

Keysight 8495D/K Attenuators

Notices

Copyright Notice

© Keysight Technologies 2011 - 2021

No part of this manual may be reproduced in any form or by any means (including electronic storage and retrieval or translation into a foreign language) without prior agreement and written consent from Keysight Technologies as governed by United States and international copyright laws.

Manual Part Number

08495-90027

Edition

Edition 6, October 14, 2021

Printed in:

Printed in Malaysia

Published by:

Keysight Technologies
Bayan Lepas Free Industrial Zone,
11900 Penang, Malaysia

Technology Licenses

The hardware and/or software described in this document are furnished under a license and may be used or copied only in accordance with the terms of such license.

Declaration of Conformity

Declarations of Conformity for this product and for other Keysight products may be downloaded from the Web. Go to <http://www.keysight.com/go/conformity>. You can then search by product number to find the latest Declaration of Conformity.

U.S. Government Rights

The Software is "commercial computer software," as defined by Federal Acquisition Regulation ("FAR") 2.101. Pursuant to FAR 12.212 and 27.405-3 and Department of Defense FAR Supplement ("DFARS") 227.7202, the U.S. government acquires commercial computer software under the same terms by which the software is customarily provided to the public. Accordingly, Keysight provides the Software to U.S. government customers under its standard commercial license, which is embodied in its End User License Agreement (EULA), a copy of which can be found at <http://www.keysight.com/find/sweula>. The license set forth in the EULA represents the exclusive authority by which the U.S. government may use, modify, distribute, or disclose the Software. The EULA and the license set forth therein, does not require or permit, among other things, that Keysight: (1) Furnish technical information related to commercial computer software or commercial computer software documentation that is not customarily provided to the public; or (2) Relinquish to, or otherwise provide, the government rights in excess of these rights customarily provided to the public to use, modify, reproduce, release, perform, display, or disclose commercial computer software or commercial computer software documentation. No additional government requirements beyond those set forth in the EULA shall apply, except to the extent that those terms, rights, or licenses are explicitly required from all providers of commercial computer software pursuant to the FAR and the DFARS and are set forth specifically in writing elsewhere in the EULA. Keysight shall be under no obligation to update, revise or otherwise modify the Software. With respect to any technical data as defined by FAR 2.101, pursuant to FAR 12.211 and 27.404.2 and DFARS 227.7102, the U.S. government acquires no greater than Limited Rights as defined in FAR 27.401 or DFAR 227.7103-5 (c), as applicable in any technical data.

Warranty

THE MATERIAL CONTAINED IN THIS DOCUMENT IS PROVIDED "AS IS," AND IS SUBJECT TO BEING CHANGED, WITHOUT NOTICE, IN FUTURE EDITIONS. FURTHER, TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, KEYSIGHT DISCLAIMS ALL WARRANTIES, EITHER EXPRESS OR IMPLIED, WITH REGARD TO THIS MANUAL AND ANY INFORMATION CONTAINED HEREIN, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. KEYSIGHT SHALL NOT BE LIABLE FOR ERRORS OR FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES IN CONNECTION WITH THE FURNISHING, USE, OR PERFORMANCE OF THIS DOCUMENT OR OF ANY INFORMATION CONTAINED HEREIN. SHOULD KEYSIGHT AND THE USER HAVE A SEPARATE WRITTEN AGREEMENT WITH WARRANTY TERMS COVERING THE MATERIAL IN THIS DOCUMENT THAT CONFLICT WITH THESE TERMS, THE WARRANTY TERMS IN THE SEPARATE AGREEMENT SHALL CONTROL.

Safety Information









CAUTION

A CAUTION notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, 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.

WARNING

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

Regulatory Markings

	<p>The CE mark is a registered trademark of the European Community. This CE mark shows that the product complies with all the relevant European Legal Directives.</p>		<p>The CSA mark is a registered trademark of the Canadian Standards Association.</p>
	<p>The CE mark is a registered trademark of the European Community. This CE mark shows that the product complies with all the relevant European Legal Directives.</p> <p>ICES/NMB-001 indicates that this ISM device complies with the Canadian ICES-001.</p> <p>Cet appareil ISM est conforme a la norme NMB-001 du Canada.</p> <p>ISM GRP.1 Class A indicates that this is an Industrial Scientific and Medical Group 1 Class A product.</p>	<p>ICES/NMB-001</p> <p>ICES/NMB-001 indicates that this ISM device complies with the Canadian ICES-001.</p> <p>Cet appareil ISM est conforme a la norme NMB-001 du Canada.</p>	
	<p>This symbol is a South Korean Class A EMC Declaration. This is a Class A instrument suitable for professional use and in electromagnetic environment outside of the home.</p>		<p>The RCM mark is a registered trademark of the Australian Communications and Media Authority.</p>
	<p>This symbol indicates the time period during which no hazardous or toxic substance elements are expected to leak or deteriorate during normal use. Forty years is the expected useful life of the product.</p>		<p>This instrument complies with the WEEE Directive (2002/96/EC) marking requirement. This affixed product label indicates that you must not discard this electrical or electronic product in domestic household waste.</p>
	<p>The CE mark is a registered trademark of the European Community. This CE mark shows that the product complies with all the relevant European Legal Directives.</p>		

Waste Electrical and Electronic Equipment (WEEE) Directive

This instrument complies with the WEEE Directive marking requirement. This affixed product label indicates that you must not discard this electrical or electronic product in domestic household waste.

Product category:

With reference to the equipment types in the WEEE directive Annex 1, this instrument is classified as a “Monitoring and Control Instrument” product.

The affixed product label is as shown below.



Do not dispose in domestic household waste.

To return this unwanted instrument, contact your nearest Keysight Service Center, or visit <http://about.keysight.com/en/companyinfo/environment/takeback.shtml> for more information.

Sales and Technical Support

To contact Keysight for sales and technical support, refer to the support links on the following Keysight websites:

- (product-specific information and support, software and documentation updates)
- www.keysight.com/find/assist
(worldwide contact information for repair and service)

Table of Contents

Regulatory Markings	3
Waste Electrical and Electronic Equipment (WEEE) Directive	4
Product category:	4
Sales and Technical Support	4
List of Figures	7
List of Tables	9
1 Introduction	
Product Overview	12
Supplied accessories	14
Instrument options	16
Specifications	18
Frequency range and attenuation	18
Attenuation accuracy	18
Maximum insertion loss	18
Attenuation repeatability	19
RF power handling capability	19
Solenoid drive	19
Switching speed	19
Maximum SWR	20
Operating life	20
2 Environmental Specifications & Physical Dimensions	
Environmental Specifications	22
Physical Dimensions	23
3 Operating Guides	
Installation	28
Initial inspection	28
Mating connectors	28
Installation instructions	29

Operating Instructions	30
Operating information	30
Operator's check	30
Performance tests	32
Service instructions	32

List of Figures

Figure 1-1	8495K programmable four-section attenuator schematic diagram	13
Figure 1-2	Solenoid cable pin configuration	15
Figure 1-3	Typical solenoid coil driver circuit	16
Figure 2-1	Dimensions of Keysight 8495D attenuator	24
Figure 2-2	Dimensions of Keysight 8495K attenuator	25
Figure 3-1	Operator's check setup	31

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK.

List of Tables

Table 1-1	Attenuator switching	14
Table 1-2	Solenoid cable connectors	15
Table 1-3	Instrument options	17
Table 1-4	Frequency range and attenuation	18
Table 1-5	Attenuation accuracy	18
Table 1-6	Solenoid drive	19
Table 1-7	Maximum SWR	20
Table 2-1	Environmental specifications	22
Table 2-2	Physical dimensions	23
Table 3-1	Attenuator and SWR settings	31

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK.

1 Introduction

Product Overview	12
Specifications	18

This manual contains operating instructions for the 8495D/K Attenuators. Included in the manual is information required to install and test these attenuators.

Product Overview

The Keysight 8495D and 8495K are 50-ohm, dc to 26.5 GHz, 0 dB to 70 dB (in 10 dB steps), coaxial attenuators with APC 3.5 connectors. Each attenuator is made up of four attenuation sections 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. In the 8495D, the edge line controls are flexed by low-torque cams. In the 8495K, the edge line controls are flexed by solenoid plungers (see [Figure 1-1](#)).

[Table 1-1](#) on page 14 shows the switching arrangement required to increase the amount of attenuation from 0 dB to 70 dB in 10 dB steps. In the 8495K, to ensure specified performance, it is recommended that the attenuator sections shown in the table below be used. Also, when changing attenuation, it is good practice to insert the required sections before deletion of the unneeded sections. With the attenuator set for 0 dB attenuation, only the insertion loss (residual attenuation) remains.

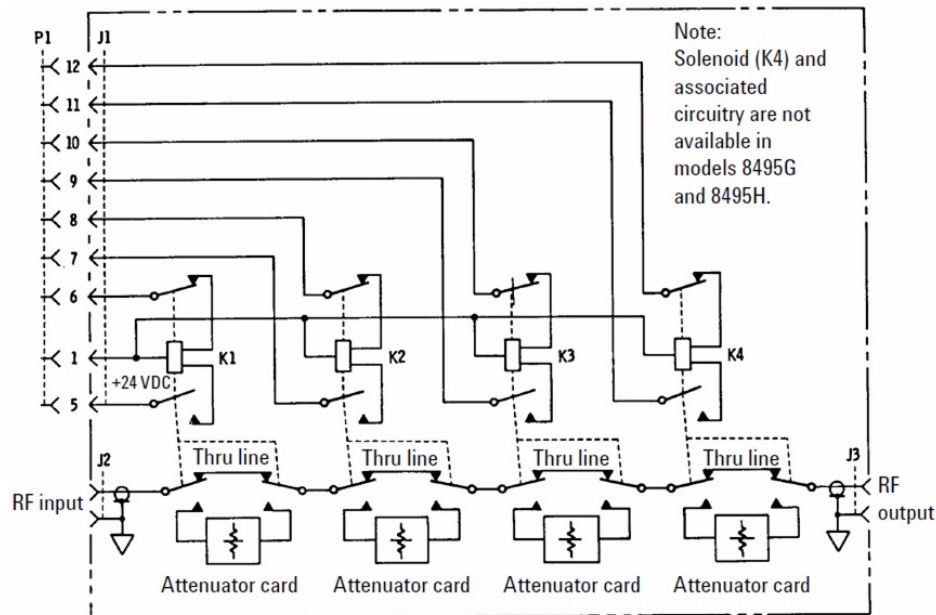


Figure 1-1 8495K programmable four-section attenuator schematic diagram

In the 8495K, each solenoid requires a drive of 20 V to 30 V. The switching current is approximately 125 mA at 24 Vdc per section for the 8495K. The solenoid switching time is less than 20 milliseconds including settling time. Once switched, the solenoid plungers are held in place by permanent magnets and the solenoid plungers automatically disconnect the selected coil drive and connect the opposite coil drive (see [Figure 1-1](#) and [Figure 1-3](#)).

Table 1-1 Attenuator switching

Attenuation (dB)	Attenuator sections			
	1 10 dB	2 20 dB	3 20 dB	4 20 dB
10	x			
20			x ^[a]	x ^[b]
30	x		x ^[a]	x ^[b]
40		x		x
50	x	x		x
60		x	x	x
70	x	x	x	x

[a] D model only

[b] K model only

CAUTION

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

Supplied accessories

A solenoid drive cable is supplied with the 8495K. The cable is 1.5 m (5 ft) long with a mating connector plug on one end and the other end is unterminated (see [Figure 1-2](#)).

Solenoid cable connectors

Refer also to [Figure 1-2](#) on page 16.

Table 1-2 Solenoid cable connectors

Section	Section 1		Section 2		Section 3		Section 4		Power V+
Solenoid Coil	Thru- line	Atten card	Thru- line	Atten card	Thru- line	Atten card	Thru- line	Atten card	
Cable wire color code ^[a]	PUR	YEL	BLK	GRN	ORN	BLU	BRN	WHT	RED
Connector plug pin number ^[b]	5	6	7	8	9	10	11	12	1
8495K	0 dB	10 dB	0 dB	20 dB	0 dB	20 dB	0 dB	20 dB	-
Option 016									
Flat pack plug pin number ^[c]	13	2	11	5	3	9	4	10	6

- [a] Five-foot cable and mating plug assembly provided.
- [b] Pin 1 (red wire) is common for all coils. Pins 2, 3, and 4 are not used.
- [c] Pin 6 is common for all coils. Pins 1, 7, 8, 12, and 14 are not used.

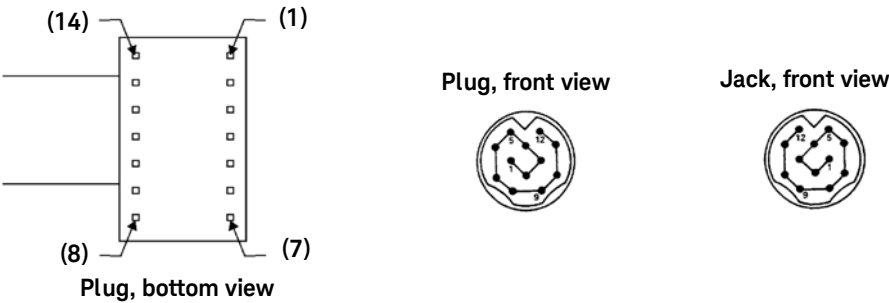


Figure 1-2 Solenoid cable pin configuration

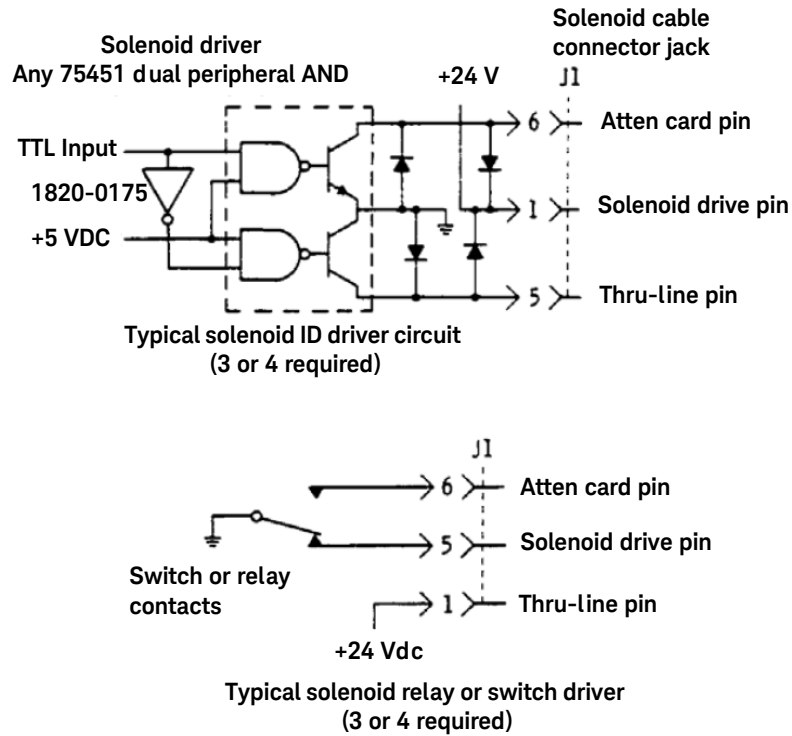


Figure 1-3 Typical solenoid coil driver circuit

Instrument options

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

Table 1-3 Instrument options

Option	Description
004	3.5 mm (f) connectors
024	24 Vdc supply voltage
011	5 V operation instead of standard 24 V
016	10-pin connector with 10-pin through to 14-pin dip plug, 16-inch DC ribbon cable
060 ^[a]	Viking connector with Viking bare wire cable

[a] Option 024 and 060 are default options unless specified otherwise.

Specifications

Frequency range and attenuation

Table 1-4 Frequency range and attenuation

Frequency range	Attenuation
Dc to 26.5 GHz	0 dB to 70 dB in 10 dB steps

Attenuation accuracy

Table 1-5 Attenuation accuracy

Attenuation accuracy (± dB, referenced from 0 dB)				
Attenuation selection (dB)	dc–6.0 GHz	6.0–12.4 GHz	12.4–18.0 GHz	18.0–26.5 GHz
10	0.3	0.4	0.5	0.7
20	0.5	0.5	0.6	0.8
30	0.6	0.7	0.8	1.0
40	0.7	0.9	1.1	1.5
50	0.8	1.0	1.2	1.6
60	1.0	1.3	1.4	1.9
70	1.1	1.5	1.7	2.3

Maximum insertion loss

$(0.4 + 0.09 f)$ dB

where “f” is the frequency in GHz.

Attenuation repeatability

±0.03 dB, typical at 18 GHz
±0.05 dB, typical at 26.5 GHz
(5 million cycles per section)

RF power handling capability

1 W average, 100 W peak with maximum pulse width of 10 microseconds.

Solenoid drive

Table 1-6 Solenoid drive

Solenoid	Coil voltage	Switching current ^[a]	Nominal coil impedance
Option 024	24 V (20 to 30 V)	125 mA (at 24 V)	190 Ω
Option 011	5 V (4.5 to 7 V) ^[b]	325 mA (at 5 V)	17 Ω

[a] Switching current is current per section.
[b] For switching multiple sections simultaneously, the minimum voltage is 5.5 V.

Switching speed

Maximum 20 milliseconds including settling time.

Maximum SWR

Table 1-7 Maximum SWR

Instrument	Frequency range (GHz)	Maximum SWR
8495D, 8495K	DC to 6.0	1.25
	6.0 to 12.4	1.45
	12.4 to 18.0	1.9
	18.0 to 26.5	2.2

Operating life

5 million cycles per section.

2 Environmental Specifications & Physical Dimensions

Environmental Specifications	22
Physical Dimensions	23

This chapter contains the environmental tests on the 8495D/K Attenuators that fully comply with Keysight Technologies' product operating environmental specifications. The physical dimensions are illustrated in the later section.

Environmental Specifications

The 8495D/K Attenuators are designed to fully comply with Keysight Technologies' product operating environmental specifications as shown in [Table 2-1](#).

Table 2-1 Environmental specifications

Characteristic	Value
Temperature	
– Operating	0 °C to +55 °C
– Storage	–40 °C to +75 °C
Humidity	
– Operating	<95% relative
– Storage	<95% relative
Altitude	
– Operating	<4600 m (15000 ft)
– Storage	<7600 m (25000 ft)
Shock	
– Operating	10 Gs, six ms, on six sides, three blows
– Non-operating	500 Gs, 1.8 ms, in six directions
Vibration	
– Operating	5 Gs, 34 Hz to 2000 Hz
EMC	Radiated interference is within the requirements of MIL-STD-461, RE02

Physical Dimensions

Table 2-2 shows the physical dimensions of the 8495D/K Attenuators.

Table 2-2 Physical dimensions

Instrument	Dimensions ^[a]	Weight
8495D	Per Figure 2-1	15 oz 425 g
8495K	Per Figure 2-2	16 oz 454 g

[a] Dimensions are in millimeters and inches. Dimensions are for general information only. If dimensions are required for building special enclosures, contact your Keysight field engineer.

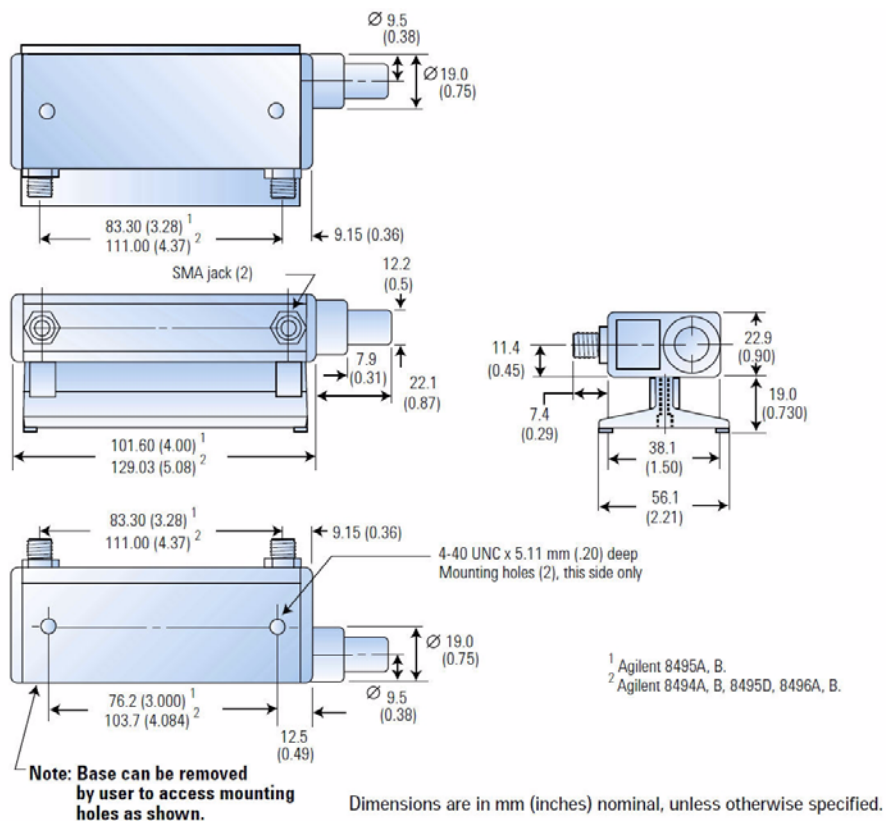


Figure 2-1 Dimensions of Keysight 8495D attenuator

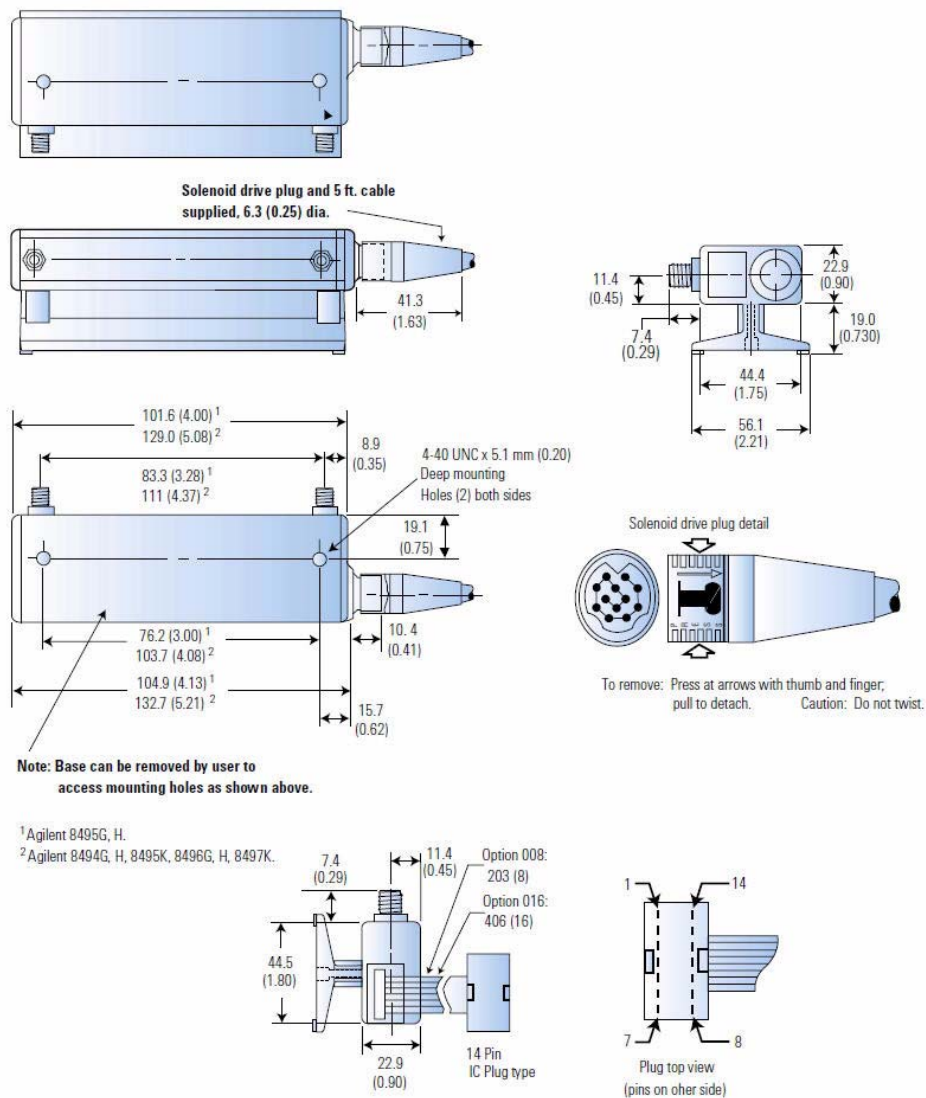


Figure 2-2 Dimensions of Keysight 8495K attenuator

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK.

3 Operating Guides

Installation	28
Operating Instructions	30

This chapter describes the installation of the 8495D/K Attenuators. The operating instruction quick-check procedure is included for verification test prior to usage.

Installation

Initial inspection

- 1** Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked both mechanically and electrically.
 - Check for mechanical damage such as scratches or dents.
 - Procedures for checking electrical performance are given under “**Operator’s check**” on page 30 or “**Performance tests**” on page 32.
- 2** If the contents are incomplete, if there is mechanical damage or defect, or if the instrument does not pass the electrical performance test, contact the nearest Keysight Technologies Sales and Service office. Refer to the Service and Support information in the front matter of this manual. Keysight Technologies will arrange for repair or replacement of the damaged or defective equipment. Keep the shipping materials for the carrier's inspection.
- 3** If you are returning the instrument under warranty or for service, repackaging the instrument requires original shipping containers and materials or their equivalents. Keysight Technologies can provide packaging materials identical to the original materials. Refer to Service and Support information in the front matter of this manual for the Keysight Technologies nearest to you. Attach a tag indicating the type of service required, return address, model number and serial number. Mark the container **FRAGILE** to insure careful handling. In any correspondence, refer to the instrument by model number and serial number.

Mating connectors

The APC 3.5 connector is a 3.5 mm air line connector that will mate with the SMA type connectors. The SWR performance of this hybrid connection is similar to a mated pair of SMA connectors when used within the frequency range of the SMA connector.

Option

The attenuators are configured with the APC 3.5 female connectors and are designated as Option 004.

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.

Installation instructions

The 8495K solenoid drive cable connector plug is connected by aligning the plug (P1) with the jack (J1) on the attenuator, and then pushing the plug over the jack. The plug is removed by grasping the ribbed sides of the plug and squeezing them together while pulling back until the plug clears the jack.

Operating Instructions

CAUTION

Do not apply RF 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.

CAUTION

For the 8495K, do not ground both solenoid drive pins of the programmable attenuator at the same time. This causes rapid cycling of the solenoid and could reduce the operating life of the attenuator. The rapid cycling may produce a buzzing sound from the attenuator.

Operating information

Either RF connector may be used as the input or output connector. Connect the solenoid drive cable of the programmable attenuator to the solenoid drive connector (J1). By applying the proper voltage and grounds to the proper pins of J1, the attenuator will either increase or decrease the amount of attenuation as selected.

Operator's check

The Operator's Check is supplied to allow 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. Therefore, the range changes and errors (read in dB) are twice that indicated by the meter.

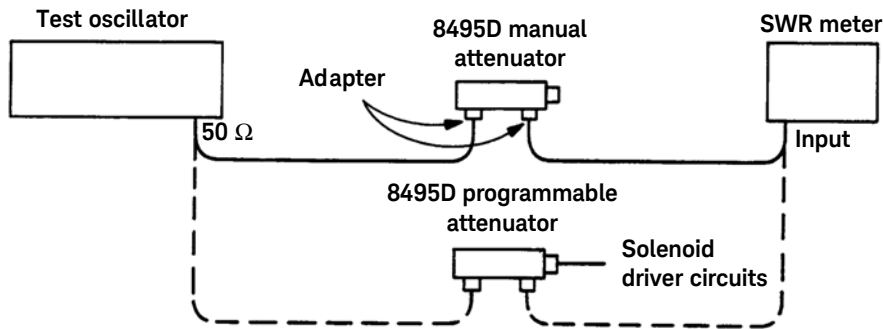


Figure 3-1 Operator's check setup

Procedure

- 1 Connect equipment as shown in [Figure 3-1](#) 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) and adjust its bandwidth to center of adjustment range. Fine-tune the oscillator frequency to obtain maximum meter indication.
- 4 Set attenuator and SWR meter range switch as listed in [Table 3-1](#) and verify that the SWR meter indicates within the limits shown.

Table 3-1 Attenuator and SWR settings

SWR meter range (dB)	Attenuation		Meter indication (dB)	
	8495D/K	Minimum	Actual	Maximum
2	0	-	Set to 0.5	-
6	10	1.20	-	1.80

Table 3-1 Attenuator and SWR settings (continued)

SWR meter range (dB)	Attenuation	Meter indication (dB) (continued)		
	8495D/K	Minimum	Actual	Maximum
12	20	0.15	-	0.85
16	30	1.05	-	1.95
22 ^[a]	40	-0.40	-	1.40
26 ^[a]	50	0.50	-	2.50
32 ^[a]	60	-0.60	-	1.60
36 ^[a]	70	0.36	-	2.65

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

Performance tests

The 8495D/K Attenuators can be tested to the accuracy of the specifications with a network analyzer or equivalent equipment of suitable accuracy. If a network analyzer is available, test instrument using the procedure in the analyzer's operating manual.

Service instructions

Adjustment

The 8495D/K Attenuators do not have internal adjustments and should not be opened.

Repair

The 8495D/K Attenuators are not recommended for repair as most components are not easily removed.

Maintenance

The connectors, particularly the connector faces, must be kept clean. For instruction on connecting and care of your connectors, refer to the *Microwave Connector Care Quick Reference Card* (08510- 90360).



This information is subject to change without notice. Always refer to the English version at the Keysight website for the latest revision.

© Keysight Technologies 2011 - 2021

Edition 6, October 14, 2021

Printed in Malaysia



08495-90027