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Agilent Technologies

# Agilent Technologies 8494A/B, 8495A/B, and 8496A/B Attenuators

## Operating and Service Manual




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# Safety and Regulatory Information

Review this product and related documentation to familiarize yourself with safety markings and instructions before you operate the instrument. This product has been designed and tested in accordance with international standards.

**WARNING**

**The WARNING notice denotes a hazard. It calls attention to a procedure, practice, or the like, that, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.**

**CAUTION**

The **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

## Instrument Markings

| | |
|---|---|
|  | When you see this symbol on your instrument, you should refer to the instrument's instruction manual for important information. |
|  | This symbol indicates hazardous voltages. |
|  | The laser radiation symbol is marked on products that have a laser output. |
|  | This symbol indicates that the instrument requires alternating current (ac) input. |
|  | The CE mark is a registered trademark of the European Community. If it is accompanied by a year, it indicates the year the design was proven. |
|  | The CSA mark is a registered trademark of the Canadian Standards Association. |
| | This ISM devise complies Canadian ICES-001. Cet appariel ISM est confrome a la norme NMB du Canada. |



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| | |
|---|---|
| 1SM1-A | This text indicates that the instrument is an Industrial Scientific and Medical Group 1 Class A product (CISPER 11, Clause 4). |
|  | This symbol indicates that the power line switch is ON. |
|  | This symbol indicates that the power line switch is OFF or in STANDBY position. |

## Safety Earth Ground

This is a Safety Class I product (provided with a protective earthing terminal). An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set. Whenever it is likely that the protection has been impaired, the product must be made inoperative and secured against any unintended operation.

## Before Applying Power

Verify that the product is configured to match the available main power source as described in the input power configuration instructions in this manual. If this product is to be powered by autotransformer, make sure the common terminal is connected to the neutral (grounded) side of the ac power supply.



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# Instrument Definition

This manual contains installation, operation and test information for the Agilent Technologies 8494A/B, 8495A/B, and 8496A/B step attenuators.

The instruments covered by this manual have a two-part serial number. The first four digits and letter comprise the serial number prefix. The last five digits form the sequential suffix that is unique to each instrument. The contents of this manual apply to instruments with serial prefixes 2544A and above.

Older instruments, those with serial number prefixes of 2543A and below, are documented in this manual under "Manual Changes" below.

An instrument manufactured after the printing of this manual may have a serial prefix that is not listed above. An unlisted serial prefix indicates that the instrument is different from those documented in this manual. A manual for an unlisted instrument is supplied with a Manual Change supplement containing change information that documents the differences.

## Manual Changes

This section contains information for adapting this manual to older instruments. If your instrument's serial number prefix is 2543A or lower, you may document your instrument by following the instructions below. If your instrument has a serial number prefix higher than is listed in this manual, it may be documented in a separate manual supplement.

If you have an older instrument, one with a serial number prefix of 2543A or lower, you must make the following changes to this manual in order for this manual to apply to your instrument.

- In "Specifications" on page 3, change the attenuation repeatability to 0.03 dB, typical after 1 million cycles.
- In "Specifications" on page 3, change the minimum life to >1 million steps or switchings per section.



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# Description

Agilent 8494A/B, 8495A/B, and 8496A/B are 50-ohm coaxial step attenuators.

For the 8494A/B, the attenuation can be varied in 1 dB steps, or 10 dB steps for the 8495A/B and 8496A/B. The attenuation shown on the control knob is the additional attenuation added in the signal path over the insertion loss of the attenuator in the 0 dB position.

- Agilent 8494A/B instruments are four-section attenuators with a range of 0 dB to 11 dB in 1 dB steps.
- The 8495A/B is a three-section attenuator with a range of 0 dB to 70 dB in 10 dB steps.
- The 8496A/B is a four-section attenuator with a range of 0 dB to 110 dB in 10 dB steps.

The attenuator sections are connected in cascade. Each section consists of a precision, thin-film attenuator card, a lossless thru-line and a ganged pair of edge line transmission lines. The edge lines are flexed to make contact with either the attenuator card or the thru-line. The edge line contacts are gold-plated leaf springs which ensure long life and high repeatability. Low-torque cams flex the edge lines. Table 1, “Attenuator Switching Order” on page 7 shows the switching arrangements.

**CAUTION**

Do not exceed the RF power rating of 1 W average or 100 W peak with a maximum pulse width of 10 μs. Do not connect an attenuator RF input or output connector to greater the 7Vdc. If the attenuator must be connected to a device with a potential greater than 7 Vdc, use a blocking capacitor

## Instrument Options

Each instrument is specified with an option number which denotes the configuration of the input and output connectors.

| Option | Connector Description |
|---|---|
| 001 | Both connectors Type N female |
| 002 | Both connectors SMA female |
| 003[1] | Both connectors APC-7 |

1. Option 003 is not available with the 8494A, 8495A, and 8496A.



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# Specifications

## Frequency Range and Attenuation

| Product | 8494A | 8494B | 8495A | 8495B | 8496A | 8496B |
|---|---|---|---|---|---|---|
| Frequency Range | dc to 4 GHz | dc to 18 GHz | dc to 4 GHz | dc to 18 GHz | dc to 4 GHz | dc to 18 GHz |
| Attenuation | 0 dB to 11 dB | 0 dB to 11 dB | 0 dB to 70 dB | 0 dB to 70 dB | 0 dB to 110 dB | 0 dB to 110 dB |
| Steps | 1 dB | 1 dB | 10 dB | 10 dB | 10 dB | 10 dB |

## Attenuation Accuracy ( dB): (Referenced from 0 dB)

| 8494A/B | 8495A/B 8496A/B | 8494A | 8494B | | 8495A | 8495B | | 8496A | 8496B | |
|---|---|---|---|---|---|---|---|---|---|---|
| Attenuation Selection (dB) | | dc–4 GHz | dc–12.4 GHz | 12.4–18 GHz | dc–4 GHz | dc–12.4 GHz | 12.4–18 GHz | dc–4 GHz | dc–12.4 GHz | 12.4–18 GHz |
| 1 | 10 | 0.2 | 0.3 | 0.7 | 0.2 | 0.5 | 0.6 | 0.2 | 0.5 | 0.6 |
| 2 | 20 | 0.2 | 0.3 | 0.7 | 0.4 | 0.7 | 0.8 | 0.4 | 0.7 | 0.8 |
| 3 | 30 | 0.3 | 0.4 | 0.7 | 0.5 | 0.9 | 1.2 | 0.5 | 0.9 | 1.2 |
| 4 | 40 | 0.3 | 0.4 | 0.7 | 0.7 | 1.2 | 1.6 | 0.7 | 1.2 | 1.6 |
| 5 | 50 | 0.3 | 0.5 | 0.7 | 0.8 | 1.5 | 2.0 | 0.8 | 1.5 | 2.0 |
| 6 | 60 | 0.3 | 0.5 | 0.8 | 1.0 | 1.8 | 2.4 | 1.0 | 1.8 | 2.4 |
| 7 | 70 | 0.4 | 0.6 | 0.8 | 1.2 | 2.1 | 2.8 | 1.2 | 2.1 | 2.8 |
| 8 | 80 | 0.4 | 0.6 | 0.8 | - | - | - | 1.3 | 2.4 | 3.2 |
| 9 | 90 | 0.4 | 0.6 | 0.8 | - | - | - | 1.5 | 2.7 | 3.6 |
| 10 | 100 | 0.4 | 0.6 | 0.9 | - | - | - | 1.6 | 3.0 | 4.0 |
| 11 | 110 | 0.5 | 0.7 | 0.9 | - | - | - | 1.8 | 3.3 | 4.4 |



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## Maximum SWR

| Instrument | Frequency Range (GHz) | Maximum SWR |
|---|---|---|
| 8495A | dc to 4 | 1.35 |
| 8495B | dc to 8<br>8 to 12.4<br>12.4 to 18 | 1.35<br>1.5<br>1.7 |
| 8494A,<br>8496A | dc to 4 | 1.5 |
| 8494B,<br>8496B | dc to 8<br>8 to 12.4<br>12.4 to 18 | 1.5<br>1.6<br>1.9 |

## Maximum Residual Attenuation

| Instrument | Maximum Residual Attenuation |
|---|---|
| 8494A,<br>8494B | 0.6 dB + 0.09 dB/GHz |
| 8495A,<br>8495B | 0.4 dB + 0.07 dB/GHz |
| 8496A,<br>8496B | 0.6 d8 + 0.09 dB/GHz |

## Attenuation Repeatability

0.01 dB typical after 5 million cycles

## RF Power Handling Capability

1 W average, 100 W peak with maximum pulse width of 10 microseconds (all models)

## Minimum Life

> 5 million cycles per section

## Environment Limits

The instrument should be stored in a clean, dry environment. The following environmental limits apply to storage and shipment, and operation.

| Characteristic | Storage and Shipping Value | Operating Value |
|---|---|---|
| Temperature | –40 to +75 °C | 0 to +55 °C |
| Humidity | < 95% relative | < 95% relative |
| Altitude | < 7600 m (25000 ft) | < 4600 m (15000 ft) |



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## Physical Characteristics

| Instrument | Dimensions [1] (depth x width x height) | Weight [2] |
|---|---|---|
| 8494A/B | 6.25 in x 2.875 in x 1.6875 in<br>159 mm x 73 mm x 43 mm | 15 oz<br>425 g |
| 8495A/B | 5.125 in x 2.875 in x 1.6875 in<br>130 mm x 73 mm x 43 mm | 11 oz<br>312 g |
| 8496A/B | 6.25 in x 2.875 in x 1.6875 in<br>159 mm x 73 mm x 43 mm | 15 oz<br>425 g |

1. Dimensions are for general information only. If dimensions are required for building special enclosures, contact your Agilent field engineer.
2. Weight and width of the instrument varies with the option selected due to the type of connectors.



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# Installation

## Initial Inspection

Inspect the shipping container for damage. If the shipping container or cushioning material are damaged, they should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. A procedure for checking electrical performance is provided under “Operator’s Check” on page 8 (see also “Performance Tests” on page 9).

If the contents of the shipment are incomplete, or if there is mechanical damage or defect, or if the instrument does not pass the electrical performance test, notify the nearest Agilent Technologies office. If the shipping container is damaged, or the cushioning material shows signs of stress, notify the carrier as well as the Agilent Technologies office. Keep the shipping materials for the carrier's inspection. The Agilent office will arrange for repair or replacement without waiting for claim settlement.

**NOTE**

Containers and materials identical to those used in factory packaging are available through Agilent Technologies offices. If the instrument is being returned to Agilent for servicing, attach a tag indicating the type of service required, return address, model number, and full serial number. Also, mark the container *FRAGILE* to assure careful handling. In any correspondence, refer to the instrument by model number and full serial number.

## Mating Connectors

Mating connectors used with the Option 001 must be type-N male connectors, which comply with U.S. military standard MIL-C-39012. For Option 002, male SMA connectors must be used. For Option 003, APC-7 mating connectors must be used.

**CAUTION**

When installing the instrument, make sure that the connectors do not support weight or bear torque. The preferred procedure is to set up all equipment in position before connecting the instrument. Either connector may be used as the input or output connector.

## Installing with Base

The attenuators may be installed with or without the base. The base is removed by unscrewing the two fillister head screws from the bottom of the base. The attenuator may be mounted without the base by inserting two 4-40 screws into the screw holes in the bottom of the attenuator. Removing the base and mounting the attenuator does not affect the performance of the attenuator.



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# Operating Instructions

**CAUTION**

Do not apply power greater than 1 W average, or 100 W peak with a maximum pulse width of 10 microseconds. If these limits are exceeded, the attenuators may be damaged.

After the instrument is connected, the attenuation may be selected. Turn counterclockwise to increase attenuation or clockwise to decrease attenuation. Either connector may be used as the input or output. Table 1 lists the attenuator switching order.

***Table 1 Attenuator Switching Order***

| 8494A/B Attenuator Sections | | | | | 8495A/B Attenuator Sections | | | | 8496A/B Attenuator Sections | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Atten (dB) | 1<br>1 dB | 2<br>2 dB | 3<br>4 dB | 4<br>4 dB | Atten (dB) | 1<br>10 dB | 2<br>20 dB | 3<br>40 dB | Atten (dB) | 1<br>10 dB | 2<br>20 dB | 3<br>40 dB | 4<br>40 dB |
| 0 | | | | | 0 | | | | 0 | | | | |
| 1 | X | | | | 10 | X | | | 10 | X | | | |
| 2 | | X | | | 20 | | X | | 20 | | X | | |
| 3 | X | X | | | 30 | X | X | | 30 | X | X | | |
| 4 | | | | X | 40 | | | X | 40 | | | | X |
| 5 | X | | X | | 50 | X | | X | 50 | X | | X | |
| 6 | | X | X | | 60 | | X | X | 60 | | X | X | |
| 7 | X | X | X | | 70 | X | X | X | 70 | X | X | X | |
| 8 | | | X | X | | | | | 80 | | | X | X |
| 9 | X | | X | X | | | | | 90 | X | | X | X |
| 10 | | X | X | X | | | | | 100 | | X | X | X |
| 11 | X | X | X | X | | | | | 110 | X | X | X | X |

**CAUTION**

Do not attempt to force the switch between 0 and the highest value position as there is a stop between these switch positions.



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# Operator's Check

The operator's check allows the operator to make a quick check of the instrument prior to use or if a failure is suspected.

## Description

The attenuator is driven from a 50-ohm signal source at 1 kHz. The output level from the attenuator is detected by a narrow-bandwidth voltmeter. The attenuator and detector range switches are stepped together and the variations in level noted. This verifies that each attenuator section is being properly switched and checks the low-frequency accuracy of the attenuator.

**NOTE**

The SWR meter used in this check is calibrated for a square-law detector and therefore the range changes and errors (read in dB) are twice that indicated by the meter.

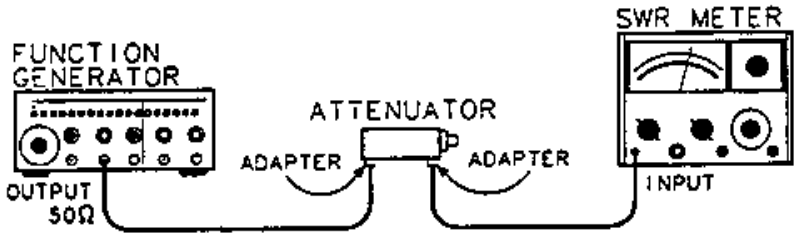



*Figure 1 Operator Check Setup*

## Procedure

1. Connect equipment as shown in Figure 1 with the attenuator set to 0 dB.
2. Set the test oscillator to 0.3 Vrms at 1 kHz.
3. Set SWR meter range to 2 dB (expanded) [or for the 8494A/B to 10 dB (expanded)] and adjust its bandwidth to center of adjustment range. Fine tune the oscillator frequency to obtain maximum meter indication.
4. Set the attenuator and SWR meter range switch as shown in Table 2 and verify that SWR meter indicates within limits shown.



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*Table 2 Attenuation and SWR Settings*

| SWR Meter Range (dB) | | Attenuation (dB) | | | Meter Indication (dB) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Minimum | | Actual | | Maximum | |
| 8494A/B | 8495A/B 8496A/B | 8494A/B | 8495A/B | 8496A/B | 8494A/B | 8495A/B 8496A/B | 8494A/B | 8495A/B 8496A/B | 8494A/B | 8495A/B 8496A/B |
| 10 | 2 | 0 | 0 | 0 | - | - | Set to 0.0 | Set to 0.5 | - | - |
| 10 | 6 | 1 | 10 | 10 | 0.40 | 1.40 | - | - | 0.60 | 1.60 |
| 10 | 12 | 2 | 20 | 20 | 0.90 | 0.30 | - | - | 1.10 | 0.70 |
| 10 | 16 | 3 | 30 | 30 | 1.35 | 1.25 | - | - | 1.65 | 1.75 |
| 10 [1] | 22 | 4 | 40 | 40 | 1.85 | 0.15 | - | - | 2.15 | 0.85 |
| 12 | 26 | 5 | 50 | 50 | 0.35 | 1.10 | - | - | 0.65 | 1.90 |
| 12 | 32 | 6 | 60 | 60 | 0.85 | 0.00 | - | - | 1.15 | 1.00 |
| 12 | 36 [1] | 7 | 70 | 70 | 1.30 | 0.90 | - | - | 1.70 | 2.10 |
| 12 [1] | 42 [1] | 8 | - | 80 | 1.80 | –0.15 | - | - | 2.20 | 1.15 |
| 14 | 46 [1] | 9 | - | 90 | 0.30 | 0.75 | - | - | 0.70 | 2.25 |
| 14 | 52 [1] | 10 | - | 100 | 0.80 | –0.30 | - | - | 1.20 | 1.30 |
| 14 | 56 [1] | 11 | - | 110 | 1.75 | 0.60 | - | - | 1.75 | 2.40 |

1. Adjust range by 2 dB, if needed, to obtain a on-scale indication.

## Performance Tests

The instrument can be tested to the accuracy of the "Specifications" on page 3, with an automatic network analyzer or equivalent equipment of suitable accuracy. If an automatic network analyzer is available, test the instrument using the procedures in the analyzer's operating manual.

**NOTE**

The attenuators have no internal adjustments and should not be opened. If defective, return the attenuator to the nearest Agilent Technologies office for repair.



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# Replaceable Parts

Table 3 lists the replaceable parts which are the only parts that can be replaced without access to the interior of the instrument. If any parts not listed below need replacement, return the instrument to Agilent Technologies.

**CAUTION**

Due to special fixtures necessary for assembly, do *not* attempt to replace any parts not listed in the table below. If the instrument is opened, the warranty is void.

***Table 3 Replaceable Parts***

| Description | Part Number |
|---|---|
| Knob | 0370-1091 |
| Option 003 APC-7 center conductor contact | 1250-0907 |
| Option 003 APC-7 connector outer shell assembly | 1250-0909 |
| Option 001 Type N female connector outer shell | 1250-0914 |
| Screws for both bases: 4-40 x 7/8 in. Fillister head | 2220-0006 |
| Label 0-110 dB for 8496A and B | 7120-0543 |
| Label 0-70 dB for 8495A and B | 7120-3376 |
| Label 0-11 dB for 8494A and B | 7120-4525 |
| Base for 8495A & B | 5041-3887 |
| Base for 8494A and B and 8496A and B | 5041-3888 |

**NOTE**

Option 002 (SMA) connectors are not replaceable without access to the interior of the instrument. If these connectors are damaged, return the instrument to Agilent Technologies.



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# Service

## Troubleshooting

Troubleshooting consists of performing the "Operator's Check" on page 8. If the instrument does not perform within limits, return the instrument to Agilent Technologies.

## Repair

The only recommended field repair is replacing the outer connector shell for the Option 001 and 003, or replacing the center contact in the 7 mm connector. For any other repair, return the entire instrument to Agilent Technologies.

### Replacing the 7 mm Connector Center Conductor Contact

Through wear or damage, the contact in the 7 mm center conductor may need replacement. This contact is a small four-pronged contact which snaps into a recess in the center conductor. With a magnifying glass, examine the contact for the necessary outward spring action by carefully pushing it in.

**CAUTION**

*Do not remove this contact for inspection.* It may be damaged by removal. The prongs of the contact should be free from burrs or wear. If the contact is removed, *do not* reuse it. Order contact as Amphenol part number 131-129* or Agilent part number 1250-0907.

If this contact needs replacement, proceed as follows:

1. Place the instrument so the connector faces down.
2. Tap the connector lightly. The contact should now protrude slightly. Insert the centering pin of the contact extractor, p/n 5060-0370, with the jaws open.
3. Allow the jaws of the tool used to close and pull straight back from the connector without twisting.
4. Snap in a new contact by pushing it in place. Test the action of the new contact by pushing it in. It should spring out again when released.

* Amphenol RF Division, Danbury, CT.



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## Replacing the Connector Outer Shell

**NOTE**

The connector outer shell can be replaced only on the Option 001 (type-N female) or the Option 003 (7 mm). The outer shell on the Option 002 (SMA) cannot be replaced in the field.

The connector outer shells on the Option 001 and 003 may be replaced as follows:

1. With a 9/16-inch (1/2-inch for 7 mm) thin open-end wrench, unscrew the outer connector body.
2. Replace the connector outer shell. See Table 3 on page 10 for replaceable parts numbers.
3. Tighten the connector with the same wrench called out in step 1.



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