Agilent Technologies

779D Directional Coupler

Operating and Service Manual

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In This Manual…

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For assistance, call your local Agilent Technologies Sales and Service Office (refer to "Service and Support" on page vi).

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

United States (tel) 1 800 452 4844	**Latin America** (tel) (305) 269 7500 (fax) (305) 269 7599	**Canada** (tel) 1 877 894 4414 (fax) (905) 282-6495	**Europe** (tel) (+31) 20 547 2323 (fax) (+31) 20 547 2390
New Zealand (tel) 0 800 738 378 (fax) (+64) 4 495 8950	**Japan** (tel) (+81) 426 56 7832 (fax) (+81) 426 56 7840	**Australia** (tel) 1 800 629 485 (fax) (+61) 3 9210 5947	

Asia Call Center Numbers

Country	Phone Number	Fax Number
Singapore	1-800-375-8100	(65) 836-0252
Malaysia	1-800-828-848	1-800-801664
Philippines	(632) 8426802 1-800-16510170 (PLDT Subscriber Only)	(632) 8426809 1-800-16510288 (PLDT Subscriber Only)
Thailand	(088) 226-008 (outside Bangkok) (662) 661-3999 (within Bangkok)	(66) 1-661-3714
Hong Kong	800-930-871	(852) 2506 9233
Taiwan	0800-047-866	(886) 2 25456723
People's Republic of China	800-810-0189 (preferred) 10800-650-0021	10800-650-0121
India	1-600-11-2929	000-800-650-1101

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.

Typeface Conventions

Italics

- Used to emphasize important information:
  Use this software *only* with the 8494A/B, 8495A/B, 8496A/B.
- Used for the title of a publication:
  Refer to the *779D Operating And Service Manual*.
- Used to indicate a variable:
  Type `LOAD BIN` *filename*.

`Instrument Display`

- Used to show on-screen prompts and messages that you will see on the display of an instrument:
  The 8494A/B, 8495A/B, 8496A/B will display the message **`CAL1 SAVED`**.

[Keycap]

- Used for labeled keys on the front panel of an instrument or on a computer keyboard:
  Press **[Return]**.

{Softkey}

- Used for simulated keys that appear on an instrument display:
  Press ***{Prior Menu}***.

`User Entry`

- Used to indicate text that you will enter using the computer keyboard; text shown in this typeface must be typed *exactly* as printed:
  Type `LOAD PARMFILE`
- Used for examples of programming code:

```
#endif // ifndef NO_CLASS
```

`Path Name`

- Used for a subdirectory name or file path:
  Edit the file *`usr/local/bin/sample.txt`*

Computer Display

- Used to show messages, prompts, and window labels that appear on a computer monitor:
  The **Edit Parameters** window will appear on the screen.
- Used for menus, lists, dialog boxes, and button boxes on a computer monitor from which you make selections using the mouse or keyboard:
  Double-click **EXIT** to quit the program.

Overview

Description

The 779D directional couplers are three-port passive devices for use in 7-mm, 50-ohm systems. A coupler is essentially a device for sampling power flowing in one direction in a transmission line. Since no coupler is perfect, some power flowing in the opposite direction is also sampled. The rejection of power flowing in the unwanted direction is called directivity and is the most important specification of a directional coupler. This coupler has 26 or 30 dB directivity, depending upon the frequency. Another specification is the forward coupling (usually called just coupling) which is the fractional amount of power transfer in the wanted direction. This coupler has a nominal 20 dB of coupling. These terms are defined in Figure 2, Coupler Terminology. Figure 2 also shows a typical coupling curve. This is a typical curve and not a specification. Table 1 contains the specifications.

The 779D is identified by its serial number found on the back plate (opposite the nameplate). All correspondence with Agilent Technologies Sales/Service offices in regard to this coupler should reference model 779D and this serial number.

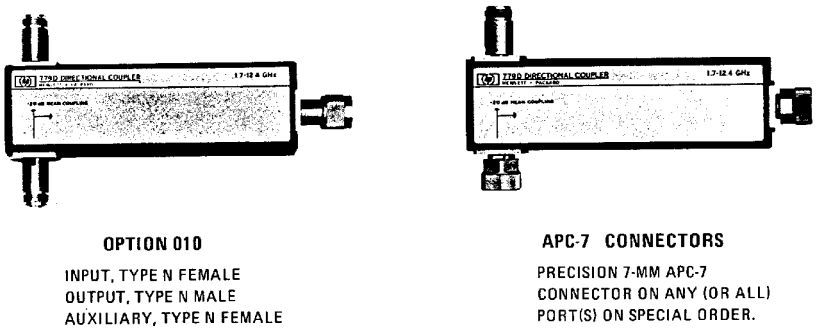


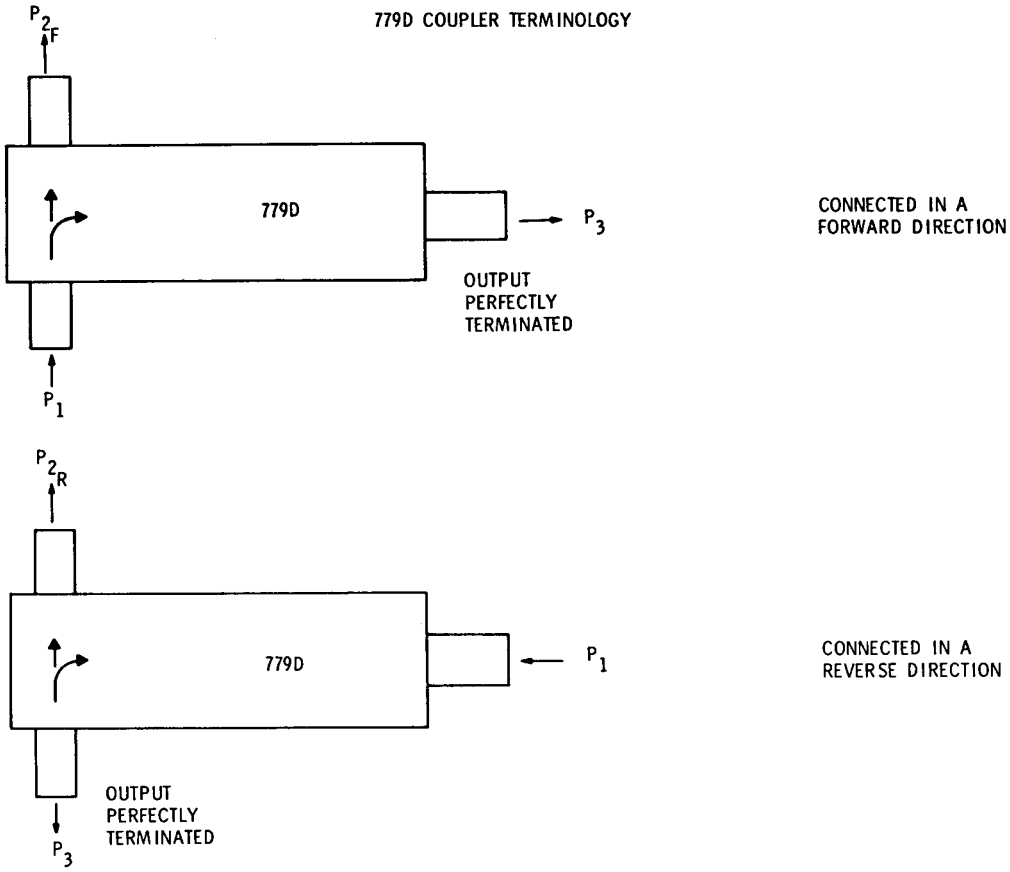
Figure 1 Connector Options

Manual Changes

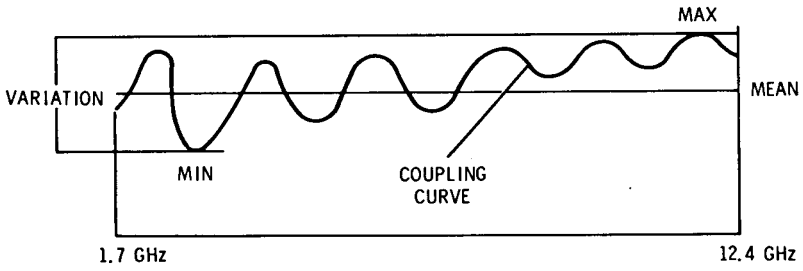
This manual provides complete information for any 779D with the serial prefix 901, 922, 929, or 1144A. If your serial prefix is different, a yellow change sheet should be supplied to adapt this manual to your serial prefix coupler.

Port Terminology

The two directly connected ports are known as the primary-line ports. Note that these couplers are polarized, i.e., the input should be at the indicated port. The third, coupled**,** port is known as the auxiliary port. These couplers may be ordered with any combination of Type N (male or female) connectors or APC-7 connectors on any or all ports.



$$\text{COUPLING} = 10 \log_{10} \frac{P_1}{P_{2_F}} \text{ dB}$$



$$\text{MEAN COUPLING} = \frac{dB_{max} + dB_{min}}{2} \text{ dB}$$

$$\text{COUPLING VARIATION} = \pm (dB_{max} - dB_{min})$$

$$\text{DIRECTIVITY} = 10 \log_{10} \frac{P_{2_F}}{P_{2_R}} \text{ dB}, \quad P_1 \text{ held constant}$$

Figure 2 779D Coupler Terminology

These couplers may be used in the measurement of reflection coefficient or SWR over a very wide frequency range. Because of the wide frequency range these couplers may also be useful as attenuators.

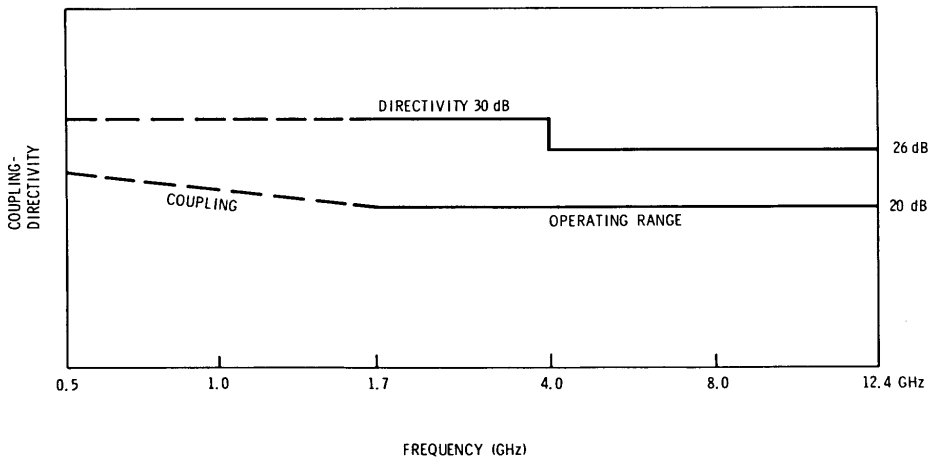


Figure 3 Coupling and Directivity Characteristics of the 779D Directional Coupler

Specifications

Specifications for the 779D are shown in Table 1..

Table 1 Specifications

Characteristic	Value
Frequency range	1.7 to 12.4 GHz
Mean coupling	20 dB ±0.5 dB
Coupling variation	±0.75 dB
Directivity	>30 dB from 1.7 to 4.0 GHz >26 dB from 4.0 to 12.4 GHz
SWR and Reflection Coefficient	
Primary line	<1.2 (0.091)
Auxiliary line	<1.2 (0.091)
Insertion loss	<0.6 dB
Maximum power input	
Primary line	50 W
Auxiliary line	0.5 W
Connectors	
Input	Type N male
Output	Type N female
Auxiliary	Type N female
Precision	7-mm APC-7[1] connector on any or all ports(s) on special order.

1. Registered trademark of Bunker Ramo Corporation

Initial Inspection and Shipping

Initial Inspection

Mechanical Check

If damage to the shipping carton is evident, ask that the carrier's agent be present when the instrument is unpacked. Inspect the parts for mechanical damage, such as scratches or dents. Also check the cushioning material for signs of severe stress (compacting).

Electrical Check

The electrical performance should be verified as soon as possible after receipt. Refer to the "Performance Tests" on page 10 for further instructions.

Claims for Damage

If there is mechanical damage or the coupler fails to meet electrical specifications upon receipt, notify the carrier and your nearest Agilent Technologies office immediately (a list of offices is at the end of this operating note). Retain the shipping carton and the padding material for the carrier's inspection.

Repackaging for Shipment

Using Factory Supplied Packaging

The same type containers and material used in factory packaging can be obtained through the Agilent Technologies offices listed at the end of this operating note.

If the coupler is being returned to Agilent Technologies for servicing, attach a tag indicating the type of service required and the return address. Also mark the container *FRAGILE* to assure careful handling.

Using Other Packaging

The following general instructions should be used for repackaging with commercially available materials.

1. Wrap the coupler in heavy paper or plastic (if shipping to a Agilent Technologies office or service center attach a tag indicating the type of service required, and your return address).
2. Use a strong shipping container. A double-wall carton made of 2.4 MPa (350 PSI) test material is adequate.
3. Use enough shock-absorbing material, 75 to 100 mm (3- to 4-inch layer) around all sides of the coupler to provide firm cushioning and prevent movement inside the container.

4. Seal the shipping container securely.
5. Mark the shipping container *FRAGILE* to assure careful handling.

Operation

Signal Flow

Figure 4 shows the signal-flow path in the 779D when connected in the forward direction (779D shown with label facing reader, as with all diagrams in this operating note).

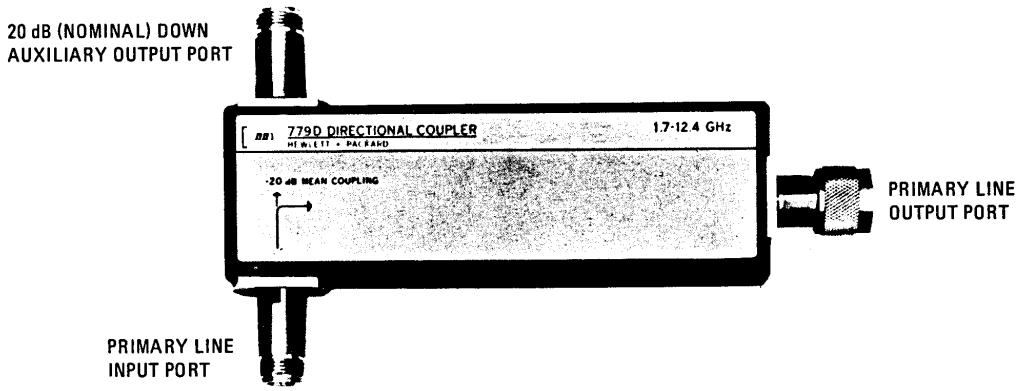


Figure 4 Signal Flow Path for Coupler Connected in the Forward Direction

CAUTION

Do *not* exceed a maximum of 50 W in the primary line. Do *not* exceed 0.5 W in the auxiliary line.

Connectors

Type N Connectors

Type N connectors used on the 779D are stainless steel for long wear and are compatible with connectors whose dimensions conform to MIL-C-39012 or MIL-C-71 (see Figure 5).

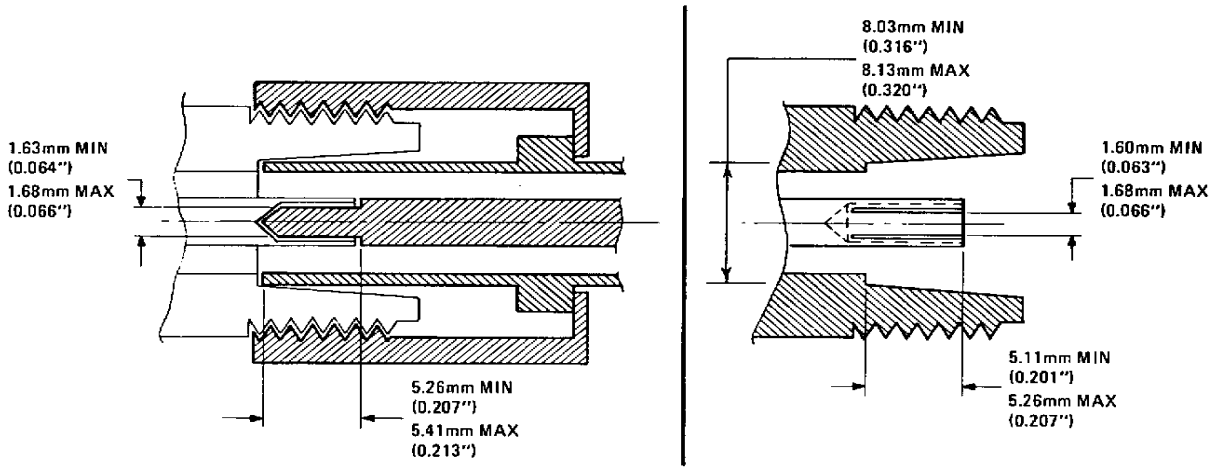


Figure 5 Type N Connector Dimension

CAUTION

Do *not* mate with Type N male connectors with a pin diameter of greater than 0.0655 ", as a discontinuity producing excess SWR will be formed even if the connector is not damaged.

APC-7 Connectors

Protect the face of the connectors from damage. Any scoring or burring of the mating surfaces causes discontinuity; the resulting increase in SWR degrades performance (see Service Note concerning APC-7 connectors obtainable free from any Agilent Technologies sales/ service office). Do not exceed the load limits given in Figure 6 for this type of connector.

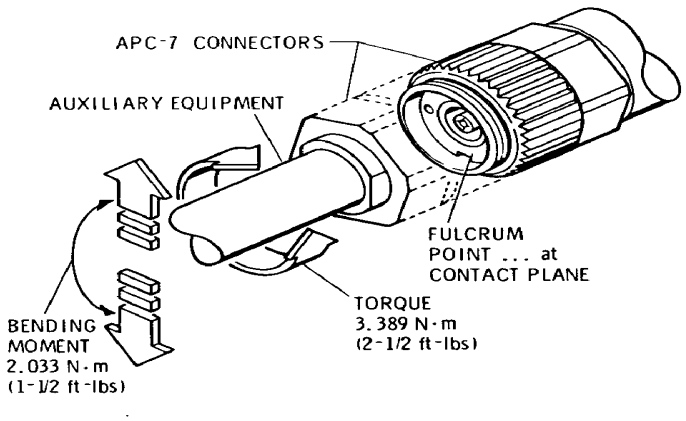


Figure 6 APC-7 Connector Load Limits

CAUTION

Do *not* drop the coupler. While the coupler probably will not break, it can be jarred out of adjustment and the connectors can be damaged.

Reflectometer Measurements

Two 779D directional couplers connected together can be used with a sweep oscillator for making broadband reflectometer measurements. In the reflectometer, one coupler samples power going to the unknown while the other samples power reflected from the unknown. When the couplers are used with two Agilent 423A crystal detectors, swept-frequency measurements of reflection coefficient versus frequency can be made easily. The detected output of the reverse coupler is displayed by an output indicator calibrated in reflection coefficient. For more information on reflectometer techniques, request a copy of application *Note 183, "High Frequency Swept Measurement*", obtainable free from any Agilent Technologies office listed at the end of this operating note.

Power Leveling

With its broad frequency coverage, the 779D can be used in leveling applications formerly requiring three or more couplers. When the 779D is used with sweep oscillators, the power output is sampled at the auxiliary port and detected with a crystal detector. The rectified detector voltage, when applied to the sweep oscillator ALC input, maintains a constant RF power level out of the main line of the directional coupler, within the flatness of the coupling curve of the directional coupler.

Performance Tests

Use the following procedure for initial electrical check, performance testing, or whenever the coupler performance is suspected. Table 2 lists the recommended test equipment. Other equipment may be substituted provided its specifications equal or exceed the critical specifications. Table 3 provides a place to record the results of the test. The coupler should be tested on a swept-frequency basis to assure that there are no out-of-specification narrow-frequency bands. If the results of the swept-frequency testing are doubtful, or if the equipment for swept-frequency testing is not available, the fixed-frequency test may be used. The performance tests should be performed in the order given. Note that in many of these tests a 10-dB attenuator is used in series with the flexible arm. This attenuator reduces mismatch ambiguity by isolation. With the attenuator the mismatch is reduced to approximately the mismatch of the attenuator which is lower than the mismatch of the other components.

Table 2 Recommended Test Equipment

Instrument	Critical Specifications	Agilent Model No.
Sweep oscillator	Frequency: band of interest Power output: >10 mW	8620C mainframe with 886222B or 86290A plug-ins
Directional coupler	Frequency range: 1.7 to 12.4 GHz Directivity: >30 dB 1.7 to 4.0 GHz >26 dB 4.0 to 12.4 GHz	779D
Network analyzer	No other network analyzer will do	8410B/8411A/8413A
Slide load	Slides $\lambda/2$ at test frequency SWR: <1.05	905A (1.8 to 18.0 GHz)
Oscilloscope with swept-frequency indicator	Vertical Sensitivity: 1 dB/cm Provision for storing trace bandwidth: variable to 30 kHz Sweep and Blanking: compatible with sweep oscillator	181A/8755C
Reflection/transmission test unit	No other transmission/reflection test unit will do	8743A
Flexible arm	Frequency range: 1.7 to 12.4 GHz SWR: <1.25	11605A
10 dB attenuator	Frequency range: 1.7 to 12.4 GHz Attenuation: 10 dB (accuracy not important since used for isolation)	8491A/B (Type N connector) Option 010 8492A (APC-7 connector) Option 010
X-Y recorder	Impedance: 200 K ohms/V Sensitivity: 50 mV/in	7035A
Coaxial termination (2)	Impedance: 50 ohms SWR: <1.1	909A Option 012 (Type N male) 909A Option 013 (Type N female) 909A Standard APC-7
Slotted-line sweep adapter**	Frequency: 1.8 to 12.4 GHz	448B*

Table 2 Recommended Test Equipment

Instrument	Critical Specifications	Agilent Model No.
Slotted section **	Frequency: 1.8 to 12.4 GHz Compatible with carriage	816A **
Carriage **	Holds slotted section	809C
BNC tee	BNC: 2 female thru 1 male	1250-0781 (UG-274A/U)
Oscilloscope	Vertical Sensitivity: >5 mV/cm Bandwidth: 5 MHz	180C/1801A/1821A
Short	Connector: coaxial 7-mm	11511A (Type N female) 11512A (Type N male) 11565A (APC-7)
Modulator	On-off Modulator for 8755B	11665B
** Agilent Model 817B Swept Slotted Line system may be used instead of these items		

Table 3 Performance Test Record

Tested by:		
Date:		
Dual-Directional Coupler:		
Instrument Serial Number:		
Directivity:		
	1.7 to 4.0 GHz	**dB** (>30 **dB)**
	4.0 to 12.4 GHz	**(dB** (>26 **dB)**
Coupling		
	Mean Coupling	**dB (20 ± 0.5 dB)**
	Coupling variation	**dB (±0.75 dB)**
Insertion Loss:		**dB (<0.6 dB)**
SWR (Reflection Coefficient)		
	Primary Line	**<1.2 (0.091)]**
	Auxiliary Line	**<1.2 (0.091)]**

Directivity Test

Specification

1.7 to 4 GHz, > 30 dB
4 to 12.4 GHz, > 26 dB

Description

Refer to Figure 7 for Test Setup and Table 4 for Test Equipment.

Directivity of a coupler is the ratio of power at the auxiliary port with coupler in forward direction to power at the auxiliary port with coupler in reverse direction (coupler terminated each time and same power). The 779D should be swept-frequency tested to be sure that there are no narrow-band out-of-specification points that would be missed with fixed-frequency testing. A fixed-frequency test follows the swept-frequency test. The fixed-frequency test should be used at frequencies where ambiguous results are obtained with swept-frequency testing.

Swept-Frequency Test

This test will be performed using a network analyzer and a reflectometer setup. The procedure is similar to using any reflectometer; calibration by returning all of the output signal and then using a sliding load to determine the true directivity (see *Application Note 183*, obtainable free from any Agilent Technologies sales/service office, for further information).

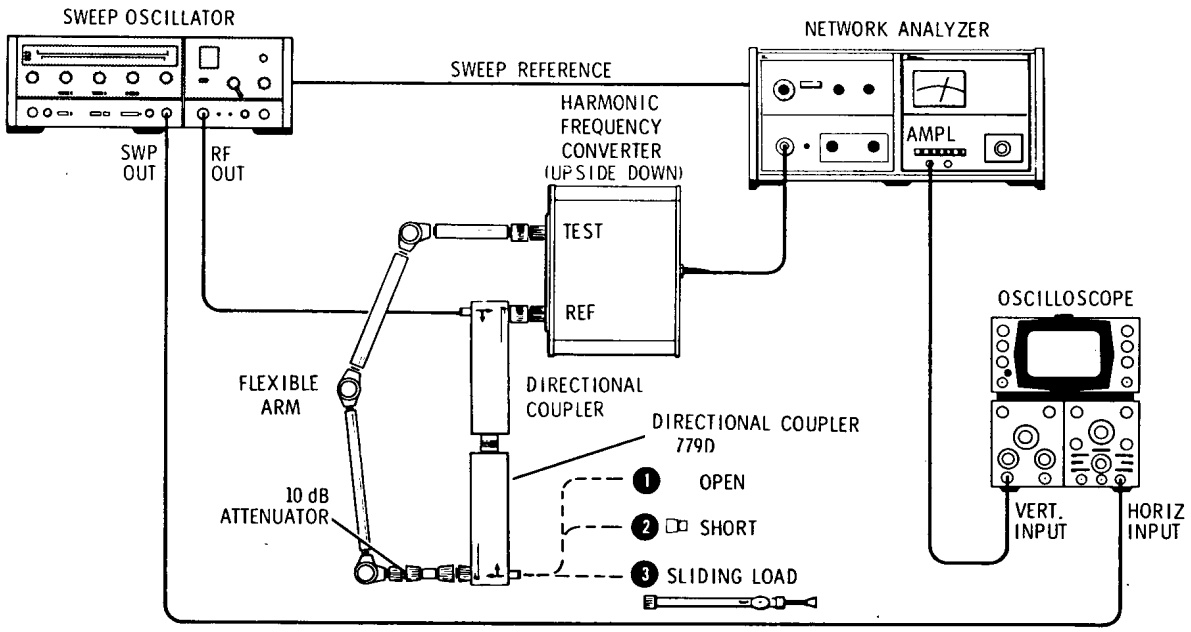


Figure 7 Directivity Test Setup

Table 4 Directivity Test Equipment

Equipment:	Model Number
Sweep oscillator	8620C/86222B/86290A
Directional coupler	779D
Harmonic frequency converter	8411A
Network analyzer	8410B with 8413A plug-in
Oscilloscope	180C/1801A/1821A
Flexible arm	11605A
10 dB attenuator	8492A
Short	11511A (Type N female) 11512A (Type N male) 11565A (Type APC-7)
Sliding load	905A

Procedure

1. Connect the equipment as shown in Figure 7.
2. Set the oscilloscope sensitivity to 50 mV/cm.
3. Adjust the network analyzer to get an amplitude trace on the oscilloscope.
4. Open (1) and short (2) the 779D under test. Take the average of the traces as the calibration trace. Mark the trace on the CRT with a grease pencil. If a short is not available use just the open circuit trace.
5. Connect a sliding load (3) to the 779D under test.
6. Increase the network analyzer test channel gain by 30 dB (1.7 to 4 GHz) or 26 dB (4 to 12.4 GHz).
7. Run a slow trace while rapidly phasing the sliding load over at least $\lambda/2$. The *average* of the traces should be below the grease pencil line at all frequencies. If not, proceed with the following.

Single-Frequency Test

Description The following single-frequency test will enable you to find the true value of directivity. A sliding load is used and both the maximum indication (where the voltage reflected from the load adds to the directivity signal) and the minimum indication (where the voltage reflected from the load subtracts from the directivity signal) are determined. Entering these values in Figure 8, Signal Separation Chart, will enable you to determine the true directivity. With a good load this should be close to the average reading. The corrected directivity reading should be less than the directivity specification at the frequency tested.

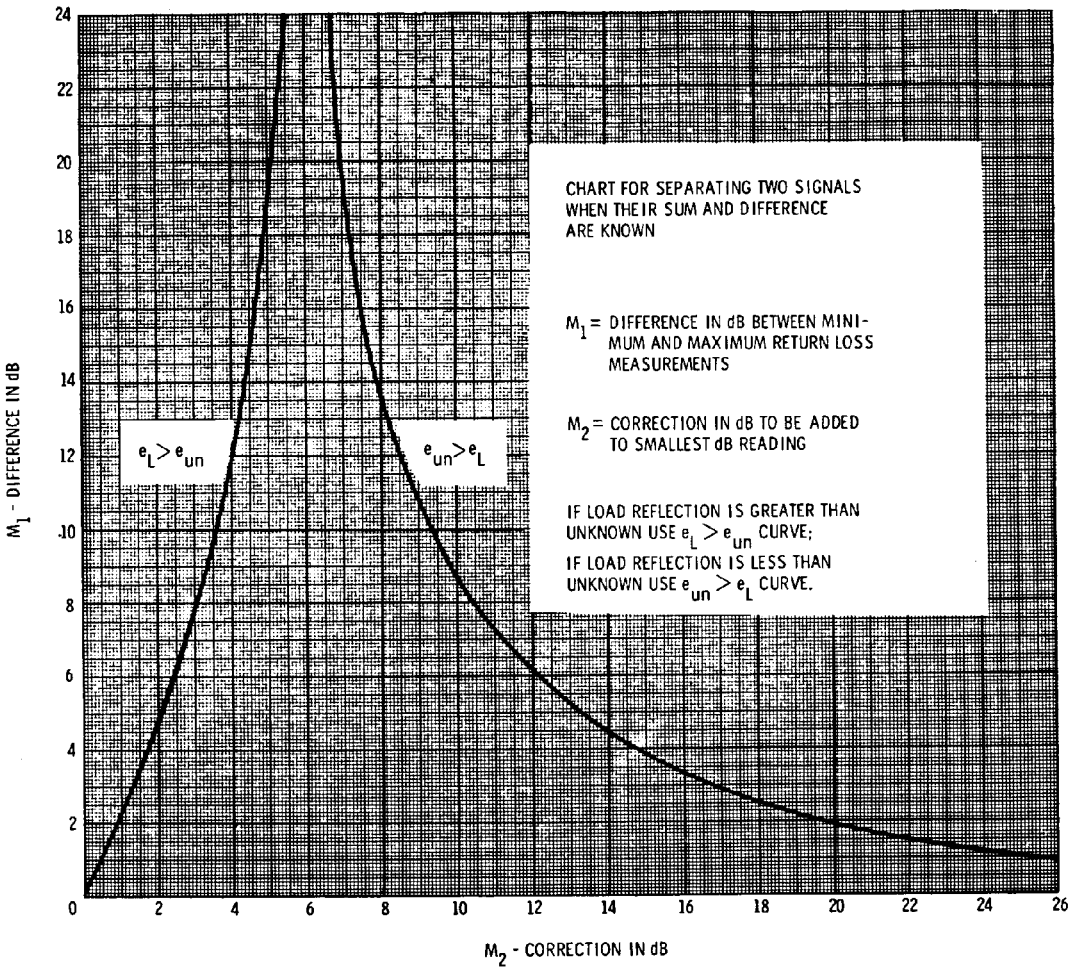


Figure 8 Signal Separation Chart

8. Manually set the sweep oscillator to the frequency of interest.

9. Remove the sliding load and set the open (1) and short (2) readings on the 8413A meter equally spaced around zero using the most sensitive scale.
10. Replace the sliding load and increase the gain as in step f above.
11. Observe amplitude meter readings while phasing sliding load.
12. To find the true value of directivity subtract the two readings (for example, 34 dB - 31 dB = 3 dB). Enter the following signal separation chart on the vertical scale at 3 dB, read over to the curve and drop down to the value of M_2 = 1.25 dB. Add this correction to the *lowest* numerical reading (31 + 1.25 dB = 32.25 dB) as the true reading. This reading should be greater than the directivity specification at that frequency.

NOTE

Only the left-hand curve ($e_{load} > e_{unknown}$) be consulted since, with a good load (SWR < 1.06), the unknown voltage being measured will be greater than the voltage reflected from the load.

13. Repeat the above measurement at all frequencies of interest.

Coupling Test

Specification

Mean coupling, 20 dB ±0.5 dB
Coupling variation, ±0.75 dB.

Description

Refer to Figure 9 for Test Setup and Table 5 for Test Equipment.

Coupling is measured by first calibrating a network analyzer for a transmission measurement without the coupler inserted. The coupler is then inserted and the amount of power coupled out the auxiliary port is measured. This value is the coupling of the directional coupler.

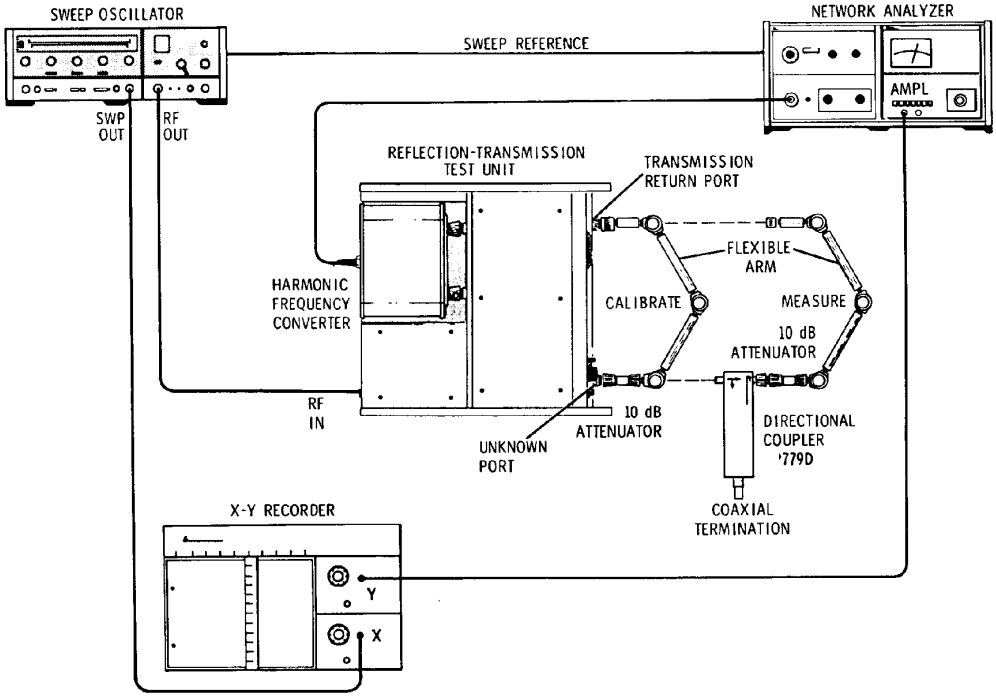


Figure 9Coupling Test Setup

Table 5 Coupling Test Equipment

Equipment	Model Number
Sweep oscillator	8620C/86222B/86290A
Reflection-transmission test unit	8743A
Network analyzer	8410B with 8413A plug-in
X-Y recorder	7035B
Harmonic frequency converter	8411A
Flexible arm	11605A
10 dB attenuator	8492A
Coaxial termination	909A Option 012 (Type N male) 909A Option 013 (Type N female) 090A Standard (APC-7)

Procedure

To calibrate for the coupling test:

1. Connect the equipment as shown inFigure 9, Coupling Test Setup.
2. Connect the two ports of the 8743A together as shown for "CALIBRATE" with a 10-dB attenuator (see “Performance Tests” on page 10 introduction). If any adapters will be necessary later in the test to connect the 779D under test, the adapters should be inserted now so that their insertion loss will be calibrated out.
3. Tune sweep oscillator manually throughout its entire frequency band without recording to be sure the X-Y recorder will remain on-scale throughout the entire frequency range. Do not reduce the sensitivity much below about 100 mV/inch since the output of the 8413A is 50 mV/dB and 0.5 dB must be resolved. The sensitivity may be increased if the trace will still stay on-scale.
4. Record a reference line on the X-Y recorder across each frequency band and mark this trace 20 dB. Record the value of network analyzer test channel gain for future use.
5. Record two traces that represent limits of acceptable coupling variations as follows:
   a. Increase the test channel gain 1 dB and run a line.
   b. Decrease the test channel gain 2 dB (1 dB less than the reference line) and run a line.

To perform a coupling test:

1. Detach the flexible arm at the unknown port of the 8743A and insert the 779D under test, as shown for "MEASURE." Detach at the end of the 10-dB attenuator connected to the unknown port.
2. Increase the test channel gain 20 dB from the setting in step d and record a trace.
3. Sweep each band and record the trace until the entire frequency range from 1.7 to 12.4 GHz has been covered.
4. Measuring from the 20-dB line recorded in step d and using the limit lines as ±1 dB calibrations, find the highest point and lowest point on the measurement traces.
   a. Highest + Lowest / 2 = Mean coupling
   b. Highest – Lowest / 2 = Coupling variation

Insertion Loss Test

Specification <0.6 dB

Description

Refer to Figure 10 for Test Setup and Table 6 for Test Equipment. The insertion loss specification includes the loss in the coaxial line plus the coupling loss. A network analyzer is used to measure transmission loss without and with the coupler inserted. The difference is the insertion loss.

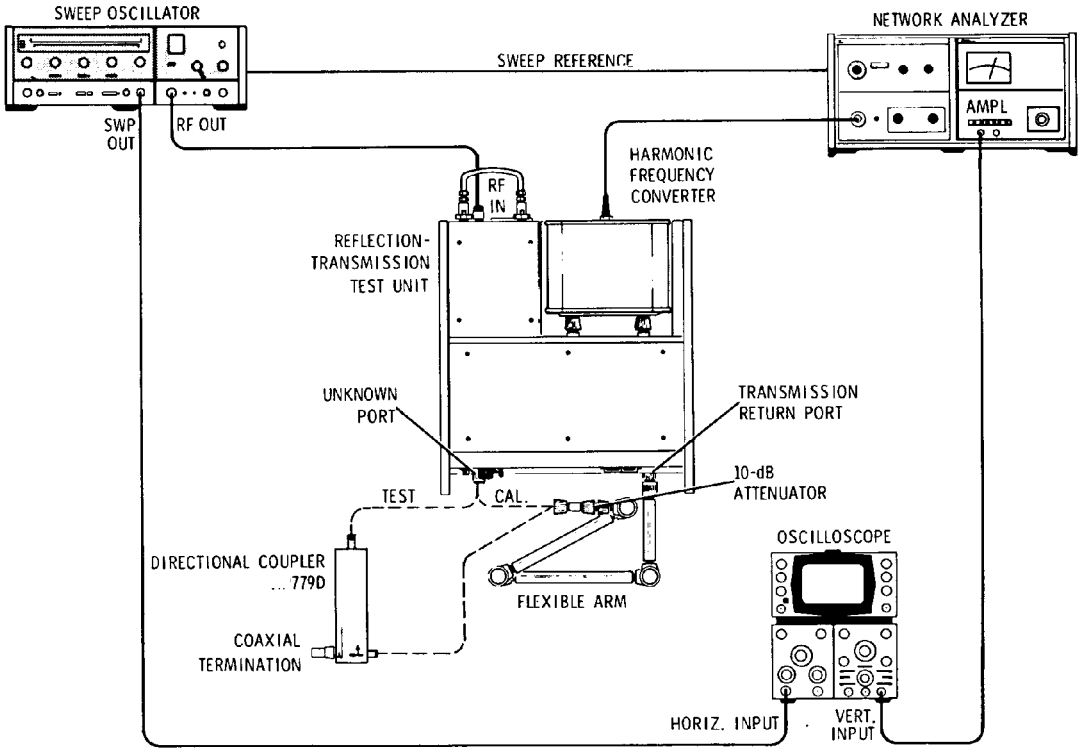


Figure 10 Insertion Loss Test Setup

Table 6 Insertion Loss Test Equipment

Equipment:	Model Number
Sweep oscillator	8620C/86222B/86290A
Reflection-transmission test unit	8743A
Network analyzer	8410B with 8413A plug-in
Harmonic frequency converter	8411A
Flexible arm	11605A
10 dB attenuator	8492A Option 010
Coaxial termination	909A Option 012 (Type N male) 909A Option 013 (Type N female) 090A Standard (APC-7)

Procedure

To calibrate for insertion loss:

1. Connect the equipment as shown in Figure 10.
2. Connect a 10-dB attenuator, such as the Agilent 8492A Option 10, to the 11605A Flexible Arm (see Power Leveling), and connect the attenuator to the 8743A unknown port. Include any adapters necessary to later connect the 779D under test. This will cancel out the loss of the adapters.
3. Set the sweep oscillator to sweep the desired band. Adjust 8410E for a stable display over the entire band being swept.
4. Dc couple and dc-balance the oscilloscope vertical amplifier. Adjust the oscilloscope to display the amplitude output from the 8413A. Set the display for 10 mV/cm sensitivity.
5. Set the trace approximately two centimeters from the top of the screen. Draw the trace on the screen of the oscilloscope with a grease pencil.
6. Decrease the 8410B test channel gain by 1 dB. The trace on the oscilloscope should drop exactly 5 centimeters. This checks the calibration of, the oscilloscope. If the trace does not drop exactly 5 cm with 10 mV/cm sensitivity, set the oscilloscope vertical gain vernier for exactly 5 cm vertical deflection.
7. Go back to the original setting on the 8410B. Drop the trace down 3 cm = 0.6 dB. Do this by noting the value where the trace crosses the center vertical graticule line. Then, with the 8410B amplitude vernier control move the trace down exactly 3 cm. Draw this trace with a grease pencil. Reset the trace to top grease pencil line with the 8410B amplitude vernier control.

To perform an insertion loss:

Since we have two insertion-loss limit lines drawn we can now insert the primary line of the 779D and see if it falls within these limit lines. If it does, the 779D is within insertion-loss specifications. Proceed as follows:

1. Open the flexible arm between the unknown port and the 10-dB attenuator (or between adapters, if used) and insert the primary line of the 779D as shown for "TEST." Be sure to support the weight of the 779D independently.
2. The trace on the oscilloscope should be between the two grease pencil lines on the CRT for the 779D to be within specifications. If not, check the connectors and especially the connector faces.

SWR (Reflection Coefficient) Test

Specification

Primary line < 1.2 (0.091)
Auxiliary line < 1.2 (0.091)

Description

Refer to Figure 11 for Test Setup and Table 7 for Test Equipment.

SWR (reflection coefficient) is measured with a swept slotted-line system. This system enables the SWR to be measured on a swept-frequency basis so that there are no narrow-band out-of-specification frequencies which could be missed with spot single-frequency testing. SWR is measured using a storage oscilloscope and while moving the probe in the slotted-line section. This procedure moves the indication through all possible phases so that the maximum SWR may be measured.

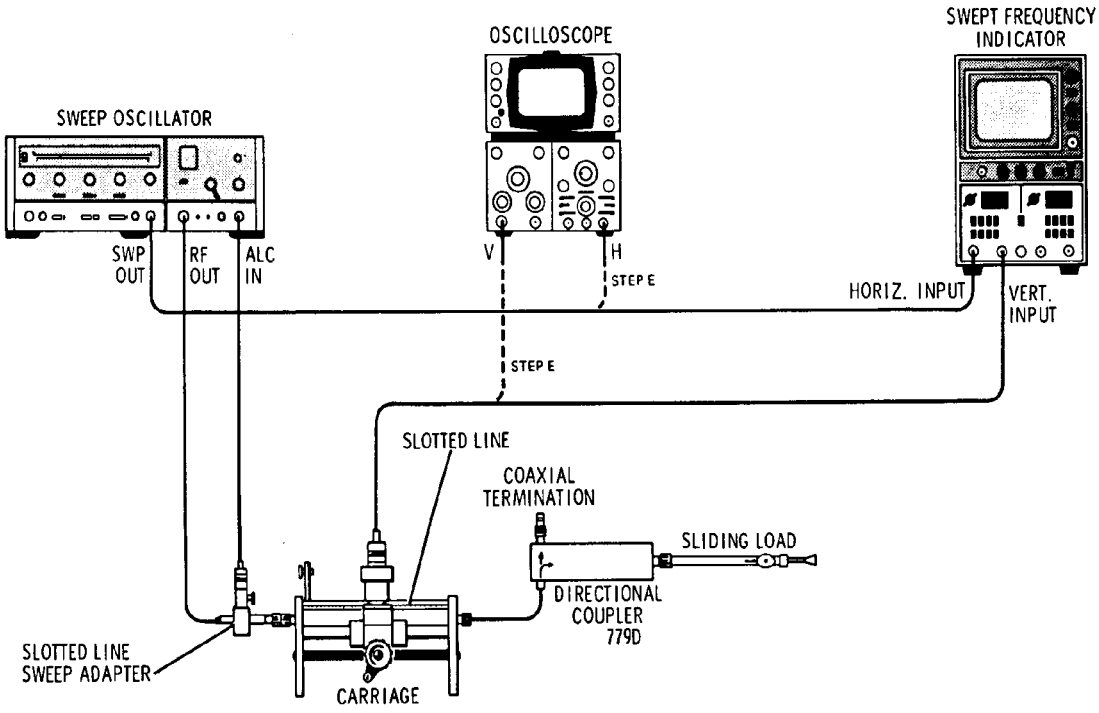


Figure 11 SWR Test Setup

Table 7 SWR Test Equipment

Equipment	Model Number
Sweep oscillator	8620C/86222B/86290A
Slotted-line sweep adapter*	448B
Carriage*	809C
BNC tee	1250-0781 (UG-274A/U)
Oscilloscope	180C/1801A/1821A
Sliding load	905A
Swept frequency indicator	182T/8755C
Slotted line *	816B
Coaxial termination	909A Option 012 (Type N male) 909A Option 013 (Type N female) 090A Standard (APC-7)
Modulator	11665B

*These items are be obtained as the Agilent 817B Swept Slotted Line System.

Procedure

To perform a Power Leveling:

1. Connect the equipment as shown in Figure 11.
2. Set sweep oscillator to sweep desired band.
3. Level the output of the sweep oscillator as instructed in the operating instructions for the swept slotted-line system. Note that, due to the extremely wide frequency range of the swept-slotted line system, the RF output may vary widely even though the input is leveled. This occurs because the efficiency of both probes drops off at the lower frequencies. Since leveling is controlled by the do voltage developed by’ the leveling probe, this voltage will depend upon the efficiency of the probe pickup. However, by matching the characteristics of both probes and using them as a matched pair the output variation can be held to approximately 3 dB.

To perform a Measurement:

1. Set sweep oscillator for single-frequency (CW) operation at the center of the band under test.
2. Locate a maximum in the standing-wave pattern. A maximum is the widest portion of the display (see Figure 12 for a typical display).

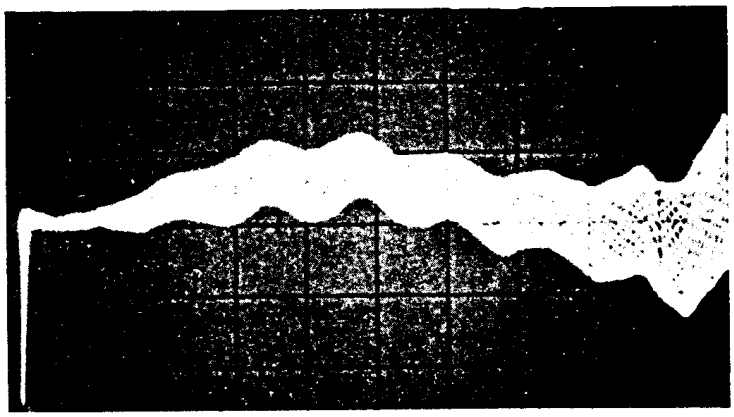


Figure 12 Typical Oscilloscope Display

3. If the slotted-line probe penetration has not been set, loosen the carriage probe by turning the knurled lock in the carriage and move the probe until the output is 5 mV.
4. Set the sweep oscillator to sweep the band of interest.
5. Temporarily connect oscilloscope to probe on slotted line. To make sure that the maximum picked in step b is the maximum in the display, observe the oscilloscope on the 5 mV/cm range, adjusting probe for 1-cm high display. Tighten the knurled lock. The position of the carriage probe is now correct for square-law operation.
6. Set swept-frequency indicator to logarithmic mode and move the carriage over at least one-half wavelength while viewing on a storage oscilloscope (if storage oscilloscope is not available take a time exposure of the trace). Read maximum width of trace in dB.
7. Compute the voltage ratio using the formula:

   a. SWR = $\log^{-1}$ (dB/20) or 1.2 SWR = 1.58 dB.

8. If the sweep rate is too high, some of the fine structure of the SWR pattern may be lost.
9. If the results do not meet specification, the width of the trace may be at fault. To compensate for the width of the trace, proceed as follows.

10. Observe the trace with the carriage stationary. Read the trace-width. Subtract this reading from the reading obtained in step 6.
11. If the results are still not within specifications, the reflection vector from the termination may be adding in-phase to the reflection vector being measured. These two signals can be resolved by using a sliding load as the termination as follows.
    a. With the above setup, set the sweep oscillator to CW on a single frequency under question.
    b. Adjust the slotted-line carriage position and the sliding load for maximum vertical deflection on the oscilloscope. Adjust the oscilloscope vertical position control to position the spot for a convenient reference.
    c. Position the slotted-line carriage for a minimum voltage and then adjust the sliding load for maximum voltage. The difference between the position of the dot now and the reference set in step b is the SWR in dB of the 779D. Compute the SWR in the same manner as given in step 7.
    d. Measure the SWR in the same manner as with the swept-frequency test.
12. Repeat the measurement on the other ports. Be sure to keep all ports not under test properly terminated.

For a discussion of swept-slotted line systems and other information concerning this method see Stephen F. Adam, "Swept-Frequency SWR Measurements in Coaxial Systems," *Hewlett-Packard Journal, Vol. 18 No.* 4, obtainable from your nearest Agilent Technologies office.

Connector Maintenance

APC-7 Connectors

Directional couplers with APC-7 connectors should be handled with particular care for two reasons:

1. Continuity through APC-7 connectors is obtained by end-to-end contact of the inner and outer conductors. Consequently, the electrical performance of the connector is largely dependent upon the condition of these exposed surfaces.
2. The inner conductor of the APC-7 connector is connected directly to the inner coaxial conductor of the directional coupler.

CAUTION

Any twisting force on this inner conductor may throw the directional coupler out of specifications.

The part of an APC-7 connector that is most likely to be damaged is the inner conductor contact. Since it protrudes slightly beyond the plane of electrical contact, any wiping action of one conductor across the other can damage the contact enough to cause a discontinuity. If damage is suspected, examine the contact with a magnifying glass and push lightly with the eraser on the end of a pencil. As the pressure is released the contact's spring action should cause it to move outward. If not, the contact is defective. Replace as follows:

Contact Replacement

Replacement inner conductor contacts are available from Agilent (part number 1250-0907, Check Digit 8), and from Amphenol RIF Division, Danbury, Connecticut (part number 131-129). When ordering from Agilent Technologies also request the Service Note concerning 7-mm connectors for further information.

The important precautions that apply to the replacement of inner conductor contacts are these:

1. Do *not* disassemble the connector.
2. Do *not* apply more than slight inward pressure to the inner conductor.
3. Do *not* apply *any* twisting force to the inner conductor.
4. Do *not* attempt to repair contacts.
5. Do *not* reuse contact.

CAUTION

Inward pressure or twisting force applied to the inner conductor of the APC-7 connector can throw the 779D out-of-specifications.

Because of the above considerations, contact removal should not be attempted with ordinary hand tools. Only the Agilent self-positioning, hypodermic-action contact extractor tool (part number 5060-0236, Check Digit 7) part of ACP-7 Connector Tool Kit 11591A, should be used. This tool exerts no appreciable inward pressure and no twisting force on the inner conductor. Instructions for removing contacts are supplied with the tool.

No tool is required for installing a replacement contact. Insert the contact gently by hand, applying only enough inward pressure to snap it in place. Then check for proper installation by inspecting the contact with a magnifying glass for even spacing of its four segments. Also, test for normal spring-action by applying light inward pressure against the end of the contact with an eraser at the end of a pencil. As the pressure is released the contact's spring-action should cause it to move outward. If not, the contact is defective. Replace with another contact.

Type N Connectors

Replacement of Type N connectors is not recommended, since just loosening the outer shell mounting screws may throw the coupler out of specifications. Return the coupler to Agilent Technologies office if a Type N connector needs repair.