Agilent Technologies

Agilent Technologies 8494/95/96G/H Attenuators

Operating and Service Manual

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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

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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.
1SM1-A	This text indicates that the instrument is an Industrial Scientific and Medical Group 1 Class A product (CISPER 11, Clause 4).

	This ISM device complies with Canadian ICES-001. Cet appareil ISM est conforme a la norme NMB du Canada.
	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.

Overview

This manual contains operating instructions for the Agilent 8494G/H, 8495G/H, and 8496G/H attenuators. Included in the manual is information required to install and test these attenuators.

Specification

Instrument specifications are indicated in **Specifications**, page 6. These specifications are the performance standards or limits against which the instruments may be tested.

Instruments Covered by Manual

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.

An instrument manufactured after the printing of this manual may have a serial prefix that is not listed above. This unlisted serial prefix indicates that the instrument is different from those documented in this manual.

Description

The 8494G/H, 8495G/H, and 8496G/H are 50-ohm coaxial programmable step-attenuators. Each attenuator is composed of three or four attenuator sections connected in cascade. Each section consists of a precision, thin-film attenuator card, a lossless thru-line, and a ganged pair of solenoid-actuated slab line transmission lines. The slab lines are flexed by the solenoid plungers to make contact with either the attenuator card or the thru-line. The slab line contacts are gold plated leaf springs which ensure long life and extremely high repeatability.

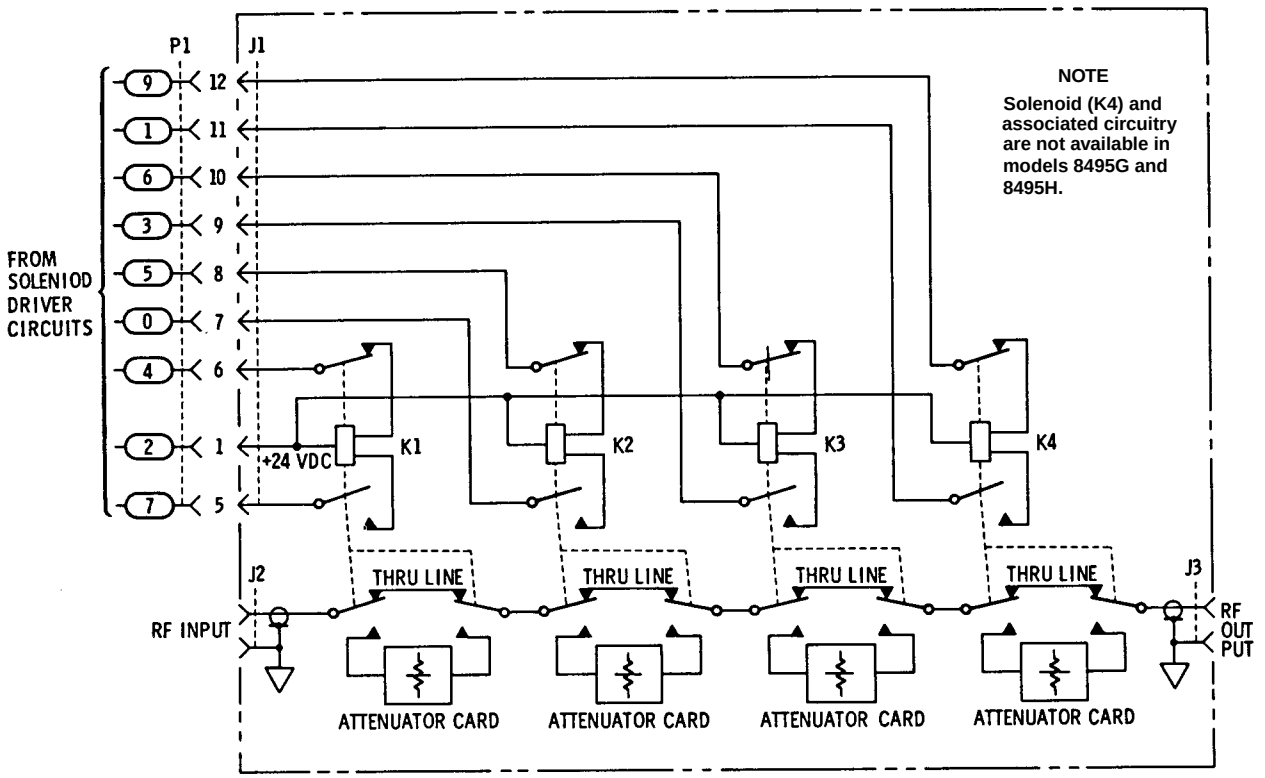


Figure 1 Typical Four Section Attenuator Schematic Diagram

Table 1 and Table 2 on page 3 and Table 3 on page 4 show the typical switching arrangement to increase the amount of attenuation in an 8494G/H, 8495G/H, or 8496G/H in a linear manner. To ensure specified performance, it is recommended that the attenuator sections that are shown in the following tables be used. With the attenuator programmed for 0 dB attenuation, the resultant attenuation is the insertion loss (residual attenuation). The 8494G/H has a minimum selectable step of 1 dB, while the 8495G/H and 8496G/H have a minimum selectable step of 10 dB. The accuracy of the attenuators is within the limits given in **Specifications**, page 6.

- The 8494G/H are four-section attenuators with a maximum attenuation of 11 dB.
- The 8495G/H are three-section attenuators with a maximum attenuation of 70 dB.
- The 8496G/H are four-section attenuators with a maximum attenuation of 110 dB.

Table 1 8494G/H Attenuator Switching Order

8494G/H Attenuator Sections				
Atten (dB)	1 1 dB	2 2 dB	3 4 dB	4 4 dB
0				
1	X			
2		X		
3	X	X		
4			X	
5	X		X	
6		X	X	
7	X	X	X	
8			X	X
9	X		X	X
10		X	X	X
11	X	X	X	X

Table 2 8495G/H Attenuator Switching Order

8495G/H Attenuator Sections			
Atten (dB)	1 10 dB	2 20 dB	3 40 dB
0			
10	X		
20		X	
30	X	X	
40			X
50	X		X
60		X	X
70	X	X	X

Table 3 8496G/H Attenuator Switching Order

8496G/H Attenuator Sections				
Atten (dB)	**1 10 dB**	**2 20 dB**	**3 40 dB**	**4 40 dB**
0				
10	X			
20		X		
30	X	X		
40			X	
50	X		X	
60		X	X	
70	X	X	X	
80			X	X
90	X		X	X
100		X	X	X
110	X	X	X	X

Each solenoid requires a drive of 20 to 30 V with a switching current of approximately 125 mA* at 24 V dc per section. 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 and Figure 2). This simplifies the coil driver circuit design and reduces the amount of heat dissipated by the solenoid coils since the solenoid coils are energized only for the 20 milliseconds switching time.

* For serial number prefixes below 1722A, change 125 mA to 110 mA.

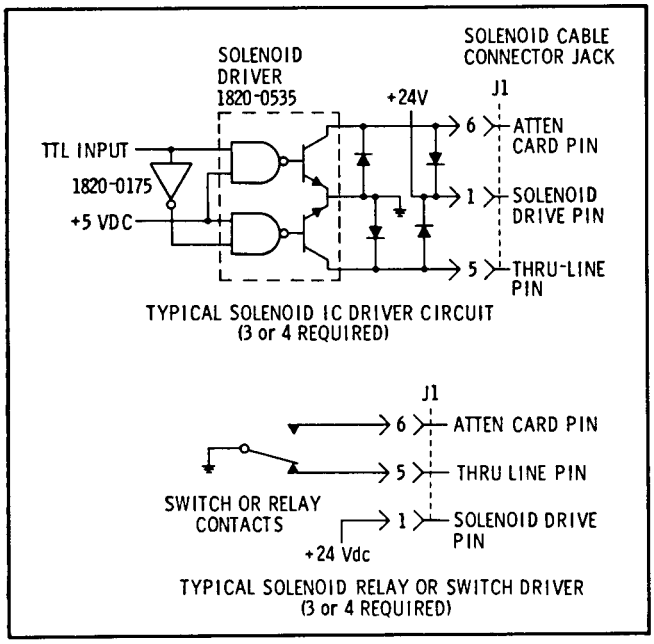


Figure 2 Typical Solenoid Coil Driver Circuits

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 7 Vdc. 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 7 mm

1. Option 003 is not available on the 8495G.

Specifications

Frequency Range and Attenuation

Instrument	Frequency Range	Attenuation
8494G	dc to 4 GHz	0 dB to 11 dB in 1 dB steps
8494H	dc to 18 GHz	0 dB to 11 dB in 1 dB steps
8495G	dc to 4 GHz	0 dB to 70 dB in 10 dB steps
8495H	dc to 18 GHz	0 dB to 70 dB in 10 dB steps
8496G	dc to 4 GHz	0 dB to 110 dB in 10 dB steps
8496H	dc to 18 GHz	0 dB to 110 dB in 10 dB steps

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

8494G/H	8495G/H 8496G/H	8494G	8494H		8495G	8495H		8496G	8496H	
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

Maximum SWR

Instrument	Frequency Range (GHz)	Maximum SWR
8495G	dc to 4	1.35
8495H	dc to 8 8 to 12.4 12.4 to 18	1.35 1.5 1.7
8494G, 8496G	dc to 4	1.5
8494H, 8496H	dc to 8 8 to 12.4 12.4 to 18	1.5 1.6 1.9

Maximum Residual Attenuation

Instrument	Maximum Residual Attenuation
8494G, 8494H	0.6 dB + 0.09 dB/GHz
8495G, 8495H	0.4 dB + 0.07 dB/GHz
8496G, 8496H	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)

Solenoid Drive

Solenoids Drive	Coil Voltage	Switching Current
All models (approximately)	20 to 30 Vdc	125 mA[1] at 24V (190Ω, 65mH)

1. For serial number prefixes below 1722S, change 125mA to 110mA.

Solenoid Cable Connector

Refer also to Figure 3.

Section	Section 1		Section 2		Section 3		Section 4		Power
Solenoid Coil	Thru-Line	Atten Card	Thru-Line	Atten Card	Thru-Line	Atten Card	Thru-Line	Atten Card	V+
Cable Wire Color Code[1]	PUR	YEL	BLK	GRN	ORN	BLU	BRN	WHT	RED
Connector Plug Pin Number [2]	5	6	7	8	9	10	11	12	1
8494G/H	0dB	1dB	0dB	2dB	0dB	4dB	0dB	4dB	–
8495G/H	0dB	10dB	0dB	20dB	0dB	40dB	–	–	–
8496G/H	0dB	10dB	0dB	20dB	0dB	40dB	0dB	40dB	–
Option 016 Flat Pack Plug Pin Number[3]	13	2	11	5	3	9	4	10	6

1. Five-foot cable and mating plug assembly provided.
2. Pin 1 Common solenoid drive (+24 Vdc).
3. Pin 6 is common for all coils. Pins 1, 7, 8, 12 and 14 are not used.

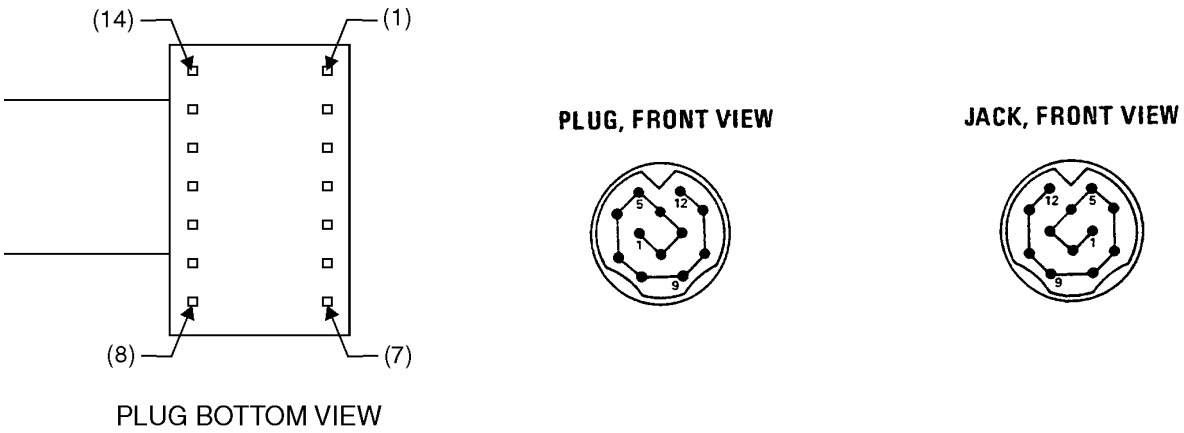


Figure 3 Solenoid Cable Pin Configuration

Minimum Life >5 million cycles per section

Switching speed Maximum 20 milliseconds including settling time.

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)

Physical Characteristics

Instrument	Dimensions [1] (depth x width x height)	Weight [2]
8494G/H 8496G/H	6.25 in x 2.875 in x 1.6875 in 159 mm x 73 mm x 43 mm	16 oz 454 g
8495G/H	5.125 in x 2.875 in x 1.6875 in 130 mm x 73 mm x 43 mm	12 oz 340 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.

Installation

Initial Inspection

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 mechanically and electrically. A procedure for checking electrical performance is given under “Operator’s Check” on page 12 (also see “Performance Tests” on page 14). If the contents of the shipment are incomplete, 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 office. Keep the shipping materials for the carrier's inspection. The 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 RF connectors used with the Option 001 must be type-N male connectors, which comply with U.S. military standard MIL-C-39012 (See Figure 7 on page 19). For Option 002, male SMA connectors must be used. For Option 003, 7 mm mating connectors must be used (Figure 6 on page 18).

The solenoid drive cable connector plug is a Viking Industries, Inc., part number TKP12-102-P-TS-100-AU (see Replaceable parts). The connector plug and contacts without the cable can be ordered from a Viking distributor. When ordering the complete cable assembly from Agilent, use the part number listed in Table 5, “Replaceable Parts,” on page 15.

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.

Installation Instructions

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.

The solenoid drive cable connector plug is connected to the attenuator by aligning the plug (Pl) with the jack (Jl) 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

Do not ground both solenoid drive pins 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.

Either RF connector may be used as the input or output connector. Connect the solenoid drive cable 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 and therefore the range changes and errors (read in dB) are twice that indicated by the meter.

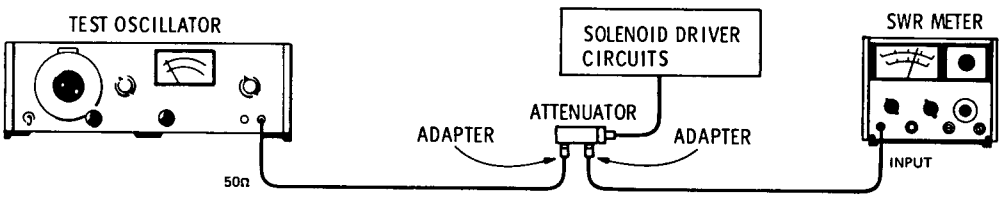


Figure 4 Operator’s Check Setup

Procedure

1. Connect equipment as shown in Figure 4 on page 12 with the attenuator set to 0 dB attenuation.
2. Set the test oscillator to 0.3 Vrms at 1 kHz.
3. Set SWR meter range to 2 dB (expanded) [or for the 8494G/H to 10 dB (expanded)] and adjust its bandwidth to center of adjustment range. Fine tune oscillator frequency to obtain maximum meter indication.
4. Set attenuator and SWR meter range switch as listed in Table 4 and verify that SWR meter indicates within limits shown.

Table 4 Attenuator and SWR Settings

SWR Meter Range (dB)		Attenuation (dB)			Meter Indication (dB)					
					Minimum		Actual		Maximum	
8494G/H	8495G/H 8496G/H	8494G/H	8495G/H	8496G/H	8494G/H	8495G/H 8496G/H	8494G/H	8495G/H 8496G/H	8494G/H	8495G/H 8496G/H
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 6, 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.

Refer to the *Agilent 11713A Attenuator/Switch Driver Operating and Service Manual* for programming instructions.

Adjustments

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

Replaceable Parts

Table 5 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.

To order a part listed in the replaceable parts table below, quote the part number, indicate the quantity required, and address the order to the nearest Agilent Technologies office.

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 5 Replaceable Parts

Description	Part Number
Option 003 7-mm center conductor contact	1250-0907
Option 003 7-mm 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
Cable, solenoid drive, 1.52 m (5 ft) long, connector plug on one end and other end unterminated	8120-2178
Base for 8495G/H	5041-3887
Base for 8494G/H and 8496G/H	5041-3888
Connector plug and contacts only without cable	TKP12-12-102P-TS-100-AU[1]
Contact insertion/extraction tool	TIE-200[1]

1. Available from distributors of Viking Industries, Inc., Chatsworth CA 91311

Service

Troubleshooting

Troubleshooting consists of performing the “Operator’s Check” on page 12. 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

The replacement procedure for the 7 mm connector center contact is covered in Figure 6 on page 18. The disassembly and assembly instructions for the 7 mm connector are covered in Figure 5.

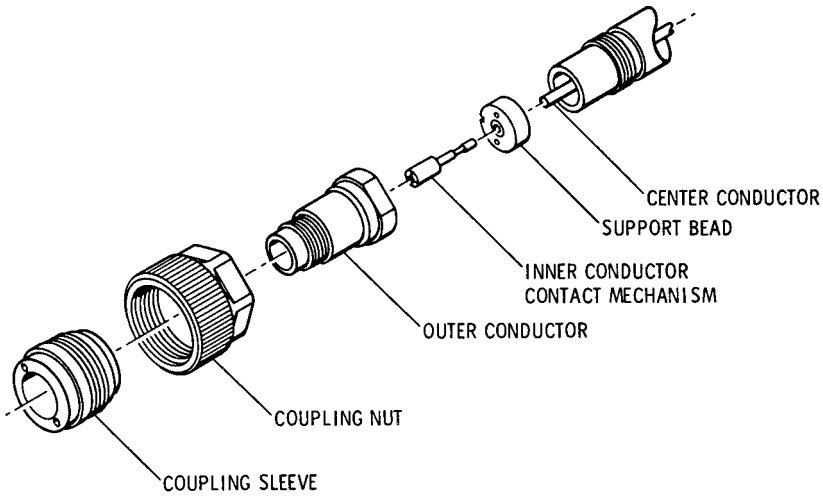
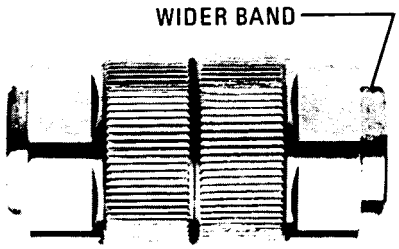


Figure 5 7 mm Connector

Making the Connection

1. On one connector, retract the coupling sleeve by turning the coupling nut counterclockwise until the sleeve and nut disengage.
2. On the other connector, fully extend the coupling sleeve by turning the coupling nut clockwise. To engage coupling sleeve and coupling nut when the sleeve is fully retracted, press back lightly on the nut while turning it clockwise.
3. Push the connectors firmly together, and thread the coupling nut of the connector with retracted sleeve over the extended sleeve.

4. Close the gap between coupling nut with the nut on the extended-sleeve connector.

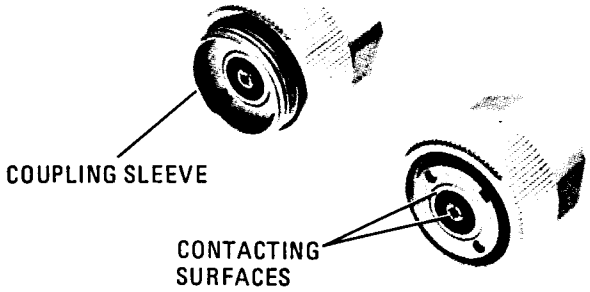


To disconnect:

1. Loosen the coupling nut of the connector showing the wider gold band.

CAUTION

Part the connectors carefully to prevent striking the inner conductor contact.



To care for the device:

1. Keep contacting surfaces smooth and clean. Irregularities and foreign particles can degrade electrical performance.
2. Protect the contacting surfaces when the connector is not in use by leaving the coupling sleeve extended.
3. Use lintless material and/or firm-bristles brush such as a tooth brush for cleaning. If a cleaning fluid is needed, use isopropyl alcohol.

CAUTION

Do not use aromatic or chlorinated hydrocarbons, esters, ethers, terpenes, higher alcohols, ketones, or ether-alcohols such as benzene, toluene, turpentine, dioxane, gasoline, cellosolve acetate, or carbon tetrachloride. Keep exposure of the connector parts to both the cleaning fluid and its vapors as brief as possible.

Replacing Amphenol 7 mm Center 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.

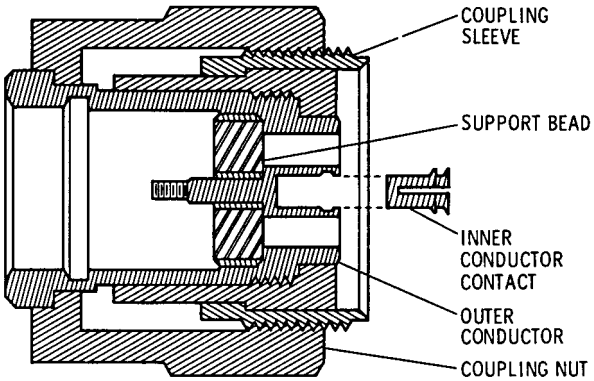


Figure 6 7 mm Connector

If this contact needs replacement, proceed as follows:

1. Place the instrument so the connector faces down, if possible.
2. Tap the connector lightly. The contact should now protrude slightly. Insert the centering pin of the Agilent collet remover with the jaws open. (Part number of the contact extractor is 5060-0370.) If this tool is not available, an ordinary draftsman's mechanical pencil may be used (the end of the jaw may have to be filed to get a good grasp at the very end).

* Amphenol RF Division, Danbury, CN.

3. Allow the jaws of the tool used to close and pull straight back from the connector without twisting. The contact should come with the tool. If not, repeat the process. Do *not* reuse the contact.
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.

Type N Connector Dimensions

For critical dimensions for the type-N connector, see below.

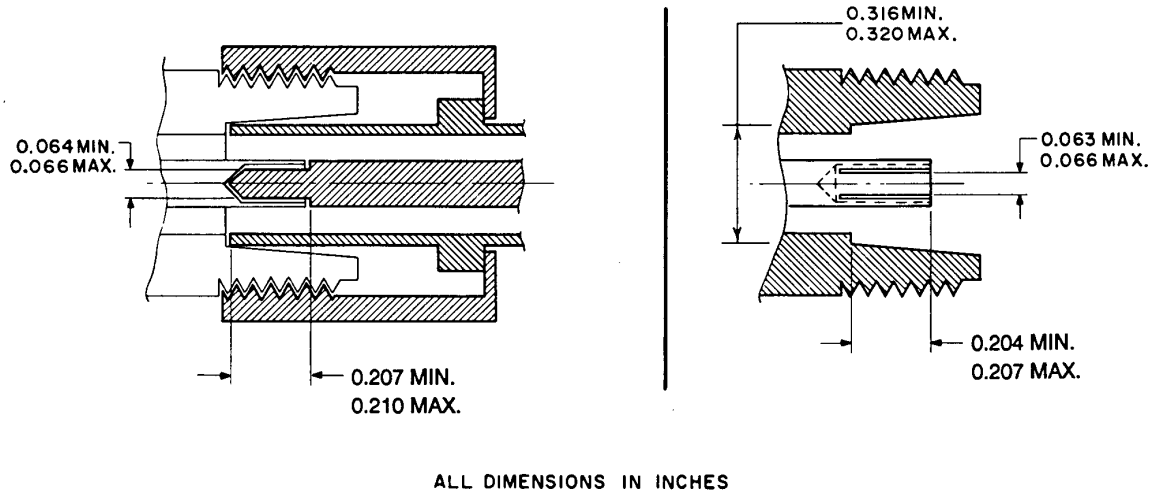


Figure 7 Type-N Connector

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. If these connectors are damaged, return the instrument to Agilent Technologies for repair.

The connector outer shells on the 0ption 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 5 on page 15 for replaceable parts numbers.
3. Tighten the connector with the same wrench called out in step 1.