User and Service Guide

# HP 83447A Lightwave Trigger Receiver

HP part number: 83447-90002
Edition 1 Printed in USA April 1996

1400 Fountaingrove Parkway,
Santa Rosa, CA
95403-1799, USA

# Printing History

| HP Part Number | Edition | Date |
|---|---|---|
| 83447-90002 | Edition 1 | April 1996 |

# Safety Symbols

The following safety symbols are used throughout this manual. Familiarize yourself with each of the symbols and its meaning before operating this instrument.

**CAUTION**

The *caution* sign denotes a hazard to the instrument. It calls attention to a procedure which, if not correctly performed or adhered to, could result in damage to or destruction of the instrument. Do not proceed beyond a *caution* sign until the indicated conditions are fully understood and met.

**WARNING**

The *warning* sign denotes a life-threatening hazard. It calls attention to a procedure 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.

| | |
|---|---|
|  | The **instruction manual** symbol. The product is marked with this symbol when it is necessary for the user to refer to the instructions in the manual. |
| ∿ | This symbol denotes that the instrument uses alternating current. |
| \| | This symbol denotes that the power supply is turned on. |
| ○ | This symbol denotes that the power supply is turned off. |
| CE | The CE mark is a registered trademark of the European Community. |
| ISM1-A | This symbol denotes that the instrument is an Industrial Scientific and Medical Group 1 Class A product. |
|  | The CSA mark is a registered trademark of the Canadian Standards Association. |

# General Safety Considerations

**WARNING**

This is a Safety Class I product (provided with a protective earthing ground incorporated in the power cord). The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. Any interruption of the protective conductor inside or outside of the instrument is likely to make the instrument dangerous. Intentional interruption is prohibited.

**WARNING**

*Before this instrument is switched on*, make sure it has been properly grounded through the protective conductor of the ac power cable to a socket outlet provided with protective earth contact. Any interruption of the protective (grounding) conductor, inside or outside the instrument, or disconnection of the protective earth terminal can result in personal injury.

**WARNING**

Light energy connected to the instrument's `OPTICAL IN` connector radiates from the instrument's `OPTICAL OUT` connector. It is only slightly attenuated.

**WARNING**

If this instrument is not used as specified, the protection provided by the equipment could be impaired. This instrument must be used in a normal condition (in which all means for protection are intact) only.

**WARNING**

There are many points in the instrument which can, if contacted, cause personal injury. Be extremely careful. Any adjustments or service procedures that require operation of the instrument with protective covers removed should be performed only by trained service personnel.

**WARNING**

No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock, do not remove covers.

**WARNING**

For continued protection against fire hazard, replace line fuse only with same type and ratings. The use of other fuses or materials is prohibited.

**CAUTION**

Always use the three-prong AC power cord supplied with this instrument. Failure to ensure adequate earth grounding by not using this cord may cause instrument damage.

**CAUTION** This product has autoranging line voltage input. Be sure the supply voltage is within the specified range.

# Certification and Assistance

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

*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.*

# Warranty

This Hewlett-Packard instrument product is warranted against defects in material and workmanship for a period of one year from date of shipment. 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 Hewlett-Packard. Buyer shall prepay shipping charges to Hewlett-Packard and Hewlett-Packard shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to Hewlett-Packard from another country.

Hewlett-Packard warrants that its software and firmware designated by Hewlett-Packard for use with an instrument will execute its programming instructions when properly installed on that instrument. Hewlett-Packard 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. HEWLETT-PACKARD 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. HEWLETT-PACKARD SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

# In This Book

| | |
|---|---|
| Chapter 1 | provides general information, specifications and characteristics, and electrostatic discharge information for the lightwave trigger receiver. |
| Chapter 2 | describes how to install the lightwave trigger receiver, connect to a high-speed optical oscilloscope, perform a quick confidence check, return the instrument for service, and how to clean connections. |
| Chapter 3 | describes how to perform a waveform test. |
| Chapter 4 | describes troubleshooting, adjustment, performance tests, and replacement procedures. |

# Contents

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# 1

# General Information

# General Information

**What you'll find in this chapter**

- A brief description of the HP 83447A lightwave trigger receiver.
- A list of options and accessories available.
- HP 83447A specifications and characteristics.
- Information about the lightwave receiver's serial number label.
- Information about avoiding damage to the instrument from electrostatic discharge.

# Description of the HP 83447A

The HP 83447A lightwave trigger receiver is used to generate an electrical trigger signal from an optical waveform. A typical usage is for eye-diagram analysis of telecommunications optical signals where an external electrical clock signal is not available as a timing reference.

For more information on using the lightwave trigger receiver refer to Chapter 3.

**Learning the inside story . . .**

The block diagram for the HP 83447A is shown in Figure 1-1. The optical input uses 9 $\mu$m single-mode fiber. The optical signal to be measured is routed to the HP 83447A. Inside the HP 83447A, the signal is passed through an asymmetric coupler, where approximately 10% of the power is tapped. The remaining 90% of the optical signal is sent directly out of the HP 83447A and can be connected to the measuring instrument. The 10% signal is detected by a high-gain avalanche photodiode (APD). The electrical signal from the APD is amplified by an AC-coupled, two-stage limiting amplifier. The output can be used as a timing reference, such as a trigger signal for an instrument like the HP 83480A digital communications analyzer.

This technique is similar to "splitting" an electrical signal from an optical-electrical (O/E) converter to trigger an oscilloscope. However, a key advantage to using the HP 83447A technique is that the optical signal to be measured experiences only a minor level of attenuation, typically 1 $dB_o$. Splitting an electrical signal usually results in a 6 $dB_e$ loss. Because the O/E element of the HP 83447A is an APD and two stages of amplification, a preamp and a limiting amplifier, the output electrical signal exceeds 200 $mV_{p-p}$ with input optical modulation powers lower than 20 $\mu W_{p-p}$, (such as a −20 dBm average power with a 10 dB or higher extinction ratio). Placing an electrical splitter after an O/E converter can degrade the frequency response of the measurement channel, resulting in inaccurate measurements. The HP 83447A triggering technique preserves the integrity of the electrical signal path.

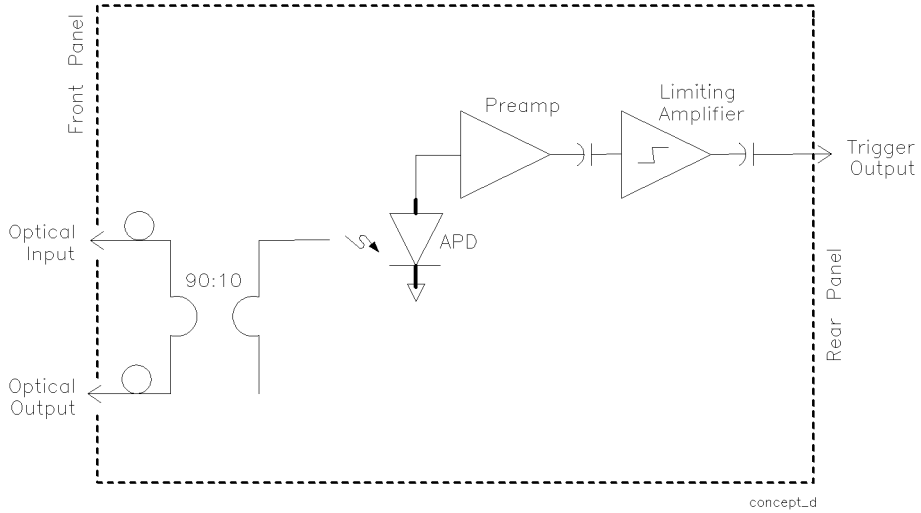



**Figure 1-1. HP 83447A block diagram.**

**Accessories supplied**

The HP 83447A lightwave trigger receiver is shipped with:

Power cable (refer to Figure 2-3)

FC/PC front-panel connector interfaces (deleted on option 010)

*HP 83447A Lightwave Trigger Receiver User and Service Guide.*

### Serial Numbers

Hewlett-Packard makes frequent improvements to its products to enhance their performance, usability, or reliability, and to control costs. HP service personnel have access to complete records of design changes to each type of equipment, based on the equipment's serial number. Whenever you contact Hewlett-Packard about your lightwave receiver, have the complete serial number available to ensure obtaining the most complete and accurate information possible.

A serial-number label is attached to the rear of the lightwave receiver. It contains the serial number and the options installed in the lightwave receiver. Whenever you specify the serial number or refer to it in obtaining information about your lightwave receiver, be sure to use the complete number.

# Front-panel features

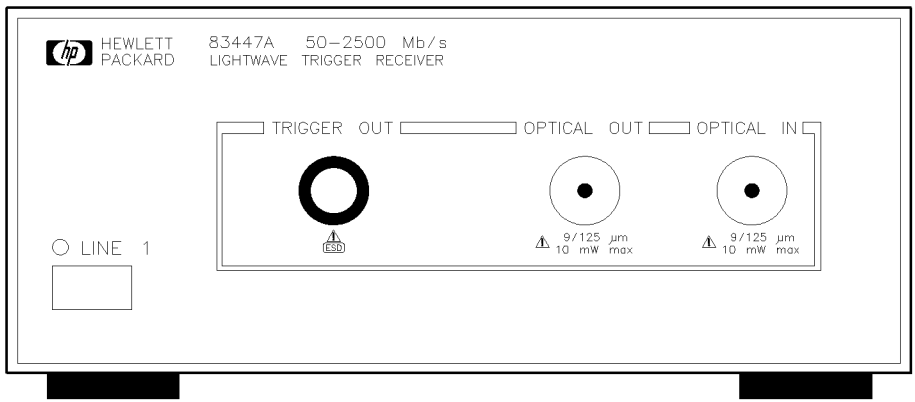



**Figure 1-2. The HP 83447A front panel.**

1. Line switch.
2. Powerline LED.
3. `TRIGGER OUT` connector (Type N).
4. `OPTICAL OUT` connector. This output accepts any of the connector interface adapters from the HP 81000-series.
5. `OPTICAL IN` connector. Maximum signal input is +3 dBm and minimum signal input is −20 dBm. This input accepts any of the connector interface adapters from the HP 81000-series.

**NOTE**

Optical output power is typically ≃1 dB lower than the input power.

**WARNING**

Light energy connected to the instrument's `OPTICAL IN` connector radiates from the instrument's `OPTICAL OUT` connector. It is only slightly attenuated.

Table 1-1 lists specification, *characteristics*, typical performance, and nominal values. The distinction between these terms is described as follows:

- Specifications describe warranted performance over the temperature range 0°C to +55°C (unless otherwise noted). All specifications apply after the instrument's temperature has been stabilized after 30 minutes of continuous operation.
- *Characteristics* provide useful information by giving functional, but nonwarranted, performance parameters. *Characteristics are printed in italics*.
- Typical Performance, where listed, is not *warranted*, but indicates performance which most units will meet.
- Nominal Value indicates the expected, but not *warranted*, value of the parameter.

**Table 1-1. HP 83447A Specifications and Characteristics**

| Specifications[1] | HP 83447A |
|---|---|
| Data rate (NRZ) | 50 Mb/s to 2.5 Gb/s |
| Operating input power | |
| Minimum | −20 dBm |
| Maximum | +3 dBm |
| Maximum through-path optical insertion loss | 1.5 dB |
| Minimum electrical trigger output return loss | 10 dB |
| Minimum electrical output level | |
| Optical input > −15 dBm | 400 mV pk-pk |
| Optical input > −20 dBm | 200 mV pk-pk |
| **Characteristics** | |
| *Maximum output jitter[2] measurement.* | |
| *<1000 Mb/s at −15 dBm* | *0.012 UI (rms)* |
| *<1000 Mb/s at −20 dBm* | *0.02 UI (rms)* |
| *>1000 Mb/s at −15 dBm* | *0.03 UI (rms)* |
| *>1000 Mb/s at −20 dBm* | *0.05 UI (rms)* |
| *Wavelength range* | *1200–1600 nm* |
| *Maximum safe, continuous optical input power* | *10 mW peak* |
| *Nominal trigger output impedance* | *50 ohms* |

1 Tested at 1310 nm and 1550 nm using SONET/SDH-Compliant DFB laser directly modulated at the specified data rate, NRZ coding format. Extinction ratio $\geq$8.2 dB.

2 Jitter measured with $2^{23}-1$ PRBS sequence. Measurement system jitter will be subtracted, (RSS), from the composite jitter.

**Table 1-1. HP 83447A Specifications and Characteristics, continued**

| GENERAL SPECIFICATIONS | |
|---|---|
| **Temperature Range** | |
| Operating | 0°C to +55°C |
| Storage | −40°C to +70°C |
| **Humidity** | Maximum relative humidity 90% for temperatures up to 65°C., decreasing linearly to 50% relative humidity at 40°C. |
| **Altitude** | |
| Operating | Altitude up to 15,000 feet (4,572 meters). |
| Non-operating | 50,000 feet (15,300 meters). |
| **EMI Compatibility** | Conducted and radiated emissions meet the requirements of CISPR Publication 11 and EN 55011 Group 1, Class A. |
| **Power Requirements** | 100/120/220/240 V (±10%), 47 to 63 Hz |
| Power Consumption | Power consumption 75 VA max |
| **Installation Category** | Category II per I.E.C. 1010 |
| **Pollution Degree** | Degree 2 per I.E.C. 664 |
| **Usage** | For indoor use. |
| **Weight** *(characteristic)* | *3.36 kg (7.5 lb)* |
| **Dimensions** (H × W × D) | 10 × 21.3 × 36 cm |
| | 3.9 × 84 × 14.2 in |
| **FRONT-PANEL INPUT / OUTPUT** | |
| **Optical Input and Output Connectors** | 9/125 μm single-mode fiber connector, Diamond HMS-10/HP with universal interface adapters. |
| **Electrical Output Connectors** | Type-N female, 50Ω (nominal) |

# Declaration of Conformity

**DECLARATION OF CONFORMITY**
according to ISO/IEC Guide 22 and EN 45014

**Manufacturer's Name:** Hewlett-Packard Co.

**Manufacturer's Address:** 1400 Fountaingrove Parkway
Santa Rosa, CA 95403-1799
USA

declares that the product:

**Product Name:** Lightwave Trigger Receiver

**Model Number:** HP 83447A

**Product Options:** This declaration covers all options of the above product.

conforms to the following Product specifications:

Safety: IEC 1010-1:1990+A1 / EN 61010-1:1993
CAN/CSA-C22.2 No. 1010.1-92

EMC: CISPR 11:1990/EN 55011:1991 Group 1, Class A
IEC 801-2:1984/EN 50082-1:1992 4 kV CD, 8 kV AD
IEC 801-3:1984/EN 50082-1:1992 3 V/m, 27-500 MHz
IEC 801-4:1988/EN 50082-1:1992 0.5 kV Sig. Lines, 1 kV Power Lines

**Supplementary Information:**

These product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC.

Santa Rosa, California, USA Sept. 20, 1995

Dixon Browder/Quality Manager

European Contact: Your local Hewlett-Packard Sales and Service Office or Hewlett-Packard GmbH, Department ZQ/Standards Europe, Herrenberger Strasse 130, D-71034 Böblingen, Germany (FAX: +49-7031-14-3143)

# Electrostatic Discharge Information

Electrostatic discharge (ESD) can damage or destroy electronic components. All work on electronic assemblies should be performed at a static-safe work station. Figure 1-3 shows an example of a static-safe work station using two types of ESD protection:

- Conductive table-mat and wrist-strap combination.
- Conductive floor-mat and heel-strap combination.

Both types, when used together, provide a significant level of ESD protection. Of the two, only the table-mat and wrist-strap combination provides adequate ESD protection when used alone.

To ensure user safety, the static-safe accessories must provide at least 1 MΩ of isolation from ground. Refer to Table 1-2 for information on ordering static-safe accessories.

**WARNING**

These techniques for a static-safe work station should not be used when working on circuitry with a voltage potential greater than 500 volts.

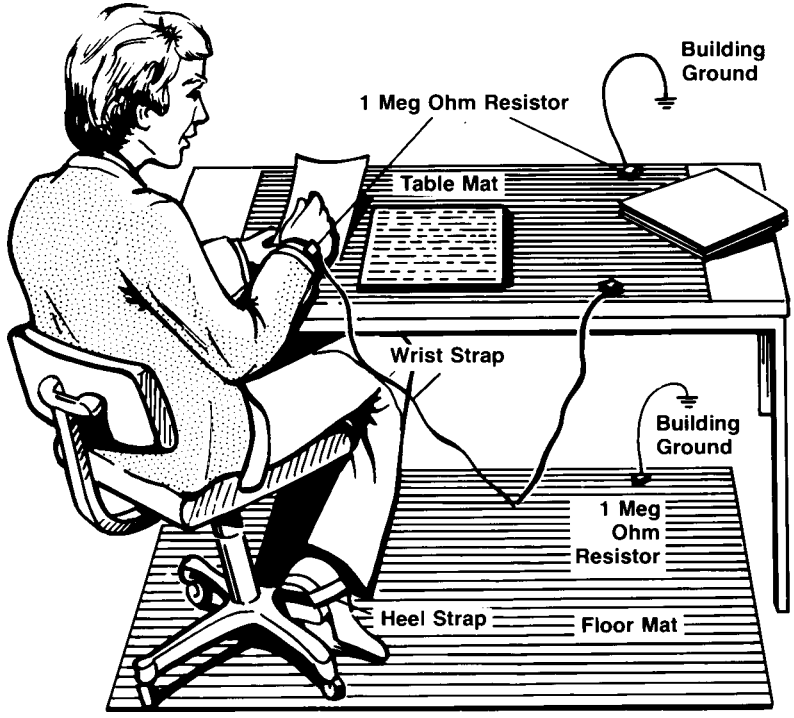



**Figure 1-3. Example of a static-safe work station.**

# Reducing ESD damage

The following suggestions may help reduce ESD damage that occurs during testing and servicing operations.

- Before connecting any coaxial cable to an instrument connector for the first time each day, momentarily ground the center and outer conductors of the cable.
- Personnel should be grounded with a resistor-isolated wrist-strap before touching the center pin of any connector and before removing any assembly from the unit.
- Be sure that all instruments are properly earth-grounded to prevent a buildup of static charge.

Table 1-2 lists static-safe accessories that can be obtained from Hewlett-Packard using the HP part numbers shown.

**Table 1-2. Static-Safe Accessories**

| HP Part Number | Description |
|---|---|
| 9300-0797 | Set includes: 3M static control mat 0.6 m × 1.2 m (2 ft × 4 ft) and 4.6 cm (15 ft) ground wire. (The wrist-strap and wrist-strap cord are not included. They must be ordered separately.) |
| 9300-0980 | Wrist-strap cord 1.5 m (5 ft). |
| 9300-1383 | Wrist-strap, color black, stainless steel, without cord, has four adjustable links and a 7 mm post-type connection. |
| 9300-1169 | ESD heel-strap (reusable 6 to 12 months). |

2

# Installation and Preparation for Use

# Installation and Preparation for Use

**What you'll find in this chapter**

- Installing the HP 83447A.
- Connecting the HP 83447A lightwave trigger receiver to a high-speed oscilloscope.
- How to perform a quick confidence check of the HP 83447A.
- How to return the HP 83447A for service.
- Cleaning connections for accurate measurements.

This instrument has been designed and tested in accordance with IEC Publication 1010, *Safety Requirements for Electronic Measuring Apparatus*, and has been supplied in a safe condition. The instruction documentation contains information and warnings which must be followed by the user to ensure safe operation and to maintain the instrument in a safe condition.

**N O T E**

Clean the cabinet using a damp cloth only.

# Installing the HP 83447A

**CAUTION**

VENTILATION REQUIREMENTS: When installing the instrument in a cabinet, the convection into and out of the instrument must not be restricted. The ambient temperature (outside the cabinet) must be less than the maximum operating temperature of the instrument by 4°C for every 100 watts dissipated in the cabinet. If the total power dissipated in the cabinet is greater than 800 watts, then forced convection must be used.

**CAUTION**

This product is designed for use in Installation Category II and Pollution Degree 2 per IEC 1010 and 664 respectively.

## Step 1. Inspect the shipment

Inspect the lightwave trigger receiver shipping container for damage. If the shipping container or cushioning material is damaged, keep it until you have verified that the contents are complete and you have tested the lightwave receiver mechanically and electrically.

The lightwave trigger receiver is packed within a carton. Refer to "How to Return the HP 83447A for Service", for the description and part numbers of the packaging materials. Refer to "Accessories" in "Description of the HP 83447A" in Chapter 1, for the accessories shipped with the lightwave receiver.

If the contents are incomplete or if the lightwave receiver does not pass the verification test (this procedure is provided in "Performing a Quick Confidence Check"), notify the nearest Hewlett-Packard office. If the shipping container is damaged or the cushioning material shows signs of stress, also notify the carrier. Keep the shipping materials for the carrier's inspection. The HP office will arrange for repair or replacement without waiting for a claim settlement.

If the shipping materials are in good condition, retain them for possible future use. You may wish to ship the lightwave receiver to another location or return it to Hewlett-Packard for service. Refer to the section "How to Return the HP 83447A for Service" later in this chapter for additional information.

## Step 2. Set the line voltage selector

Use the following procedure to set the lightwave trigger receiver's voltage selector to the voltage range (100, 120, 220, or 240 V) corresponding to the available ac voltage.

**CAUTION**

Before connecting the lightwave receiver to the power source, you must set the rear-panel voltage selector correctly to adapt the lightwave receiver to the power source. An improper selector setting can damage the lightwave receiver when it is turned on.

1. Pry open the fuse holder door with a small screwdriver.

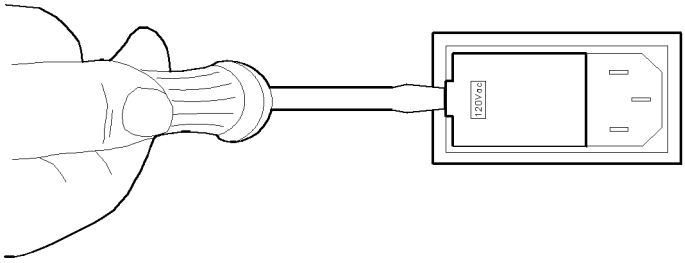



**Figure 2-1. Opening the fuse holder door.**

**CAUTION**

You must remove the voltage tumbler to change the voltage selector. Rotating the voltage tumbler while it is in the line module damages the line module.

2. Remove the voltage tumbler (the voltage tumbler is not attached to the unit).
3. Replace the voltage tumbler so the desired line voltage value shows through the small opening in the fuse holder door.

## Step 3. Check the fuse

The recommended fuse is listed below:

- For a 100/120 V operation: T 0.315A, 250 V, time delay, HP part number 2110-0449.
- For a 220/240 V operation: T 0.16A, 250 V, time delay, HP part number 2110-0448.

**WARNING**

**For continued protection against fire hazard, replace line fuse only with same type and ratings. The use of other fuses or materials is prohibited.**

The line fuse is housed in a small container next to the voltage tumbler (refer to Figure 2-2). The spare fuse is stored below the line fuse.

To check the fuse, insert the tip of a screwdriver on the side of the container and gently pull outward to remove the container.

If the fuse is defective or missing, install a new fuse in the proper position and reinsert the fuse container.

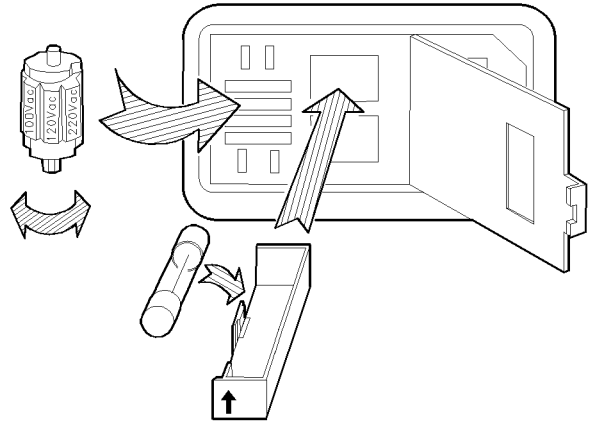



**Figure 2-2. Selecting the line voltage value and checking the fuse.**

## Step 4. Connect the HP 83447A to a power source

The lightwave trigger receiver is a portable instrument and requires no physical installation other than connection to a power source.

**CAUTION**

*Do not* connect ac power until you have verified that the line voltage is correct, the proper fuse is installed, and the line voltage selector switch is properly positioned, as described in the following paragraphs. Damage to the equipment could result.

**Table 2-1. HP 83447A Power Requirements**

| Characteristic | Requirement |
|---|---|
| Input Voltage | 100, 120, 220, or 240 V (±10%) |
| Frequency | 47 to 63 Hz |
| Power | 75 VA (maximum) |

**Power cable**

The lightwave receiver is equipped with a three-wire power cable, in accordance with international safety standards. When connected to an appropriate power line outlet, this cable grounds the instrument cabinet.

**WARNING**

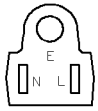
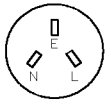
Failure to ground the lightwave receiver properly can result in personal injury. Before turning on the lightwave receiver, you must connect its protective earth terminals to the protective conductor of the main power cable. Insert the main power cable plug only into a socket outlet that has a protective earth contact. *Do not* defeat the earth-grounding protection by using an extension cable, power cable, or autotransformer without a protective ground conductor.

If you are using an autotransformer, make sure its common terminal is connected to the protective earth contact of the power source outlet socket.

Various power cables are available to connect the lightwave receiver to the types of ac power outlets unique to specific geographic areas. The cable appropriate for the area to which the lightwave receiver is originally shipped is included with the unit. You can order additional ac power cables for use in different areas. Figure 2-3 lists the available ac power cables, illustrates the plug configurations, and identifies the geographic area in which each cable is appropriate.

**CAUTION**

Always use the three-prong ac power cord supplied with this instrument. Failure to ensure adequate earth grounding by not using this cord may cause instrument damage.

| PLUG TYPE ** | CABLE HP PART NUMBER | PLUG DESCRIPTION | CABLE LENGTH CM (INCHES) | CABLE COLOR | FOR USE IN COUNTRY |
|---|---|---|---|---|---|
| 250V   | 8120-1351<br>8120-1703 | Straight* BS1363A<br>90° | 229 (90)<br>229 (90) | Mint Gray<br>Mint Gray | Great Britain, Cyprus, Nigeria, Singapore, Zimbabwe |
| 250V   | 8120-1369<br>8120-0696 | Straight* NZSS198/ASC112<br>90° | 201 (79)<br>221 (87) | Gray<br>Gray | Argentina, Australia, New Zealand, Mainland China |
| 250V   | 8120-1689<br>8120-1692 | Straight* CEE7-Y11<br>90° | 201 (79)<br>201 (79) | Mint Gray<br>Mint Gray | East and West Europe, Central African Republic, United Arab Republic (unpolarized in many nations) |
| 125V   | 8120-1348<br>8120-1538 | Straight* NEMA5-15P<br>90° | 203 (80)<br>203 (80) | Black<br>Black | United States Canada, Japan (100 V or 200 V), Brazil, Colombia, Mexico, Philippines, Saudia Arabia, Taiwan |
| | 8120-1378<br>8120-4753<br>8120-1521<br>8120-4754 | Straight* NEMA5-15P<br>Straight<br>90°<br>90° | 203 (80)<br>230 (90)<br>203 (80)<br>230 (90) | Jade Gray<br>Jade Gray<br>Jade Gray<br>Jade Gray | |
| 250V   | 8120-5182<br>8120-5181 | Straight* NEMA5-15P<br>90° | 200 (78)<br>200 (78) | Jade Gray<br>Jade Gray | Israel |
| | | | | | |

* Part number for plug is industry identifier for plug only. Number shown for cable is HP Part Number for complete cable, including plug.

** E = Earth Ground; L = Line; N = Neutral.

**Figure 2-3. AC power cables available.**

## Step 5. Turn on the HP 83447A

With the power cable inserted into the line module, turn the lightwave receiver on by pressing the line switch. The green light-emitting diode (LED) should light. If the LED should fail to light, refer to "Performing a Quick Confidence Check" in this chapter.

# Connecting the HP 83447A to a Digital Communications Analyzer

The following procedure describes how to connect the lightwave trigger receiver to a digital communications analyzer, such as the HP 83480A. Refer to Figure 2-4.

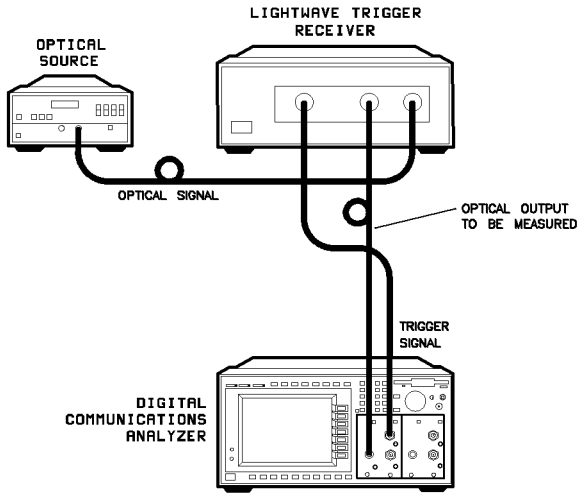



**Figure 2-4. Connecting the HP 83447A to a digital communications analyzer.**

1. Clean all connectors before connecting them. Refer to the "Cleaning Connections for Accurate Measurements" section, later in this chapter for instructions.

   Notice that the connector interface has a small protrusion. This protrusion fits in the slot of the optical connector of the front panel.

2. Connect an optical cable from the `OPTICAL OUT` connector on the lightwave trigger receiver to the optical data input connector on the digital communications analyzer. An adapter may be necessary.

3. Connect the cable from the laser output to the `OPTICAL IN` connector interface on the lightwave trigger receiver.

4. Connect the laser source to the fiber optic cable.

**CAUTION**

Do not exceed the maximum input to the receiver's `OPTICAL IN`. The maximum input power is shown on the front panel of the trigger receiver.

5. Connect the trigger receiver's `OPTICAL OUT` to the optical input of an HP 83480A which includes a module such as the HP 83485A/B or 83481A.
6. Connect the `TRIGGER OUT` to the trigger input of the digital communications analyzer.
7. Turn the lightwave trigger receiver on.

**WARNING**

Light energy connected to the instrument's `OPTICAL IN` connector radiates from the instrument's `OPTICAL OUT` connector. It is only slightly attenuated.

# Performing a Quick Confidence Check

To verify the basic functionality of the trigger receiver, use the following procedure. Clean all optical interfaces as described in the "Cleaning Connections for Accurate Measurements" section, later in this chapter, before making measurements.

1. Turn on the trigger receiver.
2. Connect the optical source 1200–1600 nm >−20 dBm with modulation at 50 Mb/s to 2.5 Gb/s rate to optical input.
3. Connect the trigger out to an analyzer trigger in.
4. Adjust the trigger level of the analyzer to 0 volts. Confirm the analyzer is triggering properly.
5. Verify there is an optical signal at the optical output.

## If the verification check fails

If the trigger receiver does not pass the verification check, you should review the procedure being performed when the problem occurred. A few minutes spent performing some simple checks may save waiting for your instrument to be repaired. Before calling Hewlett-Packard or returning the unit for service, please make the following checks:

1. Is the rear-panel voltage selector switch set correctly? Is the line fuse good?
2. Does the line socket have power?
3. Is the unit plugged in to the proper ac power source?
4. Is the unit turned on? Check that the green light-emitting diode (LED) next to the line switch is on, indicating that the power supply is on.
5. If other equipment, cables, and connectors are being used with the trigger receiver, are they connected properly and operating correctly?

6. Review the procedure for the test being performed when the problem appeared. Are all the settings correct?
7. Are the connectors clean? Refer to "Cleaning Connections for Accurate Measurements" for more information about cleaning the connectors.

If the trigger receiver still fails, you have two options:

- Return the lightwave receiver to Hewlett-Packard for repair. If the lightwave receiver is still under warranty or is covered by an HP maintenance contract, it will be repaired under the terms of the warranty or contract (the warranty is at the front of this manual). If the lightwave receiver is no longer under warranty or is not covered by an HP maintenance plan, Hewlett-Packard will notify you of the cost of the repair after examining the unit. Refer to the "How to Return the HP 83447A for Service" section, later in this chapter, for more information.
- Have the unit repaired by qualified service personnel. Refer to Chapter 4.

**WARNING** No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock do not remove covers.

# How to Return the HP 83447A for Service

When an instrument is returned to a Hewlett-Packard service office for servicing, it must be adequately packaged and have a complete description of the failure symptoms attached.

When describing the failure, please be as specific as possible about the nature of the problem. Include copies of additional failure information (such as instrument failure settings, data related to instrument failure, and error messages) along with the instrument being returned.

Please notify the service office before returning your instrument for service. Any special arrangements for the instrument can be discussed at this time. This will help the service office to service and return your instrument as quickly as possible.

## Packaging

The original shipping containers should be used. If the original materials were not retained, identical packaging materials are available through any Hewlett-Packard office. Packaging materials are listed below.

Outer Carton ..... 9211-6485
Foam Pad Set ..... 9220-4805

**CAUTION**

Instrument damage can result from using packaging materials other than those specified. Never use styrene pellets as packaging material. They do not adequately cushion the instrument or prevent it from shifting in the carton. They may also cause instrument damage by generating static electricity.

## Instrument shipping preparation procedure

1. Write a complete description of the failure and attach it to the instrument. Include any specific performance details related to the problem.

   The following information should be returned with the instrument.

   - Type of service required.
   - Description of the problem:
     Whether problem is constant or intermittent.
     Whether instrument is temperature-sensitive.
     Whether instrument is vibration-sensitive.
     Instrument failure settings.
     Error codes.
     Performance data.
   - Company name and return address.
   - Name and phone number of technical contact person.
   - Model number of returned instrument.
   - Full serial number of returned instrument.
   - List of any accessories returned with instrument.

2. Pack the instrument in the appropriate packaging material. Refer to "Packaging", in this section, for information about the original packaging material.

   If the original or equivalent packaging materials cannot be obtained, instruments can be packaged using the following instructions.

**CAUTION**

Inappropriate packaging of instruments may result in damage to the instrument during transit.

- Wrap the instrument in antistatic plastic to reduce the possibility of damage caused by electrostatic discharge.
- For instruments weighing less than 54 kg (120 lb), use a double-walled, corrugated cardboard carton of 159 kg (350 lb) test strength.
- The carton must be large enough to allow 3 to 4 inches on all sides of the instrument for packing material, and strong enough to accommodate the weight of the instrument.

- Surround the equipment with 3 to 4 inches of packing material, to protect the instrument and prevent it from moving in the carton. If packing foam is not available, the best alternative is S.D-240 Air Cap™ from Sealed Air Corporation (Commerce, California 90001). Air Cap™ looks like a plastic sheet filled with air bubbles. Use the pink (antistatic) Air Cap™ to reduce static electricity. Wrapping the instrument several times in this material will protect the instrument and prevent it from moving in the carton.

3. Seal the carton with strong nylon adhesive tape.
4. Mark the carton "FRAGILE, HANDLE WITH CARE".
5. Retain copies of all shipping papers.

## Sales and service offices

Hewlett-Packard has sales and service offices located around the world to provide complete support for Hewlett-Packard products. To obtain servicing information or to order replacement parts, contact the nearest Hewlett-Packard Sales and Service Office. In any correspondence or telephone conversation, refer to the instrument by its model number, serial number, and option designation.

**Table 2-2. Hewlett-Packard Sales and Service Offices**

| U.S. FIELD OPERATIONS | | |
|---|---|---|
| **Headquarters**<br>Hewlett-Packard Company<br>19320 Pruneridge Avenue<br>Cupertino, CA 95014 U.S.A.<br>(800) 752-0900 | **California, Northern**<br>Hewlett-Packard Company<br>301 East Evelyn<br>Mountain View, CA 94041<br>(415) 694-2000 | **California, Southern**<br>Hewlett-Packard Company<br>1421 South Manhatten Ave.<br>Fullerton, CA 92631<br>(714) 999-6700 |
| **Colorado**<br>Hewlett-Packard Company<br>24 Inverness Place, East<br>Englewood, CO 80112<br>(303) 649-5000 | **Georgia**<br>Hewlett-Packard Company<br>2000 South Park Place<br>Atlanta, GA 30339<br>(404) 955-1500 | **Illinois**<br>Hewlett-Packard Company<br>5201 Tollview Drive<br>Rolling Meadows, IL 60008<br>(708) 342-2000 |
| **New Jersey**<br>Hewlett-Packard Company<br>150 Green Pond Road<br>Rockaway, NJ 07866<br>(201) 586-5400 | **Texas**<br>Hewlett-Packard Company<br>930 East Campbell Road<br>Richardson, TX 75081<br>(214) 231-6101 | |
| **EUROPEAN FIELD OPERATIONS** | | |
| **Headquarters**<br>Hewlett-Packard S.A.<br>150, Route du Nant-d'Avril<br>1217 Meyrin 2/Geneva<br>Switzerland<br>(41 22) 780.8111 | **France**<br>Hewlett-Packard France<br>1 Avenue Du Canada<br>Zone D'Activite De Courtaboeuf<br>F-91947 Les Ulis Cedex<br>France<br>(33 1) 69 82 60 60 | **Germany**<br>Hewlett-Packard GmbH<br>Hewlett-Packard Strasse<br>61352 Bad Homburg<br>Germany<br>(+49 6172) 16-0 |
| **Great Britain**<br>Hewlett-Packard Ltd.<br>Eskdale Road, Winnersh Triangle<br>Wokingham, Berkshire RG11 5DZ | | |

**Table 2-2. Hewlett-Packard Sales and Service Offices (continued)**

| INTERCON FIELD OPERATIONS | | |
|---|---|---|
| **Headquarters**<br>Hewlett-Packard Company<br>3495 Deer Creek Rd.<br>Palo Alto, California 94304-1316<br>(415) 857-5027 | **Australia**<br>Hewlett-Packard Australia Ltd.<br>31-41 Joseph Street<br>Blackburn, Victoria 3130<br>(61 3) 895-2895 | **Canada**<br>Hewlett-Packard Ltd.<br>17500 South Service Road<br>Trans-Canada Highway<br>Kirkland, Quebec H9J 2X8<br>Canada<br>(514) 697-4232 |
| **China**<br>China Hewlett-Packard Company<br>38 Bei San Huan X1 Road<br>Shuang Yu Shu<br>Hai Dian District<br>Beijing, China<br>(86 1) 256-6888 | **Japan**<br>Yokogawa-Hewlett-Packard Ltd.<br>1-27-15 Yabe, Sagamihara<br>Kanagawa 229, Japan<br>(81 427) 59-1311 | **Singapore**<br>Hewlett-Packard Singapore Ltd.<br>Pte. Ltd.<br>Alexandra P.O. Box 87<br>Singapore 9115<br>(65) 271-9444 |
| **Taiwan**<br>Hewlett-Packard Taiwan<br>8th Floor, H-P Building<br>337 Fu Hsing North Road<br>Taipei, Taiwan<br>(886 2) 712-0404 | | |

# Cleaning Connections for Accurate Measurements

Accurate and repeatable measurements require clean connections. Use the following guidelines to achieve the best possible performance when making measurements on a fiber-optic system:

- Keep connectors covered when not in use.
- Use dry connections whenever possible.
- Use the cleaning methods described in this section.
- Use care in handling all fiber-optic connectors.
- When inserting a fiber-optic connector into a front-panel adapter, make sure that the fiber end does not touch the outside of the mating connector or adapter.

Because of the small size of cores used in optical fibers, care must be used to ensure good connections. Poor connections result from core misalignment, air gaps, damaged fiber ends, contamination, and improper use and removal of index-matching compounds.

Use dry connections. Dry connectors are easier to clean and to keep clean. Dry connections can be used with physically contacting connectors (for example, Diamond HMS-10/HP, FC/PC, DIN, and ST). If a dry connection has 40 dB return loss or better, making a wet connection will probably not improve (and can degrade) performance.

**CAUTION**

Hewlett-Packard strongly recommends that index matching compounds NOT be applied to their instruments and accessories. Some compounds, such as gels, may be difficult to remove and can contain damaging particulates. If you think the use of such compounds is necessary, refer to the compound manufacturer for information on application and cleaning procedures.

**Cleaning Accessories**

| Item | HP Part Number |
|---|---|
| Isopropyl alcohol | 8500-5344 |
| Cotton swabs | 8520-0023 |
| Small foam swabs | 9300-1223 |
| Compressed dust remover (non-residue) | 8500-5262 |

**Dust Caps Provided with Lightwave Instruments**

| Item | HP Part Number |
|---|---|
| Laser shutter cap | 08145-64521 |
| FC/PC dust cap | 08154-44102 |
| Biconic dust cap | 08154-44105 |
| DIN dust cap | 5040-9364 |
| HMS10/HP dust cap | 5040-9361 |
| ST dust cap | 5040-9366 |

## Inspecting Fiber-Optic Cables

Consistent measurements with your lightwave equipment are a good indication that you have good connections. However, you may wish to know the insertion loss and/or return loss of your lightwave cables or accessories. If you test your cables and accessories for insertion loss and return loss upon receipt, and retain the measured data for comparison, you will be able to tell in the future if any degradation has occurred.

Connector (or insertion) loss is one important performance characteristic of a lightwave connector. Typical values are less than 1 dB of loss, and sometimes as little as 0.1 dB of loss with high performance connectors. Return loss is another important factor. It is a measure of reflection: the less reflection the better (the larger the return loss, the smaller the reflection). The best physically contacting connectors have return losses better than 50 dB, although 30 to 40 dB is more common.

**You can visually inspect your cables**

Although it is not necessary, visual inspection of fiber ends can be helpful. Contamination or imperfections on the cable end face can be detected as well as cracks or chips in the fiber itself. Use a microscope (100X to 200X magnification) to inspect the entire end face for contamination, raised metal, or dents in the metal as well as any other imperfections. Inspect the fiber for cracks and chips. Visible imperfections not touching the fiber core may not affect performance (unless the imperfections keep the fibers from contacting).

## To clean a non-lensed connector

**CAUTION**

Do not use any type of foam swab to clean optical fiber ends. Foam swabs can leave filmy deposits on fiber ends that can degrade performance.

1. Apply isopropyl alcohol to a clean lint-free cotton swab or lens paper.

   Cotton swabs can be used as long as no cotton fibers remain on the fiber end after cleaning.

2. Before cleaning the fiber end, clean the ferrules and other parts of the connector.
3. Apply isopropyl alcohol to a new clean lint-free cotton swab or lens paper.
4. Clean the fiber end with the swab or lens paper. Move the swab or lens paper back and forth across the fiber end several times.

   Some amount of wiping or mild scrubbing of the fiber end can help remove particles when application of alcohol alone will not remove them. This technique can remove or displace particles smaller than one micron.

5. Immediately dry the fiber end with a clean, dry, lint-free cotton swab or lens paper.
6. Blow across the connector end face from a distance of 6 to 8 inches using filtered, dry, compressed air. Aim the compressed gas at a shallow angle to the fiber end face.

   Nitrogen gas or compressed dust remover can also be used.

**CAUTION**

Do not shake, tip, or invert compressed air canisters, because this releases particles in the can into the air. Refer to instructions provided on the compressed air canister.

7. As soon as the connector is dry, connect or cover it for later use.

## To clean an adapter

1. Apply isopropyl alcohol to a clean foam swab.

   Cotton swabs can be used as long as no cotton fibers remain after cleaning. The foam swabs listed in this section's introduction are small enough to fit into adapters.

   Although foam swabs can leave filmy deposits, these deposits are very thin, and the risk of other contamination buildup on the inside of adapters greatly outweighs the risk of contamination by foam swabs.

2. Clean the adapter with the foam swab.
3. Dry the inside of the adapter with a clean, dry, foam swab.
4. Blow through the adapter using filtered, dry, compressed air.

   Nitrogen gas or compressed dust remover can also be used.

**CAUTION**

Do not shake, tip, or invert compressed air canisters, because this releases particles in the can into the air. Refer to instructions provided on the compressed air canister.

# 3

# Using the HP 83447A

# Using the HP 83447A

**What you'll find in this chapter**

- Example of generating oscilloscope eye diagrams when a separate trigger signal is not available.

The HP 83447A may also be used as a general purpose receiver when a linear response is not required. Its limiting amplifier makes it appropriate for digital signals.

# Waveform Test

Eye diagrams are important tools to characterize the waveform performance of a laser transmitter. An eye diagram is generated on an optical oscilloscope by observing the data output from the laser while triggering the oscilloscope from a related clock signal. Typically only the optical data signal is available, so the trigger must be derived directly from the data.

The trigger can be generated usually:

- from a recovered clock signal
- from the data using an electrical splitter
- from the data using an optical splitter

The trigger from a recovered clock uses a small portion of the optical signal and feeds it to circuitry that reconstructs the clock signal from the data.

The trigger on data can be made in two ways: electrically and optically. Electrical uses a small portion of the electrical signal (electrical coupler) coming out from an O/E converter and applies it to the oscilloscope trigger input. In case of triggering on an optical data signal, an optical coupler carrys a small portion of the optical data signal to a high gain avalanche photodiode O/E converter and applies it to the oscilloscope's trigger input.

## Triggering on data versus triggering on clock

Trigger signal generated from the pattern will produce a timing reference on either a rising or falling edge. A group of bits at "0" or "1" will provide a trigger when the stream appears and when the stream changes. Therefore, depending on how many bits are displayed on the oscilloscope screen, only a minority of the bits in the patterns will yield trigger events. An eye diagram will be generated, but will not be a complete representation of an entire pattern (only the clock recovery trigger provides this). Eye diagram measurements, triggered with a signal derived from the data, will be inaccurate.

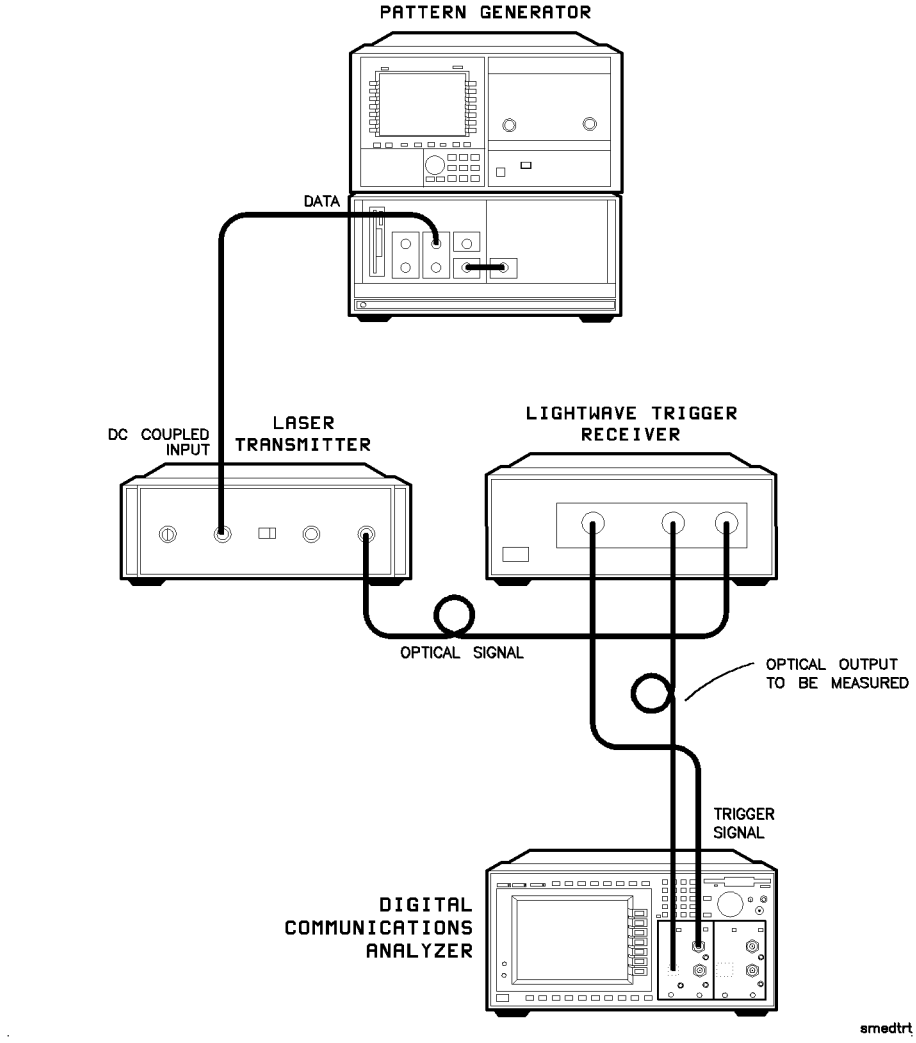



**Figure 3-1. Setup for measuring eye diagram by triggering from recovered trigger.**

# 4

# Servicing the HP 83447A

# Servicing the HP 83447A

**What you'll find in this chapter**

- General information
- Troubleshooting
- Adjustment procedures
- Performance tests
- Replacement procedures
- Replaceable parts

**WARNING** These servicing instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing unless you are qualified to do so.

**WARNING** The opening of covers or removal of parts is likely to expose dangerous voltages. Disconnect the instrument from all voltage sources while it is being opened.

**WARNING** The power cord is connected to internal capacitors that may remain live for five seconds after disconnecting the plug from its power supply.

**WARNING** This is a Safety Class 1 Product (provided with a protective earthing ground incorporated in the power cord). The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. Any interruption of the protective conductor inside or outside of the instrument is likely to make the instrument dangerous. Intentional interruption is prohibited.

**WARNING** For continued protection against fire hazard, replace line fuse only with same type and ratings, (type T 0.315A/250V for 100/120V operation *or* T 0.16A/250V for 220/240V operation). The use of other fuses or materials is prohibited.

# General Information

**NOTE**

Clean the cabinet using a damp cloth only.

**Serial-number information**

Whenever you contact Hewlett-Packard about your lightwave trigger receiver, have the complete serial number and option designation available. This will ensure you obtain accurate service information. Refer to "Description of the HP 83447A" in Chapter 1 for more information.

**Safety considerations**

Before servicing this lightwave trigger receiver, familiarize yourself with the safety markings on the instrument and the safety instructions in this manual. This instrument has been manufactured and tested according to international safety standards. To ensure safe operation of the instrument and the personal safety of the user and service personnel, the cautions and warnings in this manual must be heeded.

Refer to the summary of safety considerations at the front of this manual. Individual chapters also contain a detailed safety notation.

**WARNING**

Failure to ground the lightwave trigger receiver properly can result in personal injury, as well as instrument damage.

Before turning on the lightwave trigger receiver, connect a three-wire power cable with a standard IEC 320-C13 (CEE 22-V) inlet plug to the lightwave receiver power receptacle. The power cable outlet plug must be inserted into a power-line outlet socket that has a protective earth-contact. *Do not* defeat the earth-grounding protection by using an extension cable, power cable, or autotransformer without a protective ground conductor.

If you are using an autotransformer, make sure its common terminal is connected to the protective ground conductor of its power-source outlet socket.

**Reliability considerations**

The lightwave trigger receiver input circuitry can be damaged by power levels that exceed the maximum safe input-level specifications. Refer to Table 1-1 for the input specifications. To prevent input damage, these specified levels must not be exceeded.

**Protection from electrostatic discharge**

Electrostatic discharge (ESD) can damage or destroy electronic components. All work on electronic assemblies should be performed at a static-safe work station. Refer to "Electrostatic Discharge Information" in Chapter 1 for more information on preventing ESD.

**Required service tools**

Table 4-1 lists the tools that may be required to service the trigger receiver.

**Table 4-1. Required Tools**

| Description | HP Part Number |
|---|---|
| Small Pozidriv screwdriver | 8710-0899 |
| Wire cutter | 8710-0012 |
| Long-nose pliers | 8710-1107 |
| 3/16 nut driver | N/A |
| 5/16 box wrench | 8720-0015 |
| 5/8 open end wrench | 8710-1894 |
| 7 mm nut driver | 8710-1217 |
| 8 mm nut driver | 8710-1222 |
| Torx driver T-10 | 8710-1623 |
| Torx driver T-15 | 8710-1622 |
| **Description** | **Suhner P/N** |
| Suhner connector removal tool | 74Z-0-0-225 |

The main functional blocks of the lightwave trigger receiver are the printed circuit card, the power supply and the optical coupler.

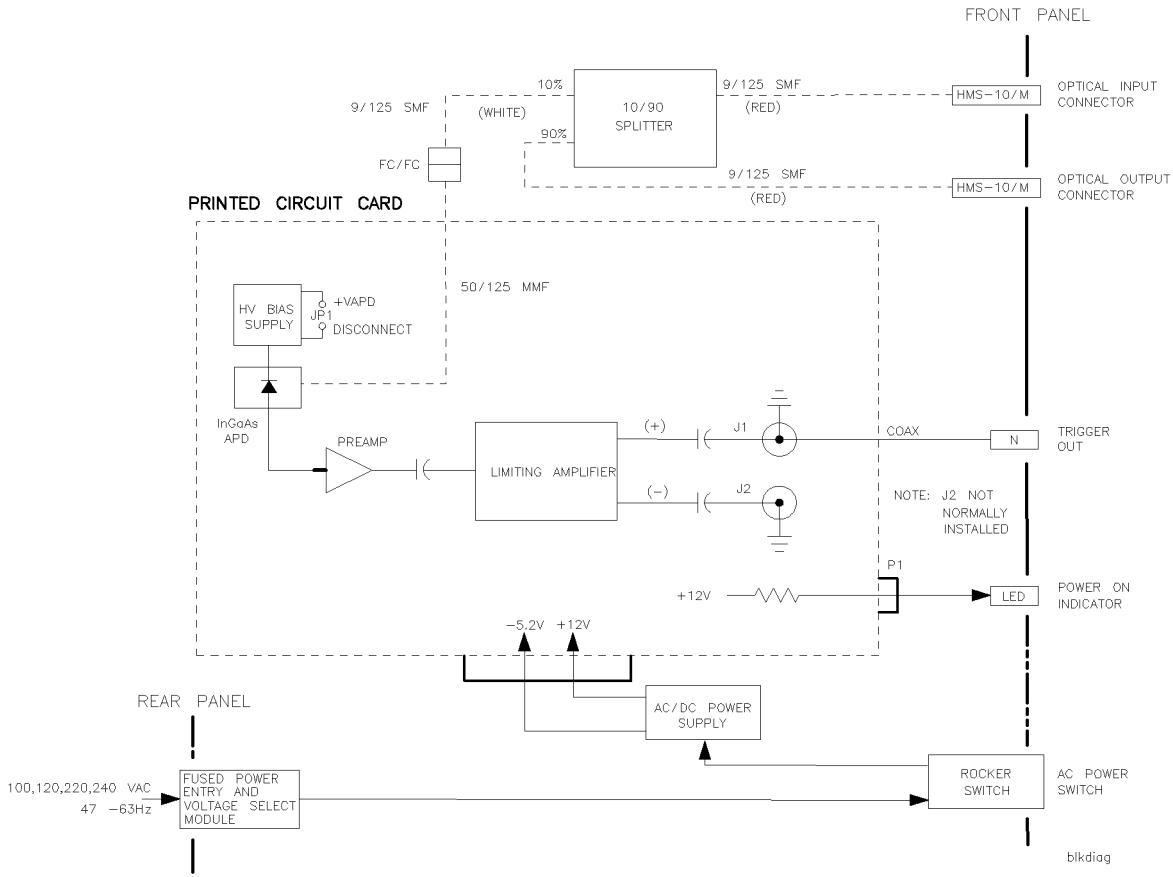



**Figure 4-1. HP 83447A block diagram.**

**WARNING**

The opening of covers or removal of parts is likely to expose dangerous voltages. Disconnect the instrument from all voltage sources while it is being opened.

**WARNING**

The power cord is connected to internal capacitors that may remain live for five seconds after disconnecting the plug from its power supply.

**Optical coupler**

The HP 83447A includes an optical coupler that is used to split off 10% of the optical signal. Ninety percent of the optical signal is passed through to the optical output port. Ten percent of the signal is sent to a high-gain avalanche photodetector diode. The photodiode output can then be used as a trigger signal.

**Photodetector assembly**

Modulated light enters the InGaAs avalanche photodetector diode (APD) through a single-mode fiber front-panel connector. The APD converts the modulated light to a current replica of the modulation. The APD is biased in the 40 to 100V range by a thermally compensated high voltage bias supply.

The APD output signal is converted to a voltage and amplified by a low noise preamp stage. The preamp output is ac coupled to a limiting amplifier stage, which outputs a fixed signal level independent of the optical input.

### Troubleshooting the power supply

If the +5 V power supply output voltage is low, the power supply could be in a current-limiting or overvoltage crowbar mode. If the power supply is too low, use the R12 potentiometer to decrease the voltage, then cycle the power of the trigger receiver. Decreasing the voltage and cycling the power may bring the power supply back to normal operation. If the power supply output voltage cannot be brought within tolerance, disconnect the power supply from the photodetector and electrical amplifier unit, and recheck the +5 V power supply. If the power supply is still low, replace the power supply. If the power supply is operational, suspect the photodetector assembly.

**NOTE**

The power supply +5 V output is a floating output and is wired to supply −5.2 V to the detector card.

The −12 V power supply is *not* used. The voltages on the power supply terminals are described in Table 4-2.

**Table 4-2. Voltages on the DC Power Supply Terminals**

| Terminal | Description | Voltage |
|---|---|---|
| E2, −OUT | −5.2V power supply | −5.32 Vdc ±10 mV |
| E2, +OUT | Common ground | 0 Vdc |
| E1, −OUT | −12 V power supply | −12 Vdc (approximate) |
| E1, COM | Common ground | 0 Vdc |
| E1, +OUT | +12 V power supply | +12.12 Vdc ±10 mV |

## Power supply adjustment procedure

The trigger receiver has several adjustments, two of which are on the power supply. To adjust the power supply, use an HP 3456A digital multimeter (or equivalent) to measure the dc output voltage at the power supply terminals. If the dc output voltage is not within tolerance, adjust the power supply.

**WARNING**

**Only trained service personnel should perform measurements inside the instrument chassis. Use extreme care. The exposed terminals on the power supply transformer carry ac line voltage. You can be killed or seriously injured if you contact them when power is applied.**

1. On the power supply board, connect the multimeter between the −OUT terminal and the +OUT terminal of E2 on the dc power supply.
2. Measure the power supply output voltage. The voltage reading should be +5.32 Vdc ±10 mV.

**NOTE**

The +5 V power supply circuit has current-limiting and overvoltage control. If the +5 V power supply is adjusted above +5.8 V (approximate), the +5 V power supply will shut down.

3. If the voltage reading is not +5.32 Vdc, adjust the +5V ADJ potentiometer (R12) for a reading of +5.32 Vdc ±10 mV.
4. On the power supply board, connect the multimeter between E1 COM and E1 +OUT.

5. Measure the power supply output voltage. The voltage reading should be +12.12 Vdc ±10 mV.
6. If the voltage is not +12.12 Vdc, adjust the +12V ADJ for a reading of +12.12 Vdc ±10 mV.

# Photodetector assembly adjustment procedure

There are two adjustments on the photodetector assembly.

- The R26 +VAPD adjust sets the APD bias for optimum sensitivity.
- The R1 High Input Limit Set sets maximum operating power for jitter performance.

Since the equipment setup is the same as the setup required for testing instrument sensitivity, the adjustment procedures are included after the performance test.

Replacement photodetector assemblies come from the factory pre-adjusted. Slight re-adjustments may be required as the instrument ages.

The performance tests in this section require the following test equipment:

**Table 4-3. Required Test Equipment**

| Model Number | Type |
|---|---|
| HP 70001A | modular measurement system mainframe |
| HP 70004A | color display |
| HP 70841B | pattern generator module |
| HP 70311A | clock source |
| HP 83480A | digial communications analyzer mainframe |
| HP 83485A | optical plug-in |
| HP 8156A | optical attenuator with option 101 (1300 nm–1550 nm) and option 012 (FC/PC connectors) |
| HP 8153A | lightwave multimeter |
| HP 81536A | power sensor module |
| HP 81534A | optical return loss module |
| HP 81554SM | laser source module, 1300–1550 nm |
| HP 81000BR | reference reflector |
| HP 81109AC | patchcord HRL, Diamond HMS-10/HP |
| HP 8752A | network analyzer |
| HP 8493A option 006 | 6 dB attenuator pad |
| BCP 420A-23ST | Lsr Xmit 1300, 2.5 Gbit * |

*BCP (Broadband Communications Products, Inc.)
305 East Drive, Suite A
Melbourne, FL 32904
(407) 984-3671

# Test 1. Through-path optical insertion loss

**Test Setup**

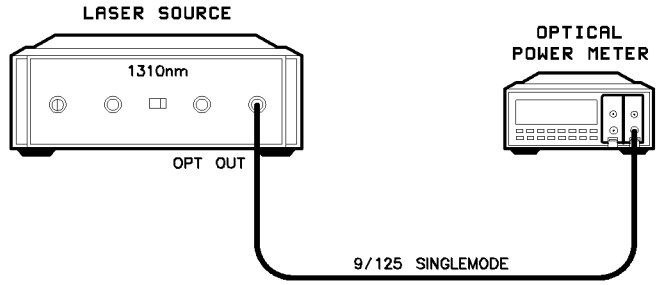



**Figure 4-2. Through-path optical insertion loss test setup.**

**Procedure**

*Perform this procedure first with a 1310 nm source and then with a 1550 nm laser source.*

1. Clean and connect the optical source fiber to the power meter as shown in Figure 4-2.

   Note the power reading.

2. Disconnect the source fiber from the power meter and connect it to the HP 83447A `OPTICAL INPUT` connector.

3. Clean and connect an FC/PC single-mode fiber jumper cable from the HP 83447A `OPTICAL OUTPUT` connector to the power meter.

4. Note the reading. This reading must be less than 1.5 dB below the input power reading.

   Record the following:

   at wavelength 1310 nm:

   - Source fiber power (PIN, dBm) _____
   - Optical output connector power (POUT, dBm) _____
   - Through-path insertion loss (PIN-POUT, 1.5 dB max) _____

   at wavelength 1550 nm:

   - Source fiber power (PIN, dBm) _____
   - Optical output connector power (POUT, dBm) _____
   - Through-path insertion loss (PIN-POUT, 1.5 dB max) _____

# Test 2. Trigger output amplitude

1. Connect equipment as shown in Figure 4-3.
2. Initialize the instruments.

**Test Setup**

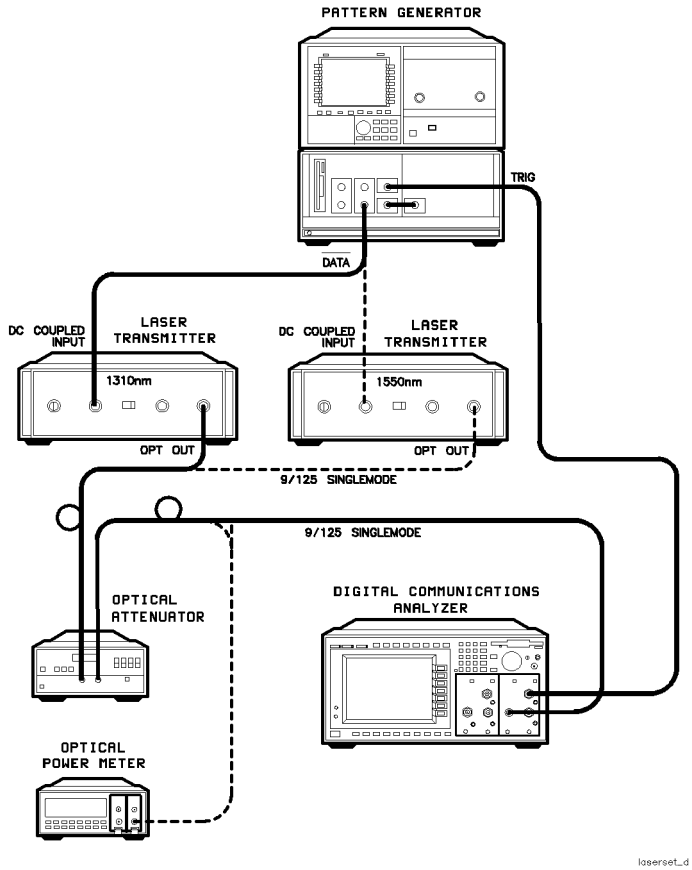



**Figure 4-3. Laser transmitter setup.**

3. Set the test equipment to the settings shown in Table 4-4.

**Table 4-4. Laser Transmitter Setup**

| | |
|---|---|
| Pattern Generator | $2^{23}-1$ pattern<br>1.00 Vpp data amplitude<br>0.000V data high level (0V term.)<br>normal polarity, clock trigger<br>trigger mode clock/32<br>23 zeroes trigger pattern |
| Clock Source | 2.48832 GHz frequency<br>**ON** |
| Laser Transmitter<br>(both 1310 and 1550 nm) | connect the 1310 nm unit first, then the 1550 nm unit<br>analog mode<br>bias cal mode<br>clean the optical connectors, FC/PC adapter<br>1.00 Vpp drive |
| Optical Attenuator | clean the optical connectors<br>calibrate to read actual power<br>fully charged or on an ac adapter<br>Set power to −10 dBm<br>FC/PC adapters |
| Optical Power Meter | 1310 nm wavelength<br>clean the connector<br>FC/PC adapter |
| Digital Communication Analyzer | electrical channel **OFF**<br>optical channel **ON**<br>Time base units: Bit Period<br>Bit rate: STM16/OC48<br>Scale: 2 bits<br>250 $\mu$W/div<br>−400 mV trigger level<br>display persistence = 1 sec, zero mV offset |
| | |

4. With the laser turned off, perform the analyzer vertical calibration (Dark Cal).
5. Turn on the laser and observe the eye pattern on the digital communications analyzer.
6. On the Measure Eye menu, select the Measure Extinction Ratio function.

7. Adjust the pattern generator output level, if necessary, for an extinction ratio of $\geq$8.2 dB.

   *Perform this procedure first with a 1310 nm source and then with a 1550 nm laser source.*

8. Connect the equipment as shown in Figure 4-4.

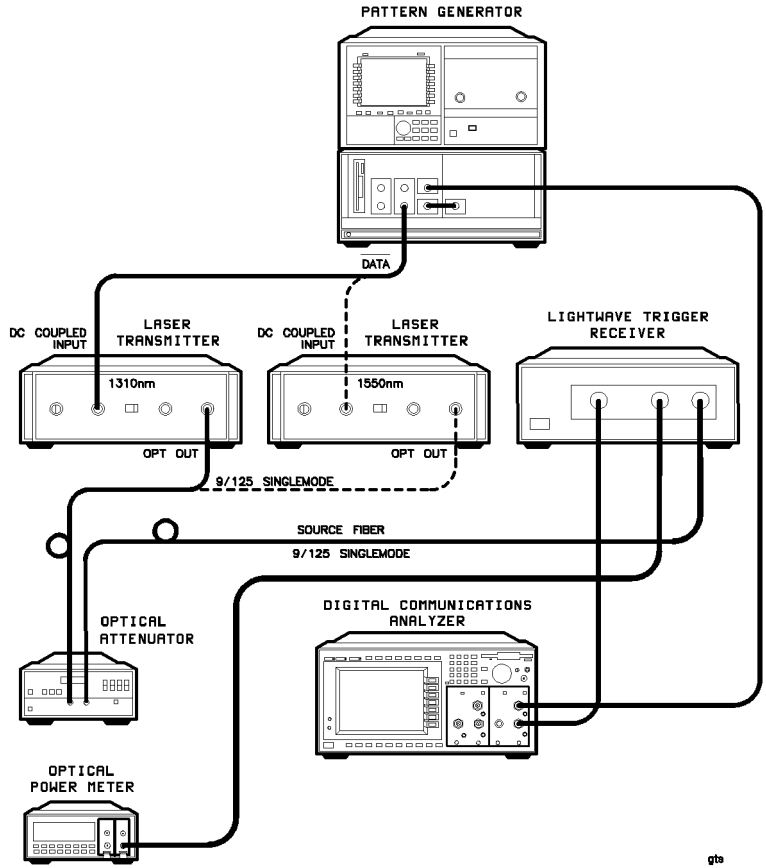



**Figure 4-4. General test setup.**

9. Set the test equipment to the settings shown in Table 4-5.

**Table 4-5. Trigger Output Amplitude Test Setup**

| | |
|---|---|
| Pattern Generator | $2^{23}-1$ pattern<br>data amplitude set for >8.2 dB extinction ratio on transmitter<br>0.000V data high level (0V term.)<br>normal polarity<br>clock trigger<br>trigger mode clock/32<br>23 zeroes trigger pattern<br>clock input termination −2 V |
| Clock Source | 2.48832 GHz frequency |
| Laser Transmitter<br>(both 1310 and 1550 nm) | connect the 1310 nm unit first, then the 1550 nm unit<br>analog mode<br>bias cal mode<br>clean the optical connectors<br>FC/PC adapter<br>drive set for >8.2 dB extinction ratio |
| Optical Attenuator | clean the optical connectors<br>calibrate to read actual power<br>set power to −15 dBm<br>FC/PC adapters |
| Optical Power Meter | 1310 nm wavelength<br>clean the connector<br>FC/PC adapter |
| Digitalizing Oscilloscope | electrical channel **ON**<br>optical channel **OFF**<br>Time base units: Bit Period<br>Bit rate: STM16/OC48<br>Scale: 2 bits<br>100 mV/div<br>−400 mV trigger level<br>display persistence = 1 sec<br>zero mV offset |
| HP 83447A being tested | −15 dBm input power<br>clean the optical connectors<br>FC/PC adapter |

10. The electrical channel should be enabled and the optical channel disabled.
11. Set the optical power into the HP 83447A to −15 dBm.
12. Turn on the color grade measurements on the digital communications analyzer by selecting `Display`, `Color Grade` ON
13. Using the Vamptd measurement on the digital communications analyzer, measure the eye amplitude on the electrical channel (Trigger out). It should be above 0.4 vpp (average low-to-average high).
14. Place the vertical cursors at the eye mid-point, and accumulate at least 10,000 samples. Record the following:

    at wavelength 1310 nm:

    - Optical Power |−15.0 dBm, ± 1 dB| _____
    - Trigger amplitude |must be > 400 $mV_{p-p}$| _____

    at wavelength 1550 nm:

    - Optical Power |−15.0 dBm, ± 1 dB| _____
    - Trigger amplitude |must be > 400 $mV_{p-p}$| _____

15. Reduce the optical power to −20 dBm.
16. Measure the eye amplitude and record the following:

    at wavelength 1310 nm:

    - Optical power _____
    - Trigger eye amplitude |must be > 200 $mV_{p-p}$| _____

    at wavelength 1550 nm:

    - Optical power _____
    - Trigger eye amplitude |must be > 200 $mV_{p-p}$| _____

17. Raise the optical power to +3 dBm maximum by reducing the attenuation. Measure the power and then plug the transmitter connector directly into the HP 83447A`OPTICAL INPUT`. Record the following:

    at wavelength 1310 nm:

    - Maximum input power [$P_{MAX}$, dBm] _____

    at wavelength 1550 nm:

    - Maximum input power [$P_{MAX}$, dBm] _____

**CAUTION** Do not exceed +3 dBm optical power.

18. Verify the electrical trigger output eye is still of good quality.

If the test fails, readjust R1.

**+VAPD adjustment**

19. The +VAPD Adjustment (R26) is clearly labeled on the printed circuit card. The objective of this adjustment is to set the avalanche photodetector gain for best jitter performance.

**WARNING** Hazardous voltage because +VAPD is nominally 100 Vdc. Use caution when making this measurement.

**Detector bias adjustment**

20. Configure the test equipment as shown in Figure 4-4.
21. Initialize the test equipment as follows:

    Pattern Generator

    Pattern ..... $2^{23}-1$
    Data amplitude
    (as required for 8.2 dB extinction ratio) ..... 1 to 2 Vpp
    Data out high level (0V term.) ..... 0.000V
    Polarity ..... normal
    Trigger ..... clock
    Trigger mode ..... clock/32, 23 zeroes trigger pattern
    Clock input termination ..... −2V

Clock Source

Frequency ..... 2.48832 GHz
Amplitude ..... ECL

Laser Transmitter

Clean the optical connectors and the FC adaptor.
Mode ..... analog
Bias ..... cal mode

Optical Attenuator

Clean the optical connectors.
Calibrate to read actual power.
Charge fully or use with an AC adaptor.
Power out ..... −10 dBm

Optical Power Meter

Clean the optical connectors and the FC adaptor.
Wavelength ..... 1310 nm

Digital Communications Analyzer

Electrical channel ..... on
Optical channel ..... off
Time/division ..... 150 psec/div
Amplitude/division ..... 100 mV/div
Trigger level ..... 400 mV
Trigger polarity ..... negative
Display persistence ..... 1 sec
Offset ..... 0 mV

HP 83447A

Clean the optical connectors.
Optical input ..... −10 dBm

22. Connect the HP 83447A and turn the HP 83447A AC power on. A 2.48832 Gbps eye diagram appears on the digital communications analyzer.
23. Wait until the HP 83447A has been on for at least ten minutes.
24. Turn off the BCP model 420A optical transmitter.

25. Increase the electrical channel vertical sensitivity to 20 mV/div. A noisy straight line is displayed.
26. Adjust R26 slowly clockwise until the display indicates an increase in noise (primarily positive-going).
27. Adjust R26 counter-clockwise until the excess noise just disappears.

**High input limit adjustment**

28. Turn the laser transmitter on.
29. Set the electrical channel vertical sensitivity to 150 mV/division.
30. Disconnect the optical fiber from the `OPTICAL INPUT` connector.
31. Attach the optical fiber to the optical power meter.
32. Set the attenuator for +3.5 dBm.
33. Connect the source to the `OPTICAL INPUT` on the HP 83447A.

    If no eye diagram is displayed, adjust R1 slowly clockwise until a good eye diagram is displayed.

# Test 3. Trigger output RMS jitter

**Test Setup**

Connect the cables as shown in Figure 4-4.

If the through-path optical insertion loss test and the trigger output amplitude test have just been performed, initializing the test equipment is not necessary. Otherwise, set the test equipment to the settings shown in Table 4-4.

**Procedure**

*Perform this procedure first with a 1310 nm source and then with a 1550 nm laser source.*

1. Make sure the analyzer delay is set to <50 nsec for all jitter measurements, and the electrical channel is switched on.
2. Set the analyzer electrical channel offset to 0.0 VDC.
3. Set the optical power into the HP 83447A to −15 dBm.
4. Adjust the data eye position (do not exceed 100 nsec) until one of the "X" transition crossings is in the center of the display.
5. Select jitter measurement from the Measure Eye menu.
6. Increase the vertical sensitivity to 20 mV/div and the time/div to 20 psec/div.
7. Switch to the time histogram mode.
8. Adjust the horizontal cursors to sample the narrowest portion of the transition crossings (the "waist"). Keep the cursors within 2.5 mV of each other.

9. Accumulate 1000 samples and read the sigma (RMS). The limits specified below include 7.6 psec RMS measurement system jitter:

   at wavelength 1310 nm:

   - Total RMS jitter at 2.5 Gbps (14.2 ps, max) _____

   at wavelength 1550 nm:

   - Total RMS jitter at 2.5 Gbps (14.2 ps, max) _____

10. Change the clock frequency to 1.0 GHz. Measure the jitter again, as above:

    at wavelength 1310 nm:

    - Total RMS jitter at 1.0 Gbps (21.4 ps, max) _____

    at wavelength 1550 nm:

    - Total RMS jitter at 1.0 Gbps (21.4 ps, max) _____

11. Change the clock frequency to 622 MHz. Measure the jitter again, as above:

    at wavelength 1310 nm:

    - Total RMS jitter at 622 Mbps (33.0 ps, max) _____

    at wavelength 1550 nm:

    - Total RMS jitter at 622 Mbps (33.0 ps, max) _____

12. Change the clock frequency to 155 MHz. Measure the jitter again, as above:

    at wavelength 1310 nm:

- Total RMS jitter at 155 Mbps (129 ps, max) _____

    at wavelength 1550 nm:

- Total RMS jitter at 155 Mbps (129 ps, max) _____

13. Change the clock frequency to 50.0 MHz. Measure the jitter again, as above:

    at wavelength 1310 nm:

- Total RMS jitter at 50 Mbps (400 ps, max) _____

    at wavelength 1550 nm:

- Total RMS jitter at 50 Mbps (400 ps, max) _____

# Test 4. Trigger port electrical return loss

**Test Setup**

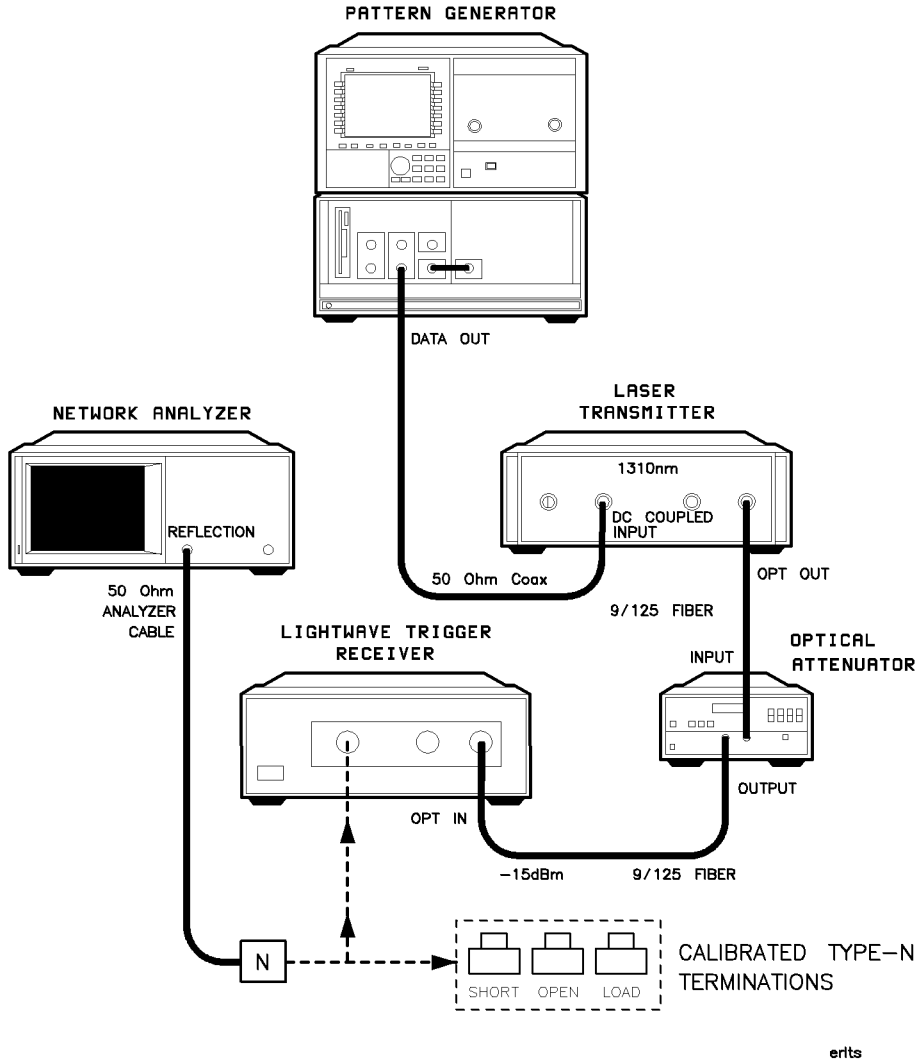



**Figure 4-5. Electrical return loss test setup.**

Configure the test equipment as shown in Figure 4-5.

Initialize the test equipment as follows:

### Clock source

Frequency ..... 2.48832 GHz
Amplitude ..... ECL

### Pattern generator

Pattern ..... $2^{23} - 1$
Data out amplitude ..... 1.030 Vpp
Data out high level (0V term.) ..... 0.000 V
Polarity ..... normal
Trigger ..... clock
Trigger mode ..... clock/32, 23 zeroes trigger pattern
Clock input termination ..... −2V

### Laser transmitter

Clean the optical connectors and the FC adapter.
Mode ..... analog
Bias ..... cal mode

### Optical attenuator

Clean the optical connectors.
Calibrate to read actual power.
Charge fully or use with an AC adapter.
Power out ..... −15 dBm

### HP 83447A

Do not connect the network analyzer cable to the HP 83447A.
Clean the optical connectors.
Optical input ..... −15 dBm

### Network analyzer

State ..... instrument preset
Mode ..... reflection measurement
Scale/div ..... 5 dB
Markers 1, 2 and 3 ..... on
Start frequency ..... 0.3 MHz
Stop frequency ..... 3000 MHz
Number of points ..... 201

Marker 1 ..... 1 GHz
Marker 2 ..... 2 GHz
Marker 3 ..... 2.5 GHz
Marker delta mode ..... off
Averaging ..... on
Averaging factor ..... 16
Reflection port power ..... 0.0 dBm

**Procedure**

1. Turn the HP 83447A on.
2. Using the Calibrate Terminations kit, calibrate the network analyzer for 1-port reflection measurements, at the end of the analyzer cable.
3. Make sure averaging is on.
4. Attach the network analyzer cable to the Trigger Output.
5. Restart averaging and read the return loss figures at 1, 2 and 2.5 GHz (markers 1, 2 and 3):

- Trigger output 1 GHz R.L. |10.07 dB min| _____
- Trigger output 2 GHz R.L. |10.07 dB min| _____
- Trigger output 2.5 GHz R.L. |10.07 dBm min| _____

# Test 5. Input optical return loss

**Test equipment**

**Table 4-6. Input Optical Return Loss**

| Product | Description | Quantity |
|---|---|---|
| HP 8153A | Lightwave multimeter | 1 each |
| HP 81534A | Return loss module | 1 each |
| HP 81000AI | Diamond HMS-10 connector interface | 4 each |
| HP 81000BR | Reference reflector | 1 each |
| HP 81000UM | Universal through adapter | 1 each |
| HP 81554SM | 1310/1550 nm single mode source module | 1 each |
| HP 81101AC | patchcord, Diamond HMS-10/HP | 1 each |
| HP 81109AC | patchcord HRL, Diamond HMS-10/HP | 1 each |

**Procedure**

Make sure that the test equipment has warmed up before proceeding.

1. Before mating, carefully clean all connectors. Refer to "Cleaning Connections for Accurate Measurements" in Chapter 2.
2. To calibrate the return loss module:
   a. Connect the `OPTICAL OUTPUT` of the HP 8155SM to the `OPTICAL INPUT` of the HP 81534A using a Diamond fiber patchcord.
   b. Make sure the source is turned off.
   c. Zero the return loss meter.
   d. Connect the orange end (higher return loss connector) of the HP 81109AC fiber patchcord to the `OPTICAL OUTPUT` of the HP 81534A.
   e. Connect the other end (HMS-10/HP Diamond) of the HP 81109AC fiber patchcord to the HP 81000BR reference reflector.

f. Set the HP 81554SM as follows:

Averaging time ..... 200 ms
Lambda ..... 1310 nm
CAL REF ..... 0.18 dB

g. Turn the source on and measure the reference reflection (Dispersion→Reference).

h. Remove the HP 81000BR from the test setup and terminate the fiber for no reflections. This may be done by wrapping the fiber around the shaft of a 5-mm diameter rod five times.

i. Set Param REF AUX (T: is displayed on the left).

j. Measure the reference absorption (Dispersion→Reference).

3. Connect the output fiber of the HP 81534A to the `OPTICAL INPUT`. Measure the optical return loss.

# Replacement Procedures

**What you'll find in this section**

This section contains the replacement procedures for the following assemblies:

- RF cable and RF connector
- AC cable assembly
- Power supply
- Photodetector assembly

**CAUTION**

This instrument contains static-sensitive components. Read the electrostatic discharge information in Chapter 1 before removing any assemblies.

# Replacing the RF cable or the RF connector

When replacing the RF cable or RF output connectors, use the appropriate torque value. Refer to Table 4-7. When disconnecting the cables at the photodetector assembly, use the Suhner removal tool (Table 4-7).

**CAUTION**

Avoid bending or distorting the semirigid cables when removing or reinstalling assemblies. Before removing an assembly, always loosen both ends of any semirigid cable attached to the assembly. When reinstalling cables, tighten to specified torque only. If a torque-measuring tool is not available, make semirigid cable connections finger-tight only. *Do not overtighten*.

**NOTE**

Replacing the RF cable or the RF connector may cause the trigger receiver to no longer meet the specifications and characteristics. (Refer to Table 1-1.) The RF cable and RF connector must be replaced *carefully* to minimize the risk of the trigger receiver failing specifications. To be sure it does meet specifications, you should return the trigger receiver to Hewlett-Packard for recalibration.

**Table 4-7. Torque Values**

| Description | Tool Size | Torque |
|---|---|---|
| Nut RF OUTPUT type-N connectors | 1/2 inch | 25 inch-pounds |
| SMA cable connections | 5/16 inch | 10 inch-pounds |
| PCB surface mount connectors | Suhner tool 74Z-0-0-225 | |

## Replacing the ac cable assembly

The ac cable assembly consists of the line module, the line switch, and the cable harness.

When replacing the ac cable assembly, unsolder the connections to the dc power supply. Remove the line module. Remove the line switch. Refer to Figure 4-6 and Table 4-8 when installing a new ac cable assembly.

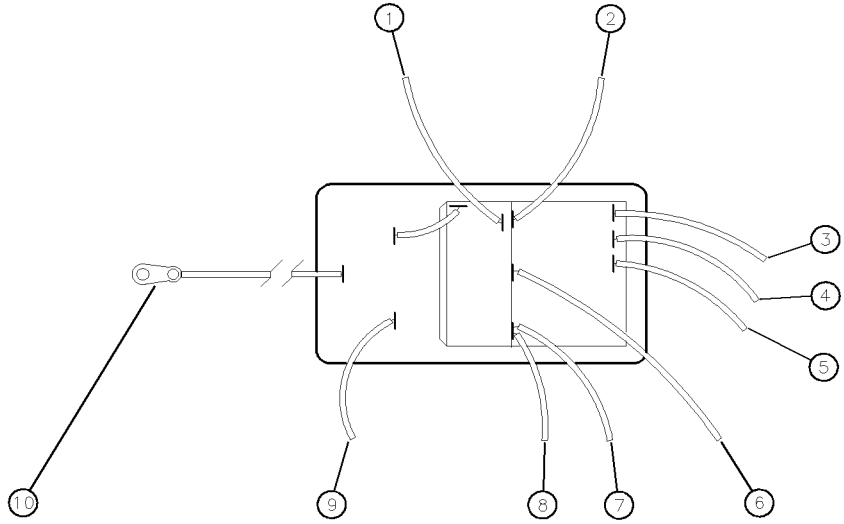



**Figure 4-6. Wiring diagram for the line module.**

**Table 4-8. Line Module to DC Power Supply Connections**

| Index Number | Cable Attachment (from the Line Module) | Cable Color |
|---|---|---|
| 1 | ac power harness | White/brown/gray |
| 2 | ac power harness | Gray |
| 3 | dc power supply (labeled 5) | White |
| 4 | dc power supply (labeled 4) | Yellow |
| 5 | dc power supply (labeled 3) | Orange |
| 6 | dc power supply (labeled 2) | Red |
| 7 | dc power supply (labeled 1) | Blue |
| 8 | ac power harness | White/gray/red |
| 9 | ac power harness | White/gray |
| 10 | (Terminal solder lug) bottom of rear-panel | — |

# Replacing the power supply

Unsolder the connections to the dc power supply. Remove the four screws that attach the power supply to the chassis. Refer to Table 4-1, Figure 4-7, Table 4-9, and Table 4-8 when installing a new power supply.

Adjust the 5.2 V and 12 V power supplies to the proper voltages listed in Figure 4-7.

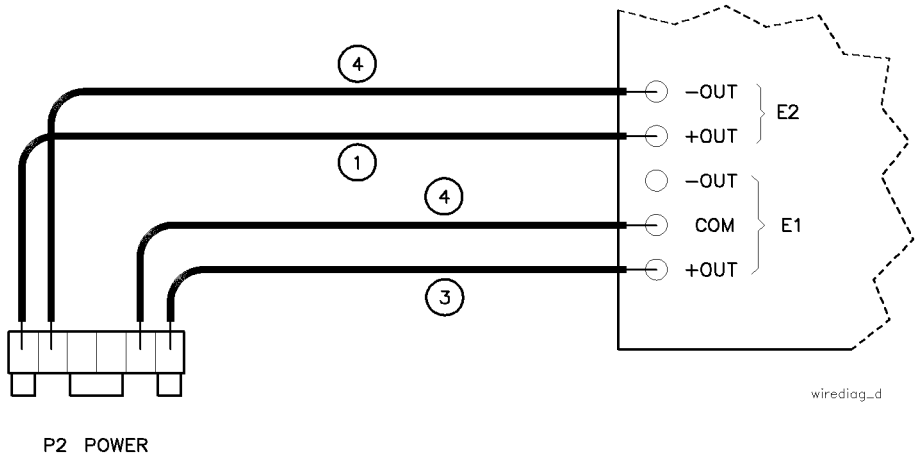



**Figure 4-7. Wiring diagram for the power supply terminals.**

**Table 4-9. DC Power Supply Terminal Connections**

| Index Number | Cable Attachment | Cable Color |
|---|---|---|
| 1 | E2 +OUT | black |
| 2 | E2 –OUT | violet |
| 3 | E1 +OUT | red |
| 4 | E1 COM | black |

## Replacing the photodetector assembly

1. Carefully remove the photodetector's optical fiber connector from the flange on the optical coupler deck. Lay it on the photodetector board.

**CAUTION** Handle the optical fiber very carefully. If the fiber is bent at a sharp angle, it can be permanently damaged.

2. Remove the fiber connector from the front flange connector on the front panel.
3. Remove the four screws securing the optical coupler deck. Lift the optical coupler deck out of the unit.
4. Remove the cable assemblies from connector P1 on the photodetector assembly.
5. Use the Huber Suhner connector tool (refer to Table 4-1) to remove the coax cable assembly from the photodetector assembly.

**CAUTION** These connectors are small and delicate. Failure to use the Huber Suhner connector tool can result in concealed damage that will cause an unreliable connection.

6. Remove the eight screws securing the photodetector assembly to the chassis and remove the assembly.
7. Install the replacement photodetector assembly.
8. With the ac power switched on, verify the front panel LED power indicator is on.

# Replaceable parts

**What you'll find in this section**

This section contains information for:

- identifying and ordering replacement assemblies
- mechanical parts for the lightwave receiver

**Replaceable parts table format**

Table 4-10 lists information for each major assembly and for each major mechanical and electrical part that is not part of a major assembly. Table 4-11 lists information for the trigger receiver replaceable hardware. The following information is listed in Table 4-10 and Table 4-11:

- Item number of callout in Figure 4-8 and Figure 4-9.
- Hewlett-Packard part number.
- Description of the assembly.

**Part ordering information**

To order an assembly or mechanical part listed in this chapter, quote the Hewlett-Packard part number, and indicate the quantity required.

To order a part that is *not* listed, include the following information with the order:

- Lightwave receiver model number.
- Lightwave receiver serial number.
- Description of where the part is located, what it looks like, and its function (if known).
- Quantity needed.

Parts can be ordered by addressing the order to the nearest Hewlett-Packard office. Customers within the USA can also use either the direct mail-order system or the direct phone-order system described below. The direct phone-order system has a toll-free phone number available.

**Direct mail-order system**

Within the USA, Hewlett-Packard can supply parts through a direct mail-order system. Advantages of using the system are as follows:

- Direct ordering and shipment from Hewlett-Packard.
- No maximum or minimum on any mail order. (There is a minimum order amount for parts ordered through a local HP office when the orders require billing and invoicing.)
- Prepaid transportation. (There is a small handling charge for each order.)
- No invoices.

To provide these advantages, a check or money order must accompany each order. Mail-order forms and specific ordering information are available through your local HP office.

**Direct phone-order system**

Within the USA, a phone order system is available for regular and hotline replacement parts service. A toll-free phone number is available, and Mastercard and Visa are accepted.

**Regular orders**

The toll-free phone number, (800) 227-8164, is available Monday through Friday, 6 am to 5 pm (Pacific time). Regular orders have a 4-day delivery time.

**Hotline orders**

Hotline service is available 24 hours a day, 365 days a year, for emergency parts ordering. The toll-free phone number, (800) 227-8164, is available Monday through Friday, 6 am to 5 pm (Pacific time). After-hours and on holidays, call (415) 968-2347.

To cover the cost of freight and special handing, there is an additional hotline charge on each order (three line items maximum per order). Hotline orders are normally delivered the next business day after they are ordered.

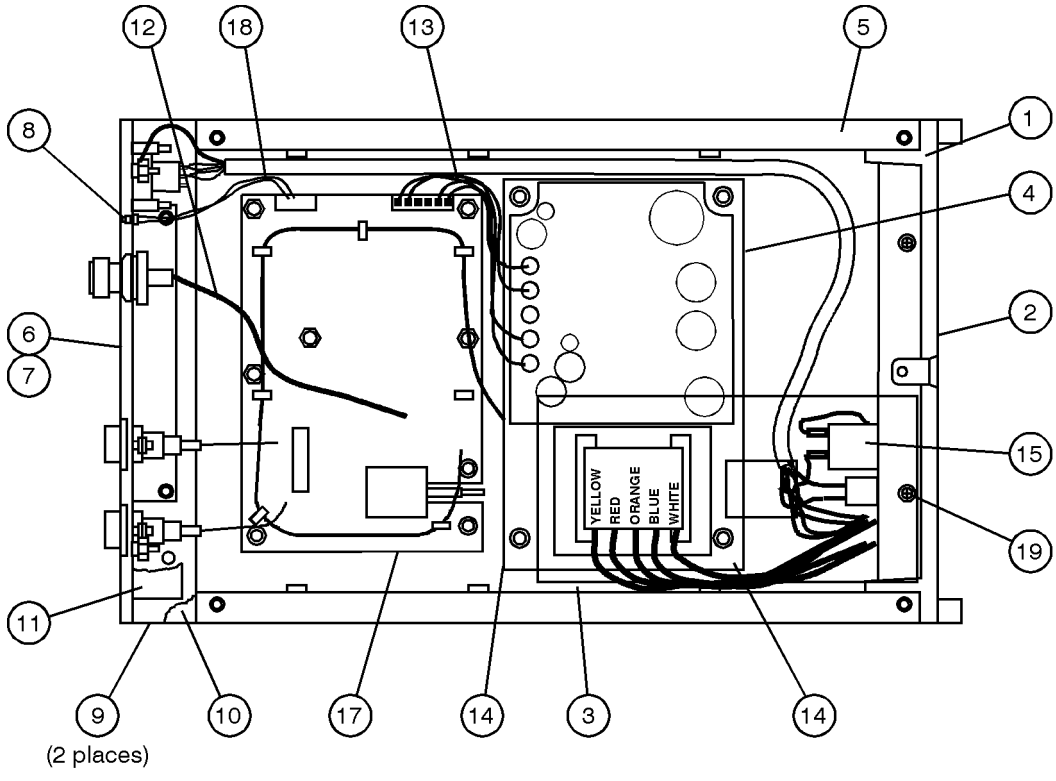



**Figure 4-8. HP 83447A assembly level replaceable parts.**

**Table 4-10. Assembly-Level Replaceable Parts**

| Index Number | HP Part Number | Description |
|---|---|---|
| 1 | 5021-5814 | REAR FRAME |
| 2 | CH834454-CDR | PANEL, REAR |
| 3 | 11982-00003 | INSULATOR |
| 4 | CH834452A-CDR | DECK |
| 5 | 5021-5830 | SIDE STRUT |
| 6 | 1250-1811 | RF CONNECTOR, TYPE N |
| 7 | CH834753-1-CDR | FRONT PANEL, DRESS |
| 8 | 1990-1238 | LED, GREEN |
| | 85680-40004 | LED MOUNT (NOT SHOWN) |
| 9 | 5001-0538 | TRIM, SIDE |
| 10 | 5021-8413 | FRONT FRAME |
| | CH834751-CDR | FRONT PANEL, SUB (NOT SHOWN) |
| 11 | 5041-8803 | TRIM, TOP |
| 12 | 834757-CDR | CABLE, RF |
| 13 | 834460A-CDR | DC CABLE ASSEMBLY |
| 14 | 0950-2099 | POWER SUPPLY |
| 15 | 11982-60002 | AC CABLE ASSEMBLY (INCLUDES THE LINE SWITCH AND LINE MODULE) |
| 16 | OCPL834762-CDR | OPTICAL COUPLER, TERMINATED |
| 17 | 834720-CDR | PD/AMP ASSY |
| | 834721-CDR | PD/AMP ASSY (EXCHANGE) |
| 18 | 834756-CDR | LED WIRE HARNESS |
| | 5041-8801 | FOOT, BOTTOM FRONT (NOT SHOWN) |
| | 1460-1345 | TILT STANDS FOR FRONT FEET (NOT SHOWN) |
| | 5041-8822 | FOOT, BOTTOM REAR (NOT SHOWN) |
| | 5062-3729 | TOP COVER (NOT SHOWN) |
| | 5062-3887 | BOTTOM COVER (NOT SHOWN) |
| | 5062-3805 | SIDE COVER (NOT SHOWN) |
| | 2110-0202 | FUSE (NOT SHOWN) |
| | 0890-0732 | SHRINK TUBING (NOT SHOWN) |
| | 1400-0249 | TY-RAP (NOT SHOWN) |
| | CNHWSTL-250-3-01-CDR | OPTICAL FIBER CABLE CLAMPS |

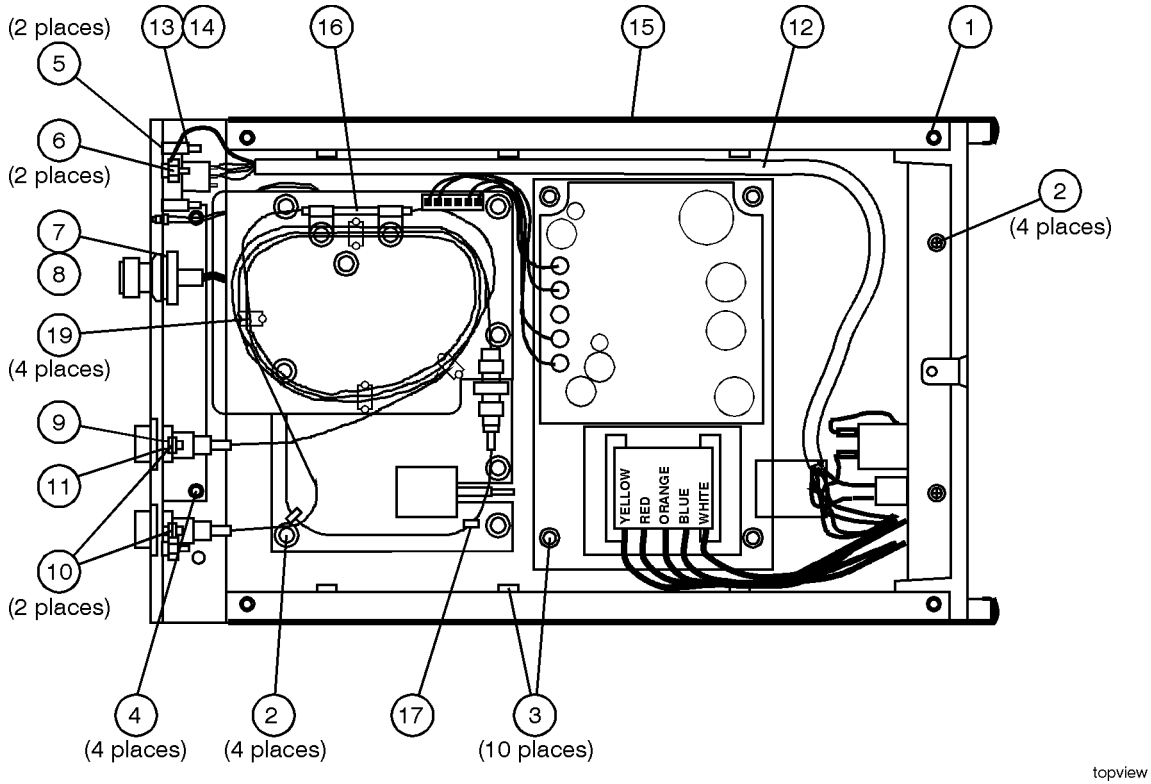



**Figure 4-9. HP 83447A replaceable hardware.**

**Table 4-11. Replaceable Hardware**

| Index Number | HP Part Number | Description |
|---|---|---|
| 1 | 0515-2044 | SCREW, MACH M4.0 X 10MM FLAT-HD |
| 2 | 0515-0372 | SCREW, MACH M3.0 X 8MM PAN-HD |
| 3 | 0515-0337 | SCREW, MACH M3.5 X 10MM PAN-HD |
| 4 | 0515-1400 | SCREW, MACH M3.5 X 8MM FLAT-HD |
| 5 | 0380-0019 | STANDOFFS |
| 6 | 0535-0082 | HEX NUT WITH LOCK WASHER, 7 MM |
| 7 | 2190-0016 | LOCK WASHER |
| 8 | 2950-0001 | HEX NUT, 3/8 X 32 |
| 9 | 2200-0166 | SCREW, MACH 4-40 X 5/16 FLAT-HD |
| 10 | 83410-20003 | OPTICAL ADAPTER BEZEL |
| 11 | 2260-0009 | 4-40 NUT WITH LOCK WASHER |
| 12 | 1400-0249 | CABLE CLAMP |
| 13 | 0610-0001 | #2-56 HEX NUT |
| 14 | 2190-0014 | #2 LOCK WASHER |

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