

HP 8491A/B, 8492A, 8493A/B/C, 11581A, 11582A and 11583A/C Coaxial Attenuators

Product Overview

dc to 26.5 GHz



- **High accuracy**
- **Low SWR**
- **Broadband frequency coverage**
- **Small size**

Description

Hewlett-Packard coaxial fixed attenuators provide precision attenuation, flat frequency response, and low SWR over broad frequency ranges (dc to 26.5 GHz) at low prices. Attenuators are available in eight attenuation values: 3, 6, 10, 20, 30, 40, 50, and 60 dB; with performances specified from dc to 26.5 GHz; and with choice of four connector types: Type-N, APC-7, SMA¹, and APC 3.5².

These attenuators are all tested on a state-of-the-art HP precision analyzer to assure specifications over the full frequency ranges. Although the HP 8493C is not specified above 26.5 GHz, it performs resonance free to 34 GHz with only a small loss in performance.

Precision construction

The attenuators employ a film on an attenuator card as the resistive element. The uniformity and repeatability of the film deposition process result in high accuracy and low SWR over very wide frequency ranges.

The HP 8493C features thin-film-tantalum nitride on a sapphire substrate for exceptional precision performance to 26.5 GHz. In fact, it performs resonance-free to 34 GHz, the top frequency limit of the APC-3.5 connector.

The choice of connector type and material also ensure accurate and repeatable attenuation. The HP 8491A/B attenuators are furnished with Type-N connectors whose dimensions are compatible with either MIL-C-71 or MIL-C-39012 connector specifications.

These connectors are stainless steel for long wear and high repeatability. The HP 8492A is furnished with Amphenol precision 7 mm connectors (APC-7). These sexless connectors have a clearly defined reference plane for precise and unambiguous measurements. The HP 8493A/B attenuators are furnished with SMA type connectors. The connectors are heat treated beryllium copper for greater strength and wear.

The HP 8493C is furnished with the APC 3.5 connector which is compatible with standard SMA connectors but is more rugged and offers improved repeatability over hundreds of connections.

1. As per USASI Committee C83.2 compatible with OSM, ARM, WPM, BRM, NPM, etc.

2. Mate with MIL-C-71 or MIL-C-39012 connectors.

Description (cont'd)

Quality assurance in testing

The flat frequency response and low SWR of the attenuators are assured over the entire frequency range by full frequency band testing on a state-of-the-art HP precision analyzer. Full frequency band testing ensures that narrow resonances in the frequency band are not overlooked. Actual attenuation values taken at dc, 4, 8, 12, 18, and 26.5 GHz are stamped on the attenuator body for permanent and easy reference.

Testing each attenuator with a state-of-the-art HP precision analyzer brings standards lab accuracy to production testing because the system can determine its own measurement uncertainties and compensate for them in the testing process. System calibration is derived from precise physical standards which are directly traceable to the National Bureau of Standards. In addition, automatic testing eliminates the possibility of human error in setting instrument controls, taking data, or making calculations.

Applications

Ruggedness, reliability and small size make these attenuators useful both on the bench and in systems applications. With their high accuracy and low SWR they are ideally suited for extending the range of sensitive power meters for higher power measurements and for "padding" poorly matched devices to improve system SWR.

These same characteristics lend themselves to applications as calibration standards in attenuation and RF substitution measurements. With their broad dc to 26.5 GHz frequency range and reasonable cost, general applications, such as the reduction of power level to sensitive components and instrumentation systems, are attractive and appropriate uses for these attenuators.

Accuracy

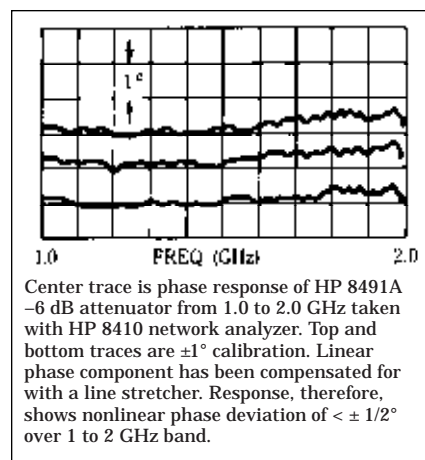
The accuracy of an attenuator directly affects the accuracy of the measurement where the attenuator is used. In fact, attenuators are used extensively as the standard against which other instruments or devices are calibrated.

HP's fixed attenuators achieve flat frequency response (typically a few hundredths of a dB) and overall accuracy (typically $\pm 2\%$ of value in dB at 26.5 GHz) through the use of thin-film attenuator cards. These cards are composed of high stability tantalum nitride resistive film deposited on a sapphire or alumina substrate.

Quality assurance in specifications

The following examples demonstrate the reliability and comprehensiveness of specifications. Although the absolute accuracy for a 3-dB attenuator is specified as ± 0.3 dB, test data statistics indicate an expected value of 3 dB ± 0.20 dB from dc to 18 GHz. Similarly a 30-dB attenuator is specified as ± 1.0 dB, but typically is no worse than 30 dB ± 0.75 dB from dc to 18 GHz. The other attenuation values are also specified as conservatively.

In addition, Hewlett-Packard precision attenuators meet more comprehensive performance standards. Linear phase response is an example. Not only is wide bandwidth significant, but also linear phase response is an important parameter for applications where pulse distortion must be kept to a minimum. The excellent linearity of the HP attenuators is typified in the accompanying illustration of an actual network analyzer measurement.



Economy

Automated procedures have resulted in economies of scale in production and testing. The automated resistive film deposition process permits high-volume manufacture with excellent yield. Furthermore, characteristics are consistently uniform; hand "touch-up" is not required to meet specifications. Automatic testing means exceptionally thorough, high-accuracy measurements can be performed in appreciably shorter time than could be done manually.

The overall result is outstanding attenuator performance at attractive prices.

Calibration Data

Optional calibration data

Use of calibration data has always been an effective means of reducing measurement uncertainty at RF and microwave frequencies. This data is available for HP's fixed attenuators as Option UK6. Data which is generated by an automatic network analyzer provides a tabulated list of attenuation and SWR's at 26 to 67 frequencies (see Table 2). Measurements to 60 dB are directly traceable to NBS standards and feature very low measurement uncertainties. Option UK6 data is available when the attenuators are first purchased and recalibrations are available through HP Customer Service Centers around the world.

Table 1. SWR data uncertainties

| Connector Type | Frequency Range (GHz) | SWR Data Uncertainties | |
|---------------------|-----------------------|--------------------------|---------------------------|
| | | Measured SWR 1.0 to 1.35 | Measured SWR 1.35 to 1.86 |
| APC 7 & Male Type-N | dc to 12.4 | ±0.025 | ±0.041 |
| | 12.4 to 18.0 | ±0.031 | ±0.050 |
| Female Type-N | dc to 8.0 | ±0.025 | ±0.046 |
| | 8.0 to 12.4 | ±0.031 | ±0.063 |
| | 12.4 to 18.0 | ±0.042 | ±0.071 |
| Male SMA | dc to 8.0 | ±0.031 | ±0.054 |
| | 8.0 to 12.4 | ±0.045 | ±0.084 |
| | 12.4 to 18.0 | ±0.077 | ±0.137 |
| Female SMA | dc to 8.0 | ±0.054 | ±0.088 |
| | 8.0 to 12.4 | ±0.077 | ±0.132 |
| | 12.4 to 18.0 | ±0.122 | ±0.206 |
| Male APC-3.5 | dc to 10 | ±0.025 | ±0.041 |
| | 10 to 18 | ±0.031 | ±0.050 |
| | 18 to 26.5 | ±0.045 | ±0.067 |
| Female APC-3.5 | dc to 10 | ±0.020 | ±0.030 |
| | 10 to 18 | ±0.025 | ±0.037 |
| | 18 to 26.5 | ±0.035 | ±0.050 |

Table 2.

Coaxial attenuator calibration frequencies* (MHz)

| | | | | |
|------|------|-------|-------|----------------------------|
| 100 | 4500 | 9000 | 13000 | 16750 |
| 500 | 5000 | 9500 | 13500 | 17000 |
| 1000 | 5500 | 10000 | 14000 | 17250 |
| 1500 | 6000 | 10500 | 14500 | 17500 |
| 2000 | 6500 | 11000 | 15000 | 17750 |
| 2500 | 7000 | 11500 | 15500 | 18000 |
| 3000 | 7500 | 12000 | 16000 | (each 250 MHz to 26.5 GHz) |
| 3500 | 8000 | 12400 | 16250 | |
| 4000 | 8500 | 12500 | 16500 | |

*dc to 12.4 GHz models include 26 frequencies, dc to 18 GHz models include 42 frequencies, dc to 26.5 GHz models include 67 frequencies (2 to 26.5 GHz).

Table 3. Attenuation data uncertainties

| Attenuation (dB) | HP 8491, 8492 and 8493 Attenuation data uncertainty (dB) | | | | |
|------------------|--|------------|---------------|------------------|------------------|
| | 0.1 to 2.0 GHz | 2 to 6 GHz | 6 to 12.4 GHz | 12.4 to 18.0 GHz | 18.0 to 26.5 GHz |
| 3 | ±0.07 | ±0.06 | ±0.06 | ±0.11 | ±.15 |
| 6 | ±0.07 | ±0.07 | ±0.07 | ±0.11 | ±.15 |
| 10 | ±0.08 | ±0.07 | ±0.07 | ±0.12 | ±.15 |
| 20 | ±0.09 | ±0.08 | ±0.08 | ±0.13 | ±.15 |
| 30 | ±0.12 | ±0.11 | ±0.11 | ±0.15 | ±.18 |
| 40 | ±0.15 | ±0.14 | ±0.14 | ±0.21 | ±.25 |
| 50 | ±0.23 | ±0.23 | ±0.23 | ±0.34 | n/a |
| 60 | ±0.50* | ±0.48* | ±0.90* | ±0.90* | n/a |

*The uncertainties noted represent 99.7 % probability values.

Ordering Information

To order, basic model number and option (specifies attenuation value) must be specified. Option UK6 calibration data can also be ordered with the basic model number and attenuation value option.

Ordering example:

| HP 8491A Option 003, Option UK6 | | | | | |
|---------------------------------|-------|-----|-------|---------------------------|--|
| 003 | 3 dB | 030 | 30 dB | Optional calibration data | |
| 006 | 6 dB | 040 | 40 dB | | |
| 010 | 10 dB | 050 | 50 dB | | |
| 020 | 20 dB | 060 | 60 dB | | |

Specifications

Specifications describe the instruments warranted performance. **Supplemental characteristics** (shown in italics) are intended to provide information useful in applying the instrument by giving typical, but non-warranted, performance parameters.

Frequency range:

HP 8491A and 8493A, dc to 12.4 GHz

HP 8491B, 8493B and 8492A, dc to 18 GHz

HP 8493C, dc to 26.5 GHz

Attenuation accuracy:

| | HP 8491A/93A | HP 8491B/93B/92A | | HP 8493C | |
|-------|----------------|-------------------|----------------|----------|----------------|
| | dc to 12.4 GHz | dc to 12.4 | 12.4 to 18 GHz | dc to 18 | 18 to 26.5 GHz |
| 3 dB | ±0.3 dB | ±0.3 dB | | ±0.5 dB | ±1.0 dB |
| 6 dB | ±0.3 dB | ±0.3 dB | ±0.4 dB | ±0.6 dB | |
| 10 dB | ±0.5 dB | ±0.6 dB | | ±0.3 dB | ±0.5 dB |
| 20 dB | ±0.5 dB | ±0.6 dB | ±1.0 dB | ±0.5 dB | ±0.6 dB |
| 30 dB | ±1.0 dB | ±1.0 dB | | ±0.7 dB | ±1.0 dB |
| | HP 8491A only | HP 8491B/92A only | | | |
| 40 dB | ±1.5 dB | ±1.5 dB | | ±1.0 dB | ±1.3 dB |
| 50 dB | ±1.5 dB | ±1.5 dB | | N/A | |
| 60 dB | ±2.0 dB | ±2.0 dB | | N/A | |

Supplemental characteristics

Temperature Stability:

0.0001 dB/dB/°C (all except HP 8493C)

0.0002 dB/dB/°C (HP 8493C)

Maximum input power: 2 W avg., 100 W peak³

Power sensitivity: 0.001 dB/dB/W (all except HP 8493C)

0.001 dB/W (HP 8493C)

SWR:

| | HP 8491B/8493B | | | HP 8492A | | | HP 8493C | | |
|-------|-----------------|-----------------|------------------|---------------|-----------|------------|----------|-----------|--------------|
| | HP 8491A/8493A | | | | | | | | |
| | dc to 8 (GHz) | 8 to 12.4 (GHz) | 12.4 to 18 (GHz) | dc to 8 | 8 to 12.4 | 12.4 to 18 | dc to 8 | 8 to 12.4 | 12.4 to 26.5 |
| 3 dB | 1.25 | 1.35 | 1.5 | 1.2 | 1.3 | 1.5 | 1.10 | 1.15 | 1.25 |
| 6 dB | 1.2 | 1.3 | 1.5 | 1.2 | 1.3 | 1.35 | 1.10 | 1.15 | 1.27 |
| 10 dB | 1.2 | 1.3 | 1.5 | 1.15 | 1.25 | 1.3 | 1.10 | 1.15 | 1.25 |
| 20 dB | 1.2 | 1.3 | 1.5 | 1.15 | 1.25 | 1.3 | 1.10 | 1.15 | 1.25 |
| 30 dB | 1.2 | 1.3 | 1.5 | 1.15 | 1.25 | 1.3 | 1.10 | 1.15 | 1.25 |
| | HP 8491A/B only | | | HP 8491B only | | | | | |
| 40 dB | 1.2 | 1.3 | 1.5 | 1.15 | 1.25 | 1.35 | 1.10 | 1.15 | 1.25 |
| 50 dB | 1.2 | 1.3 | 1.5 | 1.15 | 1.25 | 1.35 | N/A | N/A | N/A |
| 60 dB | 1.2 | 1.3 | 1.5 | 1.15 | 1.25 | 1.35 | N/A | N/A | N/A |

Environmental

Temperature, non-operating: -55 ° to +85 °C.

Temperature, operating: 0 ° to +55 °C.

EMC: Radiated interference is within the requirements of MIL STD 461 method RE02, VDE 0871 EN55011 and FCC part 18.

| | | HP 8491A | HP 8493A | HP 8491B | HP 8493B | HP 8492A | HP 8493C | |
|-------------------|-------------|---------------------|------------------|---------------------|------------------|-----------------|----------------|-----------------|
| Connectors (50 Ω) | | Type-N ² | SMA ¹ | Type-N ² | SMA ¹ | APC-7 | APC-3.5 | |
| Dimensions | Millimeters | 67 X 21 | 40 X 13 | 67 X 21 | 40 X 13 | 70 X 21 | 3,6,10,20 dB | 30,40 dB |
| | Inches | 2 7/16 X 13/16 D | 1 9/16 X 1/2 D | 2 7/16 X 13/16 D | 1 9/16 X 1/2 D | 2 3/4 X 13/16 D | 33.8 X 8 | 36.8 X 8 |
| Weight | Net | 110 g (4 oz) | 30 g (1 oz) | 110 g (4 oz) | 30 g (1 oz) | 110 g (4 oz) | 8.5 g (0.3 oz) | 9.4 g (0.33 oz) |
| | Shipping | 220 g (8 oz) | 220 g (8 oz) | 220 g (8 oz) | 220 g (8 oz) | 220 g (8 oz) | 45 kg (1 lb.) | |

1. As per USASI Committee C83.2 compatible with OSM, ARM, WPM, BRM, NPM, etc.

2. Mate with MIL-C-71 or MIL-C-39012 connectors.

3 At 20 °C derated to 1.3 W avg. at 55 °C.



Attenuator sets

HP 11581A/11582A/11583A/11583C

A calibrated set of four HP fixed coaxial attenuators (3, 6, 10, and 20 dB) is available. Each set includes a calibration report certified traceable to the National Bureau of Standards. The reports included with the HP 11581A, 11582A, 11583A and 11583C indicate the accuracy of measurement and list the attenuation and reflection coefficient at each port of the attenuator.

The set of four attenuators is furnished in a handsome walnut accessory case. In addition to protecting the units when not in use, the case is also a convenient storage place for the attenuators and the calibration reports.

Calibration data as described on page 3 is included with rack attenuator set.

Ordering Information

HP 11581A (3,6,10,20 dB values HP 8491A)
HP 11582A (3, 6,10,20 dB values HP 8491B)
HP 11583A (3, 6, 10, 20 dB values HP 8492A)
HP 11583C (3, 6, 10, 20 dB values HP 8493C)

For more information about Hewlett-Packard test and measurement products, applications, services, and for a current sales office listing, visit our web site, <http://www.hp.com/go/tmdir>. You can also contact one of the following centers and ask for a test and measurement sales representative.

United States:

Hewlett-Packard Company
Test and Measurement Call Center
P.O. Box 4026
Englewood, CO 80155-4026
1 800 452 4844

Canada:

Hewlett-Packard Canada Ltd.
5150 Spectrum Way
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