Test Receiver ESVD

for digital mobile radio networks

- For field-strength measurements in the planning stage and operation of mobile radio networks (GSM, PCN)
- For RFI measurements to European standards EN55011 to 55022, ETS, FCC, VCCI and VDE 0871 to 0879
- In line with CISPR 16-1, VDE 0876 and ANSI C63.2
- Frequency range 20 to 1000 (2050) MHz
- Level measurement range −14 to +137 dBµV
- Frequency resolution 100 Hz, setting error $<1 \cdot 10^{-7}$
- Field-strength measurements using test antennas
- Filter bandwidths for coverage measurements in cellular networks
- Programmable test receiver for selective voltage measurements in laboratory and test department
- Manual operation or control via internal or external controller
- Battery supply (int./ext.) or AC supply

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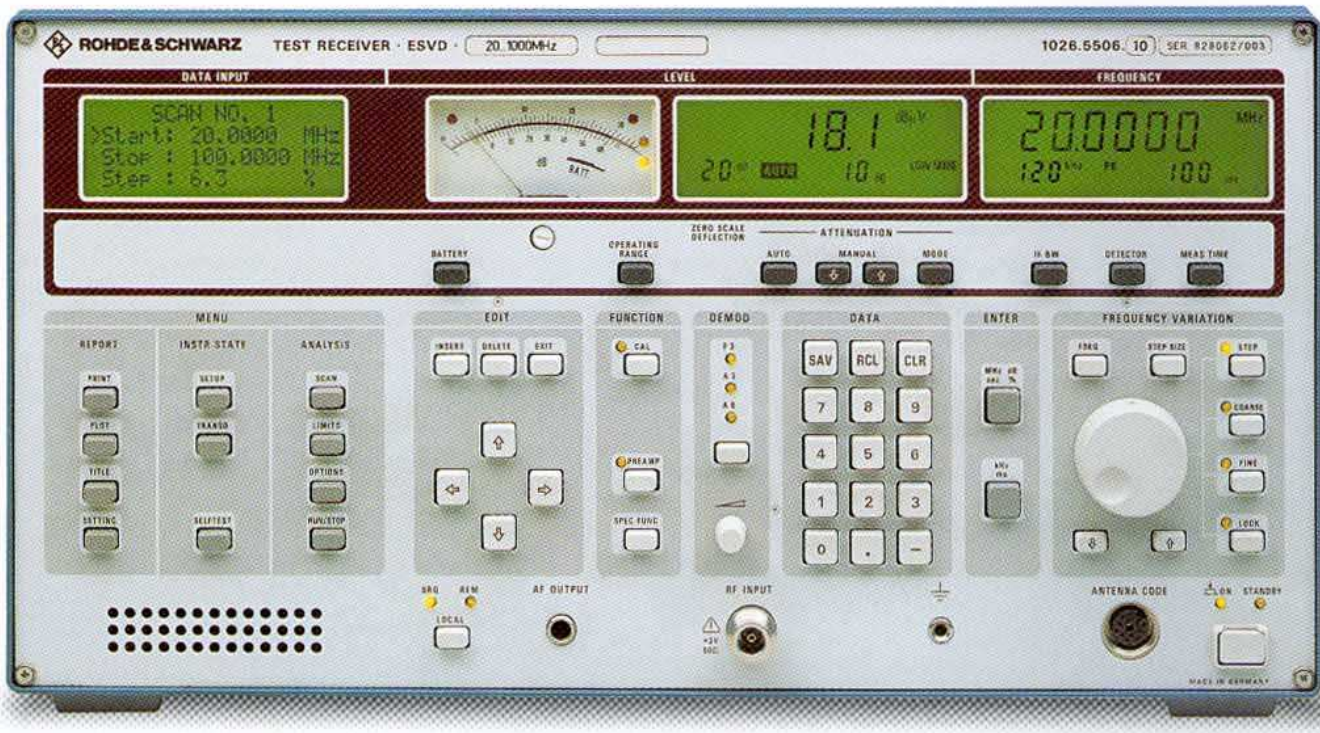


Test Receiver ESVD is equally suitable for the measurement of signal strength and interference.

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

The number of measurements required to ensure electromagnetic compatibility is continuously increasing in the field of RFI measurements. Thanks to the built-in intelligence of Test Receiver ESVD, the time required for such measurements is reduced considerably. Being also a specialist for EMI measurements to CISPR, CENELEC, ETSI, FCC, VCCI and VDE standards, the ESVD can furnish results more rapidly and accurately than has been possible up to now.

Description

Test Receiver ESVD for digital mobile radio networks is a triple-conversion heterodyne receiver covering the frequency range from 20 to 1000 (2050) MHz. Its main features and facilities are:

- RF attenuator switchable in 10-dB steps in the range 0 to 120 dB
- One preselector with fixed tuning and five tracking preselectors, option ESVD-B2 with four additional filters with fixed tuning
- Preamplifier with wide dynamic range, can be switched between preselector and 1st mixer
- Crystal-stabilized synthesizer as 1st LO, variable in 100-Hz steps, sweep mode for fast frequency scans; frequency accuracy complying with GSM recommendations
- High-level mixer ensuring high isolation of 1st LO for converting the input frequency to the first IF (1354.7 MHz or 394.7 MHz)
- High-level mixers for conversion to the second (74.7 MHz) and third (10.7 MHz) IF
- IF filters (10 kHz, 120 kHz, 300 kHz and 1 MHz) in the third IF stage with group-delay optimization
- Precise I/Q demodulator
- Highly linear envelope detector with more than 70 dB dynamic range
- Peak, average and quasi-peak detectors operating in parallel, which enables simultaneous measurements in different weighting modes
- Peak indication with IF bandwidth correction factors for measuring broadband interference (PK/MHz) automatically taken into account
- Measurement monitoring by means of automatic overload detection in the relevant ESVD stages and by the permanently activated peak detector

- 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

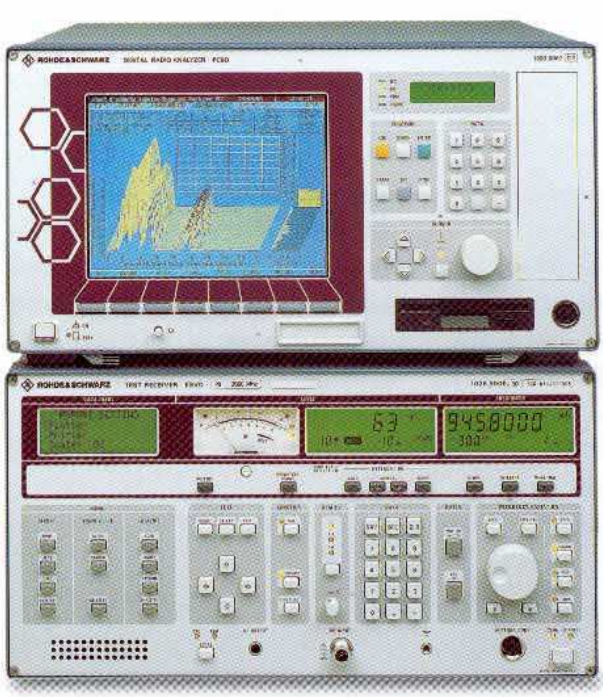
- Flash EPROMs allowing convenient and fast firmware updating with the aid of a PC
- Digital level indication on LC display and analog level indication on moving-coil meter taking into account transducer factors and their units
- Automatic calibration at a keystroke with the aid of a high-precision built-in generator
- Demodulator circuits for FM, AM and A0; built-in loudspeaker and headphones connector
- Automatic monitoring of all synthesizer loops and supply voltages during operation
- Detection of faulty modules by built-in selftest facilities

Design

The service-friendly modular design of ESVD ensures excellent results regarding RFI emission and immunity. A quiet, temperature-controlled blower minimizes self-heating of ESVD. Comprehensive built-in test functions allow any module requiring servicing to be easily identified and replaced independently of other modules.

Special features

- High measurement accuracy; error <1 dB
- Wide dynamic range: noise figure typ. 7 dB with preamplifier, 12 dB without preamplifier, third-order intercept point 20 dBm (without preamplifier)
- IF filter with optimum group delay ensuring fast frequency scanning and distortion-free demodulation of digitally modulated signals; correct averaging of pulse and sine signals
- Inphase and quadrature output for evaluating any modulated signal
- Frequency-dependent transducer factors are automatically taken into account
- Automatic level calibration
- Level shown on analog meter and digital display with 0.1-dB resolution
- Fast synthesizer, frequency resolution 100 Hz, any frequency step in <30 ms, sweep mode for fast frequency scanning
- Measurement of voltage, field strength, current and pulse spectral density with full indication of units
- 60-dB range also for quasi-peak and average indication; ESVD furnishes correct results at all times due to continuous level monitoring at all relevant stages of the signal path
- Parallel detectors for average, peak and quasi-peak indication
- Macros for automatic test runs
- Output of results as lists and diagrams on printer or plotter including limit lines and labelling
- Nonvolatile storage of 9 complete instrument setups and 22 transducer factors and limit lines



Interference analysis in GSM networks with ESVD and PCSD

Functions

ESVD combines three classes of instruments in one:

- the system-compatible test receiver for GSM field-strength and EMI measurements
- the compact, manually tunable and battery-operated test receiver
- the automatic test receiver which performs EMI measurements and reports the results

Field-strength measurements in mobile radio networks

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

The user-friendly operating concept and the easy-to-read LCDs for settings and test results make the ESVD a handy and convenient test instrument for manual operation. The internal or external battery – 12 or 24 Volt – makes the ESVD suitable for mobile use.

Within a mobile radio band the field strength can be recorded very fast on different frequencies with measurement rates of up to 2.5 ms per value. Thus, for example, field-strength statistics of several base stations in the GSM band are possible at normal speed of the test vehicle with a single receiver using the Lee method.

For additional evaluation of the signals received, the ESVD can be fitted with an I/Q demodulator (ESVD-B1). This most general type of demodulator is very important in digital communication systems as an interface between analog and digital signal processing. It allows processing of any kind of modulated signals. The characteristics of option ESVD-B1 closely follow the GSM and PCN specifications.

The frequency range of communication networks above 1 GHz is covered by the optional frequency extension to 2.05 GHz (ESVD-B2).

RFI field-strength and RFI power measurements

For solving complex EMC problems, manual measurement often is the most efficient way, as the operator can fully utilize his experience in identifying interference sources. ESVD features conventional test receiver operation with tuning knob, result indication on a meter and a built- in loudspeaker.

The entry keys for automatic measurements are arranged on the left of the front panel. Three groups of menu keys are provided below a four-line LCD window to enter frequency scans, limit lines, transducer factors, configuration data and complex test routines.

During a frequency scan (lin or log) up to five subranges are scanned. Nonvolatile storage of 22 limit lines and of transducer factors with up to 50 values is possible. By combining the stored transducer factors, all test configurations occurring in practice can be covered.

The results of a frequency scan are output on a printer with parallel interface or on a plotter with IEC/IEEE-bus interface. Time can be saved by the simultaneous printing of lists and plotting of graphs. Plotting is also possible during the frequency scan so that an overview of the interference spectrum can already be obtained during the measurements.

Any relevant information can be added to the test report either via a line editor or, more conveniently, via an MF2 keyboard. Information can be automatically added to the parameters known to the ESVD such as date, time and receiver settings.

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

- 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 using the average and/or quasi-peak detector
- Result documentation on plotter or printer

The minimum configuration consisting of ESVD, absorbing clamp and plotter is already a powerful and cost-effective test setup for RFI measurements.

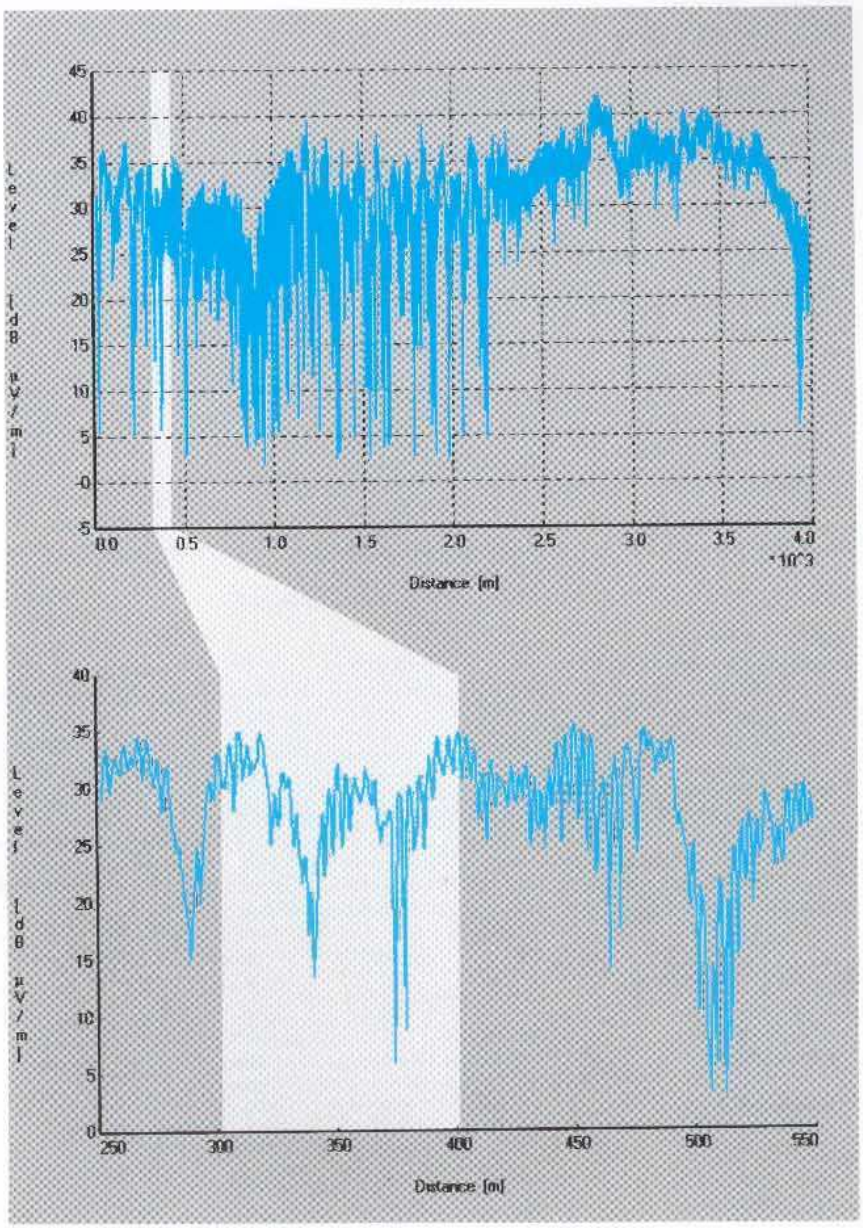
Remote control

The IEC/IEEE-bus interface complies with the latest IEEE Standard 488 Part 2. Measured values are output with a resolution of 0.01 dB. Up to 5000 measured values per second can be output via the IEC/IEEE bus when the ESVD is triggered externally.

Interfaces

For further signal evaluation and for driving or feeding add-on units, the ESVD is provided with the following interfaces:

- Coding and supply socket (ANTENNA CODE) for active antennas and for transducer factor coding
- 74.7-MHz IF output for a panoramic display
- 10.7-MHz IF output for evaluating the IF signal eg with an oscilloscope
- Regulated inphase and quadrature output for evaluating any modulated signal (option ESVD-B1)
- 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
  - inputs for external trigger signals
  - outputs for the analog display voltage with and without meter simulation
  - RS-232 interface for updating the firmware by reprogramming the built-in flash EPROMs via an IBM-compatible PC
- Parallel interface (PRINTER INTERFACE) for connecting a printer
- IEC/IEEE-bus interface
- Connector for an MF2-compatible keyboard for text entry
- Output for internal crystal reference frequency (10 MHz)
- Input for external battery (11 to 33 V) for battery-powered operation, eg in vehicles



Field strength recorded over a distance of 4 km (top), below a zoomed section over 300 m measured with ESVD and Test System TS9955

Specifications

Frequency range	20 to 1000 MHz
with option ESVD-B2	20 to 2050 MHz
Frequency setting	
with tuning knob	in 100-Hz, 100-kHz steps or in any selectable step size
numerical	by keyboard entry
in steps	of any selectable size
automatic scan	for RF analysis
Display	8-digit LCD
Resolution	100 Hz
Setting error (after 30 min. warmup)	$<1\cdot10^{-7}$
Temperature effect	$<1\cdot10^{-9}$/°C
Aging	$<1\cdot10^{-9}$/day

RF input	N connector, female, 50 Ω
VSWR	
20 to 1000 MHz	<1.2 with ≥10-dB RF attenuation <2 with 0-dB RF attenuation
1000 to 2000 MHz	<1.35 with ≥10-dB RF attenuation <2 with 0-dB RF attenuation

Preamplifier	switchable between input filter and 1st mixer
Gain	10 dB

Oscillator reradiation at RF input (0-db RF attenuation)	Off	Preamplifier On
20 to 1000 MHz	<20 dBµV	<10 dBµV
1000 to 1900 MHz	<50 dBµV	<40 dBµV
1900 to 2050 MHz	<60 dBµV	<50 dBµV

Interference rejection, nonlinearities

	20 to 1000 MHz	1000 to 1900 MHz	1900 to 2050 MHz
Image-frequency rejection 1st IF	>90, typ. 100 dB	>80, typ. 100 dB	>70, typ. 100 dB
2nd IF	>90, typ. 100 dB	>80, typ. 100 dB	>80, typ. 100 dB
IF rejection	>90, typ. 100 dB	>80, typ. 100 dB	>80, typ. 100 dB

	Off	Preamplifier On
$P_{I1, I2}$ ($\|f1-f2\|$ >5 MHz)	–10 dBm	–20 dBm
Intercept point d3		
20 to 50 MHz	typ. 15 dBm	typ. 5 dBm
50 to 1000 MHz	>15 dBm typ. 20 dBm	>5 dBm typ. 10 dBm
1000 to 2050 MHz	>13 dBm typ. 18 dBm	>3 dBm typ. 8 dBm
Intercept point k2		
20 to 1000 MHz	>35 dBm	>25 dBm
1000 to 2050 MHz	>50 dBm	>40 dBm

Preselector	
20 to 1000 MHz:	
1 fixed-tuned filter	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
1000 to 2050 MHz:	
4 fixed-tuned filters	1000 to <1250 MHz 1250 to <1522 MHz 1522 to <1795 MHz 1795 to 2050 MHz

Maximum input level	
RF attenuation 0 dB	
DC voltage	7 V
Sinewave AC voltage	130 dBµV
Pulse spectral density	97 dBµV/MHz (100 V·0.5 ns)
RF attenuation ≥10 dB	
DC voltage	7 V
Sinewave AC voltage	137 dBµV (= 1 W)
Max. pulse voltage	150 V
Max. pulse energy (10 µs)	1 mWs

RF shielding	
Voltage indication at a field strength of 10 V/m with 0-dB RF attenuation ($f \neq f_e$)	<0 dBµV
Additional error in quasi-peak indication range at 10 V/m	<1 dB

Intermediate frequencies	
1st IF 20 to 1000 MHz	1354.7 MHz
1000 to 2050 MHz	394.7 MHz
2nd IF	74.7 MHz
3rd IF	10.7 MHz

IF bandwidths

Nominal bandwidth	–3 dB (±20%)	–6 dB (±10%)	Shape factor (B_{6dB}/B_{60dB})
10 kHz	7 kHz	9.5 kHz	typ. 1:4
120 kHz	90 kHz	120 kHz	typ. 1:5
300 kHz	300 kHz	400 kHz	typ. 1:6
1 MHz	800 kHz	1 MHz	typ. 1:4

Noise indication	Off	Preamplifier On
20 to 1000 MHz		
Average value, BW = 10 kHz	<–10 dBµV typ. –15 dBµV	<–16 dBµV typ. –20 dBµV
BW = 120 kHz	typ. –5 dBµV	typ. –9 dBµV
BW = 300 kHz	typ. 0 dBµV	typ. –4 dBµV
BW = 1 MHz	typ. 4 dBµV	typ. 0 dBµV
1000 to 2050 MHz		
Average value, BW = 10 kHz	<–10 dBµV typ. –15 dBµV	<–16 dBµV typ. –20 dBµV
BW = 120 kHz	typ. –3 dBµV	typ. –9 dBµV
BW = 300 kHz	typ. 2 dBµV	typ. –4 dBµV
BW = 1 MHz	typ. 6 dBµV	typ. 0 dBµV

Voltage measurement range	Off	Preamplifier On
Lower limit (additional error caused by inherent noise <1 dB		
20 to 1000 MHz		
Average indication (AV)		
BW_{IF} = 10 kHz	<–6 dBµV typ. –12 dBµV	<–12 dBµV typ. –16 dBµV
BW_{IF} = 120 kHz	typ. –1 dBµV	typ. –5 dBµV
BW_{IF} = 300 kHz	typ. +4 dBµV	typ. 0 dBµV
BW_{IF} = 1 MHz	typ. +8 dBµV	typ. +4 dBµV
Peak indication (PK)		
BW_{IF} = 10 kHz	typ. +14 dBµV	typ. +10 dBµV
BW_{IF} = 120 kHz	typ. +25 dBµV	typ. +21 dBµV
BW_{IF} = 300 kHz	typ. +30 dBµV	typ. +26 dBµV
BW_{IF} = 1 MHz	typ. +34 dBµV	typ. +30 dBµV
Quasi-peak indication (QP)		
CISPR band C/D (100-Hz pulse frequency)	<+8 dBµV typ. +4 dBµV	<+4 dBµV typ. 0 dBµV
1000 to 2050 MHz	same values as for 20 to 1000 MHz +2 dB	same values as for 20 to 1000 MHz
Upper limit (AV, PK, QP)	137 dBµV (RF attenuation ≥10 dB)	
Inherent spurious response	<0 dBµV (equivalent input voltage)	

Level indication	
digital	3 digits in dBV, dBA, dBm, dBV/m, dBµV/m, dBµA, dBpW; resolution 0.1 dB
analog	on moving-coil meter in operating range of IF detector with digital display of zero scale deflection
Operating ranges	30, 60 dB
Detectors	average (AV), peak (PK), spectral density (PK/MHz), quasi-peak (QP)
Measuring times	1 ms to 100 s (1/2/5 steps)

Measurement error	
(AV for S/N >16 dB)	
20 to 1000 MHz	
0 to 55 °C	≤1 dB (digital display)
–10 to 0 °C	≤1.5 dB (digital display)
–10 to 55 °C	typ. <2 dB (analog display)
1000 to 2050 MHz	≤2 dB (digital display)
	typ. <3 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	interface to IEC 625-2 (IEEE 488), 24-contact Amphenol connector, female
Plotter connection	via IEC/IEEE-bus interface
Plotter language	HPGL
Printer connection	parallel interface (15-contact Cannon connector, female)
Front-panel outputs	
Supply and coding connector for antennas etc	12-contact Tuchel connector, female
AF output	jack JK34, 10 Ω
EMF	adjustable up to 1.5 V
Rear-panel outputs	
IF 74.7 MHz	BNC connector, female, 50 Ω
Gain ref. to RF input (RF attenuation 0 dB)	10 dB without preamplifier 20 dB with preamplifier
Bandwidth (–3 dB)	2 MHz
IF 10.7 MHz	
EMF in range of analog level display for unmodulated sinewave signal, bandwidth = IF bandwidth,	
operating range 30 dB	1 to 30 mV
60 dB	1 mV to 1 V
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
Inphase/quadrature demodulator outputs (option ESVD-B1)	BNC connectors, female, 50 Ω, loadable >200 Ω
EMF (peak value, regulated)	3 V
Bandwidth	½ · IF bandwidth, max. 200 kHz
Phase error between I and Q for S/N >40dB	
Output frequency	
10 to 100 kHz	typ. <1°
100 to 200 kHz	typ. <3°
for signals to GSM Rec. 5.04, IF bandwidth 300 kHz	3° rms, 7° peak
Reference output	BNC connector, female
Frequency	10 MHz
EMF	>1 V
Frequency error	see setting error
User interface	25-contact Cannon connector includes 6 control lines for an external device, analog display voltage with and without simulation of meter response, input for external triggering, RS-232-C interface for firmware update
Keyboard interface	5-contact DIN connector, female
Rear-panel inputs	
External battery	3-contact round connector, female
Required voltage	11 to 33 V

General data

Rated temperature range	–10 to +55 °C (without condensation)
Storage temperature range	–25 to +70 °C
Mechanical resistance	shock-tested to MIL-STD-810 D (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-461 B1(CE03 and RE02)
Power supply	
AC supply	100/120/240 V ±10%, 230 V +6/–10%, 47 to 420 Hz (70 VA), safety class I to VDE 0411 (IEC 348)
Battery	
Internal	12 V, 10 Ah
Operating time	approx. 2 h
External	11 to 33 V
Dimensions (W × H × D)	435 mm × 236 mm × 460 mm
Weight without options	26 kg with / 23 kg w/o battery

Ordering information

Order designation	Test Receiver ESVD	1026.5506.10
Accessories supplied	power cable, connector for external battery, operating manual	
Options		
I/Q Demodulator	ESVD-B1	1026.9001.02
UHF Frontend 1000 to 2050 MHz (only in conjunction with ESVD-B1)	ESVD-B2	1026.9501.02
Recommended extras		
For interference measurements:		
Current Probe (20 Hz to 100 (200) MHz)	EZ-17	816.2063.02
for EMS measurements	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)	HL023A1	577.8017.02
Tripod	HFU-Z	100.1114.02
Mast (for tripod)	HFU-Z	100.1120.02
Biconical Antenna (20 to 300 MHz)	HK116	4000.7752.02
Log-Periodic Antenna (200 to 1300 MHz)	HL223	4001.5501.02
Conical Log Spiral Antenna (200 to 1000 MHz)	HUF-Z4	837.2210.52
Wooden Tripod	HZ-1	837.2310.02
RF Connecting Cable (7 m)	HFU2-Z5	252.0055.55
RF Probe (BNC connector)	HFV-Z	204.1010.02
Adapter (BNC female to N male)		118.2812.00
V-Network 5 µH II 50 Ω	ESH3-Z6	836.5016.52
Preamplifier 10 dB	ESV-Z3	397.7014.52
Other accessories		
6-V lead-acid storage battery 10 Ah (2 required)		338.4012.00
Keyboard (English)	PSA-Z1	1009.5001.32
Headphones		110.2959.00
Service manual		1016.5783.24
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
Transit Case	ZZK-953	1013.9389.00
Trolley	ZZK-0011	1014.0510.00
Printer Cable	EZ-11	816.1767.02
IEC-Bus Connecting Cable, 1 m	PCK	292.2013.10
2 m	PCK	292.2013.20

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