



Agilent Technologies

772D and 773D

Directional Couplers

Operating and Service
Manual

Serial Numbers

This instrument has a two-part serial number. The first four digits and the letter comprise the serial number prefix. The last five digits form a sequential suffix which is unique to each instrument. The contents of this manual apply directly to instruments having the serial number prefix 2838 and above.

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Warranty

Certification

Agilent Technologies certifies that this product met its published specifications at the time of shipment from the factory. Agilent further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology (NIST, formerly NBS), to the extent allowed by the Institute's calibration facility, and to the calibration facilities of other International Standards Organization members.

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Hewlett-Packard to Agilent Technologies Transition

This documentation supports a product that previously shipped under the Hewlett-Packard company brand name. The brand name has now been changed to Agilent Technologies. The two products are functionally identical, only our name has changed. The document still includes references to Hewlett-Packard products, some of which have been transitioned to Agilent Technologies.

Service and Support

Any adjustment, maintenance, or repair of this product must be performed by qualified personnel. Contact your customer engineer through your local Agilent Service Center.

Online assistance: www.agilent.com/find/assist

United States <i>(tel)</i> 1 800 452 4844	Latin America <i>(tel)</i> (305) 269 7500 <i>(fax)</i> (305) 269 7599
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Taiwan <i>(tel)</i> 0800-047-866 <i>(fax)</i> (886) 2 25456723	People's Republic of China <i>(tel)</i> (preferred): 800-810-0189 <i>(tel)</i> (alternate): 10800-650-0021 <i>(fax)</i> 10800-650-0121

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.
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.

Safety and Regulatory Information

Notice	ii
Warranty	iii
Certification	iii
Warranty	iii
Assistance	iv
Service and Support	v
Safety and Regulatory Information	vi
Safety Earth Ground	vii
Before Applying Power	vii
Description	11
<i>Figure 1. 772D and 773D Directional Couplers</i>	11
772D Dual Directional Coupler	11
773D Directional Coupler	11
Specifications	12
<i>Table 1. Specifications</i>	12
<i>Figure 2. Voltage Incident on 772D Test Port and 773D Input</i>	15
<i>Figure 3. Directivity</i>	15
<i>Figure 4. 772D Error 0.1 to 2.0 GHz</i>	16
<i>Figure 5. 772D Error 2.0 to 12.4 GHz</i>	16
<i>Figure 6. 772D Error 12.4 to 18.0 GHz</i>	16
Installation	17
Initial Inspection	17
Storage and Shipment	17
Operating Information	18
Using the 772D Dual Directional Coupler	18
<i>Figure 7. 772D Dual Direction Coupler</i>	18
Using the 773D Directional Coupler	19
<i>Figure 8. 773D Directional Coupler</i>	19
Performance Tests	20
<i>Table 2. Recommended Test Equipment</i>	20
Set Up and Calibration	20
<i>Figure 9. 772D/773D Performance Test Setup</i>	21
Directivity Test	22
<i>Table 3. Correction for Element Reflection of the 905A</i>	22
Service Instructions	23
Connectors	23
<i>Figure 10. Use and Care of APC-7 Connectors</i>	23

Description

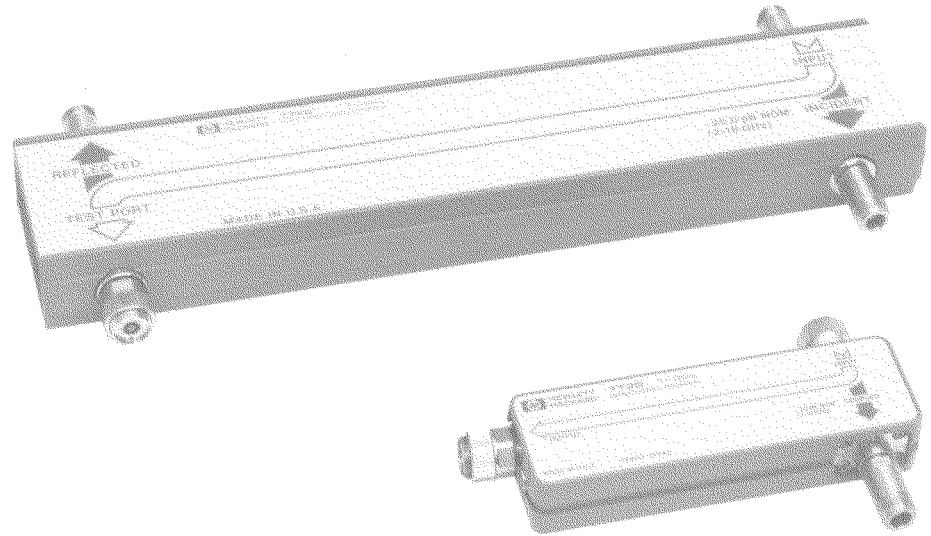


Figure 1 772D and 773D Directional Couplers

772D Dual Directional Coupler

The 772D dual directional coupler is a four port passive device. Directional couplers sample power flowing in one direction and ignore power flowing in the opposite direction. Two couplers are incorporated in the 772D so that power flowing in either direction can be sampled. Such a system is usually called a reflectometer. In a reflectometer the incident power flowing into the setup and the reflected power from the device under test are compared.

773D Directional Coupler

The 773D directional coupler is a three port passive device. Directional couplers in their auxiliary arms sample the power flowing in one direction in the mainline and ignore power flowing in the opposite direction. They can be used for measurement purposes or for power leveling. The coupling in the 773D changes the same as the coupling variation of the input coupler in the 772D. This property may be used to cancel out the coupling variation of the 772D in a reflectometer setup by using the 773D to change the coupling for tracking purposes.

Warranty

The directional couplers are warranted and certified as indicated in the front matter of this manual.

Specifications

The specifications given below are the performance standards or limits against which the directional couplers are tested. Unless otherwise stated, the specifications apply to both directional couplers.

Table 1 *Specifications*

Characteristics and Conditions	Limits	Comments
Frequency Range	2.0 to 18 GHz	
Maximum Directivity 2 to 12.4 GHz 12.4 to 18 GHz	30 dB 27 dB	For the 772D, this specification applies to the test port only. Input port directivity is 24 dB @ 2 to 18 GHz.
Maximum Primary Line SWR 772D 2 to 12.4 GHz 12.4 to 18 GHz 773D 2 to 12.4 GHz 12.4 to 18 GHz	1.28 1.40 1.21 1.27	50 Ω nominal impedance
Maximum Auxiliary Line SWR 2 to 12.4 GHz 12.4 to 18 GHz	1.3 1.3	Established with a best fit line through the coupling curve
Nominal Coupling (2.0 to 18 GHz)	20 \pm 1 dB	
Maximum Coupling Variation 772D 2.0 to 18 GHz 773D 2.0 to 18 GHz	\pm 1 dB \pm 1 dB	Test port to incident
Tracking	$\leq \pm 0.7$ dB	With 772D TEST PORT shorted and not including source-match ripple. Refers to the relative tracking of the auxiliary arms: auxiliary arms do not necessarily track in absolute power. Typical relative tracking between 772D and 773D $\leq \pm 0.7$ dB.
Primary Line Residual Loss 772D 773D	< 1.5 dB < .90 dB	
Maximum Power Input	50 W (47 dBm) average 250 W (54 dBm) peak	

Specifications

Supplemental Characteristics

Supplemental characteristics are not specifications; that is, they are not covered by the certification and warranty at the beginning of this manual. They are typical or nominal characteristics included as additional information for the user.

Characteristics	Frequency	772D	773D
Minimum Directivity	0.1 to 2.0 GHz	39 dB	39 dB
	12.4 to 20 GHz	20 dB	21 dB
Maximum Primary Line SWR	0.1 to 2.0 GHz	1.05	1.29
	18 to 20 GHz	1.29	1.16
Maximum Auxiliary Line SWR	0.1 to 2.0 GHz	1.08	1.07
	18 to 20 GHz	1.17	1.17
Primary Line Residual Loss	0.1 to 2.0 GHz	< 0.26 dB	< 0.15 dB
	18 to 20 GHz	< 1.3 dB	< 0.6 dB

Effective Source Match

Frequency	772D	773D
0.1 to 2 GHz	1.06	1.05
2 to 12.4 GHz	1.13	1.12
2.4 GHz to 18 GHz	1.18	1.15
18 to 20 GHz	1.32	1.28

Voltage Incident on 772D Test Port and 773D Input

Figure 2 depicts the typical coupling curve of the 772D and 773D.

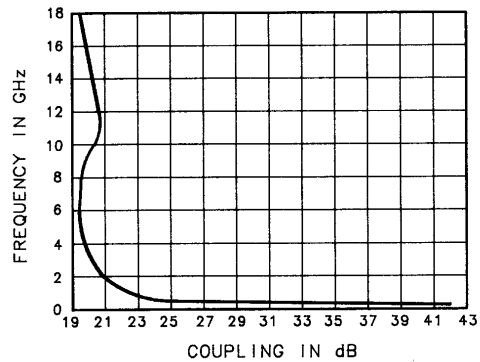


Figure 2 Voltage Incident on 772D Test Port and 773D Input

Directivity

The following graph depicts the 772D/773D typical changes in directivity over the frequency range.

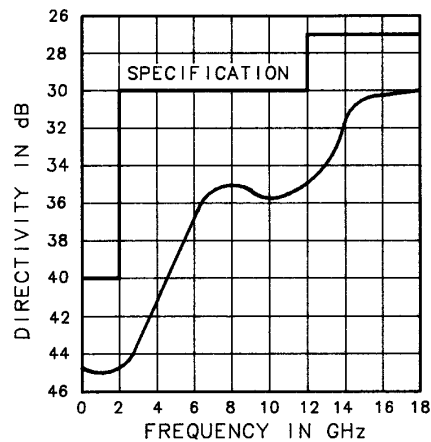


Figure 3 Directivity

Calculating 772D Error

Analysis has shown the typical measurement error of the 772D to be:

$$E_s = A + B\Gamma_x + C\Gamma_x^2$$

where: E_s = error of swept-frequency measurement

A = directivity of 772D

B = effective source match + coupler directivity

C = source match

Γ_x = reflection coefficient of unknown

Specifications

By using various techniques, such as fixed-frequency measurements, calibrating out the source match error by taking an average of the open and short-circuit readings, or by running a calibration grid this error can be reduced to:

$$E_f = A + C\Gamma_x^2$$

These two equations are graphed as follows:

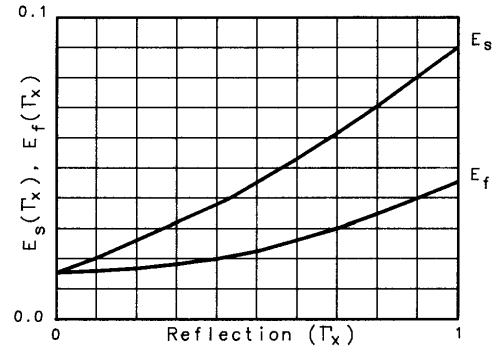


Figure 4 772D Error 0.1 to 2.0 GHz

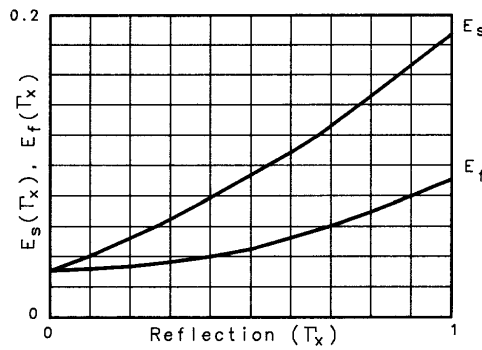


Figure 5 772D Error 2.0 to 12.4 GHz

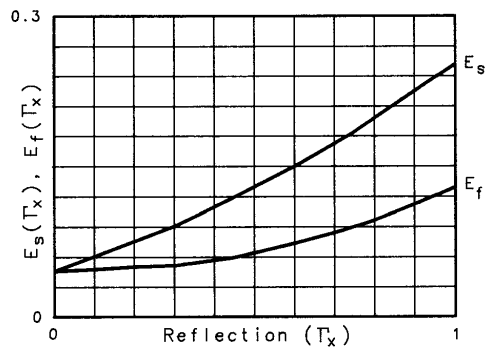


Figure 6 772D Error 12.4 to 18.0 GHz

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 mechanically and electrically. Procedures for checking electrical performance are given under Performance Tests.
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 Agilent Sales and Service office. Refer to the Service and Support information in the front matter of this manual. Agilent 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 for service, repackaging the instrument requires original shipping containers and materials or their equivalents. Agilent can provide packaging materials identical to the original materials. Refer to Service and Support information in the front matter of this manual for the Agilent office nearest 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.

Storage and Shipment

The instrument should be stored in a clean, dry environment. The following environmental limitations apply to both storage and shipment:

- a. Temperature: -5 to +75 °C
- b. Altitude < 7620 meters (25,000 feet)
- c. Humidity < 95% relative

Operating Information

Using the 772D Dual Directional Coupler

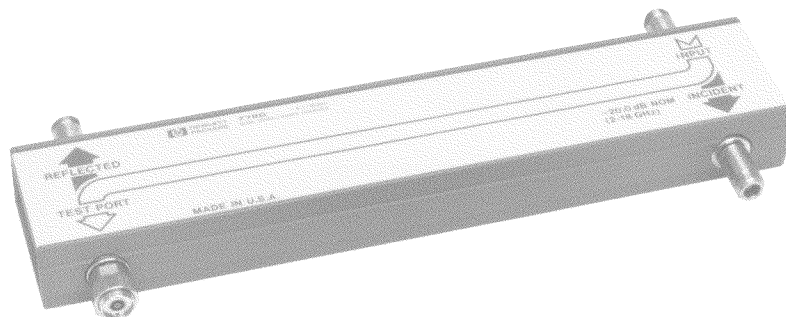


Figure 7 772D Dual Direction Coupler

CAUTION

Maximum power input is 50 W CW or 250 W peak. Greater power may damage the 772D.

1. Connect the signal from the signal source to the INPUT connector.
2. Connect the output signal from the TEST PORT connector to the test setup.
3. Connect the incident power-indicating device to the INCIDENT port. The power from this port is attenuated approximately 20 dB from that flowing on the mainline in a forward direction (from INPUT to TEST PORT).
4. Connect the reflected-power indicating device to the REFLECTED port. Coupler power from this port will be attenuated approximately 20 dB from the power reflected by a device under test connected to the TEST PORT. Mainline power flowing from the INPUT port to the REFLECTED port will be attenuated an additional amount equal to the directivity.

Using the 773D Directional Coupler

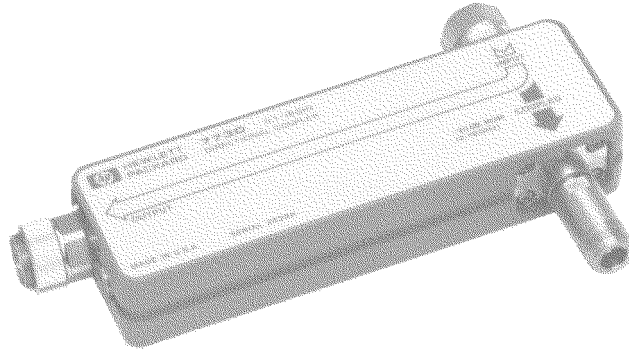


Figure 8 773D Directional Coupler

CAUTION

Maximum power input is 50 W CW or 250 W peak. Greater power may damage the 773D.

1. Connect the signal from the signal source to the INPUT connector.
2. Connect the output signal from OUTPUT to the test setup.
3. Connect the coupled signal from the COUPLED port to the detector. The power from this port is attenuated approximately 20 dB from that flowing on the mainline in a forward direction (from INPUT to OUTPUT ports). Any voltage reflected from equipment connected to the OUTPUT port will be attenuated an additional amount equal to the directivity.

Performance Tests

The following procedures test the 772D and 773D electrical performance specified in Table 1. All tests can be performed without access to the interior of the instrument.

Table 2 *Recommended Test Equipment*

Instrument	Critical Specifications	Suggested Agilent Model	Use ¹
Sweep oscillator	CW and swept frequency signal in 0.01 GHz to 40 GHz range	8350B main frame with 83592B RF plug-in (0.01 to 20 GHz)	P, T
Scalar network analyzer	Swept frequency transmission and reflection measurements from 0.01 to 60 GHz. AC/DC detection capability	8757A	P, T
Detectors (2)	Range: – 60 dBm to + 16 dBm	11664A	P, T
Fixed termination	Range: dc to 6 GHz	909F	P, T
Sliding load	Range: 1.8 to 18 GHz	905A	P, T
Coaxial short	Mates with type N (male)	85054-60026	P, T
	Mates with type N (female)	85054-60025	
	Mates with APC-7	85050-80007	
Coaxial open	Mates with type N (male)	85054-60028	P, T
	Mates with type N (female)	85054-60027	
	Mates with APC-7	85050-80010	

1. P = Performance test, T = Troubleshooting

Set Up and Calibration

To account for frequency response errors and calibrate your test setup, perform the following procedure. Refer to Figure 9 for the test setup used for the performance tests.

1. Connect your 772D or 773D to the test equipment as shown in Figure 9. Set the test equipment controls as follows:

Sweep Oscillator	Network Analyzer	RF Plug-In
Start marker: 2 GHz	Channel 1	ALC mode: internal
Stop marker: 18 GHz	Display: A/R	RF: ON
Modulation: ON	Scale: 1 dB/div	
	Reference level: 0 dBm	

2. Perform short/open calibrations according to the directions for your network analyzer. The calibration should be automatically stored in Channel 1 memory.

3. On the 8757A press M_MEM on Channel 1 display keys. On equivalent network analyzers press the key sequence that will remove calibration and frequency response errors from further measurements according to the equation: $E_s = E_f = A + CT_x^2$. (Refer to “Calculating 772D Error” under “Specifications” in this manual.)

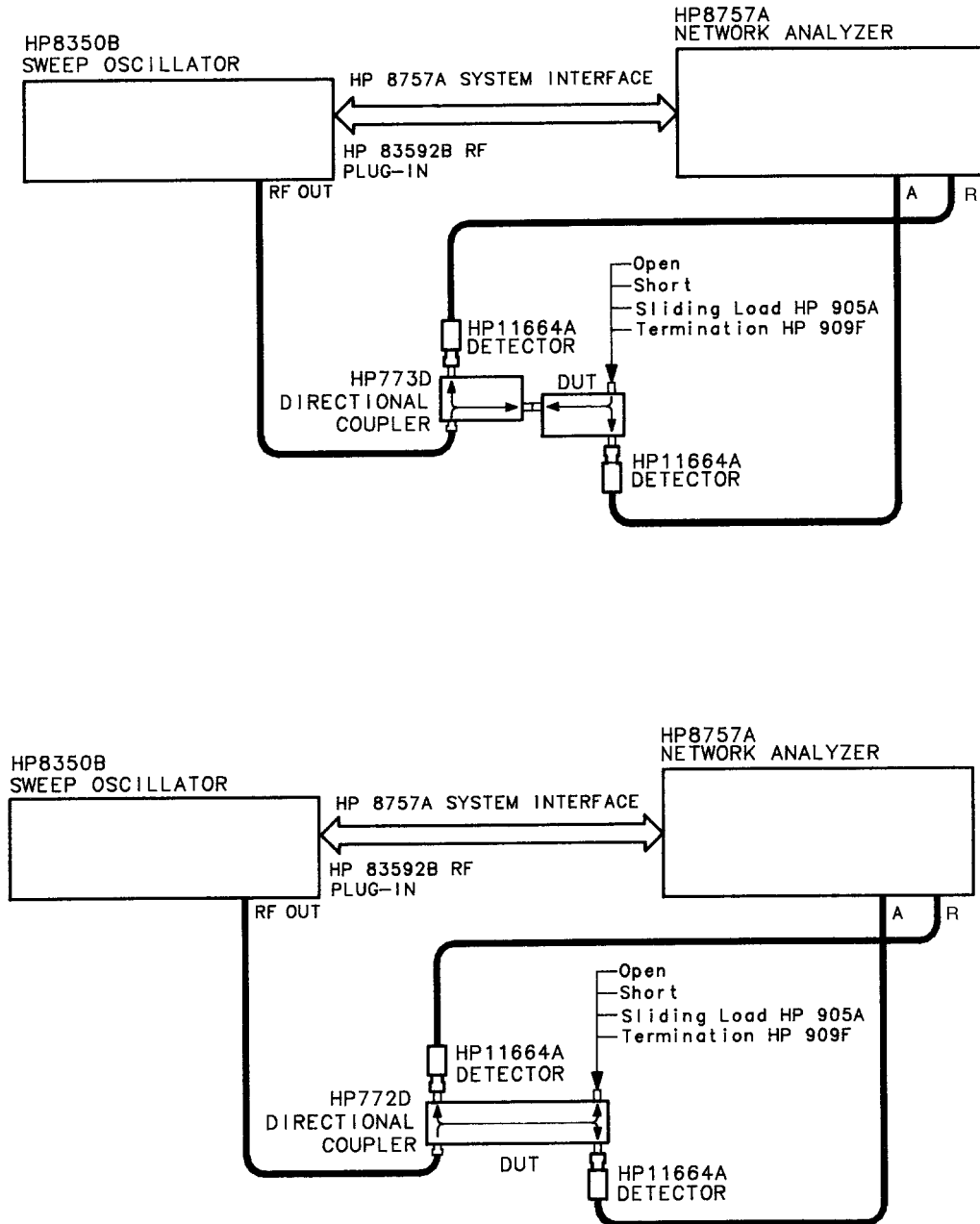


Figure 9 772D/773D Performance Test Setup

Directivity Test

This test assumes that setup and calibration have already been completed. To check that the couplers meet the directivity specification in Table 1, perform the following steps:

NOTE

The accuracy of the test system must be added to the directivity specification in Table 1.

1. Connect the fixed termination as shown in Figure 9.
2. Set the network analyzer Channel 1 reference level to 30 dBm. Verify that directivity is within specification from 2 GHz through 18 GHz.
 - Directivity (2 to 12.4 GHz) ≤ 30 dB
 - Directivity (12.4 to 18 GHz) ≤ 27 dB
3. Connect the sliding load as shown in Figure 9. At frequencies of interest, phase (move) the load element. Read the peaks and troughs and calculate the difference in dB (Δ_{dB}). Find the appropriate correction factor ($D_{c_{dB}}$) from Table 3.

Table 3 *Correction for Element Reflection of the 905A*

ΔD_{dB}	$D_{c_{dB}}$	ΔD_{dB}	$D_{c_{dB}}$	ΔD_{dB}	$D_{c_{dB}}$
1.0	0.40	3.6	1.60	6.0	2.40
1.1	0.50	3.9	1.70	6.5	2.60
1.4	0.60	4.0	1.70	7.0	2.80
1.6	0.70	4.1	1.80	7.5	2.90
1.8	0.80	4.2	1.80	8.0	3.10
2.0	0.90	4.3	1.85	8.5	3.20
2.2	1.00	4.4	1.90	9.0	3.30
2.5	1.10	4.5	1.90	9.5	3.50
2.7	1.20	4.6	2.00	10.0	3.60
3.0	1.30	4.7	2.00	12.0	4.00
3.1	1.40	4.9	2.10	14.0	4.30
3.2	1.40	5.0	2.10	16.0	4.60
3.4	1.50	5.5	2.30		

Service Instructions

Connectors

For instruction on connecting and care of your connectors, we recommend Microwave Connector Care Quick Reference Card (08510-90360).

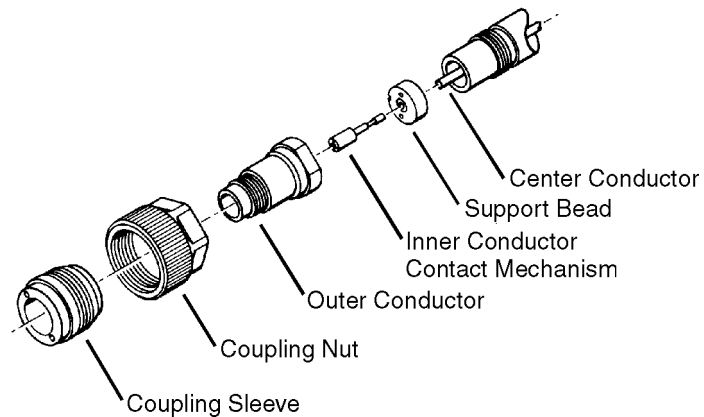
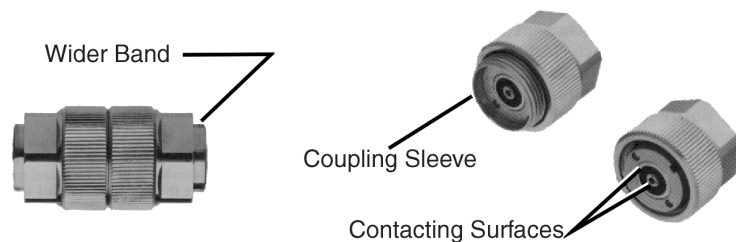


Figure 10 Use and Care of APC-7 Connectors

To Connect

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. **DO NOT** tighten the other coupling nut since this will tend to loosen the electrical connection.



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.

Service Instructions

- Care**
- Do *not* use aromatic hydrocarbons such as acetone, trichlorethylene, carbon tetrachloride or benzene to clean connector surfaces.
 - Do *not* spray any liquid solvent directly onto connector surfaces.
 - Connector wear eventually degrades performance. To prolong the life of your connectors:
 - Inspect and clean all surfaces that come in contact.
 - Do *not* connect to a damaged connector. Replace damaged connectors.
 - Turn only the connector nut (not the device) when making connection.