HP E6053A, E6058A, E6060A: Rack OTDR

User's Guide

Notices

Subject Matter

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HP E6053A, E6058A, E6060A: Rack OTDR

User's Guide

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 When the Rack OTDR is ordered without Option 004, this is a Safety Class 3 instrument (no protective earth command and DC input voltages less than 60V DC).

NOTE

When the Rack OTDR has option 004 (externally mounted DC/DC converter), and the Rack is powered by the DC/DC switcher, the system complies to Safety Class 1 (for instruments provided with a terminal for protective grounding).

You must therefore ensure that the instrument has a protective ground connection (see safety notes below).

For more details, see “Safety Considerations” on page 156.

The Rack OTDR has been manufactured and tested according to international safety standards

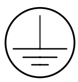
Operation – Before applying power Comply with the installation section. Additionally, the following shall be observed:

- Do not remove instrument covers when operating.
- Before the Rack OTDR Option 004 is switched on, all protective earth terminals, extension cords, auto-transformers, and devices connected to it should be connected to a protective earth via a ground socket. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in serious personal injury.
- Whenever it is likely that the protection for the Rack OTDR (or for the DC/DC switcher) has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

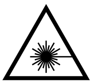
- Adjustments described in the manual are performed with power supplied to the Rack OTDR (or the DC/DC switcher) while protective covers are removed. Be aware that energy at many points may, if contacted, result in personal injury.
- Any adjustments, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible, and when unavoidable, should be carried out only by a skilled person who is aware of the hazard involved. Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation is present. Do not replace components with power cable connected.
- 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 in order to protect the apparatus against damage.



Protective conductor terminal.



Hazardous laser radiation.

Electromagnetic interference (EMI)

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.

Initial Safety Information for Laser Source

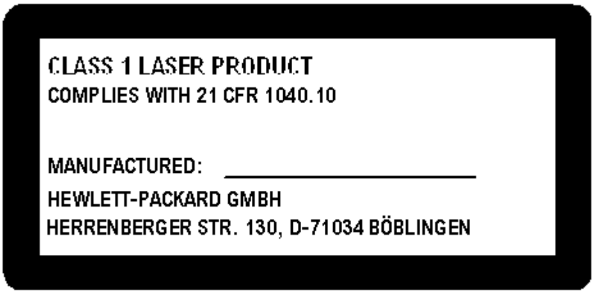
	E6053A	E6058A		E6060A
		1310 nm	1550 nm	1625 nm
Laser Type	FP-Laser InGaAsP	FP-Laser InGaAsP	FP-Laser InGaAsP	FP-Laser InGaAsP
Laser Class				
According to IEC 825 (Europe)	3A	3A	3A	3A
According to 21 CFR 1040.10 (Canada, Japan, USA)	1	1	1	1
Output Power (Pulse Max)	50 mW	120 mW	200 mW	200 mW
Pulse Duration (Max)	10 µs	10 µs	10 µs	10 µs
Pulse Energy (Max)	500 nWs	1.2 µWs	2.0 µWs	2.0 µWs
Output Power (CW)	500 µW	500 µW	500 µW	500 µW
Beam Waist Diameter	9 µm	9 µm	9 µm	9 µm
Numerical Aperture	0.1	0.1	0.1	0.1
Wavelength	1310/1550 ±25nm	1310 ±25nm	1550 ±25nm	1625 ±20nm

	E6007A
Laser Type	MQW-Laser AlGaInP
Laser Class	
According to IEC 825 (Europe)	2
According to 21 CFR 1040.10 (Canada, Japan, USA)	2
Output Power (Pulse Max)	*n/a*
Pulse Duration (Max)	*n/a*
Pulse Energy (Max)	*n/a*
Output Power (CW)	500 µW
Beam Waist Diameter	9 µm
Numerical Aperture	0.1
Wavelength	635 ±10nm

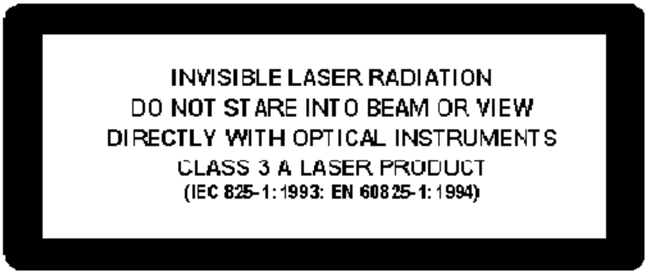
NOTE **All Rack OTDRs (E6053A, E6058A, and E6060A) use two LED devices as indicator lamps on the front panel. These LED devices are measured to be to the AEL Class 1 Laser Products per EN60825-1 Standard.**

NOTE **The following laser safety warning labels are fixed on the top of the Rack OTDR:**

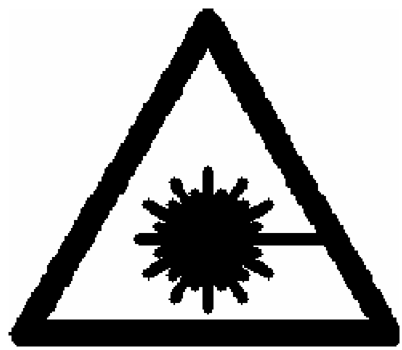
USA



Non-USA



The following symbol is fixed to the front panel, next to the laser output:

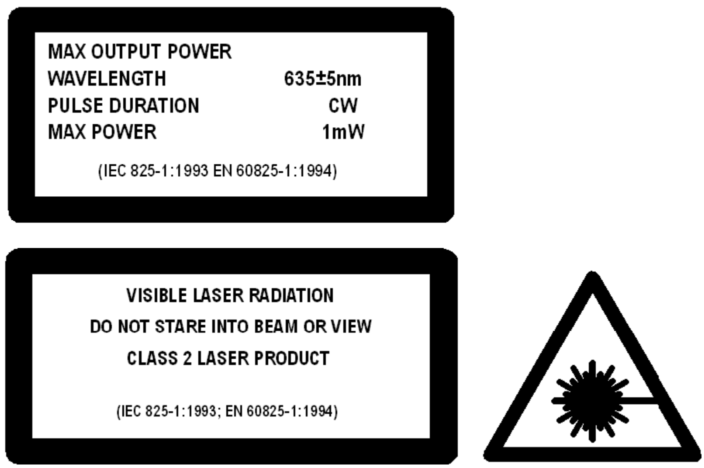


A sheet of laser safety warnings is included with the Rack OTDR. You *must* stick the labels in the local language onto the outside of the instrument, in a position where they are clearly visible to anyone using the instrument.

NOTE **The following laser safety warning labels should be fixed to the E6007A submodule**

Submodule E6007A

Non-USA



The laser safety labels for the USA, according to 21 CFR 1040.10 Class II, are already attached to the module.

A sheet of laser safety warnings is included with the laser module. You *must* stick the labels in the local language onto the outside of the instrument, in a position where they are clearly visible to anyone using the instrument.

WARNING **Use of controls or adjustments or performance of procedures other than those specified for the laser source may result in hazardous radiation exposure.**

WARNING **Refer Servicing only to qualified and authorized personnel.**

WARNING **Do not enable the laser when there is no fiber attached to the optical output connector.**

The optical output connector is towards the top of the instrument's front panel, at the right hand side. There are 3 possible positions for the optical output connector, which are adjacent to each other. Only one connector is active on any device.

The laser is enabled by the remote command `INIT`, and disabled with `ABOR`. The laser is enabled when the red LED on the right side of the front panel is lit. The LED is marked with the label `laser active`.

WARNING **Under no circumstances look into the end of an optical cable attached to the optical output when the device is operational.**
The laser radiation can seriously damage your eyesight.

There is a safety circuit which monitors the average laser power output. If the average is greater than the limit for the Rack OTDR, the laser will be disabled.

WARNING **The use of optical instruments with this product will increase eye hazard.**

NOTE **All Rack OTDRs should also have a CE class A label (HP Part number 7121-5585 CLA).**

You ***must*** return malfunctioning instruments to a HP Service Center for repair and calibration, or have the repair and calibration performed on-site by HP personnel.

The Structure of this Manual

This manual is divided into two parts:

- Chapter 1 tells you how to set up your Rack OTDR.
- The appendices contain additional information not required for routine day-to-day use.

Related Documents

The following documents also contain information that you may find useful when using a Rack OTDR:

- *HP OTDR Programming Guide* (E4310-91016)
- *HP Mini-OTDR User's Guide* (E6000-91011)
- *HP OTDR Toolkit Programming Guide* (E6090-91013)

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1

Getting Started

Getting Started

This chapter introduces the features of the HP E6053A, E6058A, and E6060A Rack OTDR.

Here you will find a quick description of the instrument, an explanation of how to insert a submodule and Optical Connector Interface, and a description of the main Rack OTDR screens.

1.1 Features of the Rack OTDR

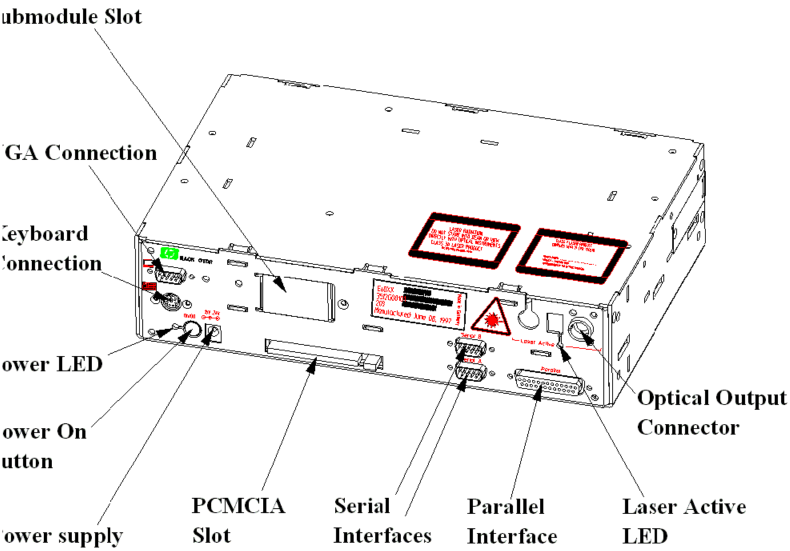


Figure 1-1 **The Rack OTDR Front panel**

Figure 1-1 shows the front panel of a Rack OTDR.

The various components of the front panel are discussed in more detail below.

Power features

The features at the bottom left of the Rack OTDR are concerned with power (Figure 1-2).

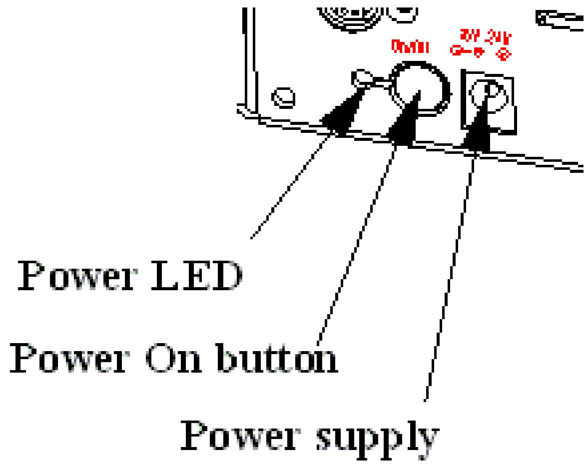


Figure 1-2 **Power features**

- The green Power LED is lit when the Rack OTDR is switched on.
- The Power On button switches the Rack OTDR on and off.
- Use the DC input connector to attach an AC/DC adapter or a DC/DC adapter to the power supply. When an adapter is connected, the instrument will boot automatically.

PC-Keyboard connections

You can attach a keyboard and a VGA-CRT using the connections at the top left of the Rack OTDR (Figure 1-3).

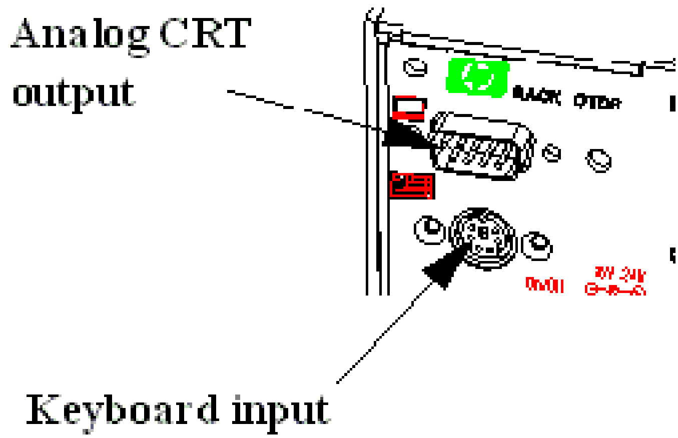


Figure 1-3 **Keyboard connections**

- Attach a VGA monitor to the analog CRT output using a standard 15-pin D-SUB connector.

NOTE **The Sync signals on the analog CRT connection deliver 3.3V. This may cause problems with some monitors.**

To ensure that signals are properly received, you should use an HP monitor (for example, the HP D2836).

- Attach a keyboard to the keyboard connection using a standard PS2 or keyboard with a mini-DIN connector (for example, the HP E6000-61901).

Optical Output Connectors

You can add an HP Connector Interface at the top right of the Rack OTDR (Figure 1-4).

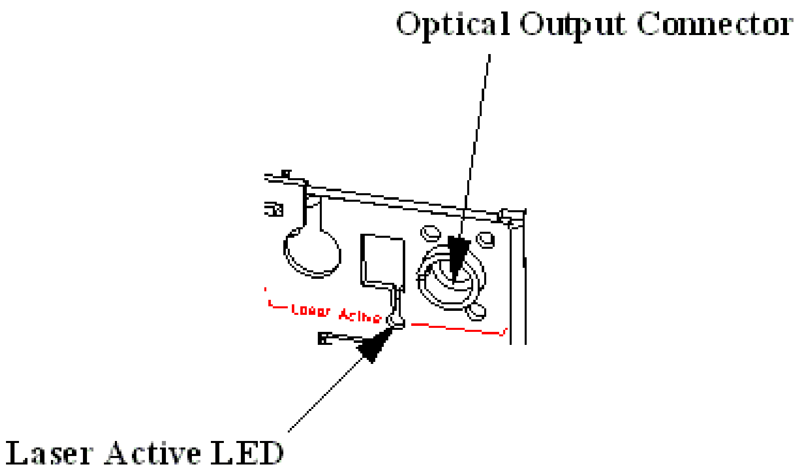


Figure 1-4 **Connector Interfaces**

- Attach a standard Output Connector (for example, HP 81000GI) to the right-hand optical output (Figure 1-5).

The other optical outputs currently have no function.

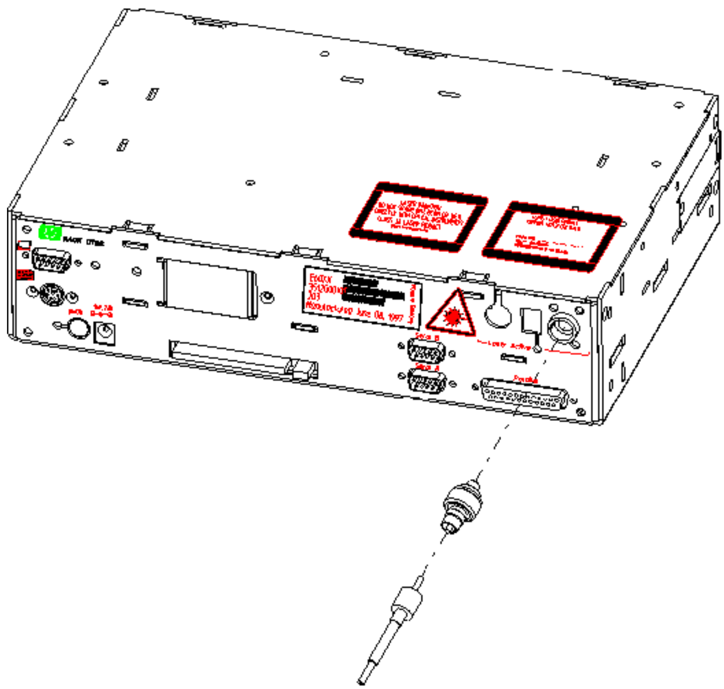


Figure 1-5 **Adding an Output Connector**

- The red LED beneath the Output Connectors is lit when the laser is active.

NOTE **For a list of the available Output Connectors, see Appendix B “Accessories”.**

Adding submodules

You can insert modules into the slots in the middle of the Rack OTDR (Figure 1-6).

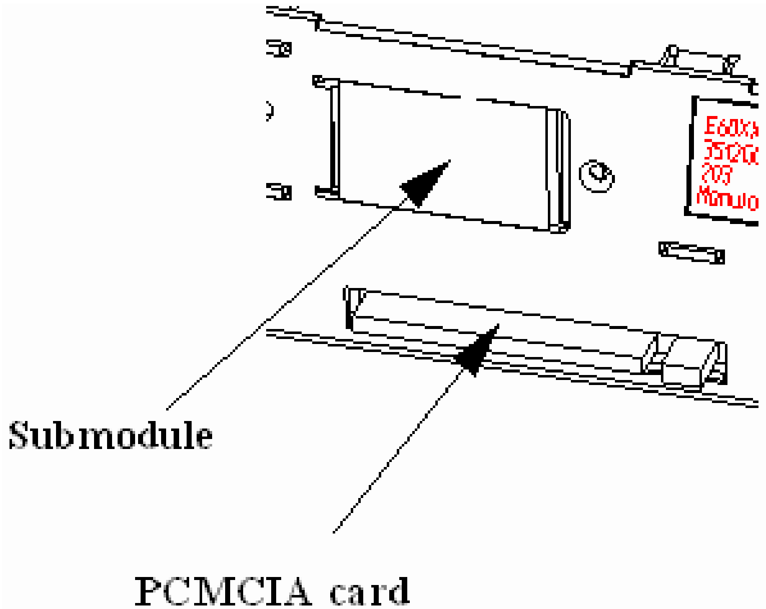


Figure 1-6 **Rack OTDR submodule slots**

- Insert an HP E6006A Power Meter submodule or an HP E6007A Visual Fault Finder submodule into the submodule slot.

- Attach an output connector to the submodule (Figure 1-7).

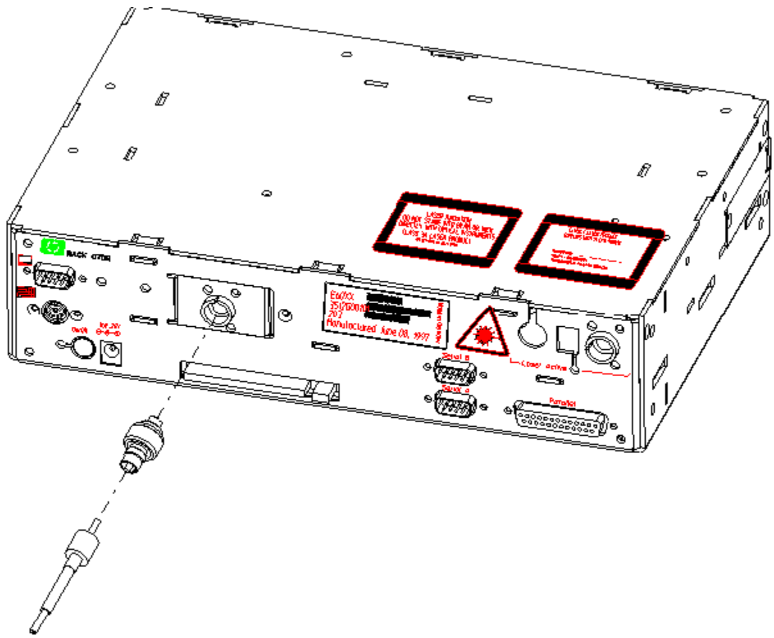


Figure 1-7 **Attaching an Output Connector to a Submodule**

NOTE **You should only insert or remove a submodule when the Rack OTDR is turned off.**

PCMCIA Slot

- Insert an SRAM card or flash disk into the PCMCIA slot.
  You should enter the card face down.

Interfaces

You can connect cables to the serial and parallel interfaces at the bottom right of the Rack OTDR (Figure 1-8).

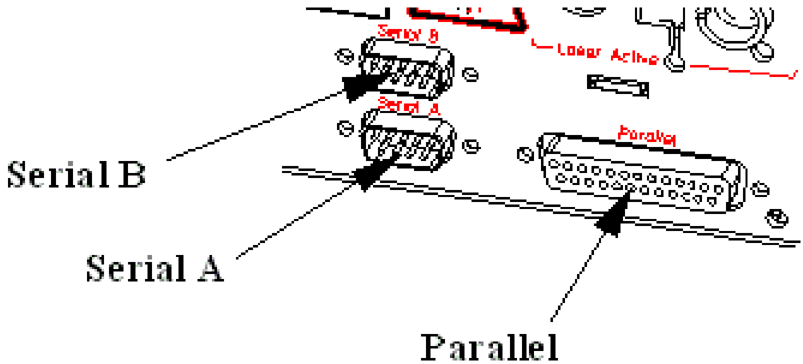


Figure 1-8 **Interfaces**

- Connect a 9-pin RS232 cable to the Serial A Interface.

  You can connect a second serial cable to Serial B. If you have option 006, you can connect an RS485 cable (see “How to Connect an RS 485 Cable” on page 43); if you do not have option 006, you can connect an RS232 cable.

NOTE **You can only send SCPI commands to the Rack OTDR via Serial A.**

- To connect a parallel printer, connect a 25-pin Centronics cable to the Parallel Interface.

1.2 How to Insert the Rack OTDR into a Rack

You prepare the Rack OTDR to be inserted into a Rack using the Rack Mount Kit. This is delivered with your Rack OTDR if you have option 003.

WARNING **Please take care to avoid injury when you assemble the Rack Mount kit, and mount the Rack OTDR in a rack.**

The Rack Mount Kit consists of two flaps, the larger of which you attach to the left of the Rack OTDR, the smaller to the right.

1 Insert the flaps in the holes at the side of the Rack OTDR towards the front.

Turn the right flap clockwise until the front of the flaps is level with the front of the Rack OTDR, and the flap clicks into the holes in the Rack-OTDR (Figure 1-9, step 1, right)

Turn the left flap counter-clockwise until the front of the flaps is level with the front of the Rack OTDR, and the flap clicks into the holes in the Rack-OTDR (Figure 1-9, step 1, left).

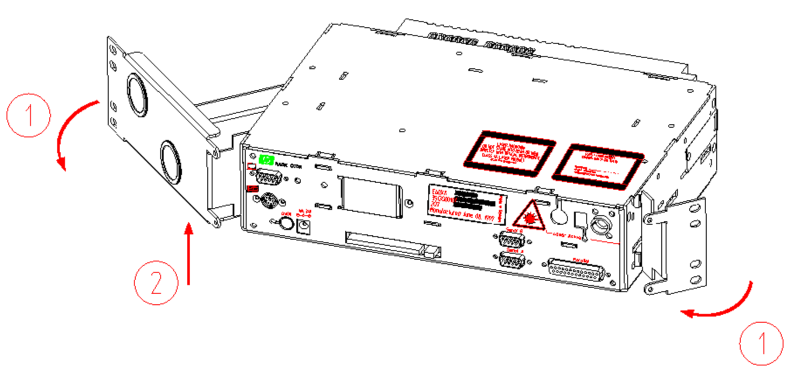


Figure 1-9 **Preparing a Rack OTDR to be inserted in a Rack**

2 Pull the left flap up, that is towards the top of the Rack OTDR (Figure 1-9, step 2).

3 Click the left flap into the holes at the front of the Rack OTDR (Figure 1-10, step 3).

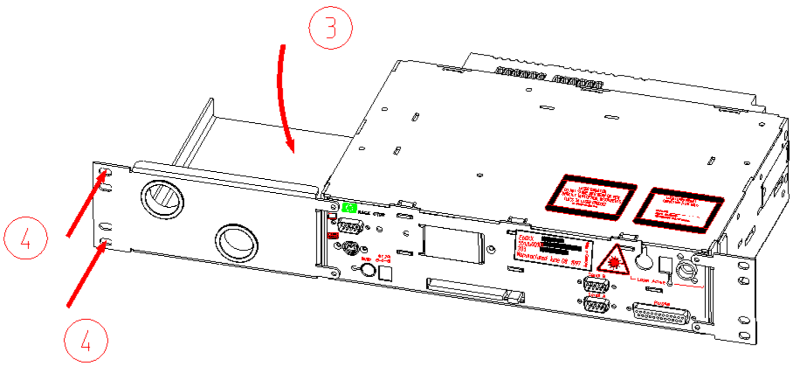


Figure 1-10 **Securing the flaps of a Rack OTDR**

4 Now screw the Rack OTDR into a Rack (Figure 1-10, step 4). Screws should be provided with your Rack.

NOTE **To remove the Rack Mount Kit, first pull the flaps up (that is, towards the top of the Rack OTDR), then turn the left flap clockwise and the right flap counter-clockwise. It is easier to move the smaller, right flap if you put your fingers behind the flap.**

1.3 How to Attach an Adapter

You can attach a 110V power supply at the bottom left of the Rack OTDR (but, see “AC Line Power Supply Requirements” on page 50).

Attach a lead from a suitable AC/DC or DC/DC adapter to the input connector to the right of the power on button.(see Figure 1-2 "Power features").

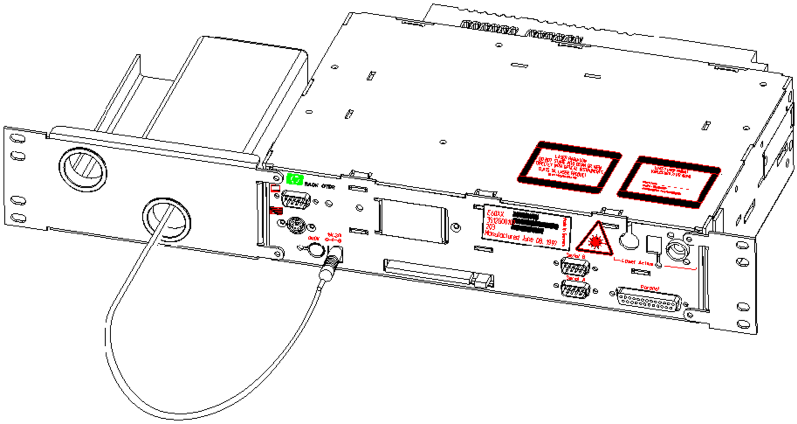


Figure 1-11 **Rack OTDR with power connector attached**

NOTE **When you attach an AC connector, the Rack OTDR automatically boots.**

1.4 How to Operate the Rack OTDR

Programming user tasks on a PC

You can select Input/output commands for sending and receiving data from the serial interface and for initializing transmission parameters.

You should follow the following steps:

1 Initialize the Hardware Interface parameters

2 Check the automatic connection to the instrument

3 Send or receive commands to/from the Rack OTDR.

The *OTDR Programming Guide* shows how to perform steps 2 and 3. Step 1 depends strongly on the Operating system.

NOTE **The programming and speed performance depend on the Operating system used on the PC. Generally speaking, speed and reliability are better with Windows NT and Windows 95 than with Windows 3.1.**

How to Operate the Rack OTDR from a Monitor and Keyboard

Attach a monitor and keyboard to the interfaces at the top left of the Rack OTDR (see Figure 1-3 "Keyboard connections").

When you now switch on the Rack OTDR, you can also use it as if it were a Mini-OTDR (for more details see the *Mini-OTDR User's Guide*: HP Product Number E6000-91011).

You can emulate the Mini-OTDR hardkeys with the following keyboard keys:

- RUN/STOP: <*f2*>
- CURSOR: Up, Down, Left, and Right arrows.
- SELECT: <*Enter*> or <*Return*> button.

- HELP: <*f1*>

You can also use your attached keyboard to enter text into the screen keyboard edit field (for example, to enter the text of a landmark or a filename).

NOTE **If you are using your keyboard to enter text, you should use the Backspace key to delete characters.**

To exit the screen keyboard, must navigate to `OK` or `Cancel`, then press <*Enter*> or <*Return*>.

Instrument Configuration

NOTE **You should configure the instrument before you first make a measurement,**

The `Instrument Setup` screen in the Rack OTDR Instrument Configuration is different to that for the Mini-OTDR. This enables you to configure Serial A and serial B separately (Figure 1-12).

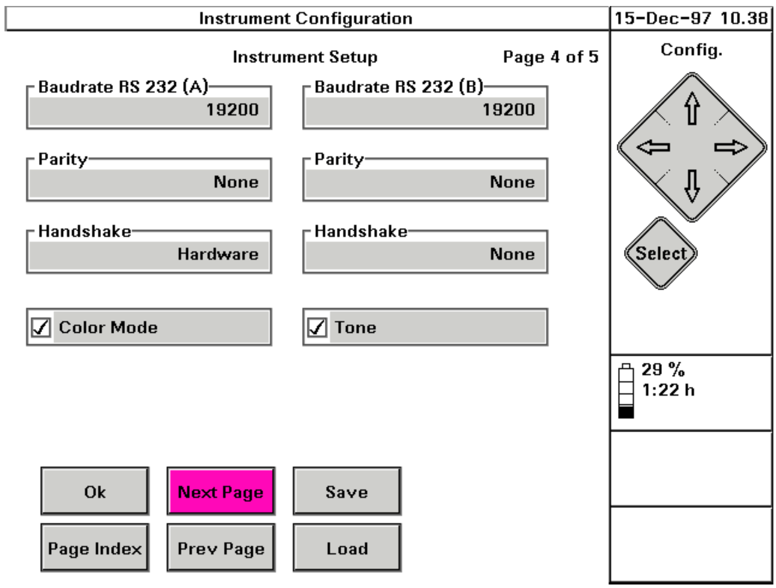


Figure 1-12 Rack OTDR Instrument Setup screen

You do not need to set the parity if you do not want to, but you should set an appropriate baud rate and hardware handshaking.

You can either set the baudrate, handshaking and parity remotely, or you can use the SCPI commands `SYSTem:COMMunicate:SERial`*`N`*`[:RECeive]:BAUD`, `SYSTem:COMMunicate:SERial`*`N`*`[:RECeive]:PACE`, and `SYSTem:COMMunicate:SERial`*`N`*`[:RECeive]:PARity [:TYPE] respectively.`

`SERial1` refers to Serial A, and `SERial2` to Serial B.

See the *HP OTDRs Programming Guide* for more details.

How to Operate the Rack OTDR with a Connected Serial Interface

Use an RS232 cable to connect a PC or other operating system to Serial A (see Figure 1-8 "Interfaces"). You can now operate the Rack OTDR using a variety of methods, explained below

Using Terminal mode

To use terminal mode, all you need is any computer system that supports a terminal - that is a keyboard to accept user inputs, and a screen to show system outputs. This can be, for example, a PC or a UNIX system.

Configure your PC's serial line, matching the configuration of the instrument.

To check that the serial line is correctly connected, enter `*idn?`.

You should see a response saying `HP E60`*`xx`*`A Rack Optical Time Domain Reflectometer .... <END>`.

NOTE **For more information about the programming commands required to configure an instrument, please consult the *HP OTDRs Programming Guide* (HP Product Number E4310-91016).**

Using a program

Connect a computer system to Serial A (see “Using Terminal mode” above), and run a program (for example a C program which sends SCPI commands and reacts to responses, or an HP VEE program).

Some example programs are given in Chapter 2 “Programming Examples”, and in the *OTDR Programming Guide* (HP Product Number E4310-91016).

Using the HP OTDR Toolkit software

If you have a PC running Windows 3.11, 95, or NT, you can also operate the Rack OTDR with the HP E6090A OTDR Toolkit software.

For more details about the HP OTDR Toolkit software, please contact your HP supplier, or consult the *HP OTDR Toolkit Operating Instructions* (E6090-91013).

NOTE **Chapter 2 “Programming Examples” gives some examples of programming the Rack OTDR.**

1.5 How to Operate a Second Instrument from the Rack OTDR

You can use the Rack OTDR to operate any instrument with a serial interface equal to the Rack OTDR serial B (RS232 or RS485 depending in the option number of your Rack OTDR).

For example, you can use an RS232 serial interface to connect the Rack OTDR to a second OTDR (if you do not have option 006). Attach a PC to Serial A and the second instrument to serial B of the Rack OTDR.

Configure serial B according to the second instrument. See “Instrument Configuration” on page 39.

Now, if you enter the SCPI command `SYSTem:BRIDge`, all SCPI characters are sent to the second instrument, whose responses are sent back to Serial A. This continues until you enter `#SCPI`.

For example, if you enter `SYST:BRID`, then `*IDN?`, you receive the identification string for the instrument attached to serial B.

1.6 How to Connect an RS 485 Cable

If you have option 006, you can connect an RS485 cable to serial B (see “Interfaces” on page 34).

Serial B has 9 pins (male), which you can number 1 to 9 from the top left pin (Figure 1-13).

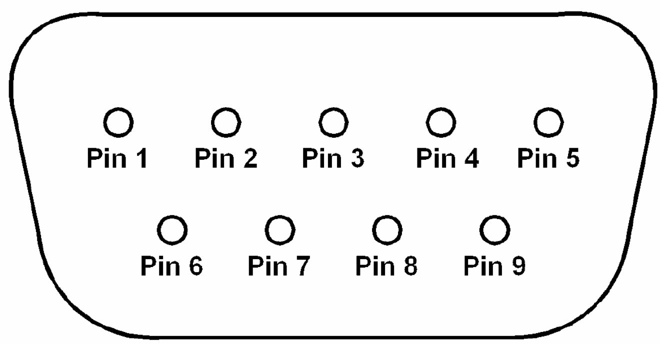


Figure 1-13 Serial Connector Pins (view towards Serial B on the front panel)

The way you connect the RS485 depends on whether you have a 2 wire RS485 or a 4 wire RS485.

Figure 1-14 shows how you should connect a 2 wire device to a single device,.

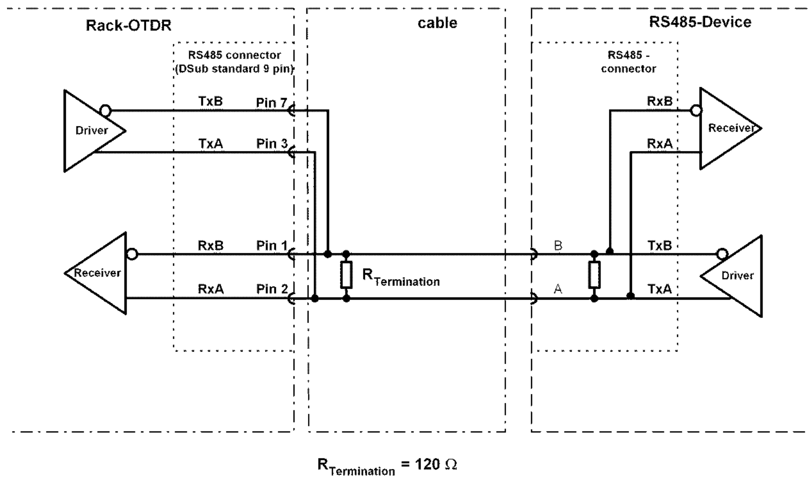


Figure 1-14 **Two wire RS485 - connection to a single RS 485 device.**

NOTE

If you are using a 2-wire RS485 line with 2 devices on it, you must make a termination using a resistor of R = 120 Ω (see Figure 1-14).

You may also make AC-coupled terminations (typically realized with a 120 Ω resistor in serial with a 100nF capacitor instead of a single resistor).

Figure 1-15 shows how you should connect a 4 wire device to a single device.

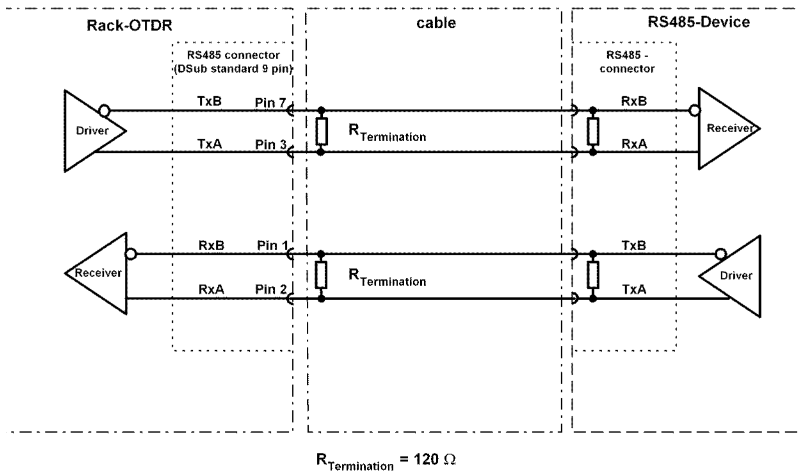


Figure 1-15 **Four wire RS485 - connection to a single RS 485 device.**

NOTE **If you are using a 4-wire RS485 line with 2 devices connected on it, you must use two termination resistors (see Figure 1-15).**

NOTE **Please ensure that the RS485 lines are terminated at both ends. For a 2 wire RS485 line you need 2 terminations, and for a 4 wire 485 line, you need 4 terminations.**

Terminations are typically realized in parallel, by resistors of 120 Ω (see Figure 1-14 and Figure 1-15). You may also make AC-coupled terminations (typically realized with a 120 Ω resistor in serial with a 100nF capacitor instead of a single resistor).

You must ensure that each RS485 line contains the same kind and the correct amount of terminations (2 terminations for 2 wire, 4 terminations for 4 wire.

Some RS485 devices may already have built-in termination resistors.

A

Installation and Maintenance

Installation and Maintenance

This appendix provides installation instructions for the Rack OTDR. It also includes information about initial inspection and damage claims, preparation for use, packaging, storage, and shipment.

A.1 Safety Considerations

When the Rack OTDR is ordered without Option 004, this is a Safety Class 3 instrument (no protective earth command and DC input voltages less than 60V DC).

NOTE ⚠ **When the Rack OTDR has option 004 (externally mounted DC/DC converter), and the Rack and DC/DC switcher are in use, the system complies to Safety Class 1 (for instruments provided with a terminal for protective grounding).**

Before operation, review the instrument and manual for safety markings and instructions. You must follow these to ensure safe operation and to maintain the instrument in safe condition.

A.2 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.

Appendix D “Performance Tests” 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.

WARNING **To avoid hazardous electrical shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer housing.**

Internal Back-Up Battery

This instrument contains a lithium battery. Replacing the battery should be carried out only by a qualified electrician or by HP service personnel.

There is a danger of explosion if the battery is incorrectly replaced. Replace only with the same or an equivalent type (PANASONIC CR 2477). Discard used batteries according to local regulations.

A.3 AC Line Power Supply Requirements

The HP Rack OTDR can operate through the supplied AC adapter between 100V and 240V ± 10%, at a frequency in the range from 50 to 60 Hz. The maximum power consumption is 20VA with all options installed.

Line Power Cable

According to international safety standards, the charger has a three-wire power cable.

The type of power cable shipped with each instrument depends on the country of destination. Refer to Figure A-1 for the part numbers of the power cables available.

NOTE — **You only need to use the line power cable to connect to the AC adapter.**

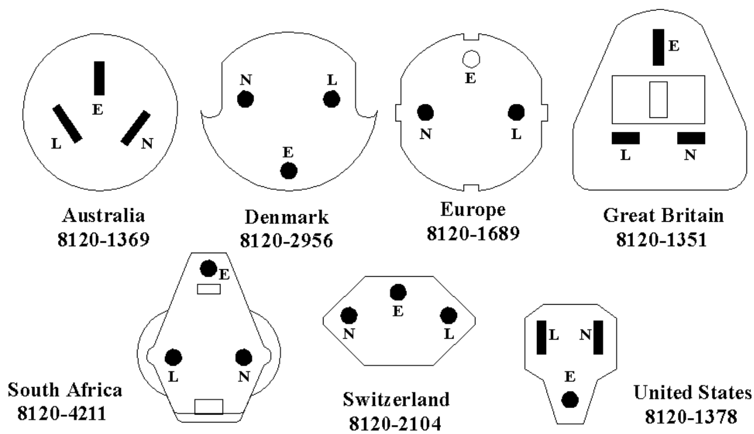


Figure A-1 **Line Power Cables – Plug Identification**

WARNING — **To avoid the possibility of injury or death, you must observe the following precautions before switching on the instrument.**

- **If this instrument is to be energized via an autotransformer for voltage reduction, ensure that the common terminal connects to the earth pole of the power source.**
- **Insert the power cable plug only into a socket outlet provided with a protective earth contact. Do not negate this protective action by the using an extension cord without a protective conductor.**

The following work must be carried out by a qualified electrician. All local electrical codes must be strictly observed. If the plug on the cable does not fit the power outlet, or if the cable is to be attached to a terminal block, cut the cable at the plug end and rewire it.

The color coding used in the cable depends on the cable supplied. If you are connecting a new plug, it should meet the local safety requirements and include the following features:

- Adequate load-carrying capacity (see table of specifications).
- Ground connection.
- Cable clamp.

WARNING **The AC power supply is for indoor use only.**

A.4 DC Power Supply Requirements

WARNING **When using a DC line supply, before switching on the instrument, make sure that the supply meets the local protection requirements.**

The HP Rack OTDR can operate from a DC power source that supplies between 16V and 24V. Typical power consumption is below 10W.

The maximum power consumption is 20VA (20W) with all options installed.

NOTE **If you have option 004 (DC/DC Adapter), see also “Power Supply Requirements” on page 157.**

A.5 Operating and Storage Environment

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

Temperature and Humidity

Protect the instrument from temperature extremes and changes in temperature that may cause condensation within it.

The temperatures and the humidity for the HP Rack OTDR are given in the table below.

	Operating Temperature	**Storage Temperature**	**Humidity**
All/Complete Systems	0°C to 55°C	-40°C to 60°C	95% at 0°C to 40°C

Altitude

The HP Rack OTDR can be used up to 3300m (10800ft.)

Installation Category

The HP Rack OTDR has an Installation Category II and Pollution Degree 2 according to IEC 664

NOTE **The AC Adapter is for indoor use only**

A.6 Parallel Interface

This is a CENTRONICS type parallel port for a parallel printer, with a DB-25 connector.

If you do not use an HP C2950M Centronics cable, the EMI performance of the optical time domain reflectometer cannot be guaranteed.

A.7 Serial Interfaces

If your Rack OTDR has the option 006, there is one AT-compatible RS232 port with a DB9 connector (serial A) and one four wire RS485 port with DB9 connector (serial B).

Otherwise, there are two ST-compatible RS232 ports with DB9 connectors (serial A and serial B).

If you do not use an HP 24542 RS232 cable or the RS232 cable supplied with the rack, the EMI performance of the optical time domain reflectometer cannot be guaranteed.

A.8 Analog CRT interface

There is an analog CRT interface with a DB15 connector. This port delivers VGA-resolution (640 x 480 dots at 62 Hz).

The EMI performance of the Optical Time Domain Reflectometer cannot be guaranteed if you do not use a recommended cable and monitor (see the note on page 29).

A.9 Keyboard Interface

There is a keyboard interface with a 6 pin mini-Din connector. This port supports standard PS2 and AT keyboards with a mini-D/N connector.

The EMI performance of the Optical Time Domain Reflectometer cannot be guaranteed if you do not use a recommended keyboard (see the note on page 29).

A.10 Claims and Repackaging

If physical damage is evident or if the instrument does not meet specification when received, notify the carrier and the nearest Hewlett-Packard Service Office. The Sales/Service Office will arrange for repair or replacement of the unit without waiting for settlement of the claim against the carrier.

Return Shipments to HP

If the instrument is to be shipped to a Hewlett-Packard Sales/ Service Office, attach a tag showing owner, return address, model number and full serial number and the type of service required.

The original shipping carton and packing material may be reusable, but the Hewlett-Packard Sales/Service Office will provide information and recommendation on materials to be used if the original packing is no longer available or reusable.

General instructions for repacking are as follows:

- Put the Rack OTDR in the packaging provided. The packaging has the following part number:

E6050-49301	Cushion convoluted

- The shipping box uses single wall corrugated carton (Material 1.40 per DIN 55468), which is the equivalent of 200-pound bursting strength material.
- Inside the shipping box are 2 inserts. One insert is a folded separator to keep the power supply and the power cord. The second insert goes around the packaging. It is a corrugated part including convoluted foam on the outer side.
- If you do not have the original shipping box you must use an appropriate shock absorbing material.
- Seal the shipping container securely.

- Mark the shipping container FRAGILE to encourage careful handling.
- In any correspondence, refer to the instrument by model number and serial number.

CAUTION **If you use foam to pack the box, make sure you use a soft foam. EPS and most other foams may be too hard.**

A.11 Installing New Firmware

To install firmware on the Rack OTDR, you need the following facilities:

- A PC running WIndows 3.11, 95, or NT, with a free serial port and hard disk space of at least 4 Mb.
- A serial cable.

Install the firmware following the instructions supplied with your upgrade kit

B

Accessories

Accessories

The HP Rack OTDR is a high performance time domain reflectometer. It is available in various configurations for the best possible match to the most common applications.

This appendix provides information on the available options and accessories.

B.1 Instrument and Options

Product	Opt	Description
HP E6053A		**1310/1550 nm High Performance Rack OTDR**
	002	HP Connector Interface
	004	DC/DC Adapter
	006	RS485
	UK6	Calibration Report
HP E6058A		**1310/1550nm Ultra High Performance Rack OTDR**
	002	HP Connector Interface
	004	DC/DC Adapter
	006	RS485
	UK6	Calibration Report
HP E6060A		**1625nm Rack OTDR**
	002	HP Connector Interface
	004	DC/DC Adapter
	006	RS485
HP E6006A		Optical Power Meter submodule
	UK6	Calibration Report
HP E6007A		Visual Fault Finder submodule

Accessories supplied

The following accessories are supplied with your Rack OTDR:

E6050-91011	Rack-OTDR User’s Guide
E4310-91016	OTDR Programming Guide
	AC/DC power supply
	Upgrade CD
	RS232 cable, 9-pin to 9-pin
	rackmount kit

Accessories available

The following accessories are also available. To order these products, please contact your Hewlett-Packard representative.

Product	Description
E6000-68951	2 MByte SRAM Card
C2950A	Centronics cable
24542U	RS232 cable, 9-pin to 9-pin
0950-2813	Flash disk
E6000-61901	Keyboard

B.2 Connector Interfaces and Other Accessories

The Rack OTDR is usually supplied with a straight contact output connector interface.

Straight Contact Connector

To connect to the instrument, you must

1 attach your connector interface (see list of connector interfaces below) to the interface adapter,

2 then connect your fiber.

Model No.	Description
HP 81000AI	Diamond HMS/10 connector interface
HP 81000FI	FC/PC connector interface
HP 81000GI	D4 connector interface
HP 81000HI	E2000 connector interface
HP 81000KI	SC connector interface
HP 81000SI	DIN 47256 connector interface
HP 81000VI	ST connector interface
HP 81000WI	Biconic connector interface

Connector Interfaces and Other Accessories

C

Specifications

Specifications

Specifications describe the instrument's warranted performance, measured with typical PC-type connectors. Uncertainties due to the refractive index of fiber are not considered.

The HP Rack OTDR is produced to the ISO 9001 international quality system standard as part of HP's commitment to continually increasing customer satisfaction through improved quality control.

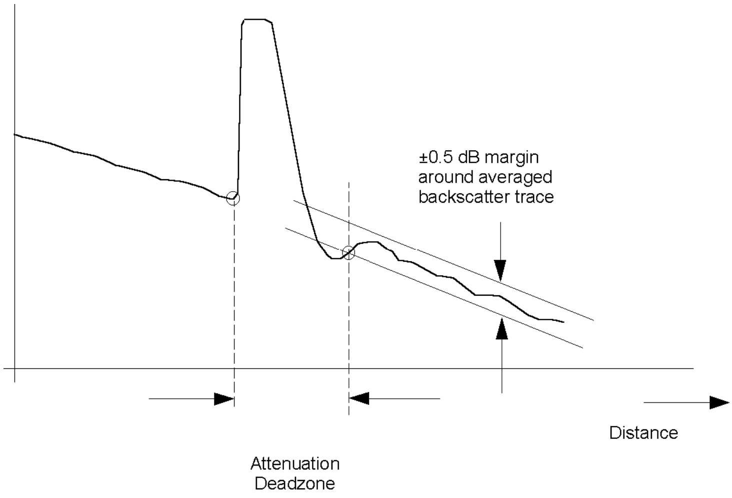
C.1 Definition of Terms

Generally, the wavelengths are given by the specific OTDR module. Therefore, the measurement conditions listed below do not contain the wavelength. Unless otherwise limited, all specifications are valid for the specified environmental conditions.
All data presented in the ± form are to be understood as peak-to-peak variation divided by 2.

Attenuation deadzone: The distance from the start of a reflection to the point where the receiver has recovered to within a ±0.5 dB margin around the undisturbed and averaged backscatter trace.

Conditions: Reflective event with specified reflectance, at specified instrument settings.

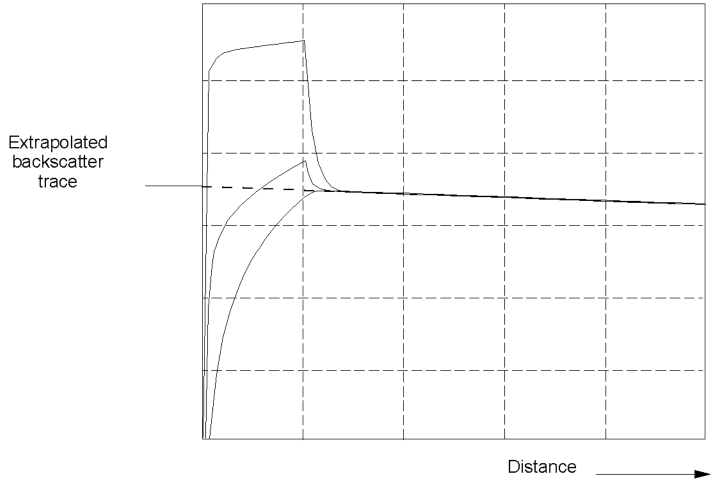
Figure C-1 Attenuation deadzone definition



Backscatter coefficient: The ratio of the optical pulse power at the OTDR output to the backscatter power at the near end of the fiber (z = 0). This ratio is inversely proportional to the pulse width. It is expressed in dB.

NOTE **A typical value is approximately 50dB for 1 µs pulse width, depending on the wavelength and the type of fiber. The extrapolated backscatter trace is a measure of the near-end backscatter power: see Figure C-2**

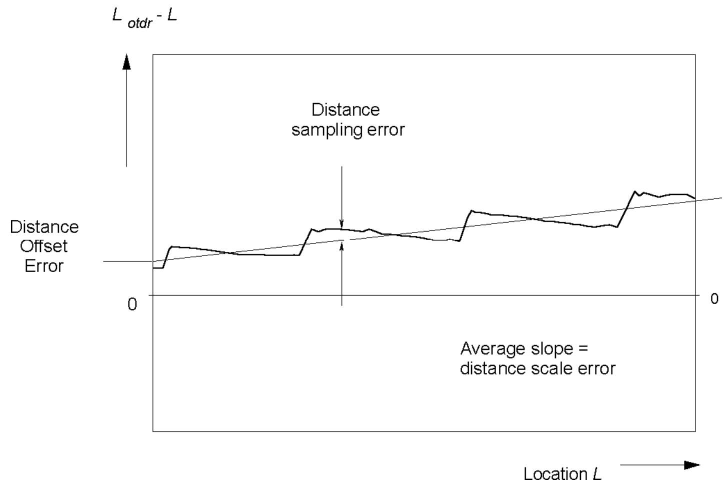
Figure C-2 **Near-end backscatter level for 3 different near-end reflectances**



Distance accuracy: The linear sum of the distance offset error, distance scale error multiplied by distance, and distance sampling error.
See Figure C-3

Figure C-3 **Elements of the distance accuracy**

(L_{otdr} = position measured with OTDR, L = actual position)



NOTE

The distance uncertainty does not include the group index uncertainty of the fiber under test.

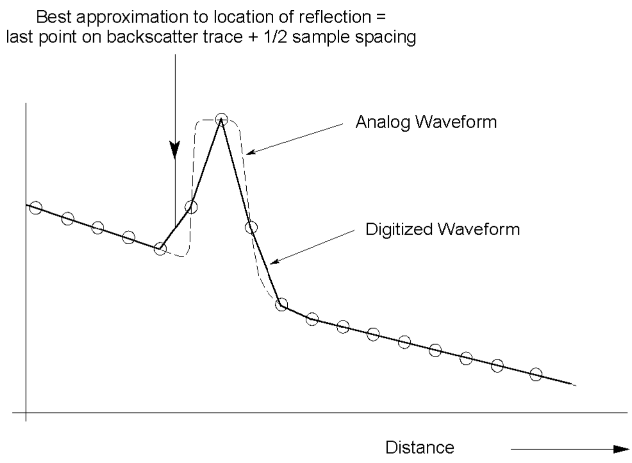
This is because the OTDR measures transit times and calculates distances by dividing by the user-defined fiber's group refractive index.

Distance offset error: The displayed location of the OTDR's front panel connector on the instrument's distance scale. See Figure C-3.

Condition: A possible influence from finite distance sample spacing is excluded.

***Measurement*:** Select “optimize resolution” for best accuracy.
Since the precise location of the front panel connector is usually not directly accessible, use a short fiber (for example 100m, to exclude any influence from distance scale error) with known length and open end to create a reflective event.
Measure the length of the fiber by determining the location of the reflective event as shown in Figure C-4. Then calculate the distance offset error by subtracting the measured length from the known length.
The influence of the finite sample spacing can be excluded by inserting additional fibers. The fiber lengths must be chosen so that they do not coincide with multiples of the distance sample spacing. For each combination, use the total length of fiber to determine the distance offset error.
Finally, average all distance offset results

Figure C-4 Determining the location of a reflective event



Distance sampling error: The distance uncertainty due to finite distance sample spacing. See Figure C-3.

Distance scale error: The difference between the average displayed distance between two distinct locations on the fiber L_{OTDR}, and correspondent actual (true) distance, L, divided by the actual distance. in meters per meter. See Figure C-3

$$\Delta S_L = \frac{(L_{otdr} - L)}{L} \quad \text{where} \quad L = \frac{cT}{2N}$$

c = the speed of light in a vacuum

L_{OTDR} = the distance measured with the OTDR at the given OTDR group index setting

T = the time of flight between the two locations on the fiber, measured at the wavelength of the OTDR

N = the OTDR group index setting

NOTE 1 **Relatively long lengths of fibers (for example, 10 km) should be used to evaluate the distance scale error. This is to remove the influence of finite distance sampling spacing.**

NOTE 2 **The distance scale error excludes the uncertainty of the fiber's group index *N*, because the same *N* is used in the calculation of *L* and L_{OTDR}.**

Measurement: Measure the time of flight, *T*, with a pulse generator, a laser source, an opto-electronic converter, and a time interval counter by determining the time difference with and without the length of fiber of length *L* inserted.
The laser source should have the same wavelength as the OTDR.

Dynamic range (RMS): The amount of fiber attenuation that causes the backscatter signal to equal the →noise level (RMS).

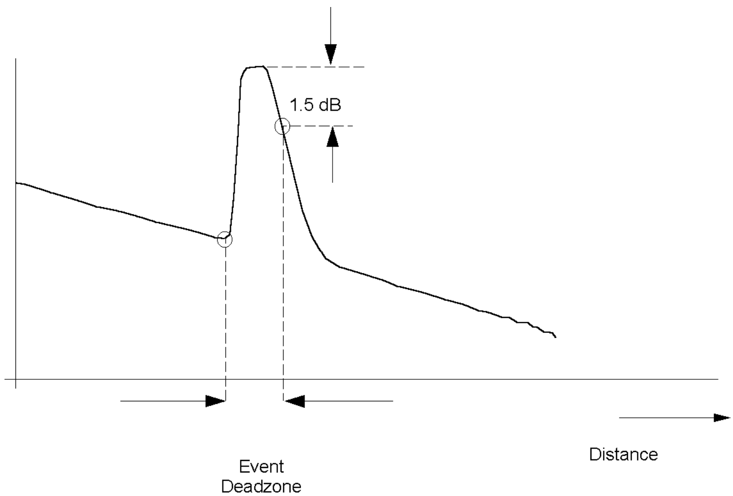
Measurement: It is recommended that you connect a single mode fiber to the OTDR with a length of more than 20 times the pulse width in meters.
Then you can determine the difference between the extrapolated backscatter trace (as in Figure C-2), and the →noise level (RMS).

Conditions: Standard single mode fiber, at specified averaging time, ambient temperature, and instrument settings.

Event deadzone: The displayed length of a reflective event from the start to the point where the trace has fallen to 1.5 dB below the peak.

Conditions: Reflective event with 35 dB return loss, at specified instrument settings.

Figure C-5 **Definition of event deadzone**



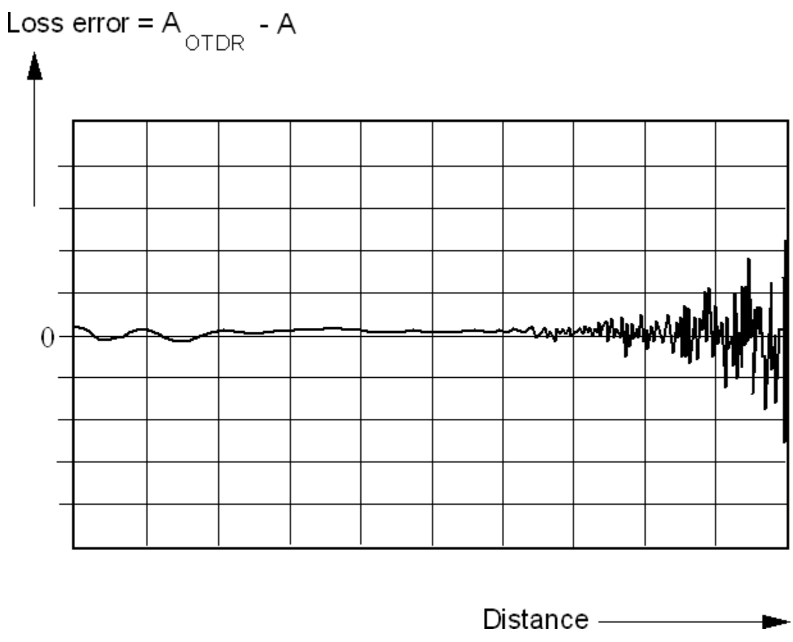
Loss accuracy, 1dB: The maximum loss error for any fiber section with a loss of 1 dB. This is the maximum difference between the displayed loss A_{OTDR}, and the actual loss, A, of the section

$$\text{Loss error}_{1dB} = \max \{ A_{OTDR} - A \}$$

Conditions: A continuous fiber with no discrete losses greater than 1 dB, for a power range from the beginning of the backscatter signal to the point where the →signal-to-noise ratio is reached, at specified instrument settings.

Measurement: Connect a long fiber (for example 50 km) to the OTDR, and calculate the 1 dB loss error as follows:
Generate two undisturbed backscatter traces with a 1 dB vertical difference. Measure this difference A_{otdr}, along the length of the fiber.
Measure the power difference, A, with a calibrated optical power meter.
Calculate the loss errors along the length of the fiber and determine the maximum within the specified power range as in the formula above.
See Figure C-6.

Figure C-6 **Loss error samples for 1 dB loss (arbitrary units)**



Noise level (98%): The displayed power level such that 98% of the noise data points lie below this level.

Conditions: Noise data points from locations after which the OTDR receiver response disappears in random noise.

NOTE **This definition is needed to relate the →noise level (RMS) to practical measurements.**

Noise level (RMS): The displayed level which corresponds to +1 standard deviation of the linear noise amplitude statistics.

Conditions: Noise data points from locations after which the OTDR receiver response disappears in random noise.

NOTE **For purely Gaussian noise statistics, the RMS noise level is approximately 1.9 dB below the →noise level (98%).**

Reflectance accuracy: For the specified reflectance range, the maximum difference between the measured reflectance of a feature on the fiber and actual (true) reflectance.

Conditions: →signal-to-noise ratio larger than the specified value, at specified instrument settings, →backscatter coefficient correctly set for the specific fiber used.

Signal-to-noise ratio (SNR): The difference between the actual backscatter level and the →noise level (98%), expressed in dB.

Definition of Terms - Power Meter Submodule

Noise: One half of the peak-to-peak change of displayed power level with constant input power level.

Conditions: Observation time as specified (drift effects excluded).

Power range: The power range is defined from the highest input power level to the smallest input power level that causes a noticeable change of displayed power level.

Conditions: Wavelength and Averaging Time as specified.

Reference conditions: The specified conditions during the spectral responsivity calibration, or conditions which are extrapolated from the conditions during calibration.

Conditions: Power level, beam diameter or fiber type, numerical aperture, wavelength, spectral width, ambient temperature as specified, at the day of calibration.
→Noise and drift observed over 15 min., with a temperature change of not more than 1 K.

Total uncertainty: The uncertainty for a specified set of operating conditions, including noise and drift.

Conditions: Power level, beam diameter or fiber type, numerical aperture, wavelength, spectral width, ambient temperature, recalibration period as specified.
→Noise and drift observed over 15 min., with a temperature change of not more than 1 K.

Definition of Terms - Visual Fault Finder Submodule

Output Power Level (CW) The output power at the specified wavelength, measured at the end of a jumper cable.

Center Wavelength The wavelength representing the center of mass of selected peaks. The power and wavelength of each used to calculate the mean wavelength $\overline{\lambda}$:

$$\overline{\lambda} = \Sigma P_i \lambda_i / \Sigma P_1$$

where: P_i is the power of a single peak.

Characteristics

Horizontal Parameters

- **Start:** 0 km to 100 km
- **Span:** 1 km to 400 km
- **Minimum sample spacing:** 8 cm
- **Refractive index:** 1.00000 to 2.00000
- **Length unit:** km, ft, or miles
- **Measurement points:** up to 16000

Vertical Parameters

- **Reflectance range:** -14 dB to > -60dB
- **Readout resolution**: 0.001 dB
- **Reflectance range**: -14 dB to -60 dB
- **Backscatter coefficient:** 20 to 60 dB at 1 µs

Source Mode

	E6053A, E6058A	E6060A
CW output power	-3 dBm	-3 dBm
CW stability (15 min., T=const.) after 10 minute warm-up	±0.1 dB	±0.15 dB
Source Mode Modulation	2 kHz squarewave with average power of -6 dBm	

Pulsewidth

You can select any of the following pulsewidths:

- 10 ns, 30 ns, 100 ns, 300 ns, 1 µs, 3 µs, and 10 µs

Output Connector

- Optional Diamond HMS-10, FC/PC, DIN 47256, E-2000, ST, Biconic, SC, NEC D4. All options are user-exchangeable.

Storage

- **Memory Card:**
  - PCMCIA Type II. SRAM up to 2 MB.
  - PCMCIA Type II. Flash Disk up to 20 MB.
- **Internal memory:** up to 100 traces (typical with 4000 data points selected).
- **Trace format:** compliant to Bellcore GR-196-CORE Issue 1 OTDR Data Standard.
- **Internal Flash disk:** provided

Scan Trace

- **Type of events:** reflective and non-reflective.

- **Maximum number of events:** 100.
- **Threshold for non-reflective events:** 0.0 to 5.0 dB, selectable in 0.01 dB steps.
- **Threshold for reflective events:** -14.0 to -65.0 dB, selectable in 0.1 dB steps.
- **Threshold for fiber breaks:** 0.1 to 10 dB, selectable in 0.1 dB steps.

Interfaces

- **Serial A RS232C:** maximum baud rate: 115200 bps
  Transmission time at 115200 bps:
  Trace data: 1s (4000 data points); 4s (16000 data points)
- **Serial B RS232C**: can be used for optical switch control. This interface can be configured as RS485 (option 006).
- **Centronics:** standard parallel port (SPP).
- **CRT**: Standard analog VGA monitor (see note on page 29).
- **Keyboard**: AT or PS2 keyboard with mini DIN connector (see note on page 29).

General

- **Laser Safety Class:** 21 CFR Class 1, IEC 825 Class 3A
- **Recalibration period:** 2 years.
- **Dimensions:** 71mm H, 290 mm W, 200mm D (3.0” x 11.6” x 8.0”).
- **Weight:** net < 2.0 kg (6.2 lbs).
- **Traffic detection:** provided
- **Real time clock and date:** provided

Environmental

See “Operating and Storage Environment” on page 52

Power

See “AC Line Power Supply Requirements” on page 50 and “DC Power Supply Requirements” on page 52.

Submodule Port

The Rack OTDR includes a slot for the submodules of the E6000A program.

The E6006A Powermeter or E6007A Visual Fault Finder can be controlled with the remote (SCPI) commands or via CRT/keyboard.

C.2 Specifications/Characteristics

Specifications: Optical Performance

(see note 1)

Module	E6053A				E6058A			
Central Wavelength	1310±25 nm/ 1550±25 nm				1310±25 nm/ 1550±25 nm			
Applicable Fiber	single-mode				single-mode			
Pulsewidth	10ns	100ns	1µs	10µs	10ns	100ns	1µs	10µs
Dynamic Range[2] [dB]	19/17	24/22	30/29	35/34	24/22	29/27	35/34	40/39
Event Deadzone[3]	5 m				5 m			
Attenuation Deadzone[4]	20/25 m				20/25 m			

Module	E6060A			
Central Wavelength	1625 nm ±25 nm			
Applicable Fiber	single-mode			
Pulsewidth	10ns	100ns	1µs	10µs
Dynamic Range[2] [dB]	18	24	30	37
Event Deadzone[3]	5m			
Attenuation Deadzone[4]	28m			

Characteristics

Distance Accuracy[5]

Offset Error: ± 1 m
Scale Error: $\pm 10^{-4}$
Sampling Error: ± 0.5 sampling spacing

Loss/Reflectance Accuracy[6]

Backscatter Measurements ± 0.05 dB (1dB step), typical
Reflectance Measurements[7] ± 2.0 dB, typical

Notes:

1 Measured at 25 °C

2 Measured with a standard single-mode fiber at SNR=1 noise level and with 3 minutes averaging time.

3 Reflectance ≤ -35 dB at 10 ns pulsewidth, and with span ≤ 4 km, optimize resolution.

4 Reflectance ≤ -35 dB at 30 ns pulsewidth, and with span ≤ 4 km.

5 Total distance accuracy = ± (offset error + scale error*distance + sampling error).

6 SNR ≥ 15 dB and with 1 µs, averaging time max. 3 minutes.

7 -20 dB to -60 dB

C.3 HP E6006A Power Meter Submodule

Characteristics

Sensor element:	InGaAs
Wavelength range:	800 - 1650 nm
Calibrated wavelengths:	850 nm, 1300 nm, 1310 nm, 1550 nm (special wavelength on request).
Power range:	+10 to -70 dBm
Max. input power (damage level)	+13 dBm / 20 mW
Display Resolution	0.01 dB
Display Units:	dBm, dB, mW, µW, nW, pW
Display Contents:	Calibrated λ in nm Modulation frequency in Hz Reference value in dB
Display Updates per second	3
Optical input:	User-exchangeable Connector Interface
Applicable fiber type	9/125 µm, 50/125 µm, 62.5/125 µm

Specifications

Uncertainty at reference conditions: ± 3%

Power level: -20 dBm
Continuous wave (CW)
Wavelength: 1300±3 nm, 1310±3 nm, 1550±3 nm
Fiber type: 50/125 µm graded index, HP/HMS-10 connector
Spectral bandwidth: up to 10 nm
Ambient temperature: +18 to +28 °C

At day of calibration (add 0.3% for aging of over one year; add 0.6% for aging of over two years).

Total uncertainty: ±5% ± 0.5 nW (1300, 1310, 1550 nm)
±10% ± 2.5 nW (850 nm)

Power level: +0 to -50 dBm
Continuous Wave (CW)
Wavelength: 850±3 nm, 1300±3 nm, 1310±3 nm, 1550±3 nm
Fiber type: SM to 50 µm graded index
(add 2% to total uncertainty for fiber 62.5 µm).
Straight and angled connectors
Ambient temperature: +10 to +40 °C

Within 2 years after calibration

Supplementary Performance Characteristics

- Automatic Zeroing Circuitry.
- Automatic Ranging.
- Modulation frequency recognition (270 Hz, 1 kHz, 2 kHz) is available at power levels between +10 and -45 dBm (peak amplitude).
- Wavelength encoding recognition (350 Hz, 550 Hz) is available at power levels between +10 and -45 dBm (peak amplitude).

- Dual Wavelength measurement is available at power levels between +10 and -45 dBm (peak amplitude).
- Reference value is presettable from +30 to -80 dBm.
- Each calibrated wavelength has its own reference memory.
- The actual display content can be transferred to reference memory (DISP → REF).
- Hold Data functionality.

General Specifications:

Dimensions: ca. 120 mm H x 40 mm W x 25 mm D (4.7” x 1.6” x 1.0”)

Weight: < 130 g.

Operating Temperature: 0 to +50 °C

Storage Temperature: -40 to +60 °C

Humidity: 95% R.H. from 0 °C to 40 °C non cond.

Recommended Recalibration Period: 2 years

C.4 HP E6007A Visual Fault Finder Submodule

Characteristics

Source type: Laser diode

Center Wavelength: 635 nm ± 10 nm (visible red light)

Output power level (CW): 0 dBm maximum

Output power level (CW) into 9 µm fiber (typ.): -3 dBm

Detection range: up to 5 km

Optical output: User-exchangeable Connector Interface

Laser Class II (21 CFR 1040), Class II (IEC 825-1)

Supplementary Performance Characteristics

- Continuous Wave and Blink Mode (1 Hz for better visibility).
- Single-Mode and multimode fibers applicable.

General Specifications:

Dimensions: ca. 120 mm H x 40 mm W x 25 mm D (4.7” x 1.6” x 1.0”)

Weight: < 100 g.

Operating Temperature: 0 to 40 °C

Storage Temperature: -40 to +60 °C

Humidity: 95% R.H. from 0 °C to 40 °C non cond.

C.5 Declaration of Conformity

Manufacturer: Hewlett-Packard GmbH
Böblingen Instruments Division
Herrenberger Strasse 130
D-71034 Böblingen
Germany

We declare that the system:

		Rack-OTDR
consisting of:	**HP E6053A**[1]	1310 nm/1550 nm single-mode Rack-OTDR
	HP E6058A[1]	1310 nm/1550 nm single-mode Rack-OTDR
	HP E6060A[1]	1625 nm single-mode Rack-OTDR
and modules:	**HP E6006A**	Optical Power Meter module
	HP E6007A	Visual Fault Finder module

conforms to the following standards:

Safety:	IEC 1010-1:1990 incl. Adm. 1:1992 and Adm.2: 1995	EN 61010-1:1993 incl. Adm.2:1995

EMC[2]:	EN 55011:1991 / CISPR 11 Group 1, Class A	
	EN 61000-4-2: 1995	ESD: 4 kV cd, 8 kV ad, 4 kV cp
	EN 61000-4-3: 1995	Radiated Immunity: 3 V/m
	EN 61000-4-4: 1995	Fast Transients: 0.5 kV, 1 kV
	EN 61000-4-5: 1995	Surges: 1 kV, 2 kV
	EN 61000-4-6: 1995	Conducted Immunity: 3 V
	EN 61000-4-11: 1994	Voltage Dips, Interruptions

Supplementary Information

The product herewith complies with the requirements of the

- Low Voltage Directive (73/23/EEC), and the
- EMC Directive (89/336/EEC).

[1] This product includes the AC/DC Adapter (Product Number 0950-3122) with CE Mark.

[2] The system was tested in a typical configuration with HP systems.

This system also conforms to other standards not listed here. If you need further information on conformance to a particular standard, please contact your local Hewlett-Packard Sales and Service Office.

Böblingen, 20 January, 1998 Wolfgang Fenske

BID Regulations Consultant

Declaration of Conformity

D

Performance Tests

Performance Tests

The procedures in this section tests the optical performance of the instrument. The complete specifications to which the Rack OTDR is tested are given in Appendix C “Specifications”.

All tests can be performed without access to the interior of the instrument. The performance tests refer specifically to tests using the Diamond HMS-10/HP connector.

These Performance Tests assume that you have attached a screen/monitor and a keyboard to your Rack OTDR. See “How to Operate the Rack OTDR from a Monitor and Keyboard” on page 38.

By attaching a keyboard, you can emulate a Mini-OTDR, using the following keyboard keys to emulate the Mini-OTDR hardkeys:

keyboard key	equivalent Mini-OTDR hardkey
<*f2*>	RUN/STOP
Up arrow	CURSOR UP
Down arrow	CURSOR DOWN
Left arrow	CURSOR LEFT
Right arrow	CURSOR RIGHT
<*Enter*> or <*Return*>	SELECT
<*f1*>	HELP

D.1 General

Equipment Required

Equipment required for the performance test is listed below. Any equipment meeting the same specifications can be used.

- Optical Attenuator HP 8156A #101
(Return loss > 40 dB, Repeatability < 0.01 dB).
- Single-mode fiber with 3 dB coupler and known length (between 4 and 5 km), for example, the HP Recirculating Delay Line (P/N 08145-67900).
- 3× Optical Connector Interface HP 81000AI.
- Single-mode fiber: length 25 ± 2 km.
- Keyboard and VGA Monitor

Test Record

Results of the performance test may be noted in the performance test record. The test record can also be used as a permanent record and may be reproduced without written permission from Hewlett-Packard.

Test Failure

If the Rack OTDR fails any performance test, return the instrument to the nearest Hewlett-Packard Sales/Service Office for repair.

Instrument Specification

Specifications are the performance characteristics of the instrument that are certified. These specifications, listed in Appendix C “Specifications”, are the performance standards or limits against that the Rack OTDR can be tested.

Appendix C “Specifications” also lists some supplemental characteristics of the Rack OTDR, and should be considered as additional information.

Any changes in the specifications due to manufacturing changes, design, or traceability to the National Bureau of Standards will be covered in a manual change supplement or revised manual. The specifications listed in such a change supersede any previously published.

Performance Tests

Perform each step in the tests in the order they are given, using the corresponding test equipment.

Make sure that all optical connections in the test setups given in the procedure are dry and clean. For cleaning use the procedure given in Appendix E “Cleaning Procedures”.

D.2 Test I. Dynamic Range

1 Connect the equipment as shown in Figure D-1. Terminate the far end.

The fiber is terminated by wrapping it five times around the shaft of a screwdriver (or some similar object with a diameter of around 5 mm).

If you are using the HP Recirculating Delay line, connect part 1 to the Mini-OTDR.

NOTE **The specific measurement techniques of the HP Rack OTDR require a fiber length which is adapted in attenuation and backscatter to the requirements of the selected pulsewidth. The fiber specified for this test**

is of general type and valid for all pulsewidths. A shorter fiber should not be used, as the uncertainty of the measurements would increase by some dB.

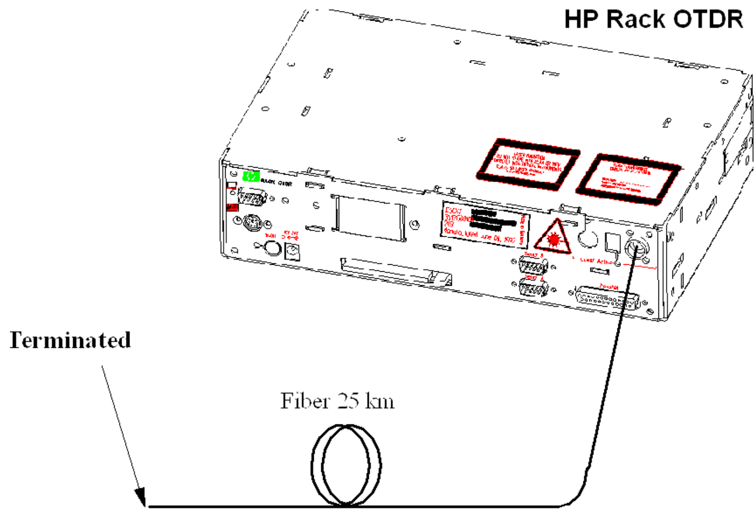


Figure D-1 **Dynamic Range Test Setup**

2 Turn on the OTDR, and after the selftest has passed, recall the default settings.

3 Set the OTDR:

[SETTINGS] menu:

- <RANGE> - select <RANGE INPUT...>:

  `Start`: - enter value ST from Table D-1. Confirm with <OK>.

  `Span`: - enter value SP from Table D-1. Confirm with <OK>.
- <PULSE WIDTH>: enter value PW from Table D-1.
- <WAVELENGTH>: If a dual wavelength module is installed, select the required wavelength
- <MEAS. MODE>: `Averaging`

- <OPTIMIZE MODE>: `Dynamic`
- <AVG. TIME>: `3 min`

NOTE **If the averaging parameter is listed for Number of Averages, you should do the following:**

- **Exit the [SETTINGS] menu**
  Press `Ok`.
- **Enter the `Instrument Config` screen.**
  Select [CONFIG.]<INSTRUMENT CONFIG>
- **Bring up the `OTDR Settings` page**
  Select [PAGE INDEX]<OTDR SETTINGS>
- **Select Averaging time**
  Move to the `Averaging Mode` box and press select, select `Averaging time` from the menu you see.
- **Save this configuration**
  Select `Save`.
- **Exit the `Instrument Config` screen**
  Select `Ok`.
- **Return to the settings screen**
  Select [SETTINGS].

You now see a box for `Avg. Time`.

[VIEW] menu:

- <EVENT TABLE>: OFF
- <CLEAR V-OFFSET>
- <CLEAR H-OFFSET>
- <PREFERENCES><DOTTED TRACE>: ON

[ANALYSIS] menu

- <2 PT. LOSS>.

Table D-1 **Pulse Width dependent settings for Dynamic Range Test**

Pulsewidth	Start	Span distance	View start position of marker B	View end	Viewed distance
PW	**ST**	**SP**	**Bpos**	**Vend**	**V**
10 µs	0 km	100 km	40 km	60 km	20 km
1 µs	0 km	100 km	40 km	60 km	20 km
100 ns	0 km	50 km	30 km	45 km	15 km
10 ns	0 km	50 km	30 km	45 km	15 km

4 Terminate the fiber, start the measurement and wait until measurement stops.

<*f2*>, wait while measuring

NOTE **After the measurement has stopped the fiber must not be terminated.**

5 View the complete trace. See Figure D-2.

NOTE **If you can already see the full trace, please ignore this command**

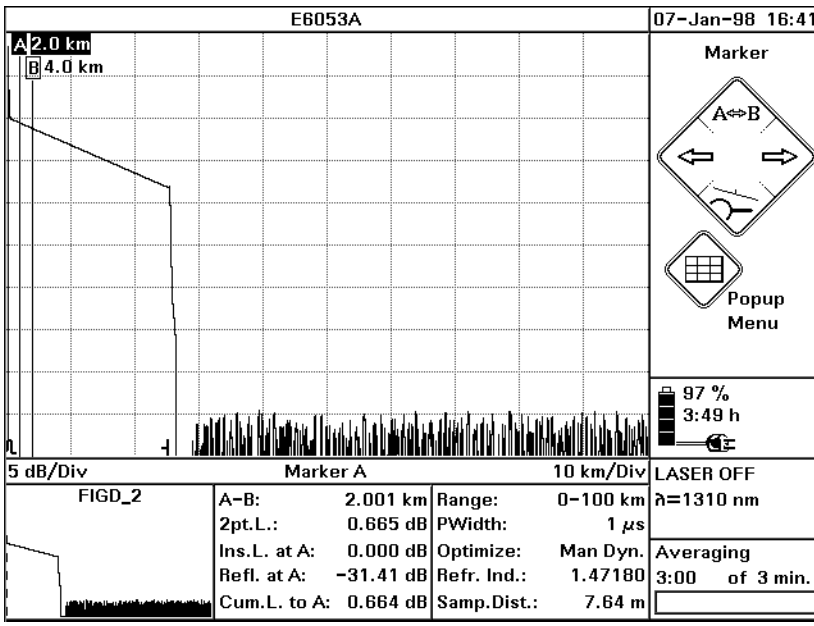


Figure D-2 **Dynamic Range Test: Full Trace View**

6 Use Cursor keys to position marker A and B at 2.5 km ± 0.5 km

7 Select marker B
UP until only B is highlighted.

8 Zoom to 0.5 dB/Div and 500m/Div
[ZOOM], then use cursors.
The current zooming figures are written below the trace to the left and right hand side.

9 Select offset

[VIEW]<ADJUST V-OFFSET>

10 Offset the trace until the extrapolated beginning of the backscatter is on a horizontal grid line. The extrapolated beginning of the backscatter is the level that the backscatter would reach if it was continued back to 0 km from the OTDR, that is if there was no initial reflection.

Use the Left and Right cursors to offset by large increments, and the Up and Down cursors to ‘fine tune’.

11 Close Offset

<SELECT>

12 Select Marker A

UP until only A is highlighted.

13 Use the cursor keys to position marker A at the end of the front reflection on the level of the extrapolated beginning of the backscatter (that is, the crossing of the frontreflection and the horizontal grid line).

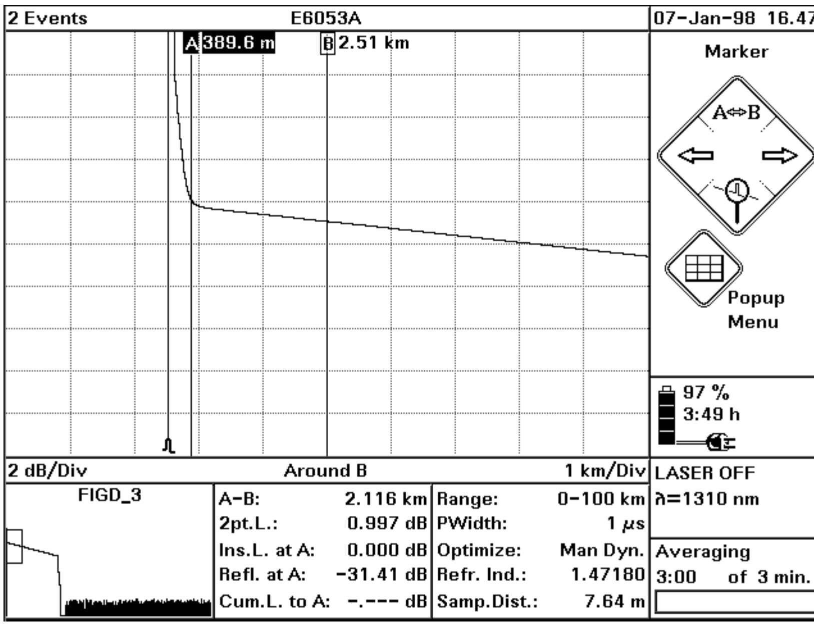


Figure D-3 **Dynamic Range Test: Position Marker at End of Frontreflection**

14 Position marker B at **Bpos** km. View the trace around marker B and zoom the trace around marker B to 2 km/Div and 1 dB/Div.

The value for **Bpos** is given in Table D-1.

UP until only B is highlighted. Use LEFT/RIGHT keys → **Bpos** km. Use DOWN (Around B) to get better resolution.

{<==> ZOOM} → 2 km/Div

{ZOOM} → 1dB/Div.

15 Note the value of the sample spacing, “Samp.Dist.”. Calculate the number of peak samples (dots) from the viewed distance V divided by the sample spacing.

Calculate 2% thereof.

To get 98% Noise Level disregard 2% of the largest noise peaks samples (dots).

Example: PW = 1 µs → V = 20km, sample spacing = 7.64m.

→ number of peak samples = 20 km / 7.64m = 2618

→ 2% thereof = 52.

16 Check the calculated 2% of the highest peak samples within the viewed distance V: that is from *Bpos* to *Vend* according to the values given in Table D-1

NOTE **To check out and disregard the 2% of the highest peak samples you need to zoom in further to get dots.You may have to change the color of the trace to view them more clearly.**

17 Position marker B at a point on the trace that equals the 98% Noise Level

18 Note 2-pt-loss between A and B as “Dynamic $\text{Range}_{98\%}$” at the actual pulsewidth.

19 Calculate the dynamic range as follows:

Dynamic Range = Dynamic $\text{Range}_{98\%}$ + 1.9 dB

20 Repeat steps 4 to 19 with all pulsewidths described in the test record.

D.3 Test II. Event Deadzone

NOTE **The setup simulates a return loss of 35 dB. To care for the fact that – due to the coupler – the light pulse travels through the attenuator twice to sum up, the attenuator needs to be set to a value 3 dB larger than the simulated return loss, that is. 35 dB + 3 dB = 38 dB.**

1 Make sure that all optical connectors are clean and connect the equipment as shown in Figure D-4.

If you are using the HP Recirculating Delay Line, connect port 2 to the OTDR, port 1 to the input of the attenuator, and port 3 to the output of the attenuator

Be sure to use the appropriate Single-Mode/Multimode delay line for the module to be tested.

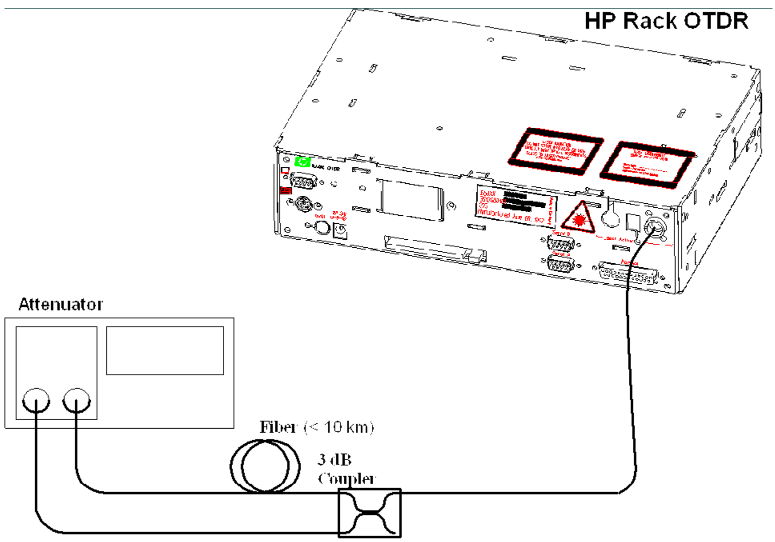


Figure D-4 **Event Deadzone Test Setup**

2 Turn on the OTDR, and after the self-test has passed, recall the default settings and the resolution mode.

[SETTINGS]<RECALL..><DEFAULT SETTING>

[SETTINGS]<OPTIMIZE MODE><RESOLUTION>

3 Set the linestyle to solid

{VIEW}<PREFERENCES><DOTTED TRACE>: OFF

4 Make sure that the length unit is set to meters.

[CONFIG]<LENGTH UNIT><METER [M]>

5 Set the Start and Span to 0.00–10.00 km, and the Averaging time to 3 min.

[Settings]<Range><0-10 km>

[Settings]<Avg Time><3 min> (see the note on page 92).

[Settings]<Meas. Mode><Averaging>

6 Select the required wavelength.

[Settings]<Wavelength>

7 Set the pulsewidth to 10 ns.

[Settings]<PulseWidth><10 ns>

8 Set up the attenuator.

- **a** Set λ to the actual wavelength.
- **b** Set the attenuation to 38 dB (see Note on page 97).
- **c** Enable the attenuator output.

9 On the OTDR start the measurement.

<f2>

10 Wait until the backscatter noise is reduced (about 10 s), then position marker A close to the beginning of the first reflection after the front reflection. See Figure D-5.

Select Marker A. Use LEFT/RIGHT keys

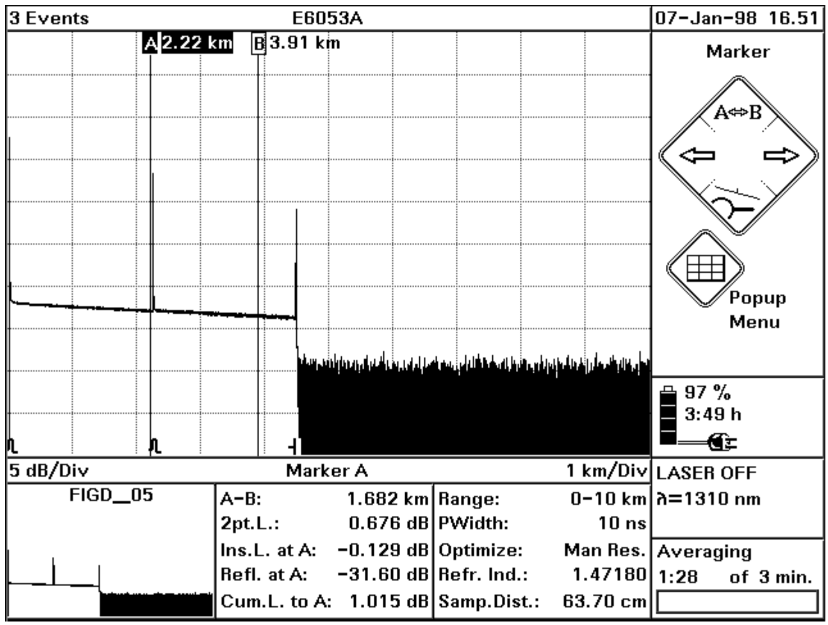


Figure D-5 **Event Deadzone Test: Position Marker A**

11 Set the start position close to the position of marker A. The start position should be just before the front edge of the reflection. Set the measurement span to start position+2 km.

[SETTINGS}<RANGE><RANGE INPUT...>. Use Cursor keys to specify Start and Span. Confirm with `OK`.

NOTE **The start position should be a little before the front edge of the reflection. For example, if the reflection is at 2.2 km, use a start position of 2 km.**

12 Run the measurement.

<f2>

13 Position marker A on top of the first reflection on the trace.
Select Marker A. Use Left/Right keys.

14 Position marker B about 5 m right from marker A.
Select Marker B. Use Left/Right keys.
Select Marker A. Use LEFT/RIGHT keys. Use DOWN (Around A) to get better resolution.

15 Set the y-axis scale to 0.5 dB/Div and the x-axis to 0.5 m/Div.
{<==> ZOOM} → 0.5 m/Div and [⇑ ⇓ Zoom] → 0.5 dB/Div.

16 Select offset, and move the peak of the reflection 3 divisions (1.5 dB) above the center of the graph.
[VIEW}<ADJUST V-OFFSET>. Use LEFT/RIGHT keys. Press SELECT to Confirm.

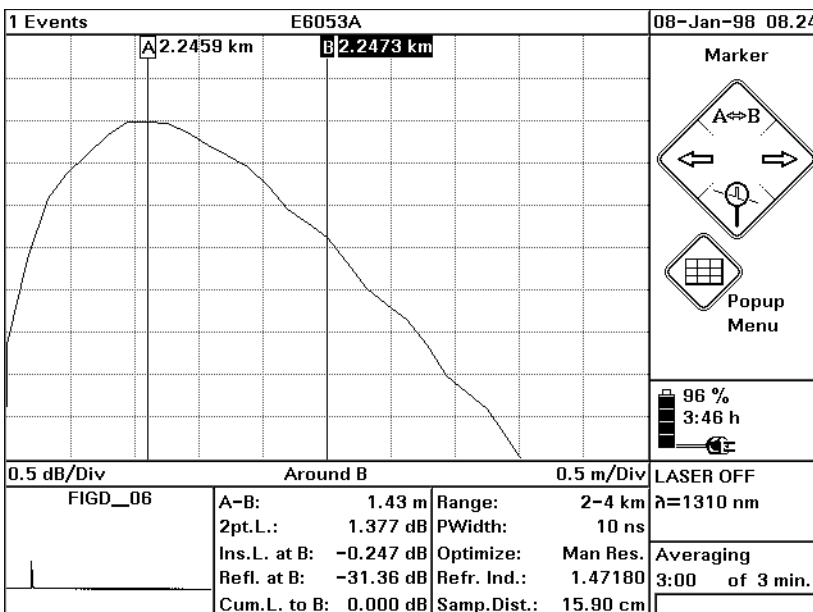


Figure D-6 **Event Deadzone Test: Position Marker B**

17 Use the LEFT/RIGHT keys to position marker B where the down slope of the reflection crosses the horizontal center line of the graph. See Figure D-6.

18 Position marker A at the beginning of the event.

Select Marker A. Use LEFT/RIGHT keys.

Use DOWN (Around A) to get better resolution.

19 Note the width of the reflection in the test record. The width is the distance between the markers A and B.

20 Stop the measurement.

<f2>

D.4 Test III. Attenuation Deadzone

NOTE

The setup simulates a return loss of 35 dB. To care for the fact that – due to the coupler – the light pulse travels through the attenuator twice to sum up, the attenuator needs to be set to a value 3 dB larger than the simulated return loss, that is. 35 dB + 3 dB = 38 dB.

As this value includes the Insertion Loss of the attenuator, you may need to determine the Insertion Loss first.

1 Connect the equipment as for the event deadzone test (see Figure D-4).

2 Turn on the OTDR, and after the self-test has passed, recall the default settings and the resolution mode.

[SETTINGS]<RECALL..><DEFAULT SETTING>

[SETTINGS]<OPTIMIZE MODE><RESOLUTION>

3 Set linestyle to SOLID.

[VIEW]<PREFERENCES><DOTTED LINE>: OFF

4 Set 2 pt. loss

[ANALYSIS]<2 PT.LOSS>

5 Make sure that the length unit is set to meters.
[CONFIG]<LENGTH UNIT><METER [M]>

6 Set the Start and Span to 0.00–10.00 km.
[SETTINGS]<RANGE><0-10 KM>

7 Set the pulsewidth to 30 ns.
[SETTINGS]<PULSEWIDTH><30 NS>. Close by OK.

8 Set up the attenuator.

  a Set λ to the actual wavelength.

  b Set the attenuation to 38 dB (see Note on page 102).

  c Enable the attenuator output.

9 On the OTDR start the measurement.
<*f2*>

10 Wait until the backscatter noise is reduced (about 10 s), then position marker A close to the beginning of the first reflection after the front reflection.
Select Marker A. Use LEFT/RIGHT keys

11 Stop the measurement.
<*f2*>

12 Set the start position close to the position of marker A and the measurement span to 2 km.
[SETTINGS]<RANGE><RANGE INPUT...>. Use Cursor keys to specify Start and Span. Confirm with `OK`.

NOTE **The start position should be a little before the front edge of the reflection. For example, if the reflection is at 2.2 km, use a start position of 2 km.**

13 Start the measurement.
<*f2*>

14 Select marker B

UP until only B is highlighted.

15 Use the LEFT/RIGHT keys to position marker B on the peak of the event. You may choose DOWN (Around B) to get better resolution.

16 Select marker A

UP until only A is highlighted.

17 Position marker A 70 m ± 1 m to the right of marker B, that is after the event. Do this by checking A-B.

NOTE **When noise is seen on the trace, a position referring to the mean value of the trace should be selected.**

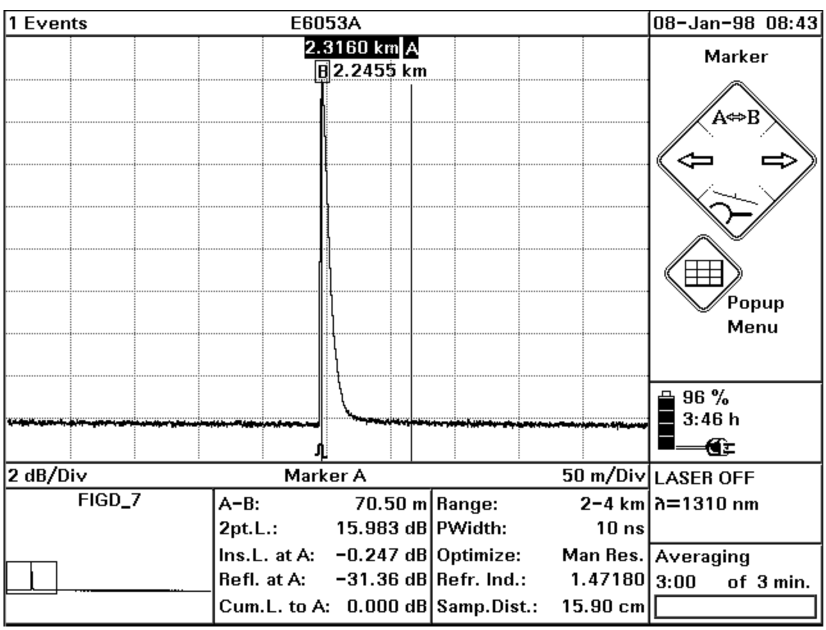


Figure D-7 **Attenuation Deadzone Test: Position Marker A**

18 Select marker B

UP until only B is highlighted.

19 Use the LEFT/RIGHT keys to position marker B on top of marker A

20 Use the LEFT key to move marker B until the 2 pt. Loss shows +0.5dB or -0.5dB.

NOTE **When noise is seen on the trace, a position referring to the mean value of the trace should be selected.**

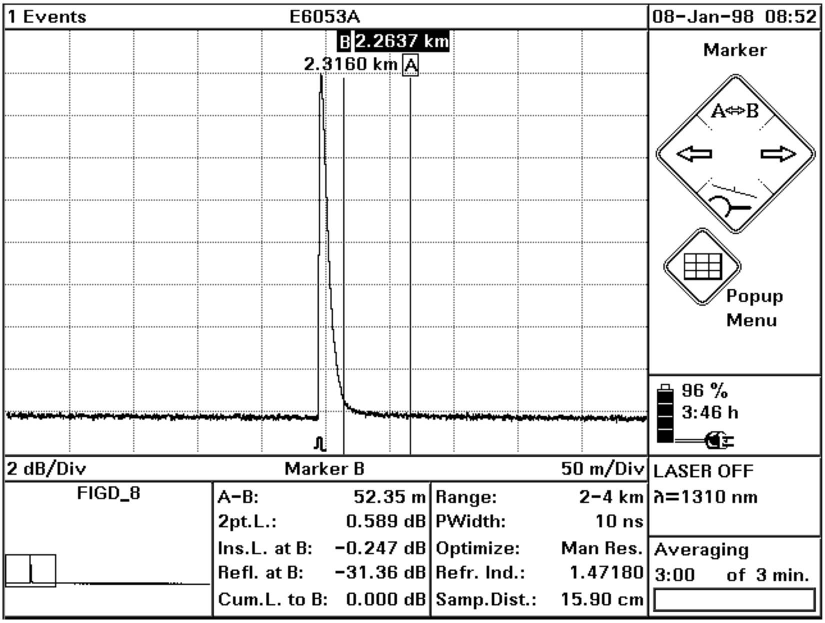


Figure D-8 **Attenuation Deadzone Test: Position Marker B at End of Reflection**

21 Set resolutions to: x-axis: .5m/Div, y-axis: 0.5dB
{<==> ZOOM} → 0.5 m/Div and [⇑ ⇓ Zoom] → 0.5 dB/Div.

22 Select marker A
UP until only A is highlighted.

23 Use the LEFT/RIGHT keys to move marker A to the start of the front reflex.

NOTE **The best approximation of the start position of the reflection is: last point on backscatter + half sample spacing, that is Samp. Dist. (see “” on page 211).**

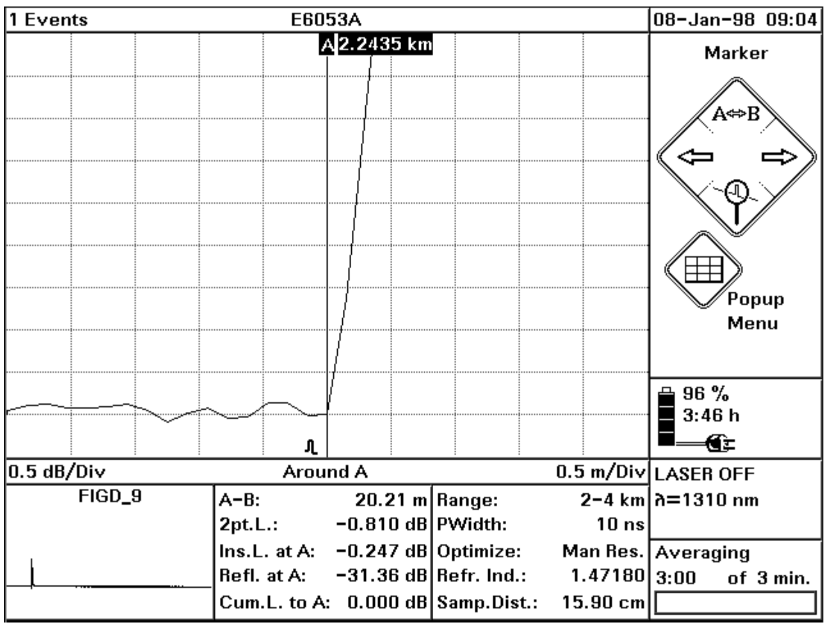


Figure D-9 **Attenuation Deadzone Test: Position Marker A at Start of Reflection**

24 Note the distance between the A-B markers as the attenuation deadzone in the test record.

D.5 Test IV. Distance Accuracy (Optional)

1 Connect the equipment as shown in Figure D-10.
If you are using an HP Recirculating Delay Line, connect port 2 to the OTDR, and leave port 1 open.

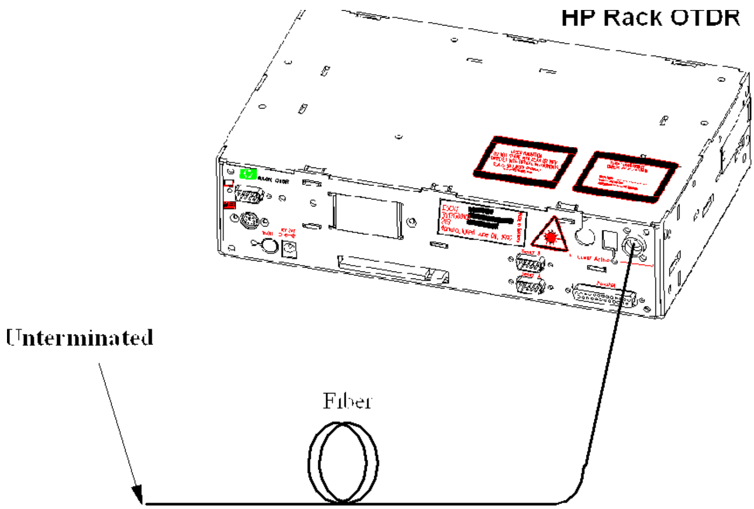


Figure D-10 **Distance Accuracy Test Setup**

2 Turn on the Mini-OTDR, and after the self-test has passed, recall the default settings and the standard mode.

3 Set the OTDR:
[SETTINGS] menu:

- <RANGE>: 0 - 10 km.
- <PULSE WIDTH>: 1 µs
- <WAVELENGTH>: If a dual wavelength module is installed, select the required wavelength
- <MEAS. MODE>: Averaging

- <OPTIMIZE MODE>: Resolution
- <AVG. TIME>: 3 min (see the note on page 92).
- <REFR. IND.>: 1.45800
- <DATA POINTS>: 16000

[VIEW] menu:

- <PREFERENCES><DOTTED TRACE>: OFF

[ANALYSIS] menu

- <2 PT. LOSS>

[CONFIG] menu

- <LENGTH UNIT><METER [M]>: ON

4 Run the measurement, wait 10 seconds, then stop the measurement

<f2> ... <f2>

5 Move marker A to the beginning of the endreflection.

Select Marker A. Use LEFT/RIGHT keys

6 Set the start position close to the position of marker A. The start position should be before the position of marker A (for example, if marker A is at 4.5 km, the start position should be 4.0 km).

[SETTINGS}<RANGE><RANGE INPUT...>. Use Cursor keys to specify Start and Span. Confirm with `OK`.

7 Set the OTDR:

[SETTINGS]<RANGE INPUT>: Start 4 km, Span 2 km

8 Run the measurement, and wait until the measurement has stopped.

9 Set marker to the beginning of the range (4.000 km).

Select Marker A. Use LEFT/RIGHT keys.

10 Set marker B to the beginning of the end reflection

Select Marker B. Use LEFT/RIGHT keys.

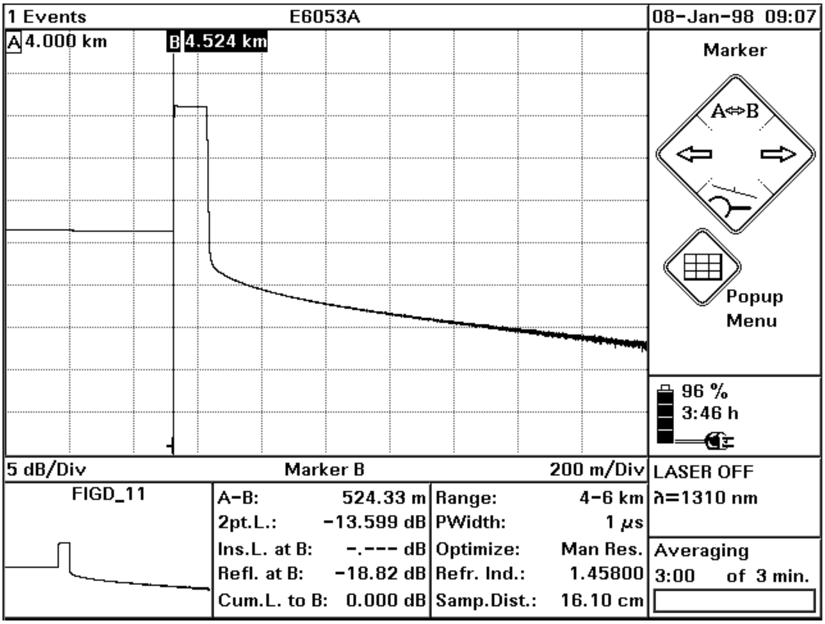


Figure D-11 **Distance Accuracy Test: Position Markers**

11 Select DOWN (Around B).

12 Zoom the display to 0.1 m/Div and 0.2 dB/Div

13 Use the LEFT/RIGHT keys to reposition marker B to the beginning of the endreflection.

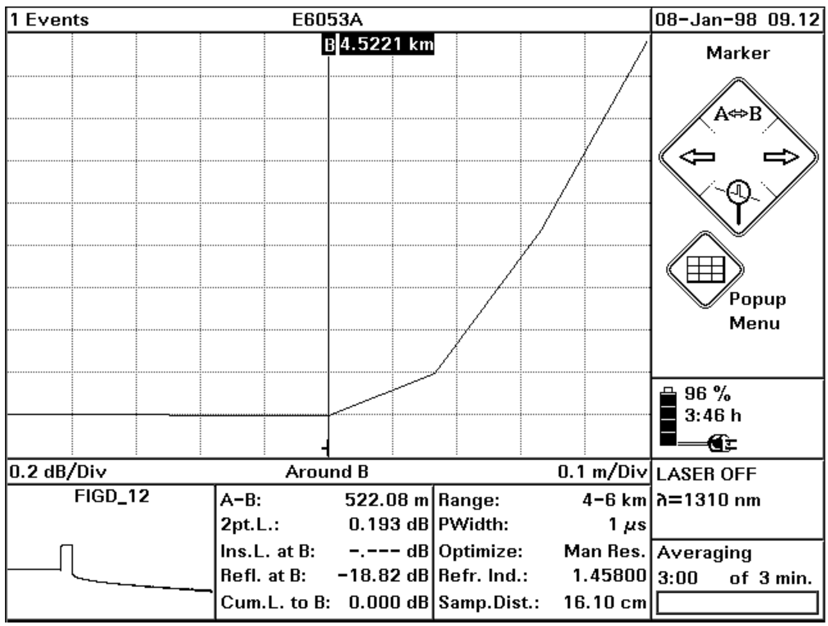


Figure D-12 **Distance Accuracy Test: Around Marker View**

NOTE

The true location of the beginning of the event cannot be determined by finite sample spacing. This is taken care of by the sampling error.

The best approximation of the start position of the reflection is: last point on backscatter + half sample spacing, that is Samp. Dist. (see “” on page 211)

14 Note the distance between markers A and B (A <–>B) plus the position of marker A (4.000 m), as Measured Distance to the test record.

15 Repeat steps 12 to 14 with the pulsewidth set to 100ns.

16 Evaluate the measurement data.

- **a** Note the length of your optical fiber to the test record.
- **b** Note the start position to the test record.
- **c** Distance accuracy

  The distance accuracy is defined as:

  Distance accuracy = (Measured Distance $\times$ Scale Error + Offset Error $\pm$ 1/2 Sampling Spacing)

  Sampling Error = Sample Spacing

  Distance accuracy = $\pm$ Fiber Length $\times$ 10^{-4} $\pm$ 1 m $\pm$ 0.08 m

Measured Distance	Known Fiber Length of Delay Line
Offset Error	$\pm$ 1 m
Scale Error	$\pm$ 10^{-4}
Sample spacing with the 2km Span	0.161m

- **d** Calculate the minimum and the maximum distances as described in the test record.
  Note them in the test record and compare them with the measured distances.

D.6 Performance Test Form Sheets

Please use copies of the following form sheets for your individual performance tests

Performance Test for the HP Rack OTDR with Single-mode Modules, single wavelength
Page 1 of 4

Test Facility:

______________________		Report No.	______________________
______________________		Date:	______________________
______________________		Customer:	______________________
______________________		Tested By:	______________________
Model:	______________		
Serial No.	______________	Ambient temperature	______ °C
Options	______________	Relative humidity	______ %
Firmware Rev.	______________	Line frequency	______ Hz
Model	HP __________ Module		
Serial No.	______________		

Special Notes:

____

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____

Performance Test for the HP Rack OTDR with Single-mode Modules, single wavelength

Model HP __________ Module Report No. _______ Date ________ Page 2 of 4

Test Equipment Used:

Description	Model No.	Trace No.	Cal. Due Date
1. Optical Attenuator	__________	________	__ / ___ /___
2. SM Fiber with 3 dB Coupler Recirculating Delay Line	08145-67900	________	__ / ___ /___
3.____	__________	________	__ / ___ /___
4.____	__________	________	__ / ___ /___
5.____	__________	________	__ / ___ /___
6.____	__________	________	__ / ___ /___
7.____	__________	________	__ / ___ /___
8. ____	__________	________	__ / ___ /___
9. ____	__________	________	__ / ___ /___
10.____	__________	________	__ / ___ /___
11.____	__________	________	__ / ___ /___
12.____	__________	________	__ / ___ /___
13.____	__________	________	__ / ___ /___
14. ____	__________	________	__ / ___ /___

Performance Test for the HP Rack OTDR with Single-mode Modules

Model HP _________ Module **Report No. _______** **Date ________** **Page 3 of 4**

No. Test Description

I. Dynamic Range 1625 nm Wavelength

Pulsewidth	Dynamic $Range_{98\%}$	**Dyn Range** = Dyn $Range_{98\%}$ + 1.9dB	Minimum Specification E6060A	Meas. Uncertainty
	dB	dB	dB	dB
10 µs	_______	_______	37	_______
1µs	_______	_______	30	_______
100 ns	_______	_______	24	_______
10 ns	_______	_______	18	_______

II. Event Deadzone 1625 nm Wavelength

	Event Deadzone	Max Spec	Meas. Uncertainty
Return Loss ≥ 35dB Conditions: Meas. Span. 2km Pulsewidth 10ns			
E6053A, E6058A	_______ m	5m	_______ m

Performance Test for the HP Rack OTDR with Single-mode Modules, single wavelength

Model HP _______ Module Report No. _______ Date ________ Page 4 of 4

No. Test Description

III. Attenuation Deadzone 1625 nm Wavelength

	Attenuation Deadzone	Maximum Specification E6060A	Meas. Uncertainty
	m	m	m
Return Loss ≥ 35dB Conditions: Meas. Span. 2km Pulsewidth 30ns	_______	28	_______

IV. Distance Accuracy 1625 nm Wavelength (Optional test)

Fiber Length: _________ m Sample Spacing: __________ m (as Δ on the screen)
Start Position: _________ m

| Distance Accuracy | = (Fiber Length x Scale Error + Offset Error +1/2 Sample Spacing)
|Distance Accuracy| = (_________ m x 10^{-4} + 1m + _________ m)
|Distance Accuracy| = ________ m

Minimum Distance = Fiber Length - | Distance Accuracy|
Maximum Distance = Fiber Length +| Distance Accuracy|

Meas.Span	Pulsewidth	Minimum Distance (typical)	Measured Distance	Maximum Distance (typical)	Meas. Uncertainty
		m	m	m	m
4 to 6 km	1 µs		________		
	100 ns	________	________	________	________

Performance Test for the HP Rack OTDR with Single-mode Modules, Dual Wavelength
Page 1 of 6

Test Facility:

________________________ Report No. ________________________

________________________ Date: ________________________

________________________ Customer: ________________________

________________________ Tested By: ________________________

Model: ________________

Serial No. ________________

Options ________________

Firmware Rev. ________________

Model HP ________ Module

Serial No. ________________

Ambient temperature ______ °C

Relative humidity ______ %

Line frequency ______ Hz

Special Notes:

____

____

____

____

____

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____

____

Performance Test for the HP Rack OTDR with Single-mode Modules, Dual Wavelength

Model HP __________ Module   Report No. _______   Date ________   Page 2 of 6

Test Equipment Used:

Description	Model No.	Trace No.	Cal. Due Date
1. Optical Attenuator	__________	________	__ / ___ /___
2. SM Fiber with 3 dB Coupler Recirculating Delay Line	08145-67900	________	__ / ___ /___
3.____	__________	________	__ / ___ /___
4.____	__________	________	__ / ___ /___
5.____	__________	________	__ / ___ /___
6.____	__________	________	__ / ___ /___
7.____	__________	________	__ / ___ /___
8. ____	__________	________	__ / ___ /___
9. ____	__________	________	__ / ___ /___
10.____	__________	________	__ / ___ /___
11.____	__________	________	__ / ___ /___
12.____	__________	________	__ / ___ /___
13.____	__________	________	__ / ___ /___
14. ____	__________	________	__ / ___ /___

Performance Test for the HP Rack OTDR with Single-mode Modules, Dual Wavelength

Model HP ______ Module **Report No. ________** **Date _________** **Page 3 of 6**

No. Test Description

I. Dynamic Range 1310 nm Wavelength

Pulsewidth	Dynamic Range$_{98\%}$	**Dyn Range** = Dyn Range$_{98\%}$ + 1.9dB	Minimum Specification E6053A	Minimum Specification E6058A	Meas. Uncertainty
	dB	dB	dB	dB	dB
10 µs	_______	_______	35	40	_______
1µs	_______	_______	30	35	_______
100 ns	_______	_______	24	29	_______
10 ns	_______	_______	19	24	_______

II. Event Deadzone 1310 nm Wavelength

	Event Deadzone	Max Spec	Meas. Uncertainty
Return Loss ≥ 35dB Conditions: Meas. Span. 2km Pulsewidth 10ns			
E6053A, E6058A	_______ m	5 m	_______ m

Performance Test for the HP Rack OTDR with Single-mode Modules, Dual Wavelength

Model HP _______ Module **Report No. _______** **Date ________** **Page 4 of 6**

No. Test Description

III. Attenuation Deadzone 1310 nm Wavelength

	Attenuation Deadzone	Maximum Specification E6053A	Maximum Specification E6058A	Meas. Uncertainty
	m	m	m	m
Return Loss ≥ 35dB				
Conditions: Meas. Span. 2km Pulsewidth 30ns	_______	20	20	_______

IV. Distance Accuracy 1310 nm Wavelength (Optional test)

Fiber Length: ________ m Sample Spacing: ________ m (as Δ on the screen)
Start Position: ________ m

| Distance Accuracy | = (Fiber Length x Scale Error + Offset Error + 1/2 Sample Spacing)

| Distance Accuracy | = (_________ m x 10^{-4} + 1m + ________ m)

| Distance Accuracy | = _______ m

Minimum Distance = Fiber Length - | Distance Accuracy|
Maximum Distance = Fiber Length +| Distance Accuracy|

Meas.Span	Pulsewidth	Minimum Distance (typical)	Measured Distance	Maximum Distance (typical)	Meas. Uncertainty
		m	m	m	m
4 to 6 km					
	1 µs		_______		
	100 ns	_______	_______	_______	_______

Performance Test for the HP Rack OTDR with Single-mode Modules, Dual Wavelength

Model HP _________ **Module** **Report No.** _______ **Date** ________ **Page 5 of 6**

No. Test Description

I. Dynamic Range 1550 nm Wavelength

Pulsewidth	Dynamic $Range_{98\%}$	**Dyn Range** = Dyn $Range_{98\%}$ + 1.9dB	Minimum Specification E6053A	E6058A	Meas. Uncertainty
	dB	dB	dB	dB	dB
10 µs	_______	_______	34	39	_______
1µs	_______	_______	29	34	_______
100 ns	_______	_______	22	27	_______
10 ns	_______	_______	17	22	_______

II. Event Deadzone 1550 nm Wavelength

	Event Deadzone	Max Spec	Meas. Uncertainty
Return Loss ≥ 35dB Conditions: Meas. Span. 2km Pulsewidth 10ns			
E6053A, E6058A	_______ m	5m	_______ m

Performance Test for the HP Rack OTDR with Single-mode Modules, Dual Wavelength

Model HP _______ Module Report No. _______ Date ________ Page 6 of 6

No. Test Description

III. Attenuation Deadzone 1550 nm Wavelength

	Attenuation Deadzone	Maximum Specification E6053A	Maximum Specification E6058A	Meas. Uncertainty
	m	m	m	m
Return Loss ≥ 35dB				
Conditions: Meas. Span. 2km Pulsewidth 30ns	_______	25	25	_______

IV. Distance Accuracy 1550 nm Wavelength (Optional test)

Fiber Length: _________ m Sample Spacing: __________ m (as Δ on the screen)
Start Position: _________ m

| Distance Accuracy | = (Fiber Length x Scale Error + Offset Error +1/2 Sample Spacing)
|Distance Accuracy| = (_________ m x 10^{-4} + 1m + _________ m)
|Distance Accuracy| = ________ m

Minimum Distance = Fiber Length - | Distance Accuracy|
Maximum Distance = Fiber Length +| Distance Accuracy|

Meas.Span	Pulsewidth	Minimum Distance (typical)	Measured Distance	Maximum Distance (typical)	Meas. Uncertainty
		m	m	m	m
4 to 6 km	1 µs		________		
	100 ns	________	________	________	________

D.7 Test V. E6006A Submodule

Test Equipment Required

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

Optional Test Equipment

Laser Source 850 nm	1	HP 81551MM	850 ± 10 nm short term stability < ±0.01 dB

Uncertainty/Accuracy Test at Reference Conditions

NOTE

Make sure that all equipment has warmed up, and all connectors are clean.

Make sure that all patchcords are fixed to the table and will not move during measurements.

Repeat each of the following steps for each of the specified wavelengths:

1 Connect the equipment as shown in Figure D-13.

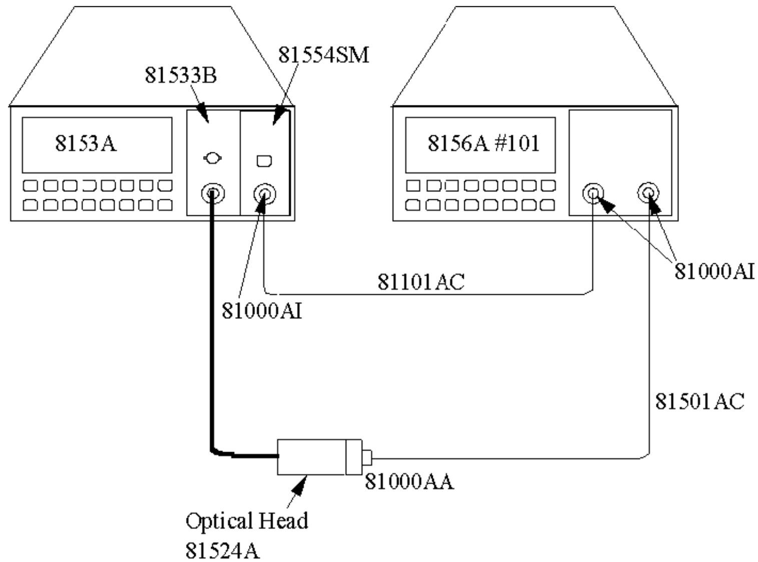


Figure D-13 **Test setup 1310 nm and 1550 nm: Reference Measurement**

2 Disable the laser source and attenuator; zero the power meter (press {ZERO}).

Reference Measurement

3 Set the laser source to 1310 nm (nominal).

4 Set both the power meter and the attenuator to 1310.00 nm.

5 Set the power meter to MEASURE mode; select parameter T=100ms; switch AUTO range on.

6 Enable the Laser Source and the HP 8156A output, and wait 3 minutes until the laser has settled.

7 On the power meter, press [dBm W] to get the display reading in W.

8 Set the attenuation of the attenuator to a value where the power meter reads 10.00 µW

Measurement of DUT

9 Connect the attenuator output cable to the DUT, as shown in Figure D-14.

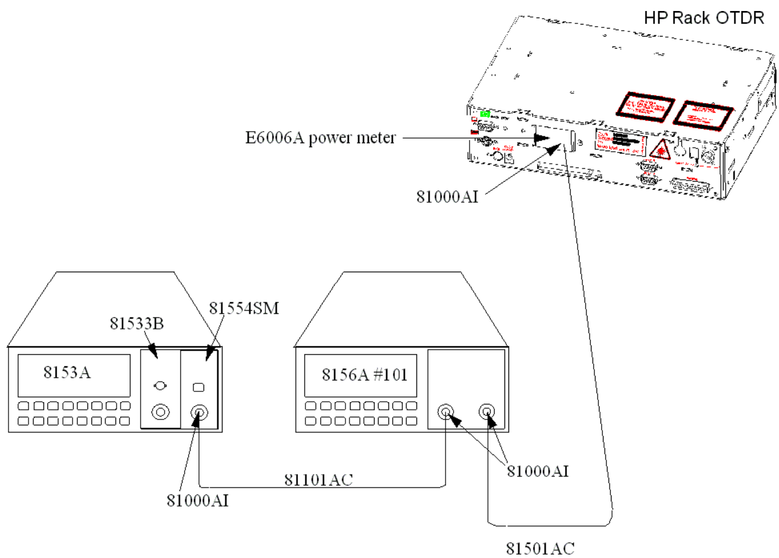


Figure D-14 **Test setup 1310 nm and 1550 nm: Measurement of the DUT**

10 Make sure that the E6006A DUT has warmed up.

11 Set the DUT to 1310.00 nm.

12 Enable the laser source and the HP 8156A output, and wait 3 minutes until the laser has settled.

13 Set the DUT to display power levels in W.

14 Note the displayed measured value on the DUT in the test

record.

Test of the other wavelength

15 Set the laser source to 1550 nm (nominal), and set the attenuator and the DUT to 1550.00 nm.

16 Repeat steps 1 to 14 for this wavelength, replacing all settings of 1310 nm/1310.00 nm by 1550 nm/1550.00 nm.

NOTE **The Reference Power Meter 81524A and the DUT are both of the same type InGaAs. This means that the wavelength dependencies are equal. As long as both the Reference Power Meter and the DUT are set to the same wavelength, the actual wavelength of the source does not noticeably add to measurement uncertainties, if the source is within a ±20 nm limit of the measuring wavelength.**

Total Uncertainty/Accuracy Test

NOTE **Make sure that all equipment has warmed up, and all connectors are clean.**

Make sure that all patchcords are fixed to the table and will not move during measurements.

Repeat each of the following steps for each of the specified wavelengths.

1 Connect the equipment as shown in Figure D-13.

NOTE **If you are performing the optional accuracy test at 850 nm, it is sufficient to measure at the highest power level. This means that you do not need to use an attenuator: you can connect the laser source directly to the optical head using an HP 81501AC patchcord.**

2 Disable the laser source and attenuator; zero the power meter (press {ZERO}).

Reference Measurement

3 Set the laser source to 1310 nm (nominal).

4 Set the Laser Source to `ATT=0`.

5 Set the power meter and the attenuator to 1310.00 nm.

6 Set the power meter to MEASURE mode; select parameter T=100ms; switch AUTO range on.

7 Enable the Laser Source and the HP 8156A output, and wait 3 minutes until the laser has settled.

8 Set the attenuation of the attenuator to 0.00 dB.

9 On the power meter, press `[dBm W]` to get the display reading in W.

10 Note the displayed reference measurement value on the power meter in the test record.

11 Repeat steps 9 and 10 for all attenuation values listed in the test record.

Measurement of DUT

12 Connect the attenuator output cable to the DUT, as shown in Figure D-14.

NOTE **If you are performing the optional accuracy test at 850 nm, it is sufficient to measure at the highest power level. This means that you do not need to use an attenuator: you can connect the laser source directly to the optical head using an HP 81501AC patchcord.**

13 Make sure that the E6006A DUT has warmed up.

14 Set the DUT to 1310.00 nm.

15 Enable the laser source and the HP 8156A output, and wait 3 minutes until the laser has settled.

16 Set the attenuation of the attenuator to 0.00 dB.

17 Set the DUT to display power levels in W.

18 Note the displayed measured value on the DUT in the test record.

19 Repeat step 18 for all attenuation values listed in the test record.

Test of other wavelengths

20 Set the laser source to 1550 nm (nominal), and set the attenuator and the DUT to 1550.00 nm.

21 Repeat steps 1 to 19 for this wavelength, replacing all settings of 1310 nm/1310.00 nm by 1550 nm/1550.00 nm.

NOTE **The Reference Power Meter 81524A and the DUT are both of the same type InGaAs. This means that the wavelength dependencies are equal. As long as both the Reference Power Meter and the DUT are set to the same wavelength, the actual wavelength of the source does not noticeably add to measurement uncertainties, if the source is within a ±20 nm limit of the measuring wavelength.**

Performance Test for the HP E6006A with Power Meter submodule

Page 1 of 3

Test Facility:

______________________________	Report No.	______________________
______________________________	Date:	______________________
______________________________	Customer:	______________________
______________________________	Tested By:	______________________

Model: **HP E6006A Power Meter**

Serial No. ______________________

Options ______________________ .

Firmware Revision ______________________

HP E6000A Handheld OTDR Mainframe	E600__A OTDR Module
Serial No. ______________________	Serial No. ______________________

Ambient Temperature ____________ °C
Relative Humidity ____________ %
Line Frequency ____________ Hz

Test Equipment used:

Description	Model No.	Trace No.	Cal. Due Date
1. Std. Lightwave Multimeter	______________	____________	_____ / _____ / _____
2. Std. Optical Head Interface	______________	____________	_____ / _____ / _____
3. Std. Optical Head	______________	____________	_____ / _____ / _____
4. Laser Source	______________	____________	_____ / _____ / _____
5. Attenuator	______________	____________	_____ / _____ / _____
6. ____________________	______________	____________	_____ / _____ / _____
7.____________________	______________	____________	_____ / _____ / _____
8.____________________	______________	____________	_____ / _____ / _____
9.____________________	______________	____________	_____ / _____ / _____

Performance Test for the HP E6000A with Power Meter Submodule

Model: HP E6006A Module Report No. __________ Date: ___________ **Page 2 of 3**

Uncertainty/Accuracy Test at Reference Conditions

Reference setting of power level 10.00 µW

Wavelength	Minimum Spec. (-3.6% of Ref.)	E6006A, DUT Measurement Results	Maximum Spec. (+3.6% of Ref.)	Measurement Uncertainty
1310.00 nm	9.640 µW	________ µW	10.360 µW	________ µW
1550.00 nm	9.640 µW	________ µW	10.360 µW	________ µW

Uncertainty/Accuracy Test

Wavelength 1310 nm

8156A setting	81524A Reference Measurement	Minimum Spec. (-5% of Ref. - 0.5 nW)	E6006A, DUT Measurement Results	Maximum Spec. (+5% of Ref. + 0.5 nW)	Measurement Uncertainty
0 dB	________ µW	________ µW	________ µW	________ µW	________ W
5 dB	________ µW	________ µW	________ µW	________ µW	________ W
15 dB	________ µW	________ µW	________ µW	________ µW	________ W
25 dB	________ µW	________ µW	________ µW	________ µW	________ W
35 dB	________ nW	________ nW	________ nW	________ nW	________ W
45 dB	________ nW	________ nW	________ nW	________ nW	________ W

Wavelength 1550 nm

8156A setting	81524A Reference Measurement	Minimum Spec. (-5% of Ref. - 0.5 nW)	E6006A, DUT Measurement Results	Maximum Spec. (+5% of Ref. + 0.5 nW)	Measurement Uncertainty
0 dB	________ µW	________ µW	________ µW	________ µW	________ W
5 dB	________ µW	________ µW	________ µW	________ µW	________ W
15 dB	________ µW	________ µW	________ µW	________ µW	________ W
25 dB	________ µW	________ µW	________ µW	________ µW	________ W
35 dB	________ nW	________ nW	________ nW	________ nW	________ W
45 dB	________ nW	________ nW	________ nW	________ nW	________ W

Performance Test for the HP E6000A with Power Meter Submodule

Model: HP E6006A Module Report No. __________ Date: ___________ **Page 3 of 3**

Optional Test

Wavelength 850 nm

8156A setting	81524A Reference Measurement	Minimum Spec. (-10% of Ref. - 2.5 nW)	E6006A, DUT Measurement Results	Maximum Spec. (+10% of Ref. +2.5 nW)	Measurement Uncertainty
n/a	________ μW	________ μW	________ μW	________ μW	________ W

D.8 Test VI: E6007A Visual Fault Finder Submodule

Test Equipment Required

Instrument or Accessories	qty	Recommended Model	Required Characteristic
Lightwave Multimeter Meter	1	HP 8153A	
Optical Power Sensor	1	HP 81530A	
Patchcord *(HMS10/HMS10, 9/50 μm, SM)*	1	HP 81101AC	
connector interface	2	HP 81000AI	
Optical Spectrum Analyzer *(optional test only)*	1	HP 75450A #101	

General

- Make sure that all equipment has warmed up, and all connectors are clean.
- Make sure that all patchcords are fixed to the table, and will not move during measurements.

Test of Output Power Level (CW)

1 Connect the equipment as shown in Figure D-15.

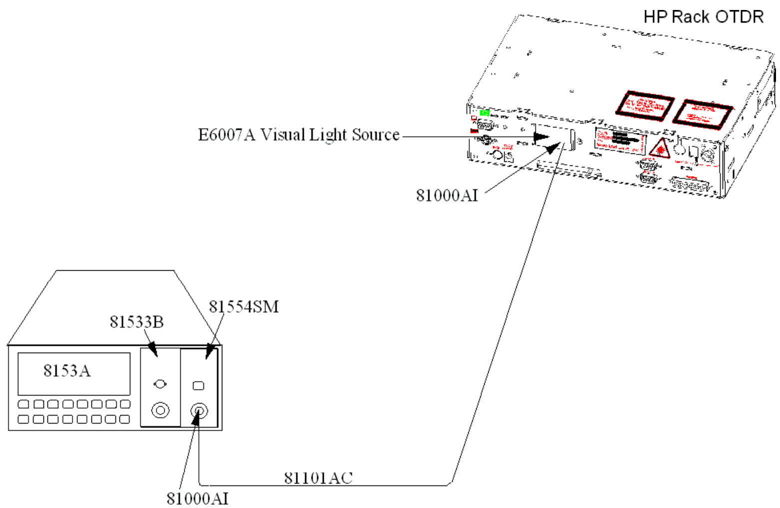


Figure D-15 **Measurement of the Output power**

2 Apply a 9/125 µm patchcord with HMS-10 connectors.

3 Set the 8153A:

dBm/W	`dBm`
wavelength	λ = 635 nm
sampling time	T = 100 ms
Range	AUTO

4 Before you switch on the DUT, zero the 8153A: press {ZERO} on the 8153A.

5 On the DUT, select Visual Fault Finder:

Select Mod	`CW`
Select	ON

and allow to settle.

6 Note the displayed power level on the 8153A in the test report.

Optional test: Center Wavelength

NOTE **The laser has been vendor tested, and specifications are purely typical. Therefore, this test is not mandatory.**

1 Connect the E6007A output to the Optical Spectrum Analyzer using an 81101A patchcord, and two 81000AI interface adapters:
- ensure that the OSA is switched on and has warmed up.
- ensure that the E6000A is switched on and has warmed up.
- enable the E6007A (DUT).

2 On the OSA:
- press INSTRPRESET
- press AUTO/MEAS and wait until `End of Automeasure` is displayed.
- choose USER and then select the type of source to be measured as FP (for Fabry-Perot Laser).

To show the display in linear mode:
- press MENU
- select AMPT on the left side of the display
- press LINEAR on the right side of the display.

3 To ensure an interference free reading of the display, you should stop the steady repeating calculations:
- select USER.
- press SINGLE SWEEP.

4 If the presentation of the graphic is not suitable, you may change

the resolution using the SPAN key.

5 If the signal is clipped, increase the reference level.

6 From the displayed measurements, check for Mean Wavelength.

Performance Test for the HP E6007A

Page 1 of 2

Test Facility:

_______________________	Report No.	_______________________
_______________________	Date:	_______________________
_______________________	Customer:	_______________________
_______________________	Tested By:	_______________________

Model: **HP E6007A Visual Light Source**

Serial No. _______________________

Options _______________________ Firmware Revision _______________________

.

HP E6000A Handheld OTDR Mainframe	E600__A OTDR Module
Serial No. _______________________	Serial No. _______________________

Ambient Temperature ______________ °C
Relative Humidity ______________ %
Line Frequency ______________ Hz

Test Equipment used:

Description	Model No.	Trace No.	Cal. Due Date
1. Std. Lightwave Multimeter	______________	______________	_____ / _____ / _____
2. Std. Optical Power Sensor	______________	______________	_____ / _____ / _____
3. ______________________	______________	______________	_____ / _____ / _____
4.______________________	______________	______________	_____ / _____ / _____
5.______________________	______________	______________	_____ / _____ / _____

Performance Test for the HP E6000A with Visual Light Source Submodule

Model: HP E6007A Module   Report No. __________   Date: _________   **Page 2 of 2**

Output Power Level (CW)

Wavelength 635 nm

fiber type	Minimum Specification	Measured value	Maximum Specification	Measurement Uncertainty
9/125 µm SM	-5.00 dBm (-3 dBm typ.)	_________ dBm	0 dBm	________ dB

Optional Center Wavelength Performance Test

	Minimum Specification	Measured value	Maximum Specification	Measurement Uncertainty
Wavelength	615 nm (625 nm typ.)	_________ nm	655 nm (645 nm typ.)	________ nm

E

Cleaning Procedures

Cleaning Procedures

In general, *whenever possible use physically contacting connectors, and dry connections*. Fiber connectors may be used dry or wet. Dry means without index matching compound. Clean the connectors, interfaces and bushings carefully each time after use.

WARNING

Make sure to disable all sources when you are cleaning any optical interfaces.
Under no circumstances look into the end of an optical cable attached to the optical output when the device is operational.
The laser radiation is not visible to the human eye, but it can seriously damage your eyesight.

E.1 Cleaning Materials

	HP P/N
Lens Cleaning Paper	9300-0761
Special Cleaning Tips	9300-1351
Blow Brush	9300-1131
Adhesive Cleaning tape	15475-68701
Isopropyl Alcohol	Not available from HP. This should be available from any local pharmaceutical supplier.
Pipe Cleaner	

WARNING **To prevent electrical shock, disconnect the Rack OTDR from the mains before cleaning. Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean internally.**

E.2 Cleaning Fiber/Panel Connectors

1. To clean the instrument panel connector remove the connector interface.
2. Apply some isopropyl alcohol to the lens cleaning paper and clean the surface and the ferrule of the connectors.
3. Using a new dry piece of cleaning paper, wipe the connector surface and ferrule until they are dry and clean.
4. Lightly press the adhesive tape several times against the connector surface to remove any remaining particles. After use store the tape in the container.

5 Protect the connector surface with a cap.

E.3 Cleaning Connector Interfaces

NOTE **If any index matching compound was used, use an ultrasonic bath with isopropyl alcohol to clean the connector interfaces.**

- Apply some isopropyl alcohol to the pipe cleaner and wash the inside the connector interface.
- Using a new dry pipe cleaner, dry the inside the connector interface.
- Remove the brush part from the blow brush and blow air through the inside the interface to remove any remaining particles.

E.4 Cleaning Connector Bushings

As used on the HP 8158B Optical Attenuator and HP 81000AS/BS Optical Power Splitter.

Normally the connector bushings require no cleaning. However, if it appears that cleaning is necessary, use only the blow brush with the brush part removed.

CAUTION **NEVER insert any cleaning tool into the bushing as this may affect the optical system.**
NEVER use any index matching compound, cleaning fluid or cleaning spray.

E.5 Cleaning Detector Windows

As used on the HP 81520A and HP 81521B Optical Heads (large area).

1. Use the blow brush to remove any particles from the surface.
2. Wipe the surface with cleaning paper or special cleaning tips.

E.6 Cleaning Lens Adapters

CAUTION **Do not use any cleaning fluid or cleaning spray.**

1. Using the blow brush, remove dust.
2. Wipe the surfaces with the special cleaning tips.

E.7 Cleaning Detector Lens Interfaces

As used on the HP 81522A Optical Head (small area) and HP 8140A and HP 8153A detector modules.

Normally, the lens interface can be cleaned by using the blow brush. If adhesive dirt must be removed perform as follows:

1. Using the blow brush, remove the dust from the lens surface.
2. Press the special cleaning tip to the lens surface and rotate the tip.

NOTE **Use alcohol for cleaning only when the above procedure does not help or if the dirt is caused by oil or fat.**

Environmental Profile

Environmental Profile

F.1 Product Summary

This information is valid for all Rack OTDRs

Transport restrictions:	none
Hazardous or restricted materials:	no hazardous materials no CFCs or brominated fire retardants
Parts requiring special disposal:	Li-Ion Backup-battery

F.2 Materials of Construction

Material	actual weight	% weight	% recyclable/ reusable
Metals			
Aluminium	1250g	54	100
Plastic parts:			
TPU	40g	2	100
Others:			
Printed Circuit Boards	510g	22	0

F.3 Energy Use/Efficiency

Normal Operation:	< 10 Watt
Standby:	< 5 Watt

F.4 Operation Emissions

Ozone:	No ozone emissions
Radio Frequency Noise:	Meets CISPR 11 (CISPR22)

F.5 Batteries

The Lithium backup battery requires special disposal. Dispose in accordance with local laws and regulations.

F.6 Materials of Packaging

Material		% weight	% recyclable/reusable
PU	250g	18	100
Corrugated Paper	1150g	82	100

F.7 Learning Products

Manuals are 100% recyclable.

F.8 HP Manufacturing Process

Hewlett-Packard has eliminated ozone depleting substances such as chlorofluorocarbons (CFCs), trichlorethane (TCA), and carbon tetrachloride from its manufacturing process worldwide.

Hewlett-Packard is surveying and working with suppliers to identify and eliminate any ozone depleting substances from their manufacturing.

G

The DC/DC Adapter

The DC/DC Adapter

G.1 Introduction

If you have Option 004 of the Rack OTDR, an external DC/DC switcher is mounted on the rear of your instrument.

The switcher is attached to your Rack OTDR (Figure G-1), with the equipment displayed in Figure G-2

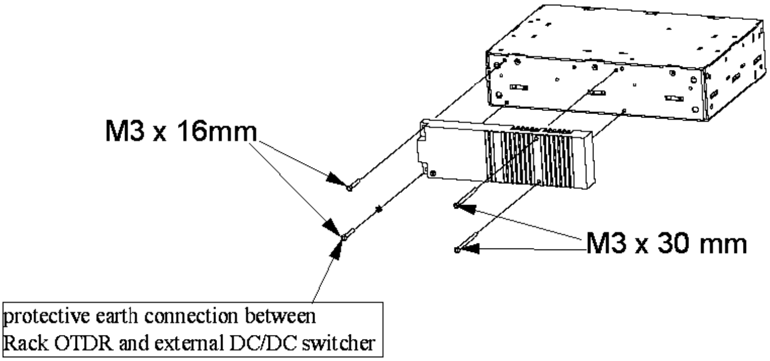


Figure G-1 **DC/DC Adapter attachment**

NOTE **The bottom left screw acts as a protective earth for the DC/DC switcher.**

The other 3 screws just act to hold the switcher in position

.

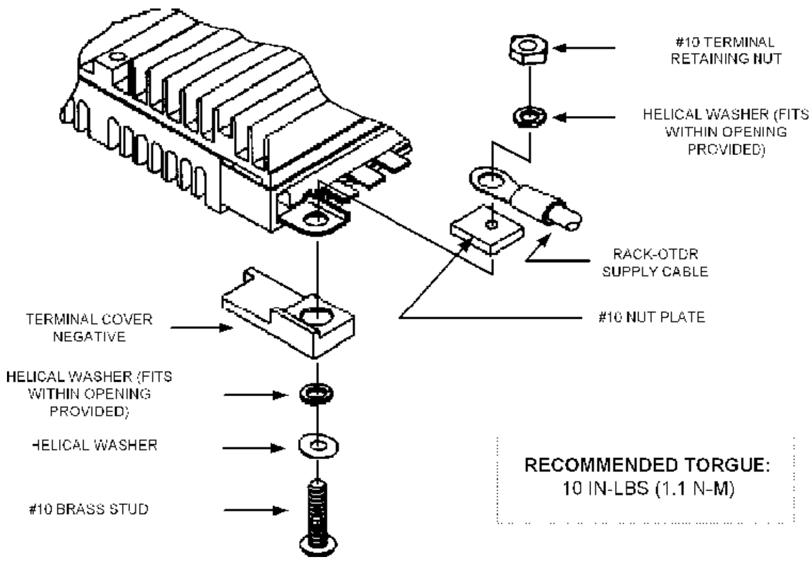


Figure G-2 **Attaching a DC/DC Adapter**

A power cord is attached to the switcher (Figure G-3).

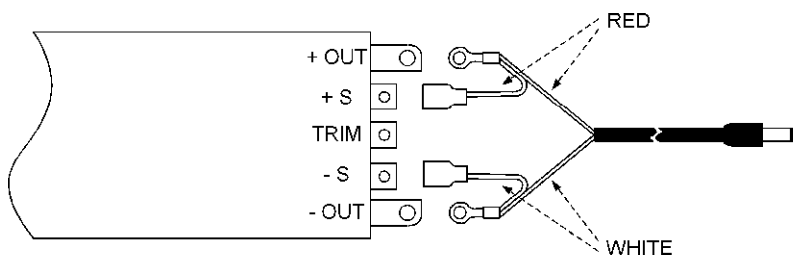


Figure G-3 **Attaching a power cord to the DC/DC switcher**

When you receive your Rack OTDR, the power cord is screwed to the side of the Rack OTDR (Figure G-4 on page 155). However, you can unscrew the power cord and pass it through your Rack OTDR flaps (Figure G-5).

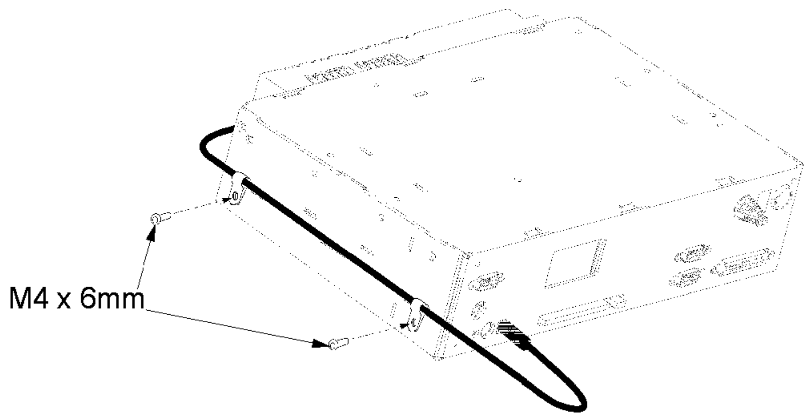


Figure G-4 **Rack OTDR power cord: without rackmount kit**

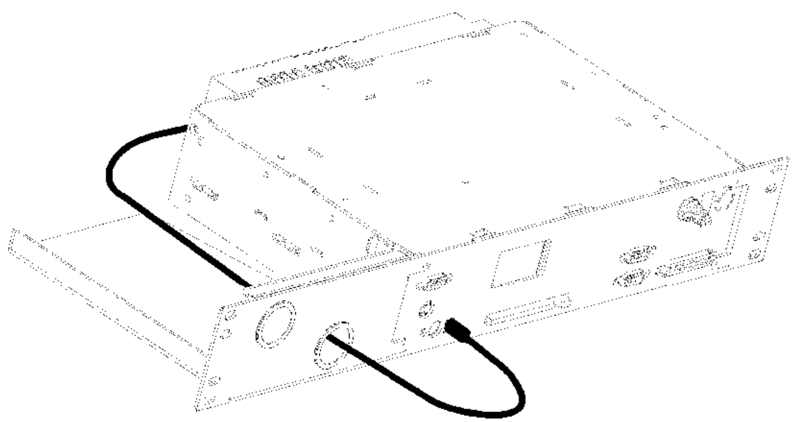
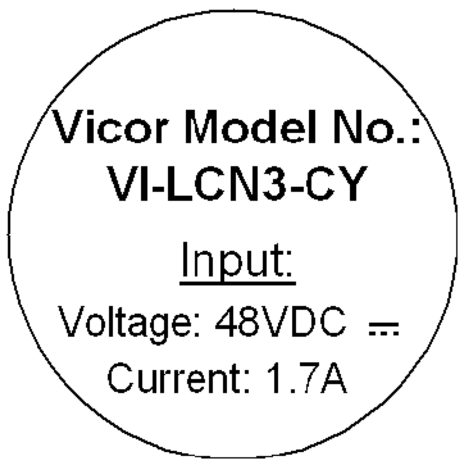


Figure G-5 **Rack OTDR power cord: with rackmount kit**

G.2 Safety Considerations

NOTE ⚠ **When the Rack OTDR has option 004 (externally mounted DC/DC converter), and the Rack and DC/DC switcher are in use, the system complies to Safety Class 1 (for instruments provided with a terminal for protective grounding).**

NOTE **The following label is fixed onto the DC/DC switcher.**



G.3 Power Supply Requirements

Input Line Fusing

NOTE

The DC/DC switcher, which is mounted on the rear side of the Rack OTDR, must be fused externally. The fuse must have 7 A, a rating of at least 60 V and must be of type “fast acting” (for example, fuse type 3AB-7).

The fuse must be inserted into the 48 VDC supply circuit using the DC/DC switcher.

Grounding

For safe operating, the externally mounted DC/DC switcher **must** be grounded (see “Safety Considerations” on page 156).

Connect a protective ground lead to the terminal marked on the DC/DC switcher:

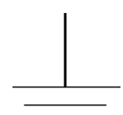


Figure G-6 **Protective ground marking**

Use a wire of at least 16 AWG wire with color code yellow-green for this connection.

Input Voltage Connection

Connect the +48 V line to the `Vin+` (positive) and the ground to the `Vin-` (negative) points of the external DC/DC switcher mounted on the rear side of your Rack OTDR (Figure G-7).

Alternatively, connect the -48 V line to the `Vin-` (negative) and the ground to the `Vin+` (positive) points.

Use wires of 16 AWG to connect the line to the points.

If you use the Rack OTDR option 004 in a battery system, you can connect the protective ground terminal (marked with the symbol shown in Figure G-6) to the corresponding ground potential of the +48 VDC and -48 VDC input.

Be sure to tighten the lead securely. We recommend a connector screw torque of 3.5 in-lbs (0.4 Nm).

NOTE

If you attach the 48 VDC line to the input of the connected external DC/DC switcher the Rack OTDR automatically boots when the switcher is not disabled.

The Rack OTDR also boots if you remotely switch on the DC/DC converter by interrupting the disabling circuit (see “Master Disable” on page 158).

WARNING **The DC/DC power supply is for indoor use only.**

Master Disable

The Master Disable input is optically isolated and incorporates a reverse polarity protection diode (Figure G-7).

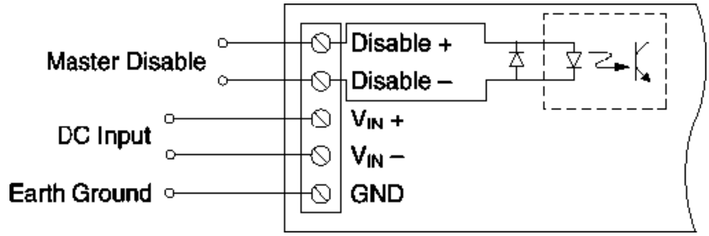


Figure G-7 **Master Disable**

Apply a current of at most 20 mA to disable output.

WARNING **20 mA is the absolute maximum current that you should apply. Never apply a higher current.**

Figure G-8 gives a diagram showing a disabled circuit.

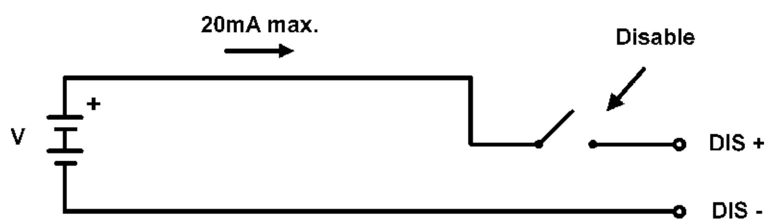


Figure G-8 **Interrupting the disabling circuit**

The typical current level is below 4 mA

G.4 Specifications

- **Dimensions**: ca. 71 mm H, 290 mm W, 230 mm D (3.0" x 11.6" x 9.1").
- **Weight**: < 2.6 kg (5.8 lb)
- **Input voltage of externality mounted DC/DC switcher**:
  +48 VDC nom. (42 .. 60 VDC)
  -48 VDC nom. (-60 .. -42 VDC): see “Input Voltage Connection” on page 157.
- **Maximum power consumption**: 25 W
- **Typical power consumption**: 10 W
- **Standby power consumption**: < 5 W

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