



HP 8147A Optical Time Domain Reflectometer

User's Guide

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User's Guide

Safety Summary

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

General This is a Safety Class 1 instrument (provided with terminal for protective earthing) and has been manufactured and tested according to international safety standards.

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

- Do not remove instrument covers when operating.
- Before the instrument 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 has been impaired, the instrument must be made inoperative and be secured against any unintended operation.
- Make sure that only fuses with the required rated current and of the specified type (normal blow, time delay, etc.) are used for replacement. The use of repaired fuses and the short-circuiting of fuseholders must be avoided.
- Adjustments described in the manual are performed with power supplied to the instrument 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.

Safety Summary

- 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.



Caution, risk of electric shock.

Frame or chassis terminal.

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.

Safety Summary

Initial Safety Information for Laser Source

The specifications for the modules are as follows:

	E4311A	E4312A	E4313A
Laser Type	FP-Laser InGaAsP	FP-Laser InGaAsP	FP-Laser InGaAsP
Laser Class			
According to IEC 825 (Europe)	3A	3A	3A
According to 21 CFR 1040.10 (Canada, Japan, USA)	1	1	1
Output Power (Pulse Max)	7.5 mW	7.5 mW	7.5 mW
Pulse Duration (Max)	10 μ s	10 μ s	10 μ s
Pulse Energy (Max)	75 nWs	75 nWs	75 nWs
Output Power (CW)	0.5 mW	0.5 mW	0.5 mW
Beam Waist Diameter	9 μ m	9 μ m	9 μ m
Numerical Aperture	0.1	0.1	0.1
Wavelength	1310 \pm 15nm	1550 \pm 15nm	1310/1550 \pm 15nm
	E4314A	E4315A	E4316A
Laser Type	FP-Laser InGaAsP	FP-Laser InGaAsP	FP-Laser InGaAsP
Laser Class			
According to IEC 825 (Europe)	3A	3A	3A
According to 21 CFR 1040.10 (Canada, Japan, USA)	1	1	1
Output Power (Pulse Max)	25 mW	25 mW	25 mW
Pulse Duration (Max)	10 μ s	10 μ s	10 μ s
Pulse Energy (Max)	250 nWs	250 nWs	250 nWs
Output Power (CW)	1 mW	1 mW	1 mW
Beam Waist Diameter	9 μ m	9 μ m	9 μ m
Numerical Aperture	0.1	0.1	0.1
Wavelength	1310 \pm 15nm	1550 \pm 15nm	1310/1550 \pm 15nm

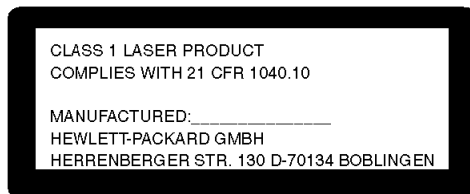
Safety Summary

	E4317A	E4318A	E4319A
Laser Type	FP-Laser InGaAsP	FP-Laser InGaAsP	FP-Laser InGaAsP
Laser Class			
According to IEC 825 (Europe)	3A	3A	3A
According to 21 CFR 1040.10 (Canada, Japan, USA)	1	1	1
Output Power (Pulse Max)	50 mW	50 mW	50 mW
Pulse Duration (Max)	20 μ s	20 μ s	20 μ s
Pulse Energy (Max)	1 mWs	1 mWs	1 mWs
Output Power (CW)	1 mW	1 mW	1 mW
Beam Waist Diameter	9 μ m	9 μ m	9 μ m
Numerical Aperture	0.1	0.1	0.1
Wavelength	1310 \pm 15nm	1550 \pm 15nm	1310/1550 \pm 15nm
	E4321A	E4324A	
Laser Type	FP-Laser InGaAsP	FP-Laser InGaAsP	
Laser Class			
According to IEC 825 (Europe)	3A	3A	
According to 21 CFR 1040.10 (Canada, Japan, USA)	1	1	
Output Power (Pulse Max)	50 mW	60 mW	
Pulse Duration (Max)	20 μ s	20 μ s	
Pulse Energy (Max)	1 mWs	1 mWs	
Output Power (CW)	1 mW	1 mW	
Beam Waist Diameter	9 μ m	9 μ m	
Numerical Aperture	0.1	0.1	
Wavelength	1625 \pm 20nm	1310/1550 \pm 15nm	

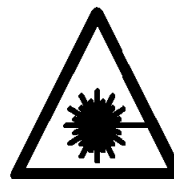
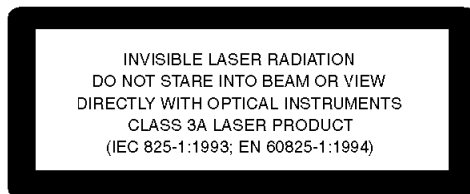
Safety Summary

NOTE

USA



Non-USA



The laser safety warning labels are fixed on the front panel of the instrument.

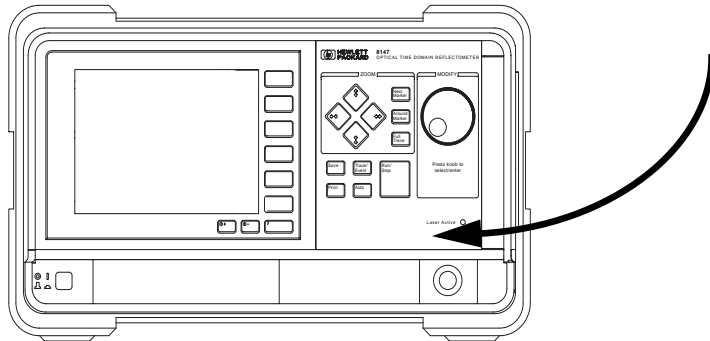
A sheet of laser safety warning labels is included with the laser module. You *must* stick the labels in the local language onto the outside of the instrument, in a position where they are clearly visible to anyone using the instrument.

The recommended position for the laser safety warning label is to the Laser Active LED on the front of the instrument as shown by the arrow in the diagram below.

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

The laser module has built in safety circuitry that disables the optical output in the case of a fault condition.

Safety Summary



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 at the bottom right corner of the instrument's front panel.
The laser is enabled by pressing RUN/STOP. The laser is enabled when the green LED on the front panel of the laser module is lit.

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 is not visible to the human eye, but it can seriously damage your eyesight.

There is a safety circuit which monitors the average laser power output, and the power output of each laser pulse. If either the average or the pulse power is greater than the limit for the module, the laser will be disabled.

Safety Summary

OTDR Year 2000 Compliance

All new OTDRs are Year 2000 compliant. However, earlier models (manufactured before July 1998, and with serial numbers DE35501422 and lower) may not yet be compliant.

There is a risk that at the millennium such models will be reset to 01 April, 1980.

You do not need to return any instruments to Hewlett-Packard to make them Year 2000 Compliant. Simply follow the instructions on our Webpages.

You can see our Webpages at www.hp.com/go/lightwave. Select Support, then Year 2000 Compliance. Select HP8147/E4310A Year 2000 Compliance for instructions as to how you can update your OTDR.

If you have any problems updating your OTDR, please contact your nearest support center, or your Hewlett-Packard representative.

Bellcore Certification of Excellence

Hewlett-Packard is officially designated Bellcore Certification Eligible, and is awarded Bellcore's Certification of Excellence for its OTDR Data Format.

The Structure of this Manual

This manual is divided into four parts:

- An introduction to the OTDR's features.
- A sample session showing a typical measurement, in chapters 2 and 3.
- A description of the capabilities of the OTDR's macro recording, in chapter 4.
- Additional information not required for routine day-to-day use in the appendix

Conventions used in this Manual

Small capitals are used to indicate front panel keys, softkeys and menu items, e. g. SETTINGS.

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Getting Started

Getting Started

This chapter introduces the features of the HP 8147A Optical Time Domain Reflectometer (OTDR). Here you will find a quick description of the instrument, how to get online help, and a sample session to help you familiarize yourself with the operation of the instrument.

1.1 How the OTDR Works

The OTDR repeatedly outputs an optical pulse into the connected fiber and measures the reflections from this pulse. The trace displayed on the screen is a graph of this reflected power (backscatter) as a function of the distance along the fiber.

Events

Events are changes in the fiber causing the trace to deviate from a straight line. Events can be *Reflective* or *Non-Reflective*.

Reflective Events occur when some of the pulse energy is reflected, for example at a connector. Reflective Events produce a spike in the trace (you see a steep rise and fall in the graph: see the first diagram below).

Non-Reflective Events occur at parts of the fiber where there is some loss but no light is reflected. Non-Reflective Events produce a dip on the trace (see the second diagram below).

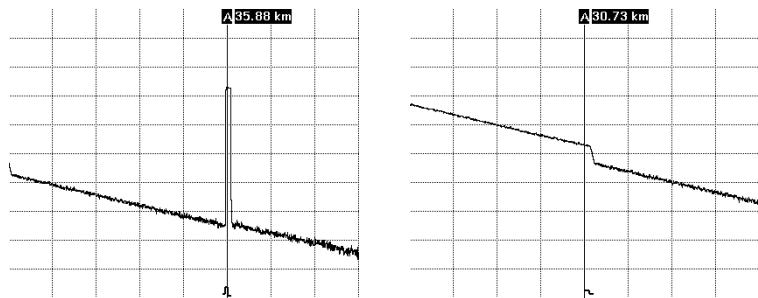


Figure 1-1 Reflective (Left) and Non-Reflective (Right) Events

The OTDR calculates the distance of such an “event” in the fiber from the time it takes the reflected signal to return. The further

Getting Started

Expert and Easy Mode

away an event is, the longer it takes for its reflection to return to the OTDR.

By examining the trace of the reflected signal, the parameters of the fiber and the connectors, splices and so on can be determined.

1.2

Expert and Easy Mode

The OTDR works in one of two possible modes:

- In expert mode you can change all parameter settings and do complex analysis on the results. You can also store settings and record macros to prepare the instrument for an inexperienced user.
- In easy mode the inexperienced user can recall stored settings, activate macros, and run measurements without concerning himself with parameters and other details.

You can change between the two modes using the OTDR's softkeys.

1.3

What You Can Measure with the OTDR

The OTDR displays the relative power of the returned signal against distance. With this information important characteristics of a link are determined:

- the location (distance) of events on the link, the end of the link or a break,
- the attenuation of the fiber in the link,
- the loss of an individual event (for example a splice) or the total end-to-end loss of the link,

Getting Started

The Front Panel

- the size of the reflection (or return loss) of an event, such as a connector.

A fully automatic function is available for these measurements. The OTDR sets itself up to achieve the best results.

In addition to these features the OTDR is able to compare measurement results:

- You can load up to four traces and display them on the OTDR's screen.
- You can load two traces and subtract them. In so doing, you can see any differences in the two measurements as a graph.
- You can also do measurements from both sides of the fiber and average them (two-way measurement). This gives the most accurate splice measurement, in the form of a graph and an event table.

1.4

The Front Panel

Figure 1-2 shows the front panel of the HP 8147A.

The front panel consists of the following elements:

1.5

The Trace Screen

The trace screen is the main screen of the OTDR:

- When you have taken a measurement, the graph of the reflected power is displayed as a function of distance. This graph is called the trace.

Getting Started

The Trace Screen

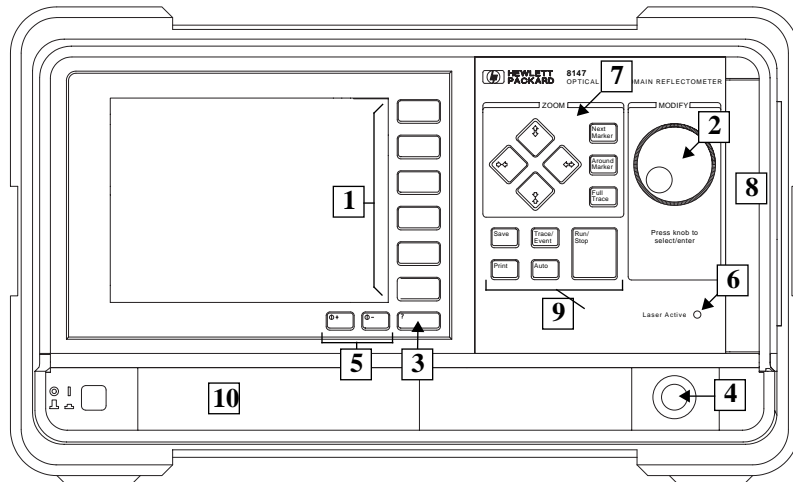


Figure 1-2

The Front Panel

1	softkeys	2	modify knob
3	help key	4	optical output
5	contrast-control keys	6	Laser Active LED
7	zoom keys	8	floppy disk drive
9	function keys	10	printer slot

- Below the trace, the event bar shows you the position of the detected events: non-reflective events such as splices, reflective events such as connectors, as well as any defined landmarks.
- The markers are your means of marking and analyzing single events or parts of the trace. In the marker-information window, you see information such as the distance, attenuation, and loss at or between the markers.
- No matter when you zoom to a point of interest on the trace, you do not lose orientation, as there is an overview display in the full-trace window. You always know where you are. The full-trace window is shown in the bottom left-hand corner of the display.

Getting Started

The Trace Screen

In addition to the trace screen shown in Figure 1-3, you have the event-table screen and the return-loss-chart screen. These are used during measurements and analyzing. See the online-documentation for information about these screens.

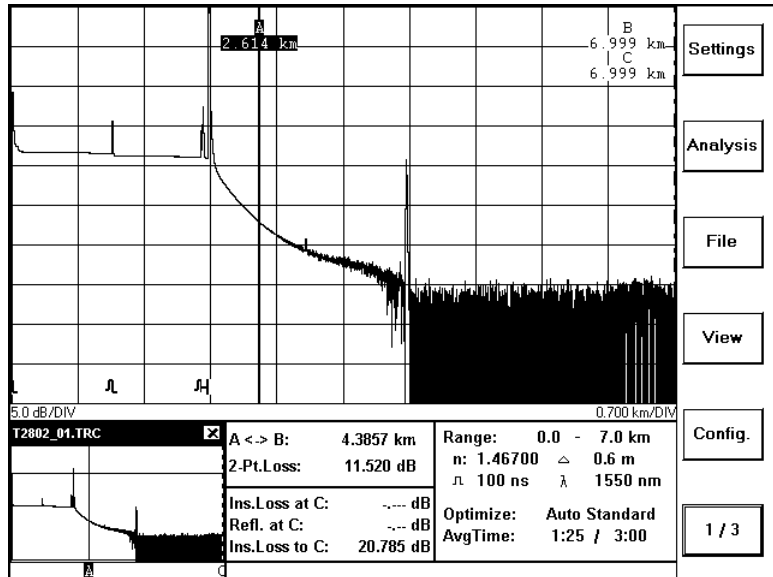


Figure 1-3 The Trace Screen

In the title bar you can see the name of the measurement file (UNNAMED.SOR if you have not already saved the measurement).

- The most important measurement parameters (such as measurement range, pulsewidth, wavelength) are always shown in the parameter window.
- On the right-hand side of the screen you can see the list of functions for the softkeys.

1.6

The Keys

There are three types of keys on the front of the OTDR: hardkeys, softkeys, and the Modify knob.

The Hardkeys

The hardkeys are the keys with a fixed function. The function is written on the key.

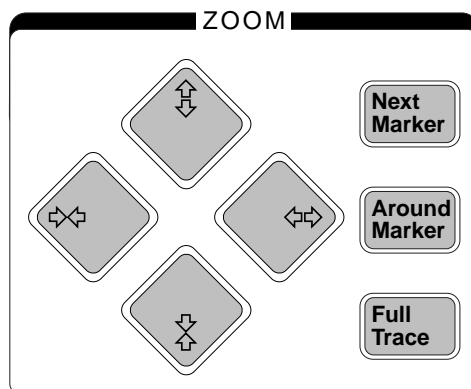


Figure 1-4

The Zoom Keys

The zoom keys are your means of zooming in and out on the displayed trace. Using the zoom keys, you can shrink or stretch the trace in either direction.

You can also zoom around or between the markers on the trace:

- The NEXT MARKER hardkey lets you toggle between the markers A, B, C, and AB.
- Pressing the AROUND MARKER hardkey zooms in the trace around the current marker or between the markers A and B. The marker (or the marked part) stays in the center of the grid, even when you change its position on the trace using the knob.

Getting Started

The Keys

- If at any stage during zooming you wish to return to the whole trace, this can be done by simply pressing the FULL TRACE hardkey.

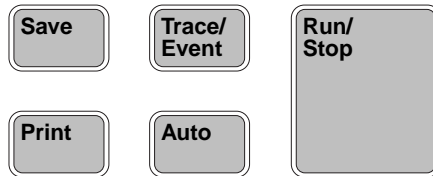


Figure 1-5

The Function Keys

The function keys let you initiate an action with a single stroke of a key:

- Pressing the SAVE hardkey saves the current measurement.
- The TRACE/EVENT hardkey lets you toggle between the trace and the event table screen.
- Pressing the PRINT hardkey prints the current measurement.
- Pressing the AUTO hardkey activates an Auto measurement mode, for automatic detection of the best settings.
- Pressing the RUN/STOP key starts or stops a measurement.
- Holding the RUN/STOP key for at least 3 seconds toggles between Average mode and Refresh mode.

Hardkeys: Keyboard equivalents

If you have a keyboard attached to your OTDR, you can emulate the hardkeys from the keyboard as following:

Getting Started

The Keys

Hardkey	Keyboard equivalent
HELP (?)	<f1>
NEXT MARKER	<f2>
AROUND MARKER	<f3>
FULL TRACE	<f4>
SAVE	<f5>
TRACE/EVENT	<f6>
PRINT	<f7>
AUTO	<f8>
RUN/STOP	<f9>

Table 1-1

Keyboard emulation of hardkeys

The Softkeys

The softkeys are to be found at the right-hand side of the screen. They have different functions in different situations. The actual function is always written on the screen beside the key. A blank softkey means that there is no action applied at this level.



Figure 1-6

The Location of the Softkeys

Softkeys: Keyboard equivalents

If you have a keyboard attached to your OTDR, you can emulate the softkeys from the keyboard by holding down the <ALT> key and pressing one of the numbers 1 to 6.

So <ALT>1 emulates the top softkey, <ALT>2 the second softkey, and so on.

Modify knob

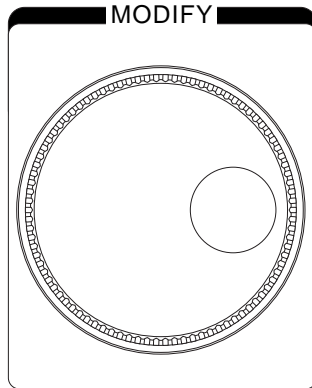


Figure 1-7 **The Modify Knob**

Turning the Knob

Turning the Modify knob is like using the cursor keys on a computer keyboard. You use the knob to select an entry in a menu or in a list, or to change the value of a parameter.

You also turn the knob to move the markers on the trace.

Pressing the Knob

Pressing the Modify knob is like using the enter key on a computer keyboard. You press the knob to confirm the selection or the parameter value.

1.7

Function Overview

Figure 1-8 gives you an overview of the menus and functions you can reach using the softkeys.

Getting Started

Function Overview

You see the name the 6 softkeys at the right of the OTDR screen. You can press the bottom softkey to toggle between the different softkey layers;

Layer 1 (1 / 3) allows you to press the other softkeys to access the menu options listed in Figure 1-8.

You use the Modify knob to select a menu option. Turn the knob to move to an option; press the knob to select the highlighted option.

Layer 2 (2 / 3) allows you to alter the START (Start of Range), SPAN (Width of Range), PWIDTH (Pulsewidth), WLENGTH (Wavelength) and AVGTIME (Averaging Time) in the parameter window.

Layer 3 (3 / 3) allows you to view an OVERVIEW of the parameter setup, allowing you to alter more than one parameter at a time. You may also alter the OPTIMIZE mode, IOR (global refractive index), and V.OFFS. (Vertical Offset), or use the fifth softkey to toggle between the selected traces.

The fifth softkey in layer 3 allows you to switch between different traces. If there is a current trace, its name will appear as the softkey

Getting Started

Function Overview

label. If there is no current trace, the label is blank, and this feature is unavailable.

Getting Started
Function Overview

Settings	Analysis	File	View	Config.	1/3	
Optimize Mode	Add/Modify Event	Close All	Trace	Enable EasyMode		
Refractive Index	Delete Event	Open Trace	Event Table	Language		
Scatter Coefficient	Add/Modify Event Comment	Close Trace	Return Loss Chart	Date / Time		
Measurement Mode	Delete Event Comment	Delete Trace	Event Bar	Length Unit		
Event Thresholds	Landmark	Trace Infos	Events before Offset	Trace Info. Labels Header		
Front Connector Check	Analyze Insertion Loss	Save Trace	Preferences	Storage Device		
Recall Settings	Analyze Reflectance	Save Trace As	Current Trace	Print Device		
Store Settings	Two-Way Measurement	Copy Trace	Vertical Offset	Setup External Printer		
Copy Settings	Subtract Measurement	Create Directory	Set Hor. Offset to A	Power-On Setting		
Delete Settings	Scan Trace	Delete Directory	Clear Hor. Offset	Assign Settings/Macros		
	Lock Event Table	Format Floppy		Unassign Settings/Macros		
	2-Pt. Loss	Print Trace		Macro-Recorder		
	2-Pt. Attenuation	Print Directory		Select Remote Interface		
	LSA-Attenuation	Cancel Print		RS-232 Settings		
	Optical Return Loss	Modify Print Layout		HP-IB Settings		
				LAN Settings		
				Perform Selftest		
				About		
StartPos	Span	PWidth	WLength	Avg Time		2/3
Overview	Optimize	IOR	V.Offs.	<filename>		3/3

Figure 1-8 Softkey functions

1.8

Getting Help

To get help on the OTDR you press the help key [?] to activate the online documentation. The key can be found in the lower right-hand corner of the display, below the softkeys.

Pressing [?] once opens up a page of the online documentation (a topic) that shows information about the current screen. From there you can jump to related topics.

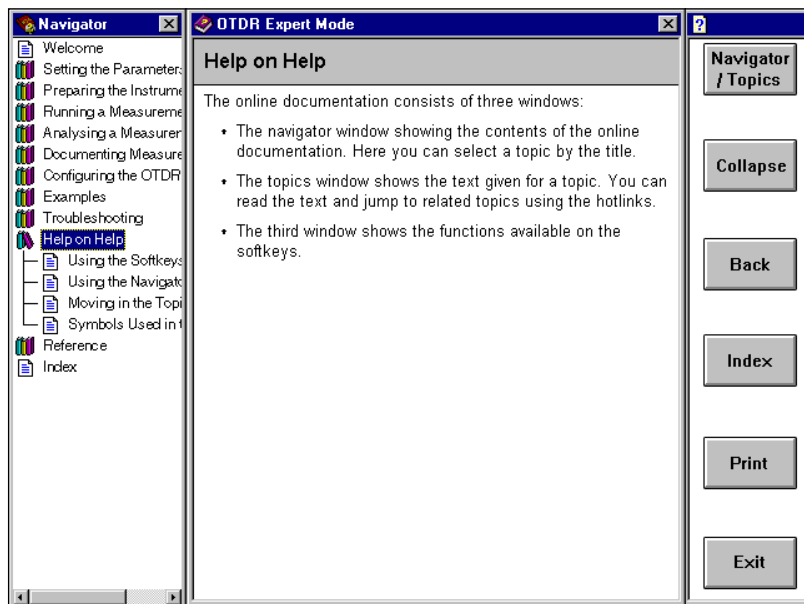


Figure 1-9

The OTDR's Help Display

To leave the online documentation and return to the measurement, you press the EXIT softkey.

On the left-hand side of the display, you can see the navigator window. The navigator is your means of switching between the

Getting Started

Getting Help

topics like the chapters of a book. The actual topic is always highlighted.

To select the Navigator, press the NAV./TOP softkey.

Getting Started
Getting Help

**Elementary Sample
Sessions**

Elementary Sample Sessions

This chapter contains a number of sample sessions of step-by-step guides, showing how you use common features of the OTDR.

In these sample sessions we use:

- An OTDR HP 8147 in expert mode with an optical module HP E4316A (1310/1550 nm, single-mode).
- A length of fiber of about 40 km, terminated at one end with a Diamond HMS-10/HP connector and unterminated at the other end. The fiber has a refractive index of 1.462, and is to be used at a wavelength of 1310 nm.
- A connector interface to match the connector on the fiber being used.

You can see some further Sample Sessions in the next chapter.

2.1 How to Connect the Fiber

Connecting the fiber to the OTDR is very easy. You do not need any tools. You connect the fiber as follows.

- 1** Clean the connectors.
- 2** Attach the required optical connector interface to the front of the OTDR.
- 3** Connect the fiber.

2.2 How To Set Up the Parameters

This section describes the initial setting up of the OTDR and shows how to change some parameters. First of all:

- 1** Switch on the OTDR.

The system is booted, and then performs a self-test.

Afterwards the trace screen appears. You can see the current parameter settings in the parameter window.

How to Change the Refractive Index

To get the most accurate distance measurements, you have to enter the correct refractive index:

- 1** Press the bottom softkey until you see screen 3 / 3.
- 2** Press the OVERVIEW softkey.

Elementary Sample Sessions

How To Set Up the Parameters

You see a screen showing values that you can set (Figure 2-1).

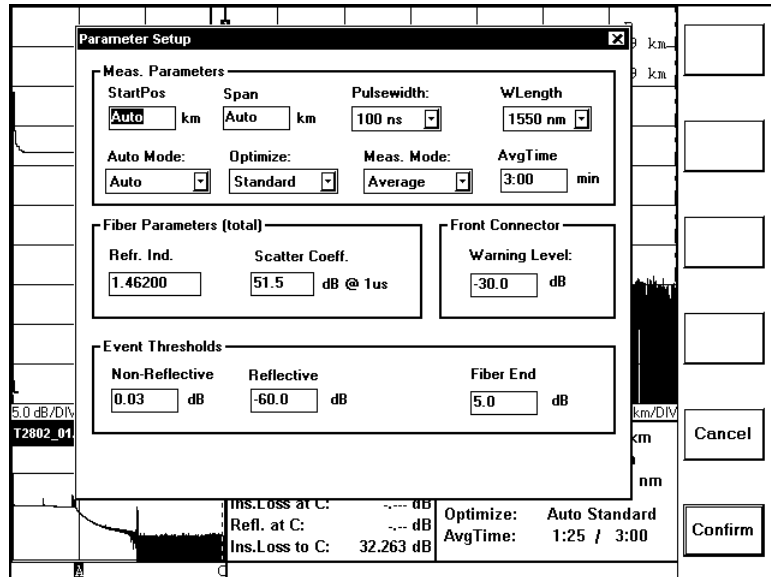


Figure 2-1

Overview screen

- 3 Turn the Modify knob to move to the Refr. Ind. box.
- 4 When the Refr. Ind. box is highlighted, press the Modify knob. You can now turn the Modify knob to increase or decrease the displayed Refractive Index.
- 5 Turn the Modify knob to change the value, for example to 1.46200.
- 6 Press the Modify knob to accept this value.
- 7 If you want to change any other trace settings, move to the appropriate box and select a new value.
- 8 Press the **CONFIRM** softkey to set the new value(s).
You can see the new Refractive Index in the table beneath the trace after n :

How to Adjust the Refractive Index for a fiber of known length

If you know the length of a fiber, you may wish to reset the Refractive Index to equal that at the fiber end:

After you have made the trace, follow the following steps:

- 1** Move the current marker to the end of the fiber.
- 2** Press the bottom softkey until you see screen 3/3.
- 3** Press the IOR softkey.
- 4** Turn the Modify knob to adjust the refractive index.
The Refractive Index for the whole fiber is now set to the value you see in the parameter window below the Trace.

NOTE

You can also alter the Refractive Index for the whole fiber by selecting {SETTINGS}REFRACTIVE INDEX - TOTAL from screen {1 / 3}.

To set the Refractive Index just at the current marker, select {SETTINGS}REFRACTIVE INDEX - PARTIAL.

2.3

How to Make an Automatic Measurement

This section describes how to run an automatic measurement.

NOTE

If you are taking a measurement at 1625 nm (E4321A module only), you must make sure that the correct scatter coefficient is selected.

An incorrect scatter coefficient will result in incorrect reflectance values.

To let the OTDR set up itself for the measurement:

Elementary Sample Sessions

How to Make an Automatic Measurement

- 1 Connect a fiber.
See “How to Connect the Fiber” on page 45.
- 2 Press the AUTO hardkey twice to activate the Auto standard optimization.
You see the optimization mode in the parameter window.
- 3 Press the RUN/STOP hardkey.
The Laser Active sign lights up. After a short initializing phase, the OTDR displays the first result.
- 4 Wait for the trace to become free of noise (takes some seconds).

Once sufficient information has been obtained, the OTDR automatically analyzes the trace and creates an event table.

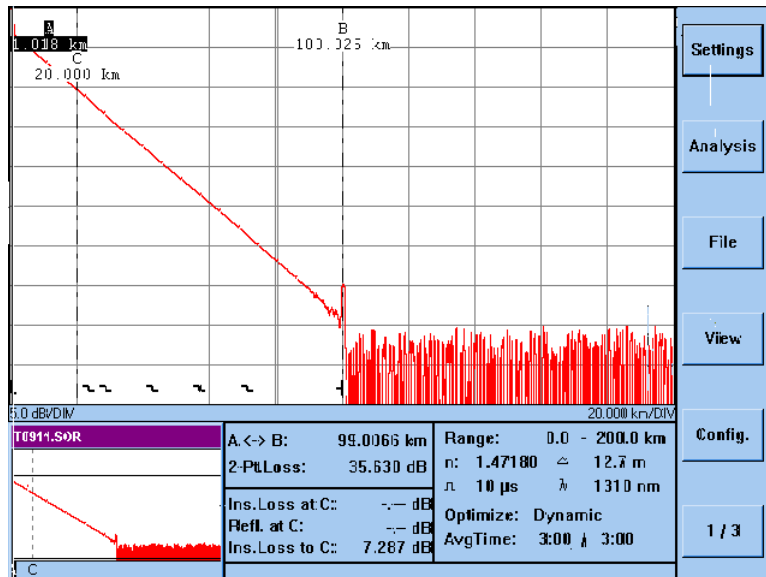


Figure 2-2

The Measurement Trace

- 5 Press the RUN/STOP hardkey.
The Laser Active sign goes off. No more samples are being taken.

2.4

How to Scan for Events

During a measurement, the OTDR automatically scans the trace for Non-Reflective Events (such as fusion splices) and Reflective Events (such as connectors). The current Event Thresholds are used.

You can change these thresholds and re-scan the trace. You can also use the scan trace function to scan traces copied to your OTDR which do not yet have an Event Table (for details of the Event Table, see “How to Use the Event Table” on page 51).

How to Change the Event Thresholds

- 1 Press the bottom softkey until you see screen 1 / 3.
- 2 Press the {SETTINGS} softkey. Select EVENT THRESHOLDS from the {SETTINGS} menu.
You see a submenu which lets you select NON-REFLECTIVE EVENTS, REFLECTIVE EVENTS, or FIBER END.
- 3 Select the Event type for which you want to set the threshold.

How to Scan for Events

You see a window displaying the current Threshold value (Figure 2-3).

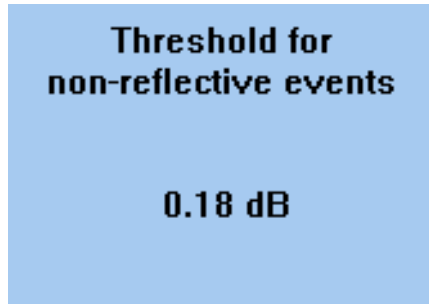


Figure 2-3

Modify Threshold value

- 4 Turn the Modify knob to select a new Threshold value.
- 5 Press the Modify knob to enter the new value.
- 6 Repeat this process to set other thresholds as required.

How to Activate the Scan Trace Function

WARNING

Activating the Scan Trace function will delete all Events that you have added manually.

- 7 Press the {ANALYSIS} softkey. Select SCAN TRACE from the {ANALYSIS} menu.

After the Scan Trace had been performed, you see the Event Bar below the trace. You can see more detailed information in the Event Table (see below).

2.5 How to Use the Event Table

You can also add events manually. See the online documentation for further information.

The OTDR automatically scans the trace for non-reflective events (for example splices) and reflective events (for example connectors). These events are shown on the event bar and in the event table. This section describes how to read the event table.

How to Display the Event Table

To display the event table on the screen:

- 1 Press the TRACE/EVENT hardkey.
 You see the Event Table (Figure 2-4).

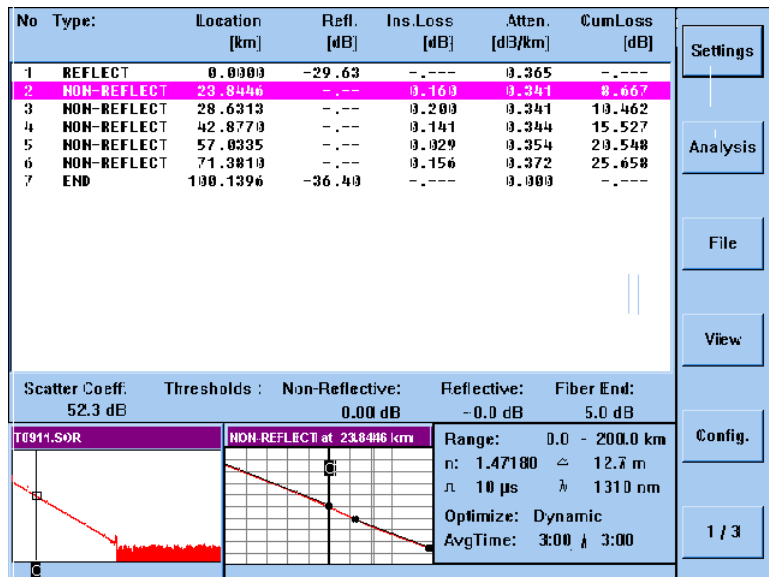


Figure 2-4 The Event Table

Elementary Sample Sessions
How to Use the Event Table

NOTE

You can also view the Event Table by selecting EVENT TABLE from the {VIEW} menu.

For each event in the table, you can see the type of the event and its location. Furthermore you see the following measurement results:

- The reflectance of the event.
- The insertion loss of the event.
- The attenuation between this event and the next one.
- The cumulative loss, that is the sum of the splice, reflectance, and attenuation loss up to the point of the current event. It includes the loss of the current event.

In the windows at the bottom of the table (full-trace window, around-marker window) you see the position of the selected event on the trace.

How to Select an Event in the Table

- 2 Turn the Modify knob to move the highlighted bar in the Event Table.

Marker C is always at the selected event. You can see the zoom around marker C in the Around Marker window at the bottom left of the OTDR screen.

How to Close the Event Table

- 3 Press the TRACE/EVENT hardkey again.

NOTE

You can also close the Event Table by selecting TRACE from the {VIEW} menu.

You now see the trace with marker C at the last selected Event.

2.6

How to Use Landmarks

How to Add a Landmark

You can add landmarks to the trace or the event table. You use landmarks to identify the physical location of an event.

How to Add a Landmark to a Trace

- 1** Move the active marker to the point where you want to add the landmark.
You see the physical location (in km) at the top of the marker.
- 2** Press the bottom softkey until you see screen 1 / 3.
- 3** Press the {ANALYSIS} softkey. Select LANDMARK – ADD/MODIFY from the {ANALYSIS} menu.

Elementary Sample Sessions

How to Use Landmarks

How to use the screen keyboard

4 You see a keyboard on the screen (Figure 2-5).

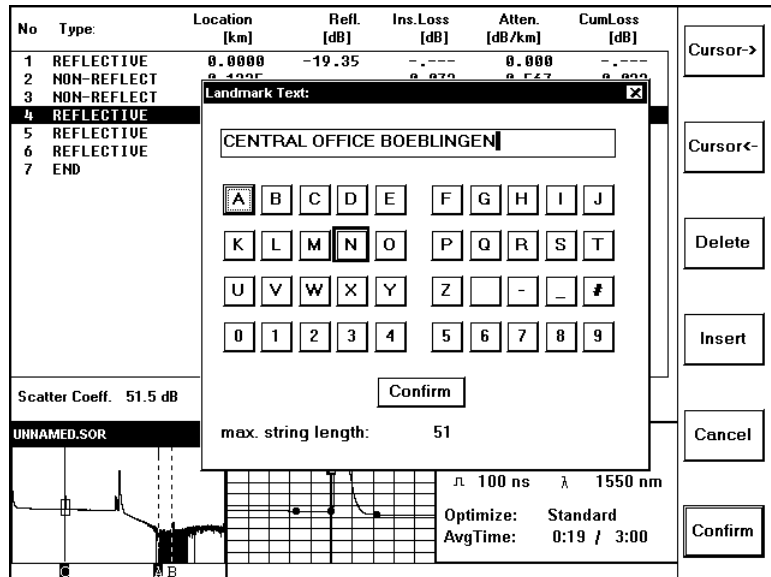


Figure 2-5

Enter a Landmark

5 Use the keyboard appearing on the screen to enter the name, for example: CENTRAL OFFICE BOEBLINGEN.

You enter text on the keyboard by turning the Modify knob to move to successive letters. When the letter you want is highlighted, press the Modify knob. Continue this process until you have the text you want.

NOTE

If you have a keyboard attached to your OTDR, you can enter text directly from the keyboard. You see the entered text in the edit field of the screen keyboard.

6 Press the CONFIRM softkey to confirm your entry.

How to Use Landmarks

The landmark is now shown on the event bar and in the event table.

How to Add a Landmark to the Event Table

If you want to add a landmark at an Event, you can either follow the steps above, or add the landmark from the Event Table.

You add a landmark from the Event Table as follows.

- 1 If you cannot already see the Event Table, bring it up.
See “How to Display the Event Table” on page 51.
- 2 Turn the Modify knob to highlight the Event where you want to add the landmark.
- 3 Follow steps 3 to 6 above.
The landmark name is added to the Event in the Event Table.

How to Modify the Name of an Existing Landmark

- 1 If you cannot already see the Event Table, bring it up.
See “How to Display the Event Table” on page 51.
- 2 Turn the Modify knob to highlight the Event that you want to modify.
- 3 Press the bottom softkey until you see screen 1 / 3.
- 4 Press the {ANALYSIS} softkey. Select LANDMARK – ADD/MODIFY from the {ANALYSIS} menu.
- 5 Use the screen keyboard to modify the name.
See “How to use the screen keyboard” on page 54.

How to Delete Landmarks

Deleting a single landmark

- 1 If you cannot already see the Event Table, bring it up.
See “How to Display the Event Table” on page 51.
- 2 Turn the Modify knob to highlight the Event that you want to

How to Change the Vertical Offset

delete.

- 3 Press the bottom softkey until you see screen 1 / 3.
- 4 Press the {ANALYSIS} softkey. Select LANDMARK – DELETE from the {ANALYSIS} menu.
The landmark is deleted from the Event Bar and the Event Table.

Deleting All Landmarks

- 1 Press the bottom softkey until you see screen 1/3.
- 2 Press the {ANALYSIS} softkey. Select LANDMARK – DELETE ALL from the {ANALYSIS} menu.
All landmarks are deleted from the Event Bar and the Event Table.

2.7

How to Change the Vertical Offset

The OTDR automatically adjusts the vertical offset so that you can see most of the trace. You can change the vertical offset manually to help you see specific points on the trace.

NOTE

See also “**How to set 2 traces to the same vertical offset**” on page 64.

You change the vertical offset as follows.

- 1 Press the bottom softkey until you see screen 3 / 3.
- 2 Press the V.OFFS. softkey
- 3 Rotate the Modify knob to move the trace up or down.
- 4 Press the Modify knob or the CONFIRM softkey to confirm the new vertical offset.

NOTE

You cannot use the normal softkeys until you have set the new offset.

How to Restore the Automatic Offset

You return the Vertical Offset to its original value as follows.

- 1 Press the bottom softkey until you see screen 3 / 3.
- 2 Press the V.OFFS. softkey
Press the AUTO softkey.

2.8

How to Print the Measurement

How to Print the Current Measurement

How to Set the Print Device and Layout

- 1 Press the bottom softkey until you see screen 1 / 3.
- 2 Press the {CONFIG} softkey and select PRINT DEVICE.
- 3 Select the internal printer, if it is not already selected.
- 4 Press the {FILE} softkey and select MODIFY PRINT LAYOUT.
You see a list of what to include in your printout (TRACE, EVENT TABLE, MARKER INFORMATION, LOGO, and MEAS PARAMETERS).
- 5 Select/Deselect what you want to print as appropriate.

How to make the Print

- 6 Press the {FILE} softkey. Select PRINT TRACE – CURRENT TRACE from the {FILE} menu.

The measurement is printed after a short initialization period. In addition to some statistical information, the print can show the following (see step 5 above):

Elementary Sample Sessions

How to Print the Measurement

- The measurement parameters that show further trace information, detailed instrument information, and the most important parameters (range, pulsewidth, and so on).
- The trace.
- Information about the markers (position, attenuation, loss, and so on).
- The event table.

This gives you all the information necessary to document the measurement, or to repeat it using the same parameters.

How to Print All Measurements

To print the results of all measurements on the OTDR's built-in printer (if installed):

- 1 Select the internal print device and layout.
See "How to Set the Print Device and Layout" on page 57.
- 2 Press the PRINT hardkey.

How to Print to an External Printer

- 1 Attach an external printer to your OTDR.
To see where the external printer slot is, see Figure 1-2 "The Front Panel".
- 2 Press the bottom softkey until you see screen 1 / 3.
- 3 Press the {CONFIG} softkey and select PRINT DEVICE.
- 4 Select EXTERNAL PRINTER.
- 5 Press the {FILE} softkey and select MODIFY PRINT LAYOUT - PAPER SIZE.
- 6 Select A4 or LETTER as appropriate.
- 7 Print the Measurement(s)
See "How to make the Print" on page 57 or "How to Print the Current Measurement" on page 57.

2.9 How to Save the Measurement

This section describes how to save the results of the measurement.

Saving a measurement not only saves the results, but also saves the parameter settings. When you recall the measurement later, you can do further analysis or compare the saved measurement with subsequent ones. You can also repeat the measurement using exactly the same parameters as the first time.

You save the measurement as follows:

- 1 Press the bottom softkey until you see screen 1 / 3.

How to Specify the Storage Device

- 2 Press the {CONFIG} softkey and select STORAGE DEVICE.
You see a submenu which allows you to select FLOPPY or HARDDISK.
- 3 If you want to save to a disk, insert a floppy disk in the OTDR floppy disk drive (see Figure 1-2) and select FLOPPY.
To save to the OTDR's built-in hard disk, select HARDDISK.

How to Specify the Bellcore Revision

- 4 Press the {FILE} softkey and select FILE TYPE.
You see a submenu which allows you to select the Bellcore revision number used to store Bellcore files.
Bellcore revision 1.1 conforms to standards, but you may need to use Bellcore revision 1.0 for backward compatibility.
- 5 Select BELLCORE REV. 1.0 or BELLCORE REV. 1.1 as appropriate.

How to Save the Trace

- 6 Press the SAVE hardkey.

NOTE

SAVE TRACE in the {FILE} menu has the same effect as the Save hardkey.

How to Run a Manual Measurement

If you have already saved a file using the command FILE – SAVE AS, the OTDR uses the last entered file name and adds the consecutive numbers (“_nn”).

The measurement is then saved in a file. The OTDR automatically names the file. The file name by default follows the scheme *Tmmdd_nn.SOR*, where *mm* is the current month, *dd* is the current date and *nn* is the consecutive number of the measurements saved on that date.

How to Save to a User-Defined Name

- 1 Select the correct storage device.
See steps 1 to 3 above.
- 2 Press the {FILE} softkey and select SAVE TRACE AS.
- 3 You see a screen keyboard.
- 4 Enter a new filename using the screen keyboard.
See “How to use the screen keyboard” on page 54.

2.10

How to Run a Manual Measurement

When you already know about the fiber under test, you can set the parameters exactly. This section describes how to setup and run a measurement manually.

How to Change the Measurement Span

To set the measurement span to about 1.5 times the length of the fiber:

- 1 Press the bottom softkey until you see screen 2 / 3.
- 2 Press the SPAN softkey.
- 3 Turn the modify knob to set the range of the measurement.

Elementary Sample Sessions
How to Run a Manual Measurement

The value in the table beneath the trace changes as you turn the knob.

Range:	0.0 - 50.0 km
n: 1.46200	\triangle 4.6 m
π 1 μ s	λ 1310 nm
Optimize:	Auto standard
AvgTime:	0:00 of 0:00

Figure 2-6 **Setting the Range**

- 4 Press the knob to enter the value.

How to Change the Optimization Mode

To increase the dynamic range of the measurement, you select to optimize for dynamic:

- 1 Press the bottom softkey until you see screen 3 / 3.
- 2 Press the OPTIMIZE softkey. The Optimize mode in the parameter window changes.

Continue pressing the OPTIMIZE softkey until the mode is DYNAMIC.

NOTE

Selecting SETTINGS - OPTIMIZE MODE - DYNAMIC from the 1 / 3 screen is equivalent to selecting OPTIMIZE.

How to Run the Measurement

Now that you have set the range correctly, the measurement can be run:

Elementary Sample Sessions

How to Display more than one trace

- 1 Press the RUN/STOP hardkey.
- 2 Wait for the trace to become free of noise (takes some seconds).
- 3 Press the RUN/STOP hardkey.

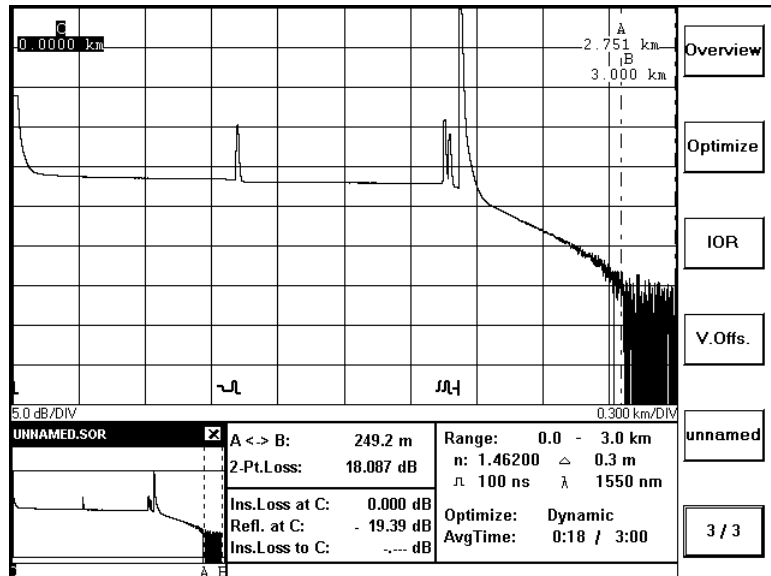


Figure 2-7

The Trace of the Manual Measurement

The OTDR has automatically scanned the trace for events. These events are shown in the event bar at the bottom of the trace.

2.11

How to Display more than one trace

- 1 Press the bottom softkey until you see screen 1/3.
- 2 Make the first trace

Elementary Sample Sessions

How to Display more than one trace

Either take the trace manually (RUN/STOP .. RUN/STOP), or open an existing trace ({FILE} - OPEN).

- 3 Press the VIEW softkey. Select CURRENT TRACE from the View menu.

You see a list of 4 linestyles. The first is labelled with the name of the current trace. The other 3 are labelled <empty>.

- 4 Select one of the linestyles labelled <empty>.

This corresponds to the new current trace.

- 5 Make a second measurement.

Either RUN/STOP .. RUN/STOP or {FILE} - OPEN TRACE as before. You now see 2 traces on the OTDR screen.

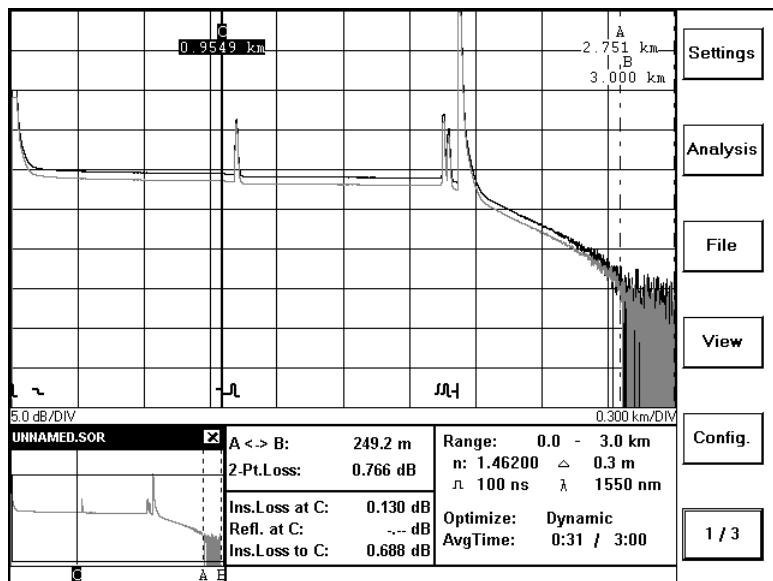


Figure 2-8

Two traces on the same picture

NOTE

If you are opening an existing trace, there is an alternative way of adding a new trace.

How to Display more than one trace

After you select {FILE} - OPEN TRACE, the first 4 softkeys correspond to the 4 possible traces. Highlight the trace you want, and press one of the softkeys labelled <empty>.

How to change the style of the current trace

- 1 Select the trace you want to change with {VIEW} - CURRENT TRACE.
- 2 Press the VIEW softkey. Select PREFERENCES from the View menu.
- 3 Select LINSTYLE to choose a new linestyle (SOLID or DOTTED), or COLOR to choose a new color (black, green, blue, or red).

How to set 2 traces to the same vertical offset

- 1 Press the bottom softkey until you see screen 3 / 3.
- 2 Select the trace you want to alter.
The fifth softkey is labelled with the name of the current trace. You can press this softkey to toggle between the traces currently displayed.
- 3 Press the V.OFFS. softkey
You can now use the Modify knob to alter the vertical offset of the current trace. When the 2 traces are level, confirm by pressing the bottom softkey.

How to Close a Trace

- 1 Press the bottom softkey until you see screen 1 / 3.
- 2 Press the FILE softkey. Select CLOSE TRACE from the {FILE} menu.
- 3 You see a list of the currently active traces, next to the line sample used to represent them. Move to the trace you want to close and select by pressing the Modify Knob.

NOTE

If you want to close all the traces, select CLOSE ALL from the FILE menu.

2.12

How to Set Labels for Trace Information

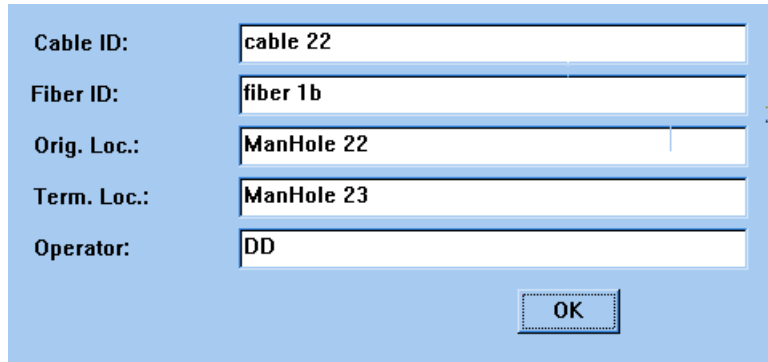
You can save up to five strings which are stored along with your trace. By default these strings are accompanied by the labels Cable Id, Fiber Id, Orig. Loc., Term. Loc. and Operator.

How to view the Current Trace Information.

- 1** Press the bottom softkey until you see screen 1 / 3.
- 2** Press the {FILE} softkey. Select TRACE INFOS from the {FILE} menu.
- 3** Select VIEW ALL from the TRACE INFOS submenu.

How to Set Labels for Trace Information

You see a window showing the current labels and trace information (Figure 2-9).



The screenshot shows a light blue window with five text input fields and an OK button. The fields are labeled as follows:

Cable ID:	cable 22
Fiber ID:	fiber 1b
Orig. Loc.:	ManHole 22
Term. Loc.:	ManHole 23
Operator:	DD

An OK button is located at the bottom right of the window.

Figure 2-9

Current Trace Information

- 4 Press the Modify knob to close this window.

How to Enter new Trace Information

- 5 Bring up the Trace Infos window as before.
- 6 Select one of the strings from the Trace Infos submenu, for example Comment.
You see a screen keyboard.
- 7 Enter the new information using the screen keyboard.
See “How to use the screen keyboard” on page 54.
- 8 Repeat this process for any other strings that you want to enter.

How to Change the Trace Info Labels

The default names for the Trace Info Labels are Cable ID, Fiber ID and so on. You change these labels as follows.

- 9 Press the bottom softkey until you see screen 1 / 3.

Elementary Sample Sessions
How to Set the Time and Date

- 10 Press the {CONFIG} softkey. Select TRACE INFO.LABELS HEADER from the {CONFIG} menu.
- 11 Select one of the labels from the Trace Infos submenu.
You see a screen keyboard.
- 12 Enter the new information using the screen keyboard.
See “How to use the screen keyboard” on page 54.
- 13 Repeat this process for any other labels that you want to alter.

2.13 How to Set the Time and Date

You can set the current Time and Date on your OTDR as follows.

- 1 Press the bottom softkey until you see screen 1 / 3.
- 2 Press the {CONFIG} softkey. Select DATE/TIME from the {CONFIG} menu.
You see a window showing the time and date currently set on your OTDR (Figure 2-10).

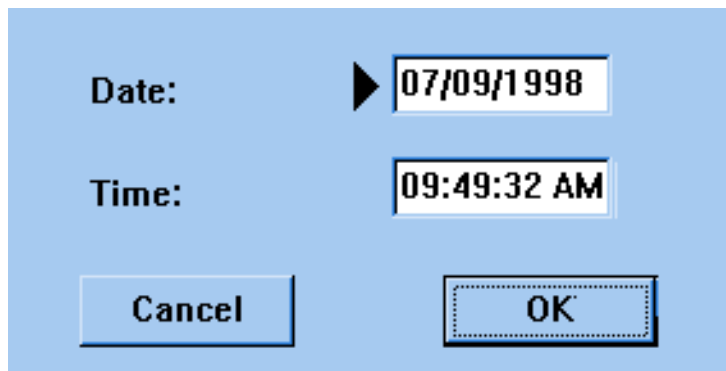


Figure 2-10 Set the Time and Date

How to Change the Date

You see an arrow pointing at the Date edit field. The date is displayed in the format *day/month/year*.

- 3 Press the Modify knob to confirm that you want to alter this value.
- 4 Turn the Modify knob to alter the date.
Each turn of the Modify knob increases or decreases the date by 1 day.
- 5 Press the Modify knob to confirm the new date.

How to Change the Time.

- 6 Turn the Modify knob until you see an arrow next to the Time edit field.
The date is displayed in the format *hour:minute:second*.
- 7 Press the Modify knob to confirm that you want to alter this value.
- 8 Turn the Modify knob to alter the time.
Each turn of the Modify knob increases or decreases the time by 1 minute.
- 9 Press the Modify knob to confirm the new time

How to Confirm the new Time and Date

- 10 Turn the Modify knob so that there is an arrow next to OK.
- 11 Press the Modify knob to confirm.

NOTE

If you do not want to make these changes, turn the Modify knob to **Cancel and press it.**

Further Sample Sessions

Further Sample Sessions

Chapter 2 “Elementary Sample Sessions” showed you how to measure a trace, and to make simple settings.

This chapter contains further step-by step guides showing what you can do to analyze a trace after it has been measured.

If you have not used an OTDR before, you should first read the previous chapter. The equipment used in this chapter is the same as before.

3.1 How to Add an Event

How to Add a Reflective Event

The OTDR automatically scans the trace for Non-Reflective and Reflective Events, but you can also add Events manually.

NOTE

Adding an Event only makes sense after the measurement has stopped. Otherwise, the automatic scanning will delete the event.

You add an Event to a trace as follows.

- 1** Press the NEXT MARKER hardkey until marker C is highlighted. Marker C is now the active marker.
- 2** Move Marker C to where you want to add the Event. You move the active marker by turning the Modify knob.
- 3** Press the bottom softkey until you see screen 1/3.
- 4** Press the {ANALYSIS} softkey. Select ADD/MODIFY EVENT from the {ANALYSIS} menu.
You see a submenu, from which you can select NON-REFLECTIVE EVENTS, REFLECTIVE EVENTS, or DECLARE FIBER END.

NOTE

Non-Reflective Events typically appear as a step on the trace; reflective Events as a peak. See “Events” on page 27.

- 5** Select REFLECTIVE EVENTS.

NOTE

If there is already an Event near marker C, you are asked whether you want to modify this Event or add a new one.

In this case, select Add by turning the Modify knob until Add is highlighted, then press the Modify knob to confirm.

Further Sample Sessions

How to Add an Event

You now see a guidance dialog beneath the trace, advising you what you should now do.

How to Set the Level Markers for Reflectance

When you are adding a Reflective Event, you see 3 level-markers with which you set the Reflectance (Figure 3-1).

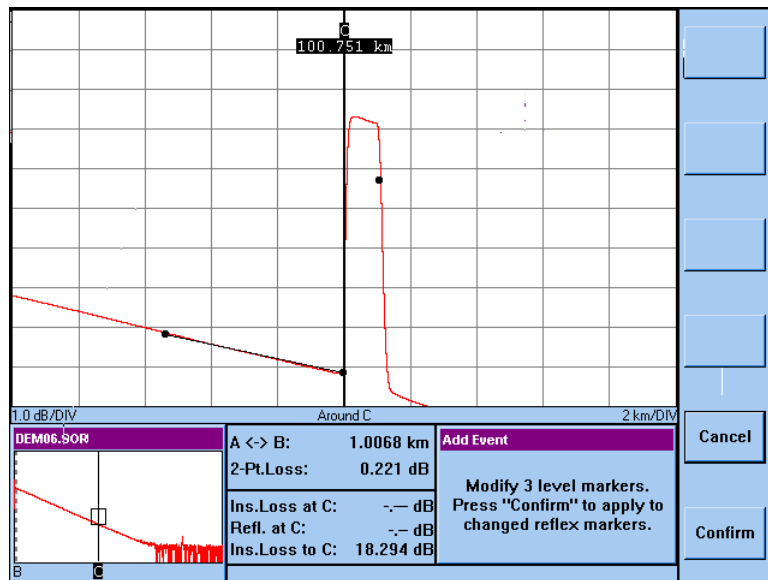


Figure 3-1 Add Reflective Event: Level-Markers

You use the level-markers to set the Reflectance as follows.

- 6 Press the Modify knob to activate the first level marker.
The leftmost of the 3 dots turns into an x to show it is active.
- 7 Turn the Modify knob to move the level-marker to the left.
You see a line between the first and second level-markers.
Make the line as long as possible, and as close to the path of the trace as possible.

Further Sample Sessions
How to Add an Event

NOTE

You should not move the level-marker left of any previous Events.

- 8 Press the knob to activate the second level-marker.
The second dot now turns to an x.
- 9 Move the second level-marker just in front of the Event, that is just in front of the position of marker C.
You may not move the level-marker to the right of marker C.
- 10 Press the Modify knob again to activate the third level-marker.
The third dot now turns into an x.
- 11 Move the third level-marker to the peak of the reflection (see Figure 3-2).

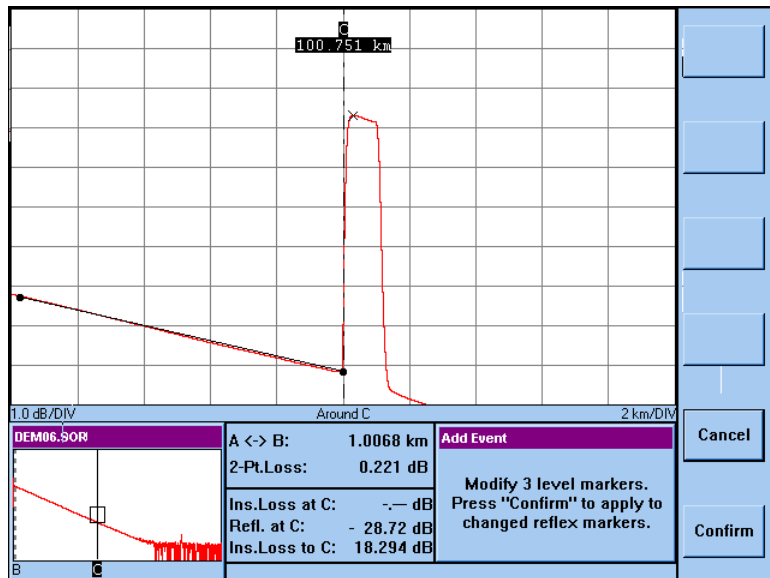


Figure 3-2

Add Reflective Event: Level-Markers set

- 12 Press the Modify knob again to confirm the Event.

Further Sample Sessions

How to Add an Event

The new Event can now be seen in the Event Bar and the Event Table.

How to Set the Level Markers for Insertion Loss

You now see 4 level-markers with which you set the Insertion Loss (Figure 3-3).

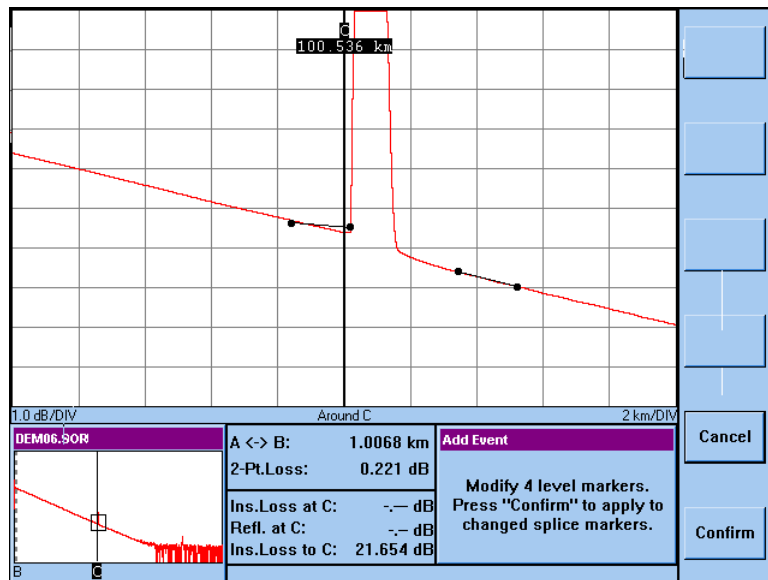


Figure 3-3

Add Non-Reflective Event: Level-Markers

You use the level-markers set the Insertion Loss as follows.

- 13 Press the Modify knob to activate the first level marker.

The leftmost of the 4 dots turns into an x to show it is active.

- 14 Turn the Modify knob to move the level-marker to the left.

You see a line between the first and second level-markers.

Make the line as long as possible, and as close to the path of the trace as possible.

NOTE

You should not move the level-marker left of any previous Event.

- 15** Press the knob to activate the second level-marker.
The second dot now turns to an x .
- 16** Move the second level-marker just in front of the Event, that is just in front of the position of marker C.
You may not move the level-marker to the right of marker C.
- 17** Press the Modify knob again to activate the third level-marker.
The third dot now turns into an x .
- 18** Move the third level-marker just behind the Event.
- 19** Press the Modify knob again to activate the fourth level-marker.
The fourth dot now turns into an x .
- 20** Turn the Modify knob to move the level-marker to the right.
You see a line between the third and fourth level-markers.
Make the line as long as possible, and as close to the path of the trace as possible (see Figure 3-4).

Further Sample Sessions
How to Add an Event

NOTE

You should not move the level-marker right of any subsequent Event.

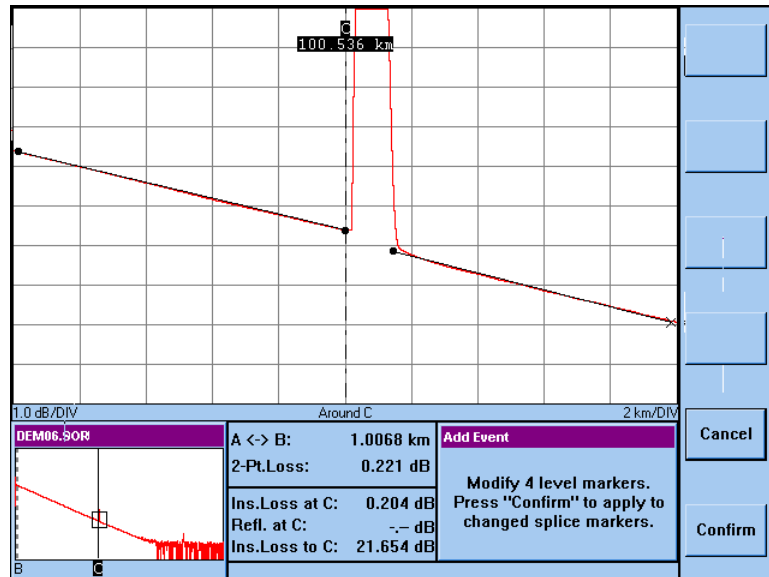


Figure 3-4

Add Non-Reflective Event: Level-Markers set

- 21 Press the Modify knob again to confirm the Event.
The new Event can now be seen in the Event Bar and the Event Table.

How to Add a Non-Reflective Event

- 1 Follow steps 1 to 4 above.
- 2 Select NON-REFLECTIVE EVENT.

NOTE

If there is already an Event near marker C, you are asked whether you want to modify this Event or add a new one.

In this case, select Add by turning the Modify knob until Add is highlighted, then press the Modify knob to confirm.

You now see a guidance dialog beneath the trace, advising you what you should now do.

Now follow the steps in “How to Set the Level Markers for Insertion Loss” on page 74.

3.2

How to Measure Loss and Attenuation

How to Measure 2-Point Loss

You can use the OTDR to measure the loss between any two points on a trace (for example, between two connectors).

You measure two-point loss as follows.

- 1 Press the NEXT MARKER hardkey until marker A is active.
- 2 Move marker A to the left point.
- 3 Press the NEXT MARKER hardkey again.
Marker B is now active.
- 4 Move Marker B to the right point.
- 5 Press the bottom softkey until you see screen 1 / 3.
- 6 Press the {ANALYSIS} softkey. Select 2-PT. LOSS from the {ANALYSIS} menu.

The loss between Marker A and Marker B is shown in the Marker Information window beneath the trace, next to the label 2-PT .
LOSS.

NOTE

To measure the Total Loss for the whole fiber, see “How to Measure the Total Loss of a Fiber” on page 79.

How to Measure 2-Point Attenuation

If you want to know the average attenuation of your link (or parts of it), you can measure the 2-point attenuation between markers A and B.

You measure the 2-point attenuation as follows.

- 1 Position markers A and B at the points between which you want to measure the attenuation.
See steps 1 to 4 above.
- 2 Press the bottom softkey until you see screen 1 / 3.
- 3 Press the {ANALYSIS} softkey. Select 2-PT. ATTENUATION from the {ANALYSIS} menu.

The attenuation between Marker A and Marker B is shown in the Marker Information window beneath the trace, next to the label 2-PT. Att.

NOTE

To measure the attenuation of the whole fiber, position Marker A on the backscatter just after the initial reflection.

If there is a reflection at the fiber's end, position Marker B in front of the leading edge of the reflection, Otherwise, place Marker B just before the trace bends into the noise.

How to Measure LSA Attenuation

As well as measuring 2-point attenuation, you can also measure the LSA (Least Square Approximation) between markers A and B. LSA is a statistical method which can be more accurate.

You measure the 2-point attenuation as follows.

- 1 Position markers A and B at the points between which you want to measure the attenuation.
See steps 1 to 4 above.

NOTE

Make sure that there is no splice or connector between the two markers.

Further Sample Sessions

How to Measure the Total Loss of a Fiber

- 2 Press the bottom softkey until you see screen 1 / 3.
- 3 Press the {ANALYSIS} softkey. Select LSA-ATTENUATION from the {ANALYSIS} menu.

The attenuation between Marker A and Marker B is shown in the Marker Information window beneath the trace, next to the label LSA-Att .

How to Measure Optical Return Loss

You measure the Optical Return Loss between two points as follows.

- 1 Position markers A and B at the points between which you want to measure the Optical Return Loss.
See steps 1 to 4 above.

NOTE

Make sure that there is no splice or connector between the two markers.

- 2 Press the bottom softkey until you see screen 1 / 3.
- 3 Press the {ANALYSIS} softkey. Select OPTICAL RETURN LOSS from the {ANALYSIS} menu.

The Optical Return Loss between Marker A and Marker B is shown in the Marker Information window beneath the trace, next to the label ORL.

3.3

How to Measure the Total Loss of a Fiber

This section tells you how to examine the Total Loss of a fiber.

There are many other measurements that can be performed on the OTDR (for example for attenuation, insertion loss, or reflectance). You can find further examples in the online documentation.

Further Sample Sessions

How to Measure the Total Loss of a Fiber

- 1 Press the NEXT MARKER hardkey until marker B is highlighted. Marker B is now the active marker.
- 2 Move Marker B to where the backscatter and left rising edge of the End Reflection meet (Figure 3-5).
You move the active marker by turning the Modify knob.

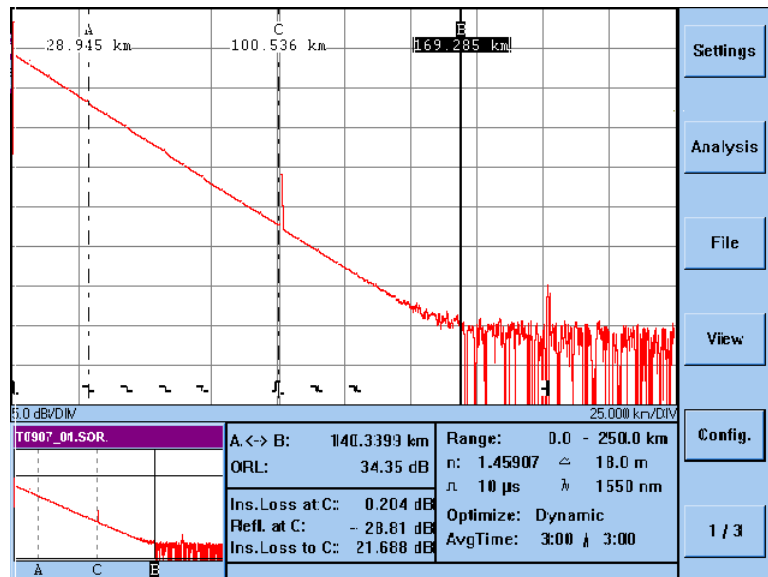


Figure 3-5

Measure Total Loss: Position Marker B

- 3 Press the Around Marker hardkey to check the position of Marker B.
- 4 Place Marker B as close as possible to the left rising edge.
- 5 Press the FULL TRACE hardkey to see the whole trace again.
- 6 Press the NEXT MARKER hardkey three times.
Marker A is now the active marker, and is highlighted.
- 7 Move Marker A to the far left, then press the AROUND MARKER hardkey to view the start of the fiber.

Further Sample Sessions

How to Measure the Total Loss of a Fiber

You now see the deadzone from the front-panel reflection at the start of the fiber.

- 8 Position Marker A so that it cuts the trace in the same vertical position as the backscatter extrapolated back to 0 m (Figure 3-6). This takes into account the loss in the deadzone.

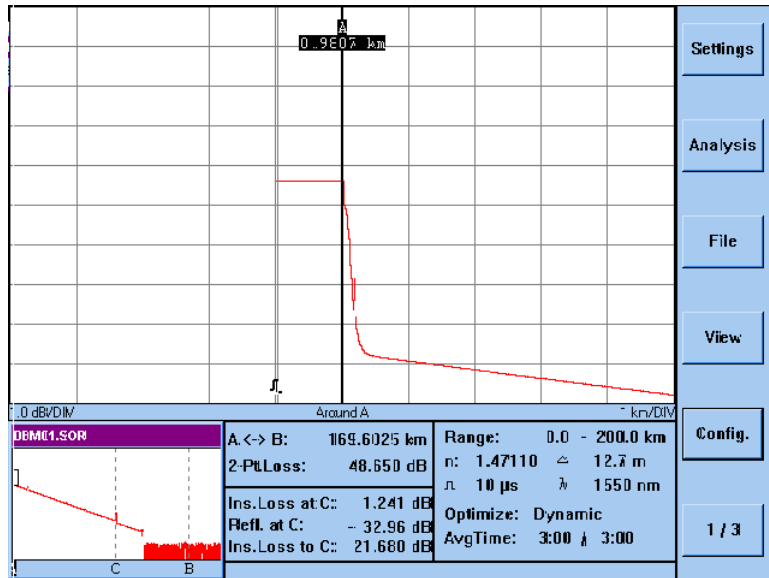


Figure 3-6

Measure Total Loss: Position Marker A

- 9 Press the bottom softkey until you see screen 1 / 3.
- 10 Press the {ANALYSIS} softkey.
- 11 Select 2-Pt. Loss from the Analysis menu.
You see the two-point loss in the marker information window below the trace.

3.4 How to Take a Two-Way Measurement

A two-way measurement lets you average two measurements, one from each end of the fiber. This means you can calculate average splice losses, and increase the splice loss accuracy.

You average a two-way measurement as follows.

- 1 Load two traces, one measured from each end of the fiber.
See “How to Display more than one trace” on page 62.

NOTE

You must have only 2 traces loaded. If you have a third or fourth trace loaded, you must close these traces.

See “How to Close a Trace” on page 64.

Both traces must have an Event Table. If a trace does not have an Event Table, you should use the Scan Trace function. See “How to Scan for Events” on page 49.

- 2 Press the bottom softkey until you see screen 1 / 3.
- 3 Press the {ANALYSIS} softkey. Select TWO-WAY MEASUREMENT from the {ANALYSIS} menu.

Further Sample Sessions

How to Take a Two-Way Measurement

You see the two traces reflecting each other (Figure 3-7).

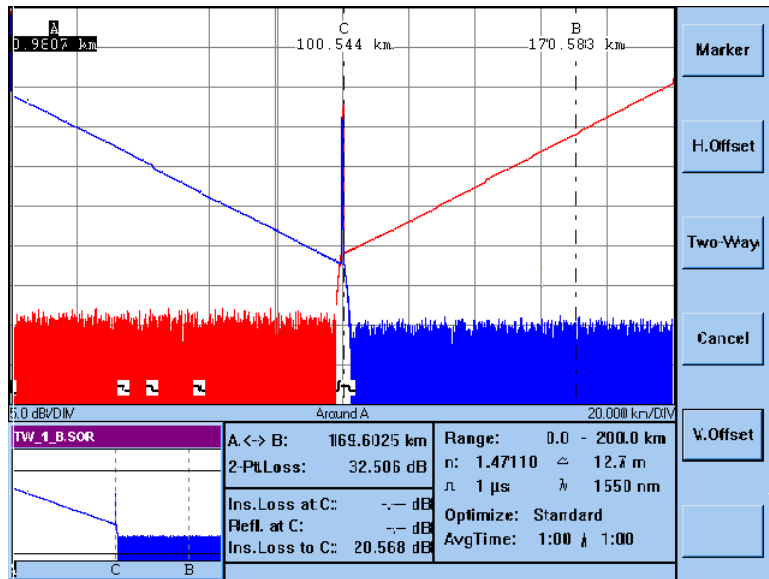


Figure 3-7

Two-Way Measurement: traces

The softkey labels change to show you functions for two-way measurement.

- 4 Use the markers to zoom on the traces (for example to select synchronization points).

How to synchronize traces before Averaging

- 5 Press the H.OFFSET softkey.
- 6 Turn the Modify knob to move the current trace horizontally. This lets you place a known point at the same position on the each trace.

Further Sample Sessions

How to Take a Two-Way Measurement

NOTE

If you want to reuse the markers, press the **MARKER** softkey.

- 7 Press the **TWOWAY** softkey to take the measurement.
The two traces are now averaged, and you see a third trace showing the average.

The two-way measurement generates a two-way measurement Event Table to show a comparison between the Events on the two traces (Figure 3-8).

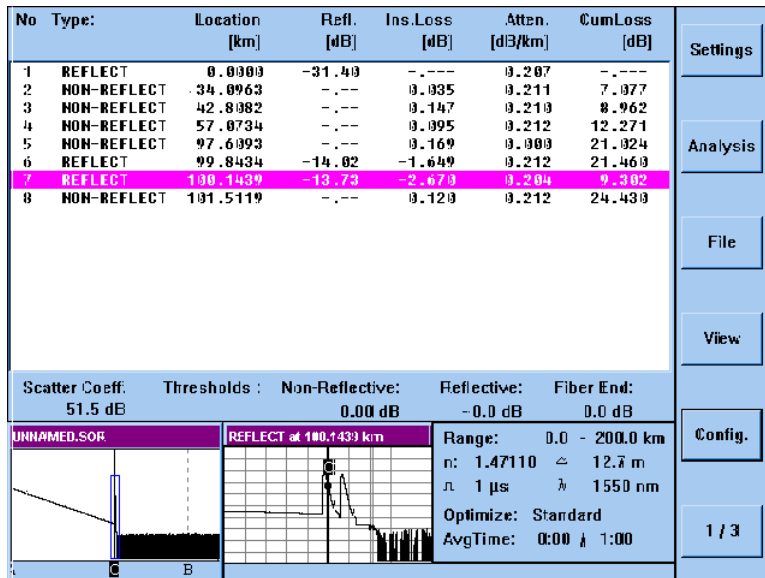


Figure 3-8 Two-Way Measurement: Event Table

3.5

How to Subtract One Measurement from Another

You can make a general comparison of two different fibers by subtracting one measurement from the other. This allows you to instantly see the differences.

You subtract measurements as follows.

- 1 Load the two traces to be compared.
See “How to Display more than one trace” on page 62.

NOTE

You must have only 2 traces loaded. If you have a third or fourth trace loaded, you must close these traces.

See “How to Close a Trace” on page 64.

- 2 Press the bottom softkey until you see screen 1 / 3.
- 3 Press the {ANALYSIS} softkey. Select SUBTRACT MEASUREMENT from the {ANALYSIS} menu.
The softkey labels change to show you functions for subtracting a measurement.
- 4 Use the markers to zoom on the traces (for example to select synchronization points).

How to Synchronize Traces before Subtracting

- 5 Press the H.OFFSET softkey.
- 6 Turn the Modify knob to move the current trace horizontally.
This lets you place a known point at the same position on the each trace.

NOTE

If you want to reuse the markers, press the MARKER softkey.

Further Sample Sessions

How to Use Stored Settings

7 Press the SUBTRACT softkey to take the measurement.

The second trace is now subtracted, and you see a third trace showing the differences (Figure 3-9).

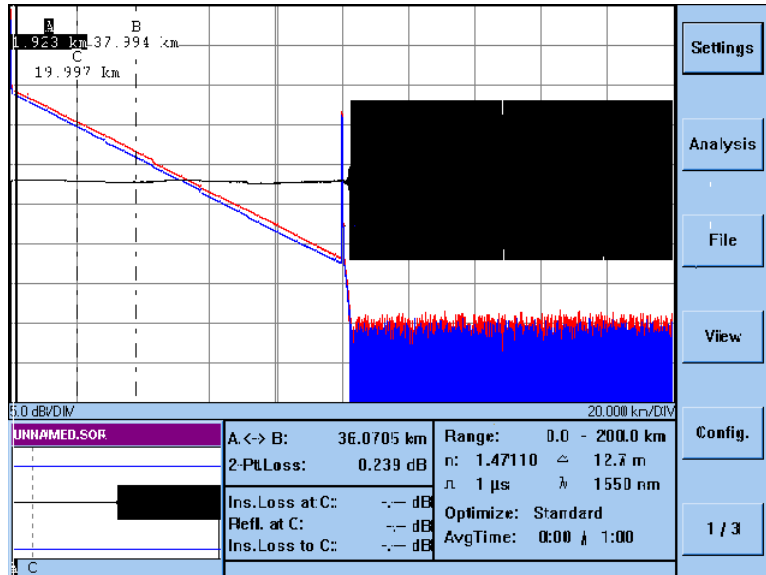


Figure 3-9 Subtract Measurements: result

3.6 How to Use Stored Settings

If you want to prepare your OTDR for future measurements, you can store different parameter settings (for example, to measure different types of links). The settings are stored in so-called settings files.

The following parameters are stored: Start position and span, Pulsewidth, Wavelength, Optimizing method, Averaging time,

Further Sample Sessions

How to Use Stored Settings

Refractive index, Scatter coefficient, Measurement mode, and Event thresholds.

How to Store Parameter Settings

- 1 Press the bottom softkey until you see screen 1 / 3.
- 2 Press the {SETTINGS} softkey. Select STORE SETTINGS from the {SETTINGS} menu.
You see a screen keyboard inviting you to enter a file name for the settings file.
- 3 Enter a file name.
See “How to use the screen keyboard” on page 54.
The file name can be up to 8 characters long. If you do not specify a file extension, it is given the default extension .SET.

How to Recall Stored Settings

After you have stored the settings, you can recall them for use with subsequent measurements as follows.

- 1 Press the bottom softkey until you see screen 1 / 3.
- 2 Press the {SETTINGS} softkey. Select RECALL SETTINGS from the {SETTINGS} menu.
- 3 Turn the Modify knob to select the settings you want to recall.

NOTE

You can also select `DEFAULT.SET` for the default settings or `LASTMEAS.SET` for the settings from the previous measurement,

- 4 Press the Modify knob to confirm your selection.

How to Delete Stored Settings

You can delete stored settings which are no longer required as follows.

How to Connect to the OTDR via LAN

- 1 Press the bottom softkey until you see screen 1 / 3.
- 2 Press the {SETTINGS} softkey. Select DELETE SETTINGS from the {SETTINGS} menu.

NOTE

If the current device is the floppy disk drive, you see a softkey called HDD. If the current device is the hard disk drive, this softkey is called FDD.

Select this softkey to move between the two devices.

- 3 Turn the Modify knob to highlight the settings you want to delete.
- 4 Press the Modify knob to select the highlighted settings.
- 5 Press the CONFIRM softkey to confirm these settings.
The delete settings can no longer be recalled.

3.7

How to Connect to the OTDR via LAN

The OTDR is configured as a TCP/IP for Microsoft Networks and compatible software.

You can connect the OTDR to a PC running such software. You do not require a login name or password.

You connect to the OTDR as follows.

- 1 Install a LAN card in your OTDR.
For more details, please contact your system administrator. See also “LAN Interface (Option 005)” on page 127.
- 2 Press the bottom softkey until you see screen 1 / 3.
- 3 Press the {CONFIG} softkey. Select LAN SETTINGS from the {CONFIG} menu.

Further Sample Sessions

How to Connect to the OTDR via LAN

You see a window where you can set the appropriate LAN settings (Figure 3-10).

Station Name: bid3138

Workgroup: LANGROUP

Domain Name:

IP Address: 15.136.152.182

Subnet Mask: 255.255.248.0

Gateway: 15.136.159.254

WINS Name Server:

DNS Name Server: 15.136.158.8

WINS Resolution Enabled: DNS Resolution Enabled:

Cancel OK

Figure 3-10 LAN Settings window

NOTE

If you do not have a LAN card installed, the LAN SETTINGS menu option is grayed.

- 4 Set the following parameters to those appropriate for your pc:
 - Station Name,
 - either Workgroup or Domain Name,
 - IP-Address,
 - Subnet Mask,
 - Gateway,

Further Sample Sessions

How to Connect to the OTDR via LAN

- either WINS Name Server or DNS Name Server.

If you do not know any of these settings, please contact your system administrator.

How to connect using Windows NT Explorer

You can now connect to the OTDR data directory as follows.

- 5 Start Windows NT Explorer
- 6 Select MAP NETWORK DRIVE from the TOOLS directory.
- 7 Select your OTDR.

The OTDR will have the name you selected for Station Name above.

You can now select the OTDR directory, which is called DATA.

NOTE

For DOS and Win 3.1, you must make a connection from the File Manager or a DOS prompt.

To do this, you simply type:

net use o: \\<station-name>\DATA

where <station-name> is the name you selected for Station Name.

Macro Programming

Macro Programming

This chapter describes how to record and play macros for the OTDR. This chapter also gives the syntax and the commands of the macro language.

A macro is a means of storing commands you would otherwise give to the OTDR manually. These commands can be repeated later. Complex measurement procedures can thus be run automatically.

Detailed information on operating the OTDR, and thus on every single command, can be found in the online documentation.

The macros are recorded in macro files that can be edited afterwards. You can thus write macros that show messages on the screen, that repeat commands in loops, and so on.

You can assign macros to the easy mode softkeys. The inexperienced user in easy mode can thus start complex measurements by pressing just one softkey.

4.1 Recording Macros

Recording a macro means storing commands you would otherwise give to the OTDR manually. You can only start to record a macro when a measurement is not running.

How to Record a Macro

To store commands by recording a macro:

- 1 Press the softkey CONFIG (screen 1/1).
- 2 In the config menu, select MACRO RECORDER.
- 3 In the submenu on display, select START RECORDING.
- 4 Use the keyboard appearing on the screen to enter the name for the macro file.

All subsequent commands entered into the OTDR will be recorded in the macro file.

While you are recording a macro, any print commands will only be recorded, not executed.

After you have entered all the commands:

- 5 Press the softkey CONFIG (screen 1/1).
- 6 In the config menu, select MACRO RECORDER.
- 7 In the submenu on display, select STOP RECORDING.

All the commands have now been stored in the macro file. You can recall these by activating the macro. You can also edit the commands in the macro file.

4.2 Activating Macros

Activating a macro gives you the chance to start complex measurements with just one command. You can only activate macros that have been recorded on the OTDR or created following the macro command syntax.

How to Activate a Macro

To activate a stored macro:

- 1 Press the softkey CONFIG (screen 1/1).
- 2 In the config menu, select MACRO RECORDER.
- 3 In the submenu on display, select PLAY MACRO.
The select-file dialog appears on the screen.
- 4 Turn the knob to select the macro to be activated.
- 5 Press the knob to confirm the selection.

The commands stored in the macro selected, are executed successively.

How to Stop a Macro

If you wish to stop the execution before the macro has finished, you have two possibilities, either halting or stopping the macro:

- 1 Press the softkey CONFIG (screen 1/1).

If you wish to stop the macro completely:

- 2 In the config menu, select MACRO RECORDER – STOP MACRO.

Alternatively: *If you wish to halt the macro and continue later:*

- 2 In the config menu, select MACRO RECORDER – HALT MACRO.

To continue the macro after halting:

- 3 In the config menu, select MACRO RECORDER – RESUME MACRO.

In easy mode you can activate macros by just pressing the assigned softkey.

4.3

Editing Macros

The recorded macros are stored on the OTDR's internal hard disk.

You can copy the macro files on a diskette to edit them on your personal computer. Use the command `CONFIG – MACRO RECORDER – COPY MACROS`.

Use any text editor to edit the files without any formatting.

When editing a macro file, heed the following rules:

- A command cannot exceed one line unless you enter a line feed in a string parameter.
- There can be more commands on one line, separated only by blanks or tabs.
- Most commands are used with parameters. These have to be separated by blanks. Strings have to be surrounded by straight quotes ("...") and may have a maximum length of 40 characters.
- Tabs and spaces in front of commands are allowed.
- The macro interpreter does not distinguish between upper and lower case letters in commands.
- Strings in arguments to commands are passed as they are (upper and lower case).
- You can add comments to a macro using the `Rem` command.
- The last command in a macro file always has to be `End`.

4.4 Macro Commands

This section shows all the macro commands available.

In the syntax description you will find the following notations:

- The characters between angled brackets (<...>) show the names of the parameters. You do not type these brackets in the actual command.
- “<wsp>” stands for any white space character.
- The parts given in brackets ([...]) can be omitted.

Overview

The available commands can be divided into six groups:

Setting Parameters

- SetAutoMeasurement
- SetAveragingTime
- SetNonRefEventThreshold
- SetOptimization
- SetPulseWidth
- SetRefEventThreshold
- SetStartValue
- SetStopValue
- SetWaveLength
- SetMeasurementState

Running Measurements

- StartMeasurement
- StopMeasurement
- WaitForStopMeasurement

Macro Programming

Macro Commands

Documenting Measurements

- Load
- PrintAll
- PrintCurrent
- Save
- SaveAs
- SetComment
- SetCommentLabel

Changing the Display

- SetCurrentTrace
- SetDottedLines
- SetEventBar
- SetGrid
- SetLengthUnit
- SetTraceColor
- SetUserMode

Comments and Flow Control

- Goto
- Label
- LoopStart
- LoopEndCount
- Message
- Rem
- Sleep
- Troff
- Tron

Analyzing Measurements

- SetABReadOut
- SetActiveMarker
- SetAnalysisMode
- SetAutoOffset
- SetDisplayMode
- SetPosMarker
- SetReflexMarker
- SetSpliceMarker
- SetXScaleMode
- SetZoomA
- SetZoomB
- SetZoomC
- StartScan
- StopScan

Additional commands

- SetMacroDelay
- SetDefaultFileName

Commands For Setting Parameters

The measurement parameters can be set using the following macro commands. The parameters are always valid for a certain trace. You can simultaneously load up to four traces into the OTDR's memory.

command	SetAutoMeasurement
syntax	SetAutoMeasurement<wsp><mode>[<wsp><trace-nr>]
description	Lets the OTDR set itself up automatically to achieve best results.
parameters	mode 0 – set parameters manually 1 – set parameters automatically
example	SetAutoMeasurement 1

Macro Programming

Macro Commands

command	SetAveragingTime
syntax	SetAveragingTime<wsp><time>[<wsp><trace-nr>]
description	Sets the duration of the measurement. A value of 0 means that the measurement is not stopped automatically.
parameters	time averaging time in s (values: 0...32760)
example	SetAveragingTime 0
command	SetNonReflEventThreshold
syntax	SetNonReflEventThreshold<wsp><threshold>[<wsp><trace-nr>]
description	Sets the threshold for the OTDR when scanning for non-reflective events on the trace.
parameters	threshold threshold in mdB
related commands	SetReflEventThreshold
example	SetNonReflEventThreshold 50
command	SetOptimization
syntax	SetOptimization<wsp><method>[<wsp><trace-nr>]
description	Selects the optimization method to be used.
parameters	method 1 – standard 2 – resolution 3 – dynamic 4 – linearity
example	SetOptimization

Macro Programming

Macro Commands

command	SetPulseWidth
syntax	SetPulseWidth<wsp><pwidth>[<wsp><trace-nr>]
description	Sets the pulsewidth and thus the length and the power of the pulses the OTDR launches into the fiber.
parameters	pwidth pulsewidth in ns (values: 10, 30, 100, 300, 1000, 3000, 10000)
example	SetPulseWidth 300
command	SetRefEventThreshold
syntax	SetRefEventThreshold<wsp><threshold>[<wsp><trace-nr>]
description	Sets the threshold for the OTDR when scanning for reflective events on the trace.
parameters	threshold threshold in mdB
related commands	SetNonRefEventThreshold
example	SetRefEventThreshold 50000
command	SetStartValue
syntax	SetStartValue<wsp><start>[<wsp><trace-nr>]
description	Sets the distance of the first measured point on the trace from the OTDR.
parameters	start start position in mm
example	SetStartValue 1000000

Macro Programming

Macro Commands

command	SetStopValue
syntax	SetStopValue<wsp><stop>[<wsp><trace-nr>]
description	Sets the distance of the last measured point on the trace from the OTDR.
parameters	stop stop position in mm
example	SetStopValue 15000000
command	SetWaveLength
syntax	SetWaveLength<wsp><wlength>[<wsp><trace-nr>]
description	Sets the wavelength to be used for the measurement.
parameters	wlength wavelength in nm (values depend on module)
example	SetWaveLength 1310
command	SetMeasurementState
syntax	SetMeasurementState<wsp><meas-state>[<wsp><trace-nr>]
description	Set the measurement state.
parameters	meas-state 10=refresh, 11=averaging, 14=CW
example	SetMeasurementState 10

Commands For Running Measurements

You can start and stop a measurement, and also wait for the user to stop the measurement. The commands are always valid for the current measurement.

command	StartMeasurement
syntax	StartMeasurement
description	Starts the measurement.
parameters	no parameters: use the current parameters – or – <start>: start position in mm <stop>: stop position in mm <pwidth> pulsewidth in ns <wlength>: wavelength in nm <time>: averaging time in s

For a description of these parameters see section “Commands For Setting Parameters” on page 98.

related commands	SetCurrentTrace
examples	StartMeasurement StartMeasurement 0 1000000 10 1330 0

command	StopMeasurement
syntax	StopMeasurement
description	Stops the currently running measurement.
parameters	none
example	StopMeasurement

Macro Programming

Macro Commands

command	WaitForStopMeasurement
syntax	WaitForStopMeasurement
description	Suspends the macro execution until averaging time has elapsed or the user presses Run/Stop.
parameters	none
example	WaitForStopMeasurement

Commands For Documenting Measurements

You can document the current measurement by saving it on disk or printing it out. You can also load a stored measurement. The commands are always valid for the current trace (the storing location in the OTDR's memory).

command	Load
syntax	Load<wsp><filename>
description	Loads a measurement file from the selected drive.
parameters	full file name including drive and path
example	Load C:\HP8147\TRACES\T0711_01.SOR
command	PrintAll
syntax	PrintAll
description	Prints all currently loaded measurements (up to four) on the current printing device.
parameters	none
example	PrintAll

Macro Programming

Macro Commands

command	PrintCurrent
syntax	PrintCurrent
description	Prints the current measurement on the current printing device.
parameters	none
related commands	SetCurrentTrace
example	PrintCurrent
command	Save
syntax	Save
description	Saves the current measurement on the current storing device using an automatic file name.
parameters	none
related commands	SetCurrentTrace
example	Save
command	SaveAs
syntax	SaveAs<wsp><filename>
description	Saves the current measurement in a specified file on the selected drive.
parameters	full file name including drive and path
related commands	SetCurrentTrace
example	Save C:\HP8147\TRACES\T0711_02.SOR

Macro Programming

Macro Commands

command	SetComment
syntax	SetComment<wsp><"comment"><wsp><field-nr>
description	Enters text into one of the five information fields for the current measurement.
parameters	"comment" string field-nr number of the information field (0...4)
related commands	SetCurrentTrace
example	SetComment "single-mode fiber" 1

command	SetCommentLabel
syntax	SetCommentLabel<wsp><"label"><wsp><field-nr>
description	Adds a label to one of the five information fields for a measurement.
parameters	"label" string field-nr number of the information field (0...4)
example	SetCommentLabel "fiber type" 1

Commands For Changing the Display

The OTDR's display can be changed in many ways.

command	SetCurrentTrace
syntax	SetCurrentTrace<wsp><trace-nr>
description	Selects the trace (the storage location in the OTDR's memory) all further actions are performed on.
parameters	trace-nr number of the trace (0...3)
example	SetCurrentTrace 1

Macro Programming

Macro Commands

command	SetDottedLines
syntax	SetDottedLine<wsp><style>[<wsp><trace-nr>]
description	Selects the linestyle used to display a trace.
parameters	style 0 – solid, 1 – dotted trace-nr number of the trace (0...3),
example	SetDottedLines 1
command	SetEventBar
syntax	SetEventBar<wsp><state>
description	Switches the event bar shown at the bottom of the trace on or off.
parameters	state 0 – event bar off 1 – event bar on
example	SetEventBar 0
command	SetGrid
syntax	SetGrid<wsp><state>
description	Switches the grid shown behind the trace on or off.
parameters	state 0 – grid off, 1 – grid on
example	SetGrid 0
command	SetLengthUnit
syntax	SetLengthUnit<wsp><unit>
description	Selects the length unit to be used for all distance measurements.
parameters	unit 0 – meter, 1 – feet, 2 – miles
example	SetLengthUnit 2

Macro Commands

command **SetTraceColor**
syntax SetTraceColor<wsp><color>[<wsp><trace-nr>]
description Selects the color used to display a trace.
parameters color 0 – black, 1 – red, 3 – blue, 7 – green
 trace-nr number of the trace (0...3),
example SetTraceColor 1

command **SetUserMode**
syntax SetUserMode<wsp><state>
description Sets the OTDR to expert or easy mode.
parameters state 0 – expert mode, 1 – easy mode
example SetUserMode 1

Commands for Comments and Flow Control

command **Goto**
syntax Goto<wsp><label-nr>
description Jumps to a label and continues with the command following the
 label.
parameters label-nr number of the label (0...9)
example Goto 3

Macro Programming

Macro Commands

command	Label
syntax	Label<wsp><label-nr>
description	Sets a label to be used for a jump in macro execution.
parameters	label-nr number of the label (0...9)
example	Label 3
command	LoopEndCount
syntax	LoopEndCount<wsp><n>
description	Sets the end of a loop and the number of times the loop is to be executed.
parameters	n number of loops
related commands	LoopStart
example	LoopEndCount 3
command	LoopStart
syntax	LoopStart
description	Defines the start of a loop.
parameters	none
related commands	LoopEndCount
example	LoopStart

Macro Programming

Macro Commands

command	Message
syntax	Message<wsp><"text"><wsp><"caption">
description	Shows a message box on the display. With it you can ask the user to fulfil a specific task. Pressing the Modify knob will resume the macro execution.
parameters	"text" the text shown in the message box "caption" the text shown in the title bar of the message box
example	Message "Connect the fiber to the OTDR!" "Action"
command	Rem
syntax	REM<wsp><comment>
description	Use this command to enter comments in a macro file.
parameters	comment any characters
example	Rem Set the measurement parameters
command	Sleep
syntax	Sleep<wsp><time>
description	Suspends the macro execution for a while.
parameters	time time to wait in s
related commands	WaitForStopMeasurement
example	Sleep 10

Macro Programming

Macro Commands

command	Troff
syntax	Troff
description	Switches the macro status message bar off.
parameters	none
related commands	Tron
example	Troff
command	Tron
syntax	Tron
description	Switches the macro status message bar on.
parameters	none
related commands	Troff
example	Tron

Commands for Analyzing Measurements

When some analyzing is performed while recording a macro, the appropriate commands will be recorded in the macro file.

These commands are rather complex. Do not change their parameters in the macro file, otherwise the system might crash.

SetABReadOut <...>	Sets the read-out for markers A and B to 2-point loss, 2-point attenuation, or LSA attenuation.
SetActiveMarker <...>	Selects one of the markers as the active one.
SetAnalysisMode <...>	Sets the OTDR to analyze insertion loss, reflectance, or none of them.
SetAutoOffset <...>	Sets the OTDR to adjust the vertical offset automatically.
SetDisplayMode <...>	Sets the OTDR to display the trace or the event table.
SetPosMarker <...>	Sets the position of a marker in an array index.
SetReflexMarker <...>	Sets the position of the level-markers in analyze-reflectance mode.
SetSpliceMarker <...>	Sets the position of the level-markers in analyze-insertion-loss mode.
SetXScaleMode <...>	Sets display to zoom around marker or to full trace.
SetZoomA <...>	Sets zooming information for marker A.
SetZoomB <...>	Sets zooming information for marker B.
SetZoomC <...>	Sets zooming information for marker C.
StartScan	Starts the Scan trace
StopScan	Stops the Scan trace

Example

Additional commands

The following commands must be added manually with a text editor:

command	SetMacroDelay
syntax	SetMacroDelay<time>
description	Sets a delay between two macro commands.
parameters	time in ms
example	SetMacroDelay 500
command	SetDefaultFileName
syntax	SetMacroDelay<wsp><filename><trace-nr>
description	Set a default file name to be used by future save operations.
parameters	filename file name trace-nr number of the current trace (0 ..3)
example	SetDefaultFileName C:\HP8147\TRACES\T2.SOR 1

4.5

Example

The following example shows a macro used to measure an undefined number of fibers. The user simply starts the macro, attaches the fibers, and stops the measurement when it is sufficiently free of noise. The macro then prints and saves the measurement automatically.

```
Rem REPEAT.MAC
Rem Macro for repeated measurements in automatic mode.
Rem Does not stop automatically once it has been
started.
```


Macro Programming

Example

```
Rem Set automatic mode for current measurement
SetAutoMeasurement 1
Rem Averaging time 0: user has to stop the measurement
SetAveragingTime 0

Rem Repeat for all measurements
LoopStart
  Message "Attach the next fiber to the OTDR!" "Action"
  StartMeasurement
  Message "Press Run/Stop when trace is free of noise"
  "Wait"
  WaitForStopMeasurement
  Rem Save the measurement using the automatic file
  name
  Save
  PrintCurrent
LoopEndCount 3
End
```

Macro Programming
Example

**Installation and
Maintenance**

Installation and Maintenance

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

A.1 Safety Considerations



The OTDR is a Class 1 instrument (that is, an instrument with an exposed metal chassis directly connected to earth via the power supply cable). The shown symbol is used to indicate a protective earth terminal in the instrument.

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 “Single-Mode Module 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 enclosure (covers, panels, and so on).

AC Line Power Supply Requirements

A.3 AC Line Power Supply Requirements

The HP 8147 can operate from any single-phase AC power source that supplies between 100V and 240V at a frequency in the range from 50 to 60Hz. The maximum power consumption is 150VA with all options installed. The HP 8147 is classified for Installation Category II and Pollution Degree 2 in accordance with IEC 1010-1.

Line Power Cable

According to international safety standards, this instrument has a three-wire power cable. When connected to an appropriate AC power receptacle, this cable earths the instrument cabinet. 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.

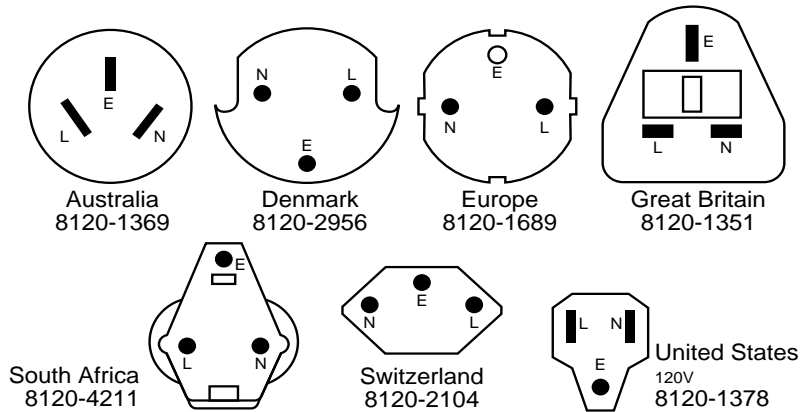


Figure A-1 **Line Power Cables – Plug Identification**

AC Line Power Supply Requirements

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.
- Before switching on the instrument, the protective earth terminal of the instrument must be connected to a protective conductor. You can do this by using the power cord supplied with the instrument.
- Do not interrupt the protective earth connection intentionally.

The following work should 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

To avoid the possibility of injury or death, please note that the HP 8147 does not have a floating earth for AC.

The HP 8147 is not designed for outdoor use. To prevent potential fire or shock hazard, do not expose the instrument to rain or other excessive moisture.

Appendix A. Installation and Maintenance

AC Line Power Supply Requirements

The AC power requirements are summarized on the rear panel of the instrument.

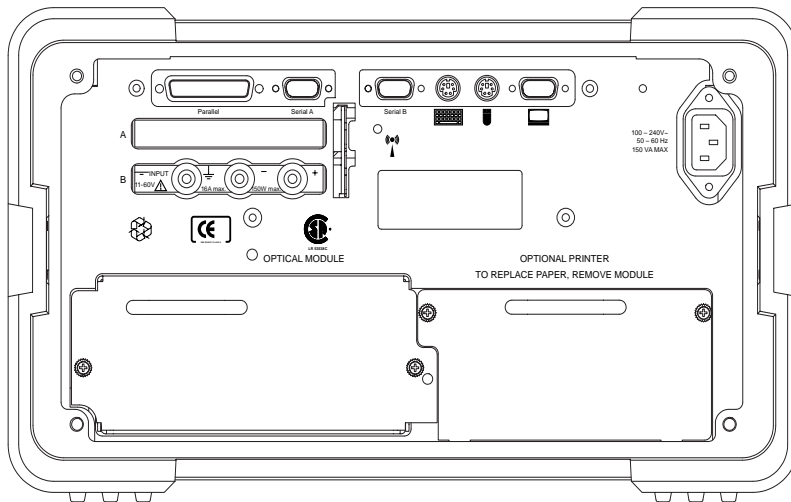


Figure A-2

Rear Panel Markings

Replacing the 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 (TADIRAN TL5186 (360mAh), UL component recognition MH12193). Discard used batteries according to local regulations.



A.4 DC Power Supply Requirements (Option 001)

WARNING

**To avoid the possibility of injury or death, please note that the HP 8147 has a floating earth for DC.
When using a DC line supply, before switching on the instrument, make sure that the supply meets the local protection requirements.**

The HP 8147 can operate from a DC power source that supplies between 11V and 30V (for +12V or +24V battery sources). The maximum power consumption is 150W with all options installed.



To ensure that the case of the instrument is at a known potential, you can connect the chassis earth to a suitable earthing point.

A.5 Operating and Storage Environment

The following summarizes the HP 8147 operating environment ranges. In order for the OTDR to meet specifications, the operating environment must be within these limits.

Temperature

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

The storage and operating temperatures for the HP 8147 are given in the table below. Please note the restricted operating range when you are using the floppy disk drive, or the optional thermal printer.

	Operating Range	Storage Range
Specified	0°C to 55°C	-40°C to 70°C
Floppy Disk Drive	5°C to 50°C	
Thermal Printer	5°C to 40°C	

Humidity

The operating humidity for the HP 8147 is 95% from 0°C to 40°C. When using the floppy disk drive, or the optional thermal printer, the humidity range is reduced to 35% to 85% at 40°C.

CAUTION

Only use dry paper with the printer. Wet paper will damage it.

Altitude

The HP 8147 can be used up to 3300m (10800ft.)

Switching on the OTDR

Instrument Positioning and Cooling

Mount or position the instrument upright and horizontally so that air can circulate around it freely. When operating the OTDR, choose a location that provides at least 75mm (3 inches) of clearance at the rear, and at least 25mm (1 inch) of clearance at each side. Failure to provide adequate air clearance may result in excessive internal temperature, reducing instrument reliability.

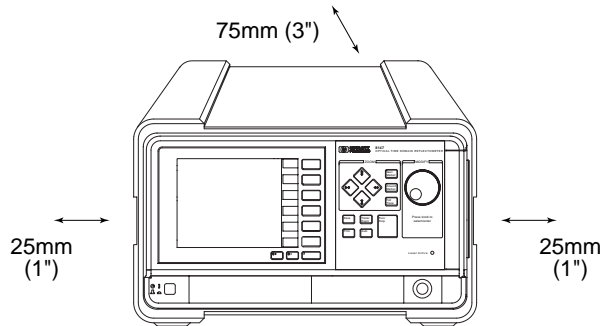


Figure A-3

Correct Positioning of the OTDR

A.6 Switching on the OTDR

When you switch on the OTDR it goes through self test.

If the OTDR indicates a problem with the printer or the laser module, switch off the instrument, make sure the module or printer is properly inserted and try switching the instrument on again.

A.7 Optical Output

CAUTION

Make sure that you only use the correct cables with your chosen output.

A.8 Parallel Interface

This is a CENTRONICS type parallel port for a parallel printer, with a DB-25 connector, at the back of the instrument.



If a cable is connected to this port, the EMI performance of the optical time domain reflectometer cannot be guaranteed.

A.9 Serial Interfaces

There are two AT-compatible RS232 ports, with DB-9 connectors at the back of the instrument.



If a cable is connected to this port, the EMI performance of the optical time domain reflectometer cannot be guaranteed.

A.10 Keyboard, Mouse, and VGA Display Interfaces

There are connectors on the back of the OTDR for standard Personal Computer keyboard, display and mouse. The supported devices are:

- AT-type keyboard,
- PS/2-type mouse, and
- VGA Display.



If a keyboard, mouse or display are connected to these ports, the EMI performance of the optical time domain reflectometer cannot be guaranteed.

A.11 HP-IB Interface (Option 004)

You can connect your HP-IB interface into a star network, a linear network, or a combination star and linear network. The limitations imposed on this network are as follows:

- The total cable length cannot exceed 20 meters
- The maximum cable length per device is 2 meters
- No more than 15 devices may be interconnected on one bus.



If a cable is connected to this port, the EMI performance of the optical time domain reflectometer cannot be guaranteed.

Appendix A. Installation and Maintenance

HP-IB Interface (Option 004)

Connector

The following figure shows the connector and pin assignments (Connector Part Number: 1251-0293).

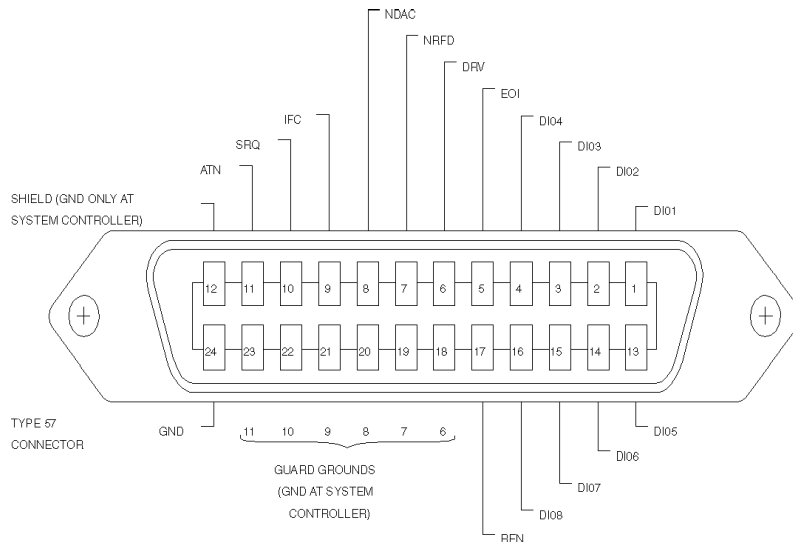


Figure A-4

The HP-IB Connector

CAUTION

HP products delivered now are equipped with connectors having ISO metric-threaded lock screws and stud mounts (ISO M3.5 x 0.6) that are black in color. Earlier connectors may have lock screws and stud mounts with imperial-threaded lock screws and stud mounts (6-32 UNC) that have a shiny nickel finish.

CAUTION

It is recommended that you do not stack more than three connectors, one on top of the other.
Hand-tighten the connector lock screws. Do not use a screwdriver.

LAN Interface (Option 005)

HP-IB Logic Levels

The 8147 HP-IB lines use standard TTL logic, as follows:

- True = Low = digital ground or 0 Vdc to 0.4 Vdc
- False = High = open or 2.5 Vdc to 5 Vdc

All HP-IB lines have LOW assertion states. High states are held at 3.0Vdc by pull-ups within the instrument. When a line functions as an input, it requires approximately 3.2mA to pull it low through a closure to digital ground. When a line functions as an output, it can sink up to 48mA in the low state and approximately 0.6mA in the high state.

NOTE

The HP-IB line screens are not isolated from ground.

A.12 LAN Interface (Option 005)

NOTE

For more information about the LAN connection, see “How to Connect to the OTDR via LAN” on page 88.

The LAN interface option uses unshielded twisted-pair cables that comply with the IEEE 802.3 Type 10Base-T standard.



If a cable is connected to this port, the EMI performance of the optical time domain reflectometer cannot be guaranteed.

LAN Interface (Option 005)

Connector

The following figure shows the connector and pin assignments for the RJ-45 connector used for the LAN interface.

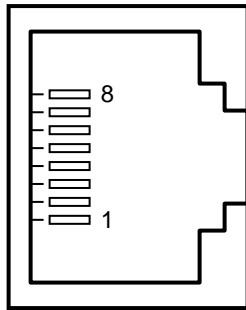


Figure A-5

LAN Connector

Pins	Signal
1	transmit +
2	transmit -
3	receive +
6	receive -

Available HP Cables

- HP 92268A 4-meter cable with attached 8-pin connectors.
- HP 92268B 8-meter cable with attached 8-pin connectors.
- HP 92268C 16-meter cable with attached 8-pin connectors.
- HP 92268D 32-meter cable with attached 8-pin connectors.
- HP 92268N 300-meter cable (no connectors supplied).

A.13 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 repackaging are as follows:

- Wrap instrument in heavy paper or plastic.
- Use strong shipping container. A double wall carton made of 350-pound test material is adequate.
- Use enough shock absorbing material (3 to 4 inch layer) around all sides of the instrument to provide a firm cushion and prevent movement inside container. Protect control panel with cardboard.
- Seal shipping container securely.
- Mark shipping container FRAGILE to encourage careful handling.
- In any correspondence, refer to instrument by model number and serial number.

A.14 Installing or Changing the Paper Roll

This procedure applies to the OTDR's internal printer.

How to Remove the Paper Roll

- 1 Loosen the screws of the printer module at the rear of the OTDR.
- 2 Pull out the printer module.
Instructions on how to change the paper roll are also given on the top of the printer module.

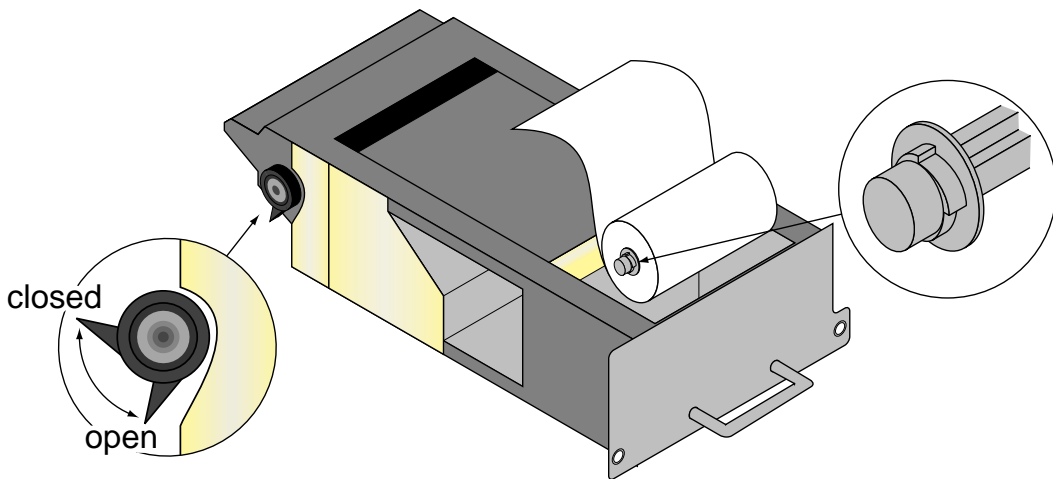


Figure A-6 **The Printer Module Turned Upside Down**

- 3 Release the paper by turning the paper-hold knob into open position.
- 4 Press the roll holders at both sides of the paper roll to release it.

Installing or Changing the Paper Roll

If there is paper left in the printer:

- 5 Gently pull the remaining paper out of the printer.
- 6 Pull the roll-holder axis out of the roll.

How to Insert the New Paper Roll

- 1 Insert the axis into the new paper roll.

NOTE

Make sure that both the axis and the paper roll are positioned as shown in Figure A-6. You must particularly make sure that the printable side of the paper is facing up.

The printable side is the side which contains printout. If there is no printout on the paper, you can tell which is the printable side by scoring the paper with your thumbnail. If you see a black line, this is the printable side.

- 2 Push the printer roll back into the roll holders.
- 3 Turn the paper-hold knob into open position.
- 4 Gently push the paper through the paper slot until it comes out at the front of the printer module.
- 5 Turn the paper-hold knob into closed position to fix the paper.
- 6 Turn the outer part of the paper-hold knob clockwise, so that about 6 cm of paper is showing.

NOTE

You must use the outer part of the paper-hold knob to release the paper. DO NOT pull the paper by hand.

- 7 Cleanly rip the paper, so that the paper roll has a straight edge, and no paper is protruding out of the printer module.
- 8 Insert the printer module back into the OTDR.
- 9 Tighten up the screws.

Installing New Software

NOTE

Please ensure that the module is properly inserted into the OTDR, so that the printer is level with the backplate of the OTDR.

If your printer output is not as expected, please remove the printer module and replace it securely. If the problem persists, please contact your nearest Hewlett-Packard representative.

How to Purchase New Paper Rolls

You can order paper from Hewlett-Packard. Ask for Product Number E4310-68951 for 4 rolls of paper for the built-in thermal printer.

Paper rolls can also be obtained from the following addresses:

Japan and Asia	Central Europe	North and South America
Seiko Instruments Inc., 1-8, Nakase, Mihama-ku, Chiba-shi Chiba 261, Japan	Seiko Instruments GmbH Siemenstrasse 9b 63263 Neu-Isenburg Germany	Seiko Instruments USA Inc. 2990 W.Lomita Blvd. Torrance CA 90505 U.S.A.
Tel: +81 (0)43 211-1111 Fax: +81 (0)43 211-8023	Tel: +49 (0)6102 297-0 Fax: +49 (0)6102 297-211	Tel: +1 310 517-7770 Fax: +1 310 517-7792
Art.No.: TP080-25CJ3/H4	Art.No.: MM-80-401-N	Art.No.: TP080-25CJ3/H4

A.15 Installing New Software

If there have been done any enhancements on the OTDR's software, you will receive a diskette containing the new software.

Installing the new software is easy:

Appendix A. Installation and Maintenance

Installing New Software

- 1** Turn off the OTDR.
- 2** Insert the diskette into the flexible disk drive.
- 3** Turn on the OTDR.
The new software is installed automatically.
- 4** Take the diskette out of the disk drive and store it safely.

Appendix A. Installation and Maintenance
Installing New Software

Accessories

Accessories

The HP 8147 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

Model No.	Description
HP E4310A	HP 8147 Optical Time Domain Reflectometer including <ul style="list-style-type: none"> • Monochrome Display • Floppy Disk Drive • Internal Hard Disk Drive • RS232C Interface (x 2) • Centronics Interface • Mouse Interface • Keyboard Interface • VGA Monitor Interface • CD-ROM upgrade • User's Guide • OTDRs Programming Guide
Option 001	DC Power Supply input 11-30 V
Option 002	Thermal Printer
Option 003	Color Screen VGA-LCD
Option 004	HP-IB Interface
Option 005	LAN Interface
Option 007	Soft Transit Case
Option AB2	Chinese localization
HP E6090A	HP OTDR Toolkit software

Appendix B. Accessories

Instrument and Options

You must select one optical module from those listed below:

Model No.	Option	Description
HP E4311A		1310nm, single-mode module
	UK6	Calibration Report
HP E4312A		1550nm, single-mode module
	UK6	Calibration Report
HP E4313A		1310/1550nm, single-mode module
	UK6	Calibration Report
HP E4314A		1310nm, single-mode module
	UK6	Calibration Report
HP E4315A		1550nm, single-mode module
	UK6	Calibration Report
HP E4316A		1310/1550nm, single-mode module
	022	angled connector
	UK6	Calibration Report
HP E4317A		1310nm, single-mode module
	UK6	Calibration Report
HP E4318A		1550nm, single-mode module
	UK6	Calibration Report
HP E4319A		1310/1550nm, single-mode module
	022	angled connector
	UK6	Calibration Report
HP E4321A		1625 nm, single-mode module
	UK6	Calibration Report
HP E4324A		1310/1550 nm, single-mode module

HP-IB Cables and Adapters

Model No.	Option	Description
	022	angled connector
	UK6	Calibration Report

B.2 HP-IB Cables and Adapters

The optional HP-IB connector is compatible with the connectors on the following cables and adapters.

Model No.	Description
HP 10833A	HP-IB Cable 1 m (3.3 ft.)
HP 10833B	HP-IB Cable 2 m (6.6 ft.)
HP 10833C	HP-IB Cable 4 m (13.2 ft.)
HP 10833D	HP-IB Cable 0.5 m (1.6 ft.)
HP 10834A	HP-IB Adapter 2.3 cm extender

B.3 Connector Interfaces and Other Accessories

The HP 8147 OTDR is 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 cable.

Model No.	Description
HP 81000AI	Diamond HMS-10
HP 81000FI	FC/PC/SPC
HP 81000GI	D4
HP 81000HI	E2000
HP 81000KI	SC
HP 81000NI	FC/APC (for use with option 022 only)
HP 81000SI	DIN 47256
HP 81000VI	ST
HP 81000WI	Biconic

Appendix B. Accessories

Connector Interfaces and Other Accessories

Rack mount kit

You can also order a rack mount kit, complete with shelf and sliding rails.

Model No.	Description
HP E4411AU Option 1CP	Rack mount kit

Appendix B. Accessories

Connector Interfaces and Other Accessories

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 8147 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.

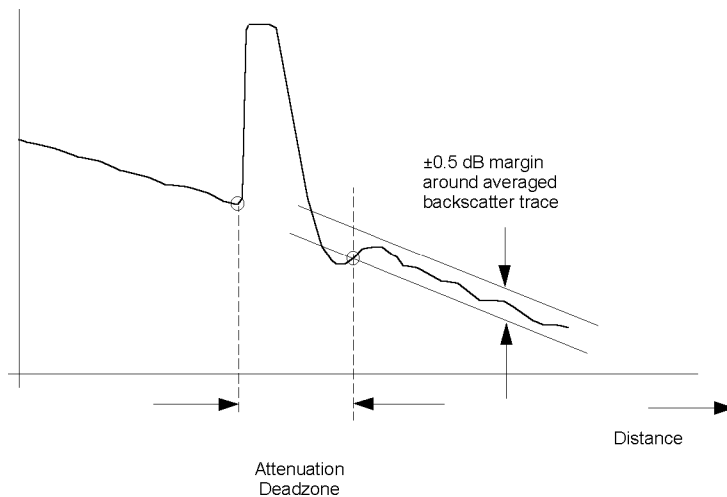
All data presented in the \pm form are to be understood as peak-to-peak variation divided by 2.

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



Definition of Terms

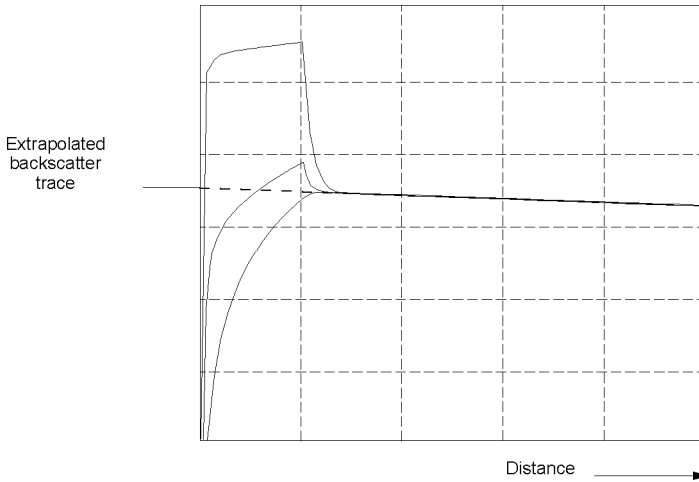
Backscatter coefficient: The ratio of the optical pulse power at the OTDR output to the backscatter power at the near end of the fiber ($z = 0$). This ratio is inversely proportional to the pulse width. It is expressed in dB.

NOTE

A typical value is approximately 50dB for 1 μ s 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

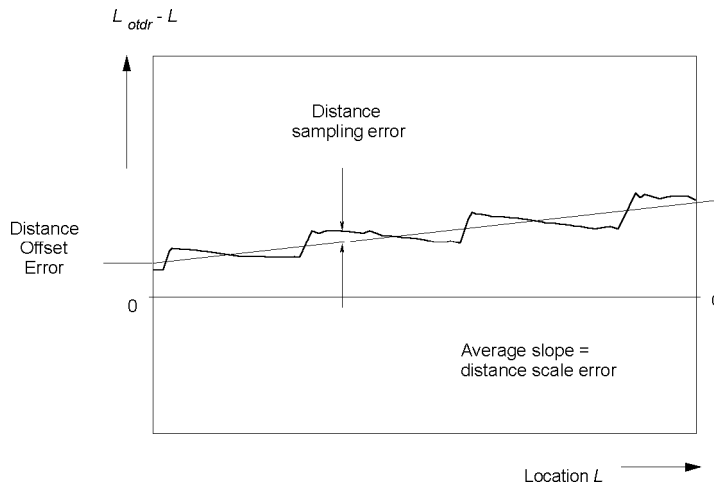


Distance accuracy: The linear sum of the distance offset error, distance scale error multiplied by distance, and distance sampling error. See Figure C-3

Definition of Terms

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 Figure C-3.

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

Definition of Terms

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 Figure C-4. Then calculate the distance offset error by subtracting the measured length from the known length.

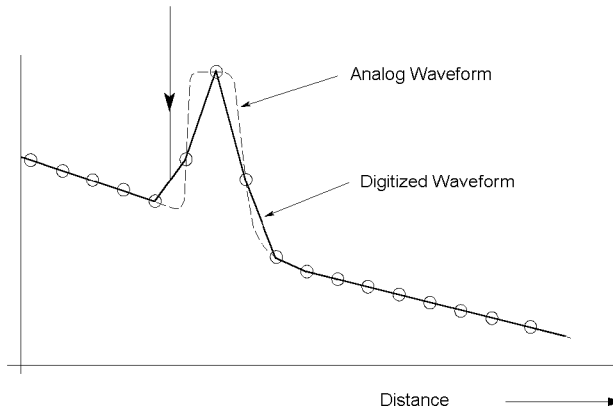
The influence of the finite sample spacing can be excluded by inserting additional fibers. The fiber lengths must be chosen so that they do not coincide with multiples of the distance sample spacing. For each combination, use the total length of fiber to determine the distance offset error.

Finally, average all distance offset results

Figure C-4

Determining the location of a reflective event

Best approximation to location of reflection =
last point on backscatter trace + 1/2 sample spacing



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 Figure C-3

Definition of Terms

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

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).

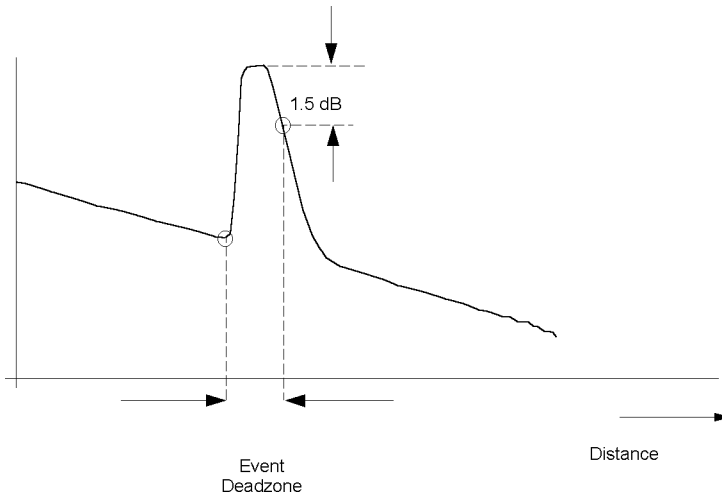
Conditions: Standard single mode fiber, at specified averaging time, ambient temperature, and instrument settings.

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.

Definition of Terms

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

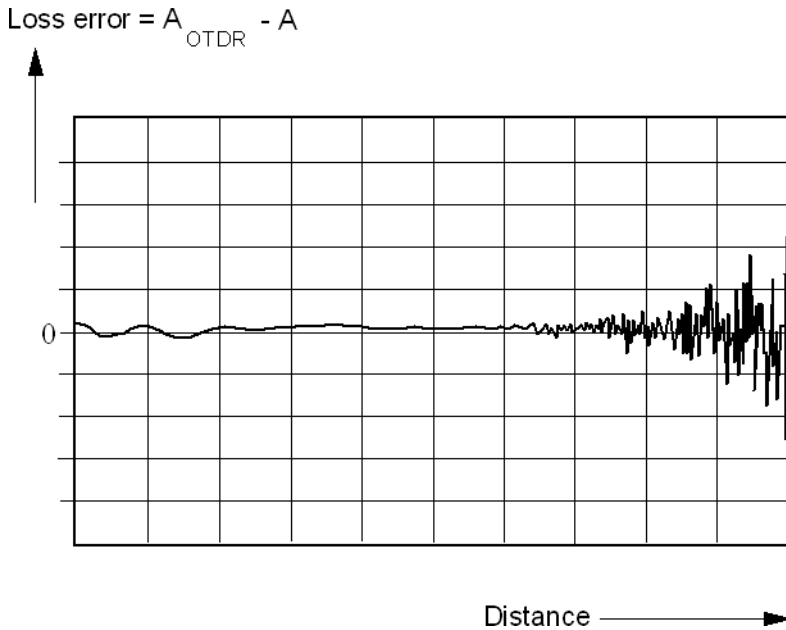
$$\text{Loss error}_{1\text{dB}} = \max \{ A_{OTDR} - A \}$$

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 \rightarrow signal-to-noise ratio is reached, at specified instrument settings.

Definition of Terms

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.

Specifications

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.

C.2 Specifications

Horizontal Parameters

- **Start:** 0 km to 499 km
- **Span:** 1 km to 500 km
- **Read-out resolution:** 10 cm
- **Minimum sample spacing:** 10 cm
- **Refractive index:** 1.00000 to 2.00000
- **Length unit:** km, ft, miles selectable (10 cm resolution)

Specifications

- **Measurement points:** up to 16000

Vertical Parameters

- **Vertical Scale:** 0.1 to 5.0 dB/Div (in 1, 2, 5 mode)
- **Read-out resolution:** 0.001 dB
- **Reflectance range:** -20 dB (typ. -14 dB) to -60 dB
- **Reflectance accuracy:** ± 2 dB
- **Linearity:** 0.05 dB/dB
- **Backscatter coefficient:** 20 – 80 dB at 1 μ s

CW Mode

- **Output power:** < 0 dBm (IEC825 class 1/3A)
- **Stability (15 min., T= const.):** ± 0.05 dB after 10 min. warm-up.

Pulsewidth

You can select any of the following pulsewidths:

- 10ns, 30ns, 100ns, 300ns, 1 μ s, 3 μ s, and 10 μ s (all modules). You can also select 20 μ s for E4317A – E4319A, E4321A, and E4324A.

Output connector

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

NOTE

For other connector types. please contact your local Hewlett-Packard sales office or representative.

Specifications

Automatic setup and analysis

Provided.

Documentation

- **3.5" disc drive (optional):** for 720/1440 kByte Floppy Disk Drive. MS-DOS (double density and high density). Reduced operating temperature of 5°C to 40°C, with 35% to 85% humidity at 40°C.
- **Built-in hard disk:** min. 4500 traces and related instrument settings available.
- **Thermal printer (optional):** Print speed typ. < 40 s while instrument continues to operate. Reduced operating temperature of 5°C to 40°C with 35% to 85% humidity at 40°C.
- **Trace information:** 5 comment labels of up to 15 alpha-numerical characters and 5 comments of up to 41 alpha-numerical characters are provided for each trace.
- **Trace format:** compliant to Bellcore GR-196-CORE Issue 1, OTDR Data Standard.
- **Real time clock and date:** provided.
- **Compare mode:** up to 4 traces can be compared on screen.
- **Instrument settings:** storage and recall of user-selectable instrument settings.

Scan Trace

- **Type of events:** reflective and non-reflective events (minimum detectable loss change 0.05 dB, best case).
- **Max number of events:** 100
- **Threshold for non-reflective events:** 0.0 (disabled) up to 5.0 dB, selectable in 0.01 dB steps.
- **Threshold for reflective events:** -65.0 up to 0.0 dB (disabled), selectable in 0.1 dB steps.

Specifications

- **Threshold for Fiber End:** 0.0 (disabled) up to 40.0 dB.

Display

- **Display points:** 640 x 480 points
- **Update rate:** 3 measurements/second in refresh mode
- **Monochrome-LCD:** 16 cm (6.3")
- **Color-LCD (optional):** 16 cm (6.3")

Interfaces

- **RS232C Capabilities:** all instrument parameters and modes can be programmed.
 - Max. baud rate 19200
 - Handshake functions: no handshake, X on, X off, hardware
 - Used lines: RX, TX, CTS, RTS, GND
- **Centronics:** standard parallel port (SPP)
- **VGA Monitor:** DSUB 9 pin
- **Keyboard:** PS/2 (Mini DIN)
- **Mouse:** PS/2 (Mini DIN)
- **LAN (optional):** RJ-45 connector. Supports TCP/IP and Novell IPX protocols. For data transfer only.
- **HP-IB (optional):** all instrument parameters and modes can be programmed.
 - HP-IB interface function codes: SH1, AH1, T5, L4, SR0, RL1, PP0, DT0, C0

NOTE

There are two free slots which can be used for only two of the DC/LAN/HP-IB options.

General

- **Laser safety class:** 21CFR class 1, IEC825 class 3A.

Appendix C. Specifications

Specifications

- **Recalibration period:** 2 years
- **Dimensions:** 218 mm H, 371 mm W, 305 mm D (8.6" × 14.6" × 12.0")
- **Weight:** net 9 kg (19.8 lbs), including one laser module.

Environmental

- **Storage Temperature:** -40°C to +70°C
- **Operating Temperature:** 0°C to +55°C
- **Humidity:** 95% R.H. from 0°C to +40°C

NOTE

Reduced ranges when printer and/or floppy disk drive are installed.

Power

- **AC:** 100 to 240 V_{rms} ± 10%, 150 VA_{max}, 50 to 60 Hz
- **DC (optional):** 11 to 30 Vdc
- **Battery back-up:** typically 5 years with instrument switched off at 20°C.

C.3 Module Specifications

Optical Performance

Guaranteed specifications unless otherwise noted..

Module	E4311A				E4312A				E4313A			
Central Wavelength	1310 ±15 nm				1550 ±15 nm				1310/1550 ±15 nm			
Applicable Fiber	single-mode				single-mode				single-mode			
Pulsewidth	30 ns	100 ns	1 μs	10 μs	30 ns	100 ns	1 μs	10 μs	30 ns	100 ns	1 μs	10 μs
Dynamic Range¹ [dB]	13	16	22	29	12	15	21	28	13/12	16/15	22/21	29/28
typical	30				30				30/30			
Event Deadzone²	4 m				4 m				4 m			
Attenuation Deadzone³	20 m				30 m				20/30 m			
Attenuation Deadzone⁴	10 m				12 m				10/12 m			

Module	E4314A				E4315A				E4316A			
Central Wavelength	1310 ±15 nm				1550 ±15 nm				1310/1550 ±15 nm			
Applicable Fiber	single-mode				single-mode				single-mode			
Pulsewidth	30 ns	100 ns	1 μs	10 μs	30 ns	100 ns	1 μs	10 μs	30 ns	100 ns	1 μs	10 μs
Dynamic Range¹ [dB]	16	20	28	35	15	19	27	34	16/15	20/19	28/27	35/34
Event Deadzone²	4 m				4 m				4 m			
Attenuation Deadzone³	20 m				30 m				20/30 m			
Attenuation Deadzone⁴	10 m				12 m				10/12 m			

Appendix C. Specifications

Module Specifications

Module	E4317A				E4318A				E4319A			
Central Wavelength	1310 ±15 nm				1550 ±15 nm				1310/1550 ±15 nm			
Applicable Fiber	single-mode				single-mode				single-mode			
Pulsewidth	100 ns	1 μs	10 μs	20 μs	100 ns	1 μs	10 μs	20 μs	100 ns	1 μs	10 μs	20 μs
Dynamic Range¹ [dB]	24	32	39	40	23	31	38	39	24/23	32/31	39/38	40/39
Event Deadzone²	4 m				4 m				4 m			
Attenuation Deadzone³	30 m				40 m				30/40 m			
Attenuation Deadzone⁴	10 m				12 m				10/12 m			

Module	E4321A				E4324A			
Central Wavelength	1625 ±20 nm				1310/1550 ±15 nm			
Applicable Fiber	single-mode				single-mode			
Pulsewidth	100 ns	1 μs	10 μs	20 μs	100 ns	1 μs	10 μs	20 μs
Dynamic Range¹ [dB]	25	31	38	40	28/27	34/33	41/40	42/41
	typical			42				45/43
Event Deadzone²	5 m				4.5 m			
Attenuation Deadzone³	30 m				20/30 m			
Attenuation Deadzone⁴	14 m				10/12 m			

The guaranteed values above are tested specifications. HP OTDR modules have the pulsewidths listed in “Pulsewidth” on page 153.

Distance Accuracy

Offset Error: ± 0.5 m

Scale Error: ± 5 × 10⁻⁵

Sampling Error: ± 0.5 Sample spacing

Distance Accuracy = Offset Error + Scale Error*distance + Sampling Error

Loss/Reflectance Accuracy

Backscatter Measurements⁵: ± 0.05 dB

Appendix C. Specifications

Other Specifications

Reflectance Measurements⁶: (-20 dB to -60 dB): ± 2.0 dB

Notes:

- 1 Measured with a standard single-mode fiber at SNR=1 noise level and with 3 minutes averaging time at 25°C. Optimizing mode: dynamic.
- 2 Reflectance ≤ -35 dB at 10 ns pulsewidth and with span ≤ 4 km, Optimizing mode: resolution.
- 3 Reflectance ≤ -35 dB at 30 ns pulsewidth and with span ≤ 4 km, Optimizing mode: resolution.
- 4 Reflectance ≤ -50 dB at 30 ns pulsewidth and with span ≤ 4 km, Optimizing mode: resolution (typical value).
- 5 SNR ≥ 15 dB and with 1 μ s pulsewidth.

C.4 Other Specifications

Acoustic Noise Emission

For ambient temperature up to 30°C:

$L_p = 50$ dB(A)

$L_w = 5.4$ Bel

Typical operator position, normal operation.

Data are results from type tests per ISO 7779 (EN 27779).

C.5 Declaration of Conformity

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

We declare that the system:

System Name: Optical Time Domain Reflectometer

Trade Number: **HP 8147**

Model Numbers: HP E4310A Mainframe with dedicated modules
HP E43xxA

Options: all

conforms to the following standards:

Safety: IEC 1010-1 (1990)
+ Adm. 1 (1992) + Adm. 2 (1995) EN 61010 (1993)
IEC 825-1 (1993) EN 60825-1 (1994)

EMC: EN 55011 (1991) / CISPR 11 Group 1, Class A¹

EN 50082-1 (1992) consisting of:

IEC 801-2 (1991) ESD 4kV cd, 8kV ad

IEC 801-3 (1992) Radiated Immunity 3 V/m

IEC 801-4 (1988) Fast Transients 0.5kV, 1kV

Supplementary Information

The product herewith complies with the requirements of the

Appendix C. Specifications

Declaration of Conformity

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

This system conforms also to other standards not listed here. If you need further information on conformity, please contact your local Hewlett-Packard Representative.

¹ This system was tested in a typical configuration with HP systems (Type test).

Böblingen, 15 December 1995

Hans Baisch

updated: 1996, 1997, 1998

BID Regulations Consultant

Appendix C. Specifications
Declaration of Conformity

**Single-Mode Module
Performance Tests**

Single-Mode Module Performance Tests

The procedures in this section tests the optical performance of the instrument. The complete specifications to which the HP 8147 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.

General

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).
- Power Meter HP 8153A with Power Sensor HP 81531A,
HP 81532A or HP 81536A.
- Optical Fiber HP 81101AC.
- 4 × Optical Connector Interface HP 81000AI.
- Standard single-mode fiber: length > 20 km.

If you are using slanted output connectors, you need the following additional equipment:

- 81113PC: single-mode patchcord DIN angled-PC
- 81000FI Adapter PC
- 81000UI Universal Interface

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.

General

Test Failure

If the HP 8147 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 HP 8147 can be tested. Appendix C “Specifications” also lists some supplemental characteristics of the HP 8147 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”.

Conventions used in this Appendix

Small capitals are used to indicate elements of the user interface.

- Menu items are shown with small capitals only, for example STANDARD.
- Softkeys are shown in braces, for example {SETTINGS}.
- Front panel keys (“hardkeys”) are shown in brackets, for example [RUN/STOP].

Test I. Dynamic Range

- Pressing the bottom softkey until the appropriate screen appears is written as $\{\rightarrow n/3\}$. For example, $\{\rightarrow 1/3\}$ means that you should press the bottom softkey until you see screen $\{1/3\}$.

D.2 Test I. Dynamic Range

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

NOTE

The specific measurement techniques of the HP 8147 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.

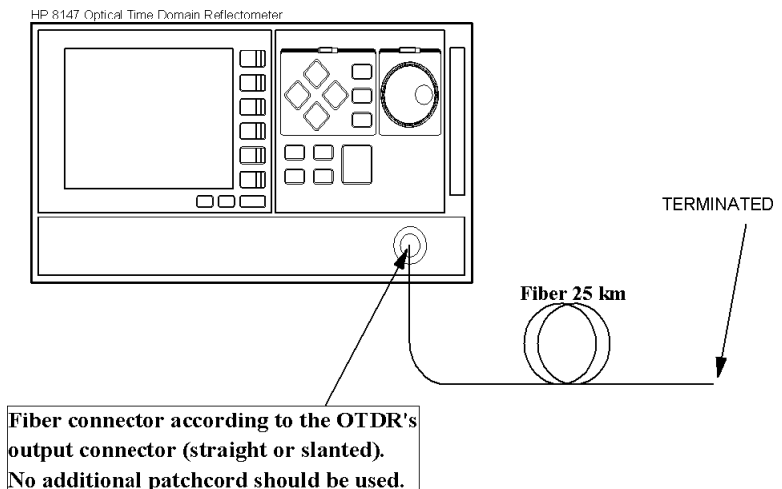


Figure D-1

Dynamic Range Test Setup

Appendix D. Single-Mode Module Performance Tests

Test I. Dynamic Range

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).

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

{→1/3}{SETTINGS} → RECALL SETTINGS → *Default Setting*

NOTE

The default settings will normally be in the file `DEFAULT.SET`.

{SETTINGS} → OPTIMIZE MODE → DYNAMIC

- 3 Set the OTDR to measure 2-pt-loss.

{ANALYSIS} → 2-pt-loss

- 4 Select the required wavelength if a dual wavelength module is installed.

{→2/3}{WLENGTH}, use modify knob → wavelength, press modify knob

NOTE

If you are taking a measurement at 1625 nm (E4321A module only), you must make sure that the correct scatter coefficient is selected (default value is 52.3 dB).

An incorrect scatter coefficient will result in incorrect reflectance values.

- 5 Switch the Center Trace off. Select the Linestyle in dots.

{→1/3}{VIEW}, → Vertical Offset → Center Trace (off)

{VIEW}, → Preferences → Linestyle → Dotted.

- 6 Set the first pulsewidth listed in the Performance Test Form Sheets (see “Performance Test Form Sheets” on page 200).

Appendix D. Single-Mode Module Performance Tests

Test I. Dynamic Range

{→2/3}{PWIDTH}, use modify knob → **PW**, press modify knob.

Table D-1

Module dependent settings for Dynamic Range Test

module	Start	Span	position of marker B	View Start	View End	Viewed distance
	ST	SP	Bpos	Vsta	Vend	V
E4311A, E4312A, E4313A	0 km	80 km	70 km	60 km	80 km	20 km
E4314A, E4315A, E4316A	0 km	80 km	70 km	60 km	80 km	20 km
E4317A, E4318A, E4319A	0 km	80 km	70 km	60 km	80 km	20 km
E4321A, E4324A	0 km	100 km	90 km	80 km	100 km	20 km

- 7** Set the measurement ranges to 0 - 80 km (0 - 100 km if you are using the E4324A module).
 {STARTPOS}, use modify knob → **ST** (from Table D-1), press modify knob.
 {SPAN}, use modify knob → **SP** (from Table D-1: for example, 80 km for the E4316A module), press modify knob.
- 8** Set the averaging time to 3 min.
 {AVGTIME}, use modify knob → 3:00, press modify knob
- 9** Terminate the fiber, start the measurement and wait until measurement stops.
 [RUN/STOP], wait while measuring

NOTE

After measurement has stopped the fiber must not be terminated.

Test I. Dynamic Range

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

[FULL TRACE]

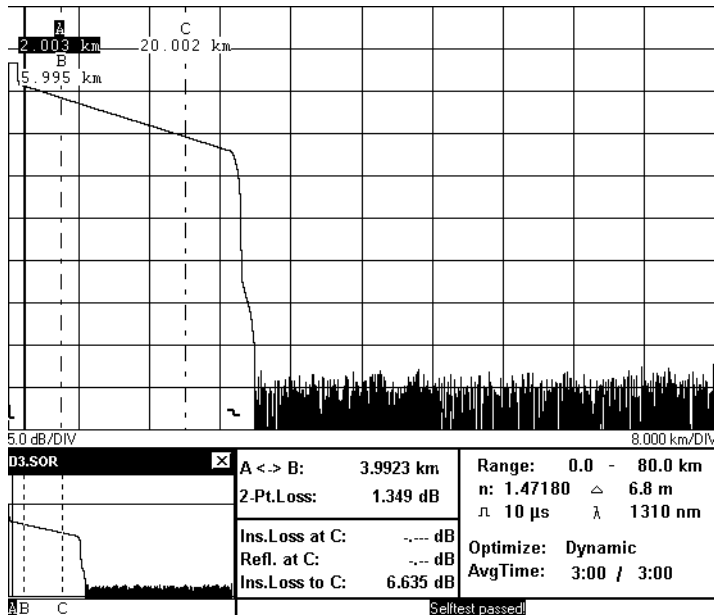


Figure D-2 Dynamic Range Test: Full Trace View

11 Position marker B to the value **Bpos** in Table D-1. View the trace around marker B and zoom the trace around marker B to 2 km/div and 1 dB/div.

This will result in a view distance V of 20 km.

NOTE

You can see the current zoom levels between the trace and the reference tables, at the left and right edges of the trace screen.

{NEXT MARKER} until only marker B is selected, use modify knob \rightarrow **Bpos** (for example 70 km for the E4316A module).
 {AROUND MARKER}

Appendix D. Single-Mode Module Performance Tests

Test I. Dynamic Range

{↔ ZOOM} → 2 km/div

{↑ ZOOM} → 1dB/div.

- 12** Note the value of the sample spacing, Δ (displayed right of the refractive index). Calculate the number of peak samples (dots) from the viewed distance V divided by the sample spacing Δ . Calculate 2% thereof.

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

Example: $PW = 10 \mu s \rightarrow V = 20 km, \Delta = 6.8 m.$

\rightarrow number of peak samples = $20 km / 6.8 m = 2941$

\rightarrow 2% thereof = 59.

- 13** Check out and disregard 2% of the highest peak sample inside the viewed distance V (see Table D-1).

NOTE

To check out 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.

- 14** Position marker B at a point on the trace that equals the 98% Noise Level.

- 15** View the complete trace.

[FULL TRACE]

- 16** Move marker A to the end of the frontreflection on the falling edge, or one digit left or right of it.

$3 \times$ [NEXT MARKER], use modify knob, position marker A on front reflection

- 17** Move marker C to the end of the frontreflection and show the trace around marker C.

$2 \times$ [NEXT MARKER], use modify key, [AROUND MARKER]

- 18** Set the x-axis scale to 500 m/DIV, and the y-axis scale to 0.5 dB/DIV.

[↔ ZOOM] → 500 m/DIV, [↑ ZOOM] → 0.5 dB/DIV

- 19** Move marker C until the frontreflection and the beginning of the

Appendix D. Single-Mode Module Performance Tests

Test I. Dynamic Range

backscatter are displayed.

use modify knob

- 20 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 the backscatter would reach if it was continued back to 0 km from the OTDR, that is if there was no initial reflection.

{→3/3}{V.OFFS.}, use modify knob; confirm with {CONFIRM}.

- 21 Position marker A at the end of the frontreflection on the level of the extrapolated beginning of the backscatter (crossing between frontreflection and horizontal grid line). See Figure D-3.

2 × [NEXT MARKER], use modify knob, position marker A at end of frontreflection

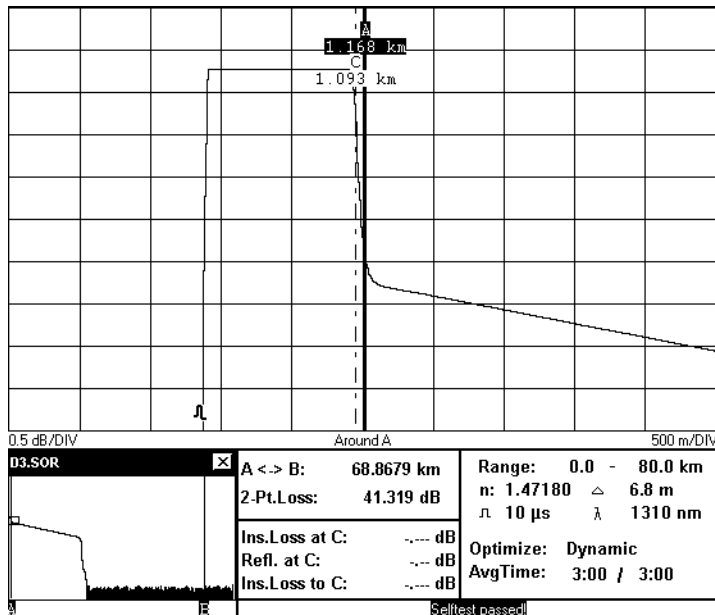


Figure D-3

Dynamic Range Test: Position Marker at End of Frontreflection

Test II. Event Deadzone

- 22 Note 2-pt-loss between A and B as “Dynamic Range_{Peak}” at the actual pulsewidth.
- 23 Calculate the dynamic range as follows:
Dynamic Range = Dynamic Range_{Peak} + 1.9 dB
- 24 Repeat steps 8 to 23 with all pulsewidths described in the Performance Test Form Sheets.

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. $35 \text{ dB} + 3 \text{ dB} = 38 \text{ dB}$.

- 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.

Test II. Event Deadzone

NOTE

If the OTDR's output is of slanted type, use an 81113PC to adapt the Delay Line

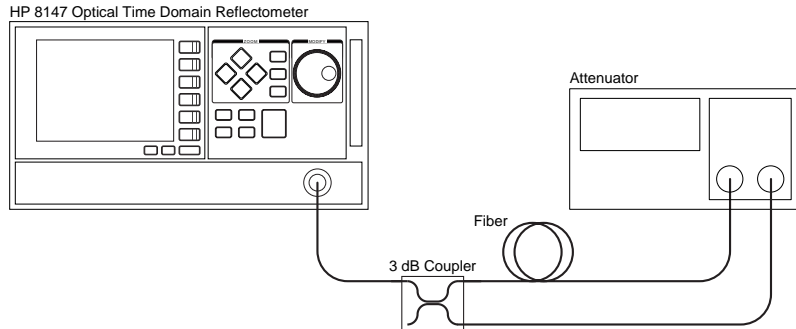


Figure D-4 Event Deadzone Test Setup

- 2 Turn on the OTDR, and after the self-test has passed, recall the default settings and the resolution mode.
 {→1/3}{SETTINGS} → RECALL SETTINGS → *Default Setting*

NOTE

The default settings will normally be in the file **DEFAULT.SET**.

- {SETTINGS} → OPTIMIZE MODE → RESOLUTION
- 3 Set the linestyle to SOLID.
 {VIEW} → PREFERENCES → LINSTYLE → SOLID
- 4 Make sure that the length unit is set to meters.
 {CONFIG} → LENGTH UNIT → METER
- 5 Set the measurement range to 0.00–8.00 km.
 {→2/3} → {STARTPOS}, use modify knob → 0 km, press modify knob,
 {SPAN}, use modify knob → 8 km, press modify knob
- 6 Select the required wavelength.
 {WLENGTH}, use modify knob → wavelength, press modify knob

Test II. Event Deadzone

NOTE

If you are taking a measurement at 1625 nm (E4321A module only), you must make sure that the correct scatter coefficient is selected (default value is 52.3 dB).

An incorrect scatter coefficient will result in incorrect reflectance values.

- 7 Set the pulsewidth to 10 ns.
{PWIDTH}, use modify knob → 10 ns, press modify knob
- 8 Set up the attenuator.
 - a Set λ to the actual wavelength.
 - b Set the attenuation to 38 dB.
 - c Enable the attenuator output.
- 9 On the OTDR start the measurement.
[RUN/STOP]

Appendix D. Single-Mode Module Performance Tests

Test II. Event Deadzone

- 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.

[NEXT MARKER] until marker A is selected, use modify knob

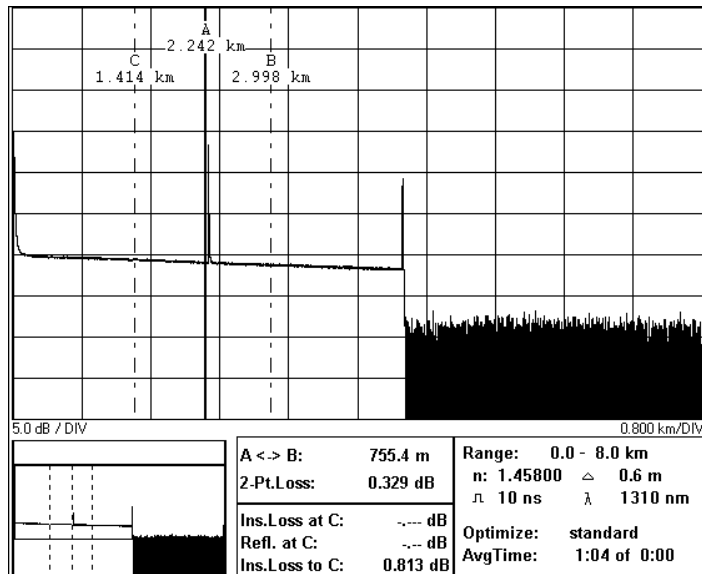


Figure D-5 Event Deadzone Test: Position Marker A

- 11 Stop the measurement.
[RUN/STOP]
- 12 Set the start position close to the position of marker A. The start position should be just before the front edge of the reflection (assuming the reflection is at 2.2 km, the start position at 2 km will be fine).
{STARTPOS}, use modify knob \rightarrow Position of A, press modify knob
- 13 Set the measurement span to start position+2 km.
{SPAN}, use modify knob \rightarrow Start Position+2 km, press modify knob

Test II. Event Deadzone

- 14 Run the measurement.
[RUN/STOP]
- 15 Position marker A as close as possible to the left of the first reflection on the trace.
[NEXT MARKER] until only marker A is selected, use modify knob to set marker A
- 16 Position marker B about 10 m right from marker A.
[NEXT MARKER], use modify knob to set marker B
- 17 Select marker A and marker B and view the trace between the markers.
 $2 \times$ [NEXT MARKER], [AROUND MARKER], use modify knob to center the peak of the reflection between the markers.
- 18 Select Marker A and position the marker at the beginning of the event.
[NEXT MARKER], use modify knob.
- 19 Set the y-axis scale to 0.5 dB/DIV.
[\updownarrow ZOOM] \rightarrow 0.5 dB/DIV

NOTE

You can see the current zoom levels between the trace and the reference tables, at the left and right edges of the trace screen.

- 20 Select Marker C and position the marker at the top of the event.
 $2 \times$ [NEXT MARKER], use modify knob
- 21 Select [AROUND MARKER] and set the x-axis scale to 50 cm/div
[\leftrightarrow ZOOM] \rightarrow 50.0 cm/DIV
- 22 Select the offset adjust level and move the peak of the reflection 3 divisions (1.5 dB) above the center of the graph.
{ $\rightarrow 3/3$ } {V.OFFS}, use modify knob; confirm with {CONFIRM}.

Appendix D. Single-Mode Module Performance Tests

Test II. Event Deadzone

23 Position marker B where the down slope of the reflection crosses the horizontal center line of the graph. See Figure D-6.

3 x [NEXT MARKER], use modify knob

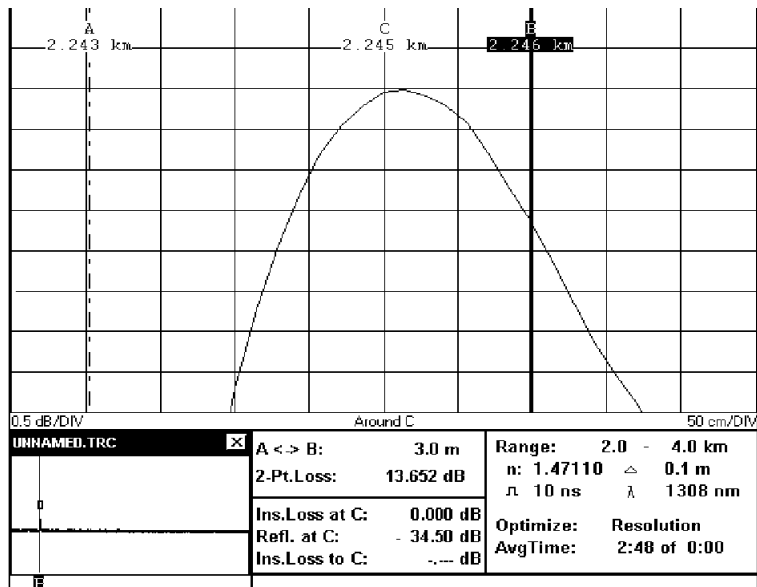


Figure D-6

Event Deadzone Test: Position Marker B

24 Note the width of the reflection in the test record. That is, the distance between the markers A and B.

25 Stop the measurement.

[RUN/STOP]

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. $35 \text{ dB} + 3 \text{ dB} = 38 \text{ dB}$.

- 1 Connect the equipment as for the event deadzone test (see “Test II. Event Deadzone” on page 173).
- 2 Turn on the OTDR, and after the self-test has passed, recall the default settings and the resolution mode.
{→1/3}{SETTINGS} → RECALL SETTINGS → *Default Setting*

NOTE

The default settings will normally be in the file `DEFAULT.SET`.

- {SETTINGS} → OPTIMIZE MODE → RESOLUTION
- 3 Set the linestyle to SOLID.
{VIEW} → PREFERENCES → LINSTYLE → SOLID
 - 4 Make sure that the length unit is set to meters.
{CONFIG} → LENGTH UNIT → METER
 - 5 Set the measurement range to 0.00–8.00 km.
{→2/3}{STARTPOS}, use modify knob → 0 km, press modify knob
{SPAN}, use modify knob → 8 km, press modify knob
 - 6 Set the pulsewidth to 30 ns.
{PWIDTH}, use modify knob → 30 ns, press modify knob
 - 7 Set up the attenuator.
 - a Set λ to the actual wavelength.
 - b Set the attenuation to 38 dB.
 - c Enable the attenuator output.

Test III. Attenuation Deadzone

- 8** On the OTDR start the measurement.
[RUN/STOP]
- 9** 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.
[NEXT MARKER] until marker A is selected, use modify knob
- 10** Stop the measurement.
[RUN/STOP]
- 11** Set the start position close to the position of marker A. The start position should be a little before the front edge of the reflection.
{STARTPOS}, use modify knob → Position of A, press modify knob
- 12** Set the measurement span to start position +2 km.
{SPAN}, use modify knob → Start Position +2 km, press modify knob
- 13** Start the measurement.
[RUN/STOP]
- 14** Position marker A as close as possible to the left of the first reflection on the trace. See Figure D-7.
[NEXT MARKER] until only marker A is selected, use modify knob to set marker A
- 15** Position marker B as close as possible to the right of the first reflection on the trace. See Figure D-7.
[NEXT MARKER], use modify knob to set marker B

Appendix D. Single-Mode Module Performance Tests

Test III. Attenuation Deadzone

16 Position marker C close to marker B. See Figure D-7.

[NEXT MARKER], use modify knob to set marker C

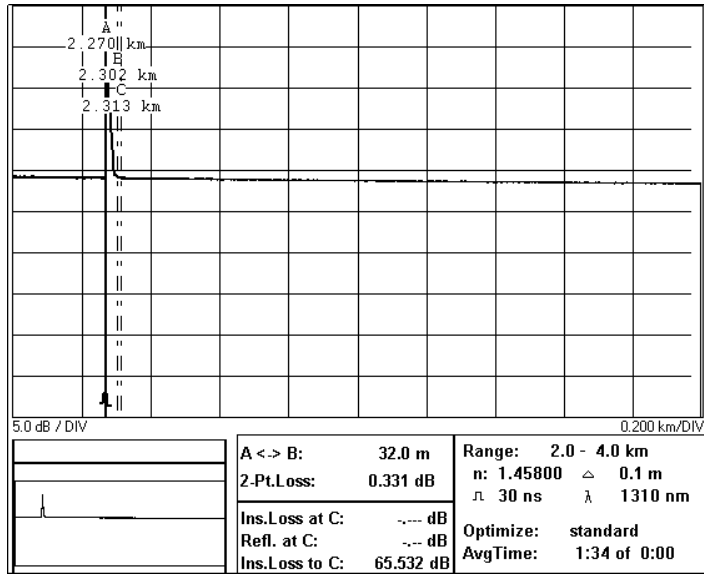


Figure D-7

Attenuation Deadzone Test: Position Marker C

17 View the trace around marker C. Set the y-axis scale to 0.5dB/DIV. Set the x-axis scale to 5.00 m/DIV.

[AROUND MARKER], [\updownarrow ZOOM] \rightarrow 0.5 dB/DIV,

[\leftrightarrow ZOOM] \rightarrow 5.00 m/DIV

NOTE

You can see the current zoom levels between the trace and the reference tables, at the left and right edges of the trace screen.

18 Move the trace so that the backscatter is at the center line of the graph.

{ \rightarrow 1/3}{VIEW} \rightarrow VERTICAL OFFSET \rightarrow ADJUST LEVEL, use modify knob and press modify knob

Appendix D. Single-Mode Module Performance Tests

Test III. Attenuation Deadzone

19 Position marker B on the end of the reflection. See Figure D-8.

The power at marker B should be approximately 0.5 dB above the center of the graph.

$3 \times$ [NEXT MARKER], use modify knob (counter-clockwise)

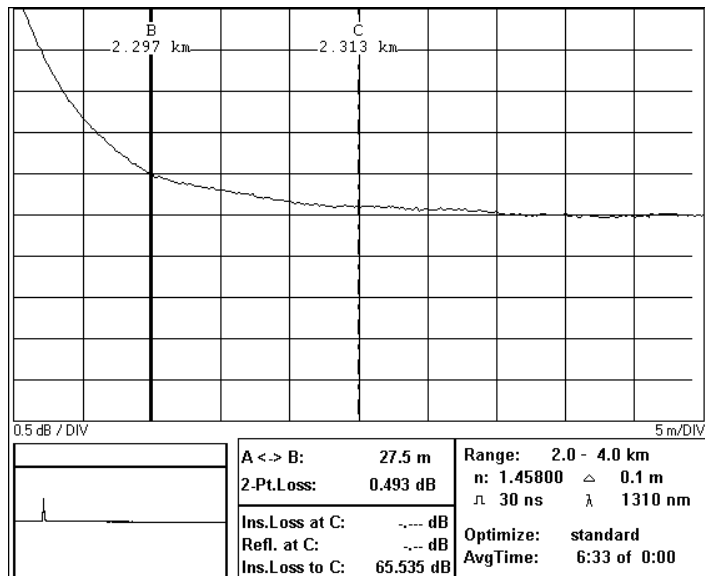


Figure D-8

Attenuation Deadzone Test: Position Marker B at End of Reflection

20 View the trace around marker A. Set the y-axis scale to 0.5 dB/DIV and set the x-axis scale to 5.00 m/DIV.

[FULL TRACE], $3 \times$ [NEXT MARKER], [AROUND MARKER],
 \updownarrow ZOOM \rightarrow 0.5 dB/DIV, [\leftrightarrow ZOOM] \rightarrow 5.00 m/DIV

21 Move the trace so that the backscatter is at the center line of the graph.

{3/3} {V.OFFS}, use modify knob; confirm with {CONFIRM}.

22 Position marker A at the start of the reflection. See Figure D-9.
 use modify knob (counter-clockwise)

Test III. Attenuation Deadzone

NOTE

The best approximation of the start position of the reflection is: last point on backscatter + half sample spacing Δ (see Definition of Terms).

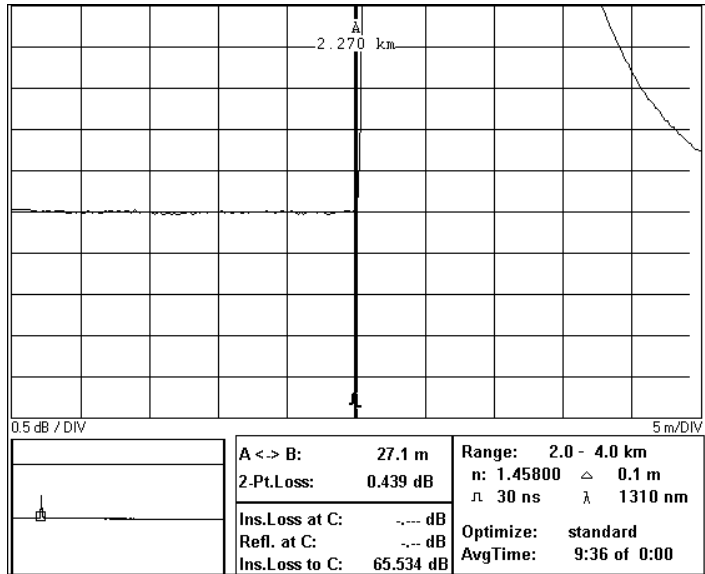


Figure D-9

Attenuation Deadzone Test: Position Marker A at Start of Reflection

23 Stop the measurement.

[RUN/STOP]

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

If the attenuation deadzone is out of specification, ensure that marker B is 0.5 dB above the backscatter. Try to reposition marker B to get a better result.

Test IV. Distance Accuracy

D.5 Test IV. Distance Accuracy

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

NOTE

If the OTDR's output is of slanted type, use an 81113PC to adapt to the Delay Line.

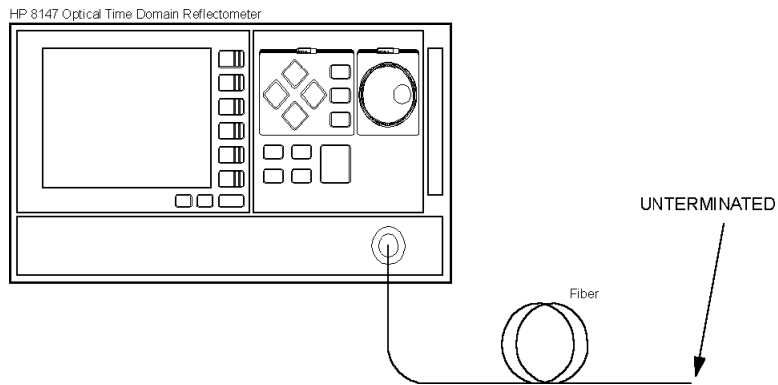


Figure D-10

Distance Accuracy Test Setup

- 2 Turn on the OTDR, and after the self-test has passed, recall the default settings and the resolution mode.
{→1/3}{SETTINGS} → RECALL SETTINGS → *Default Setting*

NOTE

The default settings will normally be in the file **DEFAULT.SET**.

{SETTINGS} → OPTIMIZE MODE → RESOLUTION

- 3 Set the linestyle to SOLID.

{VIEW} → PREFERENCES → LINSTYLE → SOLID

Test IV. Distance Accuracy

- 4 Set the distance unit to meters.
{CONFIG} → LENGTH UNIT → METER
- 5 Select the required wavelength if a dual wavelength module is installed.
{→2/3}{WLENGTH}, use modify knob → wavelength, press modify knob

NOTE

If you are taking a measurement at 1625 nm (E4321A module only), you must make sure that the correct scatter coefficient is selected (default value is 52.3 dB).

An incorrect scatter coefficient will result in incorrect reflectance values.

- 6 Set the measurement range to 0.00–8.00 km
{STARTPOS}, use modify knob → 0 km, press modify knob
{SPAN}, use modify knob → 8 km, press modify knob
- 7 Set the pulsewidth to 1 μ s.
{PWIDTH} → 1 μ s
- 8 Set the Refractive Index to n: 1.45800
{→3/3}{IOR}, use modify knob; confirm with {CONFIRM},
- 9 Start the measurement.
[RUN/STOP]
- 10 Move marker A close to the beginning of the endreflection.
[NEXT MARKER] until only marker A is selected, use modify knob
- 11 Stop the measurement.
[RUN/STOP]
- 12 Set the start position close to the position of marker A. The start position should be before the position of marker A.
{→2/3}{STARTPOS}, use modify knob → position of marker A, press modify knob
- 13 Set the measurement span to start position +2 km.

Appendix D. Single-Mode Module Performance Tests

Test IV. Distance Accuracy

{SPAN}, use modify knob → start position +2 km, press modify knob

14 Start the measurement.

[RUN/STOP]

15 View the complete trace and wait until the backscatter noise has decreased (about 30 s).

[FULL TRACE]

16 Stop the measurement.

[RUN/STOP]

17 Move marker A to the start position (left border of the main screen). See Figure D-11.

[NEXT MARKER] until marker A is selected, use modify knob

18 Move marker B to the beginning of the endreflection. See Figure D-11.

[NEXT MARKER], use modify knob

Appendix D. Single-Mode Module Performance Tests

Test IV. Distance Accuracy

19 Move marker C close to marker B. See Figure D-11.

[NEXT MARKER], use modify knob

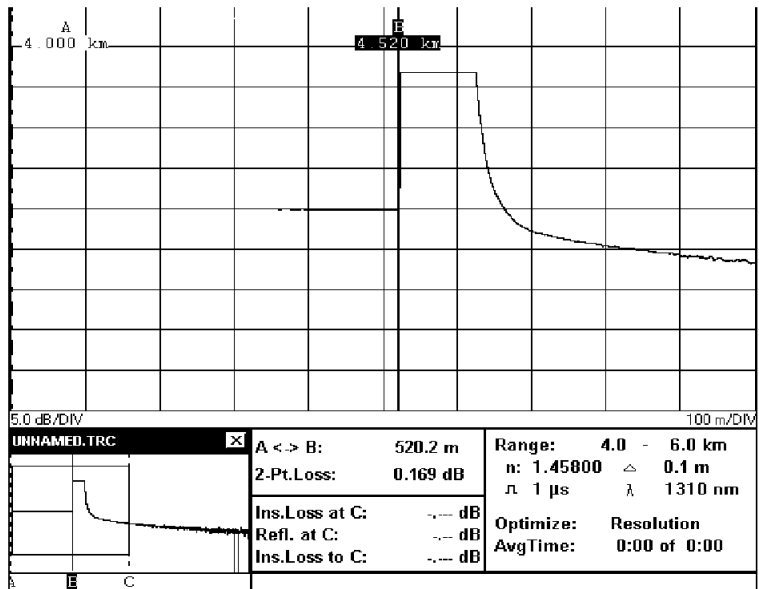


Figure D-11

Distance Accuracy Test: Position Markers

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Test IV. Distance Accuracy

- 20** View the trace around marker C. Set the y-axis scale to 0.1 dB/DIV and the x-axis scale to 0.1 m/DIV. See Figure D-12.
[AROUND MARKER], [\uparrow ZOOM] \rightarrow 0.1 dB/DIV,
[\leftrightarrow ZOOM] \rightarrow 10.0 cm/DIV

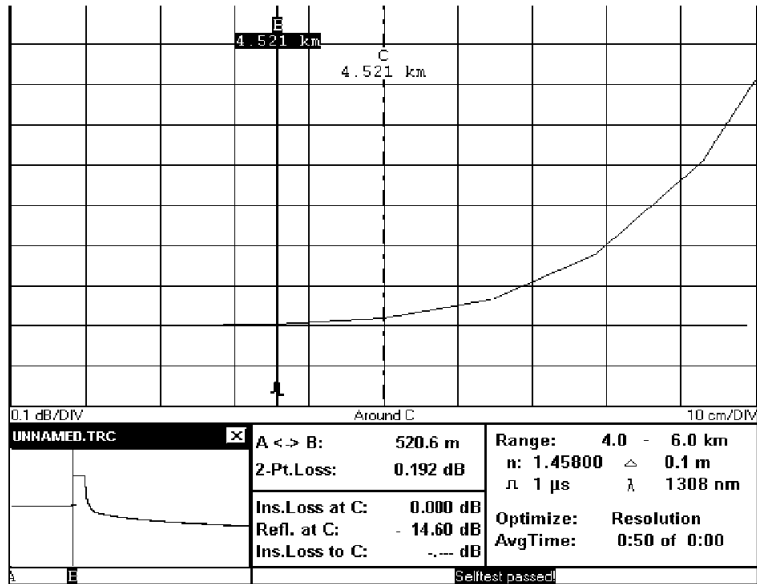


Figure D-12

Distance Accuracy Test: Around Marker View

- 21** Position the beginning of the reflection on the screen.
- Center the reflection in horizontal direction.
Use modify knob
 - Center the reflection in vertical direction.
{ \rightarrow 3/3} {V.OFFS.}, use modify knob; confirm with {CONFIRM}.
- 22** Position marker B on the beginning of the reflection, for this test, the last point on the backscatter. See Figure D-12.
3 \times [NEXT MARKER], use modify knob to move marker B

Test IV. Distance Accuracy

NOTE

The best approximation of the start position of the reflection is: last point on backscatter + half sample spacing Δ (see Definition of Terms)

- 23** Note the distance between markers A and B ($A \leftrightarrow B$) as Measured Distance to the test record.
- 24** Repeat steps 12 to 21 with the pulsewidth set to 100 ns.
- 25** Evaluate the measurement data.
 - a** Note the length of your optical fiber to the test record.

NOTE

If you are using an 81113PC to adapt to the Delay Line, you must add the length of both the patchcord and the Delay Line.

- b** Note the start position to the test record.
- c** Distance accuracy
 The distance accuracy is defined as:

$$\text{Distance accuracy} = \pm (\text{Measured Distance} \times \text{Scale Error} + \text{Offset Error} + \text{Sampling Error})$$

$$\text{Sampling Error} = 1/2 \text{ sample spacing}$$

$$\text{Distance accuracy} = \pm (\text{Fiber Length} \times 5 \times 10^{-5} + 0.5 \text{ m} + 0.05 \text{ m})$$

Measured Distance	Known Fiber Length of Delay Line
Offset Error	$\pm 0.5 \text{ m}$
Scale Error	$\pm 5 \times 10^{-5}$
Sample spacing with the 2km Span	0.1m

The sample spacing is displayed as Δ on the screen. Ensure, that 0.1 m is displayed at the 2 km span. If not, use the displayed Δ as sample spacing.

- 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 Test V. Loss Accuracy

NOTE

A return loss of > 40 dB is required for the attenuator used.

- 1 Connect the equipment as shown in Figure D-13.
 If you are using the HP Recirculating Delay Line, connect port 1 to the attenuator output.
 Make sure that port 2 is properly terminated.
 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).

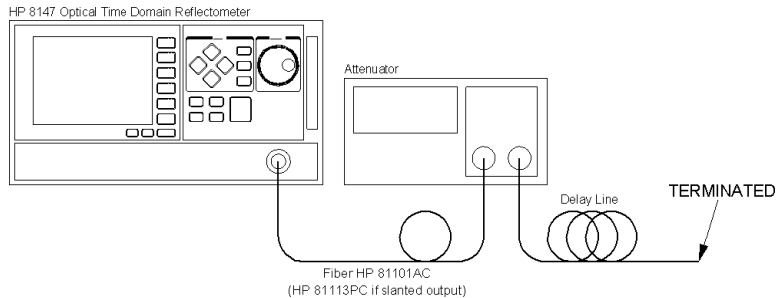


Figure D-13

Loss Measurement Test Setup

- 2 Turn on the OTDR, and after the self-test has passed, recall the default settings and the standard mode.
`{→1/3}{SETTINGS} → RECALL SETTINGS → Default Setting`

NOTE

The default settings will normally be in the file **DEFAULT.SET**.

`{SETTINGS} → OPTIMIZE MODE → STANDARD`

- 3 Set the linestyle to SOLID.
`{VIEW} → PREFERENCES → LINSTYLE → SOLID`

Test V. Loss Accuracy

- 4 Set up the attenuator.
 - a Set λ to the actual wavelength.
 - b Set the attenuation to 0 dB.
 - c Enable the attenuator output.
- 5 On the OTDR set the distance unit to meters.
{CONFIG} → LENGTH UNIT → METER
- 6 Select the required wavelength if a dual wavelength module is installed.
{→2/3}{WLENGTH}, use modify knob → wavelength, press modify knob

NOTE

If you are taking a measurement at 1625 nm (E4321A module only), you must make sure that the correct scatter coefficient is selected (default value is 52.3 dB).

An incorrect scatter coefficient will result in incorrect reflectance values.

-
- 7 Set the measurement range to 0.00–5.00 km.
{STARTPOS}, use modify knob → 0 km, press modify knob
{SPAN}, use modify knob → 5 km, press modify knob
 - 8 Set the pulsewidth to 1 μ s.
{PWIDTH} → 1 μ s
 - 9 Set the averaging time to 3 minutes
{AVG.TIME}, use modify knob → 3:00, press modify knob
 - 10 Terminate the fiber, start the measurement and wait until measurement stops.
[RUN/STOP]
 - 11 Position marker A at 0.0000 km.
[NEXT MARKER] until marker A is selected, use modify knob to move

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Test V. Loss Accuracy

12 Position marker B about in the middle of the backscatter. Note the position of marker B. See Figure D-14.

[NEXT MARKER] until marker B is selected, use modify knob

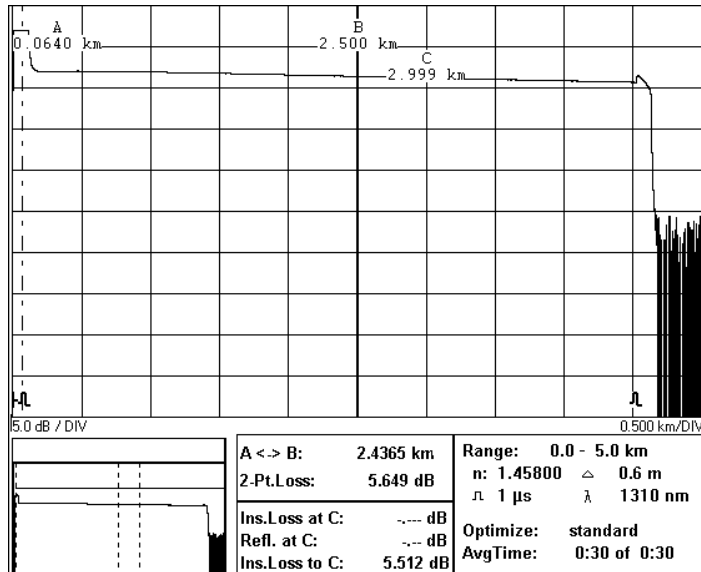


Figure D-14

Loss Accuracy Test: Position Marker B

- 13** Start the measurement and wait until measurement stops.
[RUN/STOP]
- 14** Check that marker A is still set to 0.0000 km.
Note the 2-pt-loss between marker A and marker B as Measured Loss at the actual attenuator setting and step the attenuator up to the next attenuation listed in the test record.
- 15** Repeat steps 12 and 13 for all noted attenuator settings.

Test V. Loss Accuracy

Reference measurement

- 1 Connect the equipment as shown in Figure D-15.
Connect the Power Sensor to the Attenuator Output. Don't change any other component of the setup. If you are using the HP Recirculating Delay Line connect Port 2 to the Power Meter.

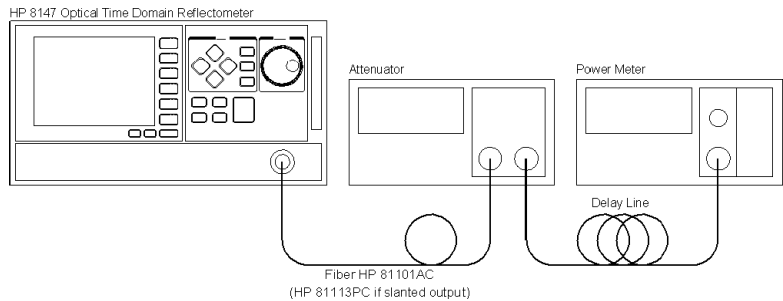


Figure D-15

Loss Accuracy Test: Reference Measurement Setup

- 2 Set up the power meter.
Ensure that the connectors are clean, and that the instrument has warmed up.
 - a Set power meter to measure in dB.
 - b Set actual wavelength.
 - c Set measurement time to 1 s.
- 3 Set up the OTDR to CW mode
{→1/3}{SETTINGS} → MEASUREMENT MODE → CONTINUOUS WAVE
- 4 Set up the attenuator:
 - a Set the attenuation to 0 dB
 - b Disable the attenuator's output.
- 5 Zero the power meter: Press ZERO and wait until zeroing has finished.

Test VI. Reflectance Accuracy

- 6 Enable the attenuator.
- 7 At the power meter press DISP → REF.
- 8 On the attenuator set the attenuation to the next attenuation noted in the test record.
- 9 On the Power Meter read the displayed power and note it as Measured Attenuation at the actual attenuation to the test record.
- 10 Repeat steps 8 and 9 for all attenuations noted in the test record.
- 11 Calculate the backscatter accuracy as described in the test record.

D.7 Test VI. Reflectance Accuracy

- 1 Connect the equipment as shown in Figure D-16.
If you are using the HP Recirculating Delay Line, connect port 2 to the attenuator output and leave port 1 open.

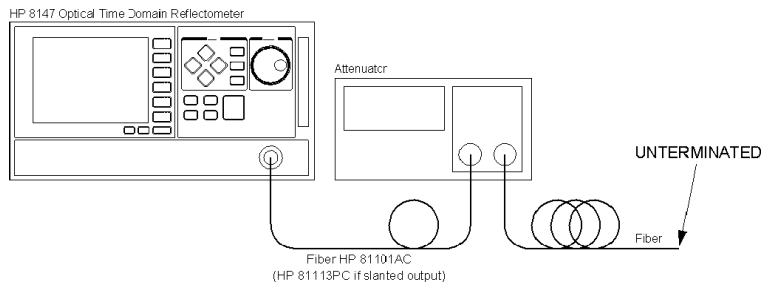


Figure D-16

Reflection Measurement Test Setup

- 2 Turn on the OTDR, and after the self-test has passed, recall the default settings and the standard mode.
{→1/3}{SETTINGS} → RECALL SETTINGS → *Default Setting*

Test VI. Reflectance Accuracy

NOTE

The default settings will normally be in the file DEFAULT.SET.

- {SETTINGS} → OPTIMIZE MODE → STANDARD
- 3** Set the linestyle to SOLID.
{VIEW} → PREFERENCES → LINSTYLE → SOLID
- 4** Set up the optical attenuator.
 - a** Set λ to the actual wavelength.
 - b** Set the attenuation to 6 dB.
 - c** Enable the attenuator output.
- 5** Set the length unit to meters.
{→1/3}{CONFIG} → LENGTH UNIT → METER
- 6** Set the OTDR to analyze reflectance.
{ANALYSIS} → ANALYSE REFLECTANCE
- 7** Select the required wavelength if a dual wavelength module is installed.
{→2/3}{WLENGTH}, use modify knob → wavelength, press modify knob

NOTE

If you are taking a measurement at 1625 nm (E4321A module only), you must make sure that the correct scatter coefficient is selected (default value is 52.3 dB).

An incorrect scatter coefficient will result in incorrect reflectance values.

- 8** Set the measurement range to 0.00–5.00 km
{STARTPOS}, use modify knob → 0 km, press modify knob
{SPAN}, use modify knob → 5 km, press modify knob
- 9** Set the pulsewidth to 1 μ s.
{PWIDTH} → 1 μ s
- 10** Start the measurement.

Test VI. Reflectance Accuracy

[RUN/STOP]

- 11** View the complete trace and wait until the backscatter noise has decreased (about 30 s).

[FULL TRACE]

- 12** Check the endreflection. See Figure D-17. Position marker A in the middle of the frontreflection.

- a** [NEXT MARKER] until A is selected, move marker to frontreflection

Ensure that marker A is on the top of the frontreflection
[AROUND MAKER], move marker

- b** Position marker B in the middle of the endreflection.

[FULL TRACE], [NEXT MARKER], move marker to endreflection, [AROUND MAKER], move marker

- c** Check, that the 2-pt-loss is bigger than 0 dB. If not, increase the attenuation on the attenuator by steps of 1 dB until the 2-pt-loss is bigger than 0 dB.
 - Stop the measurement.
 - Step attenuator up by 1 dB.
 - Start the measurement.

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Test VI. Reflectance Accuracy

- Ensure that 2-pt-loss is bigger than 0 dB. If not, repeat the increasing.

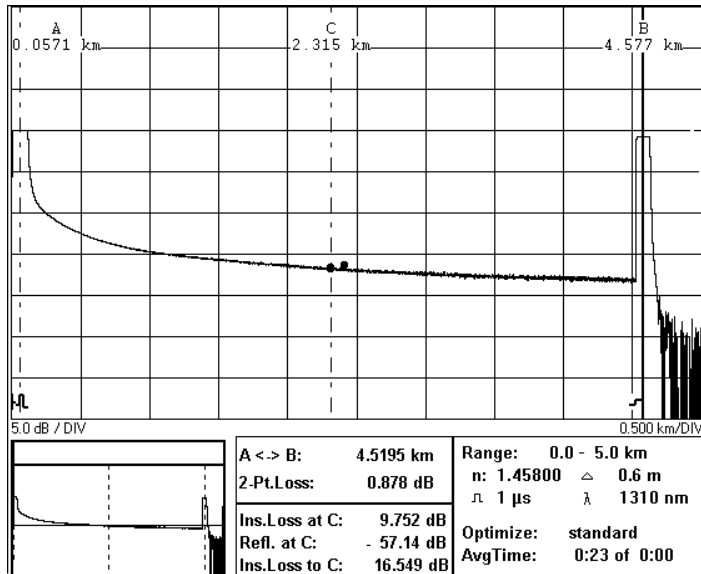


Figure D-17

Reflectance Accuracy Test: Position Markers

13 Select marker C.

[NEXT MARKER]

14 Position marker C at the beginning of the endreflection.

[FULL TRACE], use modify knob

15 Show the trace around marker C and set marker C close to the rising edge of the endreflection.

[AROUND MARKER], use modify knob

16 Set x-axis scale to 20 m/Div and y-axis scale to 5 dB/Div.

[↔ ZOOM] → 20 m/DIV, [↑ ZOOM] → 5 dB/DIV

NOTE

You can see the current zoom levels between the trace and the reference tables, at the left and right edges of the trace screen.

Test VI. Reflectance Accuracy

17 Select the first auxiliary marker. After selecting the auxiliary marker, the marker changes from dot to X.

Press modify knob

18 Position the X as far as possible to the left of the rising edge, but so that it is still displayed on the screen. See Figure D-18.

Use modify knob to position the X

Press modify knob to select the next auxiliary marker, the auxiliary marker, that has been selected, becomes a dot and the now selected auxiliary marker becomes a X

NOTE

There must not be any event between the X and the right edge of the endreflection.

19 Position the X at the beginning of the endreflection.

See Figure D-18.

Use modify knob to position the X

Press modify knob to select the next auxiliary marker

Appendix D. Single-Mode Module Performance Tests

Test VI. Reflectance Accuracy

- 20** Position the X as far as possible after the rising edge, but ensure, that it is before the falling edge and that it is still displayed on the screen. See Figure D-18.

Use modify knob to position the X

Press modify knob to select marker C

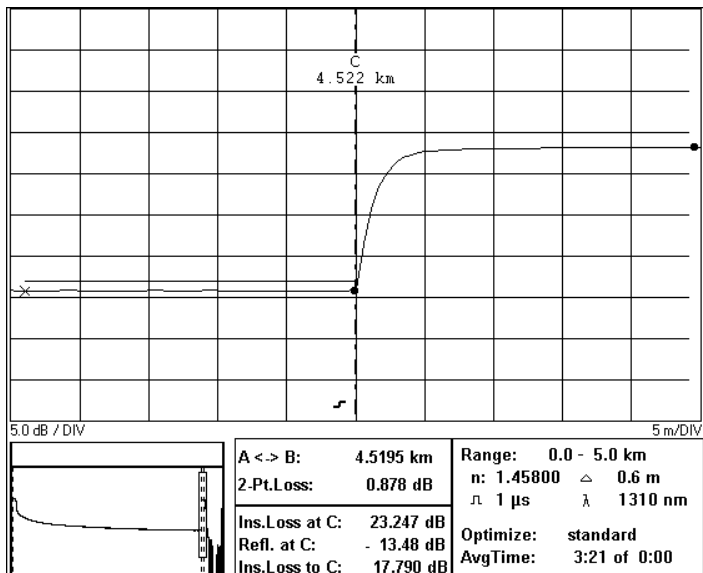


Figure D-18

Reflectance Accuracy Test: Position Auxiliary Markers

- 21** Stop the measurement.

[RUN/STOP]

- 22** Note the “Reflection at C” as $\text{Reflection}_{0\text{dB}}$ in the test record.

- 23** On the attenuator step the attenuation up by 2 dB.

- 24** Start the measurement.

[RUN/STOP]

Performance Test Form Sheets

25 Show the trace around marker C and wait until the backscatter noise has decreased (about 30 s). Ensure, that marker C and its auxiliary markers (dots) are correctly placed.

[AROUND MARKER]

26 Note the “Reflection at C” as $\text{Reflection}_{2\text{dB}}$ in the test record.

D.8 Performance Test Form Sheets

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

Appendix D. Single-Mode Module Performance Tests
Performance Test Form Sheets

Performance Test for the HP 8147 E4310 with Single-mode Modules

Page 1 of 11

Test Facility:

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

Model: **E4310A**

Serial No. _____ Ambient temperature _____ °C
Options _____ Relative humidity _____ %
Firmware Rev. _____ Line frequency _____ Hz
Model HP _____ Module

Serial No. _____

Special Notes:

Appendix D. Single-Mode Module Performance Tests
Performance Test Form Sheets

Performance Test for the HP 8147 E4310 with Single-mode Modules

Model HP _____ **Module** _____ **Report No.** _____ **Date** _____ **Page 2 of 11**

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. Power Meter	_____	_____	__ / __ / __
4. _____	_____	_____	__ / __ / __
5. _____	_____	_____	__ / __ / __
6. _____	_____	_____	__ / __ / __
7. _____	_____	_____	__ / __ / __
8. _____	_____	_____	__ / __ / __
9. _____	_____	_____	__ / __ / __
10. _____	_____	_____	__ / __ / __
11. _____	_____	_____	__ / __ / __
12. _____	_____	_____	__ / __ / __
13. _____	_____	_____	__ / __ / __
14. _____	_____	_____	__ / __ / __

Appendix D. Single-Mode Module Performance Tests
Performance Test Form Sheets

Performance Test for the HP 8147 E4310 with Single-mode Modules

Model HP _____ **Module** _____ **Report No.** _____ **Date** _____ **Page 3 of 11**

No. Test Description

I. Dynamic Range 1310 nm Wavelength

Pulsewidth	Dynamic Range _{98%} dB	Dyn Range = Dyn Range _{98%} + 1.9dB dB	Minimum Specification				Meas. Uncertainty dB
			E4311A E4313A	E4314A E4316A	E4317A E4319A	E4324A	
20 μs	_____	_____	<i>n/a</i>	<i>n/a</i>	40	42	_____
10 μs	_____	_____	29	35	39	41	_____
1 μs	_____	_____	22	28	32	34	_____
100 ns	_____	_____	16	20	24	28	_____
30 ns	_____	_____	13	16	<i>n/a</i>	<i>n/a</i>	_____

II. Event Deadzone 1310 nm Wavelength

Return Loss ≥ 35dB Conditions Meas. Span. 2km Pulsewidth 10ns	Event Deadzone	Max Spec	Meas. Uncertainty
E4311A, E4313A, E4314A, E4316A	_____ m	4 m	_____ m
E4317A, E4319A	_____ m	4 m	_____ m
E4324A	_____ m	4.5 m	_____ m

Appendix D. Single-Mode Module Performance Tests
Performance Test Form Sheets

Performance Test for the HP 8147 E4310 with Single-mode Modules

Model HP _____ **Module** _____ **Report No.** _____ **Date** _____ **Page 4 of 11**

No. Test Description

III. Attenuation Deadzone 1310 nm Wavelength

Maximum Specification					
Attenuation Deadzone	E4311A, E4313A, E4314A, E4316A	E4317A, E4319A	E4324A	Meas. Uncertainty	
m	m	m	m	m	
Return Loss \geq 35dB					
Conditions:					
Meas. Span. 2km					
Pulsewidth 30ns	_____ 20	30	20	_____	

IV. Distance Accuracy 1310 nm Wavelength

Fiber Length: _____ m Sample Spacing: _____ m (as Δ on the screen)					
Start Position: _____ m					
Distance Accuracy = (Fiber Length x Scale Error + Offset + 1/2 Sample Spacing)					
Distance Accuracy = (_____ m x Error + _____ m)					
Distance Accuracy = _____ m 5×10^{-5} + 0.5 m					
Minimum Distance = Fiber Length - Start Position - Distance Accuracy					
Maximum Distance = Fiber Length - Start Position + Distance Accuracy					
Meas.Span	Pulsewidth	Minimum Distance	Measured Distance	Maximum Distance	Meas. Uncertainty
4 to 6 km		m	m	m	m
	1 μ s	_____	_____	_____	_____
	100 ns	_____	_____	_____	_____

Appendix D. Single-Mode Module Performance Tests
Performance Test Form Sheets

Performance Test for the HP 8147 E4310 with Single-mode Modules					
Model HP _____	Module _____	Report No. _____	Date _____	Page 5 of 11	
No. Test Description					
V. Loss Measurement 1310 nm Wavelength					
	Attenuator Settings	Measured Loss	Measured Attenuator Loss	Loss Accuracy	Specification
					Meas. Uncertainty
	Position of Marker B: _____ km				
		dB	dB		
a.	0	_____	Ref = 0dB		
b.	1	_____	_____		
c.	2	_____	_____		
d.	3	_____	_____		
e.	4	_____	_____		
f.	5	_____	_____		
		Δ loss	Δ Att.	Δ loss - Δ Att.	
		dB	dB	dB	
	[b.] - [a.]	_____	_____	_____	± 0.05 dB
	[c.] - [b.]	_____	_____	_____	± 0.05 dB
	[d.] - [c.]	_____	_____	_____	± 0.05 dB
	[e.] - [d.]	_____	_____	_____	± 0.05 dB
	[f.] - [e.]	_____	_____	_____	± 0.05 dB
					_____ dB
VI. Reflection Measurement 1310 nm Wavelength					
	Reflectance Accuracy ± 2.0 dB	Minimum Reflection	Measured Reflection	Maximum Reflection	Meas. Uncertainty
	Conditions:	dB	dB	dB	dB
	Pulsewidth: 1 μ s				
	Endreflection: 14.7 dB				
	Reflection _{0dB}	12.7	_____	16.7	
	Reflection _{2dB}	12.7	_____	16.7	_____

Appendix D. Single-Mode Module Performance Tests
Performance Test Form Sheets

Performance Test for the HP 8147 E4310 with Single-mode Modules

Model HP _____ **Module** _____ **Report No.** _____ **Date** _____ **Page 6 of 11**

No. Test Description

I. Dynamic Range 1550 nm Wavelength

Pulsewidth	Dynamic Range _{98%}	Dyn Range = Dyn Range _{98%} + 1.9dB	Minimum Specification				Meas. Uncertainty
			E4312A E4313A	E4315A E4316A	E4318A E4319A	E4324A	
	dB	dB	dB	dB	dB	dB	dB
20 μs	_____	_____	<i>n/a</i>	<i>n/a</i>	39	41	_____
10 μs	_____	_____	28	34	38	40	_____
1 μs	_____	_____	21	27	31	33	_____
100 ns	_____	_____	15	19	23	27	_____
30 ns	_____	_____	12	15	<i>n/a</i>	<i>n/a</i>	_____

II. Event Deadzone 1550 nm Wavelength

Return Loss ≥ 35dB	Event Deadzone	Max Spec	Meas. Uncertainty
Conditions Meas. Span. 2km Pulsewidth 10ns			
E4312A, E4313A, E4315A, E4316A	_____ m	4 m	_____ m
E4318A, E4319A	_____ m	4 m	_____ m
E4324A	_____ m	4.5 m	_____ m

Appendix D. Single-Mode Module Performance Tests
Performance Test Form Sheets

Performance Test for the HP 8147 E4310 with Single-mode Modules

Model HP _____ **Module** _____ **Report No.** _____ **Date** _____ **Page 7 of 11**

No. Test Description

III. Attenuation Deadzone 1550 nm Wavelength

Maximum Specification				
Attenuation Deadzone	E4312A, E4313A, E4315A, E4316A	E4318A E4319A	E4324A	Meas. Uncertainty
m	m	m	m	m
Return Loss \geq 35dB				
Conditions:				
Meas. Span. 2km				
Pulsewidth 30ns	_____ 30	40	30	_____

IV. Distance Accuracy 1550 nm Wavelength

Fiber Length: _____ m		Sample Spacing: _____ m (as Δ on the screen)			
Start Position: _____ m					
Distance Accuracy = (Fiber Length x		Scale Error + Offset	+ 1/2 Sample Spacing)		
Distance Accuracy = (_____ m x		Error	+ _____ m)		
Distance Accuracy = _____ m		5×10^{-5}	+ 0.5 m		
Minimum Distance = Fiber Length - Start Position - Distance Accuracy					
Maximum Distance = Fiber Length - Start Position + Distance Accuracy					
Meas.Span	Pulsewidth	Minimum Distance	Measured Distance	Maximum Distance	Meas. Uncertainty
4 to 6 km		m	m	m	m
	1 μ s	_____	_____	_____	_____
	100 ns	_____	_____	_____	_____

Appendix D. Single-Mode Module Performance Tests
Performance Test Form Sheets

Performance Test for the HP 8147 E4310 with Single-mode Modules

Model HP _____ **Module** _____ **Report No.** _____ **Date** _____ **Page 8 of 11**

No. Test Description

V. Loss Measurement 1550 nm Wavelength

Attenuator Settings	Measured Loss	Measured Attenuator Loss	Loss Accuracy	Specification	Meas. Uncertainty
Position of Marker B: _____ km					
	dB	dB			
a. 0	_____	Ref = 0dB			
b. 1	_____	_____			
c. 2	_____	_____			
d. 3	_____	_____			
e. 4	_____	_____			
f. 5	_____	_____			
	Δ loss	Δ Att.	Δ loss - Δ Att.		
	dB	dB	dB		
[b.] - [a.]	_____	_____	_____	± 0.05 dB	
[c.] - [b.]	_____	_____	_____	± 0.05 dB	
[d.] - [c.]	_____	_____	_____	± 0.05 dB	
[e.] - [d.]	_____	_____	_____	± 0.05 dB	
[f.] - [e.]	_____	_____	_____	± 0.05 dB	
					_____ dB

VI. Reflection Measurement 1550 nm Wavelength

Reflectance Accuracy ± 2.0 dB	Minimum Reflection	Measured Reflection	Maximum Reflection	Meas. Uncertainty
Conditions:	dB	dB	dB	dB
Pulsewidth: 1 μ s				
Endreflection: 14.7 dB				
Reflection _{0dB}	12.7	_____	16.7	
Reflection _{2dB}	12.7	_____	16.7	_____

Appendix D. Single-Mode Module Performance Tests
Performance Test Form Sheets

Performance Test for the HP 8147 E4310 with Single-mode Modules

Model HP _____ **Module** _____ **Report No.** _____ **Date** _____ **Page 9 of 11**

No. Test Description

I. Dynamic Range 1625 nm Wavelength

Pulsewidth	Dynamic Range _{98%}	Dyn Range = Dyn Range _{98%} + 1.9dB	Minimum Specification	Meas. Uncertainty
			E4321A	
	dB	dB	dB	dB
20 μs	_____	_____	40	_____
10 μs	_____	_____	38	_____
1 μs	_____	_____	31	_____
100 ns	_____	_____	25	_____
30 ns	_____	_____	<i>n/a</i>	_____

II. Event Deadzone 1625 nm Wavelength

Return Loss ≥ 35dB	Event Deadzone	Max Spec	Meas. Uncertainty
Conditions Meas. Span. 2km Pulsewidth 10ns			
E4321A	_____ m	5 m	_____ m

Appendix D. Single-Mode Module Performance Tests
Performance Test Form Sheets

Performance Test for the HP 8147 E4310 with Single-mode Modules

Model HP _____ **Module** _____ **Report No.** _____ **Date** _____ **Page 10 of 11**

No. Test Description

III. Attenuation Deadzone 1625 nm Wavelength

Maximum Specification		
Attenuation Deadzone	E4321A	Meas. Uncertainty
m	m	m
Return Loss \geq 35dB		
Conditions:		
Meas. Span. 2km		
Pulsewidth 30ns _____	30	_____

IV. Distance Accuracy 1625 nm Wavelength

Fiber Length: _____ m		Sample Spacing: _____ m (as Δ on the screen)			
Start Position: _____ m					
Distance Accuracy = (Fiber Length x		Scale Error + Offset	+ 1/2 Sample Spacing)		
Distance Accuracy = (_____ m x		Error	+ _____ m)		
Distance Accuracy = _____ m		5×10^{-5}	+ 0.5 m		
Minimum Distance = Fiber Length - Start Position - Distance Accuracy					
Maximum Distance = Fiber Length - Start Position + Distance Accuracy					
Meas.Span	Pulsewidth	Minimum Distance	Measured Distance	Maximum Distance	Meas. Uncertainty
4 to 6 km	1 μ s	_____	_____	_____	_____
	100 ns	_____	_____	_____	_____

Appendix D. Single-Mode Module Performance Tests
Performance Test Form Sheets

Performance Test for the HP 8147 E4310 with Single-mode Modules

Model HP _____ **Module** _____ **Report No.** _____ **Date** _____ **Page 11 of 11**

No. Test Description

V. Loss Measurement 1625 nm Wavelength

Attenuator Settings	Measured Loss	Measured Attenuator Loss	Loss Accuracy	Specification	Meas. Uncertainty
Position of Marker B: _____ km					
	dB	dB			
a. 0	_____	_____	Ref = 0dB		
b. 1	_____	_____			
c. 2	_____	_____			
d. 3	_____	_____			
e. 4	_____	_____			
f. 5	_____	_____			
	Δ loss	Δ Att.	Δ loss - Δ Att.		
	dB	dB	dB		
[b.] - [a.]	_____	_____	_____	± 0.05 dB	
[c.] - [b.]	_____	_____	_____	± 0.05 dB	
[d.] - [c.]	_____	_____	_____	± 0.05 dB	
[e.] - [d.]	_____	_____	_____	± 0.05 dB	
[f.] - [e.]	_____	_____	_____	± 0.05 dB	
					_____ dB

VI. Reflection Measurement 1625 nm Wavelength

Reflectance Accuracy ± 2.0 dB	Minimum Reflection	Measured Reflection	Maximum Reflection	Meas. Uncertainty
Conditions:	dB	dB	dB	dB
Pulsewidth: 1 μ s				
Endreflection: 14.7 dB				
Reflection _{0dB}	12.7	_____	16.7	
Reflection _{2dB}	12.7	_____	16.7	_____

Appendix D. Single-Mode Module Performance Tests
Performance Test Form Sheets

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. If there is a need to use an index matching compound, use only HP index matching oil (part number 8500-4922). 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 HP model 8147A 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/Front-Panel Connectors

- 1** To clean the instrument front 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.

Cleaning Connector Interfaces

- 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.

Cleaning Detector Windows

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.

Appendix E. Cleaning Procedures
Cleaning Detector Lens Interfaces

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 then when above procedure does not help or if the dirt is caused by oil or fat.

Error Codes

Error Codes

This appendix provides information on all display and remote error messages.¹

F.1 Display Error Messages

Activate Marker C First

The selected function (ADD EVENT, ADD LANDMARK, MODIFY LANDMARK, DELETE LANDMARK, or DELETE EVENT) failed because another marker than marker C is currently active.

The active marker is shown as a solid line with its title inverted. Press the NEXT MARKER hardkey to activate marker C.

Analyze Needs Two Traces

You need two traces to perform subtract measurement.

Load the two measurements. Close any other loaded traces.

Analyze Needs Two Traces With Event Tables

You need exactly two traces with valid event tables to perform two-way measurement.

Load the two measurements, made from both sides of the fiber. Close any other loaded traces. If an event table is not available, select ANALYSIS – SCAN TRACE to build one.

ATTENTION: There may be Problems by Porting this File to Another System

You have entered a file name that does not meet the DOS specifications (8 characters for the file name, 3 characters for the extension). This may lead to problems if you port the file to a DOS-PC.

Averaging Time Cannot Be Set In Refresh Mode

You cannot set the averaging time while the instrument is in refresh mode.

If you want to do averaged measurements, change the measurement mode first.

Display Error Messages

Battery Low, Print Cancelled

DC power goes down, printing is stopped, since the printer consumes a lot of power.

CRC Error

The cyclic redundancy check (CRC) for the opened file failed. The file is damaged and cannot be loaded.

Try another file. If the error occurs again, try another diskette or contact the nearest Hewlett-Packard Service Office to check the hard disk.

Error Reading File

A general error in reading a file appeared.

Try another file. If the error occurs again, try another diskette or contact the nearest Hewlett-Packard Service Office to check the hard disk.

File Exists

The entered name for a trace or macro file already exists. You cannot overwrite the file.

Enter another filename or delete the existing file.

File Name May Be Too Long

You entered a file name longer than 5 characters. The OTDR automatically appends `_nn.sor` in automatic file name generation (SAVE hardkey or FILE – SAVE). The resulting file name will not meet the DOS specifications.

General Printer Error

A general printer error occurred.

Check the printer and try again or turn off and on the instrument.

Display Error Messages

Illegal Filename

The entered file name is no valid file name.

File names must not contain a backslash.

Illegal Filename or Drive Not Ready

A file could not be saved. Reasons may be an invalid file name, an invalid drive or directory specification, or a defect drive.

Landmark Already Exists

You tried to add a landmark at a position where there already exists a landmark.

Use ANALYSIS – LANDMARK – MODIFY to modify an existing landmark.

Macro Error

During the execution of a macro, a syntax error was detected.

See the user's guide for a complete description of the macro commands.

Make a Measurement First

The selected function (for example, editing partial refractive index, editing partial scatter coefficient, saving a file) is not available unless there is a valid measurement.

Run a measurement and try again.

Name Too Long

The entered name or label is too long.

Consider the following limits:

directory:	44
file name:	25
setting label:	8
landmark:	51
trace info label:	15

trace info: 41

No Event Next to Marker C

DELETE EVENT failed because there is no event near marker C.

Place marker C at the event that you want to delete. You can also use the event table to select the event.

No Event Table Found

DELETE EVENT failed because there is no valid event table.

Run the scan-trace algorithm to build the event table (ANALYZE – SCAN TRACE).

No Landmark Next to Marker C

Modifying or deleting a landmark failed because there is no landmark near marker C.

Place marker C at the landmark that you want to modify or delete. You can also use the event table to select the landmark.

Nothing Selected

In a select-files dialog, you have pressed the CONFIRM softkey before selecting at least one file.

Select a file first or press the CANCEL softkey to close the dialog box.

Printer Door Closed

The printer door is closed. The actual printout was cancelled.

Open the printer door and start the print again.

Printer Not Ready

The printer is not ready. The actual printout was cancelled.

Check the printer and start the print again.

Display Error Messages

Printer Out of Paper

The printer has run out of paper. The actual printout was cancelled.

Change the paper roll and start the print again.

Printer Port Could Not Be Opened

The printing could not be started because the printer port could not be opened.

Check the printer and turn off and on the instrument. If the error occurs again, contact the nearest Hewlett-Packard Service Office to check the printer port.

Problems With Intermediate File Detected

During the printing there appeared problems with an intermediate file detected. The actual printout was cancelled.

Check the printer and turn off and on the instrument. If the error occurs again, contact the nearest Hewlett-Packard Service Office to check the hard disk.

Selected File Could Not Be Printed

The selected file could not be printed.

Try to print another file or check the printer.

Stop Measurement First

The selected function (for example, changing measurement parameters) is not available while a measurement is running.

Stop the measurement and try again.

Stop Scantrace First

The selected function (for example, adding or deleting events, editing refractive indexes) is not available, while the Scan-Trace algorithm is running.

Wait until the algorithm has finished.

Display Error Messages

Too Many Different Indexes

You cannot enter partial refractive indexes or scatter coefficients for more than 20 different sections.

Unable to Copy All Files

Not all the selected files could be copied. Maybe some of the files already exist and could not be overwritten.

Try to copy single files.

Unable to Create Directory

A directory could not be created. Maybe the directory name is invalid.

Directory names may be up to 44 characters long.

Unable to Delete All Files

Not all the selected files could be deleted.

Try to delete single files.

Unable to Find Events

The Scan-Trace algorithm could not find any events.

To increase the resolution, you can select a smaller pulsewidth or let the OTDR optimize for resolution.

Unable to Open File

A general error in opening macro file appeared.

Try another file. If the error occurs again, try another diskette or contact the nearest Hewlett-Packard Service Office to check the hard disk.

Unable to Play Macro

You cannot activate a macro while a macro is already running.

Stop the running macro first.

Display Error Messages

Unable to Read Directory

A directory could not be read after you changed to it.

Change to another directory and try again. If the error occurs again, try another diskette or contact the nearest Hewlett-Packard Service Office to check the hard disk.

Unable to Set Pulsewidth

The pulsewidth set in the executed macro is not valid.

Valid values for the pulsewidth are 10 ns, 30 ns, 100 ns, 300 ns, 1 s, 3 s, 10 s.

Unable to Set Start mm

The start position set in the executed macro is not valid.

The start position has to be greater than 0 and less than the currently set stop position.

Unable to Set Wavelength

The wavelength set in the executed macro is not valid.

Valid values for the wavelength depend on the module.

Unable to Write to File

A general error in writing a trace file or a macro file appeared.

Try another file. If the error occurs again, try another diskette or contact the nearest Hewlett-Packard Service Office to check the hard disk.

WARNING: Front Connector May Be Damaged

The initial front connector check has shown that the connector's reflectance is higher than the stored threshold.

Check and clean the connector and the connector interface, or change the threshold to avoid further messages.

F.2 Remote Error Messages

-100	Command error
-101	Invalid character
-102	Syntax error
-103	Invalid separator
-104	Data type error
-105	GET not allowed
-108	Parameter not allowed
-109	Missing parameter
-112	Program mnemonic too long
-113	Undefined header
-120	Numeric data error
-121	Invalid character in number
-123	Exponent too large
-124	Too many digits
-128	Numeric data not allowed
-131	Invalid suffix
-134	Suffix too long
-138	Suffix not allowed

Appendix F. Error Codes

Remote Error Messages

-141	Invalid character data
-148	Character data not allowed
-150	String data error
-151	Invalid string data
-158	String data not allowed
-161	Invalid block data
-168	Block data not allowed
-170	Expression error
-171	Invalid expression
-178	Expression data not allowed
-181	Invalid outside macro definition
-183	Invalid inside macro definition
-200	Execution error
-222	Data out of range
-223	Too much data
-224	Illegal parameter value
-272	Macro execution error
-273	Illegal macro label
-276	Macro recursion error
-277	Macro redefinition not allowed
-278	Macro header not found

Appendix F. Error Codes

Remote Error Messages

-310	System error
-321	Out of memory
-400	Query error
-401	Measurement running!
-402	Parameter too long!
-403	Parameter too small!
-404	No permission for command!
-405	Interrupted by laser safety!
-406	Battery low!
-407	Printer out of paper!
-408	Printer door closed!
-409	General printer error!
-410	Event table not available!
-411	Trace data not available!
-412	File already exists!

Overview

Overview

G.1 Elementary Sample Sessions

Figure G-1 to Figure G-5 represent sample sessions for commonly used features.

The following conventions are used:

- Keys are written in boxed text. Hardkeys are in bold, softkeys in normal font.
Softkey options are listed at the right-hand side of the screen. If an option in a figure is unavailable, you should press the bottom softkey so that it reads `PARAMS` instead of `MENUS`.
- Menu items are in normal font without a box.
Menu items are selected by pressing the appropriate softkey, then using the modify knob to move to the appropriate option. When the correct item is highlighted, press the Modify knob.

Appendix G. Overview
Elementary Sample Sessions

- Other explanatory text is in italics.

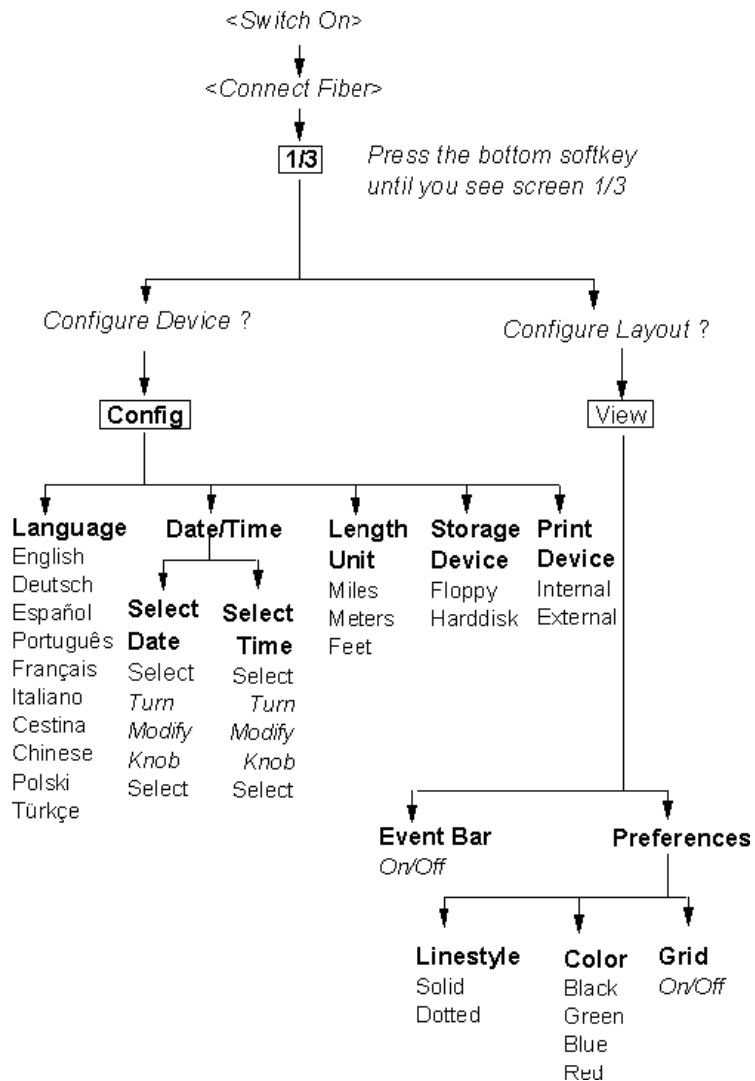


Figure G-1 **Configure the instrument**

Appendix G. Overview
Elementary Sample Sessions

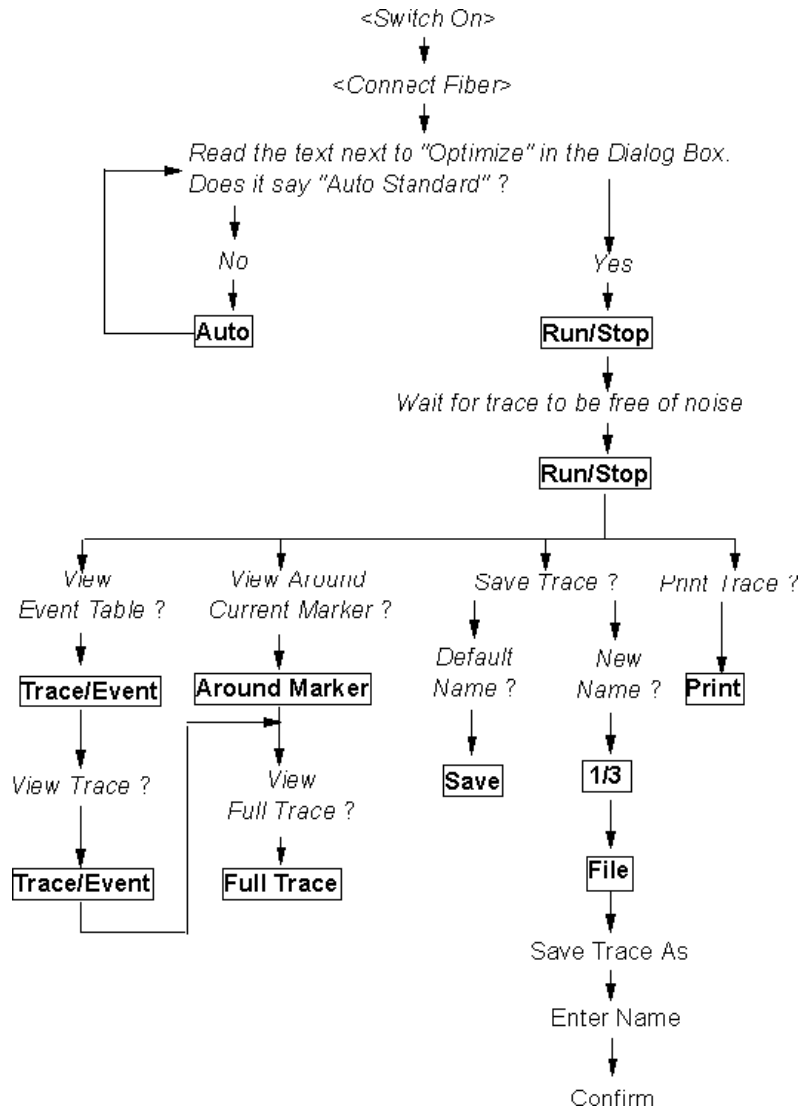


Figure G-2 View a Trace

Appendix G. Overview
Elementary Sample Sessions

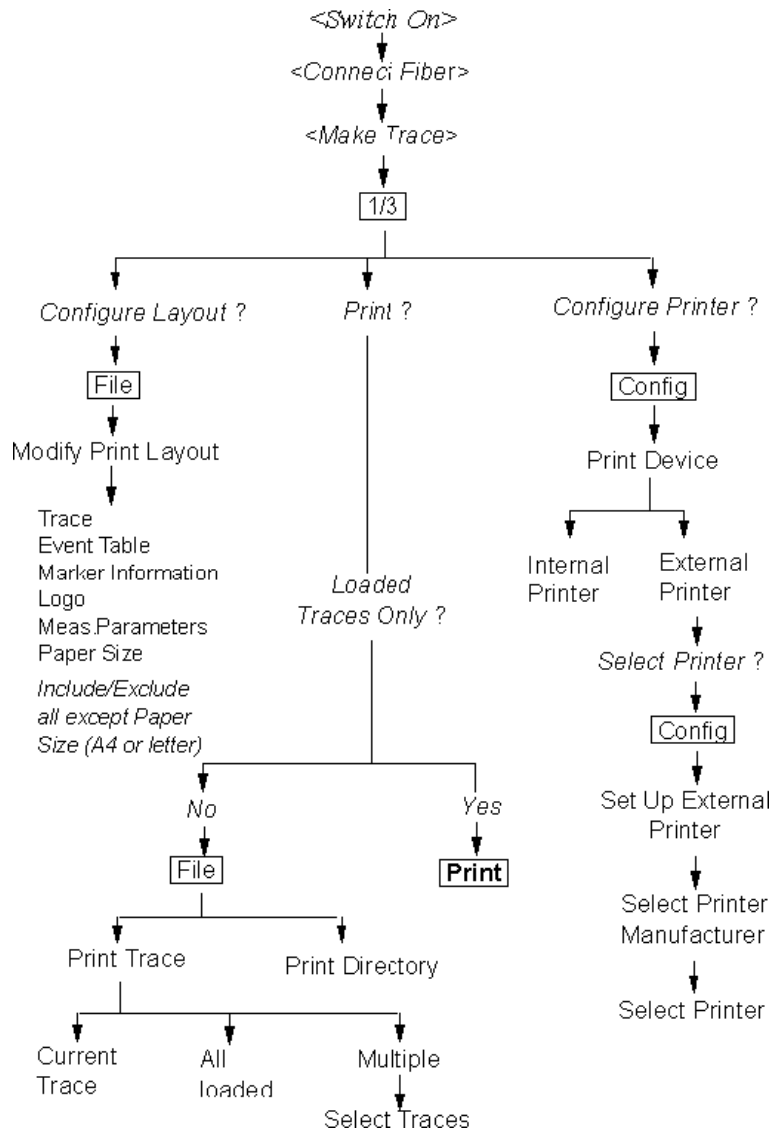


Figure G-3 Use the printer

Appendix G. Overview
Elementary Sample Sessions

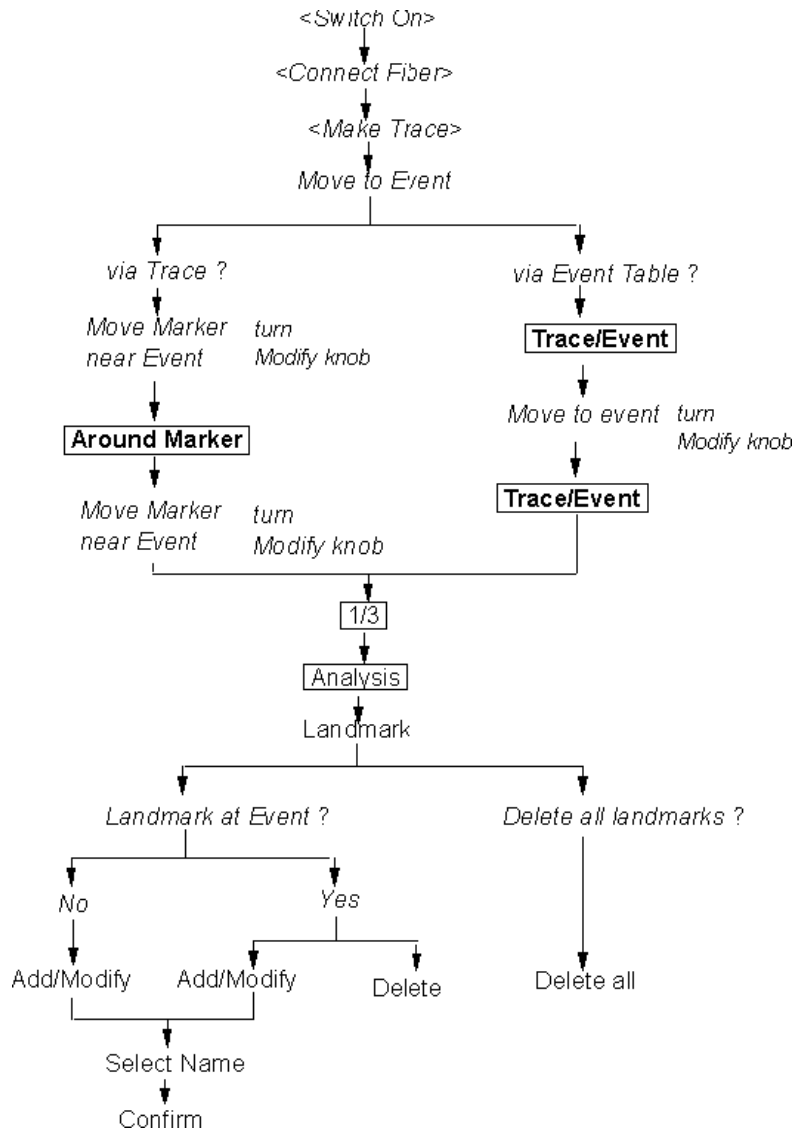


Figure G-4

Add/Delete Landmarks

Appendix G. Overview
Elementary Sample Sessions

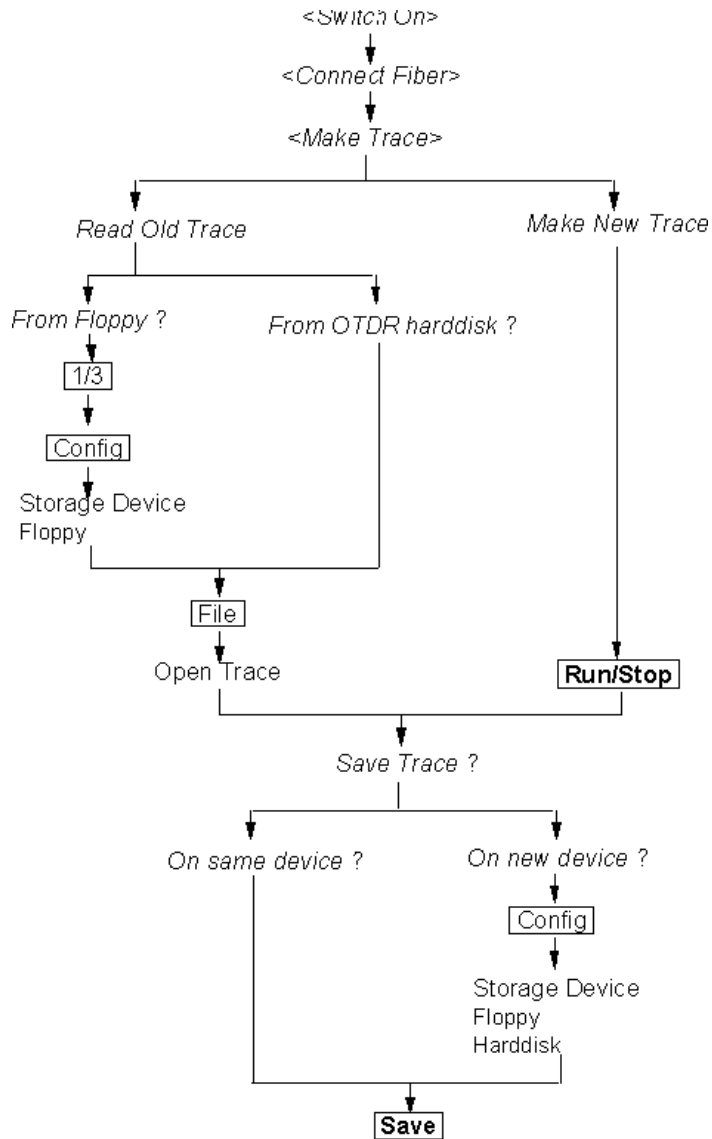


Figure G-5 Read from/Write to a Floppy Disk

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