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## RF Step Attenuators

for versatile use up to 26.5 GHz

The Rohde & Schwarz line of RF step attenuators comprises five models covering the frequency range from DC to 26.5 GHz. The largest attenuation range is 0 dB to 139 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 2.7/5.2/26.5 GHz
- ◆ Long life (more than  $5 \times 10^6$  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  $\Omega$
- ◆ Continuous power-handling capacity 1 W



**ROHDE & SCHWARZ**

# Overview of all instruments



## R&S®RSM

**DC to 26.5 GHz**

**0 dB to 110 dB**

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



## R&S®RSG

**DC to 5.2 GHz**

**0 dB to 139 dB**

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



## R&S®RSP

**DC to 2.7 GHz**

**0 dB to 139.9 dB**

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



### R&S®DPSP

DC to 2.7 GHz  
0 dB to 139 dB



### R&S®DPS

DC to 2.7 GHz  
0 dB to 139 dB

◆ Independent of AC supply

# General

## R&S®RSM, R&S®RSG and R&S®RSP

### Construction

The RF step attenuators are accommodated in a compact 19" housing suitable for use as a rackmount in test assemblies or as a bench model. To facilitate cabling, the user may transfer the connectors from the front to the rear panel of the attenuators. The R&S®RSM has connector interfaces which can be equipped 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, 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 the R&S®RSM see table on page 9) are determined from their checksum. Upon switching off, an attenuation is set for the R&S®RSG and the R&S®RSP that is higher than the last active value; with the R&S®RSM the maximum value of 110 dB is obtained.

The value set before switching off can be called up again by RCL 0. 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 called up again by means of the STO and RCL keys. The step keys allow simple calling of preselected frequency or attenuation steps. The attenuators can perform more than  $5 \times 10^6$  switching operations, which ensures 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 with the R&S®RSM 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.

## R&S®DPSP and R&S®DPS

### Construction

The tried-and-tested RF Step Attenuators R&S®DPS and R&S®DPSP are accommodated in a compact design-80 housing and can be integrated into 19" racks with the aid of adapters. Owing to its built-in batteries which are charged during operation from the AC supply, the R&S®DPS is suitable for mobile operation. On both models, the connectors on the front panel can be transferred to the rear panel without requiring additional parts. The carrying handle can be removed 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 R&S®DPS/R&S®DPSP.

### Switching on/off

The switching routine of the R&S®DPSP corresponds to that of the R&S®RSG. The R&S®DPS retains the attenuation value upon switching off or uses a newly set value upon switching on. The setting time is 20 ms only. The attenuators can perform more than  $5 \times 10^6$  switching operations, which ensures a long life.

### Interface

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

# 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 and 4), for linearity measurements (Fig. 2) or as a reference attenuator (Fig. 3). They also generate very small defined voltages if a precisely determined input voltage is available. Their special construction provides a high degree of accuracy and a very wide frequency range.

The Rohde & Schwarz RF step attenuators can be controlled via an IEC/IEEE bus (except for the R&S®DPS) and 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

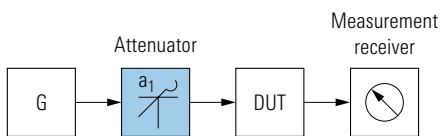
- ◆ Stepwise switching down to 0 dB attenuation
- ◆ High switching reliability
- ◆ Power-handling capacity up to 1 W
- ◆ Long life
- ◆ Error correction by means of stored correction data with the R&S®RSM, R&S®RSG and R&S®RSP

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. With high attenuations, i.e. very low output voltages, accurate voltage division furthermore requires that power not be coupled directly from the attenuator input to the output. This condition is fulfilled owing to an effective shielding. All attenuators are designed for 50 Ω line systems; they can be adapted to 75 Ω with the aid of the Matching Pads R&S®RAM (see data sheet PD 0758.1906.32).

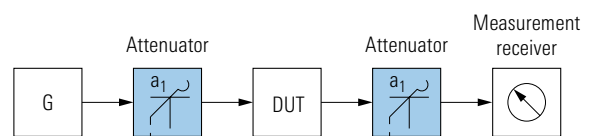
The attenuation settings are performed using electromagnetic switches. The setting times are very short and always of the same duration since all attenuator pads necessary for obtaining a specific attenuation are switched at the same time (even when switching between largely differing values). Remote-controlled 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:

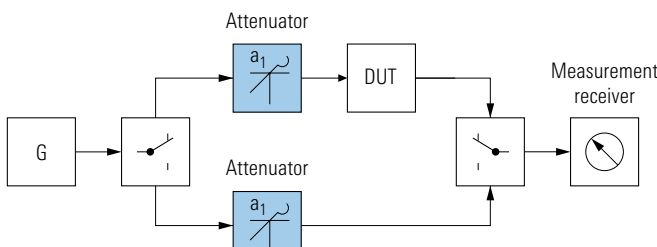
- ◆ Cable (DC to 7 GHz), 100 cm, N male connector, adaptable; order no. 1046.3150.02
- ◆ Microwave Cable and Adapter Set R&S®FS-Z15 (DC to 26.5 GHz) for the R&S®RSM, 100 cm, adaptable from (f) to (m); order no. 1046.2002.02



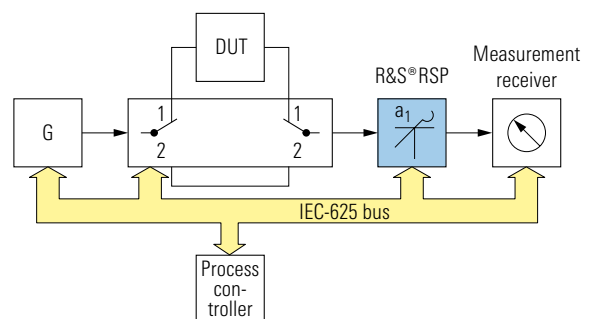
**Fig. 1 Test setup for gain and attenuation measurements (series configuration)**



**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 a programmable RF step attenuator**



## Specifications

Type	R&S® RSM	R&S® RSG
<b>Order No.</b>	<b>1060.3990.02</b>	<b>1009.4505.02</b>
Frequency range	DC to 26.5 GHz	DC to 5.2 GHz
Attenuation range	0 dB to 110 dB	0 dB to 139 dB
Smallest step	10 dB	1 dB
Residual attenuation (0 dB position)	$\leq(0.8 + 0.09 f)$ dB [f in GHz]	DC ≤1 GHz ≤3 GHz ≤5.2 GHz
Maximum attenuation error (in dB + % of attenuation value)	see table on page 9	≤1 GHz ≤3 GHz ≤5.2 GHz
Correction data stored for each attenuation setting	at 200 MHz intervals (804 values measured) maximum values and accuracy, see page 9	
Test report	available for attenuation of every pad and residual attenuation	
Characteristic impedance	50 Ω	
VSWR	≤4 GHz ≤1.25 ≤8 GHz ≤1.35 ≤12.4 GHz ≤1.4 ≤20 GHz ≤1.7 ≤26.5 GHz ≤2	≤3.5 GHz ≤5.2 GHz
Power-handling capacity Continuous Pulse	1 W 50 W/10 μs, duty cycle 10 <sup>-3</sup>	
Life	>5 × 10 <sup>8</sup> switching cycles <sup>1)</sup> per section	
Switching time	≤20 ms	≤20 ms
Selftest	checking of correction values	
Operating range	0 °C to +55 °C	
Storage temperature range	-40 °C to +70 °C	
Power supply	100/120/220/230 V ±10 %, 47 Hz to 420 Hz (15 VA), meets VDE 0411 (IEC 348), safety class I	100/120/220/240 V ± meets VDE 0411 (IEC
Remote control (and connectors)	meets IEC 625-1/IEEE 488 (24-contact Amphenol), user port for attenuation setting by binary coded signals (15-contact D-Sub)	
Electromagnetic compatibility/RF leakage	complies with EC requirement (CE mark); standards: EN 55011, EN 61326-1 interference suppression on power lines to VDE 0875, grade K	meets requirements
Mechanical resistance	shock-tested to MIL-STD-810D, test procedure 516.3, method 1 (40 g shock spectrum), and vibration-tested (2 g, 5 Hz to 55 Hz); corresponding to IEC Publications 60068-27 and 60068-6	shock-tested to
Connectors	PC 3.5 mm, female	
Dimensions (W × H × D)	435 mm × 103 mm × 376 mm	
Weight	5.3 kg	
Accessories supplied	power cable	
Recommended extras	Microwave Cable and Adapter Set R&S®FS-Z15, 1046.2002.02 Adapter for PC 3.5 mm, male, 1021.0529.00 Adapter for N connector, male, 1021.0541.00 Matching Pad R&S®RAM (50/75 Ω), 358.5414.02 19" Rack Adapter R&S®ZZA-92, 396.4886.00 Set of front handles, 396.5147.00 Adapter for N connector, female, 1021.0535.00	

<sup>1)</sup> A switching cycle is defined as a switchover from one setting to another and back again.

	R&S®RSP		R&S®DPSP		R&S®DPS
	<b>831.3515.02</b>		<b>334.6010.02</b>		<b>334.7217.02</b>
	DC to 2.7 GHz		DC to 2.7 GHz		
	0 dB to 139.9 dB		0 dB to 139 dB		
	0.1 dB (above 1 dB)		1 dB		
0.1 (typ. 0.05) dB 0.8 (typ. 0.5) dB 1.2 (typ. 0.8) dB 1.6 (typ. 1.3) dB	DC ≤1 GHz ≤2.7 GHz	≤0.12 (typ. 0.08) dB ≤1.2 (typ. 0.8) dB ≤1.8 (typ. 1.4) dB	at 200 MHz at 1 GHz at 2.7 GHz	≤0.4 dB ≤0.8 dB ≤1.2 dB	
(0.2 dB + 1%) (0.4 dB + 1%) (0.6 dB + 1.3%)	see table on page 9		±(0.2 dB + 1.3%), max. 1 dB; for >4 dB attenuation		
at 50 MHz intervals					
available for attenuation of every pad and residual attenuation			supplied with unit		
50 Ω			50 Ω		
1.1 + 0.2 f 1.8	≤2 GHz ≤2.7 GHz	≤1.2 + 0.1 f ≤1.4	≤1.5 GHz ≤2.7 GHz	≤1.1 + 0.2 f ≤1.4; for >4 dB attenuation	
1 W 200 W/10 μs, max. 150 V >5 × 10 <sup>6</sup> switching cycles <sup>1)</sup>			1 W 200 W/10 μs, max. 150 V >5 × 10 <sup>6</sup> switching cycles <sup>1)</sup> per section		
≤20 ms (attenuation not corrected)			≤20 ms		
checking of correction values					
0 °C to +55 °C			0 °C to +45 °C		
-40 °C to +70 °C			-40 °C to +70 °C	-40 °C to +60 °C	
10%, 47 Hz to 440 Hz (20 VA), 348), safety class I			115/125/220/235 V ±10%, 47 Hz to 440 Hz (10 VA), NiCd battery for 5000 switching operations, charger incorporated		
meets IEC 625-1/IEEE 488 (24-contact Amphenol)			meets IEC 625-1/IEEE 488 (24-contact Amphenol)		
of VDE 0871, limit value class B, regarding radiated and conducted interference					
to DIN 40046, part 7 (30 g, 11 ms), and vibration-tested to DIN 40046, part 8 (2 g, 5 Hz to 55 Hz); corresponding to IEC Publications 60068-27 and 60068-6					
N female, on front or rear panel			N female, on front or rear panel		
435 mm × 103 mm × 359 mm			241 mm × 110 mm × 234 mm		
5.5 kg			3 kg		
power cable			power cable		
19" Rack Adapter R&S®ZZA-92, 396.4886.00 Set of front handles, 396.5147.00 Matching Pad R&S®RAM (50/75 Ω), 358.5414.02			19" Rack Adapter, 078.8016.00 Matching Pad R&S®RAM (50/75 Ω), 358.5414.02		



# Tables

## Maximum attenuation error for the R&S®RSM

Frequency	Attenuation (referenced to 0 dB position)								
	10	20	30	40	50	60	70 to 80	90 to 110	dB
≤8 GHz	±0.3	±0.4	±0.5	±0.5	±0.7	±0.8	±1.0	±1.5	dB
≤12.4 GHz	±0.4	±0.6	±0.7	±0.7	±0.9	±1.2	±1.4	±2.1	dB
≤18 GHz	±0.5	±0.7	±0.9	±0.9	±1.2	±1.4	±1.8	±2.7	dB
≤26.5 GHz	±0.7	±0.9	±1.0	±1.5	±1.8	±2.1	±2.9	±3.7	dB

## Measurement error of correction values for the R&S®RSM

Frequency	Attenuation			
	0 to 40	50 to 80	90 to 110	dB
≤26.5 GHz	±(0.2 + 0.004 × A)	±(0.4 + 0.008 × A)	±(0.6 + 0.013 × A)	dB

## Maximum attenuation error for the R&S®RSP

Frequency	Without correction	With correction (≥3 dB attenuation)
≤0.5 GHz	—	±(0.05 dB + 0.5%)
≤1 GHz	±(0.2 dB + 1%)	±(0.1 dB + 0.5%)
≤2 GHz	±(0.3 dB + 1%)	±(0.15 dB + 1%)
≤2.7 GHz	±(0.4 dB + 1%)	—

# Operation

## R&S®RSM

The programmable RF Step Attenuator R&S®RSM permits attenuation values between 0 dB 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 entire 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 the 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.

## R&S®RSG

The R&S®RSG allows attenuation values from 0 dB 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 residu-

al attenuation in the 0 dB position. Variations of the residual attenuation and of the individual attenuator pads have been measured and stored in the factory at 50 MHz intervals and may be displayed on the front panel or called via the IEC/IEEE bus.

## R&S®RSP

The RF Step Attenuator R&S®RSP provides attenuation values between 0 dB and 139.9 dB in the frequency range 0 GHz to 2.7 GHz. Above 1 dB, the smallest attenuation step is 0.1 dB. The R&S®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 pressing 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 set-

ting. The RCL 99 function provides attenuation values between 3 dB and 139.9 dB, the residual attenuation being taken into account when the attenuation is set.

## R&S®DPSP

The R&S®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.

## R&S®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.



More information at  
[www.rohde-schwarz.com](http://www.rohde-schwarz.com)  
(search term: RF Step Attenuators)



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