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User's Guide

HP E5970A Optical Power Meter

SERIAL NUMBERS

This manual applies to all instruments.



HP Part No. E5970-91011
Printed in the Federal Republic of Germany

First Edition
E0295

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New editions are complete revisions of the guide reflecting alterations in the functionality of the instrument. Updates are occasionally made to the guide between editions. The date on the title page changes when an updated guide is published. To find out the current revision of the guide, or to purchase an updated guide, contact your Hewlett-Packard representative.

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ISO 9001 Certification

Produced to ISO 9001 international quality system standard as part of our objective of continually increasing customer satisfaction through improved process control.

Control Serial Number: Edition 1 applies directly to all instruments.
Edition 1 : 1st February 1995 : E5970-91011 : E0295

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Safety Summary

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements.

General This is a Safety Class III instrument and has been manufactured and tested according to international safety standards.

Operation - Before applying power Comply with the installation section. Additionally, the following shall be observed:

- Do not remove instrument covers when operating.
- Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.
- Do not install substitute parts or perform any unauthorized modification to the instrument.
- Be aware that capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

Safety Symbols



The apparatus will be marked with this symbol when it is necessary for the user to refer to the instruction manual to protect the apparatus against damage.



Caution, risk of electric shock.



Frame or chassis terminal.



Protective conductor terminal.



Hazardous laser radiation.

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Warning



The WARNING sign denotes a hazard. It calls attention to a procedure, practice or the like, which, if not correctly performed or adhered to, could result in injury or loss of life. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

Caution



The CAUTION sign 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 or destruction of part or all of the equipment. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

Introduction

This guide has two sections

- How to operate the instrument (chapters 1 and 2), and
- Supporting information, which is not required for the general operation of the instrument (appendices A to F).

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Contents

1. Making Measurements

Switching the Power Meter On 1-1
Switching the Power Meter On Permanently 1-2
Zeroing the Instrument 1-2
Switching the Power Meter Off 1-3
Configuring the Wavelength 1-3
Measuring Absolute Power 1-4
Holding the Value on the Display 1-5
Releasing the Value on the Display 1-5
Measuring Relative Power 1-6
Selecting the Relative Power Measurement 1-6
Holding the Value on the Display 1-6
Releasing the Value on the Display 1-7
Measuring a Reference 1-7
Entering or Editing the Reference 1-7
Example: Making a Loss and Power Measurement 1-8

2. Identifying Modulated Light

Identifying Fibers in a Cable 2-1
Example: Identifying the Modulation Frequency 2-2

A. Preparing for Operation

Initial Inspection A-1
Power Supply Requirements A-1
Changing the Batteries A-2
Operating and Storage Environment A-3
Temperature A-3
Humidity A-3
Optical Input A-3
Attaching a Connector Adapter A-4
Removing a Connector Adapter A-4
Connecting Bare Fibers A-5

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B. Ordering Information
Instruments B-1
AC Adapter (HP E5974A only) B-1
Connector Adapters B-2

C. Specifications
Definition of Terms C-1
Performance Specifications C-1
Supplementary Performance Characteristics C-3
Typical Spectral Responsivity C-3
General Specifications C-4

D. Performance Test
Required Test Equipment D-1
Performance Test D-2
General D-2
Linearity Test D-2
Uncertainty Test D-4
P_c, The Wavelength-Corrected Power Level D-7

E. Cleaning Procedures
The Cleaning Kit E-1
Other Cleaning Tools E-2
Preserving Connectors E-3
Cleaning Instrument Housings E-4
Cleaning Procedures E-4
Cleaning Cable Connectors E-4
Cleaning Connector Adapters E-5
Cleaning Connector Interfaces E-5
Cleaning Bare Fiber Adapters E-6
Cleaning Bare Fiber Ends E-6
Cleaning Physical Contact Interfaces E-7
Cleaning Recessed Lens Interfaces E-7

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1

Making Measurements

This chapter describes the normal operation of the power meter, that is making power and loss measurements.

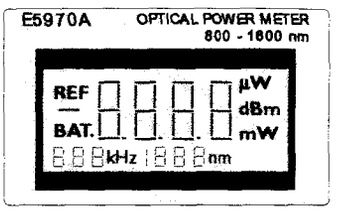
Switching the Power Meter On

Note

Normally the power meter switches off automatically after a period of 20 minutes. If you need to make measurements for a longer period, see "Switching the Power Meter On Permanently".

To switch the power meter on:

1. Press On/Off.



The Power Meter Display at Power On

The whole display, except the bottom right corner, is filled for approximately 2 seconds, then the number 8888 is displayed for approximately 2 seconds, after which the power meter is ready to use.

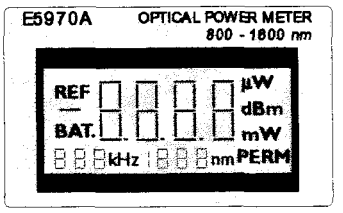
If the power meter does not switch on, check the battery (see "Changing the Batteries" in Appendix A for information on accessing, and changing, the battery).

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Switching the Power Meter On Permanently

To switch the power meter on permanently:

1. Press and hold On/Off.
2. Wait until PERM appears in the bottom right corner of the display (approximately 2 seconds). (The whole display is filled for approximately 2 seconds while you hold the button).



The Power Meter Display at Permanent Power On

3. Release On/Off.

The number 8888 is displayed for approximately 2 seconds, after which the power meter is ready to use.

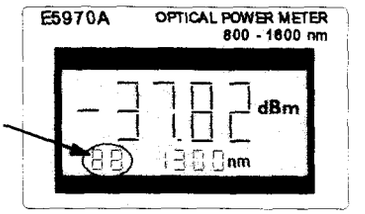
If the power meter does not switch on, check the battery (see "Changing the Batteries" in Appendix A for information on accessing, and changing, the battery).

Zeroing the Instrument

You do not have to zero the instrument. The instrument zeros itself approximately 20 seconds after you switch it on, and then approximately every 10 minutes during operation.

While the instrument is zeroing itself, 88 appears in the lower left hand corner (where the modulation is shown).

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The Calibration Indicator

While the instrument is zeroing, any key presses you make are stored, and are executed when the zero operation is finished.

Switching the Power Meter Off

To switch the power meter off:

1. Press (On/Off).

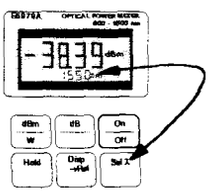
Configuring the Wavelength

The wavelength is shown at the bottom of the display in the middle. There are four calibrated wavelengths that you can choose from:

- 850nm
- 1300nm
- 1310nm
- 1550nm

To change the wavelength

1. Press (Sel λ) repeatedly until the wavelength you want is shown.



The Sel λ Key and the Wavelength Display

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Power readings are valid for wavelengths within ±2nm of the selected wavelength. If the measurement wavelength is not within these limits, you can correct the reading using the typical spectral responsivity curve given in "Typical Spectral Responsivity" in Appendix C.

If you cannot change the wavelength check the following:

- Is REF shown at the top left of the display?
  If it is,
  1. Press (dB/Ref).
  2. Change the wavelength as described above.

Note



You may have changed the value of your reference. See "Measuring a Reference" and "Entering or Editing the Reference" for information about taking and editing references.

- Is the wavelength shown on the display alternating with HOL?
  If it is,
  1. Press (Hold).
  2. Change the wavelength as described above.

Measuring Absolute Power

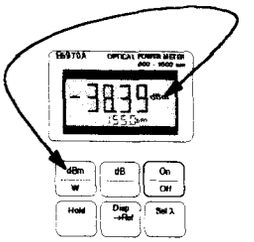
The power measured at the optical input is shown by the large digits on the display, with the units to the right of the measurement.
There are three units that you can choose from:

- dBm, which is one of the units for absolute power measurements,
- Watts, which is the other unit for absolute power measurements, and
- dB, which is the unit for relative power measurements, and is described in "Measuring Relative Power".

To select absolute power measurement and the unit:

1. Press (dBm/W) repeatedly until the unit you want is shown.

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The dBm/W Key and the Power Unit

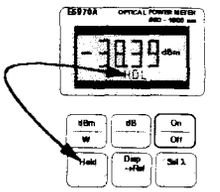
If you cannot change the unit check the following:

- Is the wavelength shown in the middle at the bottom of the display alternating with HOL?
  If it is,
  1. Press (Hold).
  2. Change the unit as described above.

Holding the Value on the Display

The value for the power on the display is updated approximately every half a second. To hold the value,

1. Press (Hold).



The Hold Key and the Hold Indicator

While the value is being held, the indicator HOL is shown, alternating with the wavelength, in the middle at the bottom of the display.

Releasing the Value on the Display

If a power value is being held on the display, you can release it by pressing (Hold) a second time.

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Measuring Relative Power

The power measured at the optical input is shown by the large digits on the display, with the units to the right of the measurement.

To make relative power measurements, you need to select dB units, and then measure or edit in the reference against which the relative power is measured.

Selecting the Relative Power Measurement

Altogether there are three units that you can choose from:

- dBm, which is one of the units for absolute power measurements, and is described in "Measuring Absolute Power",
- Watts, which is the other unit for absolute power measurements, and is described in "Measuring Absolute Power", and
- dB, which is the unit for relative power measurements.

To select the relative power measurement and the unit:

1. Press (dB/Ref) repeatedly until the units at the right of the display are dB.



The dB/Ref Key and the Power Unit

OR

Make a reference measurement (see "Measuring a Reference").

If you cannot change to measuring the relative power, check the following:

- Is the wavelength shown in the middle at the bottom of the display alternating with HOL?

  If it is,

  1. Press (Hold).
  2. Change the unit as described above.

Holding the Value on the Display

The value for the power on the display is updated approximately every half a second. To hold the value,

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1. Press (Hold).

While the value is being held, the indicator HOL is shown, alternating with the wavelength, in the middle at the bottom of the display.

Releasing the Value on the Display. If a power value is being held on the display, you can release it by pressing (Hold) a second time.

Measuring a Reference

Note



A separate reference is stored for each calibrated wavelength. Make sure the correct wavelength has been selected before you measure.

To measure a reference:
1. Connect the power meter to the point at which the reference is to be measured.
2. Press (Disp—Ref).

If you cannot measure a reference, check the following
- Is REF shown at the top left of the display?
  If it is,
  1. Press (dB/Ref).
  2. Measure the reference as described above.
- Is the wavelength shown in the middle at the bottom of the display alternating with HOL?
  If it is,
  1. Press (Hold).
  2. Measure the reference as described above.

Entering or Editing the Reference

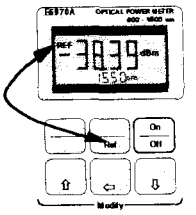
Note



A separate reference is stored for each calibrated wavelength. Make sure the correct wavelength has been selected before you edit.

To enter or edit a reference value:
1. Press (dB/Ref) repeatedly, until REF is shown at the top left of the display.

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The dB/Ref Key and the Reference Indicator

2. Edit the value for the reference using the Modify keys
   - ⇧ increases the value of the flashing digit by one.
   - ⇦ scrolls the flashing digit to the next digit on the left.
   - ⇩ decreases the value of the flashing digit by one.

If you cannot enter or edit the reference, check the following

- Is the wavelength shown in the middle at the bottom of the display alternating with HOL?

  If it is,

  1. Press Hold.
  2. Measure the reference as described above.

Example: Making a Loss and Power Measurement

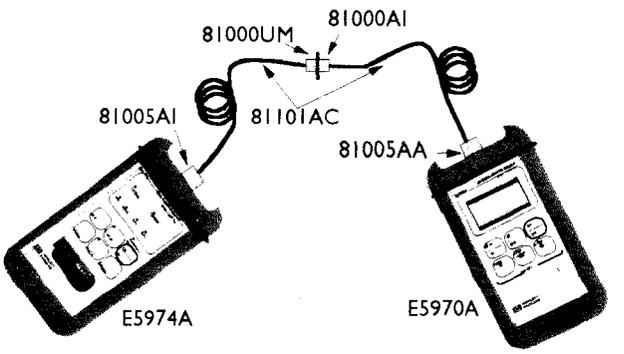
This example describes how to measure the power through, and the loss due to a badly made connection.

In this example, we use

- The HP E5970A Optical Power Meter with a HP 81005AA HMS-10 Adapter,
- A HP E5974A Dual Laser Source with a HP 81005AI HMS-10 Adapter,
- Two HP 81101AC Diamond HMS-10/HP to HMS-10/HP Patchcords,
- HP 81000UM Universal Through Adapter with a HP 81000AI HMS-10 Adapter.

1. Set up the equipment as shown in the diagram:

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Set Up for Power and Loss Measurement Example

a. Switch on both the instruments.
b. Press [1550nm] on the laser source, and make sure CW is lit (press [Mod] repeatedly until it is, if necessary).
c. Press [Sel λ] on the power meter until 1550nm is selected.

2. Measure the reference:
   a. Press [Disp→Ref].
3. Make the DUT.
   a. Separate the two connectors in the through adapter (HP 81000UM).

4. Measure the loss:
   a. Read the value for the loss in dB on the display of the power meter.
5. Measuring the power through the connector pair:
   a. Press [dBm/W].
   b. Read the value for the power in dBm on the display of the power meter.
   c. Press [dBm/W].
   d. Read the value for the power in Watt on the display of the power meter.

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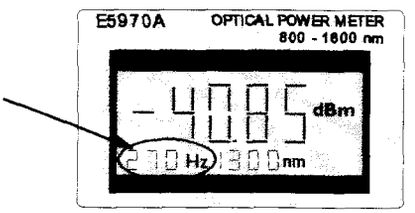
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2 Identifying Modulated Light

This chapter describes how to use the power meter to identify different fibers in a cable.

Identifying Fibers in a Cable

The HP E5970A Optical Power Meter recognizes signals modulated at 270Hz, 330Hz, 1kHz, and 2kHz. The modulating frequency is shown at the bottom left of the display.



The Modulation Indicator

The modulating frequencies recognized by the power meter are available from the HP E5972A and HP E5974A sources, except for the 330Hz modulation. By connecting one or more sources you can use the power meter to identify fibers at the far end of the cable.

Note

If you are not making absolute power measurements, for example where you only need to identify the modulation frequency, it is not necessary to set the value for the wavelength.

If the power meter does not display the modulation, but does display -- in the position of the modulation indicator, then the power of the incoming signal

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is not high enough for the power meter to identify the modulation. This will happen at power levels below -45dBm at 850nm, and at power levels below -50dBm at 1300nm, 1310nm and 1550nm.

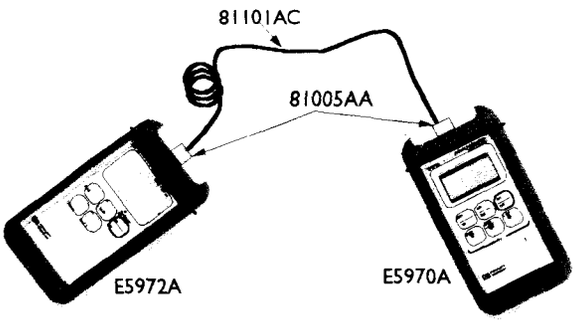
Example: Identifying the Modulation Frequency

In this example, we will identify on the power meter the modulating frequency being used by the source.

The example uses the following equipment:

- The HP E5970A Optical Power Meter with a HP 81005AA HMS-10 Adapter,
- A HP E5972A LED Source with a HP 81005AA HMS-10 Adapter,
- A HP 81101AC Diamond HMS-10/HP to HMS-10/HP Patchcord.

1. Set up the equipment as shown in the diagram:



Set Up for Power and Loss Measurement Example

2. Switch on both the instruments.
3. Press (270Hz) on the source. Note that the modulation indicator on the power meter shows 270Hz (after a slight delay).
4. Press (1kHz) on the source. Note that the modulation indicator on the power meter shows 1kHz (after a slight delay).
5. Press (2kHz) on the source. Note that the modulation indicator on the power meter shows 2kHz (after a slight delay).

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Preparing for Operation

This section covers the information you need to know to set up your instrument.

Initial Inspection

Inspect the shipping container for damage. If there is damage to the container or cushioning, keep them until you have checked the contents of the shipment for completeness and verified the instrument both mechanically and electrically.

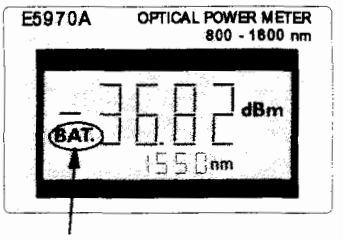
The Appendix D gives a procedure for checking the operation of the instrument. If the contents are incomplete, mechanical damage or defect is apparent, or if an instrument does not pass the operator's checks, notify the nearest Hewlett-Packard office.

Power Supply Requirements

The instrument is powered by two 1.5V dry batteries (Mignon AA size), for an operating period of approximately 36 hours, or two 1.2V rechargeable batteries for an operating period of approximately 12 hours.

When the batteries are low, the low-battery indicator is shown on the display. At this stage, there is approximately enough charge for another 30 minutes of use.

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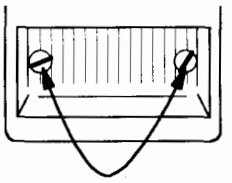


The Low-Battery Indicator

Changing the Batteries

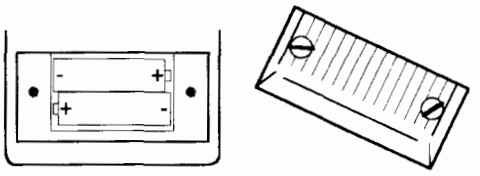
To change the batteries,

1. Loosen the thumbscrews on the rear of the instrument.



The Thumbscrews on the Rear of the Instrument.

2. Remove the cover.



Removing the Rear Cover.

3. Remove the batteries.
4. Making sure that the polarity is correct (it is shown on the bottom of the battery compartment), insert the new batteries.
5. Put the cover back on.
6. Tighten the thumbscrews with your fingers.

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Operating and Storage Environment

The following summarizes the operating environment ranges. In order for the instrument to meet its specifications, the operating environment must be within these limits.

Warning **The instrument is water-protected. Do not submerge in water.**



A

Temperature

The instrument should be protected from temperature extremes and changes in temperature that may cause condensation within it.

The storage and operating temperatures are given below.

Operating Temperature Range:	-10°C to +55°C
Storage Temperature Range:	-40°C to +70°C

Humidity

The operating humidity for the instrument is ≤95%.

Optical Input

The connector adapters and accessories listed in "Connector Adapters" in Appendix B are used so that you can use the instrument with various optical connector types.

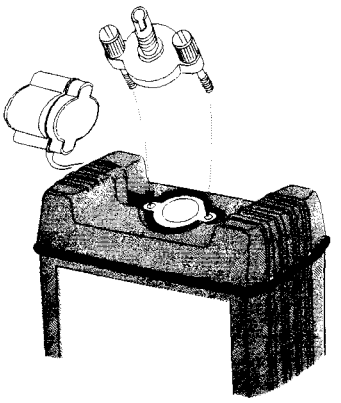
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Attaching a Connector Adapter

Warning **Be careful not to touch the photodetector or its glass cover while attaching the adapter. Any contact with the photodetector could dirty or damage it.**

A

To attach an adapter:
1. Pull the dust cap off the photodetector.



Attaching the Adapter

2. Carefully place the adapter onto the photodetector.
3. Tighten the thumbscrews with your fingers.

Removing a Connector Adapter

Warning **Be careful not to touch the photodetector or its glass cover while removing the adapter. Any contact with the photodetector could dirty or damage it.**

To remove the adapter:
1. Loosen the thumbscrews.
2. Remove the adapter from the photodetector.
3. Cover the photodetector with the dust cap.
4. Put the adapter into its box.

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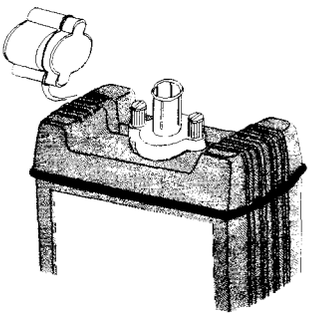
Connecting Bare Fibers

There are two parts to the bare fiber adapter.

- the connector adapter
- the bare fiber connector

To connect a bare fiber,

1. Attach the adapter:
   a. Pull the dust cap off the photodetector.
   b. Carefully place the adapter onto the photodetector.



The Adapter on the photodetector

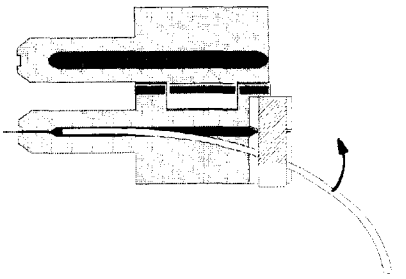
   c. Tighten the thumbscrews with your fingers.
2. Insert the bare fiber into the connector
   a. Remove approximately 10mm of the secondary coating of the fiber.
   b. Strip away a few millimeters from the end of the fiber (using a fiber cleaver).
   c. Use the adjusting screw to lift the clamping plate of the connector.



The Clamping Plate

   d. Open the connector.
   e. Insert the fiber into the notch so that the secondary coating section lies in the large V-notch, and the bare fiber end lies in the small V-notch, protruding slightly out of the end of the connector.

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Inserting the Bare Fiber

f. Slide the fiber with secondary coating under the clamping plate, and undo the screw until the fiber is clamped.
g. Carefully close the connector, making sure that the fiber does not move.
h. Hold the connector closed, and gently pull back the end of the connector until it is even with the end of the connector.

3. Insert the connector into the adapter.

Note

Make sure the instrument does not move, or the fiber is not disturbed while you are measuring.

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Ordering Information

This section covers the instruments and accessories in the handheld fiber-optic test range.

Instruments

Description		Product Number
Optical Power Meter	800 to 1600nm	HP E5970A
LED Source	1300nm	HP E5972A
Dual Laser Source	1310/1550nm	HP E5974A
Commercial Calibration Report		Option UK6

AC Adapter (HP E5974A only)

Product Number	Option Number	Region
HP E5974A	001	U.S.
HP E5974A	002	Europe
HP E5974A	003	U.K.
HP E5974A	004	Australia

If an applicable AC adapter is not listed above, you can use an AC adapter which satisfies the following specifications:

Voltage	9±1V DC		
Current	≤150mA		
Plug	tube jack	inside diameter	1.35mm
		outside diameter	3.7mm
		jack length	≥9mm
		polarity	inner contact is positive

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Connector Adapters

Connector Adapters for the HP E5970A Optical Power Meter and HP E5972A LED Source

Description	Product Number
HMS-10 Adapter	HP 81005AA
FC/PC Adapter	HP 81005FA
DIN 47256 Adapter	HP 81005SA
ST Adapter	HP 81005VA
Biconic Adapter	HP 81005WA
SMA Adapter	HP 81005JA
Bare Fiber Adapter	HP 81005BA

Connector Adapters for the HP E5974A Dual Laser Source

Description	Product Number
HMS-10 Adapter	HP 81005AI
FC/PC Adapter	HP 81005FI
DIN 47256 Adapter	HP 81005SI
ST Adapter	HP 81005VI
Biconic Adapter	HP 81005WI

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Specifications

Definition of Terms

Power Range	The range of input power for which the instrument can be used.
Maximum Input Power	The input power not to be exceeded to avoid destroying the instrument.
Uncertainty at reference conditions:	The inaccuracy in measuring a defined power level at reference conditions (assuming specified HP connector-interfaces and patchcords; connectors and patchcords must be absolutely clean and undamaged).
Total Uncertainty	The inaccuracy in measuring any power level within the specified range and specified conditions (assuming specified HP connector-interfaces and patchcords; connectors and patchcords must be absolutely clean and undamaged).

Performance Specifications

Specifications describe the instrument's warranted performance over the -10°C to +55°C temperature range. Characteristics provide information about non-warranted performance.

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Description		HP E5970A
Sensor Element		InGaAs
Wavelength Range		800 to 1600nm
Calibrated Wavelengths		850, 1300, 1310, 1550nm
Power Range		+11 to -70dBm
Maximum Input Power		+13dBm/20mW
Uncertainty at reference conditions[1]		±3% ±0.13dB
Total Uncertainty		±5%±0.5nW[2] ±0.22dB±0.5nW[2] ±10%±2.5nW[3] ±0.3dB±2.5nW[3]
Display	Type	LCD, 4 digits
	Resolution	0.01dB/0.001μW
	Units	dBm, dB, μW, mW
	Contents	Calibration Wavelength, Modulation Frequency, REFerence Value, PERManent Operation, Low BATtery.
Optical Input		Non-Contact, Removable Connector Adapters
Applicable Fiber Type		9/125μm to 50/125μm
Operating Time (typical)		36 hours (12 hours for rechargeable batteries)

[1] Power Level -20dBm, Continuous Wave, Wavelength 1310nm±2nm, Ambient Temperature +23°C±3K, Relative Humidity 45 to 75%,9/125μm SM fiber, HP/HMS-10 Connector, within 2 years.
[2] Wavelengths 1300/1310/1550nm±10nm, Power Level +5 to -50dBm, Continuous Wave, Ambient Temperature-5 to +45° C, within 2 years.
[3] Wavelength 850nm±5nm, Power Level +5 to -45dBm, Continuous Wave, Ambient Temperature -5 to +45° C, within 2 years.

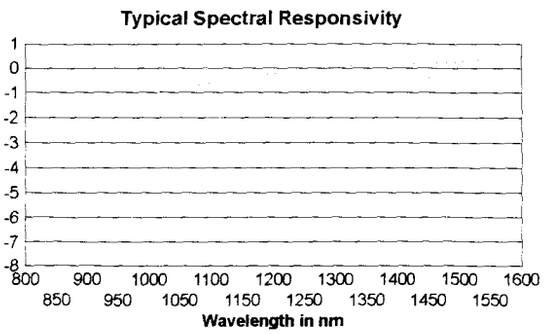
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Supplementary Performance Characteristics

Instrument warm-up is not required.
Modulation frequency recognition and wavelength encoding recognition is available at power levels between +5 and -50dBm (+5 to -45dBm for 850nm).
Detected frequencies are 270Hz, 330Hz, 1kHz, and 2kHz.
Reference value is presettable from +30 to -80dBm. Each calaibrated wavelength has its own reference memory. Display content can be transferred to reference memory.

Typical Spectral Responsivity



C

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General Specifications

Power Supply

Dry Battery	2×AA 1.5V
Rechargeable NiCd Battery	2×AA 1.2V
Auto Off Time[1]	20minutes (approx.)

Dimensions	95mmW×49mmH×195mmD 3.7"×1.9"×7.7"
Net Weight[2]	500g (approx.)
Operating Temperature	-10 to +55°C
Storage Temperature	-40 to +70°C
Relative Humidity	non-condensing.
Recommended Recalibration Period	2 years
Electromagnetic Compatibility according to	EN 50 081-1, EN 50 082-1

[1] The Auto Off mode can be disabled.
The time given is after power on.

[2] Including batteries and connector adapter.

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Performance Test

The procedures in this section test the optical performance of the instrument. The complete specifications to which the HP E5970A is tested are given in Appendix C. All tests can be performed without access to the interior of the instrument.

Required Test Equipment

The equipment required for the performance test is listed in the table below. Any equipment which satisfies the critical specifications of the equipment given in the table, may be substituted for the recommended models.

Instrument or Accessorries	Quantity	Recommended Model	Required Characteristic
Lightwave Multimeter	1	HP 8153A	
Optical Head Interface Module	1	HP 81533B	
Optical Detector Head	1	HP 81520A #C01	
Optical Detector Head	1	HP 81524A #C01	
Laser Source 850 nm	1	HP 81551MM	850±10 nm short term stability <±0.01dB
Laser Source 1310/1550 nm	1	HP 81554SM	1310±10nm (±2nm) 1550±10nm short term stability <±0.005dB
Optical attenuator 850 nm	1		attenuation >50dB Return Loss >26dB repeatability <±0.04dB
Optical attenuator	1	HP 8156A #101	attenuation >50dB Return Loss >45dB repeatability <±0.01dB
Patchcord HMS10/HMS10,9/50μm, SM	2	HP 81101AC	
Patchcord HMS10/HMS10,50/125μm, MM	2	HP 81501AC	
connector interface	4	HP 81000AI	
connector adapter	1	HP 81000AA	
connector adapter	1	HP 81005AA	

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Performance Test

General

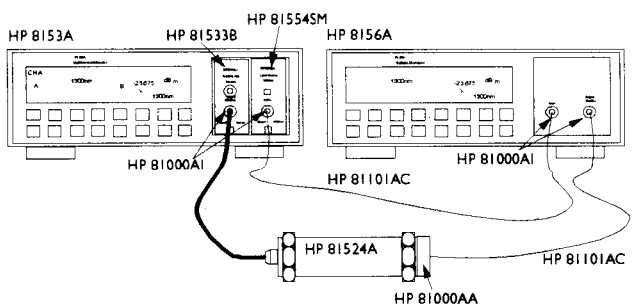
- Make sure all the equipment has warmed up and all connectors are clean.
- Make sure that all patchcord are fixed to the table so that they won't move during measurements.
- Make sure that the ambient conditions are in the following ranges:

temperature 23°C±3K
relative humidity 45 to 75 %

Linearity Test

Even though there is no specification for this parameter, it is recommended to test the linearity first to make sure that the other tests give the correct results.

1. Set up and switch on the equipment.
   a. Make sure that all the connectors are clean.
   b. Connect up the equipment as shown in the figure:



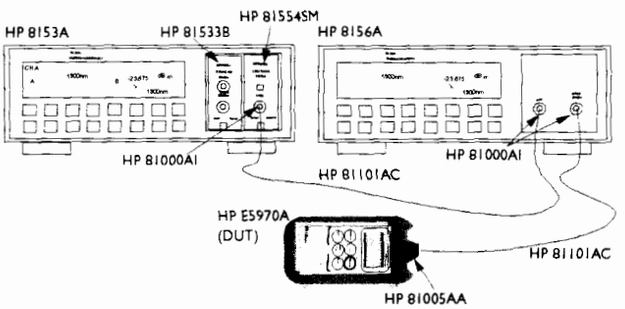
Test Setup for the Reference Measurement (1310/1550nm)

   c. Switch on the lightwave multimeter, and the attenuator, and leave them to warm up.
   d. Switch on the E5970A (DUT), holding the ON/OFF key until PERM is shown on the display.
   e. Make sure that all patchcords are fixed to the table so that they won't move during measurements.
   f. Set the Laser Source to 1310nm (nominal)
   g. Set both the 8153A power meter and the attenuator to the actual wavelength of the laser source.

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h. Set the averaging time, T, on the8153A power meter to 100ms.
i. With the laser source disabled, zero the 8153A power meter, by pressing (Zero).
j. Enable the Laser source and wait 1 minute for it to stabilize.

2. Set the -20dBm reference level.
   a. On the 8153A, press (dBm/W) until the 8153A is measuring in dBm.
   b. Set the 8156A to the attenuation that gives -20.00dBm on the 8153A display.
      i. Note the setting of the 8156A for setting 1 in the test report.
   c. On the 8153A, press (Disp—Ref).
   d. On the 8153A, press (dB).
3. Measure the other reference power levels.
   a. On the 8156A set the attenuation to give +16.00dB on the 8153A.
      i. Note the setting of the 8156A for setting 2 in the test report.
   b. On 8156A set attenuation to give + 8.00 dB on the 8153A display,
      i. Note the setting of the 8156A for setting 3 in the test report.
   c. On 8156A set attenuation to give - 14.00 dB on the 8153A display,
      i. Note the setting of the 8156A for setting 4 in the test report.
   d. On 8156A set attenuation to give - 33.00 dB on the 8153A display,
      i. Note the setting of the 8156A for setting 5 in the test report.
4. Connect the DUT as shown in the figure:



Test Setup for the DUT Measurement (1310/1550nm)

   a. Make sure the E5970A (DUT) has warmed up (the E5970A has warmed up after it performs its first zero operation).
   b. Set the DUT:
      λ = 1310 nm
      Units = dBm
5. Measure the DUT
   a. Set the 8156A to the value noted for setting 1.

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b. On the E5970A (DUT) press [Disp→Ref]
c. Set the 8156A to the value noted for setting 2.
   i. Note the value shown on the DUT in the test report.
d. Set the 8156A to the value noted for setting 3.
   i. Note the value shown on the DUT in the test report.
e. Set the 8156A to the value noted for setting 4.
   i. Note the value shown on the DUT in the test report.
f. Set the 8156A to the value noted for setting 5.
   i. Note the value shown on the DUT in the test report.

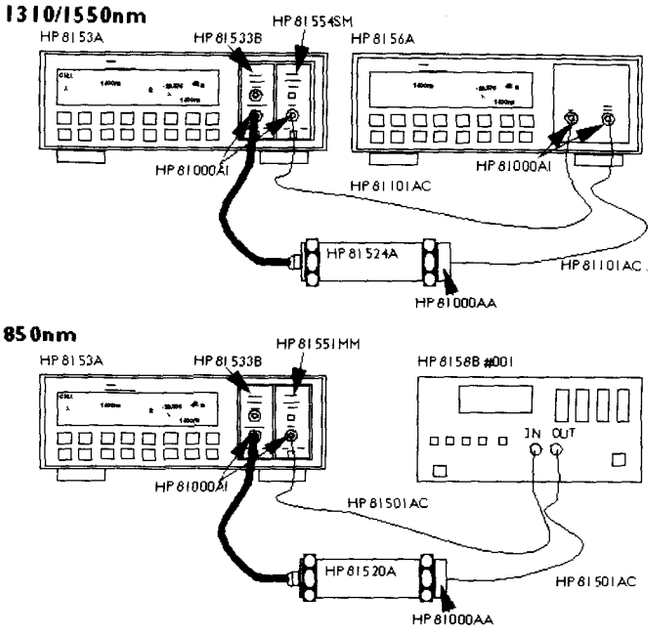
6. Calculate the linearity of the DUT at each setting. This is the difference between the value measured by the DUT the reference value of the 8153A. Note the results in column 5 in the test report.

If the instrument fails this test fails it needs to be readjusted. This can only be done at a Hewlett-Packard Lightwave Service Center.

Uncertainty Test

1. Make sure that you satisfy the environmental conditions:
   - ambient temperature: +23°C±3K
   - relative humidity: 45 to 75 %
2. Make sure all your connectors are clean.
3. Switch on the instruments.
   a. Switch on the E5970A (DUT) for permanet operation, by holding the ON/OFF key for more than 2 seconds until PERM is shown in the display.
      - Set the DUT to "dBm".
   b. Switch on the laser source
      - Set the laser source attenuation to 0
      - Set the wavelength to 1310nm.
   c. On the optical power meter
      - Set the averaging time, T, to 100 ms,
      - Set AUTOranging on.
   d. Switch on the attenuators.
4. With the laser source and the attenuator disabled, connect the equipment as shown in the figure below (please note that the setup is different for 850nm).

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Setup for the Uncertainty Test Reference Measurement

a. Make sure that all patchcord are fixed to the table and won't move during measurements.
b. Make sure that all the instruments are warmed up.
c. With the laser source disabled, zero the power meter, press (Zero).
d. Note the actual wavelength of the laser source in the test report.
e. Set the power meter and the attenuator to the wavelength of the laser source.
f. Enable the laser source and the attenuator output.

5. Make the reference measurement:
   a. Change the attenuation of the attenuator until the optical power meter displays -3.00dBm.

Note

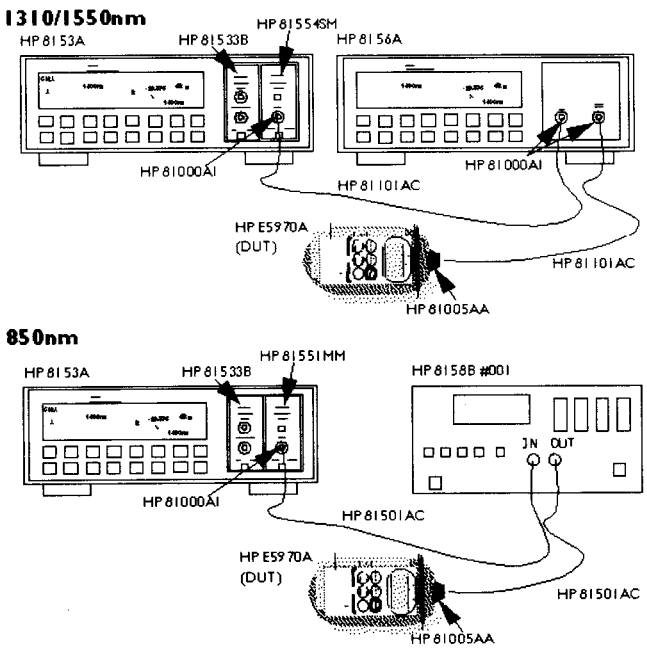
In some cases the laser source will not be powerful enough to give -3.00dBm. In such a case, set the attenuator to 0dB and correct the appropriate values in the test report.

i. Note the setting of the attenuator for setting 1 in the test report.

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b. Change the attenuation of the attenuator until the optical power meter displays -20.00dBm
   i. Note the setting of the attenuator for setting 2 in the test report.
c. Change the attenuation of the attenuator until the optical power meter displays -30.00dBm
   i. Note the setting of the attenuator for setting 3 in the test report.
d. Change the attenuation of the attenuator until the optical power meter displays -50.00dBm
   i. Note the setting of the attenuator for setting 4 in the test report.

6. Measure the DUT.
   a. Make sure the E5970A (DUT) has warmed up (the E5970A has warmed up after it performs its first zero operation).
   b. Connect the attenuator output cable to the DUT as shown in the figure (please note that the setup is different for 850nm).



Setup for the Uncertainty Test DUT Measurement

   c. Set the attenuator to its value for setting 1.
      i. Note the displayed power level of the DUT in the test record.
   d. Set the attenuator to its value for setting 2.

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i. Note the displayed power level of the DUT in the Test Record.

e. Set the attenuator to its value for setting 3.

i. Note the displayed power level of the DUT in the Test Record.

f. Set the attenuator to its value for setting 4.

i. Note the displayed power level of the DUT in the Test Record.

7. Repeat from step 4 to step 6 at 1550nm, and then at 850nm.

P_c, The Wavelength-Corrected Power Level

If the wavelength of the source being used is not in the range 1310±2nm for the reference conditions, 1300±10nm, 1310±10nm 1550±10nm, or 850±5nm respectively for the test, the power level needs to be corrected.

For example, if the actual wavelength is 1308.5nm, and the wavelength to be tested is 1310nm, then this is within ±2nm and no correction is necessary. However, if the wavelength to be tested is 1300nm, this is outside the ±2nm window and correction is necessary.

The correction depends on the wavelength tested and is given in the following equations:, where

P_c is the wavelength-corrected power level,
P_m is the measured power level
λ_{src} is the wavelength of the laser source.

- For the test wavelength at 850nm:

$$P_c = P_m - 0.02dB/nm \times (\lambda_{src} - 850)nm$$

- For the test wavelength at 1300nm:

$$P_c = P_m - 0.0026dB/nm \times (\lambda_{src} - 1300)nm$$

- For the test wavelength at 1310nm:

$$P_c = P_m - 0.0026dB/nm \times (\lambda_{src} - 1310)nm$$

- For the test wavelength of 1550nm, no correction is necessary.

Example For a test wavelength of 1300nm, with a source wavelength, λ_{src} of 1311nm, and a measured power level, P_m, of -20.01dBm,

$$P_c = P_m - 0.0026dB/nm \times (\lambda_{src} - 1300)nm$$

$$= -20.01dBm - 0.0026dB/nm \times (1311 - 1300)nm$$

$$Pc = -20.039dBm$$

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Performance Test for the HP E5970A

Test Facility:

_____ Report No. _____

_____ Date _____

_____ Customer _____

_____ Tested By _____

Model HP E5970A Optical Power Meter

Serial No. _____ Ambient temperature _____ °C

Options _____ Relative humidity _____ %

Firmware Rev. _____ Line frequency _____ Hz

Test Equipment Used:

	Description	Model No.	Trace No.	Cal. Due Date
1.	Lightwave Multimeter	HP 8153A		
2.	Optical Head Interface Module	HP 81533B		
3.	Optical Head	HP 81520A #C01		
4.	Optical Head	HP 81524A #C01		
5.	Laser Source, 850nm	HP 81551MM		
6.	Laser Source, 1310/1550nm	HP 81554SM		
7.	Optical Attenutor, 850nm			
8.	Optical Attenutor, 1310/1550nm	HP 8156A #101		
9.	Patchcord HMS-10/HMS-10, 9/50μm	HP 81101AC		
10.	Patchcord HMS-10/HMS-10, 50/125μm	HP 81501AC		
11.	Connector interface	HP 81000AI		
12.	Connector adapter	HP 81005AA		
13.	Connector adapter	HP 81005AA		

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Model HP E5970A Optical Power Meter No. _____ Date _____

Setting Number	Test Description performed at 1310nm **Linearity** Reference (8153A Display)	Attenuator Setting	DUT (E5970A Display)	Minimum Spec.	Result Reference - DUT	Maximum Spec.
1	(Disp→Ref) 0.00dB	_____dB	(Disp→Ref) 0.00dB			
2	+16.00dB	_____dB	_____dB	-0.13dB	_____dB	+0.13dB
3	+8.00dB	_____dB	_____dB	-0.13dB	_____dB	+0.13dB
4	-14.00dB	_____dB	_____dB	-0.13dB	_____dB	+0.13dB
5	-33.00dB	_____dB	_____dB	-0.15dB	_____dB	+0.15dB

D

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Model HP E5970A Optical Power Meter No. _____ Date _____

	Test Description			Minimum Spec.	Result		Maximum Spec.
	Uncertainty						
	Test Wavelengths = 1300nm and 1310nm						
	Source Wavelength (λ_{src}) = _____nm						
Setting Number	Reference (8153A Display)	Attenuator Setting	P_m (E5970A Display)		P_c† λ_{test} = 1300nm	λ_{test} = 1310nm	
1	-3.00dBm	_____dB	_____dBm	-3.22dBm	_____dBm	_____dBm	-2.78dBm
2	-20.00dBm	_____dB	_____dBm	-20.22dBm	_____dBm	_____dBm	-19.78dBm
3	-30.00dBm	_____dB	_____dBm	-30.22dBm	_____dBm	_____dBm	-29.78dBm
4	-50.00dBm	_____dB	_____dBm	-50.44dBm	_____dBm	_____dBm	-49.57dBm
For 1308nm < λ_{src} < 1312nm							
	-20.00dBm	_____dB		-20.13dBm		_____dBm	-19.87dBm
			Measurement Uncertainty		_____dB	_____dB	

D

† $(\lambda_{test}-2)nm < \lambda_{src} < (\lambda_{test}+2)nm$:

$$P_c = P_m$$

$(\lambda_{test}-10)nm < \lambda_{src} < (\lambda_{test}-2)nm$ or $(\lambda_{test}+2)nm < \lambda_{src} < (\lambda_{test}+10)nm$:

$$P_c = P_m - (0.0026 dB/nm) \times (\lambda_{src} - \lambda_{test}) nm$$

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Model HP E5970A Optical Power Meter No. _____ Date _____

	Test Description		Minimum Spec.	Result	Maximum Spec.
	Uncertainty				
	Test Wavelengths = 1550nm				
		Source Wavelength (λ_{src}) = _____nm			
Setting Number	Reference (8153A Display)	Attenuator Setting		P_c (= P_m) (E5970A Display)	
1	-3.00dBm	_____dB	-3.22dBm	_____dBm	-2.78dBm
2	-20.00dBm	_____dB	-20.22dBm	_____dBm	-19.78dBm
3	-30.00dBm	_____dB	-30.22dBm	_____dBm	-29.78dBm
4	-50.00dBm	_____dB	-50.44dBm	_____dBm	-49.57dBm
		Measurement Uncertainty		_____dB	

D

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Model HP E5970A Optical Power Meter No. _____ Date _____

	Test Description			Minimum Spec.	Result	Maximum Spec.
	Uncertainty Test Wavelength = 850nm Source Wavelength (λ_{src}) = _____nm					
Setting Number	Reference (8153A Display)	Attenuator Setting	P_m (E5970A Display)		P_c†	
1	-3.00dBm	_____dB	_____dBm	-3.3dBm	_____dBm	-2.7dBm
2	-20.00dBm	_____dB	_____dBm	-20.3dBm	_____dBm	-19.7dBm
3	-30.00dBm	_____dB	_____dBm	-30.3dBm	_____dBm	-29.7dBm
4	-50.00dBm	_____dB	_____dBm	-51.55dBm	_____dBm	-48.73dBm
			Measurement Uncertainty		_____dB	

D

† 845nm < λ_{src} < 855nm:

$$P_c = P_m$$

840nm < λ_{src} < 845nm or 855nm < λ_{src} < 860nm:

$$P_c = P_m - (0.02dB/nm) \times (\lambda_{src} - \lambda_{test})nm$$

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Cleaning Procedures

The Cleaning Kit

A full cleaning kit contains the following items:

Isopropyl alcohol This is usually available from pharmaceutical suppliers or chemists.

If possible, use alcohol supplied for medical purposes, rather than impure alcohol or alcohol with additives.

Caution
Do not use other solvents as some can damage plastic materials and claddings. For example, Acetone dissolves the adhesives used in fiber optic devices.

Warning
Never drink this alcohol as this can lead to blindness or other serious damage to your health.

Cotton-swabs Use swabs such as Q-tips or other cotton-swabs. These are typically available from local distributors of medical or hygiene products (such as supermarkets or pharmacys).

Note If you are cleaning connector interfaces or adapters, the diameter of the cotton swab is important. Cotton swabs for babys normally have a smaller diameter.

Caution

- Do not use foam swabs, as these can leave filmy deposits on the surface you are cleaning.
- Store your cotton-swabs carefully and never reuse them. Dust and dirt from the air or from previous cleaning, can scratch or dirty your optical device.

Soft-tissues These are available from most stores and distributors of medical and hygiene products (such as supermarkets or pharmacys).

Use multi-layer tissues made from non-recycled cellulose. These are more absorbent and softer than other types and they do not scratch the surface of your device.

Caution
Store your soft-tissues carefully and never reuse them, as dust and dirt from the air or from previous cleaning can scratch and dirty your optical device.

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Pipe-cleaner These are available from tobacco shops.

Ensure that the bristles of the pipe-cleaner are soft, so that they do not scratch your device during cleaning.

Caution
Store your pipe-cleaner carefully and never reuse them as dust and dirt from the air or from previous cleaning can scratch and dirty your optical device.

Compressed Air This is available from laboratory suppliers.

It is essential that your compressed air is free of dust, water and oil. Only use clean, dry air. If you do not, it can lead to filmy deposits or scratches.

When using compressed air from a can,

- Hold the can upright. A slant can cause propellant to escape with the compressed air and dirty your optical device.
- Spray the first couple of seconds into the air, as the first stream of compressed air can contain condensation or propellant. Any condensation produces a filmy deposit.

If you are using compressed air from a can, you should select one with a CFC-free propellant, for the sake of the environment.

Other Cleaning Tools

To examine devices you also require:

Microscope Select a microscope with a magnification range of between 50X and 300X. These should be available from photographic stores or laboratory suppliers.

Ensure that the light source of the microscope is flexible. This helps you to examine your device closely and from different angles.

A microscope allows you to determine the type of dirt on your device and its extent. Then you can choose the correct cleaning procedure and later to examine the results of cleaning. With a microscope you can also decide if your optical device is scratched.

Ultrasonic bath These are typically available from photographic stores or laboratory suppliers.

An ultrasonic bath very gently removes greasy and other stubborn dirt from optical devices.

Only use an ultrasonic bath with isopropyl alcohol, as other solvents can damage or dirty your optical device.

Premoistened cleaning wipes These are available from HP. The part number is HP 92193N (80 Wipes per box). These are tissues that are moistened with isopropyl alcohol.

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Infrared sensor card	This is typically available from laboratory suppliers. With this card you can qualitatively check the uniformity of your emitted laser light, because when the laser light is projected onto the sensor card it becomes visible.
Lens Cleaning Paper	Some lens cleaning papers and cleaning kits available, for example, in photographic stores are not suitable for cleaning fiber optic devices. To be sure, please ask the salesperson or the manufacturer.

Preserving Connectors

Listed below are some hints on how best to keep your connectors in the best possible condition.

Making Connections	Before you make any connection you must ensure that all cables and connectors are clean. If they are dirty, use the appropriate cleaning procedure. When inserting the ferrule of a patchcord into a connector or an adapter, make sure that the fiber end does not touch the outside of the mating connector or adapter. Otherwise you will rub the fiber end against an unsuitable surface, producing scratches and dirt deposits on the surface of your fiber.
Dust Caps and Shutter Caps	Be careful when replacing dust caps after use. Do not press the bottom of the cap onto the fiber as any dust in the cap can scratch or dirty your fiber surface. When you have finished cleaning, put the dust cap back on, or close the shutter cap if the equipment is not going to be used immediately. Keep the caps on the equipment always when it is not in use. All Hewlett-Packard's lightwave instruments and accessories are shipped with either laser shutter caps or dust caps. If you need additional or replacement dust caps, contact your Hewlett-Packard sales office.
Immersion Oil and Other Index Matching Compounds	Where it is possible, do not use immersion oil or other index matching compounds with your device. They are liable to impair and dirty the surface of the device. In addition, the characteristics of your device can be changed and your measurement results affected.

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Cleaning Instrument Housings

Use a dry and very soft cotton tissue to clean the instrument housing and the keypad. Do not open the instruments as there is a danger of electric shock, or electrostatic discharge. Opening the instrument can cause damage to sensitive components, and in addition your warranty will be voided.

Cleaning Procedures

If you are unsure about the correct cleaning procedure for your device or if you are unsure whether the procedure given here is suitable for your device, check with the manufacturer or sales distributor, or try the procedure on a dummy or test device first.

Cleaning Cable Connectors

Cleaning connectors is difficult as the core diameter of a singlemode fiber is only about 9μm. This generally means you cannot see streaks or scratches on the surface. To be certain of the condition of the surface of your connector and to check it after cleaning, you need a microscope.

For scratches, or dust that has been burnt onto the surface of the connector, you may have no option but to polish the connector. This depends on the degree of dirtiness, or the depth of the scratches. This is a difficult procedure and should only be done by skilled personal, and as a last resort as it wears out your connector.

Warning
Never look into the end of an optical cable that is connected to an active source.

To assess the projection of the emitted light beam you can use an infrared sensor card. Hold the card approximately 5 cm from the output of the connector. The invisible emitted light is project onto the card and becomes visible as a small circular spot.

Preferred Procedure

1. Clean the connector by rubbing a new, dry cotton-swab over the surface using a small circular movement.
2. Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt

Use this procedure particularly when there is greasy dirt on the connector:

1. Moisten a new cotton-swab with isopropyl alcohol.
2. Clean the connector by rubbing the cotton-swab over the surface using a small circular movement.
3. Take a new, dry soft-tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.
4. Blow away any remaining lint with compressed air.

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An Alternative Procedure

The better, more gentle, but more expensive cleaning procedure is to use an ultrasonic bath with isopropyl alcohol.

1. Hold the tip of the connector in the bath for at least three minutes.
2. Take a new, dry soft-tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.
3. Blow away any remaining lint with compressed air.

Cleaning Connector Adapters

Caution

Some adapters have an anti-reflection coating on the back to reduce back reflection. This coating is extremely sensitive to solvents and mechanical abrasion. Extra care is needed when cleaning these adapters.

Preferred Procedure

1. Clean the adapter by rubbing a new, dry cotton-swab over the surface using a small circular movement.
2. Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt

Use this procedure particularly when there is greasy dirt on the adapter:

1. Moisten a new cotton-swab with isopropyl alcohol.
2. Clean the adapter by rubbing the cotton-swab over the surface using a small circular movement.
3. Take a new, dry soft-tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.
4. Blow away any remaining lint with compressed air.

Cleaning Connector Interfaces

Caution

- Be careful when using pipe-cleaners, as the core and the bristles of the pipe-cleaner are hard and can damage the interface.
- Do not use pipe-cleaners on optical head adapters, as the hard core of normal pipe cleaners can damage the bottom of an adapter.

Preferred Procedure

1. Clean the interface by pushing and pulling a new, dry pipe-cleaner into the opening. Rotate the pipe-cleaner slowly as you do this.
2. Then clean the interface by rubbing a new, dry cotton-swab over the surface using a small circular movement.
3. Blow away any remaining lint with compressed air.

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Procedure for Stubborn Dirt

Use this procedure particularly when there is greasy dirt on the interface:

1. Moisten a new pipe-cleaner with isopropyl alcohol.
2. Clean the interface by pushing and pulling the pipe-cleaner into the opening. Rotate the pipe-cleaner slowly as you do this.
3. Moisten a new cotton-swab with isopropyl alcohol.
4. Clean the interface by rubbing the cotton-swab over the surface using a small circular movement.
5. Using a new, dry pipe-cleaner, and a new, dry cotton-swab remove the alcohol, any dissolved sediment and dust.
6. Blow away any remaining lint with compressed air.

Cleaning Bare Fiber Adapters

Bare fiber adapters are difficult to clean. Protect from dust unless they are in use.

Caution
Never use any kind of solvent when cleaning a bare fiber adapter as

- Solvents can damage the foam inside some adapters.
- They can deposit dissolved dirt in the groove, which can then dirty the surface of an inserted fiber.

Preferred Procedure

Blow away any dust or dirt with compressed air.

Procedure for Stubborn Dirt

Use this procedure particularly when there is greasy dirt on the adapter:

Caution
Be careful when using pipe-cleaners, as the core and the bristles of the pipe-cleaner are hard and can damage the adapter.

1. Clean the adapter by pushing and pulling a new, dry pipe-cleaner into the opening. Rotate the pipe-cleaner slowly as you do this.
2. Clean the adapter by rubbing a new, dry cotton-swab over the surface using a small circular movement.
3. Blow away any remaining lint with compressed air.

Cleaning Bare Fiber Ends

Bare fiber ends are often used for splices or, with other optical components, to create a parallel beam. The end of a fiber can often be scratched. You make a new cleave. To do this:

1. Strip off the cladding.
2. Take a new soft-tissue and moisten it with isopropyl alcohol.
3. Carefully clean the bare fiber with this tissue.
4. Make your cleave and immediately insert the fiber into your bare fiber adapter to protect the surface from dirt.

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Cleaning Physical Contact Interfaces

Remove any connector interfaces from the optical output of the instrument before you start the cleaning procedure.

Cleaning interfaces is difficult as the core diameter of a singlemode fiber is only about 9μm. This generally means you cannot see streaks or scratches on the surface. To be certain of the degree of pollution on the surface of your interface and to check whether it has been removed after cleaning, you need a microscope.

Warning
Never look into an optical output, because this can seriously damage your eye sight.

To assess the projection of the emitted light beam you can use an infrared sensor card. Hold the card approximately 5 cm from the interface. The invisible emitted light is project onto the card and becomes visible as a small circular spot.

Preferred Procedure

1. Clean the interface by rubbing a new, dry cotton-swab over the surface using a small circular movement.
2. Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt

Use this procedure particularly when there is greasy dirt on the interface:

1. Moisten a new cotton-swab with isopropyl alcohol.
2. Clean the interface by rubbing the cotton-swab over the surface using a small circular movement.
3. Take a new, dry soft-tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.
4. Blow away any remaining lint with compressed air.

Cleaning Recessed Lens Interfaces

Preferred Procedure

1. Blow away any dust or dirt with compressed air.

If this is not sufficient, then

1. Clean the interface by rubbing a new, dry cotton-swab over the surface using a small circular movement.
2. Blow away any remaining lint with compressed air.

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Procedure for Stubborn Dirt

Use this procedure particularly when there is greasy dirt on the interface, and using the procedure for light dirt is not sufficient. Using isopropyl alcohol should be your last choice for recessed lens interfaces because of the difficulty of cleaning out any dirt that is washed to the edge of the interface:

1. Moisten a new cotton-swab with isopropyl alcohol.
2. Clean the interface by rubbing the cotton-swab over the surface using a small circular movement.
3. Take a new, dry soft-tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.
4. Blow away any remaining lint with compressed air.

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