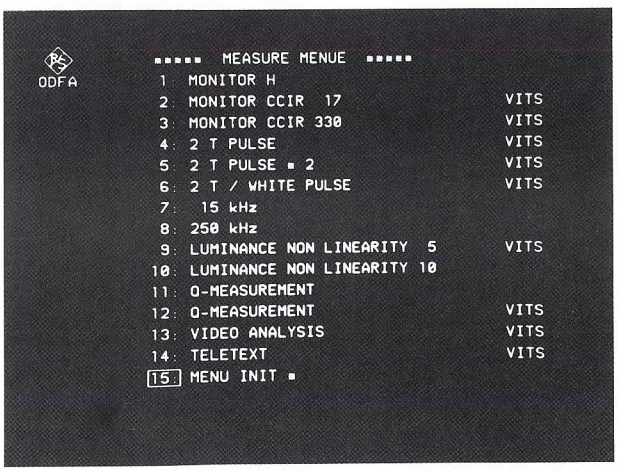
The setting parameters which are required less often can be recalled by menu keys and selected and modified on the screen with the aid of a cursor.

Menus Whereas the mode keys are associated with single functions, the six menu keys of the ODFA are assigned groups of complex measurement tasks; it is possible to select the following menus:

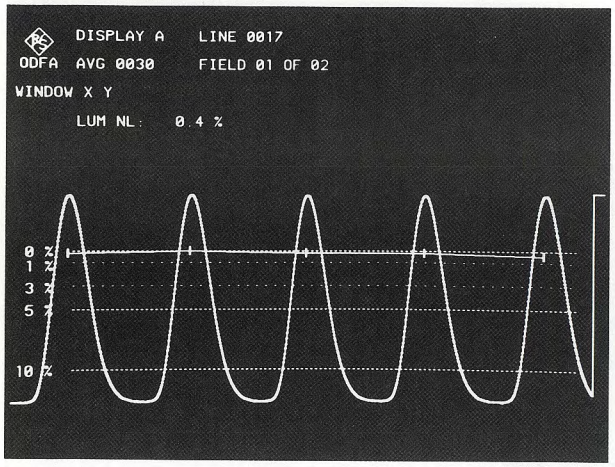
- MEAS Automatic measurement in the test lines and the full field (see diagram below)



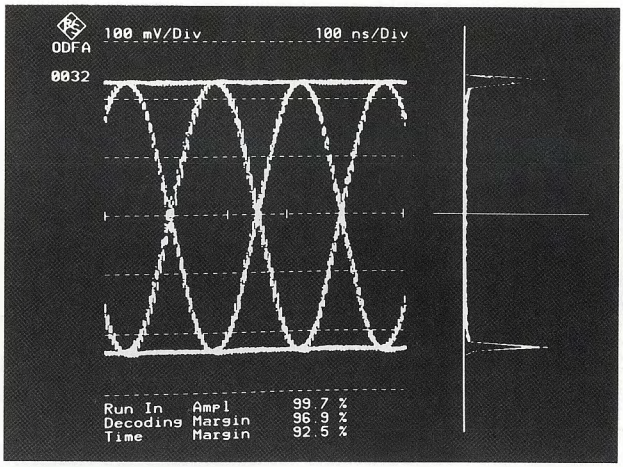
Transient response of 250-kHz-squarewave signal



Automatic test routines of ODFA



Line-time nonlinearity characteristic and spike display with measured-value indication



Eye pattern of a teletext line with indication of decoding and timing margins plus histogram display

- **COPY** Output on a plotter and selection of the IEC/IEEE-bus address of the plotter
- **DISPLAY** Selection of specific curves for display, mathematical curve processing and text insertion
- **MEMORY** Storage of curves and settings plus scale selection (17 scales are available)
- **TRIGGER** Selection of trigger settings other than the default settings in the scope mode
- **FILTER** Selection of analog filters for TV signal measurements (spike filter, lowpass, 4.43-MHz bandpass)

Sweep mode In this mode flicker-free display and cursor readoff of swept-measurement curves (amplitude and group-delay response characteristics) of a DUT from Group-delay Measuring Set LFM 2 or Selective Demodulator LDS are possible on the ODFA. The tolerance masks included in the specifications of TV transmitting and receiving equipment can be displayed on the ODFA and thus allow rapid and clear assessment of the transmission parameters.

Specifications

Display

Screen	130 mm × 100 mm (flat-faced)
Colour	green
Persistence	medium (GR)
Graticules, tolerance masks and front-panel parameters	electronically inserted

Y axis

Resolution	1024 steps (= 10 bits)
Deflection factor	10 to 500 mV/div
Frequency range	0 to 10 MHz (DC coupling) 100 Hz to 10 MHz (AC coupling)
Frequency response flatness	
≤5 MHz	≤±0.1 dB (20 to 500 mV/div)
≤10 MHz	≤±0.3 dB (50 to 500 mV/div)
Y inputs	BNC female
Front panel	1 MΩ; 75 Ω can be connected in parallel
Return loss	≥34 dB (up to 6 MHz)
Rear panel	75-Ω loop-through filter
Return loss	≥34 dB (up to 6 MHz)
Total attenuation	1:125
continuous	≥1:2.5
in steps	1/2/5

TV measurements

Lowpass filter	
Attenuation at 1 MHz	≤4 dB
at 4.43 MHz	≥40 dB
Bandpass filter	4.43 MHz
Clamping for CCVS (CVS)	to black level
Hum suppression with ≤30% superimposed, referred to picture signal	≥40 dB
Black level discontinuities with any picture signal	≤±1%

X axis

Time base	100 ns/div to 500 ms/div, switchable in 1/2/5 steps
Inherent error of X axis	≤±0.5% ±2 ns

Triggering

Trigger source	int./ext./50 Hz
Trigger level NORM, AUT	adjustable
50 Hz	fixed
V1, V2, H	automatically set to half the sync pulse height
Line selection	lines 1 to 625
Polarity selection	+/–
Start delay	2 separate, digital delay adjustments for alternating display
Step width	1/1000 display width (min. 100 ns)
Min. time windows selectable	main time base/100 for > 10 µs/div
Remote control	interface to IEC 625-1/ IEEE 488

General data

Rated temperature range	+5 to +40 °C
Operating temperature range	0 to +50 °C
Storage temperature range	–20 to +70 °C
Power supply	100/120/220/240 V ±10%, 47 to 63 Hz (330 VA)
Dimensions (W × H × D)	492 mm × 205 mm × 514 mm
Weight	25 kg

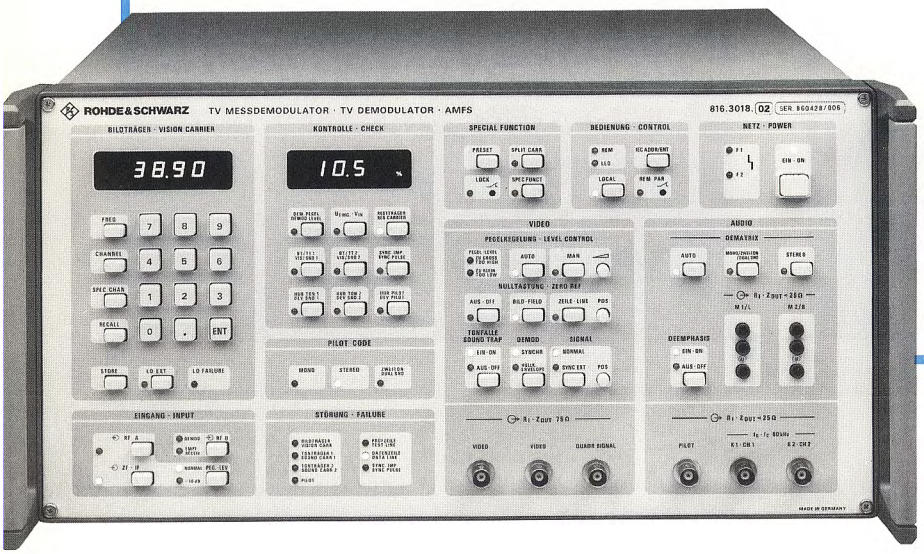
Ordering information

Order designation	▶ TV Digital Oszilloscop ODFA 373.8085.02
Accessories supplied	power cord

AMFS

TV Demodulator AMFS ♦ 38.9 and 42 to 960 MHz

- Precision vestigial-sideband demodulator to standard B/G
- Synthesizer LO of high spectral purity
- Two-carrier sound demodulation by intercarrier or split-carrier method, switch-selected
- Measurement of main vision and sound parameters
- Suitable for measurements on transmitters with ABC



IEC 625 Bus

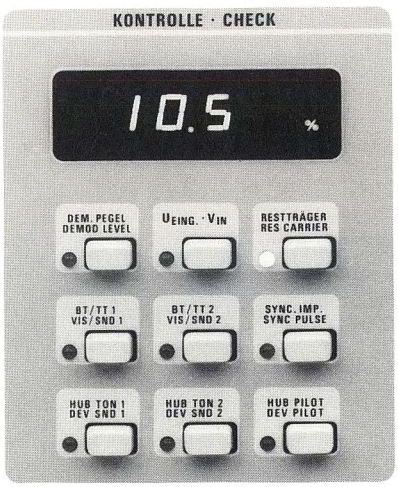
The transmitted TV signal has to comply with stringent quality requirements to make the picture and sound reproduced on a domestic receiver meet present-day standards. Most quality data can be measured only after conversion to a video or audio frequency. This calls for a high-precision test demodulator which permits correct evaluation of the transmitted signals.

Uses, characteristics

The **TV Demodulator AMFS** fully meets all requirements for distortion-free signal conversion and demodulation; in addition, it also permits rapid checking of transmitter systems by measurement and digital display of the main TV transmission parameters. Thanks to its **extremely low inherent error** and **high measurement accuracy**, the AMFS allows optimum adjustment of TV transmitters and transposers in development, test departments and servicing as well as reliable on-site quality control of the transmitter.

For measurements on TV transmitters, the AMFS has a variety of facilities:

- **Disconnectible sound trap**, the group delay characteristic then being fully corrected, **thus allowing accurate measurements in the frequency range of the colour subcarrier** and the vestigial-sideband **filter edge adjacent to sound**.
- **Synchronous detection** as the normal mode; with excessive interference in the incoming signal, automatic (or manual) **switchover to envelope detection**.
- **Quadrature signal output** Quantitative assessment of the incidental phase modulation of the vision carrier is possible by way of XY representation on an oscilloscope. This is especially helpful for **alignment of linearity precorrection circuits** as well as **adjustment of the modulator balance** of vision transmitters.
- **ABC (annular beam control) mode** In the power-saving ABC mode of klystron transmitters, the IF signal contains no sync pulses. Nevertheless, the AMFS handles these non-standard signals thanks to synchronization via an **external sync pulse input**.
- Inserting a **zero-reference pulse** permits the **modulation depth of the vision carrier** and thus the **residual carrier** to be determined accurately.
- **Demodulation** of the two FM **sound** carriers can be switched over from the intercarrier to the **split-carrier method**. Because of the extremely low incidental phase modulation of the synthesizer LO, the high-quality split-carrier demodulation can also be used for measuring purposes.



Display of TV Demodulator AMFS

The TV receive channel can be selected in various ways:

- **Direct entry of the vision carrier frequency** in the range 42 to 960 MHz with a resolution of 10 kHz
- **Entry of the channel number** (all VHF/UHF an special channels)
- Recall of one of **25 frequencies stored in memory**
- Application of an **external oscillator frequency**

The AMFS handles TV transmitter levels between 50 mV and 2.5 V and can thus be connected directly to the outputs of TV transmitters or to the checkpoints of TV transposers and TV test transmitters.

Test parameters

The following **transmission parameters** can measured and digitally displayed or interrogated via the integrated IEC/IEEE-bus interface:

- **IF demodulation level** in %
- **Input level** in mV, dBµV or dBpW
- **Residual carrier** in %; for this parameter, test line 17 including the luminance bar must be present
- **Amplitude of sync pulse** referred to the CVSO in %
- **Level ratio** of sound carrier 1 and 2 with respect to vision carrier
- **FM deviation** of sound carriers and pilot signal in kHz

Using the appropriate measuring instruments, the following parameters can also be measured: video and chrominance signal distortions, VF/AF frequency response, S/N ratios, AF harmonic distortion and channel crosstalk.
For analysis in the video range the **TV Digital Oscilloscope ODFA** (see page 138) and the **Video Analyzer UAF** (see page 130) are ideal whereas in the audio range an **Audio Analyzer** such as the UPA will be useful (see catalog 90/91, page 404).

Error messages, remote control

Front-panel LEDs signal the absence or departure from fixed thresholds of the following signal components:

vision carrier, sound carrier 1, sound carrier 2,
pilot, sync pulse, test line, data line

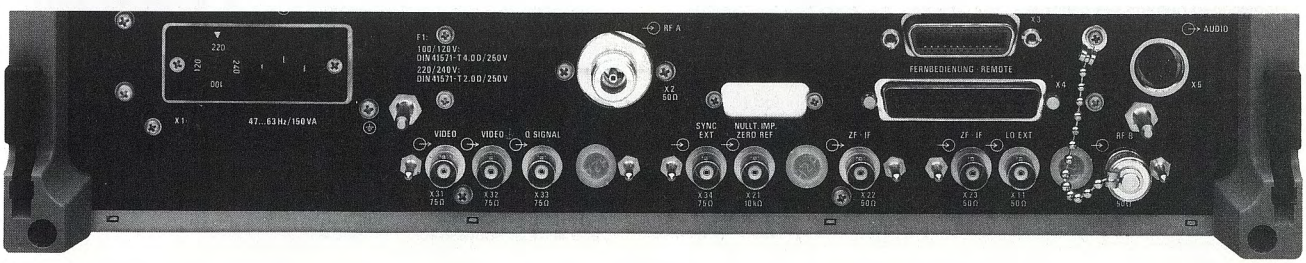
These **error messages** can be interrogated via the IEC/IEEE-bus interface and are also available via **floating relay contacts** at a **remote-control connector**. Based on these results, switchover to a standby transmitter or another modulation feeder link is possible when the AMFS is used as a monitoring demodulator.

The **IEC/IEEE-bus interface** permits **remote control** of the AMFS or its use in **automatic test systems**. All device functions can be activated via the bus. It is also possible to set the most important device functions via parallel control lines, thus making the AMFS suitable for use in test systems which are not IEC/IEEE-bus-compatible.

The front-panel keys can be disabled by a switch that cannot be operated inadvertently. In the **"lock state"** all the keys are inoperative, so that accidental changes to settings cannot be made during in-service monitoring of a transmitter.

ODFA, UPA and UAF for assessment and analysis in conjunction with AMFS

Rear-panel connectors of AMFS



AMFS

Specifications

Frequency

Range ..... 42 to 959.99 MHz
Setting of receive channel ..... channel number (also special channels), vision carrier frequency, memory location number or external LO frequency
Resolution ..... 10 kHz
Frequency error ..... $<\pm 5$ kHz
Number of memory locations ... 25
External oscillator frequency ... $f_{vision}+38.9$ MHz
Incidental phase modulation[1]) of local oscillator .....

42 to 211	211 to 460	460 to 960	MHz
<4	<8	<15	Hz

Inputs
RF input A ..... N female (50 Ω), rear panel
Level range[2]): −10 dB ..... 200 to 800 mV
Normal ..... 650 mV to 2.5 V
Return loss ..... ≥30 dB

RF input B ..... BNC female (50 Ω), rear panel
Level range[2]) ..... 50 to 200 mV
internally switchable to ..... 0.5 to 200 mV
Return loss ..... >10 dB

IF input ..... BNC female (50 Ω), rear panel
Level range[2]): −10 dB ..... 50 to 250 mV
Normal ..... 150 to 750 mV
Return loss
(33 to 40 MHz) ..... ≥30 dB

External oscillator input ..... BNC female (50 Ω), rear panel
Input level ..... 100 mV_{rms} to 1 V_{rms}

Sync input for
ABC operation ..... BNC female (75 Ω), rear panel
Pulse ..... 0 V negative-going to −4 V

Input for zero-reference pulse ..... BNC female (75 Ω), rear panel
Control pulse ..... >+2 V
Delay of zero-reference
pulse referred to control pulse .. 3 µs

Outputs

IF output ..... BNC female (50 Ω), rear panel
Output level[2]), AGC ..... 100 mV
Amplitude/frequency response
(33 to 40 MHz) ..... ≤0.5 dB

Video signal outputs ..... 2 each, BNC female (75 Ω) on front and on rear panel
Output level ..... 1.12 V_{pp} ±2%, CVSO (with zero-reference pulse)
DC offset of video signal ..... 0 V = zero carrier
Isolation of outputs ..... <0.2 dB level variation at terminated output when changing the other outputs from terminated to open circuit
Return loss (0 to 6 MHz) ..... ≥26 dB

Quadrature signal output ..... BNC female (75 Ω) on front panel and on rear panel
Output level ..... CVSO of 1.12 V_{pp} obtained from 90° phase shift
Return loss (0 to 6 MHz) ..... ≥20 dB

Audio signal outputs
Balanced outputs per
channel (main outputs) ..... 3-contact connector (9 Rel.Kli) on front panel
5-contact miniature connector (T3363) and 50-contact connector on rear panel

Output signal	Channel 1	Channel 2
Mono	M1	M1
Stereo	L	R
Dual sound	M1	M2

Output level
(f_{mod} = 500 Hz,
deviation ±30 kHz) ..... +6 dBm ±0.2 dB (into 600 Ω)
Output impedance ..... <25 Ω
Permissible load ..... ≥300 Ω || ≤5 nF

Unbalanced outputs per channel
(auxiliary outputs) ..... BNC female on front panel
50-contact connector on rear panel

Output signal	Channel 1	Channel 2
Mono	M1	M1+P (unmod.)
Stereo	0.5 (R+L)	R+P (117.5 Hz)
Dual sound	M1	M2+P (274.1 Hz)

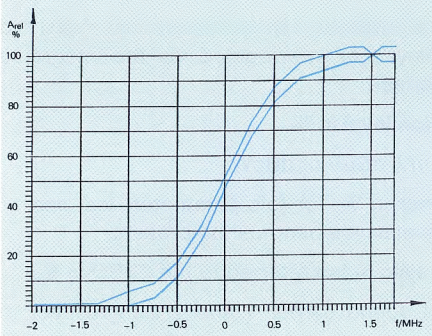
Output level
(f_{mod} = 500 Hz,
deviation ±30 kHz) ..... +6 dBm ±0.2 dB (into 600 Ω)
Output impedance ..... <25 Ω
Permissible load ..... ≥300 Ω || ≤5 nF

Pilot output (unbalanced) ..... BNC female (25 Ω), front panel
Output signal: mono ..... 54.6875 MHz unmodulated
stereo ..... 54.6875 MHz with AM (117.5 Hz)
dual sound ..... 54.6875 MHz with AM (274.1 Hz)
Output level
(f_{mod} = f_{pilot}, ±2.5 kHz deviation) . −15.6 dBm ±0.5 dB (into 600 Ω)

Gain control ..... for RF and IF inputs, switch-selected: manual/automatic
Control range ..... ≥12 dB
AGC error ..... ≤±0.15 dB
Increase of input sensitivity
(RF input A and IF input) ..... 10 dB (manually selectable)
Additional dynamic range when
using RF input B ..... 40 dB

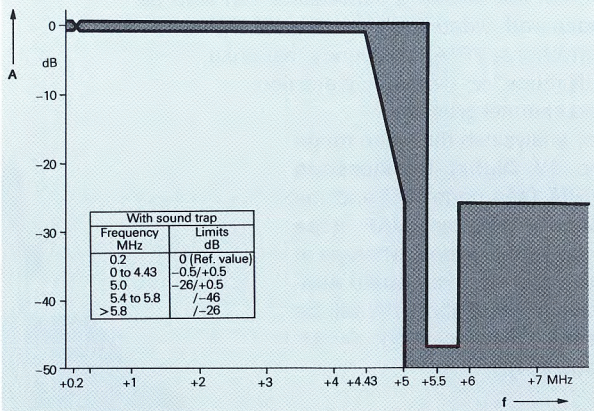
Transmission characteristics in video channel
All data specified refer to synchronous detection mode.

Linear distortion

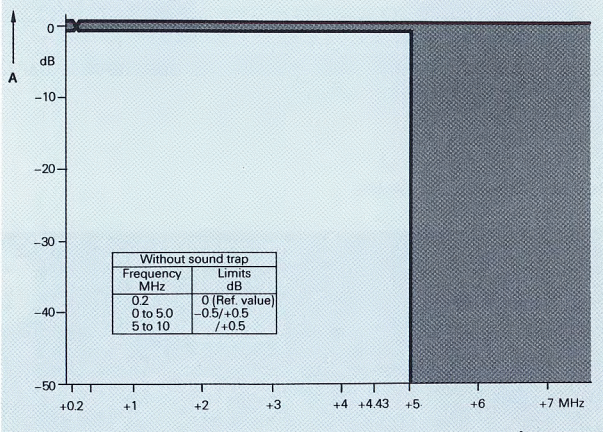


Frequency	Lower limit	Upper limit
MHz	%	%
<−1.65	0	0.8
−1.65	0	0.8
−1.35	0	0.8
−1.0	0	6
−0.75	3	9
−0.5	12	18
−0.25	27	33
0	48	52
0.25	67	73
0.5	82	88
0.75	91	97
1.0	94	100
1.25	97	103
1.4	97	103
1.5	0	0
1.6	97	103
5.0	97	103
> 5.0	–	103

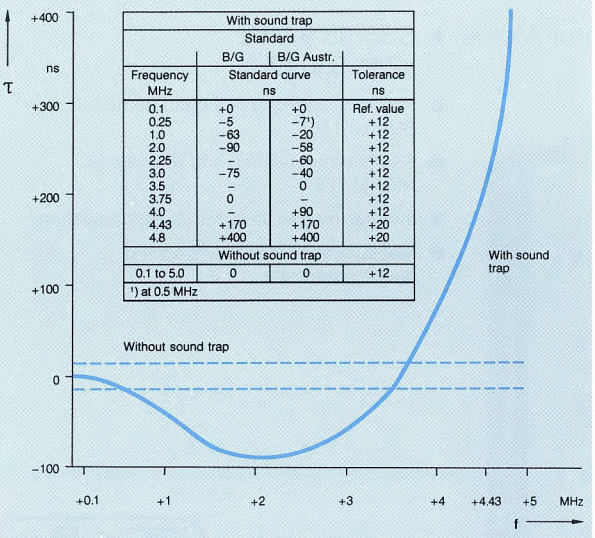
Tolerance mask for Nyquist slope of AMFS RF and IF sections, Standard B/G



Tolerance of overall amplitude characteristic (RF, IF, VF) for standard B/G with ...



and without sound trap



Group delay characteristic of AMFS with and without sound trap

Signal distortion			
Tilt	50 Hz ≤0.5%	15 kHz ≤1%	250 kHz ≤1%
K rating factor	≤0.25%	≤0.5%	≤0.5%
Pulse height, referred to black-to-white transition	2T pulse 100% ±2%		20T pulse 100% ±3%
Baseline distortion, K_{2T}, K_{20T}	≤0.6%		≤0.5%
Chrominance-to-luminance delay	sound trap on ≤±20 ns		sound trap off ≤±12 ns

Nonlinear distortion	
Nonlinearity of demodulator characteristic, line-time nonlinearity and differential gain	
Modulation range 10 to 75%	<2%
8 to 100%	<3% (typ. 1%)
Differential phase	
Modulation range 8 to 90%	≤±1°
Intermodulation distortion	
IM product (1.07 MHz) for vision carrier modulated 10 to 90% with f_{SC} and vision/sound ratio 10:1	52 dB down referred to black-to-white transition
S/N ratio (referred to black-to-white transition, demodulator mode) with sound trap and sound carrier modulated to standard or without sound trap and without sound carrier	
Noise (100 kHz to 5 MHz, rms measurement)	
unweighted	≥60 dB (typ. 63 dB)
weighted to CCIR Rec. 567	≥67 dB (typ. 70 dB)
Periodic noise (peak measurement)	
up to 1 kHz	≥52 dB
5 to 6 MHz	≥60 dB
Quadrature signal	
Bandwidth (−3 dB)	approx. 1 MHz
Phase error of conditioned switching carrier	≤±1°
Zero reference line-repetitive	pulse of approx. 4 µs, shiftable over first third of line
field-repetitive	pulse of approx. 10 µs in lines 15 and 328
external	for the duration of an externally applied pulse, delay approx. 3 µs with respect to control pulse
Error of zero reference with respect to CVSO	≤1%

Transmission characteristics in sound channel

Intercarrier demodulation	normal mode; switchover to split-carrier demodulation possible

Signal characteristics	Balanced outputs	Unbal. outputs	Pilot output
Deemphasis	50 µs	–	–
Frequency response without deemphasis			
40 Hz to 15 kHz	≤±0.2 dB	≤±0.3 dB	selective
15 to 60 kHz	–	≤±1 dB	54.6785 kHz
with deemphasis referred to τ = 50 µs			
40 Hz to 15 kHz	≤±0.3 dB	–	–
Harmonic distortion (f_{mod} = 40 Hz to 15 kHz)			
Deviation 50 kHz	≤±0.5%	≤±0.5%	–
70 kHz	≤±1%	≤±1%	–
S/N ratio³), vision modulation with			
all-black signal	≥60 dB	–	–
FuBK test pattern	≥55 dB	–	–
sinewave signal	≥50 dB	–	–
Stereo crosstalk attenuation⁴)	≥40 dB	–	–
Channel crosstalk attenuation⁵)	≥80 dB	≥80 dB	–

Split-carrier demodulation	same data as intercarrier demodulation except:
S/N ratio for all vision modulations	≥62 dB

Indication and control

Digital readout	vision carrier – receive frequency – IEC/IEEE-bus address, software version measured values – IF demodulation level in % – RF/IF input level in mV, dBµV, dBpW – residual carrier in % – sync pulse amplitude in % – power ratio of sound carriers to vision carrier in dB – deviation of sound carriers – deviation of pilot in kHz
LED indication	all device setups, audio signal coding – mono/stereo/dual sound errors – vision carrier, sound carrier 1 or 2, pilot, test line, data line, sync pulse
Remote control and interrogation	IEC 625-2/IEEE 488 bus, parallel lines (floating) relay contacts

General data

Rated temperature range	+5 to +40 °C
Operating temperature range	0 to +45 °C
Storage temperature range	−40 to +70 °C
Power supply	100/120/230/240 V ±10%, 47 to 63 Hz (150 VA), safety class I, to VDE 0411 (IEC 348)
Dimensions (W × H × D)	435 mm × 236 mm × 470 mm
Weight	25 kg
Labelling	German + English

Ordering information

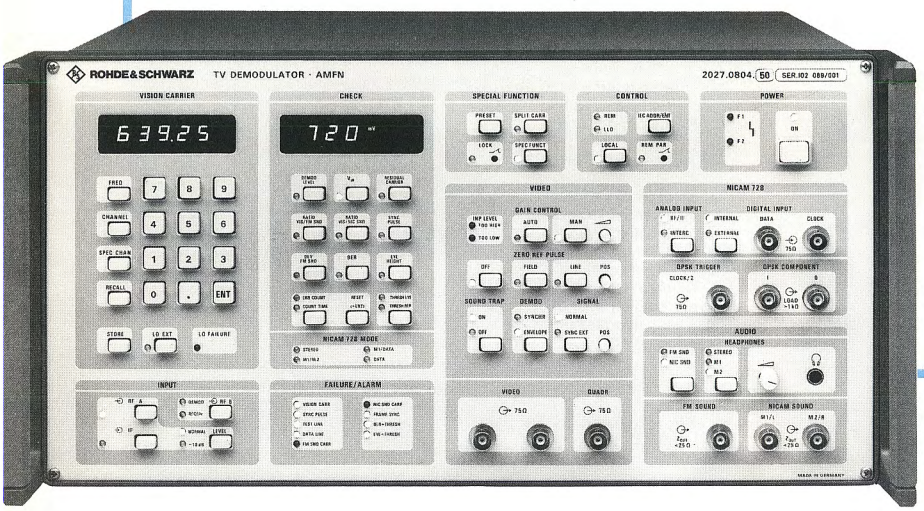
Order designation	▶ TV Demodulator AMFS
Standard B/G, dual-sound model	816.3018.02
Accessories supplied	power cord, manual
Recommended extra	
19″ Rack Adapter ZZA-951	396.9488.00
Service kit	816.3082.00

¹) rms rectification, bandwidth 40 Hz to 20 kHz.
²) Levels are rms values referred to sync pulse.
³) Referred to output level at f_{mod} = 500 Hz and deviation = ±30 kHz, measurement to DIN 45 405 with deemphasis on, weighting to CCIR 468-3; channel not measured is without signal.
⁴) Reference level +6 dBm, with deemphasis on, f_{mod} = 40 Hz to 15 kHz, deviation ±15 kHz in channel 1 and ±30 kHz in channel 2.
⁵) Reference level +6 dBm, selective measurement with deemphasis on, signal in interfering channel: f_{mod} = 40 Hz to 15 kHz, deviation ±55 kHz.

AMFN

TV Demodulator AMFN ♦ 5.85/38.9 MHz 42 to 960 MHz

- Precision vestigial-sideband demodulator, Standard B/G
- Sound demodulation and decoding to NICAM 728
- Intercarrier and split-carrier demodulation
- Measurement of main vision and sound parameters



IEC 625 Bus

Uses, characteristics

The **TV Demodulator AMFN** is provided especially for demodulating and decoding TV signals with **QPSK-modulated sound carriers to NICAM 728**. All the other characteristics of the AMFN are the same as those of TV Demodulator AMFS to standard B/G (see page 140).

The following parameters can be measured and digitally displayed or interrogated via the integrated IEC/IEEE-bus interface:

- IF demodulation level in %
- Input level in mV, dBµV, dBm or dBpW
- Residual carrier in %
- Amplitude of sync pulse referred to CVSO in %
- Level ratio of sound carrier 1 (FM sound) and sound carrier 2 (NICAM sound) with respect to vision carrier
- FM deviation of sound carrier 1 in kHz
- Bit error rate of NICAM sound signal from $0 \cdot 10^{-9}$ to $9 \cdot 10^{-3}$
- Eye height of NICAM sound signal from 10 to 100 %
- Number of parity errors of NICAM sound signal
- Duration of parity error count

Front-panel LEDs signal the absence or departure from fixed thresholds of the following signal components:

- vision carrier
- sync pulse
- test line
- dat line
- FM sound carrier
- NICAM sound carrier
- NICAM frame alignment word
- bit error rate
- eye height

These error messages can be interrogated via the IEC/IEEE-bus interface and are also partly available via floating relay contacts at a remote control connector.

Specifications

Frequency ..... same as AMFS

Inputs ..... same as AMFS, plus

5.85-MHz intercarrier input ..... BNC female (50 Ω), rear panel
Input level ..... 20 to 150 mV_{PP}

NICAM-728 data input ..... BNC female (75 Ω), front panel
Input level ..... TTL

NICAM clock input ..... BNC female (75 Ω), front panel
Input level ..... TTL

Transmission characteristics in video channel ..... same as AMFS

Zero reference ..... same as AMFS

Transmission characteristics in FM sound channel
Frequency response (f_{mod} = 40 Hz to 15 kHz, referred to deemphasis)
Balanced output ..... ≤ ±0.3 dB
Unbalanced output ..... ≤ ±0.2 dB
Deemphasis (not switchable) ..... 50 µs
Harmonic distortion (f_{mod} = 40 Hz to 15 kHz)
Deviation ±50 kHz ..... ≤ 0.5 %
Deviation ±70 kHz ..... ≤ 1 %
S/N ratio (intercarrier mode, referred to output level, f_{mod} = 500 Hz, deviation ±30 kHz, measured to DIN 45405 with deemphasis, weighted to CCIR 468-3)
All-black signal ..... ≥ 60 dB
FuBK test pattern ..... ≥ 55 dB
Sinewave signal (0 to 5 MHz) .... ≥ 50 dB
S/N ratio (split-carrier mode)
All vision modulations ..... ≥ 62 dB

Transmission characteristics in NICAM sound channel

Frequency response, referred to deemphasis
- f_{mod} = 30 Hz to 14 kHz ..... ≤ ±0.3 dB
- f_{mod} = 15 kHz ..... ≤ ±1 dB

Deemphasis J17
Group delay at f_{mod} = 15 kHz, referred to 500 Hz ..... ≤ 100 µs
Harmonics at f_{mod} = 2 kHz and output level = 6 dBm ..... ≤ 0.1 %
Channel crosstalk ..... ≤ −80 dB
S/N ratio (free channel, referred to 6-dBm output level, measured to DIN 45505)
- unweighted ..... ≥ 78 dB
- weighted to CCIR 468-3 ..... ≥ 78 dB

Aliasing referred to nominal audio level at $f_{interference}$ = 17 kHz ($f_{interference}$ = 32 kHz-f_{mod}) ..... < −55 dB
Other interfering frequencies ..... < −55 dB

Linear distortion in NICAM sound channel

FM carrier suppression in QPSK demodulator ..... ≥ 40 dB
Amplitude/frequency response, departure from nominal (limiting filter) up to 182 kHz ..... ≤ ±0.5 dB
Group delay response, departure from nominal
- up to 120 kHz ..... ≤ ±100 ns
- 120 kHz to 182 kHz ..... ≤ ±200 ns

Outputs

IF, video-signal and quadrature signal outputs same as AMFS

Outputs for I/Q components of QPSK signal ..... BNC female (100 Ω) front panel
- Output level ..... 0.8 V_{PP}
- Permissible load ..... ≥ 1 kΩ || ≤ 1 nF

Clock/2 output ..... BNC female (75 Ω), front panel
- Output level ..... TTL

NICAM-728 data output ..... BNC female (75 Ω), rear panel
- Output level ..... TTL

NICAM-728 clock output ..... BNC female (75 Ω), rear panel
- Output level ..... TTL

NICAM audio outputs
- balanced, floating ..... 2 XLR female (< 25 Ω), rear panel
- unbalanced ..... 2 BNC female (< 25 Ω), front panel

Signals (L, R, M1, M2)

NICAM coding	Output M1/L	Output M2/R
STEREO	L	R
M1/M2	M1	M2
M1/DATA	M1	M1

Output level at f_{mod} = 400 Hz and 22 dB below overload level ..... 0 dBm ±0.2 dB
Permissible load ..... ≥ 300 Ω || ≤ 5 nF

FM audio outputs
- balanced, floating ..... XLR female, rear panel
- unbalanced ..... BNC female, front panel
- Output level, f_{mod} = 500 Hz, deviation ±30 kHz ..... +6 dBm ±0.2 dB into 600 Ω
- Output impedance ..... ≤ 25 Ω
- Permissible load ..... ≥ 300 Ω || ≤ 5 nF

Headphones output ..... 6.3-mm jack (JK 34)
- Volume control ..... Front panel
- Signals ..... NICAM sound mono and stereo, FM sound

Indication

Digital readout
- Vision carrier ..... – receive frequency, channel number or memory location
  – IEC/IEEE-bus address, software version
- Additional information ..... – eye hight limit
  – bit error rate limit
- Measured values ..... – IF demodulation level in %
  – RF/IF input level in mV, dBµV, dBm or dBpW
  – residual carrier in %
  – sync pulse in %
  – power ratio of vision carrier to sound carrier 1 (FM sound), sound carrier 2 (NICAM sound) in dB
  – deviation of FM sound carrier in kHz
  – bit error rate of NICAM sound
  – eye height of NICAM sound signal in %
  – number of parity errors of NICAM sound signal
  – duration of parity error count
- LED indication ..... – all device stups
  – NICAM coding STEREO, M1/M2, M1/DATA, DATA
  – error messages
    no vision carrier
    no sync pulse
    no test line
    no data line
    no FM sound carrier
    no NICAM sound carrier
    no NICAM frame alignment word
    BER > limit value
    eye height < limit value

Remote control ..... all functions via IEC-625/IEEE-488 interface, main standard functions and all error messages via parallel TTL interface (remote-control connector)

General data

Rated temperature range ..... +5 to +40 °C
Operating temperature range ..... 0 to +45 °C
Storage temperature range ..... −40 to +70 °C
Power supply ..... 100/120/230/240 V ±10 %, 47 to 63 Hz (150 VA), safety class I, to VDE 0411 (IEC 348)
Dimensions (W × H × D) ..... 435 mm × 236 mm × 470 mm
Weight ..... 25 kg

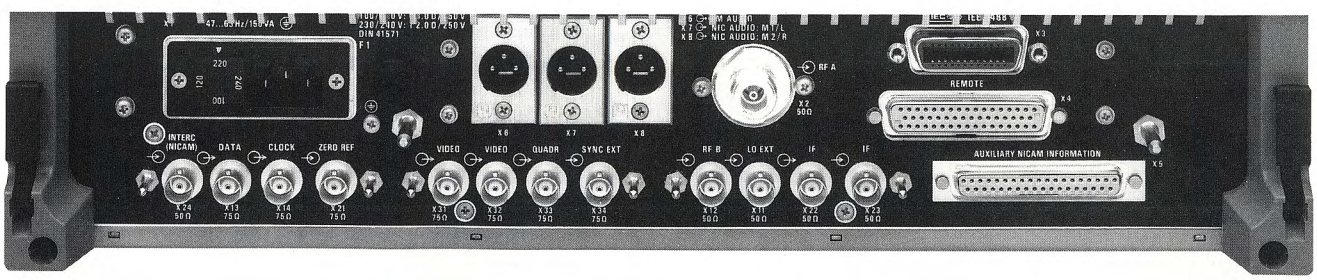
Ordering information

Order designation ..... ▶ TV Demodulator AMFN
Standard B/G Sweden NICAM 2027.0804.02

Accessories supplied ..... power cord, manual

Recommended extras
19″ Rack Adapter, 5 height units, ZZA-951 ..... 0396.9488.00

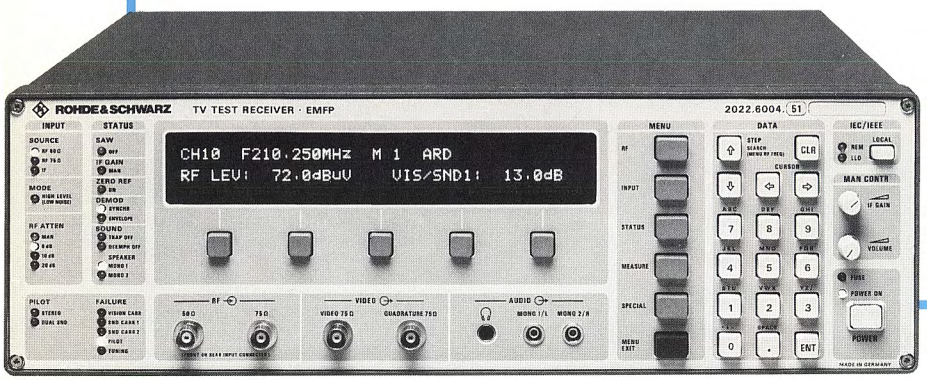
Rear-panel connectors



EMFP

TV Test Receiver EMFP ♦ 7 to 910 MHz

- TV standards B/G, I, D/K
- Fully tunable with direct numerical entry of receive frequency
- Synchronous and envelope detection; additional quadrature output
- Sound demodulation for two sound channels, disconnectible sound trap
- Softkey menus, measurement of all important parameters
- Remote-control output for NICAM Demodulator NDZ
- Result logging on IEC/IEEE-bus-compatible printer without additional controller



IEC 625 Bus

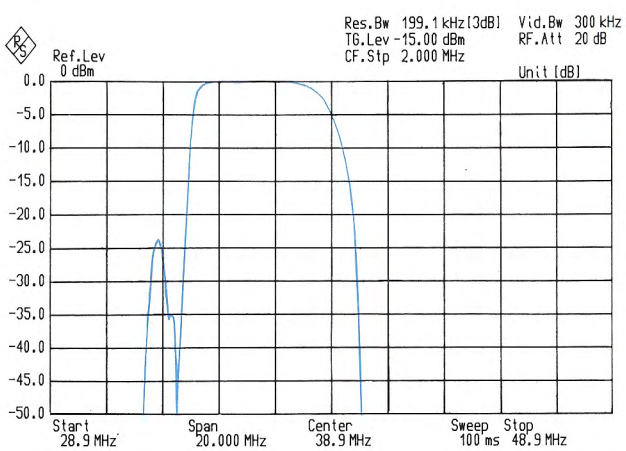
As the youngest member of the EMF family, **TV Test Receiver EMFP** features the well-known, excellent characteristics of the EMFT (see catalog 90/91, page 532) and, in addition, offers a number of new setting and measuring facilities.

Uses

The EMFP receives all TV channels from 7 to 910 MHz corresponding to bands I, III, IV/V plus the special lower and upper channels and the hyperband.

Main applications

- Monitoring and test receiver in broadband-communication and transposer systems
- Test receiver in labs and testshops
- Station demodulator for small transmitters
- Tunable relay receiver



Amplitude/frequency response (RF + IF): with sound trap and SAW filter on

Even for difficult measurements involving **adjacent channels** and **single frequencies,** the EMFP is a professional and favourably priced test receiver which meets present-day requirements in TV measurement engineering.

Special features

- **Synchronous detection** with **additional quadrature output**
- Measurement of the **power level ration** of the two sound carriers with respect to the vision carrier
- Measurement of both **FM sound deviations**
- Measurement of the **input voltage (power),** digital readout in dBµV, mV, dBpW or dBm, and of the **video output level** in %
- Insertion of a vision carrier zero reference pulse for **modulation-depth or residual-carrier measurement**
- Reduction of IF gain at increased input level for **improved video S/N ratio, switch-selected sound trap** and **SAW filter** – for use as a station demodulator
- Prepared for **external digital sound demodulation** using **NICAM Demodulator NDZ** (see sound and TV broadcasting catalog PD 756.7294.21, page 97)
- Use of the EMFP plus NDZ via the remote-control output in **IEC/IEEE-bus-controlled test assemblies**
- **Automatic measurements** via the IEC/IEEE-bus interface with subsequent signal analysis (using eg UAF, UVF, ODF, ODFA or UPA)
- Hardcopy of results on an IEC/IEEE-bus-compatible printer which can be directly connected to the EMFP. Measurements at selectable intervals (for instance every 5 minutes) allow for instance recording of receive conditions over an extended period of time to investigate the influence of the weather without using an additional controller.
- **Sound monitoring** via built-in or external loudspeaker or stereo headphones switchable to one of two sound channels

Operation

Modern **hardkey/softkey entry** and **menu-guided user prompting** ensure rapid and reliable setting of the device functions and call-up of the results which are displayed on a large, **bright fluorescent readout.** An additional LED panel indicates the current operating state.

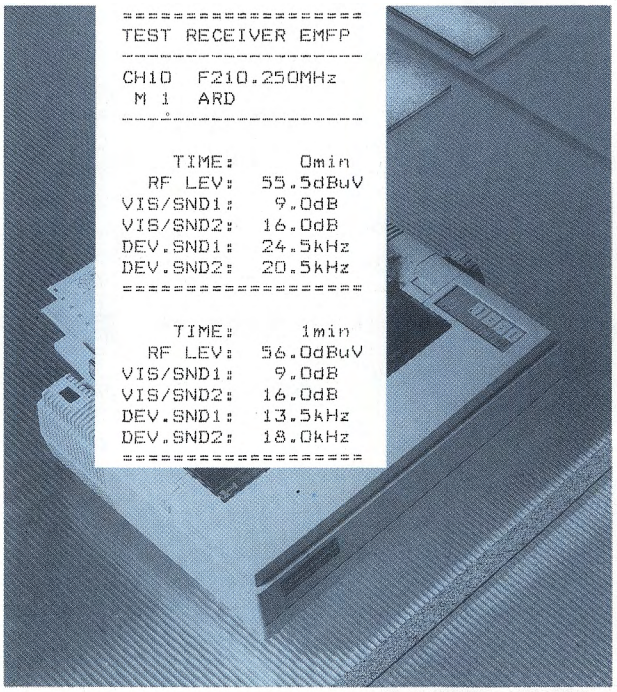
There are several possibilities of channel selection, **the frequency offset up to ±50 kHz** being regulated automatically:

- Direct numerical entry of the receive frequency in steps of 1 kHz
- Entry of the channel number
- Recall of any one of the possible 100 receive frequencies from program memory
- Activation of automatic search mode

A helpful identification, in particular for use in cable TV systems, is a **four-digit transmitter mnemonic** which can be assigned to any receive channel.

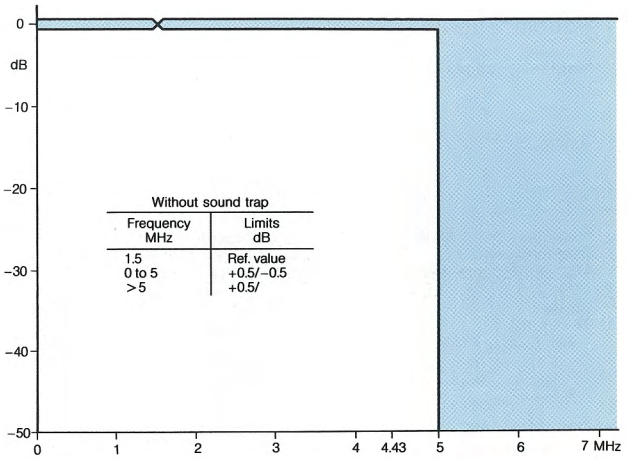
Comprehensive information from the EMFP display at a glance

Nonvolatile storage of a maximum of **10 device setups** is possible. When the EMFP is used as a relay receiver, the **key-lock function** protects it against inadvertent change of the operating state. The integrated **IEC-625/IEEE-488 interface** allows all device settings to be remote-controlled and the results and operating states to be recalled.

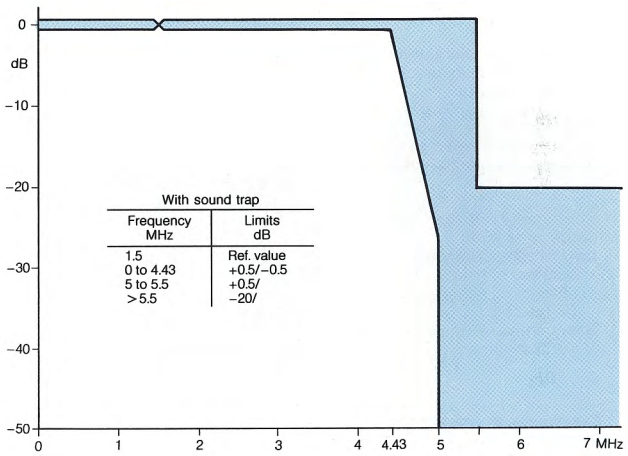


The printout shows the local receive conditions

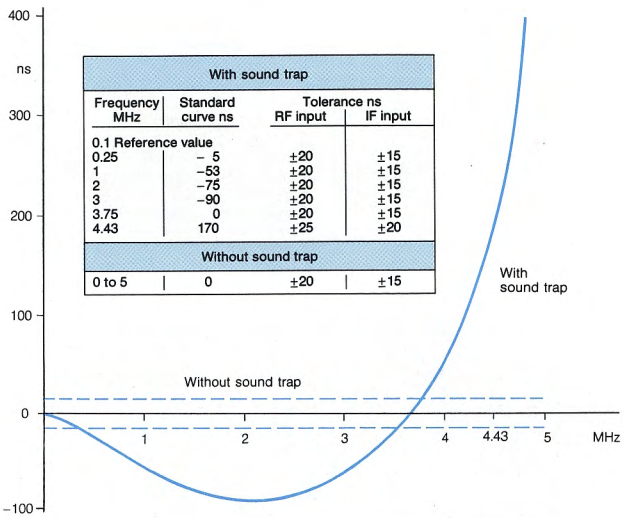
Tolerance masks



Tolerance of overall amplitude characteristic (RF, IF, VF) without sound trap



Tolerance of overall amplitude characteristic (RF, IF, VF) with sound trap (additional ripple with SAW filter ≤ ±0.3 dB)



Group-delay characteristic: curves with and without sound trap (additional ripple with SAW filter ≤ ±30 ns)

EMFP

Specifications

Frequency ranges	7 to 910 MHz; TV channels in bands I, II, III, IV/V, special upper and lower channels, hyperband, IF 38.9 MHz
Tuning	– entry of channel number – entry of frequency (1-kHz steps) – automatic search – recall from program memory
Frequency processing	by synthesizer
Frequency error	≤ ±2.5 kHz
AFC of frequency offset	±50 kHz (typ. ±100 kHz)

Inputs

RF inputs	2, BNC female (50 and 75 Ω)
Input voltage range	
Range 1 (normal)	0.1 to 50 mV
Range 2 (high-level mode)	0.3 to 150 mV
Return loss	
50 Ω	< 300 MHz: ≥ 12 dB > 300 MHz: ≥ 10 dB
75 Ω	≥ 8 dB
Input attenuation	0/10/20 dB, manually or automatically adjustable
Noise figure	VHF: ≤ 9 dB, UHF: ≤ 11 dB (with 0-dB RF input attenuation)
IF input	BNC female
Input voltage range	5 to 100 mV
Return loss	≥ 20 dB

Transmission characteristic in video channel

Amplitude/frequency response (RF + IF + video)	see tolerance masks
Group delay characteristic	see tolerance masks
S/N ratio, rms, weighted to CCIR, highpass filter, referred to black-to-white transition	≥ 58 dB (input level 3 mV) ≥ 62 dB (input level 10 mV and high-level mode)
Nonlinearity with modulation depth 10 to 75 % (synchronous detection)	
Differential gain	≤ 3 %
Differential phase	≤ ±2°
Tilt (50 Hz)	≤ 0.5 %
Gain control, manual/automatic	
Control range	≥ 34 dB (typ. 40 dB) 60 dB with automatic RF input attenuation

Transmission characteristics in audio channel

Intercarrier frequency	5.5/5.742 MHz
Frequency response, referred to 500 Hz	
deemphasis 50 µs on	≤ ±0.5 dB
deemphasis 50 µs off	≤ ±0.35 dB
Harmonic distortion at ±50 kHz deviation and f_{mod} = 5 kHz	≤ 1 %, typ. 0.5 %
Stereo crosstalk (L → R or R → L)	≥ 36 dB
Channel crosstalk, selective measurement ($M_1 \rightarrow M_2$/$M_2 \rightarrow M_1$)	≥ 70 dB
Intercarrier S/N ratio, measured to DIN 45405 (quasi-peak) with sinusoidal vision modulation (0 to 5 MHz), referred to nominal output level	
weighted to CCIR 468-3	≥ 46 dB (typ. 50 dB)
with all-black picture	≥ 54 dB
Sound monitoring	via built-in or external loudspeaker, switchable to one of two sound channels, stereo headphones via jack JK34
Volume	continuously adjustable

Outputs

Video outputs	
In-phase signal	2; 75 Ω, BNC (front/rear panel)
Output level	1 V_{PP} CVS with standard modulation
Quadrature signal	2; 75 Ω, BNC (front/rear panel)
Output level	corresponding to 1 V_{PP} with standard modulation and internal phase shift of switching carrier by 90°
IF output	50 Ω, BNC (rear panel)
Output level (AGC)	200 mV_{rms} ±3 dB
Amplitude/frequency response from 33 to 40 MHz, referred to 38.9 MHz	≤ 0.5 dB
Audio outputs	
Front panel	2; Lemo-Triax, unbalanced, Z_s < 25 Ω
Rear panel	5-contact female connector, balanced, Z_s < 25 Ω
Output level at ±30 kHz deviation and f_{mod} = 500 Hz	+6 dBm ±0.5 dB
Signals	mono, R und L (stereo), M_1 and M_2 (dual sound)

Indication

Digital readout (fluorescent display)	– RF input frequency and receive channel – RF/IF input level in dBµV, mV, dBpW, dBm – video output level in % – carrier power ratio: vision-to-sound 1/sound 2 in dB – deviation sound 1 and sound 2 in kHz
LED indication	device setups, error messages – no vision carrier – no sound 1 – no sound 2 – no pilot – incorrect tuning pilot coding – stereo – dual sound

Miscellaneous

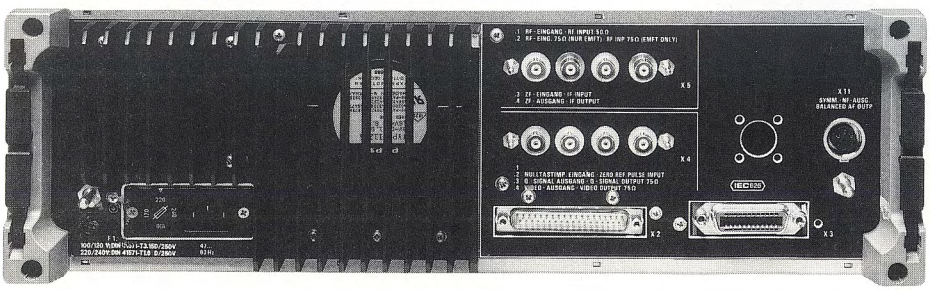
Zero reference pulse	for checking of residual carrier, field-repetitive, can be enabled in lines 15 and 328 (factory-set) of field blanking interval or triggered by external pulse
Error referred to CVS in case of synchronous detection	≤ 1.5 %
Storage	10 device setups 100 frequency or channel settings including 4-digit program identification mnemonic
Remote control	all functions via IEC-625/IEEE-488 interface, interrogation via parallel TTL interface
Printer connection	IEC-625/IEEE-488 interface

General data

Rated temperature range	+5 to +40 °C
Operating temperature range	0 to +45 °C
Storage temperature range	–20 to +70 °C
Power supply	110/120/220/240 V ±10 %, 47 to 63 Hz (110 VA), safety class I, to VDE 0411 (IEC 348)
Dimensions (W × H × D)	450 mm × 345 mm × 525 mm
Weight, 19″ bench model	16 kg

Ordering information

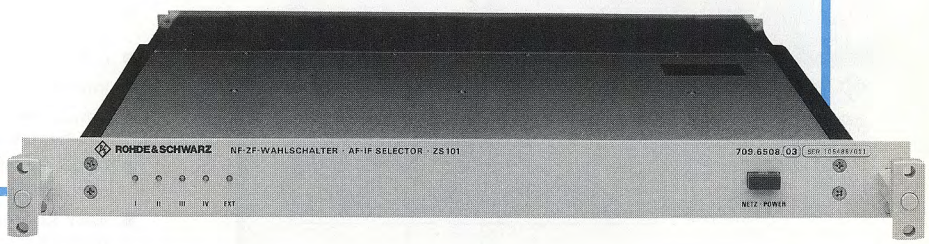
Order designation	▶ TV Test Receiver EMFP	
	Standard B/G	2022.6004.02
	Standard D/K	2022.6004.xx
	(individual models on request)	
	Standard I	2022.6004.32
Recommended extra		
Set of cables for connecting EMFP and NDZ	EMFP-Z	2022.6827.00



AF-IF Selector ZS 101
♦ for the ESM 1000 family

ZS 101

- High-isolation and low-loss 5-way signal switch with an IF and an AF circuit
- Isolation ≥ 110 dB at 90 MHz
- Can be cascaded
- Bidirectional use possible
- DC-coupled
- AC supply or battery operation
- Seated depth adjustable to three positions



Characteristics, uses

The **AF-IF Selector ZS 101** has been designed for use with the ESM 1000 family (see data sheet PD 0756.5791.11). In radiomonitoring systems it is used for switching the AF signal and IF panorama of an addressed slave receiver (eg ESM 1002) through to the master control unit (eg ESM 1001 or GB 501).

On being addressed via the IEC/IEEE bus, the receivers of the ESM 1000 family output a control signal "receiver selected". In the ZS 101, this signal establishes a connection between the AF and IF outputs of the selected receiver and the relevant inputs of the control unit. In this way, four signal paths of the ZS 101 are controlled, while the fifth path, which allows **cascading** of AF-IF selectors, is automatically through-connected to the master control unit if there is no control signal.

Design The AF-IF Selector contains an AF and an IF switching circuit. All switching functions are performed by reed relays. Special circuits and multiple shielding as well as high decoupling between control and signal paths make for **excellent isolation** (≥ 110 dB for the IF circuit, ≥ 95 dB for the AF circuit). This ensures efficient elimination of crosstalk effects even at very high signal levels.

The **AF circuit** consists of two separate, highly decoupled switches, which can either be operated jointly in a floating balanced system or separately in two unbalanced systems. IF and AF circuits are switched simultaneously. Since the switches do not have any directional elements, the **ZS 101 may also be operated as a demultiplexer,** switching for instance a calibration signal successively to various test and feed points.

If n number of ZS 101 Selectors are used in cascaded mode, n × (4 +1) paths can be switched. They are controlled via singleor multi-contact connectors by TTL levels for which active high or active low level can be selected. The switched signal paths are indicated by LEDs both on the front and on the rear panel.

The 19″ cabinet design facilitates use of the ZS 101 in systems. To ensure easy access to the connectors when the ZS 101 is rackmounted, its **seated depth can be adjusted to three different positions** to match the other units of the system. The limitation to 4 + 1 switching paths makes for short rack wiring, since the selector can be accommodated in the immediate vicinity of the receivers. The ZS 101 can be **powered from the AC supply or a battery,** so it is also suitable for use in mobile systems.

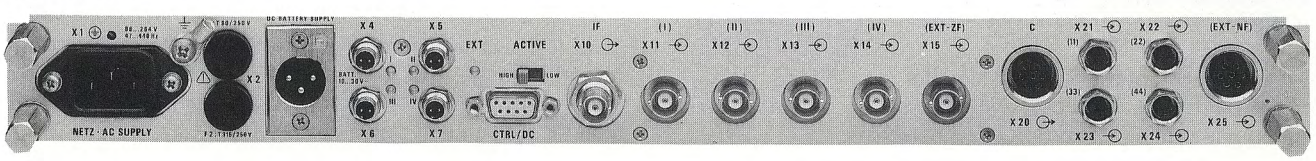
Specifications

IF circuit	4 +1 inputs, 1 output, 50 Ω, BNC connectors	
Transmission data		
Frequency range	**0 to 90 MHz**	**at 130 MHz typ.**
Insertion loss	≤ 0.7 dB	1 dB
Isolation	≥ 110 dB	110 dB
VSWR	≤ 1.2	1.7
3rd-order intercept point	≥ 35 dBm	
Max. working level	0 dBm	
Max. permissible input level without damage	33 dBm	
AF circuit	4 +1 two-contact inputs, 1 output, multi-contact connectors	
Transmission data in 600-Ω balanced mode		
Frequency range	**0 to 16 kHz**	**at 30 kHz typ.**
Insertion loss	≤ 0.5 dB	1 dB
Isolation	≥ 95 dB	92 dB
Control inputs	4, via single-contact connectors or multi-contact connector	
Control levels	TTL, selectable active high or active low	
Switching time	≤ 1 ms	

General data

Rated temperature range	−10 to +55 °C
Operating temperature range	−30 to +55 °C
Storage temperature range	−40 to +70 °C
Permissible humidity	to VG 95332 sheet 5, severity 8
EMC	to VG 95373, part 22, limit value class 2
Mechanical stress	to DIN 40046, parts 7 and 8, shock- and vibration-tested
Power supply	AC: 88 to 264 V, 47 to 440 Hz, 5 VA or DC: 10 to 30 V, 1 W (negative pole to chassis)
Dimensions (W × H × D, depth adjustable to three positions)	480 mm × 45 mm × 305/427/532 mm
Order designation	▶ AF-IF Selector ZS 101 709.6508.03
Accessories supplied	all mating connectors (except BNC)

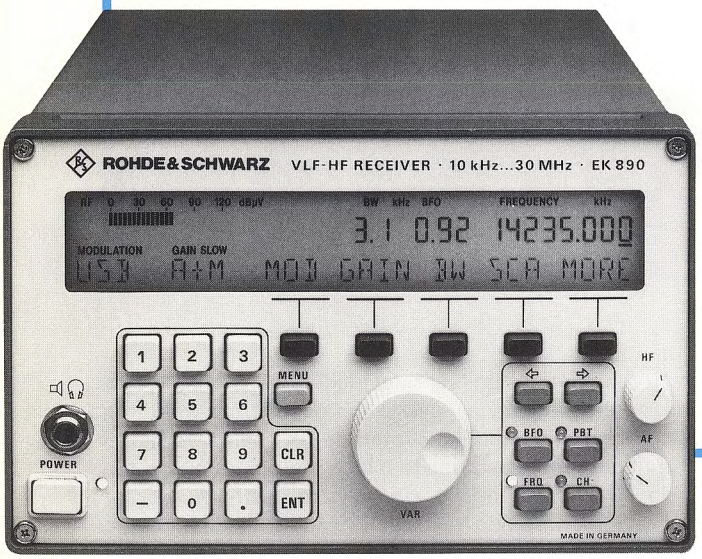
Rear-panel connectors



EK 890

VLF-HF Receiver EK 890 ♦ 10 kHz to 30 MHz

- Excellent large-signal behaviour, very good intercept points
- High resolution of tuning frequency down to 1 Hz
- Fast and low-noise synthesizer
- Demodulators for AM, SSB (LSB, USB) and telegraphy included in basic configuration
- Can be extended to up to six IF filter bandwidths
- Interface fully complying with international standards
- Low power consumption (< 25 A), therefore little self-heating
- Powerful microprocessor for control of bus, menus and user programs
- Easy to operate via terminal, computer or detached front panel (control unit)



RS-485-Bus

Characteristics, uses

With the **VLF-HF Receiver EK 890**, Rohde & Schwarz is presenting a new generation of high-tech shortwave receivers. Thanks to its compact design resulting from the use of large-scale integration SMD components as well as full system compatibility, the EK 890 provides the basis for extremely economical and user-specific solutions.

Due to the **excellent RF characteristics** and the remote-control capability via standardized data interfaces, the EK 890 is suitable for all shortwave applications in the civil and public sector. This receiver is an ideal choice for receiving systems which have to fulfill **extremely high reliability** requirements, in particular under harsh environmental and EMC conditions.

Typical fields of application of EK 890

- Police and security services
- Coastal radio stations, emergency radio services
- Press and information agencies
- Broadcasting and news services
- Foreign offices and embassies
- PTT administrations for radiomonitoring to CCIR
- Ground, shipborne and airborne communications

The EK 890 can be operated via an ASCII terminal, a computer or via the front panel which may also be detached from the receiver (Control Unit GB 890, on request). In master-slave operation, the EK 890 as a master receiver can control up to 99 slave receivers; the well-proven EK 085 (see catalog 90/91, page 556) can also be used as a master receiver.

Two wired and bus-integrated slots for plug-in modules are provided for user-specific extensions, eg special digital demodulators, IF converters or preselectors.

The **built-in intelligence** means that the EK 890 can be used for highly complex shortwave receiving tasks. Flexible programming of the processor permits the following operating modes:

- manual tuning
- channel scan, sequential and programmable
- frequency scan
- channel reception

The EK 890 thus fulfills the requirements for versatile use in speech reception and data communication systems of any kind, as well as for all radiomonitoring, radio detection and radio intelligence (COMINT) applications.

Further main features

- High rejection of strong interfering signals
- 1000 programmable channel memory locations
- Scan mode for programmable frequency ranges, channel ranges and any desired channel sequences
- Remote control of all instrument settings — over any distance when using modems
- Ideal hand-off receiver in stationary, mobile and remote receiving systems
- High availability thanks to long MTBF and short MTTR
- Easy to adapt to special requirements by means of optional plug-in modules
- Highly versatile thanks to flexible software

The built-in memory has capacity for non-volatile storage of 1000 complete channel settings, so that channel management and control by an external computer is not required (but it is additionally possible).

Due to its excellent receiver characteristics — regarding dynamic range, low synthesizer noise and gain control range — the EK 890 is an ideal **high-performance front end** for subsequent signal processing.

Control modes

EK 890 with remote control panel In its standard version, the EK 890 is remote-controlled by ASCII command sequences via a multi-standard interface (RS-232-C, RS-485, RS-422/423, 2-/4-wire). In the simplest case, a terminal can be used as the control unit; for more convenience a computer can be used: then the system can handle complex tasks, as well as presenting any desired user interface. A demo program for generating a virtual front panel is available.

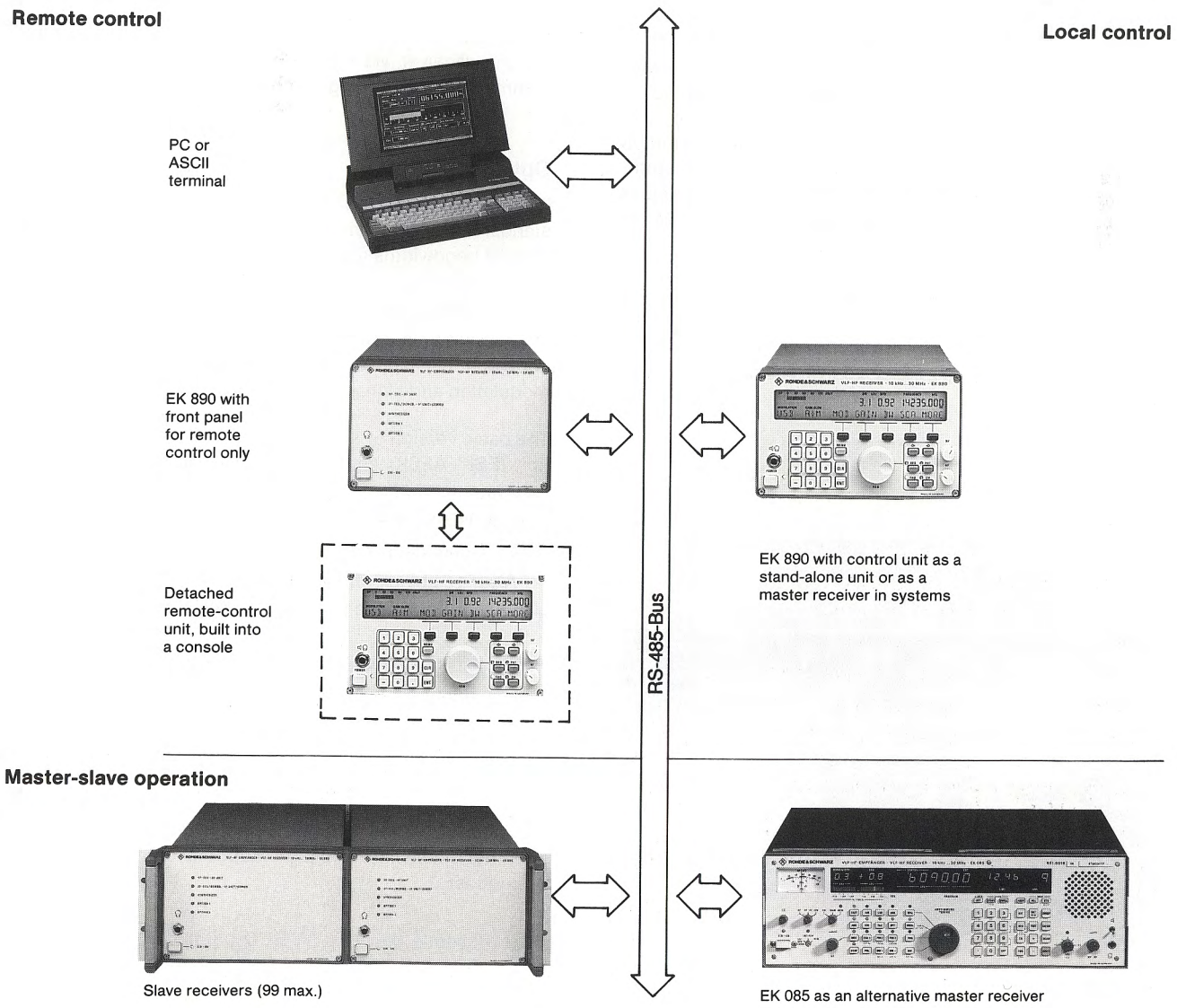
The receivers can be screwed together to yield a 19″ unit for rackmounting, but operated independently of each other.

Detached control panel The EK 890 has a suitable operating mode for every application. The remote-control interface is configured to the RS-845 standard and is bus-compatible for system operation. Users who want to control their radiomonitoring system from a central control unit (front panel) instead of from a computer can use the EK 890 as a master receiver.

EK 890 with Control Unit GB 890 The EK 890 is optionally available with the GB 890, an operator front panel, which can also be retrofitted. This front panel permits manual control of all functions, while full remote-control capability is maintained. This EK 890 model is particularly suitable for use as a master receiver in receiving systems or as a stand-alone unit.

The softkey-menu operator interface provides the ergonomical advantage of clean front panel layout as well as access to a large number of setting parameters. When extension modules are inserted, they are automatically included in the menu system.

All current receiver settings are continuously indicated in large high-contrast characters on a backlit LCD. An additional analog bargraph indicator allows indication of either the receive level (0 to 120 dBµV, in 5-dB steps), the DGC or MGC settings or the frequency offset (as a tuning aid and deviation indication if the optional IF signal processor is installed).



EK 890

Description

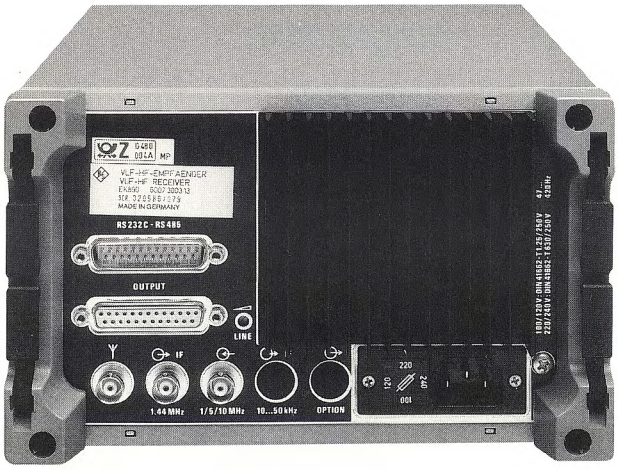
HF unit The antenna signal is routed via a lowpass filter, which is provided for rejecting image frequencies and suppressing oscillator reradiation, and applied to the input mixer where it is converted into the first IF of 41.44 MHz by means of an oscillator variable in 1-Hz steps. The crystal filter that follows determines the maximum receiving bandwidth of 8 kHz and provides for rejection of the second image frequency. A fixed frequency of 40 MHz is used for conversion into the second IF of 1.44 MHz.

The high-performance mixer at the receiver input ensures **excellent large-signal behaviour**. The intercept points are typically +70 dBm (IP_2) and +35 dBm (IP_3); the crossmodulation transfer is 10% for an interfering signal of +21 dBm. In most cases, additional filters such as suboctave filters are therefore not required.

IF unit/demodulator Six filter slots for crystal filters with bandwidths between 200 Hz and 6 kHz are available for main selectivity. All filters are employed in three different modes, ie as a centerfrequency filter and — in the USB and LSB modes — as a sideband filter; the sideband filter response is obtained by shifting the first conversion frequency and the BFO frequency. The filter section is followed by a multi-stage IF amplifier. Its gain control voltage, which is a measure of the signal voltage at the antenna, is indicated as the receive level in 5-dB steps between 0 and 120 dB.

Gain control is possible automatically (AGC), remotely (DGC) or manually (MGC, via front panel). In the AM mode, the IF signal is converted into AF by means of an envelope detector, and in the CW and SSB modes by means of the BFO which is variable in 10-Hz-steps.

Synthesizer The sinthesizer supplies all the conversion frequencies required for the HF and the IF demodulator units. Due to direct digital frequency synthesis, the first conversion oscillator can be varied in **1-Hz steps**.



The settling time of the oscillator is ≤5 ms for any frequency variation. Two phase-locked loops (PLLs) produce the 40-MHz fixed frequency and the BFO frequency. The operation of the total of four PLLs in the synthesizer is continuously monitored.

In the basic version, all the frequencies are derived from a temperature-compensated crystal oscillator. Higher accuracy requirements can be fulfilled by including an (optional) **oven-controlled** crystal oscillator or using an external frequency standard (1, 5 or 10 MHz).

Processor and software The modern 16-bit microprocessor using power-saving CMOS technology is what makes the **high-performance, reliable and user-friendly** concept of the EK 890 possible. The microprocessor is not only responsible for setting and managing the module functions, it also communicates with the outside world via the operating controls and the data interface, executes the internal programs and ensures operational reliability through various measures:

- nonvolatile storage of all settings
- continuous testing of CPU, RAM and PROM functions
- continuous monitoring (CM) of synthesizer specs
- BIT (built-in test) for module testing, the result being displayed in plain text, eg "HF UNIT NOGO"

The simple and logical ASCII command syntax for controlling the receiver via the serial interface includes control commands for operating functions.

Options

IF filter configuration The EK 890 is available in three standard models with 2, 3 of 6 fixed IF filter bandwidths. Special bandwidths are available on request.

IF Signal Processor GM 890 In the IF signal processor, the second IF is down-converted, digitized by a 12-bit A/D converter and applied to a single-chip processor for demodulation and signal processing (DSP).

The basic version of this module is designed for TTY operation (FSK, AFSK) and can optionally be extended for the following functions:

- voice/NBFM (F3E)
- TTY 2-channel (F7B)
- FAX (F1C) black-and-white; F3C with grey levels
- IF conversion to 10 to 50 kHz or 455 kHz

TTY Line Current Source GH 890 For the operation of (older) teletype units which require line current (single/double current), the Line Current Source GH 890 is available in the form of a PCB in addition to the IF Signal Processor GM 890.

Preselector FK 890 The preselector module with lowpass filter, bandpass filter and eight suboctave filters is available on request.

BCD Interface GC 890 A BCD parallel interface is available for external control of frequency-dependent add-on units.

Specifications

Frequency range	10 kHz to 30 MHz	
Resolution	1 Hz	
Frequency drift	−10 to +45 °C	aging/year
Frequency standard	5×10^{-7}	1×10^{-6}
Oven-controlled frequency standard	1×10^{-7}	1×10^{-7}
External frequency standard	1/5/10 MHz, 0.2 to 1 V_{rms}	

Antenna input	BNC connector, 50 Ω
VSWR	<3
Maximum input voltage (≤30 MHz)	15 V EMF
Oscillator reradiation into 50-Ω termination	≤10 µV

Demodulation modes	CW/MCW (A1A, A1B, A2A, A2B) AM/AME (A3E, H2A, H2B, H2E) USB/LSB (R2A, R3E, J2A, J3E) optionally: FSK/AFSK (F1A, F1B) F6 (F7B) FAX (F1C, F3C) FM (F3E)

IF bandwidth	−3 dB	−60 dB
	(±100 Hz	±250 Hz)
	(±300 Hz	±750 Hz)
	(±750 Hz	±1875 Hz)
	±1550 Hz	±2150 Hz
	(±3 kHz	±7.5 kHz)
	±4 kHz	±30 kHz
	+0.3 to 3.4 kHz	−0.3 to +4.0 kHz
	−0.3 to −3.4 kHz	+0.3 to −4.0 kHz

(values in parentheses are optional depending on receiver model)

Sensitivity
(for (S+N)/N = 10 dB; 0.1 to 30 MHz)

CW (bandwidth 200 Hz)	<0.3 µV EMF (−124 dBm)
USB/LSB (bandwidth 3.1 kHz)	<1.0 µV EMF (−113 dBm)
AM (bandwidth 6 kHz, f = 1 kHz, m = 0.6)	<2.5 µV EMF (−105 dBm)

Immunity to interference, non-linearities

Intermodulation (1.5 to 30 MHz; Δf ≥30 kHz; interfering signal 0 dBm)	
IP_2	>60 dBm (typ. 70 dBm)
IP_3	>30 dBm (typ. 35 dBm)
Crossmodulation (0.1 to 30 MHz; interfering signal 5 V EMF (+21 dBm); Δf ≥30 kHz; m = 0.3; f = 1 kHz; wanted-signal level 10 mV EMF (−33 dBm))	≤10% modulation transfer
Blocking (0.1 to 30 MHz; interfering signal 6.3 V EMF (+23 dBm); Δf ≥30 kHz; m = 0.3; f = 1 kHz; wanted-signal level 1 mV EMF (−53 dBm))	≤1 dB signal attenuation
Desensitization (interfering signal 300 mV EMF; Δf ≥30 kHz; wanted signal level 30 µV EMF; bandwidth 3.1 kHz)	≥20 dB SINAD
Inherent spurious signals (f >100 kHz)	<−113 dBm (nominal −124 dBm)
Image frequency rejection	>90 dB
IF rejection	>90 dB
Weighted S/N ratio for 1 mV EMF	>46 dB SINAD

Gain control	automatic (AGC), manual (MGC) or remote (DGC)
AGC error	≤0.5 dB (1 µV to 1 V EMF)
Regulating time	
Settling time	approx. 10 ms
Decay time	0.3/3.5 s (fast/slow selectable, for level jumps of 60 dB)
DGC range	0 to 120 dBµV EMF in 5-dB-steps

BFO	−9.99 to +9.99 kHz
Resolution	10 Hz

Channel memory	for 1000 channels, nonvolatile, storage of complete receiver setup for each channel

Data interface	RS-232-C, RS-485 (bus-compatible)
Transfer rate	50 to 38,400 baud

Outputs

IF output	1.44 MHz, 50 mV into 50 Ω
AF output	0.3 to 3.4 kHz; floating; Z_{out} = 600 Ω
Setting range	−10 to +10 dBm
Monitoring output	500 mV, Z_{out} = 332 Ω

Options

Control Unit GB 890	with controls and indicators for complete receiver setup; connector for loudspeaker or headphones (max. 1 W into 8 Ω)

IF Signal Processor GM 890

with AFSK/FSK demodulator	transfer rate (50 to 1200 baud) and deviation range (±42.5 to ±425 Hz) adjustable; V.28 interface and audible tone circuit
and optionally:	
Diplex telegraphy demodulator (F7B)	2 × V.28 interface
FM demodulator (F3E)	NBFM (3-dB bandwidth: ± 3 kHz)
Fax demodulator	
F1C	1.9 kHz ±150 Hz in VLF range ±400 Hz in HF range
F3C	1.9 kHz modulated (at AF output)
FM "video" output (optional)	1 V/kHz, Z_{out} = 1 kΩ
IF Converter[1]	10 to 50 kHz in 250-Hz steps, 0 dBm into 600 Ω; or 455 kHz, 0 dBm into 50 Ω
Line Current Source GH 890	single current: 40 mA/60 V double current: ±20 mA/±30 V
IF filter	see ordering information; special bandwidth between 200 Hz and 8 kHz on request
Oven-controlled frequency standard	aging/day ≤1×10^{-9} (on request)
BCD Interface GC 890	frequency information, 22 bit parallel (CMOS, 5 V)
Preselector FK 890 H1	lowpass filter 0 to 0.5 MHz bandpass filter 0.5 to 1.5 MHz 8 suboctave filters 1.5 to 30 MHz
Lincompex demodulator	to CCIR Rec. 455-1 (on request)

General data

Environmental conditions	
Rated temperature range	−10 to +45 °C
Operating temperature range	−25 to +55 °C
Storage temperature range	−40 to +80 °C
Humidity (non-condensing)	max. 95% at +40 °C
Vibration test	10 to 55 Hz; 0.4 mm double amplitude
Shock test	30 g, 11 ms
MTBF	>14,000 h
Power supply	100/120/220/240 V −15/+10%, 47 to 420 Hz (approx 25 VA), safety class I, to VDE 0411 (IEC 348)
Dimensions (W × H × D)	211 mm × 132 mm × 460 mm
Weight	approx. 8 kg

Ordering information

Order designation ▶ VLF-HF Receiver EK 890 6007.3003.xx

	with remote control panel	with Control Unit GB 890
with 2 IF filter bandwidths: 8 kHz/3.1 kHz	.02	.12
with 3 IF filter bandwidths: 8 kHz/3.1 kHz/600 Hz	.03	.13
with 6 IF filter bandwidths: 8 kHz/6 kHz/3.1 kHz 1.5 kHz/600 Hz/200 Hz	.04	.14

Accessories supplied ..... manual, power cable

Recommended extras

Control Unit	GB 890	6007.7709.02
19″ Adapter Kit	ZZA-98	0827.4533.00
Repair Manual		6012.0696.01

Line Current Source	GH 890	6007.6054.02

Plug-in modules (2 max. at time)

Preselector	FK 890 H1	6007.7750.02
BCD Interface	GC 890	6007.7809.02
IF Converter	UX 890	6007.7850.02
IF Signal Processor	GM 890	6007.6654.xx

Model (xx)	.02	.03	.04	.05	.12	.13	.14	.15
FSK/AFSK	x	x	x	x	x	x	x	x
F3E			x	x		x	x	x
F7B		x		x		x		x
F1C/F3C			x	x			x	x
IF converter					x	x	x	x

[1] Integrated in GM 890 with models >.12, or available as separate plug-in module UX 890.

ROHDE&SCHWARZ

ROHDE&SCHWARZ GmbH & Co. KG
W-8000 München 80 · Mühldorfstraße 15 · Postfach 80 14 69
Tel. (089) 41 29-0 · Int. +(49 89) 41 29-0
Telefax (089) 41 29-21 64 · Int. +(49 89) 41 29-21 64
Telex 5 23 703 (rs d) · Teletex 897 487 = RSD

ROHDE&SCHWARZ WERK KÖLN Graf-Zeppelin-Straße 18 · Postfach 98 02 60 **W-5000 Köln 90**	Tel. (0 22 03) 49-0 Telefax (0 22 03) 49-308 Telex 8 874 525 (rsk d)
ROHDE&SCHWARZ WERK TEISNACH Kaikenrieder Straße 27 **W-8376 Teisnach**	Tel. (0 99 23) 2 80 Telefax (0 99 23) 2 82 18
ROHDE&SCHWARZ MESSGERÄTEBAU GMBH Riedbachstraße 58 · Postfach 16 52 **W-8940 Memmingen**/Allgäu	Tel. (0 83 31) 108-0 Telefax (0 83 31) 108-254 Telex 54 512 (mbmgn d) Teletex 897 487 = RSD
ROHDE&SCHWARZ ENGINEERING AND SALES GMBH Tassiloplatz 7 · Postfach 80 14 29 **W-8000 München 90**	Tel. (0 89) 48 00 04-0 Telefax (0 89) 48 00 04-44 Telex 5 218 403 (rse d)

Zweigniederlassungen — **Subsidiaries in Germany**

Zweigniederlassung Dresden Fetscherstraße 72 **O-8019 Dresden**	Tel. (00 37-51) 45 68-2 39 Telex 24 58 (pcc dd)
Zweigniederlassung Berlin Ernst-Reuter-Platz 10 **W-1000 Berlin 10**	Tel. (0 30) 34 00 02-0 Telefax (0 30) 341 30 17 Telex 181 636 (rshb d)
Zweigniederlassung Hamburg Steilshooper Allee 47 · Postfach 602240 **W-2000 Hamburg 60**	Tel. (0 40) 63 29 00-0 Telefax (0 40) 630 78 70 Telex 2 173 748 (rsvh d)
Zweigniederlassung Köln Graf-Zeppelin-Straße 18 · Postfach 90 01 49 **W-5000 Köln 90**	Tel. (0 22 03) 8 07-0 Telefax (0 22 03) 807 50 Telex 8 874 444 (rsvc d)
Zweigniederlassung Büro Bonn Josef-Wirmer-Straße 1–3 · Postfach 14 02 64 **W-5300 Bonn 1** (Hardtberg)	Tel. (02 28) 25 91 95 Telefax (02 28) 25 50 87 Telex 8 869 569 (rsvbb d)
Zweigniederlassung Frankfurt Siemensstraße 20 **W-6078 Neu-Isenburg**	Tel. (0 61 02) 20 07-0 Telefax (0 61 02) 20 07 52 Telex 4 185 641 (rstf d)
Zweigniederlassung Telekommunikation Siemensstraße 20 **W-6078 Neu-Isenburg**	Tel. (0 61 02) 20 07-0 Telefax (0 61 02) 20 07 12 Telex 4 185 641 (rstf d)
Zweigniederlassung Karlsruhe Rüppurrer Straße 84 · Postfach 52 29 **W-7500 Karlsruhe 1**	Tel. (07 21) 3 49 51 Telefax (07 21) 37 95 61 Telex 7 826 730 (rsvk d)
Zweigniederlassung München Berg-am-Laim-Straße 47 · Postfach 80 14 49 **W-8000 München 80**	Tel. (0 89) 41 86 95-0 Telefax (0 89) 40 47 64 Telex 524 960 (rsdvm d)
Zweigniederlassung Nürnberg Münchener Straße 342 **W-8500 Nürnberg 50**	Tel. (09 11) 8 67 47 Telefax (09 11) 86 99 31 Telex 626 535 (rsvn d)

R&S International — **Telephone / Telefax / Telex**

Argentina	INTERTEL S.A. Uruguay 239 – 7. Piso Oficinas G y H **1015 Buenos Aires**	(1) 403939 (1) 498780 17800 (inter ar)
Australia	ROHDE&SCHWARZ (AUSTRALIA) Pty. Ltd. 63 Parramatta Road **Silverwater**, N.S.W. 2141	(2) 7480155 (2) 7481836 26372 (rand sa)
Austria	ROHDE&SCHWARZ-ÖSTERREICH Ges.m.b.H Sonnleithnergasse 20 **A-1100 Wien**	(1) 6026141 (1) 6026141-14 133933 (rsoe a)
Bangladesh	Business International Ltd. 146/A, New Bailey Rd., P.O.B. 727 **Dhaka-2**	(2) 408633 (2) 833650 675632 (bil bj)
Belgium	ROHDE&SCHWARZ BELGIUM N.V. Excelsiorlaan 31 Bus 1 **B-1930 Zaventem**	(2) 7209890 (2) 7250936 25306 (rs bel)
Brunei	Logistic Eng. & Maint. Serv. Ltd. Unit 112, 1st Fl., P.O.B. 298 Bangunan Gadong Kumbang Pasang Mile 2, Jalan Gadong **Bandar Seri Begawan**	(2) 21175 (2) 221175 2309 (lems bu)
Bulgaria	see Austria	
Brazil	ROHDE & SCHWARZ Precisão Eletrônica Ltda. Rua Geraldo Flausino Gomes, 42 1. Andar **04575 São Paulo – SP**	(11) 5427377 (11) 5315793 (11) 54170 (rusb)
Canada	ROHDE&SCHWARZ CANADA INC. 555 March Rd. **Kanata, Ontario K2K 1X7**	(613) 5928000 (613) 5928009 —
Chile	Importadora Janssen y Cia. Ltda. Agustinas 2356 P.O.B. 13570, Correo 21 **Santiago de Chile**	(2) 6998021 (2) 726149 340489 (oroco ck)

R&S International — **Telephone / Telefax / Telex**

China	ROHDE & SCHWARZ Representative Office Beijing Friendship-Hotel Building No. 4, Room 40429 3, Bai Shi Qiao Lu **Beijing, 100086**	(1) 8498668 (1) 8317685 222676 (rsbp cn)
Colombia	Hanseatica Cia. Ltda. Calle 15 No. 68 D-78, Ap. Aéreo 14467 **Bogotá** D.E.1	(1) 2923211, 2922153 (1) 2926614 44790 (hans co)
Czecho-slovakia	ROHDE&SCHWARZ Österreich-Repräsentant: ZENIT Drtinova 26 **CS-15000 Praha 5** ROHDE&SCHWARZ Österreich-Service: siehe oben / see above ZENIT	(2) 551091/551094 (2) 551108 12801 (zenb c)
Denmark	ROHDE & SCHWARZ DANMARK A/S Herstedøstervej 27 – 29 **DK-2620 Albertslund**	(43) 436699 (43) 437744 —
Finland	Orbis Oy Vanha Kaarelantie 9 **SF-01610 Vantaa**	(80) 5664066 (80) 531604 123134 (orbis sf)
France	ROHDE&SCHWARZ FRANCE 46, rue de la Couture, Silic 190 **F-94563 Rungis Cédex** Agences Régionales: Tertia 2 **F-13763 Aix-les-Milles Cédex** 89, boulevard du Parc de l'Artillerie **F-69007 Lyon** 13, rue Claude Chappe Technopôle 2000 **F-57070 Metz**	(1) 46872506 (1) 46870853 265759 (ruselec f) Tél.: 42244337 Fax: 42243770 Tél.: 78585779 Fax: 78695047 Tlx: 375106 Tél.: 87203304 Fax: 87203307

R&S International		Telephone Telefax Telex
France	Agences Régionales:	
	rue du Bignon Z.i. Sud-Est Immeuble Sigma i **F-35135 Chantepie**	Tél.: 99519700 Fax: 99419131
	Voie 5 B.P. 501, Technoparc 3 **F-31324 Labège Cédex**	Tél.: 61391069 Fax: 61399910
Greece	Mercury Ltd. 8, Sekeri St. **GR-10674 Athens**	(1) 3633834 (1) 3645885 214887 (merc gr)
Hongkong	Schmidt & Co. (H. K.) Ltd. 18 Fl., Great Eagle Centre 23 Harbour Rd., G.P.O. 297 **Wanchai, Hongkong**	(5) 8330222 (5) 8382652 76762 (schmc hx)
Hungary	ROHDE&SCHWARZ ÖSTERREICH Budapesti Iroda Ulaszlo u. 38. II. 1 **H-1114 Budapest**	(1) 1667690 (1) 1667690 —
India	ROHDE&SCHWARZ LIAISON OFFICE INDIA 9, Prithviraj Road B-Block **New Delhi 110 011**	(11) 699381 (11) 692238 3162268 (rsbd in)
Indonesia	P. T. DIAN GRAHA ELEKTRIKA Jalan Kebon Sirih 4 **Jakarta 10 110**	(21) 351051 (21) 354257 46222 (siejkt ia)
Ireland	see United Kingdom	
Italy	Roje Telecomunicazioni S.P.A. Via Anna Kuliscioff, 33 **I-20152 Milano**	(2) 4154141/42/43 (2) 48300569 353 462 (rt tel i)
	Via Tiburtina, 1182 **I-00156 Roma**	(6) 4110011 (6) 4110414 621545 (rojrom i)
Japan	TOYO Corporation 26-9, Yushima 3-chome, Bunkyo-ku **Tokyo 113**	(3) 5688-8800 (3) 5688-6900
Kenya	GES Engsales (K) Ltd. P. O. B. 4665 Nairobi	(2) 740939/740987 (2) 740965
Korea	Hana Technica Corp. 4 Fl. Youngdong Bldg. # 63-16 Nonhyun-Dong Kangnam-Ku, **Seoul**	(2) 5144546-8 (2) 5144549 —
Luxembourg	see Belgium	
Malaysia	DAGANG TEKNIK SDN. BHD. 39, Jalan SS 20/11 Damansara Utama **47400 Petaling Jaya**	(3) 7198297 (3) 7176558 37832 (danik ma)
Malta	Technoline Ltd. B'Kara Road **San Gwann**	(356) 374300/374329 (356) 374353 631 (reho mw)
Mexico	ELECTROINGENIERIA DE PRECISION S.A. Uxmal 520, Col. Vertiz Narvarte **03600 Mexico DF**	(5) 5597677 (5) 5753381 1764433 (epsa me)
Netherlands	ROHDE&SCHWARZ NEDERLAND B.V. Perkinsbaan 1 (NL-3439 ND Nieuwegein) Postbus 1315 **NL-3430 BH Nieuwegein**	(3402) 40900 (3402) 48122 70339 (rsned nl)
New Zealand	Communication Instruments Ltd. 47 Kenepuru Drive Porirua P. O. B. 51140 Tawa **Wellington**	(4) 379199 (4) 379195 —
Norway	Morgenstierne & Co. A/S P. O. 15 – Bogerud **N-0621 Oslo – 6**	(2) 289490 (2) 289494 71719 (morof n)
Pakistan	TELEC, Electronics & Machinery Ltd. 415, Mahboob Chambers Abdullah Haroon Rd. P.O.B. 7430 **Saddar-Karachi 0301**	(21) 518301 (21) 510908 2690 (elco pk)

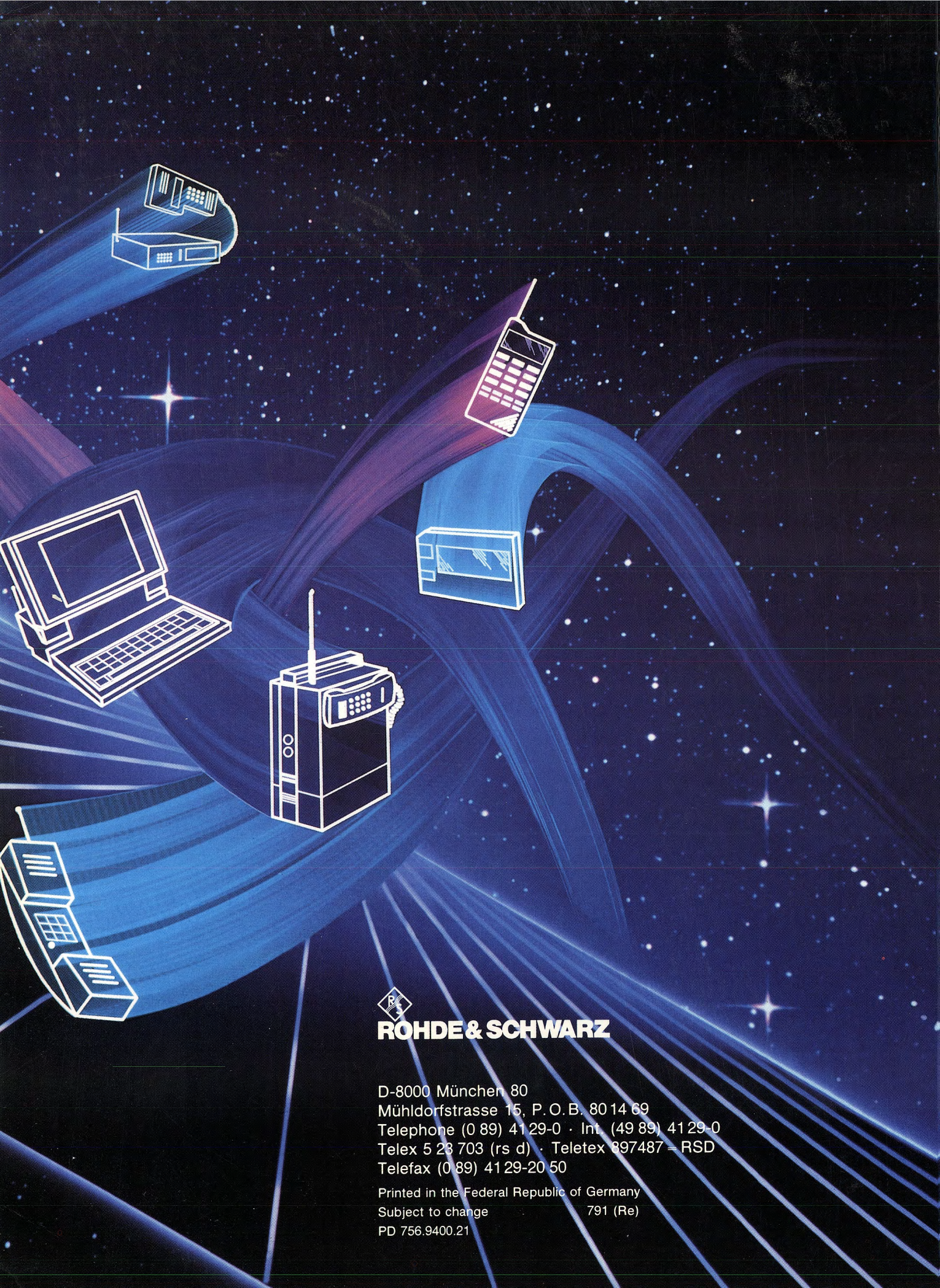
R&S International		Telephone Telefax Telex
Poland	ROHDE&SCHWARZ Österreich-Repräsentant: THM Eximpol S.A. ul. Stawki 2, pietro 28 **PL-00-950 Warszawa**	(2) 6350687 (2) 6353544 814640 (exim pl)
	ROHDE&SCHWARZ Österreich-Service: RSM Service ul. Tarnogajska 11/13 **PL-50-950 Wroclaw**	(71) 673893 — 712357 (in pl)
Philippines	MARCOM INDUSTRIAL EQUIPMENT, INC. MCC P.O. Box 1110 Eurovilla I Condominium 142 Legaspi St. Corner Herrera Legaspi Village **Makati, Metro Manila**	(2) 8170507 (2) 8106789 459 30 (marco pm)
Portugal	Mattos Tavares-Electrónica, Lda. Apartado 3029 **P-1301 Lisboa Codex**	(11) 3016261 (11) 3016260 12220 (matali p)
Romania	see Austria	
Singapore	INFOTEL Technologies Ltd. 605A MacPherson Rd. # 05-02 Citimac Industrial Complex **Singapore 1336**	2876822 2876577 38360 (inftel rs)
South Africa	S. A. Electro-Medical (Pty) Ltd. 115 Siersteen Road Silvertondale P. O. B. 1784 **Pretoria** **0001**	(12) 8041620 (12) 8042009 320756 (saem sa)
Spain	REMA Leo Haag S.A. Avenida de Burgos, 12 **E-28036 Madrid**	(1) 3839017 (1) 7662773 42838 (rema e)
Sri Lanka	LANKA AVIONICS 658/1/1, Negombo Road Mattumagala **Ragama**	(1) 530624 (1) 448363 21494 (global ce)
Sweden	ROHDE&SCHWARZ SVERIGE AB Vinthundsvägen 159 B **S-12362 Farsta**	(8) 940395 (8) 941978 054-15698 (rohde s)
Switzerland	Roschi Télécommunication AG Papiermühlestrasse 145, Postf. **CH-3063 Ittigen**	(31) 589011 (31) 588101 911759 (ragbe ch)
new from 28.03.92 on:	**Telephone (31) 9221522, Telefax (31) 9218101**	
Taiwan	Function Enterprise Co. Ltd. P. O. B. 36 – 430 8 F, No. 1 Fu Hsing North Rd. **Taipei**	(2) 7219930 (2) 7311522 25172 (function tw)
Turkey	Electronic Service & Engineering Necatibey Caddesi No. 90/2 **Karaköy-Istanbul**	(1) 1441546 (1) 1497037 24399 (mse tr)
	ROHDE & SCHWARZ Liaison Office Kumkapi Sokak 35/1 **06610 Gaziosmanpasa-Ankara**	(4) 1405183 (4) 1406533 —
United Kingdom	ROHDE&SCHWARZ UK Ltd. Ancells Business Park **GB-Fleet**, Hampshire GU 13 8UZ	(252) 811377 (252) 811447 859880 (rsukco g)
U.S.A.	ROHDE&SCHWARZ, INC. 4425 Nicole Drive **Lanham** MD 20706	(301) 459-8800 (301) 4592810 510-2230414 (RSA)
Yugoslavia	see Austria	

For other areas
not listed contact:

ROHDE&SCHWARZ GmbH & Co. KG
International Marketing Division 5Z
Postfach 80 14 69
W-8000 München 80
Telefax Int. + (49 89) 41 29 31 15
Telex 52 370 320 (rs d)

Printed in the Fed. Rep. of Germany 0691 (Ro la)

Type	Designation	Order No.	Page	Data Sheet	R&S NEWS
ADS	Dual Arbitrary Waveform Generator	1012.4002.02	28	PD 756.9351.11	135
AMFS	TV Demodulator 38.9 and 42 to 960 MHz	816.3018.02	140		128
AMFN	TV Demodulator (NICAM 728)	2027.0804.02	144		
AMS	Arbitrary Waveform Generator	1013.0000.02	28	PD 756.9351.11	135
AWD-K1	Arbitrary Waveform Designer (Software)	1026.4500.02	34	PD 756.9039.11	129
CRTS 02	GSM Radiocommunication Test Set (base station)	1025.8501.02	44	PD 756.3699.11	131
CRTS 04	GSM Radiocommunication Test Set (mobile station)	1025.8501.04	44	PD 756.3699.11	131
EK 890	VLF-HF Receiver 10 kHz to 30 MHz	6007.3003.xx	150	PD 756.8978.11	130, 133
EMFP	TV Test Receiver 7 to 910 MHz	2022.6004.02	146	PD 756.9480.11	132
ESAI	EMI Test Receiver 20 Hz to 2 GHz	804.8910.52	96	PD 756.3318.11	133
ESHS 10	EMI Test Receiver 9 kHz to 30 MHz	1004.0401.10	90	PD 756.3260.11	133
ESVS 10	EMI Test Receiver 20 to 1000 MHz	1011.2006.10	90	PD 756.9422.11	133
EZ-10	4-wire T-Network 9 kHz to 150 MHz	816.1244.02	102	PD 756.4708.11	
EZ-12	Antenna Impedance Converter 9 kHz to 30 MHz	1026.4800.02	103	PD 756.7271.11	134
FMA	Modulation Analyzer 50 kHz to 1360 MHz	852.8500.52	52	PD 756.9300.11	
FSAD	Communications & Spectrum Analyzer 100 Hz to 2 GHz (for radiomonitoring)	1005.7000.54	58	PD 756.6175.11	134
FSB	Spectrum Analyzer 100 Hz to 5.2 GHz	848.0020.52	62	PD 756.8384.11	125
FSBC	Communications & Spectrum Analyzer	851.5007.52	70	PD 756.6723.11	134
FSBS	Spectrum & Network Analyzer	851.2008.52	74	PD 756.9216.11	130
FSM	Spectrum Analyzer 100 Hz to 26.5 GHz	1020.7020.52	78	PD 756.7120.11	133
FS-Z5	S-Parameter Test Set 5 MHz to 2.7 GHz	1013.5990.52	86	PD 756.9200.11	131
NAS	Directional Power Meter 1 to 1000 MHz	828.6017.02	116	PD 756.6617.11	134
NRV-Z6	Power Sensor 50 MHz to 26.5 GHz	828.5010.52	117	PD 756.6546.11	133
NRV-Z7	Power Sensor 10 MHz to 13 GHz (20 mW)	828.5210.02	117	PD 756.6546.11	133
NRV-Z8	Power Sensor 10 MHz to 13 GHz (500 mW)	828.5410.02	117	PD 756.6546.11	133
ODFA	TV Digital Oscilloscope	373.4015.76	138		133
PSA 12	Process Controller without monitor	1012.0007.02	4	PD 756.9016.11	130
PSA 15	Process Controller with monochrome monitor	1012.1003.02	4	PD 756.9016.11	130
PSA 17	Process Controller with colour monitor	1026.1000.03	12	PD 756.9397.11	135
SDMF	D2-MAC Generator	2000.0003.02	126		131
SFZ	TV-SAT Test Transmitter	2004.5500.11	128		133
SGDF	TV Generator for D-MAC/D2-MAC	2011.1858.02	120	PD 756.8749.11	126
SGMF	TV Generator for NTSC	2016.0943.02	120	PD 756.8749.11	126
SGPF	TV Generator for PAL	2016.4049.02	120	PD 756.8749.11	126
SGSF	TV Generator for SECAM	2016.7048.02	120	PD 756.8749.11	126
SMHU 58	Signal Generator 1 kHz to 4.32 GHz	835.8011.58	36	PD 756.3518.11	132
TIF	Video Timing Analyzer	2005.3000.02	134	PD 756.3518.11	126
TS 8100	Test System, cellular radio		14		
TS 8200	same as TS 8100, plus multi-signal measurements		14		
TS 8400	Type-approval Test System		15		
TS 9955	GSM Test System		16		
TSA	Test Workstation	382.7320.02	18	PD 756.4020.11	132
TSA 90	Digital Functional Tester	382.7420.02	18	PD 756.4020.11	132
TSA 92	Analog/Digital Functional Tester	382.7520.02	18	PD 756.4020.11	132
TSA 94	Analog In-circuit Tester	382.7620.02	18	PD 756.4020.11	132
TSA 96	Combinational Tester	382.7720.02	18	PD 756.4020.11	132
TSA 98	Hybrid In-circuit Tester	382.7820.02	18	PD 756.4020.11	132
UAF	Video Analyzer	2013.0807.02	130	PD 756.8726.11	128, 135
ZAM-Z3	Computer Function for Network Analysis System ZPM	1009.9859.02	113	PD 756.3401.11	
ZRMD	SWR Bridge 10 MHz to 18 GHz	831.7010.5x	112	PD 756.8684.11	
ZS 101	AF-IF Selector for ESM 1000 family	709.6508.03	149	PD 756.9068.11	
ZWOB 2	Network Polyskop 100 kHz to 1.6 GHz	857.0259.02	106	PD 756.8861.11	130
ZWOB 4	Network Polyskop 100 kHz to 2.7 GHz	857.0259.04	106	PD 756.8861.11	130
ZWOB 6	Network Polyskop 100 kHz to 2.7 GHz	857.0507.02	106	PD 756.8861.11	130



ROHDE & SCHWARZ

D-8000 München 80
Mühldorfstrasse 15, P.O.B. 80 14 69
Telephone (0 89) 41 29-0 · Int. (49 89) 41 29-0
Telex 5 23 703 (rs d) · Teletex 897487 = RSD
Telefax (0 89) 41 29-20 50

Printed in the Federal Republic of Germany
Subject to change 791 (Re)
PD 756.9400.21