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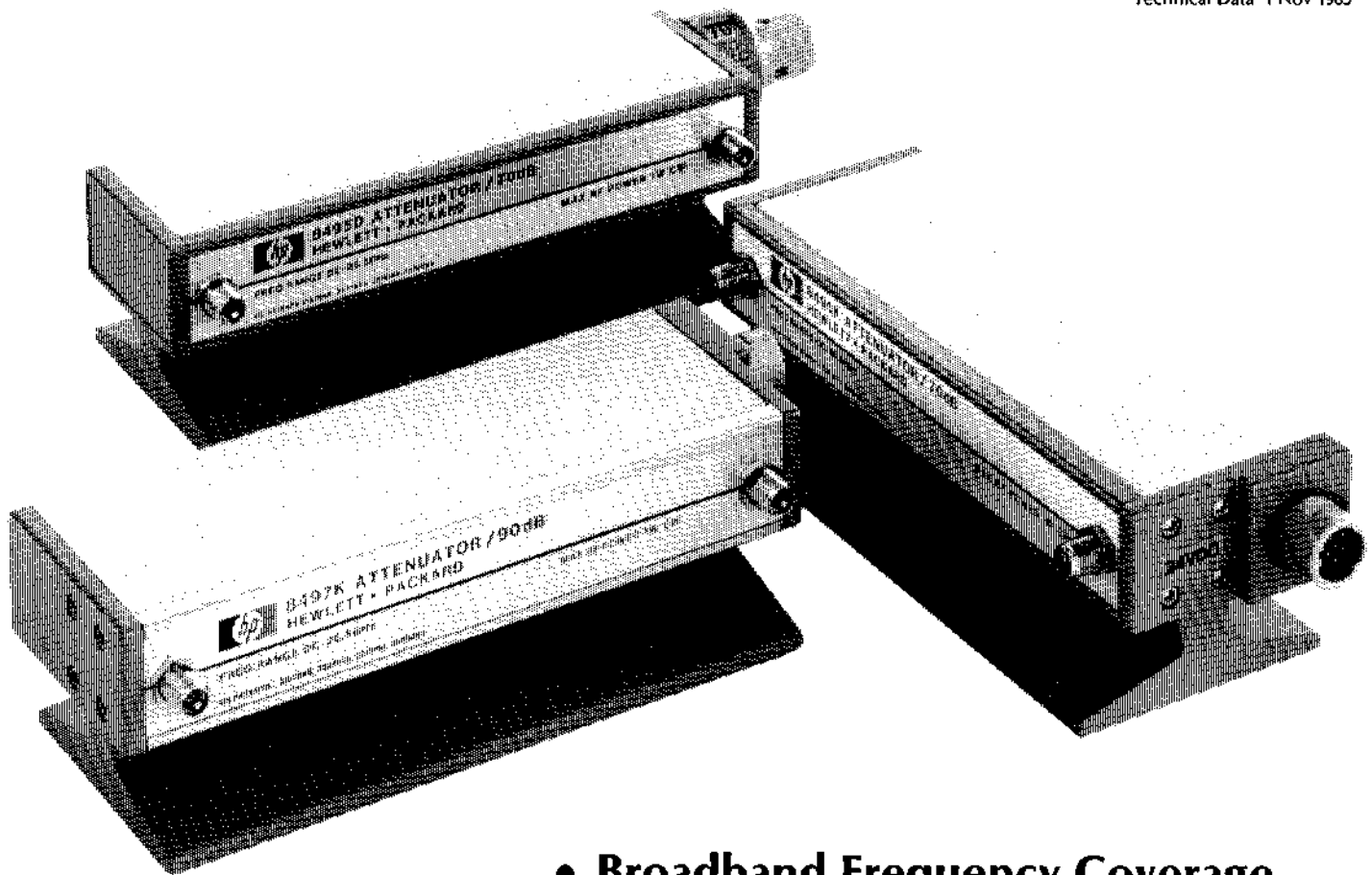
Innovating the HP Way



Step Attenuators for Bench Use dc to 26.5 GHz

models
8495D Option 004
8495K Option 004
8497K Option 004

Technical Data 1 Nov 1985



- **Broadband Frequency Coverage**
- **High Accuracy/Low SWR**
- **Low Insertion Loss**
- **Manual/Programmable Models**
- **Life >5 Million Cycles**

The 8495D Option 004, 8495K Option 004, and 8497K Option 004 attenuators offer the solution for accurate and repeatable signal level control in broadband applications to 26.5 GHz.

These attenuators have four sections, each consisting of a precision thin-film attenuator card, a lossless thru line, and a ganged pair of gold plated center conductor contacts that switch the attenuator card in and out (see Figure 5). This combination results in high accuracy and excellent repeatability.

Equivalent versions for incorporation in OEM equipment are the 33321D, 33321K, and 33323K.

70 dB Models

The 8495D/K Option 004 are low cost, general purpose step attenuators. The 8495D Option 004 manual step attenuator offers 70 dB in 10 dB steps, with a frequency coverage of dc–26.5 GHz.

The 8495K Option 004 is the programmable version with the same specifications.

90 dB Model

The 8497K Option 004 is a high performance programmable attenuator especially designed for low insertion loss (<2.8 dB at 26.5 GHz), and low SWR (<1.8 at 26.5 GHz). It offers 90 dB of attenuation in 10 dB steps with a frequency coverage of dc–26.5 GHz.

Performance

Broadband Accuracy and Low SWR

High accuracy and low SWR are achieved through the use of miniature thin-film attenuation cards composed of high stability tantalum resistive film on a sapphire substrate. This thin-film technique permits the construction of circuits which are truly distributed and without stray reactances, even at very high microwave frequencies. These precision cards and the cascaded section design provide high step-to-step accuracy.

Figure 1 shows the typical frequency response at 3 attenuation settings from 1 to 26.5 GHz of the 8497K Option 004, as tested on a HP Automatic Network Analyzer. Typical values of SWR and insertion loss are shown in Figures 2 and 3.

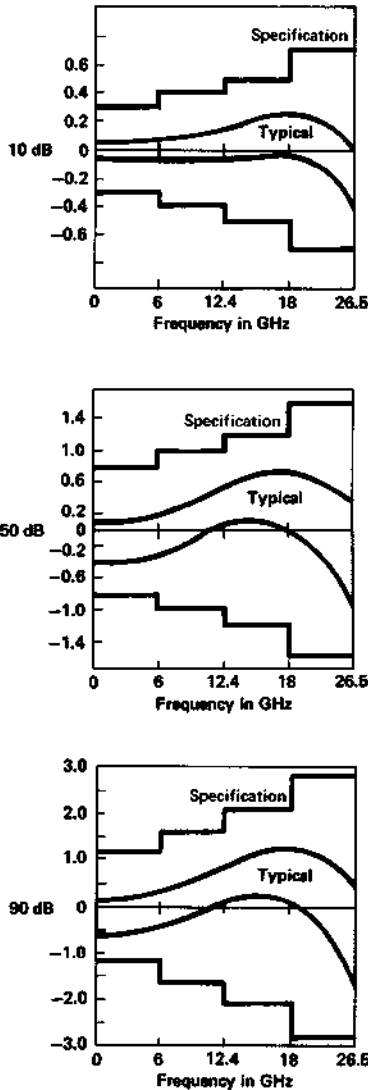


Figure 1: Typical accuracy/frequency response of the 8497K Option 004.

Reliable Performance

Each unit is tested over its operating frequency range by a computer controlled HP Automatic Network Analyzer providing accurate measurements, traceable to the National Bureau of Standards. This measurement system brings standards lab accuracy to production testing and assures that each attenuator meets specifications over the entire frequency range.

High Repeatability

Excellent repeatability (typically 0.01 dB for up to five million cycles) has been achieved by employing "edge line" design for the transmission line. The unique design feature of switching only the center conductor eliminates high friction sliding contacts, characteristic of turret type attenuators. The resulting benefits are long life and high repeatability.

Testing Procedures

When choosing a product for application in a system, there are many things to consider. How a product is tested and how well it meets its published specifications are two of them. As Figure 4 indicates, these attenuators are tested in HP's production test area using several guardbands. The test line limit (TLL) is the pass/fail criteria used by our production test area. The TLL, plus the other guardbands used, insure that you will receive a unit that always performs better than the published specification. The measurement uncertainty is defined as an estimate of the measurement error, calculated so there is 95% confidence that the actual measurement error is within the stated uncertainty. Delta Environmental is the change in performance of a unit at TLL from room temperature to the temperature extremes specified on the data sheet. The drift is the change in performance of a unit at TLL over 1 million operations.

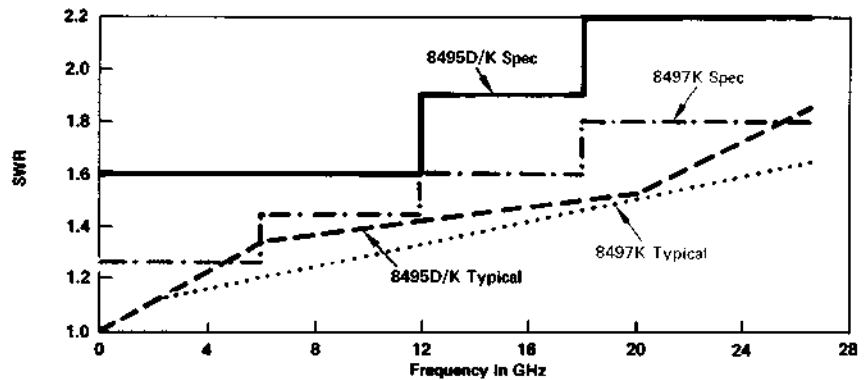


Figure 2. Typical SWR.

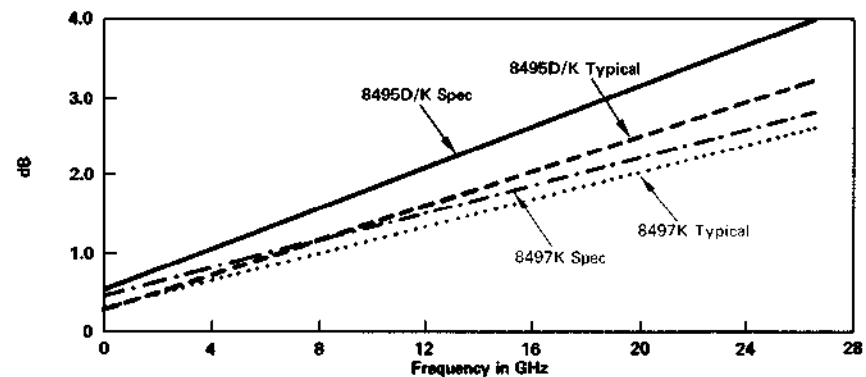


Figure 3. Typical insertion loss.

Information for Programmable Models

Typical Performance

Typical performance parameters quoted on data sheets can be confusing because manufacturers may be using different criteria for determining what is "typical". For the 8495D/K and 8497K attenuators, "typical performance" is defined as 90% confidence that a unit will meet or exceed the listed "typical". For example, if an attenuator lists a typical SWR of 1.5, then on the average, 90% of the sampled units have tested to 1.5 or better. All typical parameters quoted have been derived from examination of extensive production test data accumulated on a statistically significant sample size.

Optional Calibration Data

For precise measurements where it is important to know the actual attenuation and SWR levels Option 890 calibration data is available. These attenuators are tested at 101 frequency points per attenuation setting. Thus, a total of 1010 frequency points are listed for the 8497K, and 808 points for the 8495D/K. Use of this calibration data is an effective means to improve measurement accuracy.

This data is generated from measurements made by an automatic network analyzer and is directly traceable to NBS standards.

Attenuator Section Switching

Each attenuation section utilizes one solenoid with dual coil windings, one coil to switch in the attenuation card (e.g. 10 dB) and one to switch in the thru line (0 dB) as shown in Figure 5.

With a positive voltage applied to pin 1, the desired state (attenuation card or 0 dB) of a particular section is obtained by connecting the corresponding attenuation card pin or thru line pin to a negative voltage or ground.

As a section is switched, the internal contacts of the activated coil open, thus shutting off current flow. At the same time, the internal contacts for the other coil close so that it can be activated when desired. Figure 5 shows a section that has been switched to the thru line position (note the open thru line coil contact).

Although all sections can be switched simultaneously, the attenuator driver must not allow both pins of the same section (e.g., Section 1, pins 5 and 6) to be activated concurrently, or else that section would cycle rapidly. All terminals are "floating", so bipolar or unipolar power supplies can be used.

Automatic Testing Applications

Employing programmable HP Step Attenuators and switches in an automatic test system becomes an easy task when the HP 11713A Attenuator/Switch Driver is specified into the system.

The 11713A has all of the necessary features to provide HP-IB control of up to two programmable attenuators of the 8494/5 /6/7 family, and concurrently-up to two electromechanical switches (e.g., 8671B or 33311 series). The 11713A includes an integral power supply (with short circuit protection) that can simultaneously provide 125 milliamps at 24 volts to all contacts for control of the attenuators and switches, so no external power supply is needed. Each 11713A is provided with two (2) plug-in drive cables for the programmable attenuators to simplify connection to the driver.

The 11713A also features convenient front panel control so that the user can manually activate the individual attenuation sections and switches when in the "local" mode. Switching time for the drivers is less than 10 milliseconds.

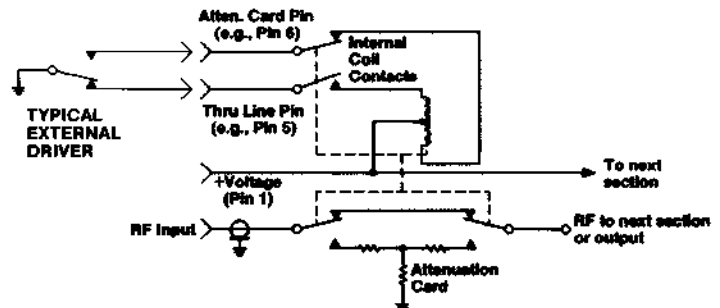


Figure 5. Section electrical diagram.

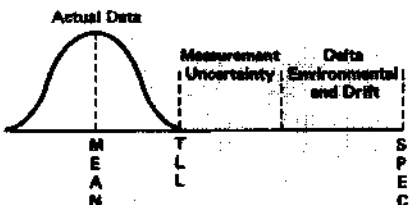


Figure 4. Specification allowances.

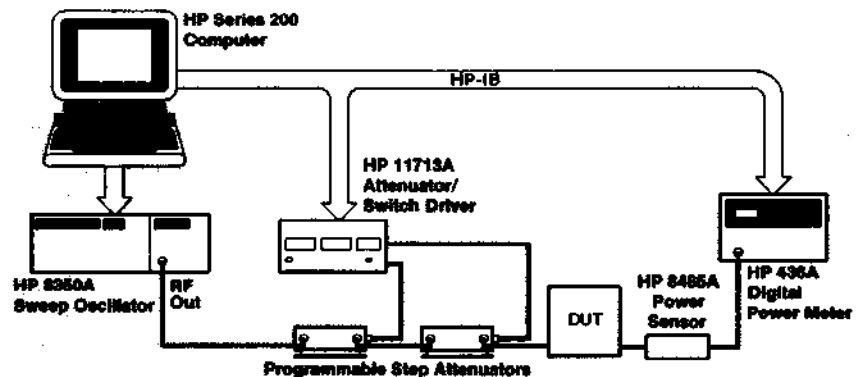


Figure 6. Typical HP-IB measurement system.

SPECIFICATIONS

Electrical

Frequency range: dc to 26.5 GHz.

Dynamic range: 8495D/K Opt. 004; 0–70 dB in 10 dB steps, 8497K Opt. 004; 0–90 dB in 10 dB steps.

Attenuation accuracy (\pm dB referenced from 0 dB setting):

Models 8495D/K Option 004 (70 dB max)*							
Frequency Range	Attenuation Setting (dB)						
	10	20	30	40	50	60	70
dc – 12.4 GHz	0.6	0.7	0.9	1.8	2.0	2.2	2.3
12.4 – 18.0 GHz	0.7	0.9	1.2	2.0	2.3	2.5	2.8
18.0 – 24.0 GHz	0.9	1.5	2.5	3.0	3.2	3.3	3.5
24.0 – 26.5 GHz	1.0	2.5	3.0	4.2	4.4	4.6	4.8

*Typical step-to-step accuracy is \pm 1 dB to 18 GHz, \pm 2 dB to 26.5 GHz.

Model 8497K Option 004 (90 dB max)*									
Frequency Range	Attenuation Setting (dB)								
	10	20	30	40	50	60	70	80	90
dc – 6.0 GHz	0.3	0.5	0.6	0.7	0.8	1.0	1.1	1.1	1.2
6.0 – 12.4 GHz	0.4	0.5	0.7	0.9	1.0	1.3	1.5	1.6	1.7
12.4 – 18.0 GHz	0.5	0.6	0.8	1.1	1.2	1.4	1.7	1.8	2.1
18.0 – 26.5 GHz	0.7	0.8	1.0	1.5	1.6	1.9	2.3	2.5	2.8

*Typical step-to-step accuracy is \pm 0.6 dB to 18 GHz, \pm 0.9 dB to 26.5 GHz.

Insertion loss (0 dB position, f is frequency in GHz):

8495D/K Option 004: $(0.5 + 0.13 f)$ dB.

8497K Option 004: $(0.4 + 0.09 f)$ dB.

SWR (characteristic impedance, 50 ohms):

Frequency Range	8495D/K Opt. 004	8497K Opt. 004
dc – 6.0 GHz	1.6	1.25
6.0 – 12.4 GHz	1.6	1.45
12.4 – 18.0 GHz	1.9	1.60
18.0 – 26.5 GHz	2.2	1.80

Attenuation temperature coefficient: less than 0.0001 dB/dB/°C.

Power sensitivity: < 0.001 dB/watt.

RF input power (max.): 1 watt average, 100 watts peak (10 μ s pulse width).

Life, minimum: 5 million cycles per section.¹

Repeatability: 0.01 dB typical to 18 GHz, 0.05 dB typical to 26.5 GHz.

Environmental

Temperature, non-operating: –40° to +75°C.

Temperature, operating: 0° to +55°C.

EMC: radiated interference is within the requirements of MIL-STD-461 method RE02, VDE 0871 and CISPR Publication II.

¹A cycle is defined as switching from the thru-line position to the attenuation card and back to the thru-line position or vice versa.

Programmable Models (K)

Switching speed: max. 20 milliseconds including settling time.

	Coil Voltage	Switching Current*	Nominal Coil Impedance
Solenoids	24V (20 – 30V)	125 mA (24V)	190 Ω (65 mh)

* Current per section; approximately 8 milliseconds duration before internal contacts open the coil circuit.

Solenoid pin and color code assignment guide:

Section	Section 1		Section 2		Section 3		Section 4	
	Thru Line	Atten. Card	Thru Line	Atten. Card	Thru Line	Atten. Card	Thru Line	Atten. Card
Solenoid Coil								
Cable Wire Color Code ¹	PUR	YEL	BLK	GRN	ORN	BLU	BRN	WHT
Connector Plug Pin Number ²	5	6	7	8	9	10	11	12
8495K Opt. 004	0 dB	10 dB	0 dB	20 dB	0 dB	20 dB	0 dB	20 dB
8497K Opt. 004	0 dB	10 dB	0 dB	20 dB	0 dB	30 dB	0 dB	30 dB

¹ Five-foot cable and mating plug assembly provided.

² Pin 1 (red wire) is common for all coils. Pins 2, 3 and 4 are not used.

To ensure warranted specifications use the following combination of sections:

Attenuation (dB)	10	20	30	40	50	60	70	80	90
8495K Opt. 004	1	4	1, 4	2, 4	1, 2, 4	2, 3, 4	1, 2, 3, 4	n/a	n/a
8497K Opt. 004	1	2	4	1, 4	2, 4	3, 4	1, 3, 4	2, 3, 4	1, 2, 3, 4

Mechanical

Connectors: APC-3.5 female (SMA compatible).

Net weight: 8495D Option 004, 425 grams (15 oz),
8495K Option 004, 454 grams (16 oz),
8497K Option 004, 454 grams (16 oz).

Dimensions in millimetres and (inches):

Models	Length	Width	Height
8495D Opt. 004	159 (6.2)	52 (2.1)	43 (1.7)
8495K Opt. 004	143 (5.6)	52 (2.1)	43 (1.7)
8497K Opt. 004	143 (5.6)	52 (2.1)	43 (1.7)

Ordering Information

To order, the basic model number, suffix letter (D or K) and connector option (004 only) must be specified. Solenoid drive plug on 5-foot cable included with programmable models. (Replacement plug and cable assembly available as HP Part Number 8120-2178.)

8495D Option 004, manual 70 dB, 10 dB steps, APC-3.5 female connectors.

8495K Option 004, programmable 70 dB, 10 dB steps, APC-3.5 female connectors.

8497K Option 004, programmable 90 dB, 10 dB steps, APC-3.5 female connectors.

Option 890, calibration data (all models)

For more information, call your local HP sales office listed in the telephone directory white pages. Ask for the Electronic Instruments Department. Or write to Hewlett-Packard: U.S.A. P.O. Box 10301, Palo Alto, CA 94303-0890. Europe P.O. Box 999, 1180 AZ Amstelveen, the Netherlands. Canada 6877 Goreway Drive, Mississauga, L4V 1M6, Ontario. Japan Yokogawa-Hewlett-Packard Ltd., 3-29-21, Takaido-Higashi, Suginami-ku, Tokyo 168. Elsewhere in the world, write to Hewlett-Packard Intercontinental, 3495 Deer Creek Road, Palo Alto, CA 94303-0890.