

HP 83400A and HP 83401A LIGHTWAVE SOURCES

SERIAL NUMBERS

This manual applies directly to instruments having serial numbers as follows:

HP 83400A SMF:	2860A00119 and above
HP 83401A MMF:	2860A00104 and above

If applicable, a Manual Changes Supplement will be supplied or made available through the nearest HP office to document any changes to this manual or any instruments not covered by this manual.

©Copyright HEWLETT-PACKARD COMPANY 1988
1400 FOUNTAINGROVE PARKWAY, SANTA ROSA, CA 95403 U.S.A.

MANUAL PART NO. 83400-90001

Printed: SEPTEMBER 1991



CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory.

WARRANTY

This Hewlett-Packard instrument product is warranted against defects in material and workmanship for a period of one year from date of delivery. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HP SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

TABLE OF CONTENTS

HP 83400A and HP 83401A Lightwave Sources

GENERAL INFORMATION

Introduction	1
Receiving and Inspection	2
General Safety and Service Considerations	2
Laser Safety, Classifications and Labels	3

INSTALLATION AND CONNECTION

Installation	5
Connection	5
List of Connections and Switches	6
Front Panel Connectors	6
Back Panel Connectors	6
Accessories	7
Typical Test Setup	7

OPERATION

Theory of Operation	9
---------------------------	---

CALIBRATION DATA

Disc (3.5 in) Calibration Data	15
Typical Procedure	15
How to Interpret Filenames	16
Labeled Cal Data (Coefficients)	16
Typical Procedure	17
Recharacterizing Your Source	17

SPECIFICATIONS

Absolute Maximum Ratings	19
Assumptions or Conditions	19
Other Typical Specifications	21

PERFORMANCE TESTS

Required Equipment	23
Center Wavelength and Spectral Width	24
Automated Test Program	26
Average Output Power	28
Electrical Input Port Match	29

SERVICE AND REPLACEABLE PARTS 31



General Information

The HP 83400 and HP 83401 Lightwave Sources are laser diode sources designed for use with the HP 8702A Lightwave Component Analyzer. Specifically, they are lightwave carriers intended to be amplitude modulated for making frequency domain measurements of the modulation characteristics of lightwave components (fiber optic systems). However, they can be used with other compatible equipment if they are properly DC powered.

Read this manual to familiarize yourself with the Lightwave Source before using it. If you are using an HP 8702A Lightwave Component Analyzer, you can consider this source manual supplemental after reading it. Therefore, you can keep this manual in the HP 8702A Accessories binder and refer to it only when needed. You should not need this manual for normal operation and daily use.

These sources can be modulated with up to 3 GHz (sinewave) as long as their absolute maximum ratings are not exceeded (see SPECIFICATIONS). In addition, each source has accompanying data that describes its modulation response characteristics. The purpose of this data is to allow you to measure your own E/O device. By entering this characterization data into the HP 8702A, its firmware can mathematically remove the modulation characteristics of the HP source. Then you can insert your E/O device knowing that a measurement reference plane has been established. In this manner, you can make accuracy enhanced (calibrated) measurements of the modulation characteristics of your DUT (device under test), described in the HP 8702A User's Guide.

Although the HP 83400A and HP 83401A can be used as lightwave sources with other equipment, this manual concentrates on their use with the HP 8702A Lightwave Component Analyzer. For other applications information, contact a Hewlett Packard Systems Engineer and request assistance.

This manual contains information covering the following instruments:

- HP 83400A 1300 nm, Single Mode Fiber, 3 GHz, 9 μ m (core)/125 μ m (cladding)
- HP 83401A 1300 nm, Multimode Fiber, 3 GHz, 50 μ m (core)/125 μ m (cladding)

These sources 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 output. The source has an HMS-10/HP flange mount that receives the connector adapter. One end of the connector adapter is HMS-10/HP and it is attached to the source's optical output. The other end is the specific connector type that attaches to your cable or device. In addition, many other connectors can be used with the appropriate patch cords (cables). Note that the HMS-10/HP connector (Option 011) is the recommended connector for use with the HP 8702A Lightwave Component Analyzer.

RECEIVING and INSPECTION

Before unpacking, compare the shipping documents to your original order. Inspect all shipping containers. Carefully unpack the shipment and save all shipping materials and documents. Check the instrument serial numbers on the documents to be sure they are the same as those on the instrument. Inspect the instrument for damage. If your shipment is damaged or incomplete, notify both the shipping carrier and the nearest Hewlett-Packard Sales and Service Office. HP will arrange for repair or replacement of damaged or incomplete shipments without waiting for a settlement from the carrier. In all cases, notify your HP Field Engineer or Customer Engineer of any problems.

NOTE: Be sure to save all packing material because your source can be returned to the factory for recharacterization of its calibration data.

GENERAL SAFETY AND SERVICE CONSIDERATIONS

Because there is no AC line voltage attached to the source, high-voltage safety precautions are not necessary. However, the DC connectors, the SMA electrical connectors, and the optical port should always be kept clean and any protective caps should be kept on these ports when not in use.

Avoid static discharge: To ensure safety and to protect the instrument, be sure to ground yourself before touching any of the connectors.

Do NOT open the instrument cover: HP will void the warranty of any source that has been opened. There are no replaceable parts or adjustments for this instrument. Do not attempt to repair or replace any connectors on the source. Only the connector adapter (ordered by option number) that attaches to the mounting flange (HMS-10/HP interface) can be changed.

Refer all servicing to HP: This instrument is covered by the standard one year return-to-HP warranty. In the event of failure or malfunctioning, contact your nearest HP office giving model number and name. In addition, Option W30 can be ordered to provide two additional years (year 2 and 3) of warrantied repair. Contact your nearest HP office for information.

LASER SAFETY, CLASSIFICATIONS, and LABELS

Laser Safety:

Before operation, the instrument and manual should be reviewed for safety markings and instructions. Follow these instructions and warnings to ensure safe operation and to maintain the instrument in a safe condition.

Laser radiation in the ultraviolet and far infrared parts of the spectrum can cause damage primarily to the cornea and lens of the eye. Laser radiation in the visible and near infrared regions of the spectrum can cause damage to the retina of the eye. The HP 83400A and HP 83401A use a laser diode that operates in the infrared A spectrum (780-1400 nm), where the greatest danger from exposure is: 1) to the eyes where cataract formation and/or retinal burn is possible, and 2) to the skin where burning is possible.

WARNING

Do not enable the laser when no fiber or equivalent device is attached to the optical output connector.

Do NOT, under any circumstances, look into the optical output or any fiber/device attached to the output while the laser is in operation.

Classifications:

United States – FDA Class 1. The HP 83400A and HP 83401A are both USFDA (United States Food and Drug Administration) Safety Class 1 according to Part 1040, Performance Standards for Light Emitting Products, from the Center for Devices and Radiological Health.

International – IEC Class 3B. The HP 83400A and HP 83401A are both IEC (International Electrotechnical Commission) Safety Class 3B laser products according to Publication 825.

The REMOTE SHUTDOWN and the KEY SWITCH on the HP Lightwave Source (laser) help satisfy the international (IEC 825) safety requirements.

NOTE: Instruments with malfunctioning lasers MUST be returned to the factory for repair as explained under the heading titled SERVICE.

Labels:

Safety labels are provided for International requirements only. The United States and Canada do not require these labels.

For all other countries, attach the class label to the top of the housing near the front. Attach the laser safety label next to the laser aperture below and to the right. These labels are supplied in several languages and shipped with your instrument.

Installation and Connection

Installation

Because the HP 83400A and HP 83401A are intended for use with the HP 8702A Lightwave Component Analyzer they are usually connected whenever a measurement or a measurement calibration (explained below) is performed. To help you connect the source, three items are included below: 1) a picture of the source with its connections and indicators, 2) a list of the connections and switches that are used when installing the source, and 3) a typical test setup drawing.

Connection

Always make connections in a consistent and repeatable manner. Always keep the connectors clean and free from contamination. Metal connectors can be cleaned with non-corrosive alcohol or a liquid freon product. Use a lint-free swab or lint-free cloth to clean the connection, and dry it with clean compressed air to remove any excess afterwards. Keep the protective cover on the connector when not in use. Refer to the latest HP Connector Care manual for part numbers of lint-free swabs, freon, and compressed air.

Fiber ends can be cleaned with any non-abrasive cleaner. HP recommends a fiber optic cleaning kit (HP model number 15475A) that used adhesive tape to clean the fiber ends. If you use alcohol or liquid freon, be sure not to damage the fiber end. Use clean compressed air to blow dry the end and remove any excess particles.

NOTE: When using the HP 8702A with the source, do NOT touch the center pin of the RF OUT connector or any cable connected to it —a static charge could cause damage to the internal RF source.

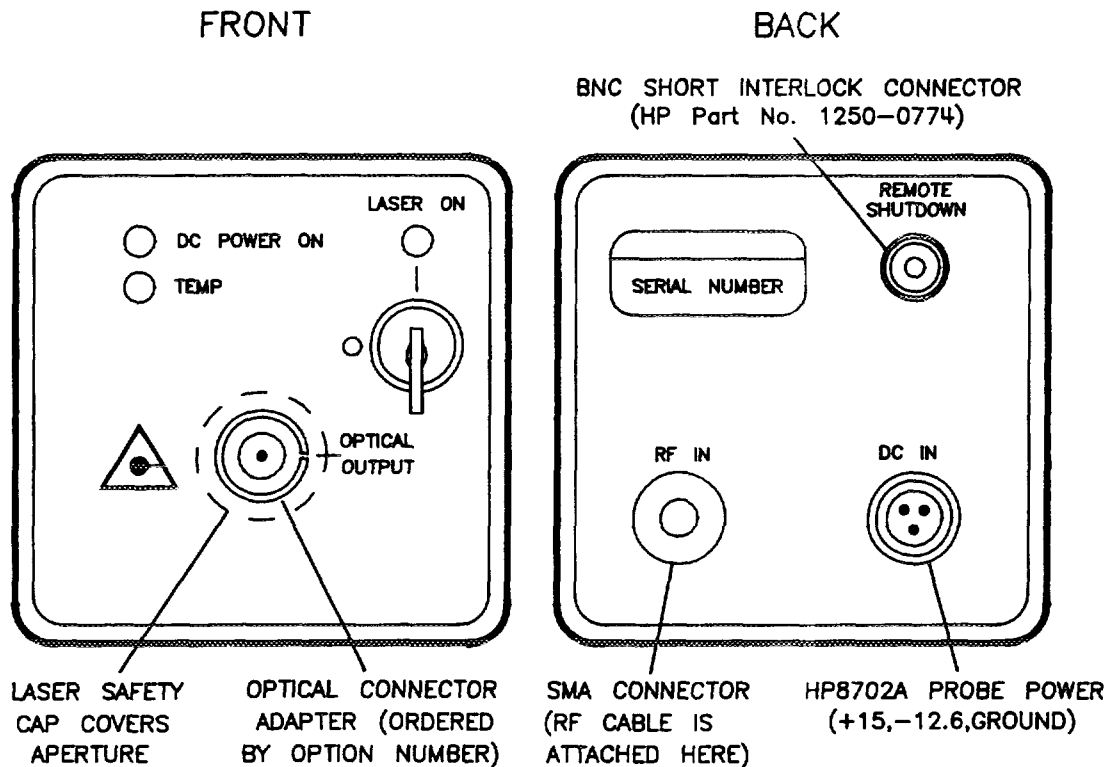


Figure 1. Lightwave Source Connectors and Indicators

LIST OF CONNECTIONS AND SWITCHES

Front Panel Connectors:

- **OPTICAL OUTPUT:** This connector type depends upon the option (connector adapter) ordered with the source. Connect your fiber cable to this output. The plastic safety cap is spring loaded and remains closed when no fiber is connected.
- **KEY SWITCH:** Two keys are supplied with each source to control the ON/OFF function of the laser. Because of the dangers involved with laser radiation, the keys provide safety by preventing use of the laser by unauthorized personnel. When the key is turned on, the LASER ON led will light.

Back Panel Connectors:

- **DC IN:** This 3 prong male input is connected to the output of the HP 8702A front panel connector marked PROBE POWER fused. Make this connection using the keyed cable supplied with the source.
- **RF IN:** This SMA threaded female connector is used to receive the modulation signal. Use the flexible RF cable supplied with the source and make the connection between the splitter (RF Interface Kit) that carries the RF OUT modulation signal of the HP 8702A and the RF IN of the Lightwave Source. If you have an HP electrical Test Set connected, you will need to make the connection from port 1 of the Test Set (7mm) to this connector (3.5mm).

- **REMOTE SHUTDOWN:** This is a safety feature. The BNC connector on the rear panel must be shorted for the laser to operate. When the terminals of the connector are open-circuited (BNC short removed), the accessible radiation does not exceed the AEL for Class 1 and Class 2 according to IEC Publication 825 (1984). Use your own short, switch, or other circuitry with a BNC cable to operate (open or short) the remote shutdown as desired. HP does not supply any other accessories with this connector/feature.

Accessories:

- **STANDS:** Use the stand, supplied with the source, to keep them elevated for ease of use.
- **CABLES:** Each lightwave source comes with one *DC IN to Probe Power* cable and one *Flexible RF cable* used to connect the RF modulation signal to the RF IN (SMA) on the lightwave source. Clips are also provided to keep the cables together.

NOTE: Refer to the REPLACEABLE PARTS list, in this manual, for part numbers.

TYPICAL TEST SETUP

The drawing below shows the HP Lightwave Source in a typical measurement application.

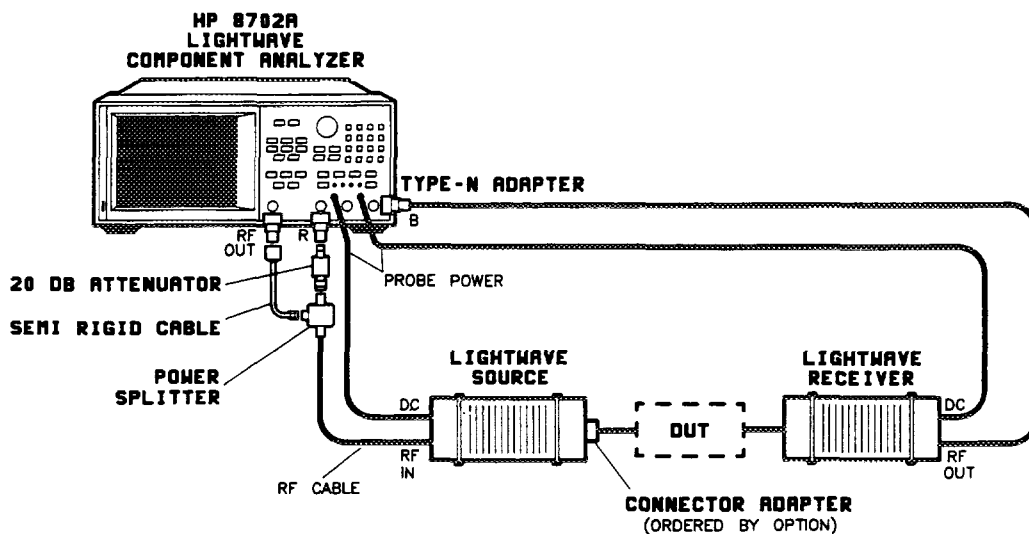


Figure 2. Typical Test Setup (Optical Transmission Measurement)

Operation

In general, the HP 83400A and HP 83401A provide a 1308 (± 10) nm diverging light beam that can be modulated by an external signal up to 3 GHz. Without modulation, light coming out of the source is less than 2 milliwatts (about +3 dBm) of power out. However, it can be modulated with up to +14 dBm (about 25 mW) of RF power. The only requirement for actual electrical operation is that DC power (-12.6V , +15V, and ground) be supplied to the DC IN connector of the source. After that, whenever the laser key switch is turned on (position 1), the laser is activated and the LED goes on (LASER ON). If a modulation signal is applied to the source's RF IN connection, the result is a modulated lightbeam that is launched into the fiber connector at the source's output.

In addition to the keyed laser switch, another safety feature is the thermal control circuitry. If the temperature of the source exceeds its preset value, it will automatically shut down.

During normal operation with the HP 8702A, the source is often connected *in* and *out* of the transmission path for different applications. However, if you are making repeated measurements, injecting the source's output into a DUT (device under test), you can turn off the laser while the DC IN bias and any RF signal remain connected and turned on.

The source can be modulated with a signal that is DC offset, providing this offset does not exceed 20 volts DC.

The HP 8702A Operating and Programming manual contains measurement examples and describes how to use the HP 83400A and HP 83401A sources in conjunction with the HP 8702A. Refer to that manual, especially the Getting Started section and User's Guide.

Theory of Operation

In order to understand more about these lightwave sources, refer to Figure 1 below.

These lightwave sources consist of a laser diode, bias circuitry, and control circuitry. The attenuator and impedance matching network blocks the DC component from the RF input that modulates the laser light. The attenuation is adjusted at the factory to provide the correct RF level to the laser. This adjustment results in maintaining an optimum transition from the 50 ohm RF input to the 25 ohm laser diode path.



Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

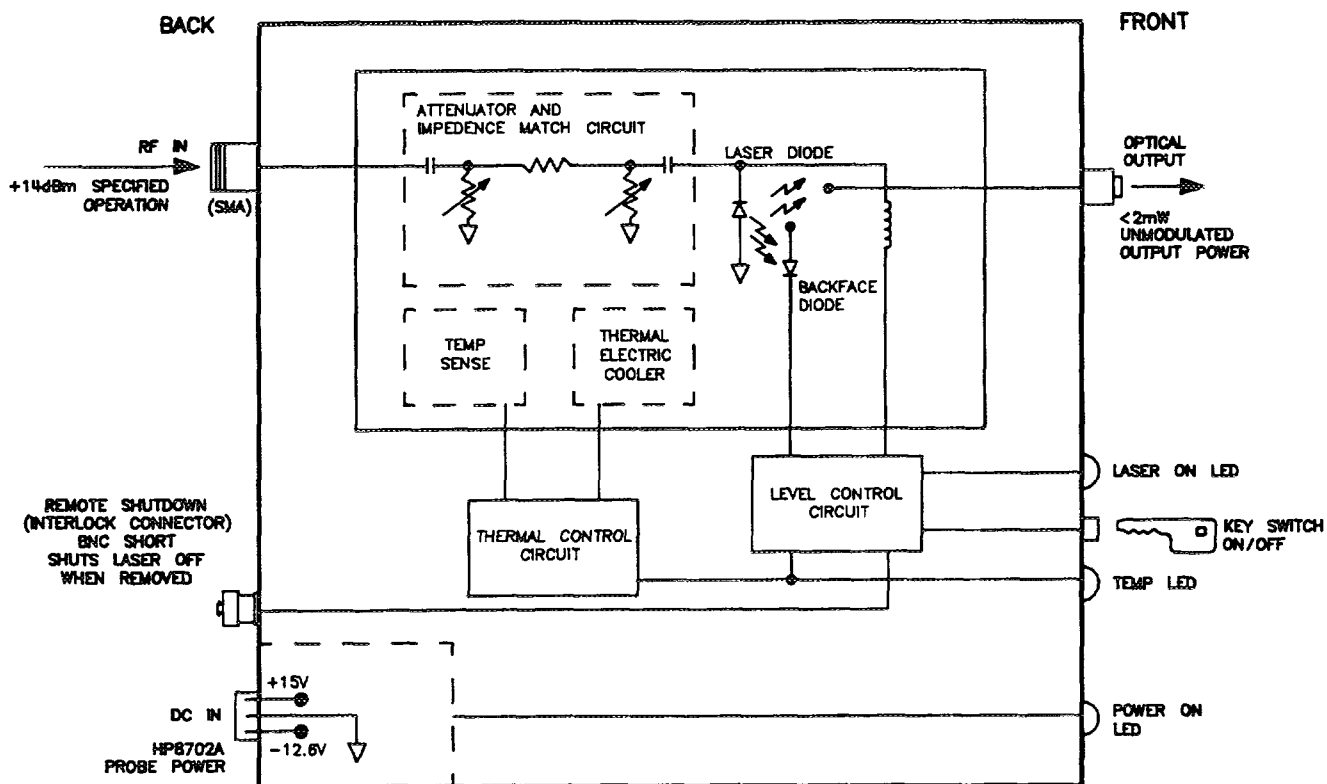


Figure 3. Lightwave Source Block Diagram

The laser diode is made from InGaAsP (Indium Gallium Arsenide Phosphide) and has a corresponding backface diode that is used to control or stabilize the lightwave output. Notice that the laser radiates light in both directions. The backface diode senses the laser output and sends a proportional current into the level control circuit. This level control circuit sends more or less current through the coil to adjust the bias current that controls the laser output.

The thermal control circuit uses a temperature sensor and a thermal electric cooler to keep the laser at a steady temperature within a few tenths of a degree. If the temperature of the laser is in error of the preset temperature by more than 5 degrees, the thermal control circuit sends a signal to the level control circuit which then shuts down the laser. When this happens, the TEMP led on the front panel goes ON.

The source also has a remote shut-down connector (BNC) that, when removed, turns off the laser. If properly used, this feature allows you to turn the laser off from a distance. To use this feature, you will have to attach your own BNC cable and a switch or other circuitry. A typical example would be: the laser is setup in a room where you do not want anyone entering while the laser is on; a switch is connected to the door; when the door is opened the BNC becomes an OPEN, and shuts down the laser.

The DC IN connector is a three pin plug that is designed for use with the HP 8702A front panel PROBE POWER (fused) connector or by a separate compatible power supply. Notice that the center pin is ground and the two other pins have a potential difference of -12.6 volts and $+15$ volts. When DC power is supplied to the source, the LED (labeled: POWER ON) is lit on the front panel but the laser light is not turned on by it.

The two keys supplied with each source to prevent anyone from turning on the laser without a key. This key switch is the ON and OFF switch for the laser. When the key switch is turned on, the level control circuit turns on both the laser and the LED (labeled: LASER ON) on the front panel.

In summary, general operation of these lightwave sources is simple, consisting mostly of making connections and following safety precautions. Because they do not have any adjusting controls and because they require connection to other instruments, they can be considered accessories. For this reason, their operation with the HP 8702A Lightwave Component Analyzer is also described in the HP 8702A Operating and Programming manual. However, read the CALIBRATION DATA section below for an explanation of how to use their accompanying Calibration Data.



Calibration Data

(Used with HP Lightwave Component Analyzer)

The following paragraphs contain information about the use of the calibration data. If you are using an HP 8702A, you can use this information and/or the similar information in the HP 8702A OPERATING and PROGRAMMING manual.

The double sided 3.5 inch disc and the label on the source contain calibration data that can be loaded into the HP 8702A Lightwave Component Analyzer. A double-sided 3.5 inch disc drive is required to load the disc data. Or, the data (nine coefficients) on the label can be manually loaded into the HP 8702A using the front panel keys. This label data is supplied for use when no disc drive is available.

Each source is measured at the factory. The measured data (101 points) is then digitized and transferred to the disc and labeled with a CAL DATA number that corresponds to the specific source it describes. In addition, nine coefficients are derived from the measured data to approximate the 101 point data. They are then put on a label that is attached to your source on the top, near the back. In both cases, the data is a mathematical model (error correction coefficient) that describes the source's modulation transfer characteristics and wavelength.

By using the HP 8702A's ability to mathematically remove these characteristics from a measurement, only the residual effects of the electrical/optical paths and the lightwave receiver remain. Then, after replacing the lightwave source with your own DUT (E/O source), the *Correction On* feature of the HP 8702A will remove the remaining residuals from the measurement of your DUT. This will result in measurement data that only describes the response of your DUT. The drawings and explanations below describe, in simple block terms, how this accomplished.

There are two ways to enter the source's calibration data into the HP 8702A: 1) from disc (101 points) or 2) manually from the CAL DATA label (nine coefficients) using the HP 8702A front panel keys.

DISC (3.5 in) CALIBRATION DATA

Each disc contains 101 digitized data points, based upon factory measurements, that describe the magnitude and phase modulation response of the particular source. Typically, the disc is inserted into an active dual sided disc drive (HP 9122-series) that is connected via HP-IB to the HP 8702A Lightwave Component Analyzer and properly addressed. Then, using the HP 8702A's *Guided Setup* or the CAL menu selection, you would read the files on the disc into the analyzer's Cal Kit memory array. This data will remain in HP 8702A non-volatile memory as a Cal Kit. Therefore, you should only have to enter it once, unless the instrument remains turned off for several days.

Whenever you enter the calibration data and perform a measurement calibration, your source's modulation characteristics are mathematically corrected (flattened) in the measurement process. Remember that your source was measured at the factory under optimal conditions and the calibration data is a model of its response under those conditions. By performing a measurement calibration (*thru* measurement RESPONSE cal) with the HP source in your system, this model is used to correct or adjust the HP 8702A's processing of the measurement. In this manner, your source is a standard because its response has already been characterized (modeled) and is now used to calibrate the system. Therefore, when you measure any other E/O device (source), its measured response is adjusted by the *CORRECTION ON* (measurement calibration) feature of the HP 8702A —your data is corrected with reference to the measurement calibration you made using the HP source and its calibration data.

Below is a typical key press sequence for loading the calibration data, beginning with the HP 8702A *Guided Setup*. However, you could press the front panel [CAL] key to access CAL KITS & STDS menu and load the data from there:

Typical Procedure:

Press the following keys in this order:

1. [Guided Setup]
2. Select the type of measurement (for example, BANDWIDTH)
3. [continue]
4. Select the type of DUT [E/O]
5. [continue]
6. Configure or connect the equipment as shown on CRT
7. [continue]
8. Set the START/STOP modulation frequencies
9. Set Sweep Time, Source Power, Sweep Type
10. [continue]
11. Select Cal Type [RESPONSE]
12. Select [CAL STD] and [SRC DISC]
13. With the disc in the drive, select [LOAD SRC DISC] and [SYSTEM CONTROLLER] to allow the HP 8702A to control the disc drive when no controller is on the HP-IB bus.
14. Select [READ FILE TITLES] and the filenames will appear.
15. Select [LOAD *filename*] —the filename is loaded on the disc.

After loaded the disc data, it will remain in memory. Press the [PRIOR MENU] keys to return to the calibration menu.

NOTE: Refer to the HP 8702A User's Guide for examples of using this data to measure an E/O test device.

16. Press **[RESPONSE]** and **[continue]** and **[SOURCE]**. At this point the HP 8702 will make the calibration measurement and the calibration will automatically be turned on. Notice the left side of the CRT where the abbreviation for correction (calibration) is: *Cor.*
17. You are now ready to insert your E/O device in place of the HP Lightwave Source and make accuracy enhanced (calibrated) measurements.

Refer to the *HP 8702 Operating and Programming Manual* for information about making measurements.

How to Interpret Filenames:

Disc data file names will be displayed as a CAL STD name. File names beginning with an S refer to single mode fiber source data and filenames beginning with an M refer to multimode fiber source data. The first two digits represent the frequency range and wavelength. For example, consider the number S1300045. The S means SMF (single mode fiber), the following 1 means that the frequency range is up to 3 GHz, and the 3 means that the wavelength is 1300 nm. The remaining 5 digits are the specific calibration data number of your source (not the same as the instrument serial number).

LABELED CAL DATA (COEFFICIENTS)

The labeled data on the source is comprised of nine coefficients that are used in a polynomial curve to describe the magnitude and phase modulation response of the particular source. These nine coefficients are derived from the same data (101 points) that is on the disc.

A typical label looks like this:

CAL DATA #S13XXXXX
83400A

A = xxxxx	(Responsivity)	F = xxxxx
B = xxxxx	(Delay)	G = xxxxx
C = xxxxx		H = xxxxx
D = xxxxx		I = xxxxx
E = xxxxx		xxxx.x nm

The equation used by the HP 8702 is as follows:

$$\text{Responsivity } (\omega) = \frac{A \cdot E^{-j\omega B} \cdot (C(j\omega)^3 + D(j\omega)^2 E(j\omega) + 1)}{F(j\omega)^4 + G(j\omega)^3 + H(j\omega)^2 + I(j\omega) + 1}$$

where $\omega = 2\pi$ (Frequency) and $j = \sqrt{-1}$

NOTE: In the HP 8702 coefficients are scaled as follows:

$$B \cdot (10^{-9}), C \cdot (10^{-30}), D \cdot (10^{-21}), E \cdot (10^{-12}), F \cdot (10^{-39}), G \cdot (10^{-30}), H \cdot (10^{-21}), I \cdot (10^{-12}).$$

Typically, you enter these values in the HP 8702 Cal Kit that is accessed by pressing the keys shown in the procedure below.

Typical Procedure:

Press the following keys in this order:

1. [Guided Setup]
2. Select the type of measurement (for example, BANDWIDTH)
3. [continue]
4. Select the type of DUT [E/O]
5. [continue]
6. Configure or connect the source as shown on CRT
7. [continue]
8. Set the START/STOP modulation frequencies
9. Set Sweep Time, Source Power, Sweep Type
10. [continue]
11. Select Cal Type [RESPONSE]
12. Select [CAL STD –COEFF] and [ENTER SRC COEFF]
13. Enter the Coefficients from the label. You must enter all of the coefficients.
14. Select [PRIOR MENU] and [SAVE SRC COEFF]

After loading the data, it will remain in memory. Press the [PRIOR MENU] keys to return to the calibration menu. Then press [continue].

15. Select [SOURCE]. At this point the HP 8702A will make the calibration measurement and the calibration will automatically be turned on. Notice the left side of the CRT where the abbreviation for correction (calibration) is: *Cor.*
16. You are now ready to insert your E/O device in place of the HP Lightwave Source and make accuracy enhanced (calibrated) measurements.

Refer to the HP 8702A OPERATING AND PROGRAMMING manual for information about making measurements.

RECHARACTERIZING YOUR SOURCE

Your source can be returned to the factory for re-characterization (calibration) at any time for a reasonable fee. HP recommends that recharacterization be done at approximately one year intervals. Contact the nearest HP Office for assistance.

MAKING A BACK-UP DISC

Hewlett Packard recommends that you make a back-up or extra copy of the disc data, label it properly, and make sure it is only used with the source that its data describes.

You must have an HP controller (computer) to copy the files. This includes all 200 and 300 series HP 9000 controllers such as: 9836, 9826, 310, 320, etc. In addition, the disc drive must be an HP CS80 disc drive, such as an HP 9122 dual sided model.

Refer to the computer User's Guide for instructions on how to make back-up copies or copy files.

Specifications

The information below describes the specifications of the HP 83400A and HP 83401A Lightwave Sources. The values were determined at the factory and are based upon measurements using a calibrated HP 8702A system, optical power meter, and optical spectrum analyzer.

The following section, under the heading PERFORMANCE TESTS, contains procedures to test and verify the values listed in the Table of Specifications below.

Weight and Dimensions

Net weight: 1.5 kilograms

Width: 8.5 cm

Height: 8.5 cm

Length: 23 cm

Absolute Maximum Ratings (do not exceed)

- Temperature Limits: Operating, 0 to 55°C; Non-operating, -40 to 55°C
- RF input power: 20 dBm
- DC power input: -12.6V supply is $> -15V$; +15V supply is $< +17V$
- DC into RF port: 20 volts.

Assumptions or Conditions:

1. All specifications apply at 25 ± 5 degrees Celsius.
2. Optical connector: HMS 10/HP Diamond (The use of an index matching oil may be required to meet specifications.)*
3. Instrument must be warmed-up for one-half hour.
4. Tested on a system at the factory.
5. Receiver: HP 83410A with calibration data.
6. HP 85044A or HP 85046A Test Set.
7. No intensity modulation applied.

* The index matching oil currently recommended is available as HP part number 6040-0648.

TABLE OF SPECIFICATIONS

- CENTER WAVELENGTH, conditions: 1 - 4, 7.

minimum: 1298 nanometers
 typical: 1308 nanometers
 maximum: 1318 nanometers

- SPECTRAL WIDTH, conditions: 1 - 4, 7.

maximum: 3.0 nanometers

- AVERAGE POWER OUT, conditions: 1 - 4, 7.

minimum: 500 microwatts
 typical: 1100 microwatts
 maximum: 2000 microwatts

- MODULATION FREQUENCY RESPONSE, conditions: 1 - 5. See Figure 5.

+/-3.5 dB (Watts/ampere)
 at +14 dBm RF input 300 kHz to 3 GHz.

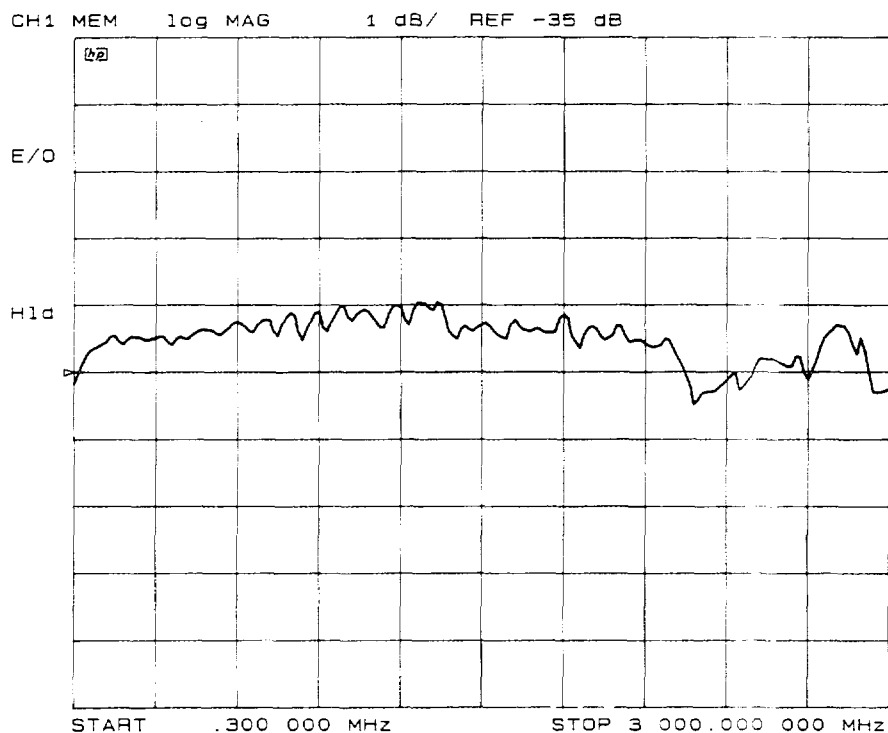


Figure 5. Typical MOD FREQ RESP PLOT

- ELECTRICAL INPUT MATCH, conditions: 1 – 6. See Figure 6.

minimum: 13 dB using an HP 85044A or HP 85046A Test Set, 300 kHz to 3 GHz.

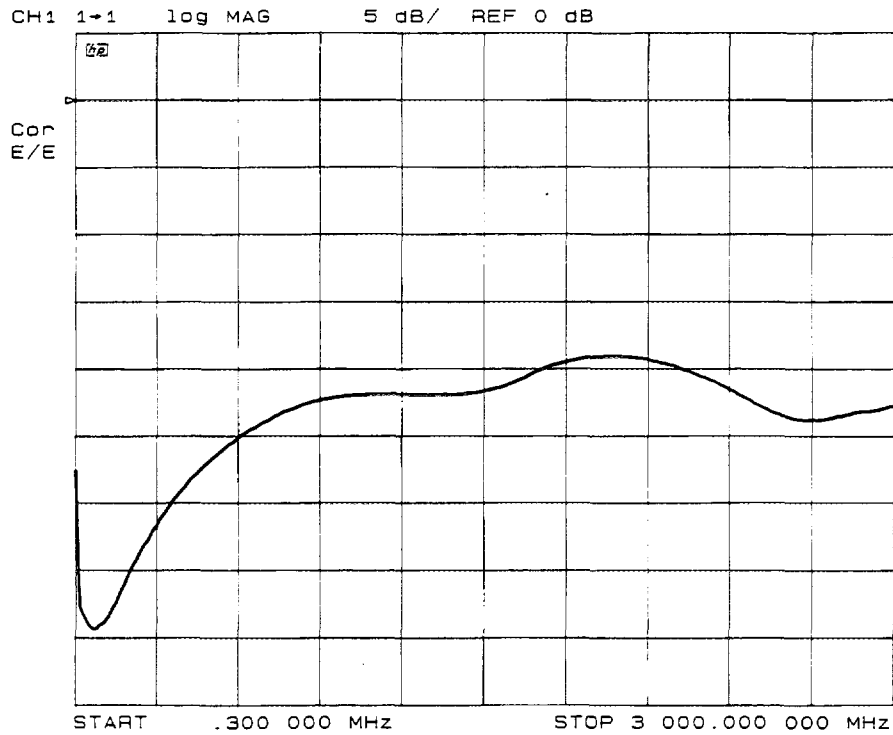


Figure 6. Typical ELEC INPUT MATCH PLOT

OTHER TYPICAL CHARACTERISTICS:

- RESPONSIVITY
 -33 dB (referenced to $1 \frac{\text{Watt}}{\text{ampere}}$) or 0.022 W/A
- MODULATION (Harmonic) DISTORTION, RF power +14 dBm:

300 kHz –1 GHz:	-25 dBc
1 GHz –3 GHz:	-7 dBc
- 1 dB MODULATION COMPRESSION LEVEL, modulated at 50 MHz:
 +17 dBm RF power

Performance Tests

The procedures in this section test the performance of the instrument. The complete specifications to which the source is tested are given in the table below. All tests can be performed without access to the interior of the instrument.

Required Equipment:

Any equipment which satisfies the critical specifications listed in the table may be substituted for recommended models.

- Optical Spectrum Analyzer
- Optical Power Meter (Model Number HP 8158B)
- Optical Cable (HP 11896/7 Interconnect Cable Kit)
- HP 8702 Lightwave Component Analyzer
- HP Receiver HP 83410A
- R/T Test Set (HP 85044A)
- HP 3.5 Cal Devices

	HP Part Number
Open	1250-1767
Short	1250-1769
Load	909D Opt 011, Opt 040

CENTER WAVELENGTH AND SPECTRAL WIDTH

Spectral Width: Max 3.0 nm

Center Wavelength: 1308 nm +/-10 nm

Procedure

1. Connect the test system as shown below.

NOTE: The *absolute level* is not critical. Also, do not use *RF modulation* when testing.

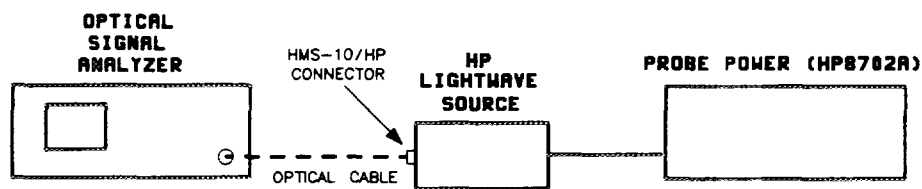


Figure 7. Test Setup

2. Make the following optical spectrum analyzer adjustments:
 - a. Center wavelength: 1308 nm.
 - b. Sweep width: 5nm/division or as needed to get all peaks > -35 dB
 - c. Reference level: -10 dBm
 - d. Y - Scale Log
 - e. Resolution: 0.1 nm
 - f. Average Time: 1
3. Measure the Source's mode pattern.
4. Adjust the analyzer's REF level and Center Wavelength so that the maximum peak is in the top graticule division and the pattern is centered on the CRT so that the first peak is almost equal to the last peak in amplitude.

5. Make another measurement of the Source's mode pattern. A pattern similar to Figure 8 should result. Measure the frequency and amplitude of each peak greater than -35 dBc (35 dB below the maximum peak) and record the value in Table 1.

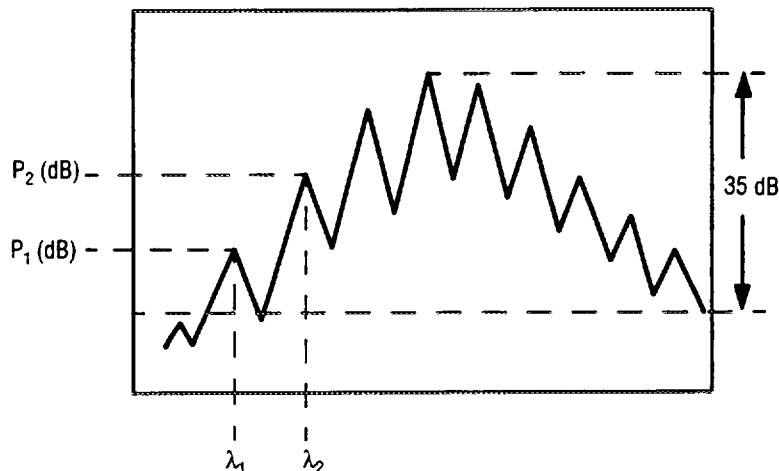


Figure 8. Typical Display of Source Mode Pattern

Table 1.

i	P _i (dB)	λ _i	P _i (lin)*	P _i (lin) • λ _i	(λ _i - λ̄) ² • P _i (lin)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
Totals					

* P_i (linear) = P_i (lin) = 10^(P_{dB}/10)

6. Using the data from the totals, in Table 1, compute the mean ($\bar{\lambda}$) and sigma (σ) as shown below, where n = the number of peaks above -35 dBc:

$$\bar{\lambda} = \frac{\sum_{i=1}^n \lambda_i P_i}{\sum_{i=1}^n P_i}$$

$$\sigma = \sqrt{\frac{\sum_{i=1}^n (\lambda_i - \bar{\lambda})^2 P_i}{\sum_{i=1}^n P_i}}$$

AUTOMATED TEST PROGRAM

The following BASIC program will calculate the mean and sigma values for center wavelength and spectral width. It can be run on any 200 or 300 series controller.

BASIC Test Program:

```

10 DIM Peak—value(1:50),Correct$(5)
20 INTER Count—peaks,Y(1:50),Mean,Variance
30 OUTPUT KBD;"K"; ! CLEAR THE SCREEN
40 PRINT "Press RETURN to retain present values."
50 INPUT "Enter the START wavelength",Start—lambda,"Enter the STOP wavelength",Stop—
lambda
60 Enter—data:
70 PRINT "ENTER 0 WHEN DONE"
80 Count—peaks=0
90 FOR I=1 TO 1.E+6
100 PRINT
    "
105 PRINT
    "
107 STATUS CRT,1;Y—pos
108 CONTROL CRT,1;Y—pos-1
110 PRINT "PEAK NUMBER =" ;I,"The present peak value is";Peak—value(I)
120 INPUT "ENTER NEW PEAK VALUE IN dB",Peak—value(I)
130 IF Peak—value(I)=0 THEN GOTO Check
140 Wavelength=DROUND(Y(I)*(Stop—lambda-Start—lambda)/560 + Start—lambda,6)
150 !
160 PRINT "PEAK NUMBER =" ;I,"The present wavelength is";Wavelength
170 INPUT "ENTER NEW WAVELENGTH",Wavelength
180 Y(I)=(Wavelength-Start—lambda)*560/Stop—lambda-Start—lambda)
190 STATUS CRT,1;Y—pos

```

```

191     CONTROL CRT,1;Y—pos-3
210     PRINT "PEAK NUMBER =";I,"PEAK WAVELENGTH =";Wavelength,"PEAK VALUE
      =";Peak—value(I)
220     Count—peaks=I
230     NEXT I
240     Check: !
250     PRINT
260     INPUT "IS THIS DATA CORRECT?",Correct$
270     IF UPC$(Correct$[1,1])<>"N" THEN GOTO Compute
280     GOTO Enter—data
290     Compute: !
300     PRINT "there are ";Count—peaks;" peaks"
310     Trace—max=MAX(Peak—value(*))
320     Compute—sigma(Peak—value(*),Trace—max,Count—peaks,Mean,Variance,Y(*))
330     PRINT "MEAN ";DROUND(Mean*(Stop—lambda-Start—lambda)/560+Start—
      11lambda,6),"2—SIGMA =";DROUND(2*SQR(Variance)*(Stop—lambda-Start—
      lambda)/560,3)
340     PAUSE
350     END
360     !
370     SUB Compute—sigma(Peak(*),Track—max,INTEGER Count—peaks,Mean,Variance,Y(*))
380     Doc—on:GOTO Doc—off
390     !
400     !
410     !
420     !
430     !
440     !
450     !
460     !
470     !
480     !
490     !
500     !
510     !
520     !
530     !
540     !
550     !
560     !
570     !
580     !
590     !
600     Doc—off: !
610     Compute—sigma:!(Peak(*),Trace—max, INTEGER Count—peaks,Mean,Variance,Y(*))
620     DISP "COMPUTING MEAN(CENTER) AND STANDARD DEVIATION"
630     Sigma—top=0
640     Bottom=0
650     Mean—top=0

```

```

660   FOR I=1 TO Count—peaks
670     Peak—mag=10*(Peak(I)/10)
680     Mean—top=Mean—top+Y(I)*Peak—mag
690     Bottom=Bottom+Peak—mag
700   NEXT I
710   Mean=INT(Mean—top/Bottom)
720   FOR I=1 TO Count—peaks
730     Peak—mag=10*(Peak(I)/10)
740     Sigma—top+(Y(I)-Mean)'2*Peak—mag+Sigma—top
750   NEXT I
760   Variance=INT(Sigma—top/Bottom)
770 SUBEND
780 !

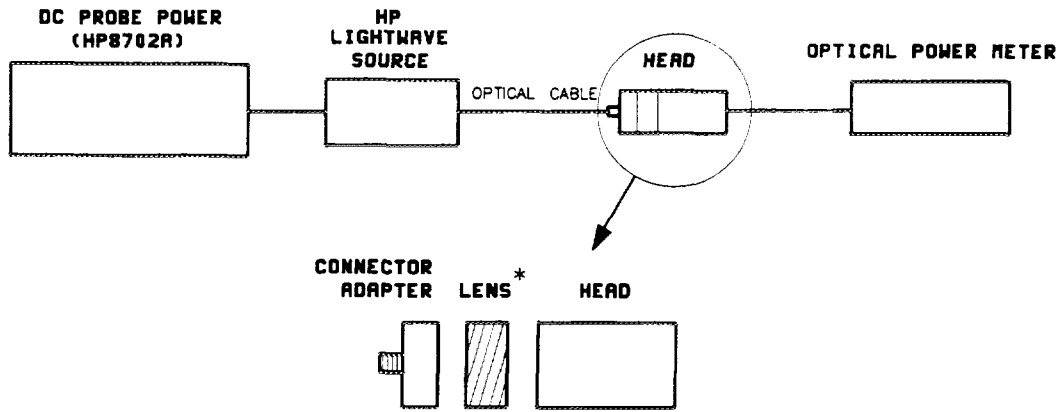
```

AVERAGE OUTPUT POWER

Minimum: 500 uw
Maximum: 2000 uw

Procedure

1. Connect the test system as shown in Figure 9 below.



* CALIBRATION ON THE LENS MUST GO INTO THE POWER METER

Figure 9. Test Setup

2. Power will be measured un-modulated. Set the frequency, press: [SET] [λ]. Use the vernier to set λ (1308 nm).
3. Zero the optical power (use lens cap), press: [MEAS] [ZERO].
4. Input the calibration on the lens.

5. Press: [SET] [REF] [dBm]. Use the vernier to set cal.
6. Connect the optical cable to the power meter head and turn on the source.
7. Measure the power and compare the results to the specified value, press: [MEAS] [μ W].

NOTES:

- Using an optical cable with a diamond HMS-10/HP connector on the source will give the most accurate results. Other connector types may have an air gap which can cause reflections resulting in measurement errors.
- Be sure that all optical connections are clean and free from scratches, dust, dirt, etc. Use non-corrosive or non-abrasive cleaner and blow the connectors dry with clean compressed air. If necessary, use an index matching compound to reduce reflections. Be careful to properly remove the compound when finished and re-clean the connector.

ELECTRICAL INPUT PORT MATCH

Specified value: 13 dB

Procedure

1. Connect the test system as shown in Figure 10.

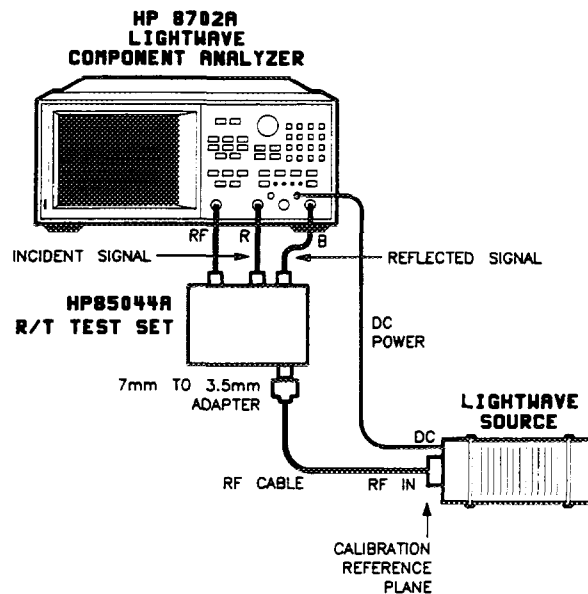


Figure 10. Test Setup

2. Set the HP 8702A parameters by pressing: **[CAL] [DEVICE TYPE] [E/E]**.

**[MENU] [POWER] [10] [x1]
[AVG] [IF BW] [100] [x1]**.

3. Perform an S_{11} response calibration (at the end of the RF cable) using the SHORT, OPEN, and LOAD from the 3.5 mm Calibration Kit. Press: **[CAL] [CALIBRATE MENU] [S11 1-PORT]** and press each device softkey to measure it. After measuring each device press: **[DONE 1-PORT CAL]**. The display will show "COR" in the status indicator area.
4. Connect the RF cable from the test set to the source RF in and measure the S_{11} reflection to determine the match as follows: Press: **[MENU] [TRIGGER MENU] [SINGLE]** to generate a single sweep.

Press: **[MKR FCTN] [MKR SEARCH] [MAX]**. The marker will locate to port match value.

5. Compare it to the specified value.

Service and Replaceable Parts

Service, Maintenance, and Repair: The instrument must be returned to HP for repair. If your source fails to operate properly, contact the nearest HP Sales and Service office and request the assistance of an HP Customer Engineer. A replacement (exchange assembly) is available for these sources. Only the parts listed below can be ordered.

Maintenance is limited to cleaning all connectors with proper cleaning materials and methods. The RF input connector (SMA) should be carefully cleaned — never over-tighten the connection. The recommended SMA torque value is 5 in./lbs. If this connector becomes loose or damaged, contact HP.

Replaceable Parts:	HP Part/Model Number
RF Cable (SMA)	8120-5157
DC Cable (Probe Power)	83400-60005
Cable Clips	83400-20008
Laser Shutter (dust) Cover	08145-64501
HMS-10/HP Connector Adapter	08154-61701
FC/PC Connector Adapter	08154-61702
DIN Connector Adapter	08154-61703
ST Connector Adapter	08154-61704

REGIONAL SALES AND SUPPORT OFFICES

For information relating to Sales or Support of Hewlett-Packard products first contact your local Hewlett-Packard office listed in the white pages of your telephone directory. If none is listed locally, contact one of the addresses listed below to obtain the address or phone number of the Hewlett-Packard Sales or Support office nearest you.

ASIA

Hewlett-Packard Asia Ltd.
47/F, 26 Harbour Road,
Wanchai, **HONG KONG**
G.P.O. Box 863, Hong Kong
Tel: (852) 5-8330833
Telex: 76793 HPA HX
Cable: HPASIAL TD

AUSTRALASIA

Hewlett-Packard Australia Ltd.
31-41 Joseph Street
BLACKBURN, Victoria 3130
Australia
Tel: (61) 895-2895
Telex: 31-024
Cable: HEWPARD Melbourne

CANADA

Hewlett-Packard (Canada) Ltd.
6877 Goreway Drive
MISSISSAUGA, Ontario L4V 1M8
Tel: (416) 678-9430
Telex: 069-8644

JAPAN

Yokogawa-Hewlett-Packard Ltd.
29-21 Takaido-Higashi, 3 Chome
Suginami-ku **TOKYO** 168
Tel: 03 (331) 6111
Telex: 232-2024 YHPTOK

MEDITERRANEAN AND MIDDLE EAST

Hewlett-Packard S.A.
Mediterranean and Middle East
Operations
Atrina Centre
32 Kifissias Avenue
Paradissos-Amarousion, **ATHENS**
Greece
Tel: (30) 682 88 11
Telex: 21-6588 HPAT GR
Cable: HEWPACKSA Athens

BENELUX & SCANDINAVIA

Hewlett-Packard S.A.
Uilenstede 475
P.O. Box 999
NL-1183 AG **AMSTELVEEN**
The Netherlands
Tel: (31) 20/43 77 71
Telex: 18 919 hpner nl

SOUTH & EAST EUROPE, AFRICA

Hewlett-Packard S.A.
7, rue du Bois-du-Lan
CH-1217 **MEYRIN 2**, Geneva
Switzerland
Tel: (41) 22/83 12 12
Telex: 27835 hmea
Cable: HEWPACKSA Geneve

FRANCE

Hewlett-Packard France
Parc d'activités du Bois Briard
2, avenue du Lac
91040 **EVRY** Cedex
Tel: 1 6/077 83 83
Telex: 6923 15F

GERMAN FEDERAL REPUBLIC

Hewlett-Packard GmbH
Hewlett-Packard-Strasse
Postfach 1641
D-6380 **BAD HOMBURG**
West Germany
Tel: 06172/400-0
Telex: 410 844 hpbhg

ITALY

Hewlett-Packard Italiana S.p.A.
Via G. Di Vittorio 9
I-20063 **CERNUSCO SUL
NAVIGLIO**
(Milano)
Tel: 02/92 36 91
Telex: 334632

UNITED KINGDOM

Hewlett-Packard Ltd.
King Street Lane
Winnersh, **WOKINGHAM**
Berkshire RG11 5AR
Tel: 734/78 47 74
Telex: 847178

EASTERN USA

Hewlett-Packard Co.
4 Choke Cherry Road
ROCKVILLE, MD 20850
Tel: (301) 670-4300

MIDWESTERN USA

Hewlett-Packard Co.
5201 Tollview Drive
ROLLING MEADOWS, IL 60008
Tel: (312) 255-9800

SOUTHERN USA

Hewlett-Packard Co.
2000 South Park Place
P.O. Box 105005
ATLANTA, GA 30348
Tel: (404) 955-1500

WESTERN USA

Hewlett-Packard Co.
5161 Lankershim Blvd.
P.O. Box 3919
NO. HOLLYWOOD, CA 91609
Tel: (818) 506-3700

OTHER INTERNATIONAL AREAS

Hewlett-Packard Co.
Intercontinental Headquarters
3495 Deer Creek Road
PALO ALTO, CA 94304
Tel: (415) 857-1501
Telex: 034-8300
Cable: HEWPACK

February, 1986

