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# Attenuators and Matching Pads, Terminations

175 mW to 1000 W/DC to 18 GHz

# Attenuators

As a rule, the reflection coefficient of commercial signal generators or test receivers is about 20%. This value may be too high for precise measurements. To improve matching, an attenuator should be inserted after the signal generator output and another one ahead of the receiver input. In this way, the reflection coefficients of both the generator and the receiver will be reduced.

Signal generators often do not have a defined source impedance. In these cases, it is advisable to insert a 16 dB (10 dB + 6 dB) attenuator. The internal reflection coefficient of such a signal source is thus reduced to about 3%, which is small enough for accurate measurements.

Attenuators can also be used as reference standards for attenuation and gain measurements in line with the substitution method, for precise voltage division, and as buffers to isolate test circuits.

## R&S®DNF (1 W/2 W)

Small attenuation error, largely frequency-independent attenuation and low VSWR are special features of the Attenuators R&S®DNF. They are sturdy, immune to vibration (complying with MIL-A-3933), only slightly temperature-dependent and resistant to short-term overloading. The Attenuators R&S®DNF are equipped with N connectors (male, female) and are available with 3/6/10/20/30 dB attenuation.

## High-power attenuators

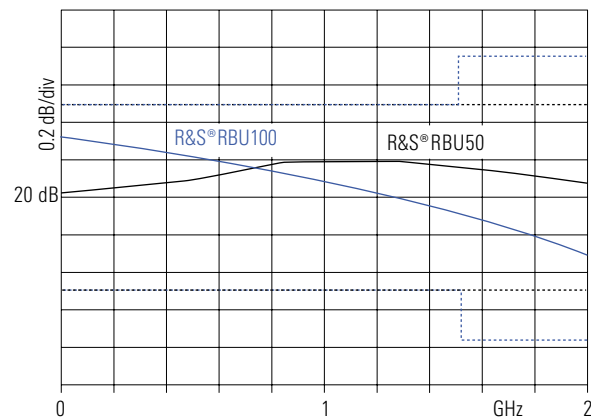
High-power attenuators are used as dummy loads for transmitters and amplifiers in the frequency range 0 Hz to 6 GHz. Their constant attenuation permits harmonics measurements to be allowed on transmitters, TV transposers and other equipment. Thus, the high-power attenuator is superior to a sim-

ple termination. The power applied can be accurately determined from the power measured at the test output and from the known attenuation. Moreover, a frequency counter or analyzer can be connected to the test output.

## R&S®RBU (50 W/100 W)

The High-Power Attenuators R&S®RBU with 3/6/10/20/30 dB attenuation are ideal for applications in the frequency range up to 2 GHz, which is of particular interest for mobile radio measurements. The attenuators are characterized by low VSWR and a small attenuation error throughout the entire frequency range. Due to the large-area heat sink, the attenuator surface temperature does not rise above 75 °C (at 25 °C ambient temperature) even under full load.

R&S®DNF



Typical attenuation (top) and VSWR (bottom) characteristics of the Attenuators R&S®RBU50 and R&S®RBU1000 (attenuation 20 dB)

## R&S®RDL50 (50 W)

The High-Power Attenuator R&S®RDL50 is suitable for the frequency range up to 6 GHz. A special feature is its constant low attenuation over the entire frequency range.



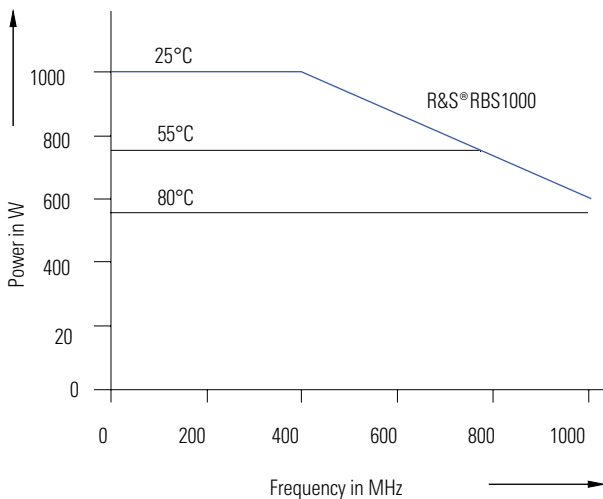
**R&S®RDL50, 50 W**

## R&S®RBS 1000 (1000 W)

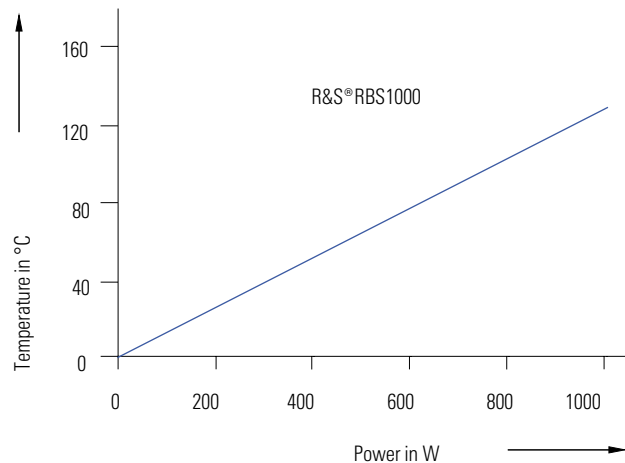
The Attenuator R&S®RBS 1000 is of planar design using special manufacturing techniques. The energy-absorbing thin-film layer is deposited on a ceramic substrate, so the heat generated can directly dissipate without having to penetrate any heat-insulating air layer. The result is a considerable reduction in size while maintaining the same power-handling capacity as conventional attenuators.



**R&S®RBS 1000, 1000 W**



**Power handling capacity as a function of frequency and ambient temperature**



**Overtemperature as a function of the power applied**

# Terminations

## R&S®RNA and R&S®RNB (1 W)

The 75 Ω and the 50 Ω Terminations R&S®RNA and R&S®RNB are versatile line terminations used in 3/7 mm coaxial line systems. A special feature is their very low reflection over a wide frequency range. The use of high-grade metal-film resistors provides a continuous power-handling capacity of 1 W.

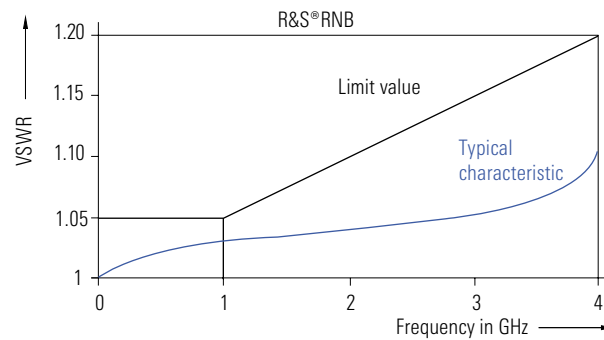
The Precision Termination R&S®RNA features extremely low VSWR over the entire frequency range from DC to 3 GHz and is, therefore, ideal for measurement applications. The Termination R&S®RNB is for general use in the frequency range DC to 4 GHz.



R&S®RNA



R&S®RNB



Limit value and typical VSWR characteristics of the R&S®RNB

## R&S®RAU (100 W)

The Termination R&S®RAU is mainly used as a dummy antenna for mobile and stationary transmitters. Its low VSWR makes it also suitable for TV equipment.



R&S®RAU

# Feedthrough Terminations, Matching Pads

For the precise measurement of insertion loss and phase shift, the signal generator, DUT and receiver must be well matched to one another. Matching pads allow systems of different characteristic impedance to be connected without involving costly retrofits.

## Feedthrough Terminations R&S®RAD (500 mW), R&S®RAD50

The Feedthrough Terminations R&S®RAD are used for matching 50 Ω lines to measuring equipment of high input impedance (e.g. oscilloscopes or tuners with 1 MΩ input impedance). The feedthrough terminations must be plugged directly onto the input connector of the measuring device to ensure optimum matching.



## Matching Pads R&S®RAM and R&S®RAZ (2 W)

The bidirectional Matching Pad R&S®RAM provides the match between 50 Ω and 75 Ω impedance systems in both directions up to 2.7 GHz, causing minimum attenuation. Care should be taken that ports with the same characteristic impedances be connected to one another.



Voltage transformation is defined as the ratio in dB of the voltages at the connectors:

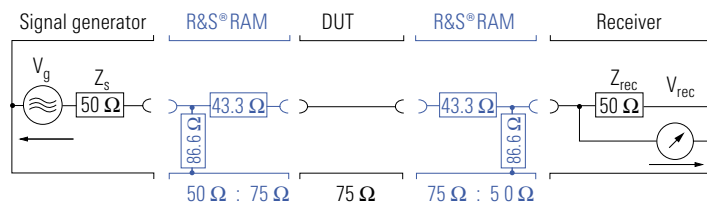
$$A_{50\Omega \rightarrow 75\Omega} = 20 \cdot \lg \frac{V_{50\Omega}}{V_{75\Omega}} = 4 \text{ dB}$$

$$A_{75\Omega \rightarrow 50\Omega} = 20 \cdot \lg \frac{V_{75\Omega}}{V_{50\Omega}} = 7.5 \text{ dB}$$

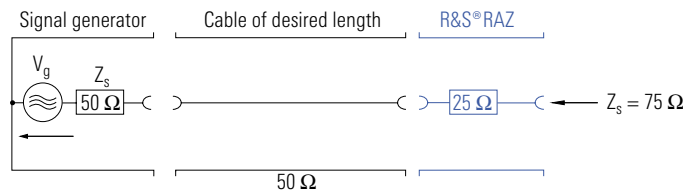
Power attenuation is the same in both directions:

$$A_p = 10 \cdot \lg \frac{V_{75\Omega}^2 \cdot 50\Omega}{75\Omega \cdot V_{50\Omega}^2} = 5.72 \text{ dB}$$

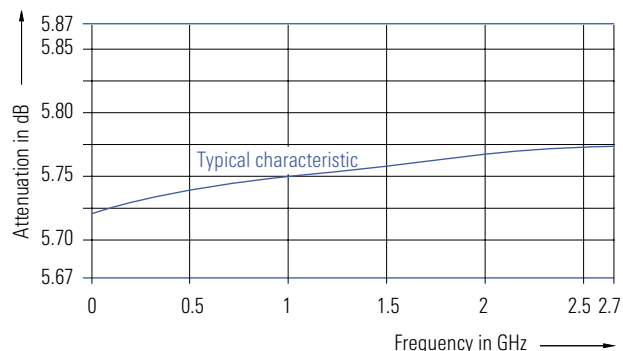
The unidirectional Matching Pad R&S®RAZ is particularly suitable for the matching of signal generators. Signal and sweep generators have in most cases a source impedance of 50 Ω. They can be adapted to feed 75 Ω systems by means of the Matching Pad R&S®RAZ involving extremely low power loss. The output voltage displayed on the generator is also valid for the 75 Ω system without requiring correction.



**Two Matching Pads R&S®RAM to match a 75 Ω DUT to a signal generator and receiver, each having a characteristic impedance of 50 Ω**



**By connecting a Matching Pad R&S®RAZ consisting of a 25 Ω series resistor, a signal generator with a 50 Ω output has an output impedance of 75 Ω**



**Frequency response and error limits of power attenuation of the Matching Pad R&S®RAM**

## Specifications/Ordering information

Type Order No.	Characteristic impedance	Power rating	Nominal attenuation	Frequency range	VSWR	Attenuation (N = nominal value)	Max. peak pulse voltage	Connectors	Dimensions, weight
<b>R&amp;S® DNF</b>									
272.4010.50	50 Ω	2 W <sup>(1)</sup>	3 dB	0 Hz to 12.4 GHz	≤1.1 (up to 4 GHz)	N ±0.3 dB to 8 GHz <sup>(2)</sup>		N male, N female	20.5 mm Ø × 55 mm, 69 g
272.4110.50			6 dB		≤1.2 (up to 10 GHz)	N ±0.5 dB to 12.4 GHz <sup>(2)</sup>			
272.4210.50		1 W <sup>(1)</sup>	10 dB		≤1.25 (up to 12.4 GHz)	N ±0.3 dB to 8 GHz <sup>(2)</sup>			
272.4310.50			20 dB			N ±0.6 dB to 12.4 GHz <sup>(2)</sup>			
272.4410.50			30 dB			N ±0.5 dB to 4 GHz <sup>(2)</sup>			
272.4410.50			30 dB			N ±0.6 dB to 12.4 GHz <sup>(2)</sup>			
272.4410.50			30 dB			N ±0.8 dB to 12.4 GHz <sup>(2)</sup>			
272.4410.50			30 dB			N ±1 dB to 12.4 GHz <sup>(2)</sup>			
<b>R&amp;S® RBU 50</b>									
1073.8895.03	50 Ω	50 W <sup>(3)</sup>	3 dB	0 Hz to 2 GHz	≤1.1	N ±0.5 dB <sup>(4)</sup>	5 kW/5 μs	N male, N female to MIL-STD-348 A	180 mm × 77 mm × 90 mm, 0.8 kg
1073.8895.06			6 dB						
1073.8895.10			10 dB						
1073.8895.20			20 dB						
1073.8895.30			30 dB						
<b>R&amp;S® RBU 100</b>									
1073.8820.03	50 Ω	100 W <sup>(3)</sup>	3 dB	0 Hz to 2 GHz	≤1.1	N ±0.5 dB to 1.5 GHz <sup>(4)</sup>	5 kW/5 μs	N male, N female to MIL-STD-348 A	236 mm × 140 mm × 141 mm, 2.8 kg
1073.8820.06			6 dB			N ±0.75 dB to 2 GHz <sup>(4)</sup>			
1073.8820.10			10 dB						
1073.8820.20			20 dB						
1073.8820.30			30 dB						
<b>R&amp;S® RDL 50</b>									
1035.1700.52	50 Ω	50 W (input), 10 W (output) <sup>(1)</sup>	20 dB	0 Hz to 6 GHz	≤1.15 (up to 2 GHz) ≤1.25 (up to 6 GHz)	N ±0.5 dB	2 kW/5 μs	N male, N female	114 mm × 89 mm × 68 mm, 0.5 kg
1035.1700.52			20 dB		≤1.4 (up to 6 GHz)				
<b>R&amp;S® RBS 1000</b>									
207.4010.55	50 Ω	1000 W see Fig. on page 3	40 dB	0 Hz to 0.4 (1) GHz see Fig. on page 3	≤1.2 input	N ±1 dB <sup>(3)</sup>	10 kW/1 μs	N female	500 mm × 285 mm × 152 mm, 12 kg

Type Order No.	Characteristic impedance	Power rating	Nominal attenuation	Frequency range	VSWR	Attenuation (N = nominal value)	Max. peak pulse voltage	Connectors	Dimensions, weight
<b>Terminations</b>									
<b>R&amp;S® RVA</b>									
1028.4994.72	75 Ω	1 W <sup>1)</sup>		0 Hz to 3 GHz	≤1.02			N male	21 mm Ø × 46 mm, 65 g
<b>R&amp;S® RNB</b>									
272.4910.50	50 Ω	1 W <sup>1)</sup> , 2 W peak		0 Hz to 4 GHz	≤1.05 (up to 1 GHz) ≤1.1 (up to 2 GHz) ≤1.2 (up to 4 GHz)			N male	20.5 mm Ø × 35 mm, 36 g
<b>R&amp;S® RAU</b>									
200.0019.55	50 Ω	100 W <sup>7)</sup>		0 Hz to 2 GHz	≤1.05 (0 Hz to 1 GHz) ≤1.1 (1 Hz to 1.5 GHz) ≤1.4 (1.5 Hz to 2 GHz)		2 kV	N female	95 mm × 152 mm × 235 mm, 2 kg
<b>R&amp;S® RAD</b>									
289.8966.00	50 Ω	500 mW <sup>8)</sup>		0 Hz to 1 GHz	≤1.05 (up to 0.1 GHz) <sup>9)</sup> ≤1.1 (up to 0.5 GHz) ≤1.2 (up to 1 GHz)			BNC male, BNC female	14.5 mm Ø × 50.5 mm, 22 g
<b>R&amp;S® RAD 50</b>									
844.9352.02	50 Ω ±0.1 %	2 W <sup>6)</sup>		0 Hz to 500 MHz	≤1.1 (up to 200 MHz) <sup>9)</sup> ≤1.25 (up to 500 MHz) <sup>9)</sup>			BNC male, BNC female	15.3 mm Ø × 50.5 mm, 22 g
<b>R&amp;S® RAIM</b>									
358.5414.02	50 Ω → 75 Ω	2 W <sup>10)</sup>	5.72 dB	0 Hz to 2.7 GHz	≤1.06 (up to 2 GHz) ≤1.2 (up to 2.7 GHz), both terminals	5.72 dB +0.15/-0.05 dB		N male, N female at 75 Ω end	21 mm Ø × 73 mm, 105 g
<b>R&amp;S® RAZ</b>									
358.5714.02	50 Ω → 75 Ω	2 W <sup>10)</sup>	1.76 dB	0 Hz to 2.7 GHz	≤1.06 (up to 2 GHz) ≤1.2 (up to 2.7 GHz), at 75 Ω end	1.76 dB ±0.2 dB		N male, N female at 75 Ω end	21 mm Ø × 73 mm, 105 g
<b>Feedthrough Terminations</b>									
<b>Matching Pads</b>									

<sup>1)</sup> At a max. ambient temperature of 30 °C; decreasing linearly to 0 W at 130 °C. (R&S®RDL50: 125 °C)

<sup>2)</sup> Attenuation change at a temperature change of 1 K: ≤0.0001 dB/dB. At a load change of 1 W: ≤0.001 dB/dB.

<sup>3)</sup> Input overload capacity up to 150 W at 20 °C ambient temperature (max. 10 min); output overload capacity up to 20 W.

<sup>4)</sup> Attenuation change at a temperature change of 1 K: ≤0.0004 dB/dB. At a load change of 1 W: ≤0.0001 dB/dB.

<sup>5)</sup> Input overload capacity up to 250 W at 20 °C ambient temperature (max. 10 min); output overload capacity up to 20 W.

<sup>6)</sup> The frequency response of the attenuation is specified on a label on the R&S®RBS 1000 with a measurement accuracy of 0.1 dB.

<sup>7)</sup> Overload capacity 100% (max. 5 s).

<sup>8)</sup> Continuous power rating up to a maximum ambient temperature of 70 °C; decreasing linearly to 0 W at 130 °C.

<sup>9)</sup> Measured with open-circuit output.

<sup>10)</sup> Ambient temperature 25 °C.



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