

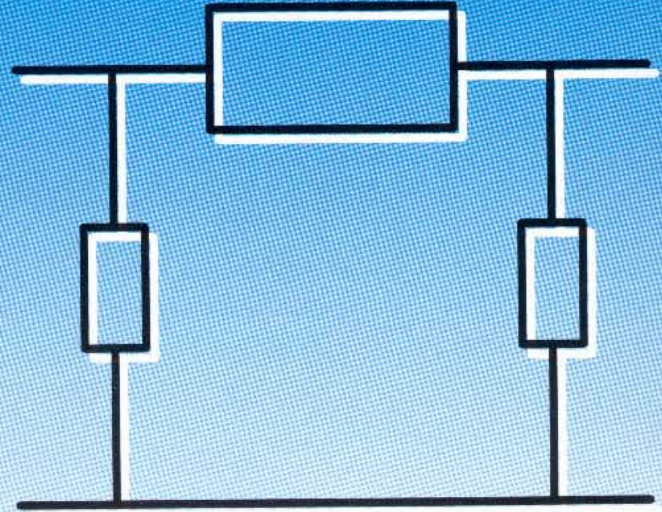


dB



dB

dB



dB

RF Step Attenuators

for versatile use up to 26.5 GHz

The Rohde & Schwarz line of RF Step Attenuators comprises seven models covering the frequency range from DC to 26.5 GHz. The largest attenuation range is 0 to 139.9 dB. Depending on the type, the attenuation can be set in steps of 0.1 dB, 1 dB or 10 dB.

- Wide frequency range: DC to 2.7/5.2/18/26.5 GHz
- Long life (more than 5×10^6 switching cycles per section)
- High accuracy
- Excellent matching
- Low residual attenuation
- Fully isolated
- Display of correction values or automatic error correction
- Manual operation and programming
- Characteristic impedance 50 Ω
- Continuous power-handling capacity 1 W

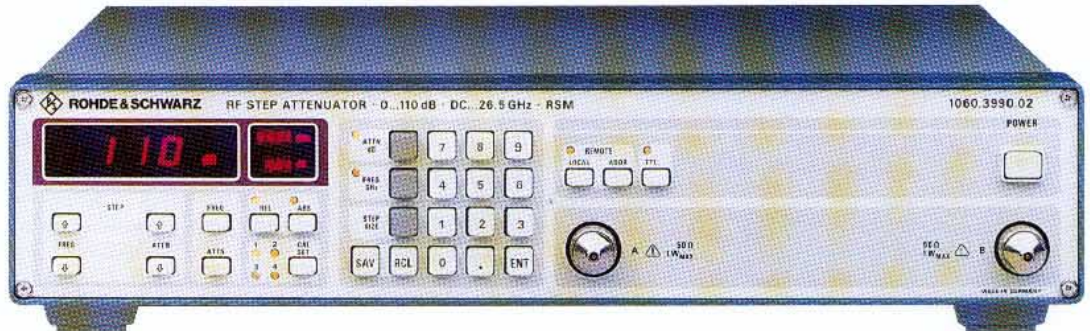


ROHDE & SCHWARZ

Models

RSM

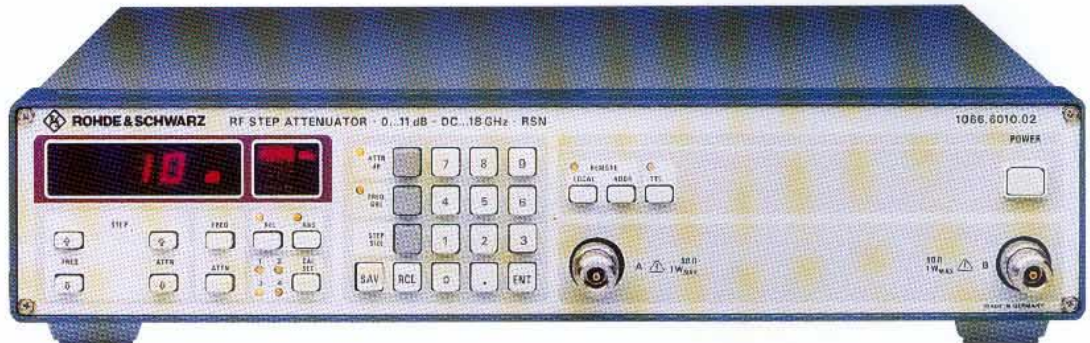
DC to 26.5 GHz
0 to 110 dB



- 10-dB steps
- Low residual attenuation
- Display of correction values

RSN

DC to 18 GHz
0 to 11 dB



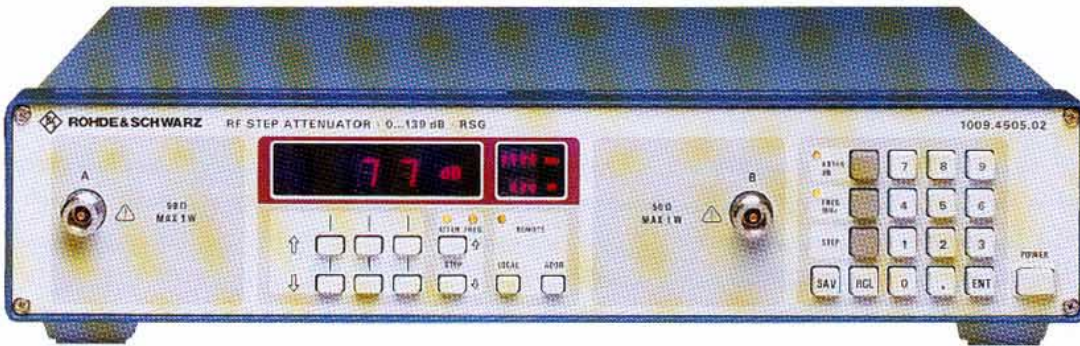
- 1-dB steps
- Low residual attenuation
- Display of correction values

RSH

DC to 5.2 GHz
0 to 139 dB



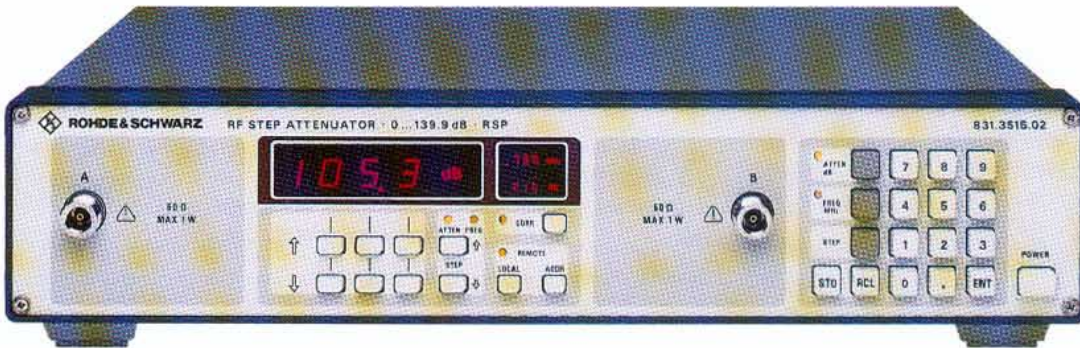
- 1-dB steps
- Fully independent of power supply



RSG

DC to 5.2 GHz
0 to 139 dB

- 1-dB steps
- Low residual attenuation
- Display of correction values



RSP

DC to 2.7 GHz
0 to 139.9 dB

- High-precision attenuator
- 0.1 dB steps
- Residual attenuation can be taken into account
- Automatic error correction

DPSP



DPS



- DPS independent of AC supply

DC to 2.7 GHz
0 to 139 dB

General

RSM, RSN, RSG and RSP

Construction

The RF Step Attenuators are accommodated in a compact 19" case suitable for use as a rackmount in test assemblies or as a bench model. To facilitate cabling, the user may refit the connectors from the front to the rear panel of the attenuators. RSM and RSN are equipped with connector interfaces which can be fitted with different connector systems without adapters being required.

Since the attenuator module is isolated electrically from the device itself, the attenuator elements themselves have no ground or AC supply connections. Therefore, the RF Step Attenuators can also be used with very small DC voltages and low-frequency AC voltages.

Switching on/off

During the switch-on routine, the attenuator is set to a frequency of 0 MHz and an attenuation of 40 dB (RSN to 10 dB), the attenuation being in no case lower than this value. A selftest is then carried out, during which the stored correction values (for maximum values and measurement accuracy of RSM and RSN see tables on page 7) are determined from their checksum. Upon switching off, an attenuation is set for RSG and RSP that is higher than the last active value; with RSM and RSN the maximum values of 110 dB and 11 dB, respectively are obtained. The value set before switching off can be recalled by RCL0. During the switchover between two attenuation values, it is ensured that no lower values are set.

Forty complete instrument setups can be stored in a nonvolatile memory and recalled by means of the STO and RCL keys. The STEP keys allow simple calling of preselected frequency or attenuation steps. The attenuators can undergo more than 5×10^6 switching operations, thus ensuring a long life.

Interface

The attenuators are equipped with an IEC 625-1 (IEEE 488) interface and thus ideal for integration into automated test assemblies. Setting is via the numeric keypad, the step keys, the IEC/IEEE-bus remote-control interface or (only RSM and RSN for attenuation values) the user port, the setting time being 20 ms only. The interface is designed for listener, talker and service request functions. The learn mode allows manually selected settings to be entered into a program. Any attenuation steps can be set by means of the commands DSH and DSL.

DPSP and DPS

Construction

The well-proven RF Step Attenuators DPS and DPSP are accommodated in a compact design-80 case and can be integrated into 19" racks with the aid of adapters. Thanks to its built-in batteries which are charged during operation from the AC supply, DPS is suitable for mobile operation. On both models, the connectors on the front panel can be refitted to the rear panel without requiring additional parts. The carrying handle can be screwed off or used as a stand to facilitate reading of the display. The

two attenuator models have the same electrical characteristics but differ in their operation.

A test report stating the attenuation values of every attenuation pad as well as the residual attenuation is supplied with each DPS/DPSP.

Switching on/off

The switching routine of DPSP corresponds to that of RSG. DPS retains the attenuation value upon switching off or goes to a newly set value upon switching on. The setting time is 20 ms only. The attenuators can undergo more than 5×10^6 switching operations, thus ensuring a long life.

Interface

DPSP is equipped with an IEC 625-1 (IEEE 488) interface and thus ideal for integration into automated test assemblies.

RSH

Construction

The RF Step Attenuator RSH is a purely mechanical, manually operated model featuring a life of more than 1×10^6 switching operations. Thanks to the special design of the plastic case, RSH can be operated either upright or lying flat.

A test report stating the attenuation values of every attenuation pad as well as the residual attenuation is supplied with each RSH.

Specifications

Type	RSM	RSN	RSG
Order No.	1060.3990.02	1066.6010.02	1009.4505.02
Frequency range	DC to 26.5 GHz	DC to 18 GHz	DC to 5.2 GHz
Attenuation range	0 to 110 dB	0 to 11 dB	0 to 139 dB
Smallest step	10 dB	1 dB	1 dB
Residual attenuation (0-dB position)	$\leq(0.8 + 0.09 f)$ dB [f in GHz]		DC ≤ 0.1 (typ. 0.05) dB ≤ 1 GHz ≤ 0.8 (typ. 0.5) dB ≤ 3 GHz ≤ 1.2 (typ. 0.8) dB ≤ 5.2 GHz ≤ 1.6 (typ. 1.3) dB
Maximum attenuation error (in dB + % of attenuation value)	see tables on page 7		≤ 1 GHz $\pm(0.2$ dB + 1%) ≤ 3 GHz $\pm(0.4$ dB + 1%) ≤ 5.2 GHz $\pm(0.6$ dB + 1.3%)
Correction data stored for each attenuation setting	at 200-MHz intervals (804 values measured)	at 100-MHz intervals (2172 values)	at 50-MHz intervals
Test report	available for attenuation of every pad and residual attenuation		available for attenuation of every pad
Characteristic impedance	50 Ω		50 Ω
VSWR	≤ 4 GHz ≤ 1.25 ≤ 8 GHz ≤ 1.35 ≤ 12.4 GHz ≤ 1.4 ≤ 20 GHz ≤ 1.7 ≤ 26.5 GHz ≤ 2	≤ 4 GHz ≤ 1.3 ≤ 8 GHz ≤ 1.4 ≤ 12.4 GHz ≤ 1.5 ≤ 18 GHz ≤ 1.8	≤ 3.5 GHz $\leq 1.1 + 0.2 f$ ≤ 5.2 GHz ≤ 1.8
Power-handling capacity, continuous pulse	1 W 50 W/10 μ s, duty cycle 10^{-3}		1 W 200 W/10 μ s, m
Life	$>5 \times 10^6$ switching cycles*) per section		$>5 \times 10^6$ switching
Switching time	≤ 20 ms		≤ 20 ms
Selftest	checking of correction values		checking of correct
Rated temperature range	0 to +55 °C		0 to +55 °C
Storage temperature range	-40 to +70 °C		-40 to +70
Power supply	100/120/220/230 V $\pm 10\%$, 47 to 420 Hz (15 VA), to VDE 0411 (IEC 348), safety class I		100/120/220/240 V $\pm 10\%$, to VDE 0411 (IEC 348)
Remote control (and connectors)	to IEC 625-1/IEEE 488 (24-contact Amphenol), user port for attenuation setting by binary coded signals (15-contact sub-D)		to IEC 625-1/IEEE 488 (24
Electromagnetic compatibility/RF leakage	complies with EC requirement (CE mark); standards: EN 50081-1, EN 50082-1, interference suppression on power lines to VDE 0875, grade K		meets requirements to VDE 0871, limit v and conducted int
Mechanical resistance	shock-tested to MIL-STD-810D, test procedure 516.3, method 1 (40 g shock spectrum), and vibration-tested (2 g, 5 to 55 Hz); corresponding to IEC Publications 68-2-27 and 68-2-6		shock-tested to DIN 40046, part 7 (30 g DIN 40046, part 8 (2 g, 5 to 55 Hz); co 68-2-27 and 6
Connectors	3.5-mm PC female	N female	N female, on front o
Dimensions (W x H x D)	435 mm x 103 mm x 376 mm		435 mm x 103 mm
Weight	5.3 kg		5.5 kg
Accessories supplied	power cable		power cab
Recommended extras	Microwave Cable and Adapter Set FS-Z15 1046.2002.02 Adapter for 3.5-mm PC connector, male 1021.0529.00 Adapter for N connector, male 1021.0541.00 Matching Pad RAM (50/75 Ω) 358.5414.02 19" Rack Adapter ZZA-92 396.4886.00 Set of front handles 396.5147.00 Adapter for N connector, female 1021.0535.00		19" Rack Adapter ZZA-9 Set of front handles 3 Matching Pad RAM (50/75

*) A switching cycle is defined as a switchover from one setting to another and back again.

RSP	DPSP	DPS	RSH
831.3515.02	334.6010.02	334.7217.02	1060.6518.02
DC to 2.7 GHz	DC to 2.7 GHz	DC to 2.7 GHz	DC to 5.2 GHz
0 to 139.9 dB	0 to 139 dB	0 to 139 dB	0 to 139 dB
0.1 dB (above 1 dB)	1 dB	1 dB	1 dB
DC ≤0.12 (typ. 0.08) dB ≤1 GHz ≤1.2 (typ. 0.8) dB ≤2.7 GHz ≤1.8 (typ. 1.4) dB	at 200 MHz ≤0.4 dB at 1 GHz ≤0.8 dB at 2.7 GHz ≤1.2 dB		DC ≤0.1 dB ≤1 GHz ≤0.7 dB ≤2.7 GHz ≤1 dB ≤5.2 GHz ≤1.6 dB
without correction ≤1 GHz ±(0.2 dB + 1%) ≤2 GHz ±(0.3 dB + 1%) ≤2.7 GHz ±(0.4 dB + 1%) with correction (≥3 dB attenuation) ≤0.5 GHz ±(0.05 dB + 0.5%) ≤1 GHz ±(0.1 dB + 0.5%) ≤2 GHz ±(0.15 dB + 1%)	±(0.2 dB + 1.3%), max. 1 dB; for >4 dB attenuation		≤1 GHz ±(0.2 dB + 1%) ≤2.7 GHz ±(0.4 dB + 1%) ≤5.2 GHz ±(0.6 dB + 1%)
switching intervals			
Matching pad and residual attenuation	supplied with unit		supplied with unit
Impedance	50 Ω		50 Ω
Return loss ≤2 GHz ≤1.2 + 0.1 f ≤2.7 GHz ≤1.4	≤1.5 GHz ≤1.1 + 0.2 f ≤2.7 GHz ≤1.4; for >4 dB attenuation		≤3.5 GHz ≤1.1 + 0.2 f ≤5.2 GHz ≤1.8
Power handling 1 W max. 150 V	1 W 200 W/10 μs, max. 150 V		1 W (at t _{amb} 20°C) 200 W/10 μs, max. 150 V
Switching cycles*)	>5 x 10 ⁶ switching cycles*) per section		>1 x 10 ⁶ switching operations
Switching time ≤20 ms (attenuation not corrected)	≤20 ms		
Temperature correction values			
0 to +55°C	0 to +45°C		0 to +55°C
0 to +70°C	-40 to +70°C	-40 to +60°C	-40 to +70°C
Power supply 115, 47 to 440 Hz (20 VA), IEC 48), safety class I	115/125/220/235 V ±10%, 47 to 440 Hz (10 VA), NiCd battery for 5000 switching operations and charger incorporated		
Connector (24-contact Amphenol)	to IEC 625-1/IEEE 488 (24-contact Amphenol)		
EMC EMC value class B, regarding radiated interference			complies with EC requirement (CE mark); standards: EN 50081-1, EN 50082-1
Shock and vibration (10 g, 11 ms), and vibration-tested to standards corresponding to IEC Publications 60068-2-6			same as on left
Mounting Front or rear panel	N female, on front or rear panel		N female
Dimensions 241 mm x 359 mm	241 mm x 110 mm x 234 mm		248 mm x 135 mm x 76 mm
Weight 3 kg	3 kg		1.2 kg
Accessories power cable	power cable		
Part numbers A-92.396.4886.00 A-396.5147.00 A-75 Ω 358.5414.02	19" Rack Adapter 078.8016.00 Matching Pad RAM (50/75 Ω) 358.5414.02		Microwave Cable and Adapter Set FS-Z15 1046.2002.02 Matching Pad RAM (50/75 Ω) 358.5414.02

Maximum attenuation error

Frequency	Attenuation (referred to 0-dB position)								dB
	10	20	30	40	50	60	70 to 80	90 to 110	
≤8 GHz	±0.3	±0.4	±0.5	±0.5	±0.7	±0.8	±1.0	±1.5	dB
≤12.4 GHz	±0.4	±0.6	±0.7	±0.7	±0.9	±1.2	±1.4	±2.1	dB
≤18 GHz	±0.5	±0.7	±0.9	±0.9	±1.2	±1.4	±1.8	±2.7	dB
≤26.5 GHz	±0.7	±0.9	±1.0	±1.5	±1.8	±2.1	±2.9	±3.7	dB
Frequency	Measurement error of correction values for								dB
	0 to 40				50 to 80		90 to 110		
≤26.5 GHz	±(0.2+0.004 x A)				±(0.4+0.008 x A)		±(0.6+0.013 x A)		dB

RSM
Upper limits and measurement error of correction values

Frequency	Attenuation (referred to 0-dB position)									dB
	1	2	3	4	5	6	7 to 8	9 to 10	11	
≤8 GHz	±0.15	±0.15	±0.2	±0.2	±0.2	±0.25	±0.25	±0.3	±0.3	dB
≤12.4 GHz	±0.2	±0.25	±0.35	±0.35	±0.35	±0.4	±0.45	±0.5	±0.55	dB
≤18 GHz	±0.3	±0.4	±0.45	±0.45	±0.45	±0.5	±0.55	±0.65	±0.7	dB
Frequency	Measurement error of correction values for									dB
	0 to 11									
≤8 GHz	±0.15									dB
≤18 GHz	±0.2									dB

RSN
Upper limits and measurement error of correction values

Operation

RSM

The programmable RF Step Attenuator RSM permits attenuation values between 0 and 110 dB to be set in 10-dB steps in the wide frequency range from DC to 26.5 GHz. Correction data for the whole frequency range are determined in the factory at 200-MHz intervals and stored in the first of four non-volatile memories. The three remaining memories may be used for storing user's correction values. This allows attenuators connected ahead or cable losses to be taken into account. Using the integrated memory for correction values, the factory-determined deviation of the actual attenuation from the nominal value is displayed (REL mode). In the ABS mode, the value displayed is the sum of correction value and residual attenuation so that the overall attenuation can be easily read off.

RSN

Operation of RSN largely corresponds to that of RSM. Attenuation values from 0 to 11 dB can be set in 1-dB steps. The correction values covering the complete range are available from memory in steps of 100 MHz.

RSG

RSG allows attenuation values from 0 to 139 dB to be set in 1-dB steps in the range from DC to 5.2 GHz. Using the special function RCL 97, it is possible to determine the low residual attenuation in the 0-dB position. Variations of the residual attenuation and of the individual attenuator pads have been measured and stored at the factory in 50-MHz intervals and may be displayed on the front panel or fetched via the IEC/IEEE bus.

RSP

The RF Step Attenuator RSP provides attenuation values between 0 and 139.9 dB in the frequency range 0 to 2.7 GHz. Above 1 dB, the smallest attenuation step is 0.1 dB. RSP is the first attenuator featuring automatic frequency-dependent attenuation correction which reduces errors to a minimum.

The variations of the individual attenuator pads (18 in total) have been measured throughout the frequency range at 50-MHz intervals and stored in the unit. The absolute accuracy of the selected attenuation values can be corrected by actuating the CORR key, the error being minimized by the automatic switching of appropriate attenuator pads. The sum of the attenuation errors of the pads is displayed. The residual attenuation is indicated in the 0-dB setting. The RCL 99 function provides attenuation values between 3 and 139.9 dB, the residual attenuation being taken into account when setting the attenuation.

DPSP

DPSP is operated by means of two rotary switches, the carry being made automatically. The switching functions are controlled by a microprocessor via an IEC/IEEE-bus interface.

DPS

The attenuation value can be set by means of three decade switches. The built-in batteries are charged during operation from the AC supply.

RSH

The attenuation value can be set manually from 0 to 139 dB in 10-dB and 1-dB steps by means of two rotary switches. Operation of RSH is purely mechanical and the model is fully independent of any power supply.

Characteristics and uses

Attenuator sets are two-port networks providing adjustable high-precision attenuation and the same constant characteristic impedance at the input and output. They are used for gain and attenuation measurements (Figs 1, 3 and 4), for linearity measurements (Fig. 2) or as a reference attenuator (Fig. 3). They also generate very small and accurately-known voltages if a precisely determined input voltage is available. Their special construction affords a high degree of accuracy and a very wide frequency range.

The Rohde & Schwarz RF Step Attenuators controllable via an IEC/IEEE bus (not with DPS and RSH) are used as independent units for AF and RF measurements. They feature:

- Small input and output reflection coefficient
- High degree of decoupling
- Wide frequency range
- High setting accuracy
- Large attenuation values
- Setting time <20 ms (not RSH)

- Stepwise switching down to 0-dB attenuation
- High switching reliability
- Power-handling capacity up to 1 W
- Long life
- Error correction by means of stored correction data with RSM, RSN, RSG and RSP

The accuracy of the selected attenuation values depends on the accuracy of the resistors used in the attenuator pads; therefore, very close tolerances have been chosen for these resistors. In addition, with high attenuations, ie very low output voltages, a precondition for accurate voltage division is that power should not be coupled directly from the attenuator input to the output. This condition is fulfilled thanks to an effective shielding. All attenuators are designed for 50-Ω line systems; they can be adapted to 75 Ω with the aid of Matching Pads RAM (see data sheet PD 756.3860).

The attenuation settings are made with electromagnetic switches. The setting

times are very short and always of the same duration since all attenuator pads necessary for obtaining a specific attenuation are switched at the same time (even when switching between largely differing values). The mechanical RSH model is provided with rotary switches.

Remote-controlled attenuators in combination with other IEC/IEEE-bus-compatible instruments are suitable for setting up fully or semi-automatic test assemblies (Fig. 4) which are especially used in production and test departments.

Various cables are available for providing low-reflection connection of the attenuators with the equipment:

- 1) Cable (DC to 7 GHz), 100 cm, N male connector, adaptable; Order No. 1046.3150.02
- 2) Microwave Cable and Adapter Set FS-Z15 (DC to 26.5 GHz) for RSM and RSN, 100 cm, adaptable from (f) to (m); Order No. 1046.2002.02



Fig. 1 Test setup for gain and attenuation measurements (series configuration)

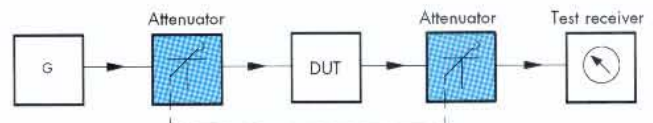


Fig. 2 Test setup for measuring the linearity of two-port networks

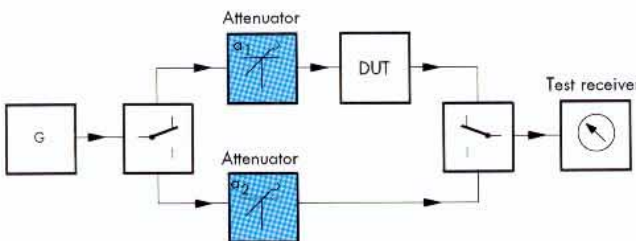


Fig. 3 Test setup with reference attenuator for high-precision gain and attenuation measurements (parallel configuration)

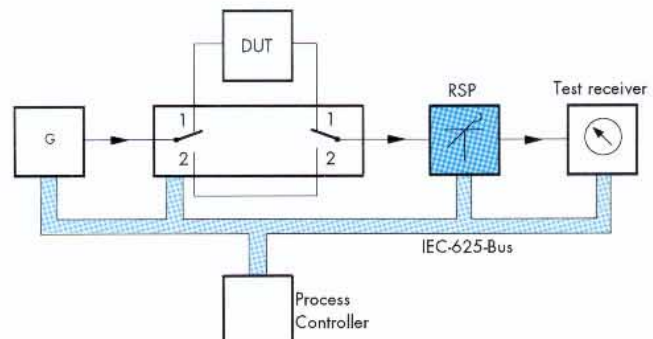


Fig. 4 Automatic test assembly for gain and attenuation measurements using programmable RF step attenuator



ROHDE & SCHWARZ

ROHDE & SCHWARZ GmbH & Co. KG · Mühlendorfstraße 15 · D-81671 München
P.O.B. 8014 69 · D-81614 München · Telephone +4989 4129-0 · Fax +4989 4129-3115