



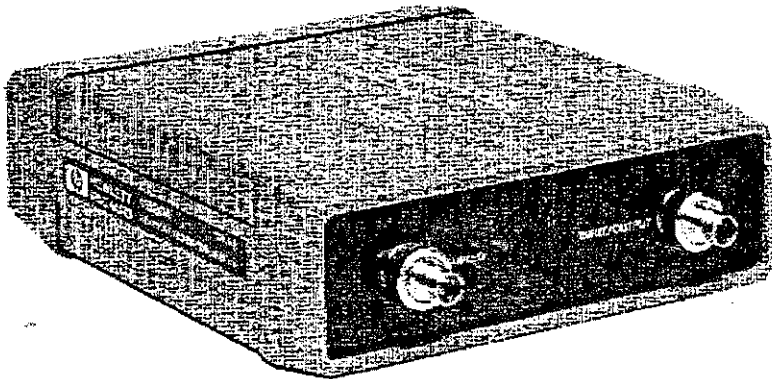
HEWLETT
PACKARD

Operating
and
Service
Manual

HP 11890A and 11891A
Lightwave Couplers

OPERATING AND SERVICE MANUAL

HP 11890A and 11891A LIGHTWAVE COUPLERS



HP Part Number 11890-90001
Printed July 1988



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HP 11890A and 11891A Lightwave Couplers

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GENERAL INFORMATION

The HP 11890A and 11891A Lightwave Couplers provide 3 dB coupling or separation of forward and reverse traveling waves. These couplers are designed to be used primarily with an HP Lightwave Component Analyzer, although they can be used with other appropriate equipment. In addition, they are ruggedly packaged to provide maximum protection.

This document applies to two different couplers. The only difference between them is that one is single-mode fiber and the other is a multimode fiber. The optical connector interfaces, ordered as options, are the same on both couplers. Below is a description of each coupler:

- HP 11890A Single-Mode Fiber, 9 μm (core)/125 μm (cladding)
- HP 11891A Multimode Fiber, 50 μm (core)/125 μm (cladding)

Connector Adapter Options

These couplers must be ordered with one or more of the following connector adapter types:

- Option 011 (HP 81000AI): HMS-10/HP
- Option 012 (HP 81000FI): FC/PC
- Option 013 (HP 81000SI): DIN 47256
- Option 014 (HP 81000VI): ST

These options are connector adapters used at the optical input or output ports. One end of the connector adapter is HMS-10/HP and it is connected to one of the three coupler ports: each port is designed to receive this type of connector. The other end of the connector adapter is the specific connector type (option). It attaches to your cable or device. In addition, many other connector types can be used with the appropriate adapters and patch cords (cables).

APPLICATION

For reflection measurements, these optical couplers are typically used to separate a transmitted signal from a reflected signal. For transmission measurements, they can be used as signal splitters. The ports are designed and labeled as follows:

- 1) INPUT/OUTPUT
- 2) OUTPUT/INPUT
- 3) COUPLED

Reflection Measurements

For reflection measurements, the coupler is used as a signal separation device. An incident signal is injected into port 1 (INPUT/OUTPUT) and one half or 50% (3dB) of it passes through the coupler, exiting at port 2 (OUTPUT/INPUT); the other half is absorbed by the internal termination. This signal that passes through is then routed to a device under test (DUT) where reflected waves may go back into the coupler port 2 (OUTPUT/INPUT). One half or 50% (3dB) of the reflected signal is coupled to port 3 (COUPLED) and the other half is output at port 1 (INPUT/OUTPUT).

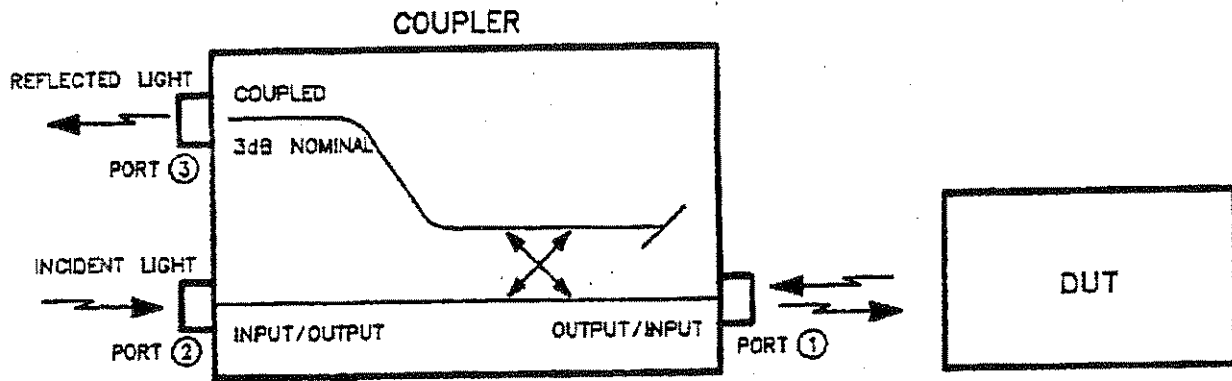


Figure 1. Coupler Used to Separate Signals

Transmission Measurements

For transmission measurements, the coupler is used as a splitter when an incident signal is injected into port 2 (OUTPUT/INPUT) and is split (-3 dB) into two separate paths. One half the signal is then output at port 1 (INPUT/OUTPUT) and the other half is output at port 3 (COUPLED).

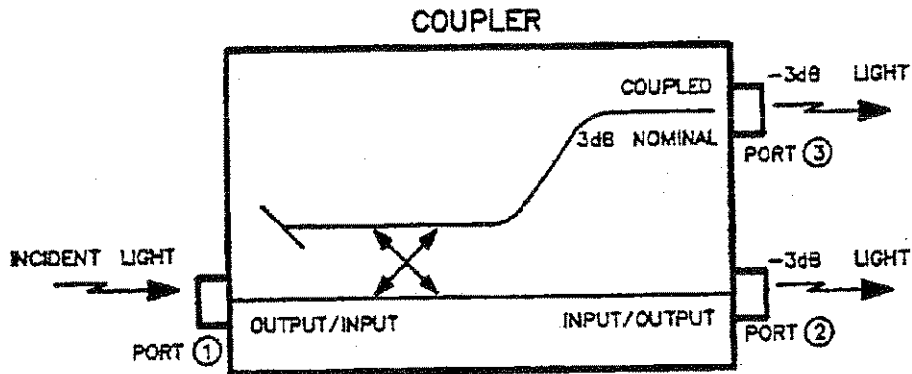


Figure 2. Coupler Used as a Splitter

Typical Application of the Coupler

Figure 3 below shows how these couplers are used in a typical Lightwave Component Analyzer system.

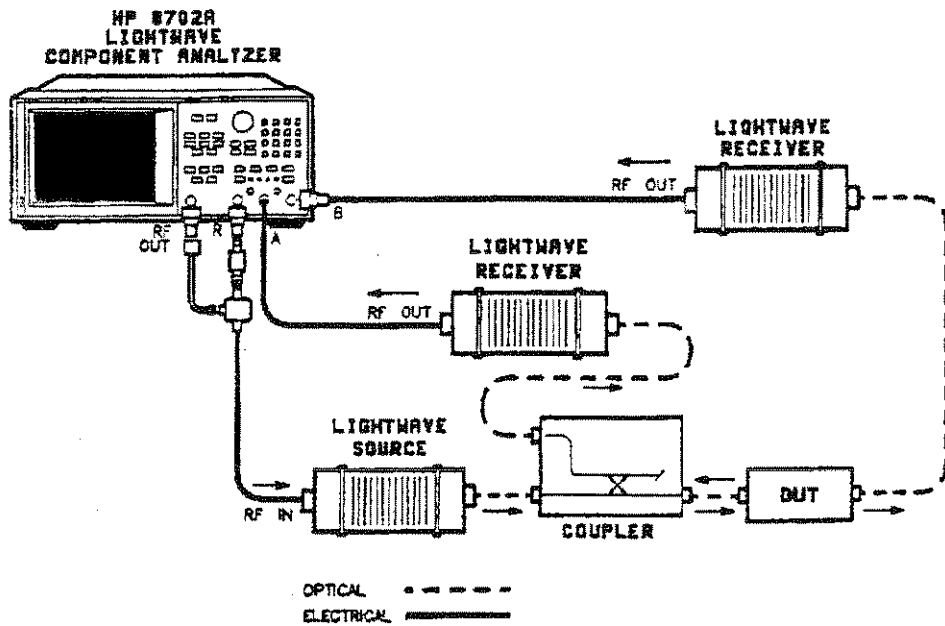


Figure 3. Typical Lightwave Coupler Test Setup

NOTE: The HP 8702A User's Guide (HP Part No. 08702-90008) has examples of reflection measurements using these couplers.

Connectors

Always make connections in a consistent and repeatable manner, and keep the connectors clean and free from contamination.

The HMS-10/HP (Option 011) connector adapters provide the optimum performance for making reflection measurements.

Cleaning Connectors

The coupler connector ports consist of both a metal connector adapter that separates from the coupler and a fiber end-face portion (fiber, ferrule, and threaded fitting) that is stationary. The connector adapter is used to mate two connectors. The fiber end-face consists of a metal portion that receives the connector adapter and a portion that holds the fiber in place. The connector adapters should be cleaned separately from the fiber end-faces. The figure below shows the stationary portion of a coupler port.

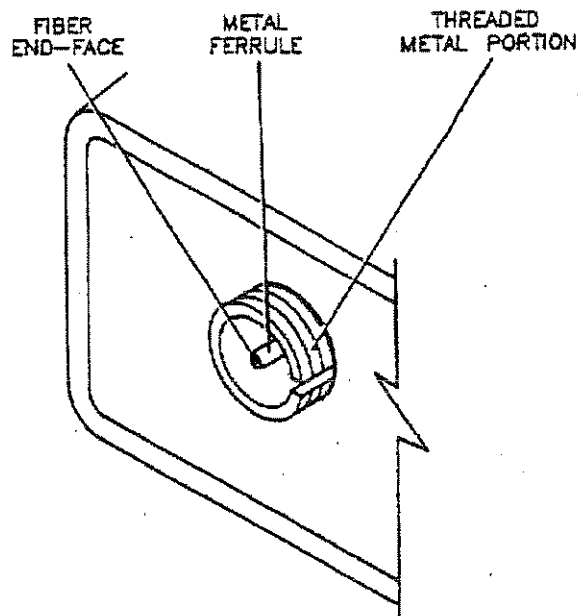


Figure 4. Coupler Port Connector Without Connector Adapter

Connector adapters can be cleaned with non-corrosive alcohol or a liquid freon product. Use a lint-free swab or lint-free cloth to clean the connector, and blow dry it with clean compressed air to remove any loose particles afterwards. Any debris left inside the adapter barrel can cause inaccurate measurements and possibly damage the fiber end. Keep the protective cover on the connector when not in use.

The threaded metal portion that holds the fiber end-face should be carefully cleaned in the same manner as the connector adapter.

For fibers, HP recommends a fiber optic cleaning kit (HP Model Number 15475A) that uses an adhesive tape to remove loose particles after cleaning the fiber ends. This kit comes with cleaning instructions. Fiber ends are sometimes cleaned using a non-corrosive or non-abrasive cleaner. If alcohol or liquid freon is used to clean fiber ends, a clean non-abrasive swab or cloth should be used. Afterward, clean compressed air should be used to blow dry the end.

NOTE: If an index matching compound (gel, oil, etc.) is used with non-contacting connector adapters, consult the manufacturer for information about cleaning agents.

TYPICAL SPECIFICATIONS

There are four typical specifications for these couplers: **Coupling Ratio, Excess Loss, Isolation, Optical Port Match.**

Typical Specifications describe the typical level of performance that can be expected from a product. These values are derived from testing various units at the factory and determining typical values. The operational tests, described after this section, can be used to check the typical values.

Test Conditions Using an HP 8702 System

Modulation frequency on the lightwave carrier, temperature is 25 (+/-5) degrees C, only HMS-10/HP optical connectors on all ports, reflection measurement referenced to a Fresnel reflection (3.5% reflected optical power at connector end-face), and the carrier wavelength is 1308 or 1550 (+/-20) nano-meters.

Typical Specification Values

1. COUPLING RATIO

HP 11890A: 50% typical (+/-10%)

HP 11891A: 50% typical (+/-20%)

Coupling ratio is a percentage measurement. It describes the percentage of signal power which passes through the coupler and appears at the *coupled* port when the coupler is used as a power splitter. For example, a 50% coupling ratio means that the signal power at the COUPLED port is 50% or one-half of the total output power, assuming the signal is injected in the OUTPUT/INPUT port.

As an equation, coupling ratio CR is defined as the signal power appearing at the respective ports:

$$CR = \frac{\text{Port 3}}{\text{Port 3} + \text{Port 2}}$$

or, using the coupler labels,

$$CR = \frac{\text{COUPLED}}{\text{COUPLED} + \text{INPUT/OUTPUT}}$$

2. EXCESS LOSS

HP 11890A: 0.5 dB typical

HP 11891A: 0.5 dB typical

Excess loss describes how much power is lost when a signal passes through or is separated by the coupler. Ideally, no power should be lost and all power should appear at one port or another. However, some small amount of power will be lost in the coupler as light leaving the fiber core and entering the cladding. For example, 0.5 dB excess loss means that 0.5 dB of an incident signal will not appear at any port; therefore, if an incident signal of 10 dBm were input, and the coupler were used as a splitter, only 9.5 dBm total output power could be measured at the outputs.

As an equation, excess loss EL is defined as the signal power appearing at the respective ports:

$$EL = \frac{\text{Port 3} + \text{Port 2}}{\text{Port 1}}$$

or, using the coupler labels,

$$EL = \frac{\text{COUPLED} + \text{INPUT/OUTPUT}}{\text{OUTPUT/INPUT}}$$

3. ISOLATION

HP 11890A: 45 dB typical
HP 11891A: 40 dB typical

Isolation is a relative measure of the directional properties of the coupler. This relative value (dB) describes how much of the incident or transmitted signal leaks over to the reflected signal path (COUPLED). For example, 50 dB of isolation means that the measured coupled signal value includes -50 dB of the transmitted signal.

NOTE: Isolation is sometimes called *Crosstalk* although there are some subtle differences in the definitions. In addition, the term *Directivity* is sometimes used to describe how well an optical coupler directs the signal, although this term does not include the loss through the coupler.

4. OPTICAL PORT MATCH

HP 11890A: 34 dB typical
HP 11891A: 34 dB typical

Optical port match is a relative measure of the amount of signal that is reflected from the optical input port of the coupler. For example, a 36 dB match means that the coupler will reflect < -36 dB of the value of the corresponding input signal.

OPERATIONAL TESTS

These operational tests can be used to determine if the coupler (single-mode or multimode) is operating at its specified typical values. Perform these tests at regular intervals (as desired or one year) and keep a copy of the results for future reference in case service is required.

Recommended Equipment

- HP Lightwave Component Analyzer (HP 8702A)
- HP Lightwave Source (HP 83400A or HP 83401A)
- HP Lightwave Receiver (HP 83410A)
- Cables: (2) HP 11886A or 11887A Interconnect Cable Kits
- HP Optical Coupler (for Optical Port Match only)
- HP 81000A Diamond Connector Adapter for all ports (option 011)
- HP 11889A RF Interface Kit (2)
- HMS-10/HP (Diamond) barrel or adapter for THRU connections
- Optical termination or absorber (index matching compound)

NOTE: Any type of light absorbing device with >37 dB of return loss can be used as an optical termination instead of index matching compounds.

1. COUPLING RATIO TEST

In this test, the coupler is used as a splitter where each signal should measure about -3 dB from the calibrated reference of 0 dB. Coupling ratio is calculated using the measured power (converted to linear) at each port:

$$\frac{\text{Port 3}}{\text{Port 3} + \text{Port 2}}$$

Perform the steps below to obtain the measured signal values at each port.

- a. Connect the system as shown below, using only HMS-10/HP connectors. The optical cables are connected using a barrel or adapter for performing a THRU response calibration.

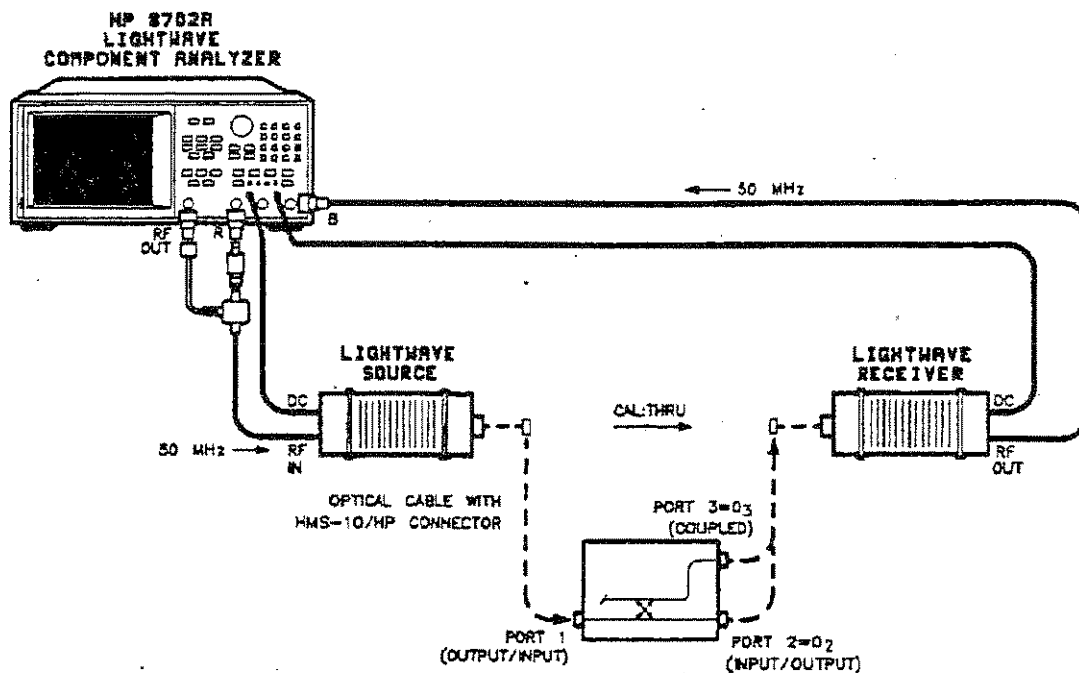


Figure 5. Coupling Ratio and Excess Loss Test Setup

- b. Begin with the HP 8702A in its PRESET condition. Then set the HP 8702A RF output power to 5 dBm at 50 MHz CW.

Press the following keys on the HP 8702A to select the parameters and perform a THRU response calibration.

[PRESET] [GUIDED SETUP]
 [CONTINUE] [CONTINUE] [CONTINUE]
 [START] [50] [M/u]
 [STOP] [50] [M/u] [CONTINUE]
 [SOURCE POWER] [5] [x1] [CONTINUE]
 CAL TYPE: [RESPONSE] [CONTINUE]
 [THRU] and, after the beep, [DONE: RESPONSE]

Here, the result of a successful calibration should be a flat line across the CRT at 0 dB.

- c. Insert the coupler between the two optical cables such that port 1 (OUTPUT/INPUT) receives the source optical input signal and port 2 (INPUT/OUTPUT) transmits the signal to the receiver.
- d. With the coupler inserted as the DUT, the trace value on the CRT is the measured value. Press [MKR] to read the value. This is a transmission measurement of the power out of the port 2 (INPUT/OUTPUT), labeled O_2 in the figure. Record the HP 8702A trace value in dB and label it as O_2 for use in the calculation in step f.

NOTE: Record and keep these values because they will be used to determine Excess Loss in the next test.

- e. Reconnect the coupler to make a transmission measurement of the power out of port 3 (COUPLED), labeled (O_3) in the figure. Read the measured trace value in dB and label it O_3 .
- f. Calculate the coupling ratio. First, convert the dB values into linear values for O_2 (INPUT/OUTPUT) and O_3 (COUPLED) as follows:

$$10^{\frac{\text{dB (measured)}}{10}}$$

Then use the following equation to calculate the coupling ratio, using linear values, as a percentage value:

$$\% \text{ Coupling Ratio} = \frac{O_2}{(O_2 + O_3)} \times 100$$

Compare the percentage value to the specification. They should be approximately the same.

TYPICAL EXAMPLE

Assume the following measured values for ports 2 and 3:

$$O_2 = -2.96 \text{ (dB)} = 0.5058 \text{ (linear)}$$

$$O_3 = -3.25 \text{ (dB)} = 0.4732 \text{ (linear)}$$

$$CR = \frac{0.5058}{0.5058 + 0.4732} = 0.5168 \text{ or } \underline{51.6\%}$$

2. EXCESS LOSS TEST

Excess loss is determined by injecting an input signal into the coupler port 1 and comparing the measured power out of ports 2 and 3:

$$\frac{\text{Port 3} + \text{Port 2}}{\text{Port 1}}$$

NOTE: Refer to and use the same test parameters and test setup of figure 5 above (Coupling Ratio test).

- a. Use the same values for Ports 2 and 3 (O_2 and O_3) obtained by performing the Coupling Ratio test above.
- b. Using the linear values, add the values measured at port 2 (INPUT/OUTPUT) and port 3 (COUPLED).

The value for Port 1 does not have to be measured because it is normalized out by performing the response THRU measurement calibration. Therefore, its linear value is equal to 1. Thus, the Excess Loss equation becomes:

$$EL \text{ (linear)} = \frac{O_2 \text{ (linear)} + O_3 \text{ (linear)}}{1}$$

- c. Convert the linear Excess Loss value into dB and compare the results to the typical specification.

$$\text{Excess Loss (dB)} = 10 \log (\text{linear Excess Loss})$$

TYPICAL EXAMPLE

Assuming the example values from the previous test:

$$O_2 = -2.96 \text{ (dB)} = 0.5058 \text{ (linear)}$$

$$O_3 = -3.25 \text{ (dB)} = 0.4732 \text{ (linear)}$$

$$\text{EL (linear)} = 0.5058 + 0.4732 = 0.9790$$

$$\text{EL (dB)} = 10 \text{ LOG } 0.9790 = \underline{-0.0922\text{dB}}$$

3. ISOLATION TEST

Isolation is determined using the coupler as a signal separation device. An incident signal (50 MHz modulated light) is injected into the INPUT/OUTPUT port and the power coming out of the COUPLED signal port is measured and compared to the incident signal.

- a. Connect the system as shown in the figure below, using only HMS-10/HP connectors. The optical cables are connected using a barrel or adapter for performing a THRU response calibration.

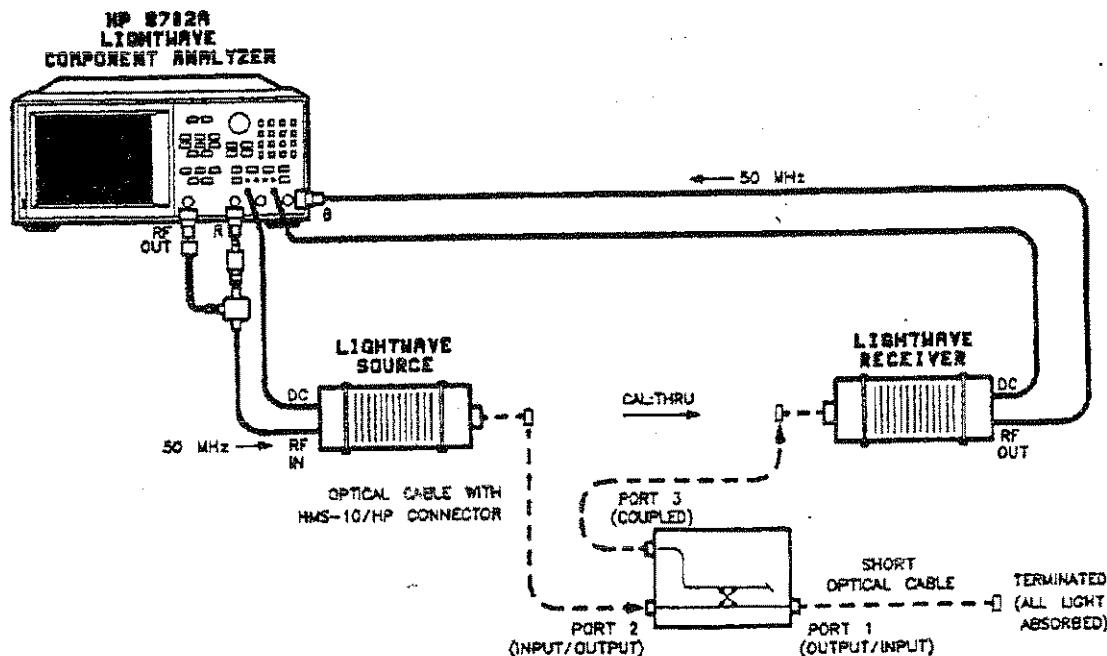


Figure 6. Isolation Test Setup

- b. Begin with the HP 8702A in its PRESET condition. Then set the HP 8702A RF output power to 20 dBm at 50 MHz. Also, set the number of points to 3 points and set the IF Bandwidth to 10 Hz. Press the following keys on the HP 8702A to select the parameters and perform the calibration:

[PRESET] [GUIDED SETUP]
[CONTINUE] [CONTINUE] [CONTINUE]
[START] [50] [M/u]
[STOP] [50] [M/u] [CONTINUE]
[SOURCE POWER] [20] [x1] [CONTINUE]
STIMULUS [MENU] [NUMBER OF POINTS] [3] [x1]
RESPONSE [AVG] [IF BW] [10] [x1]
[CAL] [CALIBRATE MENU] [RESPONSE]
and with a THRU connection, press:
[THRU] and, after the beep, [DONE: RESPONSE]

Here, the result of a successful calibration should be a flat line across the CRT at 0 dB.

- c. Connect a short cable (HP 11886A or 11887A Interconnect Cable HMS-10/HP connectors) about one to three meters long to port 1 (OUTPUT/INPUT) of the coupler. Terminate the cable end so that all light will be absorbed at that port. You can use the proper index matching compound or device.

NOTE: The terminating cable must have a known good connector surface at the coupler end. A defective connector or termination will degrade the measurement.

- d. Measure the power out of port 3 (COUPLED). Read the trace value on the HP 8702A by pressing [MKR]. Compare the results to the specification. It should be approximately equal to the typical specification value.

4. OPTICAL PORT MATCH

Optical port match is determined by measuring the power reflected from a coupler optical port. When making this measurement, the other two ports must be properly terminated with an index matching compound or device. The test is made over the entire modulation frequency span of the HP 8702A (300 kHz to 3 GHz or 3 MHz to 6 GHz for option 006).

- a. Connect the system as shown in the figure below, using only HMS-10/HP connectors. The test equipment coupler, like all of the connecting cables, should have known good connector interfaces. Do not connect the DUT coupler yet.

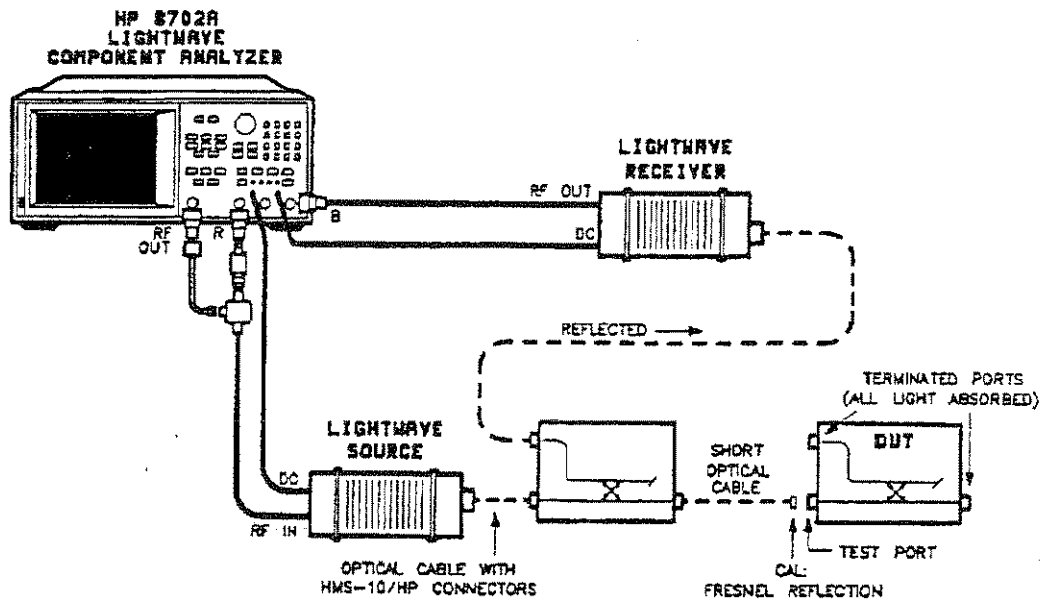


Figure 7. Optical Port Match Test Setup

- b. Begin with the HP 8702A in the PRESET condition. Set the HP 8702A to 20 dBm, 101 points, and 300 Hz IF Bandwidth). Press the following keys on the HP 8702A to select the parameters prior to performing the FRESNEL calibration:

[PRESET] [GUIDED SETUP] [REFLECTION]
 [CONTINUE] [CONTINUE] [CONTINUE] [CONTINUE]
 [SOURCE POWER] [20] [x1]
 [AVG] [IF BW] [300] [x1]
 STIMULUS [MENU] [NUMBER OF POINTS] [101] [x1]

- c. Perform a FRESNEL response calibration. The test equipment coupler should have a short cable attached to port 1, the OUTPUT/INPUT port. The other end of the cable should be a clean Fresnel reflection (3.5% reflected power) used as the calibration device. Press the following keys to perform the calibration so that a measurement reference plane will be established:

[CAL] [CALIBRATE MENU] [RESPONSE] [FRESNEL] and, after the beep, [DONE: RESPONSE]

The result of the FRESNEL response calibration should be a flat line at about 14.6 dB across the band.

- d. Measure the optical port match. Connect the cable end (the measurement reference plane of about 14.6 dB) to any one of the coupler ports. Terminate the ports NOT being measured so that no light will be reflected from them. Use the appropriate index matching compound or device.

Use the marker to read the trace value at any desired modulation frequency. The signal reflected from the test port should be approximately equal to the typical specification value.

To test the other two ports, be sure to thoroughly and carefully remove the index matching compound from the port to be tested.

NOTE: If the measured optical match is greatly above the typical specification value, check the optical termination and/or the connecting cable for end-face damage. If large interference patterns (ripple) appear on the trace, check the optical termination and/or all other optical connections in the test system.

SERVICE

Repair

These couplers cannot be repaired in the field. They must be returned to Hewlett-Packard for any type of repair. In addition, their specifications and the warranty become invalid if they are opened or if any repair is attempted by unauthorized personnel. For any repair, contact your nearest HP Sales and Support office.

Maintenance

The only maintenance recommended for the couplers is as follows:

- Inspect and clean the connector adapters
- Inspect and clean the fiber ends
- Keep the end cap covers on the coupler when not in use
- Keep the coupler protected from any extreme changes in environmental conditions, including shock and vibration

Replaceable Parts

Only the connector adapters (ordered by model number) can be replaced.

HMS-10/HP: HP Model Number 81000AI
FC/PC: HP Model Number 81000FI
DIN 47256: HP Model Number 81000SI
ST: HP Model Number 81000VI

NOTE: If the measured optical match is greatly above the typical specification value, check the optical termination and/or the connecting cable for end-face damage. If large interference patterns (ripple) appear on the trace, check the optical termination and/or all other optical connections in the test system.

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FC/PC: HP Model Number 81000FI

DIN 47256: HP Model Number 81000SI

ST: HP Model Number 81000VI

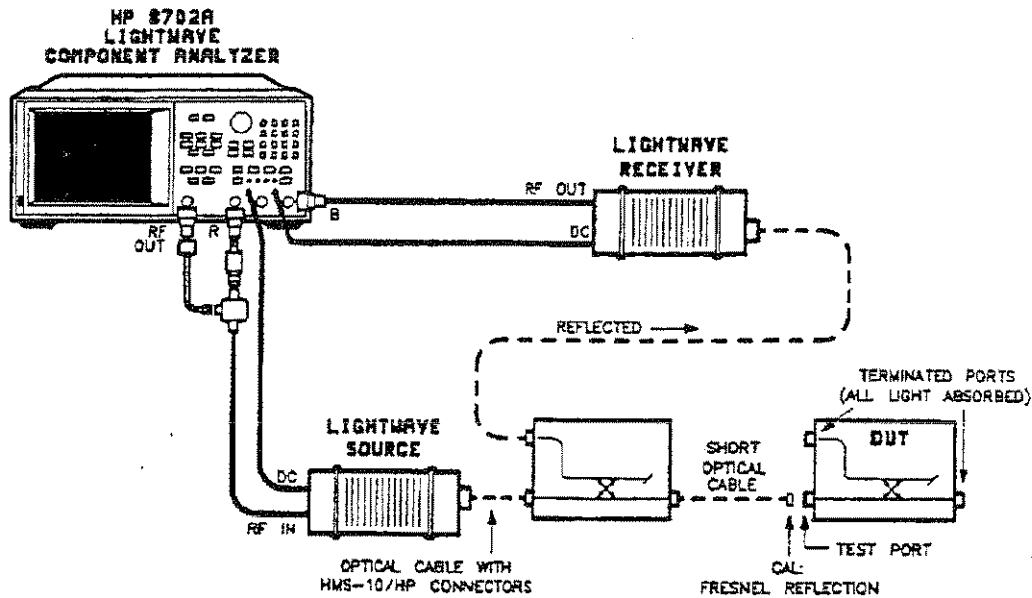


Figure 7. Optical Port Match Test Setup

- b. Begin with the HP 8702A in the PRESET condition. Set the HP 8702A to 20 dBm, 101 points, and 300 Hz IF Bandwidth). Press the following keys on the HP 8702A to select the parameters prior to performing the FRESNEL calibration:

[PRESET] [GUIDED SETUP] [REFLECTION]
 [CONTINUE] [CONTINUE] [CONTINUE] [CONTINUE]
 [SOURCE POWER] [20] [x1]
 [AVG] [IF BW] [300] [x1]
 STIMULUS [MENU] [NUMBER OF POINTS] [101] [x1]

- c. Perform a FRESNEL response calibration. The test equipment coupler should have a short cable attached to port 1, the OUTPUT/INPUT port. The other end of the cable should be a clean Fresnel reflection (3.5% reflected power) used as the calibration device. Press the following keys to perform the calibration so that a measurement reference plane will be established:

[CAL] [CALIBRATE MENU] [RESPONSE] [FRESNEL] and, after the beep, [DONE: RESPONSE]

The result of the FRESNEL response calibration should be a flat line at about 14.6 dB across the band.

- d. Measure the optical port match. Connect the cable end (the measurement reference plane of about 14.6 dB) to any one of the coupler ports. Terminate the ports NOT being measured so that no light will be reflected from them. Use the appropriate index matching compound or device.

Use the marker to read the trace value at any desired modulation frequency. The signal reflected from the test port should be approximately equal to the typical specification value.

To test the other two ports, be sure to thoroughly and carefully remove the index matching compound from the port to be tested.

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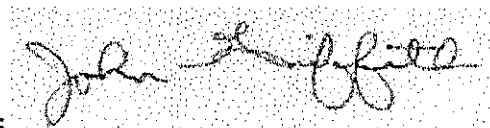
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Test Equipment List MHZ Electronics Not Sold Items Only

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Mnf	Part	Serial	WH Loc	Item Loc	Partner	Description	Specification
HDY	1-EC101-R485	23748	KHG	WASH		PHOTO-RESIST SPINNER CONTROLLER	
HDY	1-EC101-R485	23421	KHG	WASH		PHOTO-RESIST SPINNER CONTROLLER	
HDY	1-EC101-R485	23119	KHG	WASH		PHOTO-RESIST SPINNER NO CONTROLLER	
HDY	1-EC101-R485	23330	KHG	WASH		<u>PHOTO-RESIST SPINNER AND CONTROLLER</u>	Analog
HDY	1-EC101D-R485	36110	KHG	WASH		<u>PHOTO-RESIST SPINNER AND CONTROLLER</u>	Digital
HDY	1-EC101D-R790	60461	KHG	WASH		PHOTO-RESIST SPINNER CONTROLLER	
HDY	1-PM101D-R790	70580	KHG	WASH		PHOTO-RESIST SPINNER CONTROLLER	

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2.0	10	EA	JK561-15K:C5/8	2.5M	EA	66.80	
3.0	100	EA	JK400153	2.5M	EA	62.00	
4.0	100	EA	JK561-18K:C3/4	2.5M	EA	62.00	
5.0	100	EA	GU261223A	.62	EA	62.00	
6.0	1	EA	STEEL STRAP:1/2"X.023 RD	.62	EA	62.00	
7.0	1	EA	GU273423A	.62	EA	62.00	
8.0	1	EA	STEEL STRAP:3/4"X.023 RD	.62	EA	62.00	
9.0	1	EA	GU265823A	.62	EA	62.00	
10.0	1	EA	STEEL STRAP:5/8"X.023 RD	63.00	EA	63.00	
11.0	1	EA	NS02	76.05	EA	76	
12.0	1	EA	S02:1/2 OPEN SEAL	5M	EA	84.00	
13.0	1	EA	NS05	84.00	EA	84.00	
14.0	1	EA	S05:5/8"OPEN SEAL	5M	EA	24.00	
15.0	1	EA	NS071	24.00	EA	24.00	
16.0	1	EA	S071:3/4"OPEN SEAL	5M	EA	31.50	
17.0	1	EA	GU94411959	31.50	EA	31.50	
18.0	36	EA	STRETCH FILM:12"X 1500' REG	.98	EA	35.28	
19.0	1	EA	NA171500	4.45	EA	4.45	
20.0	1	EA	STRETCH FILM:17"X1500'16MICRON	61.50	EA	61.50	
21.0	1	EA	SH00099	1.99	EA	23.88	
22.0	1	EA	BOX SEALING TAPE:HP100 2"				
23.0	1	EA	GU9540005				
24.0	1	EA	TAPE REINFORCED GUM 70MMX450				
25.0	1	EA	GU007512				
26.0	12	EA	PACKING LIST:T-3 5-1/2"X 7"				
27.0	12	EA	CA02020				
28.0	12	EA	20/20 GLASS CLEANER				
29.0	15.0		ATTN:RICHARD CARTON CLOSING STAPLES ARE 10 TO A CASE				
30.0	16.0		40 CASES TO A PALLET I AM WORKING ON PALLET PRICE FOR YOU				
31.0	17.0		OR A FREE TOOL WITH A PURCHASE OF PALLET QUANTITIES				

SUB-TOTAL 716.86

SALES TAX 58.07
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100039697	65159	INSTAPAK@ A 15SLB CUBE	1	EA	1	12/24/2003	USD 434.00000	USD 434.00
Pricing Details								
100039700	66971	INSTAPAK@ B 40WB 130LB CUBE	1	EA	1	12/24/2003	USD 364.00000	USD 364.00
1095AE-02	SOLVEN001	INSTAPAK SOLVENT (1 GAL)	1	EA	1	12/24/2003	USD 18.00000	USD 18.00
							Total Value	USD 816.00
							TOTAL	USD 816.00

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